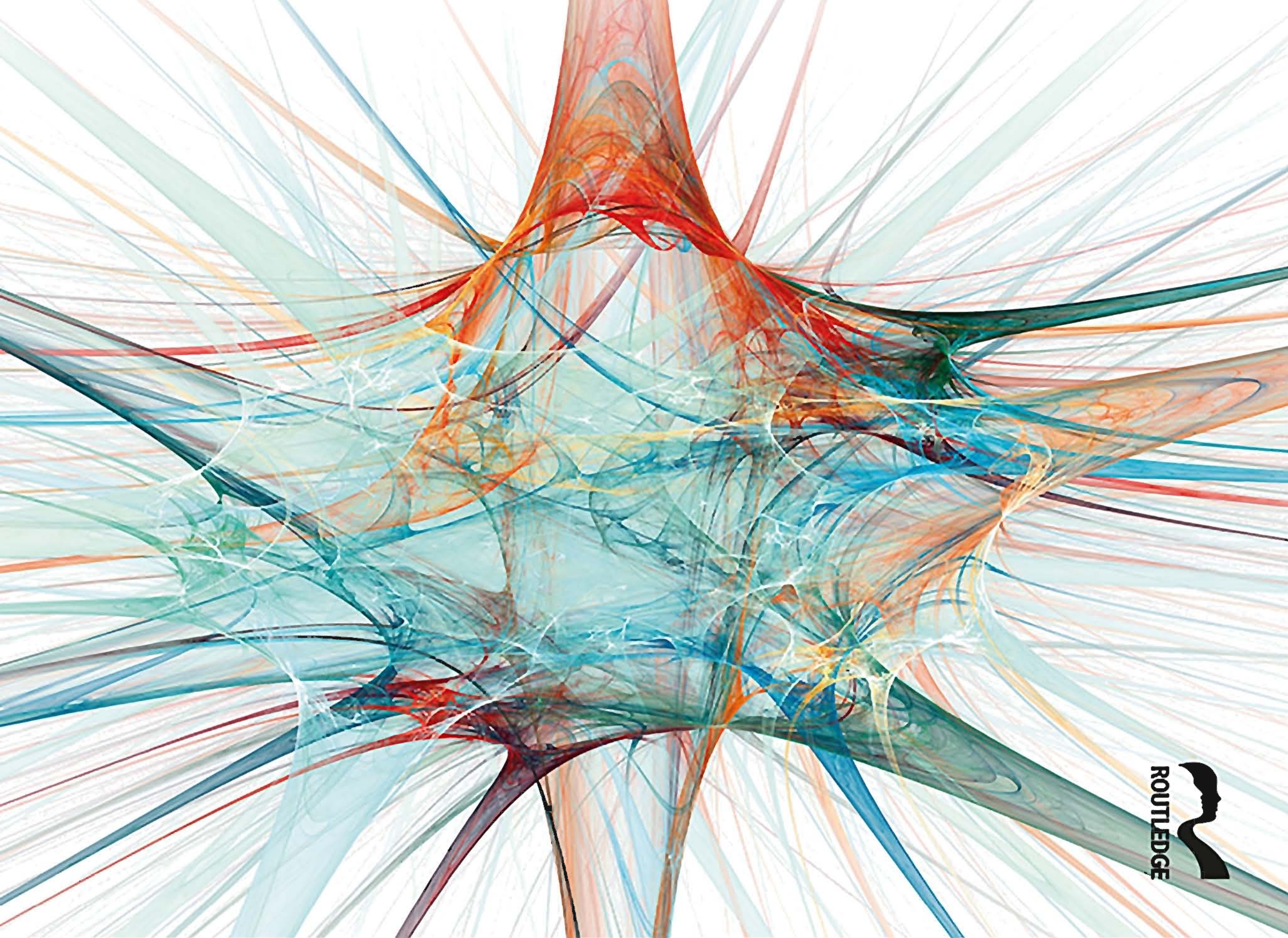
SECOND EDITION

BEHAVIOURAL ECONOMICS AND FINANCE

MICHELLE BADDELEY



Behavioural Economics and Finance

Behavioural economics and behavioural finance are rapidly expanding fields that are continually growing in prominence. While orthodox economic models are built upon restrictive and simplifying assumptions about rational choice and efficient markets, behavioural economics offers a robust alternative using insights and evidence that rest more easily with our understanding of how real people think, choose and decide. This insightful textbook introduces the key concepts from this rich, interdisciplinary approach to real-world decision-making.

This new edition of *Behavioural Economics and Finance* is a thorough extension of the first edition, including updates to the key chapters on prospect theory; heuristics and bias; time and planning; sociality and identity; bad habits; personality, moods and emotions; behavioural macroeconomics; and well-being and happiness. It also includes a number of new chapters dedicated to the themes of incentives and motivations, behavioural public policy and emotional trading. Using pedagogical features such as chapter summaries and revision questions to enhance reader engagement, this text successfully blends economic theories with cutting-edge multidisciplinary insights.

This second edition will be indispensable to anyone interested in how behavioural economics and finance can inform our understanding of consumers' and businesses' decisions and choices. It will appeal especially to undergraduate and graduate students but also to academic researchers, public policy-makers and anyone interested in deepening their understanding of how economics, psychology and sociology interact in driving our everyday decision-making.

Michelle Baddeley is a behavioural economist and applied economist based at the University of South Australia's Institute for Choice in Sydney. She is an Honorary Professor with University College London's Institute for Global Prosperity, Associate Researcher with the Cambridge Energy Policy Research Group and Associate Fellow with the Centre for Science and Policy, University of Cambridge. She has also worked with policy-makers across a diverse range of themes and her research brings economic insights from applied economics, behavioural economics, behavioural finance and neuroeconomics to multidisciplinary studies.

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Chapter 1

Introducing behavioural economics

What is behavioural economics?

With the award of the 2017 Nobel Prize in economics to behavioural economist Richard Thaler – one of the pioneers in developing behavioural public policy "nudging" – behavioural economics is very much in the news. There are, however, many misconceptions about behavioural economics, which raises the question: what is behavioural economics?

This is a question that many behavioural economists have worked on answering, for example see Hargreaves-Heap (2013) versus Thaler (2016) for some contrasting perspectives. To give a quick and simple answer: behavioural economics is a fascinating and fashionable subject, of increasing interest to policy-makers and business, as well as to a range of academic researchers and teachers. But, because it is such a broad field, it can be difficult precisely to define. Some would argue that all economics is behavioural economics because economics is about behaviour, albeit in a restricted context. Others would define behavioural economics very narrowly as the study of observed behaviour under controlled conditions, without inferring too much about the underlying, unobservable psychological processes that generate behaviour.

Overall, the clearest way to describe it is as a subject that brings together economic insights about preferences and decision-making with broader principles of behaviour from a range of other social, behavioural and biological sciences. In this, behavioural economics relaxes economists' standard assumptions to give models in which people decide quickly, often using simple rules of thumb rather than rigorously but robotically calculating the monetary benefits and costs of their decisions. Behavioural economics also explores how quick thinking leads people into systematic mistakes but also explains how people can learn from their mistakes. In behavioural economic models, people look to others when making decisions and when seeking happiness. Their decisions are affected by skills and personalities and also by moods and emotions. People aren't necessarily good at planning systematically for future events and particularly when immediate pleasures tap into emotional and visceral influences. This means that people will be susceptible to impulsive decision-making which may be detrimental to their long-term welfare, for example smoking and eating unhealthy food. So overall, behavioural economics develops more traditional economic models to explore in more depth and detail the balancing acts that we go through every day when we choose and decide. For the purposes of this book, behavioural economics will be defined broadly as the subject which attempts to enrich economic analyses of behavior – grounded as it is in theories about preferences, incentives, decision-making and strategy – with insights from psychology, sociology, cognitive neuroscience and evolutionary biology.

A quick history of behavioural economics

Whilst behavioural economics might seem like a relatively new sub-discipline of economics to some, in fact economists have been working on themes that we might today categorize as 'behavioural economics' for as long as economics has been around. Historically, economics had many links with psychology but as mathematical tools were used to simplify and structure economic theory, the subject moved away from psychological analysis. Also, with the increasing focus amongst economists on quantitative styles of decision-making, psychology's focus on subjective motivations did not rest easily with economists' focus on objective, analytical, mathematical methods of capturing economic decision-making via the observation of what people choose and decide. Economics went through something like a behavioural "dark age" – in which key insights from other social sciences were lost – until the major resurgence of behavioural and psychological economics in the 1980s and 1990s. In understanding why, it is useful to explore the historical development of behavioural economics and some of the behavioural approaches that preceded economics as we see it today – from David Hume in the 18th century through to Hyman Minsky in the 20th century. For a quick potted history see below, but more detailed accounts include Kao and Velupillai (2015) and Heukelom (2014).

David Hume (1711–1776)

Early analyses of economic psychology focused on the moral dimensions of decision-making. David Hume wrote with optimism of a society in which all people were benevolent:

> If every man had a tender regard for another … the jealousy of interest … could no longer have place; nor would there be any occasion for … distinctions and limits of property and possession … Encrease to a sufficient degree the benevolence of men … and you render justice useless … 'tis only from selfishness and the confin'd generosity of men … that justice derives its origin.
>
> (Hume 1739, pp. 547–8)

The role of the market in solving economic problems might be more complex than Hume suggests but the psychological forces of benevolence and philanthropy can be justified if there are market failures such as externalities and free-rider problems. Benevolence does imply some sort of interdependence amongst people's utility and this is something that standard economic analyses of independent, atomistic agents cannot capture but it is a theme that has received a lot of attention in modern behavioural economics.

Adam Smith (1723–1790)

Adam Smith is widely attributed with founding the subject of economics (not entirely accurately) and he too was interested in the social and psychological dimensions of behaviour, even if his interests in these areas are not apparent in the caricatures of his thinking. Whilst his name is popularly associated with his rhetorical justification of free markets and the accompanying metaphor of the Invisible Hand of the price mechanism coordinating individual behaviour in socially beneficial directions, as described in *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776), Adam Smith also thought carefully about socio-psychological motivations. One key theme in his writings is the impact that social emotions have on our choices – foreshadowing a number of areas in modern behavioural economics, particularly models of social influence. In *The Theory of Moral Sentiments* (1759) he emphasizes the importance of imaginative sympathy in human nature: "How selfish soever man may be supposed, there are evidently some principles in his nature, which interest him in the fortune of others, and render their happiness necessary to him" (Smith 1759, p. 9).

Adam Smith foreshadowed the importance of sentiment in modern behavioural economics, with his emphasis on social, unsocial and selfish passions – focusing on the importance of vividness in events in determining how strongly we respond to them. Linking with modern analyses of bad habits and inconsistent plans he analyses self-deceit and the impact of customs and fashions – which are also the focus in modern behavioural economics analyses of social influences and group bias. Vernon L Smith (1998) notes that whilst on first inspection there may seem to be a contradiction between Adam Smith's *Wealth of Nations*, emphasizing self-interest, and *The Theory of Moral Sentiments*, emphasizing sympathy – in fact these concepts can be reconciled if cooperation and noncooperation can both be understood in terms of a "self-interested propensity for exchange" in friendships as well as markets.

Jeremy Bentham (1748–1832)

Most famously, Jeremy Bentham was the founder of utilitarianism. He analysed a range of behavioural and psychological drivers of human action, especially the impacts of pleasures and pains. His conceptions of utility were focused on the balance of pain and pleasure and formed the basis for the emphasis on utility in modern economic theory. If welfare, utility and happiness are quantifiable, then right and wrong can be measured by reference to the greatest happiness principle: the greatest happiness for the greatest number. This principle has flaws in that it assumes happiness to be objectively quantifiable and easily aggregated, implying that people's utilities are separable. One focus in behavioural economics is on unravelling what happens when utilities are not easily separable.

A second Benthamite principle – of psychological hedonism – was conceived as a guide for legislators, focusing on the assumption that people maximize their own self-interest. For Bentham, pain and pleasure are the "sovereign masters" motivating what we do (Harrison 1997). Something is good if the pleasure outweighs the pain; it is evil if the pain outweighs the pleasure. Legislators can formulate rewards and punishments to exploit this psychological hedonism principle and thereby promote the greatest happiness principle (Harrison 1997). Bentham emphasized the quantification of happiness and developed a hedonic calculus – a detailed taxonomy ranking key features of pleasures and pains. Bentham's emphasis on happiness has its parallels in today's happiness and well-being literatures.

Vilfredo Pareto (1848–1923)

Vilfredo Pareto is probably best known by economists for his mathematical rigour, his concept of Pareto efficiency and his influence in general equilibrium theory. Less well known is that he developed an interest in social psychology later in his career. He spent time specifying the nature of social relationships, foreshadowing modern behavioural analyses of social influence. In *Trattato di sociologia generale* (1916; translated to "The Mind and Society" in 1935), Pareto explored a range of behavioural/psychological influences and divergences between logical and non-logical conduct, focusing on feeling, residues (instincts) divided up into classes to explain individual differences and derivations (logical justifications) – paralleling the dual processing models seen in modern behavioural economics. He also recognized the importance of diversity in skills: in describing cyclical sociological forces, he explores how intergroup conflicts mirror a struggle between foxes and lions, adopting Machiavelli's distinction between cunning foxes and courageous lions. This links to the idea in modern behavioural economics that there are differences amongst people – a challenge to the conventional economist's assumption of homogeneity – that is that all people behave in the same way, on average at least.

Irving Fisher (1867–1947)

Irving Fisher is renowned for his early analyses of investment and interest rates and the balance between impatience to spend and opportunities to invest. He sets out the impatience principle in which the *rate of time preference*, what modern economists call the *discount rate*, captures the fact that interest is the reward for postponing consumption. These ideas about balancing present versus future pleasures and rewards form the bedrock of modern analyses of inter-temporal decision-making (Fisher 1930, Baddeley 2003). However, Fisher's analysis of this principle suggests subjective, psychological motivations are driving choices. The "inner impatience" of consumers is balanced against "outer opportunities" for rewards from interest. Thaler (1997) emphasizes Fisher's focus on "personal factors" as determinants of time preference. Fisher presciently explores the idea that time preference is affected by individual differences in foresight, self-control and willpower, and factors reflecting social susceptibility to fashions and fads – all ideas developed in modern behavioural economics. Thaler also argues that Fisher's analysis of money illusion is another illustration of a way in which Fisher foreshadowed modern behavioural economics because it is a form of bias consistent in the analyses of Kahneman, Tversky and others. Fisher's explains sluggishness in the adjustment of nominal interest rates in terms of people's confusion about the difference between real and nominal values. This also links with Akerlof and Shiller's (2009) identification of money illusion as one of the animal spirits constraining rational decision-making, as we will explore in Part III of this book.

John Maynard Keynes (1883–1946)

John Maynard Keynes was one of the 20th century's great thinkers about economics – and he made key contributions to economic policy too – especially in the sphere of macroeconomics. The economists we have met so far focused mainly on the microeconomics of behaviour – how individual "agents" – people and businesses – make their decisions. When it comes to macroeconomics, capturing psychological and social influences on economic behaviour is much more complex – but these are themes that John Maynard Keynes was keen to explore. He focused on some key psychological drivers of behaviour and in *The General Theory of Employment, Interest and Money*, Keynes argues that economic and financial decision-making is driven by a series of fundamental psychological laws: the propensity to consume, attitudes to liquidity and expectations of returns from investment. Keynes applies his psychological analysis most clearly when analysing the interactions between the players in financial markets and the macro economy. Short-termist speculators, preoccupied by a thirst for liquidity, are driven by social influences and conventions to "beat the gun" and "outwit the crowd". Thus, speculation becomes similar to parlour games such as Snap, Old Maid and Musical Chairs – in all these games, the winner is the person who says "Snap" just in time – neither too early nor too late.

Like Adam Smith, Keynes also strongly emphasized the role of emotion and sentiment in economic decision-making. In a world of fundamental uncertainty, judgments will rest on flimsy foundations, introducing fragility into macroeconomic and financial systems. Keynes argues that whilst a social view of economic progress requires a long-term view, longer-term outlooks cannot rest on strictly rational grounds because in a world of uncertainty it is rational for profit-seekers to focus on the short term. Paradoxically, it is the emotionally-based animal spirits of entrepreneurs that propel the far-sighted behaviours necessary to justify sufficient capital accumulation for sustained economic growth (Keynes 1936, pp. 161–2) – as we will explore in more detail in later chapters of this book.

For Keynes, economic behaviour is the outcome of a complex mixture of the rational and psychological/emotional. This fits with modern neuroeconomic models in which behaviour is the outcome of a complex interaction of emotion and cognition. There are further parallels: Keynes's ideas about herding, reputation and beauty contests are resurfacing in modern models of behavioural economics including literatures on herding, social learning, reputation, beauty contests and animal spirits; for examples, see Bhatt and Camerer (2005), Camerer (1997, 2003b) and Ho, Camerer and Weigelt (1998) on beauty contests, learning and reputations. Keynes's dual focus on reason and emotion also foreshadows the focus in neuroeconomics on interacting systems in the brain, for example Loewenstein and O'Donoghue (2004) assert that animal spirits are a reflection of the interaction of deliberative and affective systems.

Joseph Schumpeter (1883–1950)

Joseph Schumpeter was born in the same year as Keynes and his analyses of macroeconomic influences rivalled Keynes's contributions – but he had a different conception of the drivers of macroeconomic fluctuations, focusing particularly on entrepreneurs as the heroes of the capitalist system.

Foreshadowing the modern emphasis in behavioural economics on the importance of social influences in driving corporate behaviour – for example, via corporate social responsibility initiatives. Schumpeter focused on the idea that entrepreneurship is driven by social forces but nonetheless is essential to the success of a capitalist economy. Social influences drive not only the outward-facing publicity initiatives of businesses, they also lead businesses to copy each other.

In Schumpeter's analyses, an innovative entrepreneur will bring a new idea to the marketplace and this will attract hordes of imitators – or "imitative swarms" – each seeking to emulate industry leaders. But as each new imitator joins an industry, the opportunities for new profits from new opportunities will reduce as the swarm of imitators grows too large. In this way the business cycle is driven by socio-psychological influences. At the time he was writing, Schumpeter's insights were groundbreaking but have only recently found their way into modern behavioural analyses of business behaviour.

Friedrich von Hayek (1899–1992)

One of Keynes's intellectual adversaries was Hayek but Hayek too had a keen interest in the psychological and behavioural motivations underlying decision-making. In *The Sensory Order* (1952) Hayek analyses the nature of mind and distinguishes two "orders" via which we classify objects into the phenomenal and physical: the subjective, sensory, perceptual order versus the objective, scientific order – what von Hayek referred to as the "geographical" order.

This division mirrors the focus in modern behavioural economics and neuroeconomics on interacting neural systems, for example Kahneman's (2003) separation of an intuitive System 1 from a reasoning System 2 in maps of bounded rationality. Hayek (1952) also analyses in detail the processing of stimuli and the biological aspects and characteristics of the nervous system to construct a theory of mind in which the mental order mirrors the physical order of events seen in the world around us. His assessment of modern behavioural economics would probably be damning however because he concludes that "human decisions must always appear as the result of the whole of human personality – that means the whole of a person's mind – which, as we have seen, we cannot reduce to something else" (Hayek 1952, p. 193).

George Katona (1901–1981)

George Katona's early work on economic psychology inspired some economists to return to psychological analysis. Katona (1951, 1975) uses ideas from cognitive psychology to analyse how individuals learn from groups; he distinguishes between different forms of learning, for example between the mechanical forms of learning such as the "stamping-in" of simple rules of thumb and heuristics versus learning via problem-solving and understanding (Katona 1975, p. 47). Behaviour is not about understanding deeper processes and direct experience of problems but instead is about relying on simple observation of others to acquire information.

Developing socio-psychological themes, Katona argues that group forces and group motives are important, reflecting not only imitation and conscious identification with a group but also group-centred goals and behaviour. Imitation and suggestion reinforce group situations and group coherence but are not necessary conditions for being part of a group. Reference groups provide standards for behaviour and group-centred belonging and motivation are more likely to be important in small groups. Katona (1975) argued that people prefer shortcuts and follow simplifying rules of thumb and routines, foreshadowing the "fast and frugal heuristics" analysed by Gigerenzer and Goldstein (1996) and others, as explored in Chapter 3. Individual differences of opinion are ignored and similarities in small parts of information are transmitted to large numbers of people. Socio-cultural norms, attitudes, habits, and group membership will all influence decisions. Discussion of beliefs with friends and associates will mean that the groups to which a listener belongs determine the information selected. Social learning will continue until the majority has a uniform belief system (Katona 1975).

Hyman Minsky (1919–1996)

Hyman Minsky was one of the pioneers in extending Keynes's insights about socio-psychological forces in the macroeconomy specifically into the impact of these influences on the financial system. His ideas have become much more popular in the aftermath of the 2007/8 sub-prime mortgage crisis and the subsequent global financial crises and recession because he outlines a powerful intuitive account of what might have contributed to this instability, and particularly the role played by emotions and self-fulfilling prophecies – key elements in his "financial fragility hypothesis".

Minsky's financial fragility hypothesis is about how emotional influences destabilize financial structure. He argued that boom phases are characterized by excessive optimism – leading to over-lending and over-investment – creating pressure on financial systems and the macroeconomy. A tipping point is reached when entrepreneurs, investors and financiers start to realise that their optimism is misplaced and the euphoria of the boom phase is replaced by pessimism and fear. Interest rates rise, debt burdens become unsustainable, banks withdraw finance, businesses tip into default – with impacts spreading to the "real" economy – that is, to employment and production. In this way, emotions feed the cycle and contribute to financial fragility – within economies and the global financial system more generally too, as we shall explore in more detail in Parts II and III of this book.

Behavioural economics: what's new?

Now that we have explored some of the history of behavoural economic thought, we can turn to modern economics to explore how and why behavioural economics is different from standard approaches – specifically the dominant approach associated with neoclassical economics – which focuses on the role played by rational agents in market economies. Neo-classical economics is sometimes notorious for its focus on unrealistic behavioural assumptions about humans' capacity for rationality. This translates into theories that are founded on mathematical principles – reinforcing the idea that economics treats people as if they are mathematical machines. Nonetheless, economic theory has the distinct advantage that it is analytical and relatively objective. The power of behavioural economics comes in combining more realistic behavioural assumptions – which we shall introduce in this book – with some of the analytical rigour of economic theory. Many would envisage behavioural economics and neuroeconomics as providing conceptual alternatives to standard neoclassical models which focus on a conception of people as *Homo economicus* – people are assumed to be clever and well-informed, decision-making is rational and systematic; and economic actions are described as the outcome of mechanical data processing. A lot has been done to soften the standard approach, especially in microeconomic analysis, for example by recognizing the nature and implications of asymmetric information and other forms of market failure, and by introducing Bayesian models to replace models of rationality based on perfect information. These extensions can explain non-maximizing behaviour by allowing it to be constrained by uncertainty and/or affected by strategic interactions between people and firms. Behavioural economics is another way to illuminate some of the deeper foundations of sub-optimal behaviour.

The degree of divergence between behavioural economic models and standard neoclassical models does vary across behavioural economics. Some would see behavioural economics as basically consistent with standard neoclassical approaches, with some extra psychological variables embedded, for example into utility functions, to increase realism, though at some cost in terms of tractability. For example, Camerer, Loewenstein and Rabin (2004) argue that behavioural economics

> increases the explanatory power of economics by providing it with more realistic psychological foundations … [This] does not imply a wholesale rejection of the neoclassical approach … [which] provides economists with a theoretical framework that can be applied to almost any form of economic (and even noneconomic) behavior.
>
> (Camerer, Loewenstein and Rabin 2004, p. 3).

A further complexity is that behavioural economics does draw on insights from many of the other "tribes" of economic theorists: not all "non-behavioural" economists are neoclassical economists and there are some particularly strong parallels between behavioural economics and evolutionary economics, social economics, institutional economics and heterodox economics. In drawing on insights beyond neoclassical economics, other behavioural economists take a more radical approach and would argue that the foundations of neoclassical economics are badly flawed and need to be replaced with a more fundamentally psychological approach to analysing economic decision-making. Earl (2005) sets out some axiomatic foundations for psychological economics but emphasizes that these can be expressed "permissively" as tendencies describing what people often do, rather than as "non-negotiable axioms". Choices will be fickle, susceptible to random influences and context, for example with fashions and fads. Consumer and workplace behaviours may be pathological to some degree, including dysfunctional strategic decision-making and extreme behaviour including impulsive spending or obsessive-compulsive behaviour. Some may exhibit these behaviours to a large degree; others in a minor way but it will mean that our economic decisions will be affected by irrational obsessions and aversions.

Earl's axiomatic foundations of psychological economics emphasize the importance of perception and context; the social nature of behaviour; the impacts of non-economic variables; and the importance of bounded rationality – specifically when information is too complex for human cognition. Earl's foundations also include Herbert Simon's concept of 'satisficing' (that is, finding a satisfactory solution even if it's not the best solution); attention biases occurring when attention is not allocated optimally leading to inconsistencies; and heuristics and biases shaping perceptions and judgments. The latter will include temporal biases, for example as seen in models of hyperbolic and quasi-hyperbolic discounting; emotions; impacts of context on decision rules; limited learning constrained by people's preconceptions about the world. In addition, he includes pathological behaviours, for example impulsive spending; impacts on choices of personalities and attitudes, as well as simple preferences; and altruistic choices (Earl 2005).

Axiomatic foundations unify economics and psychology in psychological economics but Earl argues that economic psychology and psychological economics are different too: the former involves economists taking subjects traditionally in the psychologists' preserve such as addiction and altruism, and analysing them using economic models and concepts.

Psychological economics comes from the other direction and involves challenging standard economic models by embedding insights from psychology to enhance understanding of economic decision-making, for example Frey's (1997) broad study of motivation (Earl 2005).

Key insights from psychology

In taking on the essential assumptions of neoclassical economics, behavioural economists populate their models with people who are far more susceptible to social and psychological influences than *Homo economicus*. On this point, it is important to note that behavioural economics is not one coherent and self-contained subject – there is a spectrum of approaches to behavioural economics, reflecting the extent to which key insights from psychology, sociology, neuroscience and evolutionary biology are brought into the frame. Some behavioural economists develop models in which the neoclassical model is "tweaked" with some socio-psychological insights – such as that people are not always selfish. Other behavoural economists focus much more strongly on the role of personality, emotions and psychological biases in economic and financial decision-making. Whilst this book takes a broad view of which psychological insights are most relevant and interesting, nonetheless it is important to recognize that behavioural economics, economic psychology and psychological economics are not necessarily the same thing. There are many parallels between them but subtle differences too. Some behavioural economists are interested only in observable and measurable impacts on behaviour and preferences and are less interested in the underlying psychological processes. They would argue that these underlying variables are not easily measurable and so cannot form the basis of an objective science.

How do behavioural economists bring psychology into their models? This is a difficult question to answer quickly because psychology encompasses such a large range of ideas and sub-disciplines and such a large number of tools and techniques.

The incorporation of psychology into economics is controversial. For some economists, embedding a deeper understanding of what motivates choices and decisions is an anathema because, for example, in positivist, neoclassical approaches, the focus is on objectively measurable data such as observed choices. Earl (2005) observes that such criticisms may reflect the fact that psychology as a discipline lacks a grand unifying theory. There are many different psychological approaches but fragmentation within psychology not only discourages economists from making an investment in understanding psychological theories; it also encourages a piecemeal, ad hoc approach to embedding psychological insights into economics (Earl 2005). This selective use of psychological insights in behavioural economics may undermine its credibility for some.

Behavioural psychology has had a profound influence on modern behavioural economics and helps to explain the distinction between it and economic psychology. In contrast to economic psychology, the areas of behavioural economics that are closest to mainstream economic theory adopt the methodology of behavioural psychology by focusing on observed choices and revealed preferences using experimental methods and abstracting from cognitive and emotional processes underlying decision-making. It could be argued that this approach has in some ways been made obsolete by technology: as the sophistication and precision of neuroscientific tools and techniques has increased, the objective information available to a scientist is no longer confined to studying what people actually do (or don't do) because it is now possible objectively to measure the physiological responses underlying observed action. However, as for psychology more generally, the early development of new neuroscientific tools has led to the evolution of neuroeconomic analyses – observable data is no longer confined to what people do; we can also measure what is going on in their brains and nervous systems whilst they do it, as the neuroeconomic studies explored in this book will show.

Behavioural tools and methods

Now that we have outlined some of the key insights that behavioural economists take from economics and psychology, we can see how they also combine different methods from economics and psychology – including economists' traditional econometric and modelling tools, alongside methods from game theory – and also experimental approaches from psychology. All these sub-disciplines already have their own large and rich literatures and there is not the space to explore them in detail in this book alongside the enormous behavioural economics literature but a quick summary is given below, alongside some reading recommendations in Further Reading.

Game theory

Many areas of behavioural economics focus on strategic interactions between people and standard game theoretic tools are used as a starting point in these analyses. Putting game theory together with behavioural insights produces the large, diverse field known as behavioural game theory, surveyed comprehensively by Camerer (2003b) and partly covered here in the chapters on learning (Chapter 5) and sociality (Chapter 6). In explaining behavioural game theory, Camerer makes a distinction between games, which are strategic situations, and game theory – which gives explanations for choices. In standard game theory, there is a divorce of theory and evidence and limited empirical evidence. Camerer (2003) cites von Neumann and Morgenstern (1944): "the empirical background of economic science is definitely inadequate. Our knowledge of the relevant facts of economics is incomparably smaller than that commanded in physics at the time when mathematicisation of that subject was achieved". Camerer suggests that this gap between theory and evidence seen in standard game theoretic approaches can be remedied to an extent by the inclusion of experimental techniques. This can be achieved by starting with classical game theory – including games that incorporate private information alongside probabilistic information about others' preferences and/or types.

Behavioural game theory can be used to test the standard economists' hypotheses by adapting classical game theory (in which people are assumed to be self-interested maximizers, engaging strategically) to allow for additional behavioural forces, for example limits to strategic thinking, and attitudes towards others' payoffs and learning. If it leads to rejections of predictions of classical game theory, evidence from behavioural game theory can be interpreted in a number of ways, particularly as much of it is based on experimental evidence: violations could reflect irrationality or weaker versions of rationality (e.g. as explored by Herbert Simon in his analyses of bounded and procedural rationality); "other-regarding" preferences (e.g. for reciprocity, equity, etc.); strategic thinking and/or reputation building.

For the purposes of this book, the reader is assumed to have a basic working knowledge of game theory and its key concepts including Nash equilibrium, mixed strategy equilibrium, reaction functions and backward induction. For the learning chapter in particular, it will be useful to know some classic games from standard introductory economics, for example the prisoner's dilemma, battle of the sexes, buyer-seller and stag-hunt games. For those who would like to learn more about game theory to enhance their understanding of related areas of behavioural economics, some good introductions are listed in the Further Reading section.

Experimental economics

Empirical testing of behavioural economics models uses a range of data and some data is similar to data used in standard economic analysis. In terms of the methodological tools used by behavioural economists, there have been some innovations and data-based statistical and econometric analyses are increasingly being supplemented by experimental evidence. In fact, some areas of behavioural economics have emerged from experimental economics. Behavioural models can explain experimental results that, for one reason or another (and there is plenty of controversy about the reasons), do not fit with simple predictions from standard theory.

Vernon L. Smith pioneered the use of experiments in economics and initially used market experiments as a pedagogical device in his principles of economics lectures (Smith 2003a). Experimental methods can be integral to behavioural economics because they enable close observation of actual choices under carefully controlled conditions, thus allowing the experimenter to abstract from ordinary complicating factors. If properly constructed, experiments can allow us properly to control conditions so as to capture the real drivers of behaviour.

The main advantage of an experimental approach is it gives us new types of data to illuminate economic decision-making that will, in some circumstances, be better than the "happenstance" data of conventional economics/econometrics. Experimental methods are also used in neuroeconomic studies particularly when the tight analytical structure of game theoretic methods can be used to complement a wide range of neuroscientific techniques (to be explored in more detail in Chapters 11 and 12). This enables the construction of neuroeconomic experiments that can be conducted quickly, efficiently and neatly to test neuroeconomic hypotheses clearly.

Experimental investigations can however be fraught with problems, as explored by Smith (1994), Binmore (1999) and others. Experimental designs must be "clean" with proper controls, clear and simple instructions and clear incentives. Results in experimental context can be conflated with impacts from methodological variables (e.g. repetition, anonymity); demographic factors (gender, age, socioeconomic group, etc.); cultural factors; game structure and/or labelling and context. Designing a clean, uncomplicated experiment is not easy to achieve and needs a lot of careful thought.

One aspect of experimental design that attracts strong views from economists is the issue of deception. Is it a methodological problem? In principle, incorporating deception into experiments conflicts with the focus in experimental economics on truthfulness as an essential element in "clean" experiments. On the other hand, particularly in neuroeconomic experiments where the experimental environment necessarily is highly constrained, it is often impossible to avoid some limited deception. Sanfey *et al.*'s (2003) fMRI study of social emotions (explored in Chapter 8) used a contrived offer algorithm in which the experimental subjects were told that they were responding to decisions from real people when in fact they were responding to offers generated by the experimenters. Sanfey *et al.* argued that their deception was necessary, given the "heavy logistic demands" of fMRI studies and did not affect/confound the interpretation of results. The use of limited deception, and only where essential, is increasing in neuroeconomic studies, especially imaging studies, because the experimental context is so restricted by technical, logistical and financial considerations. Psychologists sometimes have a more flexible attitude to deception and will incorporate carefully constrained deception when necessary. It is possible that the issue of deception in experiments is a question of experimental norms rather than objective limitations from deception.

In addition to the challenge of designing a clean experiment, it is also important to recognize the limitations of experimental evidence. These limitations are likely to be less for natural and field experiments where researchers are observing real behavior in which real choices drive real-world consequences for the people being studied. DellaVigna and Malmendier's (2004) study of gym membership, explored in Chapter 10, is an example of a natural experiment. Aside from these types of natural/field experiments, results from experiments may suffer from hypothetical bias – experimental subjects may behave in a very different way when they know that they are not making a real-world decision. Results may have limited external validity and may not be generalizable to the world outside the lab. This may reflect the selection of experimental subjects, especially as experimental subjects are often university students whose behaviour may not represent the behaviour of people outside an academic environment, such as a university. Results from behavioural experiments have been generalized mainly by increasing the size of payoffs. Richer, more sophisticated, experiments do need to be designed if insights from behavioural experiments are to be applied more widely. Some experiments do have inherent external validity, including natural experiments in which people's ordinary behaviour is already controlled by the situation in which they find themselves. In natural experiments, the experimenter is not interfering and distorting decisions.

Field experiments are used frequently in behavioural development economics – often via the adoption of randomized controlled trials incorporating techniques developed for medical/pharmaceutical testing. Randomised controlled trials are used to capture the impact of different "treatments" or policy interventions. They are constructed by randomly selecting some groups for an intervention. Other groups are used as control groups. Comparing the behaviour of treatment groups and control groups enables quantification of treatment effects. There are potential ethical problems with randomized controlled trials because some groups get access to potential beneficial interventions whilst others do not. This issue is addressed in medical trials by abandoning the random allocation of people into treatment groups versus control groups as soon as strongly significant impacts from interventions are identified.

Experimental economics is also limited by problems with experimental incentive structures. In real-world situations people face complex but often very salient incentives and it can be hard for an experimenter to identify meaningful incentive structures, particularly if subjects initially motivated by intellectual curiosity, for example, are then distracted and de-motivated by (perhaps insultingly) small experimental payments. Gneezy and Rustichini (2000a, 2000b) have explored this problem in arguing that extrinsic motivations such as money and other concrete rewards crowd out intrinsic motivations, including intellectual curiosity and a desire to be helpful. De-motivated experimental subjects can distort experimental results.

The behavioural economics literature on its own is vast and so there is not the space for a detailed account of experimental economics too. There are however already a few comprehensive accounts of experimental economics and for those interested to find out more, some readings are suggested in Further Reading.

The structure of *Behavioural Economics and Finance*

Behavioural Economics and Finance provides a broad introduction to key debates and a range of behavioural principles will be explored. The literature is already enormous and is growing rapidly so it would be impossible to cover in one book all the interesting things that behavioural economists are doing. So, the following chapters focus on aspects of behavioural economics and finance that are relatively well-established and/or have received a lot of attention. This book is sub-divided into three key sections. In the first section, we will explore a range of insights that offer behavioural alternatives to the microeconomic principles usually embraced by economists – focusing on different behavioural approaches to motivations and incentives; heuristics and bias; behavioural theories of risk, including prospect theory and its alternatives; learning; and inconsistencies in the way that people deal with time ("time inconsistency") and addictive behaviour. Cognitive neuroscience is bringing additional innovative insights and tools that are transforming behavioural economic analysis and so the Microeconomic Principles section will include two chapters dedicated to theoretical insights and empirical tools from neuroeconomics – an exciting new sub-discipline which combines economic theory with cutting-edge neuroscientific tools to unravel the economic, psychological and social influences on our economic decision-making.

The second section, focuses specifically on behavioural finance – starting with an outline of some key principles from behavioural finance and in particular a number of behavioural anomalies that Nobel Prize-winner Richard Thaler and others have identified specifically in the context of financial decision-making. This section will also explore how behavioural economic theory can be applied specifically in the context of corporate finance and investment. The other behavioural finance chapters will explore how personality and emotions drive financial trading and speculation, how these factors contribute to financial instability and – to complement the chapters on neuroeconomics – how neuroscientific tools have been used specifically to test a range of assumptions about socio-psychological influences on financial decision-making, as explored in the sub-discipline of neurofinance.

The third and final section of the book will look at behavioural influences from broader perspectives and will include chapters on behavioural macroeconomics, happiness and well-being, and behavioural public policy.

A note on mathematics

Mathematical exposition characterizes modern economics and this is not necessarily a bad thing if mathematical and intuitive explanations complement each other. Sometimes it is easier to explain things using simple equations than dense text, and many behavioural economists have set their models out using some (often quite straightforward) mathematics. Other times it is more meaningful to express things in words than in equations – especially as the human brain is not always well built to process mathematical analysis.

Given the wide range of attitudes towards mathematical analysis, in the interests of presenting the material in a way which is engaging to as many readers as possible, the main text is written in non-mathematical language. Where it is relevant and to cater for those who prefer the simplicity of mathematical analysis, the essential principles and models are separated into chapter Appendices. The essential intuition of all models will be covered in the main text of each chapter and so readers can ignore the mathematical translations if they prefer.

Chapter summary

- Behavioural economics is a wide discipline that draws on a range of other subjects from the social and natural sciences – including psychology, sociology, neuroscience and evolutionary biology.
- Whilst it has only recently developed a critical mass within economic theory and public policy-making, behavioural economics draws on long traditions in economics – from Adam Smith and Jeremy Bentham through to John Maynard Keynes, George Katona and Hyman Minsky.
- Behavioural economists rethink what economists usually assume about behaviour – not by assuming that behaviour is irrational, but by providing a more realistic analysis of how real people decide and choose, replacing the models associated with modern mainstream economics, which assume that people decide as if they are mathematical maximizers.
- Behavioural economics draws on a wide range of insights from economics more generally – including ideas about strategic decision-making from game theory, insights from theories of learning and some themes from information economics and labour economics.

Revision questions

1. How does behavioural economics differ from other areas of economics? How is it similar?
2. How do behavioural economists' descriptions of how people choose and decide differ from the descriptions of behaviour highlighted in mainstream economics?
3. From the different economists introduced in this chapter, who do you think has had the most influence on modern behavioural economics and why?
4. Can insights from behavioural economics help ordinary people to decide and choose more effectively in their everyday decision-making? If so, how and why? Illustrate with examples.

Further reading

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Part I

Microeconomic principles

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Chapter 2

Motivations and incentives

In mainstream economics, what is often loosely described as neoclassical economics, economic agents are assumed to be driven by purely economic and monetary motivations. A large section of behavioural economics takes on the assumptions associated with this mainstream model to explore other drivers of our everyday choices and decisions. In this chapter, we will explore some of these non-monetary motivations, and the models and empirical techniques that behavioural economists use to capture them. In understanding what drives the wider range of incentives and motivations that behavioural economists explore, it is important to understand well some of the assumptions and microeconomic principles from neoclassical models because these models focus strongly on the idea that rational "agents" respond perfectly to incentives. We shall begin this chapter exploring the approach to analysing incentives that is conventionally adopted by non-behavioural economists.

Incentives in neoclassical economics

In explaining how incentives drive agents' choices, neoclassical economists make assumptions to construct an artificial model of human decision-making. It is useful in understanding this artificial model to imagine that economies operate as if they are populated by a specific type of artificially conceived species: *Homo economicus*. *Homo economicus* is assumed to have an exceptional capacity for information processing and decision-making. In this model, people are assumed to be:

a. Well-informed and able to use information efficiently.
b. Independent in two senses:
   i. atomistic – they do not look to others when deciding what to do;
   ii. selfish – their utility is determined only by their own comforts.
c. Rational maximizers:
   i. using information efficiently by applying mathematical tools to guide their behaviour, so their behaviour is systematic and objectively determined, and immune from emotional and sentimental forces, especially if these are associated with systematic biases in decision-making. As rational maximizers, generally *Homo economicus* is assumed to maximize utility and profits in monetary terms;

   ii. forward-looking in a systematic way, which involves discounting the future in ways which are consistent over time so that it makes no difference whether *Homo economicus* is looking one day ahead or one decade ahead: their choices about future plans are consistent.

d. Homogenous, i.e. all members of the *Homo economicus* species behave in the same way (on average at least) so that one model can capture everyone (on average at least).

These standard assumptions imply that, at the extreme, standard economic models describe people as robotic, mathematical machines, and so understanding and controlling behaviour can be seen as, in many ways, more similar to an engineering problem than a socio-psychological problem. Behavioural economics takes on this approach to develop a more realistic view of how real people make their economic decisions and choices, starting by exploring the non-monetary incentives and motivations that drive our behaviour.

Extrinsic versus intrinsic motivations

In challenging the standard neoclassical approach to incentives, behavioural economists start by exploring the wider range of incentives and motivations that drive people's choices and decisions – and a prominent theme in this behavioural literature comes in capturing interactions between individual and cooperative goals. Constructing markets around people's willingess to pay for things that have been traditionally been sustained on the basis of social values can threaten the existence of socially beneficial actions. Titmuss (1970) described the negative impact of introducing payments for blood donation: payments undermined social values and dampened people's willingness to donate. Frey and Jegen (2001) examine this phenomenon in the context of motivation crowding theory and draw on insights from psychology about the "hidden costs of rewards": monetary incentives drive extrinsic motivation (motivation driven by external rewards) and undermine intrinsic motivations, including internally-driven motivations such as curiosity, helpfulness and self-realization. Crowding-out of intrinsic effects undermines the focus in standard economic theory on the importance of monetary rewards and incentives.

Motivating environmental awareness

Many of these insights have been applied in the context of environment decision-making. In an ideal world, people should be motivated by their sense of social responsibility to care about the environment – for example, Gowdy (2008) applies insights from behavioural economics and experimental psychology to the issue of climate change and specifically to the question of reducing CO_2 emissions. He argues that resolving the current crisis of sustainability needs more emphasis on broader facets of human behaviour, including trade-offs between greed and egoism versus cooperation and altruism. Rational choice theory does not capture these trade-offs effectively and so will not be a good guide, for example for policy-makers trying to encourage people to consider more carefully their energy and environment decisions. Financial incentives may in fact crowd out extrinsic motivations and feelings of collective responsibility unless environmental policy draws on cooperative, non-materialistic aspects of human nature. Frey (1997) argues that monetary incentives can crowd out civic motives but money can also "crowd in" civic motivations when it is used to acknowledge social worth of individual contributions (Frey and Oberholzer-Gee 1997).

Concerns about fairness will also affect the global management of environmental decisions, especially with respect to the developing world. Dealing with climate change will need cooperation, trust and reciprocity and even when cooperative frameworks are imperfect, participation can establish credibility and goodwill (Gowdy 2008). Given that richer countries in what is known as the global North got rich by burning fossil fuels, is it fair to tell the developing world to stop using them? Stiglitz (2006) argues that a fair solution could be to implement a common global carbon tax and allow each country to keep the carbon tax revenues so that if less developed countries are polluting more then they will also have more taxation revenue to spend on either reducing the taxation burden in other areas, or increasing expenditure, including expenditures to support development of new, environmentally friendly technologies.

Bénabou and Tirole (2003) adapt these insights and incorporate them within an economic analysis of principal–agent problems. External rewards offered by a principal (e.g. an employer) affect the intrinsic motivations of an agent (e.g. an employee) so that external incentives are weakly reinforcing in the short-run and negatively reinforcing in the long-run. There are many examples from experimental economics. In one study, university students were asked to solve a puzzle. Those who were not paid, and so were presumably doing the puzzle for the intellectual challenge, put more effort into the task than the students who were paid (Deci 1975).

Gneezy and Rustichini also report results from a field study of parents collecting children from school. Parents would often arrive late forcing the school to make sure a teacher was available to look after the children until their parents arrived. The school decided to introduce a fine as a deterrent but the plan backfired and more parents arrived late with a late fine than without one (Gneezy and Rustichini 2000a). This phenomenon may reflect the fact that, once a fine was introduced, arriving late was then interpreted as costly service and any guilt that parents may formerly have felt about arriving late was reduced when they felt they were choosing to pay for the privilege of arriving late. The extrinsic disincentive (the fine) crowded-out the intrinsic motivation – to cooperate by trying to arrive on time as often as possible.

Gneezy and Rustichini (2000b) found similar results to these earlier studies in an analysis of the performance of experimental subjects (students from the University of Haifa, Israel) completing a series of quizzes and offered a range of different incentives – with payments made as New Israeli Shekels (NISs). One group was given no payment; the second, third and fourth groups were paid 10 cents, 1 NIS and 3 NIS respectively and performance was lowest in the second group. Those who were not paid at all performed better than those with a small 10 cents payment. Gneezy and Rustichini found similar results for a study of volunteer work by high school children and conclude that excessively small payments can be demotivating leading to worse performance than no payment at all because small payments crowd out intrinsic motivation without offering sufficient external incentives to leverage extrinsic motivations.

Bénabou and Tirole (2006) use concepts of intrinsic and extrinsic motivation to explain pro-social behaviour. In many contexts, people exhibit pro-social behaviour involving altruism or reciprocity. This reflects not only intrinsic motivations but also social pressures and social norms which link into reputations and self-respect. Taking into account this mix of motivations, as well as heterogeneity in propensities towards altruism and self-interest, Bénabou and Tirole construct a model in which choices are the outcome of three motivators: intrinsic motivation, extrinsic motivation and reputation building.

Extrinsic rewards not only crowd-out intrinsic motivations but they also "spoil" the reputational and/or self-image value of pro-social choices.

Ariely *et al.* (2009a) explore intrinsic motivation, specifically personal preferences for giving, extrinsic motivation and image motivation. They formulate an "effectiveness hypothesis": extrinsic rewards are less effective for visible pro-social actions: extrinsic rewards deter pro-social behaviour because they dilute its signalling value. They explore these hypotheses using experimental evidence from subjects randomly assigned to one of two US charities, either the American Red Cross or the National Rifle Association. Charities were labelled as "good" or "bad" according to participants' perceptions of the majority's view. Participants were asked to engage in a simple but effortful task (pressing X and Z on a keyboard). Performance was rewarded with donations by the experimenters to the subject's nominated charity. There were significant differences in effort under "public" conditions (when subjects' efforts were revealed) versus private conditions (when efforts weren't revealed). When no monetary incentives were offered, subjects in the public condition made more effort. Monetary incentives did not increase effort in public condition; in the private condition there were significant increases in effort with monetary incentives. Ariely *et al.* interpret this as support for their effectiveness hypothesis: monetary incentives work better for anonymous giving but they have a negative impact on public giving perhaps because the social signalling value of philanthropy is diluted when efforts and payments are public knowledge.

Social motivations

As we explored in the introduction, behavioural economists learn a number of lessons from other social sciences – including insights from psychology and sociology around the idea that, as social creatures, we are not purely self-interested. Our incentives and motivations are also determined by our relationships with other people around us. Nobel Prize-winning economist Amartya Sen (1977, 1991) argues that the focus on a single assumption of self-interest in standard models suggests that people are "rational fools", considering only a single preference ordering given by self-interest without recognizing social preferences over a range of alternatives. Conversely, in his comparative analysis of Adam Smith's (1776) *An Inquiry into the Nature and Causes of the Wealth of Nations* and his (1759) *Theory of Moral Sentiments*, Vernon L. Smith (1998) hypothesizes that altruism and self-interest, whilst apparently contradictory, are actually consistent – an idea we introduced in Chapter 1. The self-interest in the *Wealth of Nations* and the sympathy in the *Theory of Moral Sentiments* are different facets of the same thing – a "self-interested propensity to exchange". In the *Wealth of Nations* it is exchange of money and goods; in the *Theory of Moral Sentiments* it is exchange of friendship. In this way, Vernon L. Smith asserts that self-interest and other-regarding sympathy are connected.

Behavioural game theory

Behavioural economists address these debates about the limits to our self-interest by building models incorporating social preferences, sometimes called other-regarding preferences. The main theoretical vehicle for analysing the links between our social preferences and social motivations is behavioural game theory – in which social preferences are introduced into standard games explored by economists – providing a starting point for many of the experimental tests of people's social preferences. Some versions of behavioural game theory were developed in response to robust experimental studies of a wide range of games showing that people do not always play games selfishly and so behaviour does not converge in the ways predicted by standard game theory – see Camerer (2003a,b) for surveys. Some of the games commonly used in these experimental analyses, and the standard game theory solutions consistent with perfectly rational choice, are summarized in Box 2.1.

Box 2.1 Box of games

Ultimatum game

Player A (the proposer) is given a sum to divide between herself and player B (the responder). If B rejects A's offer, both players get zero. IF B accepts A's offer, players get the share proposed by A. Standard game theory predicts that A will offer the minimum possible amount and B will accept it because a rational maximiser will prefer anything, no matter how small, to nothing.

Dictator game

Player A, the dictator, is given a sum of money and offers a share to player B; player B cannot veto the offer and must take what he's given by A. Standard game theory predicts that Player A will maximize by offering B the minimum possible amount.

Envy games

These games are variants of dictator or ultimatum games but are designed to disentangle preferences about relative advantage. Player A has a choice between dividing a small amount equally between themselves and Player B versus a larger amount but with proportionately more offered to Player B. For example, Player A is told to choose between:

1. £10 divided equally so that A keeps £5 and gives £5 to Player B; and
2. £15 divided unequally with Player A keeping a lesser share of £6 and giving £9 to Player B.

Standard game theory predicts that A will prefer option 2 because they will prefer more to less and will ignore how it is distributed.

Public goods games

In these games, each player makes a contribution to a public good. Their benefit may exceed their contribution but because, by definition, access to public goods is free and non-rivalrous: in other words, public goods are freely available and accessible for everyone to use, and one person using the public good does not prevent another person from using it. Under these conditions, there is no economic incentive for a perfectly rational, maximising individual to contribute money to something they can access for free. So standard game theory predicts scenarios in which players free-ride on others' contributions.

Trust games

Trust games are two stage games:

In stage 1, Player A – the trustor – offers a sum of money for Player B – the trustee. A's contribution is multiplied by some factor by the experimenter and then given to Player B.

In stage 2, B decides how much to return to A.

If A is generous/trusting and B reciprocates then there is a Pareto improvement because both players will be better off. However, standard game theory predicts 'backward induction', that is, each player reasons back from the very last stage of a game to figure out which strategies to use in the earlier stages of the game. Person A figures that B will not send anything back because he has no monetary incentive to do so and so A doesn't send anything in the first place. (Sometimes known as investment games or gift exchange games.)

Centipede games

Centipede games are multistage versions of trust games; sums of money are sent back and forth between A (the trustor) and B (the trustee) until one or other player "takes" by deciding how much to keep for themselves. At that point, the game ends. In the meantime, if the player decides to continue playing then they "pass" at each stage. Standard game theory predicts backward induction as for the trust game but in real-life experiments people backward induct only a couple of steps (Camerer 2003b).

Solidarity games

In a solidarity game, three players roll a die to determine a win. Before rolling the die, each player announces how they will allocate "gifts" to the losers.

This game can be used to separate some of the explanations for generosity in simpler games such as the ultimatum game; e.g. some studies find that the same total amount is given regardless of the size of the group and therefore apparent generosity is not about inequity aversion; gifts for each loser are positively correlated with expectations of gifts from them (Bolton and Ockenfels 2000).

Ultimatum games and dictator games

In playing experimental games, Box 2.1 summarises some of the solutions that a perfectly rational maximising player would implement. A major contribution from behavioural economics comes in showing that real people do not play these games in this sort of strictly rational way. The ultimatum game is possibly the most famous behavioural game and it has been extensively explored, not only by economists but also experimental psychologists, neuroscientists and even behavioural ecologists. In the ultimatum game, the experimenter gives Alice (the proposer) a fixed sum – say £100; Alice is instructed to offer Bob (the responder) some proportion of that sum – a minimum of £1 to a maximum of £100. If Bob agrees, then they both get the shares proposed by Alice, but if Bob refuses, both get nothing. Standard game theory assumes "monotonicity", that is, that more will be preferred to less and so Alice will want to keep as much for herself as possible. She will offer Bob £1 and keep £99 for herself. Bob will prefer £1 to nothing and so will accept Alice's offer. Thus, standard game theory predicts offers and acceptances close to zero.

Experimental evidence shows, however, that people do not play in this way in the real world: Güth, Schmittberger and Schwarze (1982) conducted the first comprehensive testing of the original ultimatum game and found that players were often guided by what they thought was a fair or just outcome. Assuming that 50% was perceived as a "fair" offer, proposers usually offered responders a lot more than zero and relatively close to 50%; and proposers rejected offers around 20%. These findings were replicated across many studies (including animal studies, for example with monkeys playing for juice). In a meta-analysis of results from the ultimatum game, Camerer found that the mean offer was around 30–40% and offers below about 20% were rejected. The findings were also scalable, with similar results for small versus large sums of money, though there were some cultural differences (Camerer 2003b; Henrich *et al.* 2004). Andersen *et al.* (2011) analysed strategies played by people in poor villages of Northeast India for whom increases in monetary stakes had a far larger impact. Andersen *et al.* found that, even when the stakes are relatively large, responders will still reject low offers and end-up with zero – interpreted by some researchers as reflecting the responders' desires to punish the proposer for making an insultingly low offer.

Experiments with trust games

Berg, Dickhaut and McCabe (1995) explore trust, reciprocity and social history and try to answer questions about why we trust and whether or not trust is a primitive response. They construct a repeated game but one which abstracts from reputation and contractual pre-commitments by using a trust game designed to test trust and trustworthiness. This game tests the extent to which people trust others and in turn reciprocate trust by being trustworthy themselves. Trusting and being trustworthy represent two challenges to narrow self-interest: trusting is a risky strategy and may not be reciprocated; trustworthiness yields no direct, immediate return.

Berg *et al.* note that a problem with trust games (and similar games including the ultimatum and dictator games) is that experimental subjects may want to impress experimenters with their generosity, so they incorporate some experimental design features to reduce the likelihood of experimental bias, introducing a double-blind procedure in which the subjects make contributions anonymously using envelopes and boxes. The experimenter cannot know (and the subjects know that the experimenter cannot know) who has been generous and so there are neither sanctions nor rewards for altruistic choices. In this way, Berg *et al.* hope that their experimental design will allow them to abstract from relationships, social influences, communication, and so on.

Berg *et al.* use two groups of subjects in two rooms: subject As in Room A and subject Bs in Room B. All subjects are given $10 to either keep or share. The game then proceeds in two stages. In Stage 1, subject A decides how much of her $10 to send to an anonymous counterpart in room B (the trustee). Stage 1 tests the trust of players A; if they do not trust the people in Room B then they will send no money. In Stage 2, A's contribution is tripled and given to player B. Player B must then decide by how much to reciprocate. Essentially, stage 2 is a dictator game; Player B has complete control over the outcome and Player A cannot veto his or her choice.

Standard game theory predicts that, if B is purely self-interested, then he has no incentive to reciprocate by being trustworthy and returning something to A. Via backward induction, player A reasons therefore that their best strategy is to send nothing because anything that they do send will be kept by B. Assuming that A is purely self-interested, then she has no incentive to send anything to B in the first place.

The problem for both players is that they get stuck in something like a prisoner's dilemma: both players could have done better by being generous. With no trust and no reciprocity A keeps $10, B does nothing and both suffer as a result because neither of them gets any more than their initial payment. On the other hand, if A had been maximally generous and offered $10 then this would have been tripled to $30. If B had sent half back to A, that is, $15, then this would have been a better outcome. Both players would have been unequivocally better off if they had been trusting and reciprocating. This links into evolutionary analyses in which making and returning kindnesses have evolutionary advantages in social environments.

Contributing nothing and not reciprocating is the standard game theory prediction but the experimental results from the trust games above resemble those seen in ultimatum games. In Berg *et al.*'s study almost all Room A subjects were trusting; 30 out of 32 subjects (94%) sent something to Room B, though there was a large degree of variability in amounts sent. There is less evidence of reciprocity from the players in room B though 57% did reciprocate by sending back more than A sent and, on average, players in room A did at least get their money back. Apart from that, the extent of trust and reciprocity was not correlated. To assess the impact of social norms, Berg *et al.* also analysed the impact of social history, that is, information about average responses in previous rounds. They found that these social norms did have some impact especially for players in room B.

The selection of experimental evidence outlined above suggests that people do not generally make choices consistent with the standard assumptions of game theory. There are a number of potential explanations: it could just be that people are inherently generous. Social norms may dictate that people play in a generous way. As explained in the context of learning models in the previous chapter, it may take time to learn the best strategies; if people have learnt social norms of generosity outside the lab then it takes time and experience to unlearn them. Responses may reflect strategic reasoning, for example if people believe that stinginess will at some point be punished by the other player. Overall, there is an empirical problem in separating these hypotheses about motivation and a number of theoretical models have been devised to explain the results, as explored in the following section.

In attempting to reconcile the experimental results and varying interpretations, behavioural economists have come up with a range of theoretical explanations for the range of social preferences and motivations revealed in the experiments outlined above. These models focus on the different reasons for cooperation and altruism including traits of kindness and fairness, warm glow giving, inequity aversion, preferences for relative as well as absolute payoffs and strategic thinking. A selection of the models is outlined below.

Punishment and cooperation

Negative incentives can be motivating too. For example, punishment is a powerful negative incentive, and behavioural economists have explored punishment as a way to explain some of the experimental findings from behavioural game theory, as outlined above. These models present theoretical explanations for other-regarding behaviour but what sort of incentives and motivations encourage people to cooperate and/or to punish people who don't? How are these motivations reinforced in a social context? Cooperation and punishment play a crucial role in explaining why people sometimes cooperate and other times do not. It is helpful to think about what deters people from violating social norms of reciprocity and what people can do to encourage others to cooperate.

Altruistic punishment

Studies in behavioural economics and neuroeconomics have shown that people are willing to pay to punish norm violators. They also find that people who are initially cooperative, will start to defect if they are not punished. Fehr and Gächter (2000) study altruistic punishment of social norm violations. They begin by defining social norms as behavioural regularities based on socially shared belief about how to behave. Social norms are enforced via informal social sanctions and these sanctions determine work effort, consumption choices, common pool resources, as well as provision of public goods. Social history is important and people do punish inappropriate behaviour even when costly to themselves. Fehr and Gächter (2000) explore these insights in an experimental study of altruistic punishment based on an adaptation of Fehr and Schmidt's (1999) version of a public goods game, which we will explore in more depth below. Their experimental game was conducted in two stages: a contribution stage and a punishment stage. In the punishment stage, the players were given the opportunity to use monetized punishment points to punish defectors who had been mean in the contribution stage of the game. They find that, without punishment, there was almost complete defection from social norms but with punishment a larger proportion cooperated.

There are further differences dependent on the level of anonymity in the interactions. They divided the treatments into Partner and Stranger treatments. When subjects were playing with strangers they were less likely to cooperate; when they were playing with known partners and violations were punished, 82.5% of subjects cooperated fully. At the other extreme, in the no-punishment Stranger treatments, contributions converged onto full free-riding over time. A similar experimental design has been adapted for neuroeconomic analysis by de Quervain *et al.* (2004) who find that altruistic punishment stimulates neural responses usually associated with reward processing, as we will explore in more detail in the neuroeconomics chapters.

Ostracism in social networks

Punishment can be particularly effective in social networks. Fowler and Christakis (2010) and Randa *et al.* (2011) examined punishment within social networks. They conducted online experiments using Mechanical Turk (MTURK) to investigate large-scale cooperation in social networks. The experimental subjects played public goods games either with or without punishment and were assigned partners either randomly or via their own choices. When partners are randomly allocated, cooperation is equally beneficial to all partners. There is no incentive to cooperate and so cooperation decays over time, confirming Fehr and Gächter's (2000) study. Also, social factors may operate as much as a carrot as a stick: people are inclined to cooperate because they benefit in terms of their own social connectedness. Questions of depersonalization and identification (as explored in more detail in the identity section below) may also be relevant: if people feel that they have built a positive cooperative relationship with someone they know and/or identify with then that will encourage them to partner with that person again.

Fowler and Christakis (2010) found that voluntary costly punishment can help sustain cooperation. Subjects were influenced by the contributions of others, including those with whom they did not interact initially. These social influences persist over time and spread through social networks. Randa *et al.* (2011) developed this study to show experimentally that people make and break social networks in response to cooperation versus defection by others. Cooperation decays over time if social links are outside the control of individuals (because they are fixed or determined randomly) or if links are updated infrequently. However, if subjects have short-term control of their social connections they can decide to break links with defectors and form links with cooperators. When people can choose who they do (and don't) interact with, it creates an incentive to cooperate because defectors will be excluded from social networks if they behave uncooperatively.

Social motivation theory

In explaining some of the findings about social motivations, some behavioural economists have developed a range of theoretical models to capture social preferences and motivations – via *social motivation theory*. In social motivation theories, theories of utility are developed essentially to extend neoclassical conceptions of utility. These general utility models are designed to reconcile, albeit in a limited way in terms of links with other social sciences, the range of experimental evidence – from the market games evidence in which people exhibit pure self-interest through to the games which reveal generous behaviour in other contexts, for example the ultimatum, dictator and trust games explored above.

Bolton and Ockenfels' Equity, Reciprocity and Competition (ERC) model

Bolton and Ockenfels' (1998, 2000) equity, reciprocity and competition (ERC) model is a general model of motivation, devised to capture other-regarding preferences. They argue that models with altruistic preferences cannot fully explain play in ultimatum games, dictator games and solidarity games because needs of others and reducing inequality are not necessarily primary goals.

Bolton and Ockenfels suggest that a good model should explain a number of statements summarising some empirical regularities they identified from previous experimental analyses:

> **Statement 1:** In dictator games, on average dictators keep at least half but give less than the whole pie.
> **Statement 2:** In ultimatum games, responders accept all offers of the whole pie and reject all offers of nothing
> **Statement 3:** In ultimatum games, proposers will propose a payoff to themselves of at least half but less than the whole pie, i.e. offering some proportion less than half to the recipient.
> **Statement 4:** Average offers in ultimatum games exceed average offers in dictator games.

Developing a comparative model from Bolton (1991) and Bolton and Ockenfels (1998), the ERC model assumes narrow self-interest but with people balancing trade-offs between their absolute pecuniary payoffs and relative payoffs. Relative payoffs are judged against a social reference point, assumed to be an equal share to each player, that is a share of ½ for a game with two players. The model is designed to capture play in one-shot games and it allows for incomplete information. Given imperfect information, "observables" are used to construct two thresholds at which behaviour deviates from monotonicity – the proposer's offer threshold in the dictator game and the responder's rejection threshold in the ultimatum game.

From this, Bolton and Ockenfels construct a *general motivation function* which incorporates monetary payoffs and relative shares. They illustrate their hypotheses using an *example motivation function* for a two-player game, incorporating a social reference point of equal shares. This function is also constructed so that larger deviations from equal share have proportionately larger impact in lowering utility. Each player's type is given by the ratio of weights they assign to pecuniary versus relative payoffs, with the weights determined by individual differences, for example in age, education, politics and religion. Narrow self-interest increases as the weight on pecuniary payoffs increases. The mathematics of their model is explored in the Mathematical Appendix A2.1.

Bolton and Ockenfels argue that their model is consistent with experimental evidence from a range of experimental contexts – including dictator and ultimatum games when generosity is observed, and auction games which reveal competitive play as predicted by standard game theory models. They argue that their model can reconcile apparently anomalous findings. This develops findings by Roth *et al.* (1991) who identified differences in outcomes from market games versus bargaining games including the ultimatum game. Roth *et al.* describe evidence from experiments in Israel, Japan, the US and Yugoslavia. Market games converged onto the equilibria predicted by standard models but there was a wide variety of standard and non-standard outcomes for ultimatum games, suggesting that cultural differences may play a role in the formation of other-regarding preferences.

Bolton and Ockenfels' emphasis on narrow self-interest means that their model fits more neatly with mainstream assumptions of rationality but they assert that their motivation function can also connect different social preferences seen in different contexts, for example sometimes people exhibit social preferences for fairness; other times they want to reciprocate and other times they want to compete. So the ERC model can reconcile evidence about equity, reciprocity and generosity with evidence about competitive self-interested behaviour, allowing heterogeneous preferences to reflect differing motivations. The ERC model is also consistent with interplays of equity and strategy. For example, generous offers in ultimatum games may not reflect pure altruism and inequity aversion but may also reflect proposers strategically anticipating how responders might react.

Inequity aversion in Fehr and Schmidt's Fairness, Competition and Co-operation (FCC) model

Fehr and Schmidt's model develops Loewenstein, Thompson and Bazerman's (1989) analysis of aversion to unequal outcomes within an experimental context. They analyse subjects' responses to hypothetical dispute scenarios in which the experimental subject is either acknowledged or snubbed by a hypothetical partner in a range of scenarios including non-business interactions with a peer and business interactions between a customer and sales person. Subjects were asked to grade their satisfaction with the hypothetical solution. Loewenstein *et al.* used the fit of reported satisfactions to a range of social utility functions and found that a utility function which incorporated discrepancies in the payoffs between the members of each pair, that is, a function incorporating payoffs in which the experimental participant the subject got a better outcome than their partner, and payoffs in which the participant's outcome was worse than their partner's, correlated well with reported satisfaction.

Fehr and Schmidt develop Loewenstein *et al.*'s (1989) model to construct their own model of Fairness, Competition and Co-operation (FCC) capturing the impacts on utility of what they describe as *inequity aversion*, that is, dislike of unequal outcomes. In this model, utility is affected by payoff differentials between players. If a person has a smaller payoff than other players then this will lower their utility; and if they have a larger payoff then that will raise their utility, as described mathematically in Mathematical Appendix 8.2.

Fehr and Schmidt describe two forms of inequity aversion: advantageous inequity aversion – inequity aversion experienced by people in a position of relative advantage; and disadvantageous inequity aversion – inequity aversion experienced by people in a position of relative disadvantage. For example, a banker who is unhappy about poverty is experiencing advantageous inequity aversion; a poor person who is unhappy about bankers being rich is experiencing disadvantageous inequity aversion.

Overall, Fehr and Schmidt's (1999) insights are somewhat similar to Bolton and Ockenfels (1998, 2000) though Fehr and Schmidt are less reliant on an assumption of narrow self-interest and assert that seemingly irrational behaviour in ultimatum games and dictator games reflects inequity aversion. Like Bolton and Ockenfels, Fehr and Schmidt claim that their FCC model can reconcile a range of experimental results showing that people are sometimes cooperative and sometimes selfish – in contrast to standard approaches predicting self-interested and uncooperative behaviour in all contexts. The FCC model can capture the range of responses including the fairness and cooperation seen in ultimatum games, public good games with punishments and gift exchange games (introduced on p. 24). It can also explain the uncooperative competitive behaviour observed in market games and public good games without punishment.

Fehr and Schmidt's assertion about the generality of their model has created some controversy. Binmore and Shaked (2010a, 2010b) assert that the empirical support for the inequity aversion model is not as robust as Fehr and Schmidt claim. Fehr and Schmidt (2010) respond that Binmore and Shaked have not posed a fundamental challenge to their approach. The dispute remains unresolved. More nuanced empirical testing of the various theories of inequity aversion will be helpful in resolving the debate.

Extending behavioural motivation models

The models presented above are an introduction to other-regarding preferences but many behavioural economists argue that they don't go far enough in properly embedding the range of non-economic incentives and motivations driving behaviour. The social motivation models outlined above incorporate social elements as not much more than an "add-on" to neoclassical utility theory. Other behavioural economic models designed to capture social motivations build more links with other social and behavioural sciences, especially with psychology and sociology. Some of these insights link to elements similar to the Fehr and Schmidt model but with stronger psychological foundations. These include models of fairness, kindness and reciprocity, for example Rabin (1993), Kahneman, Knetsch and Thaler (1986), and Falk and Fischbacher (2006). Fehr and Gintis (2007) assert that formal models of inequity aversion (Fehr and Schmidt 1999) and reciprocal fairness

(Falk and Fischbacher 2006) are indispensible tools in analyzing social phenomena but there is a large number of other theoretical explanations for generous behaviour.

Other models have focused on the emotional satisfaction derived from giving, for example Andreoni's (1990) model of warm glow giving capturing the fact that utility increases with the act of giving, for example in donations to public goods. Theories of altruism and warm glow giving have been applied to ordinary daily activities including the trade-offs between volunteering and work. For example, Sauer (2011) analyses volunteering and finds that it is optimal when warm glow and expected future economic returns sufficiently outweigh disutility of extra work effort and childcare costs. Highly-educated women receive more 'warm glow' than men, and there are substantial economic and non-economic returns to volunteering, with returns to effort particularly high for those in part-time work.

Another set of theories revolves around the insight that generosity and altruism may represent investments in our interpersonal relationships and connections, as seen in social capital and social network theories – enormous literatures in themselves and beyond the scope of this book. For those interested to learn more, see Dasgupta (2007), Goyal (2009) on social networks and Halpern (2005), Putnam (2001) on social capital.

CHOICE OVERLOAD

Neoclassical utility theory assumes that people's choices are constrained just by monetary constraints – specifically prices, income and wealth. Behavioural economics also captures a range of non-monetary, psychological/cognitive constraints which interact with some of the behavioural incentives and motivations explored in this chapter. Some of the main cognitive constraints include choice overload and information overload. The standard model in economics focuses on the importance of choice and implicitly it is assumed that the more choices we have the better we will be. Psychological research has shown, however, that too much choice – choice overload – can be demotivating. Iyengar and Lepper (2000) describe findings from three experimental studies illustrating the negative impacts from having too much choice. For all studies, participants were more satisfied with their selections and performed better when their set of options was limited. The first study examined the behaviour of shoppers at an upmarket grocery store. A tasting booth displayed either a limited choice of six jam flavours or an extensive choice of 24 jam flavours. Motivation was explored in two ways: the number of shoppers drawn to the booth and the number of jams they bought. For 242 subjects exposed to the extensive choice treatment, 145 stopped at the booth but only four bought jam. On the other hand, for 260 subjects exposed to the limited choice treatment, 104 stopped but 30 of those bought some jam. The study revealed that there was no correlation between the two forms of motivation: 40% of shoppers stopped at the booth displaying a limited range and 30% of them subsequently bought some jam. For the group encountering a booth with an extensive selection of jams: 60% of customers stopped but only 3% of them bought jam. For the second study, students were offered six or 30 potential essay topics for optional credit. Motivation was assessed in terms of number and quality of essays written. In the limited choice condition, 74% wrote an essay and the mean grade for these essays was 8.09. In the extended choice condition 60% wrote essays, with a mean grade of 7.69. For the third study, Iyengar and Lepper studied the choices of university students choosing chocolates and extended their experimental design by introducing three treatment conditions: no choice, limited choice (from six types of chocolate) and extensive choice (from 30 types of chocolate). The subjects in the extensive choice group reported feeling that they had been offered too much choice and those who had a limited set of choices experienced more satisfaction. All these studies suggest that too much choice can be demotivating.

In capturing some the links with attention, Reutskaja *et al.* (2011) use eye-tracking techniques to detect how visual attention shifts when people are engaged in these choice tasks. The pattern of eye movements can serve as a proxy for how motivated people are by different stimuli. They apply this to studies similar to Iyengar and Lepper's (2000) choice overload experiments. Eye tracking monitors the direction of a person's gaze and uses this information to make inferences about which objects are attracting a person's attention. Reutskaja *et al.* assessed the choices of hungry consumers choosing snack items but making their decisions within a strictly limited timeframe. They found that the experimental subjects assessed objects according to their appeal and this assessment correlated strongly with willingness to pay. However, the eye-tracking evidence revealed that people had a tendency to look and choose according to the spatial placements on items within shop displays.

The extent to which people perceive themselves to be overloaded with choices will also depend on the timeframe within which they must make their decisions. Gabaix and Laibson (2000) construct a model of decision-making that blends together insights about bounded rationality, satisficing and heuristics. If people have plenty of time to decide then they can reach the correct answer but real-life situations often involve time constraints. Gabaix and Laibson test their hypotheses using experiments on 259 Harvard undergraduates and find that their subjects decided by identifying representative scenarios. In contrast to the backward induction hypothesized in standard game theory models, their evidence shows that people economize by simplifying decisions using heuristics quickly to identify feasible paths.

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We have seen in this chapter that behavioural economists extend the range of incentives and motivations that drive behaviour, including a range of intrinsic as well as extrinsic motivations and incentives. In exploring this literature, it is important to remember that behavioural economists do not argue against the idea that money is often a powerful incentive. They are showing that we are driven by *other* motivations too – and sometimes these other motivations interact with extrinsic motivations – such as money – in complicated ways, as captured in motivation crowding and social motivation theories. These complex influences on decision-making may also be distorted by the cognitive tools that people use to help them decide quickly – as we shall see in the next chapter, on Heuristics and Bias.

Chapter summary

- Behavioural economists move beyond conventional economics in exploring a wider range of incentives and motivations, beyond financial and monetary motivations.
- Financial and monetary motivations are captured in the category of extrinsic motivations. Intrinsic motivations are internally generated and are associated with internal rewards – such as pride in a job done well, satisfaction in performing tasks and desire to do good.

- Motivation crowding theory is about how extrinsic motivations crowd out intrinsic motivations so that when people are paid money they are sometimes less likely to draw on their intrinsic motivations – for example wanting to be fair to others.
- Social motivation theory explores how social incentives are a key extrinsic motivation and are driven by people's perception of social norms and social reference points.
- Social motivation theory links to models of social preference, which build on key ideas from game theory, but with a behavioural–psychological dimension included.
- Motivations and incentives can be dampened by choice and information overload, and some behavioural experiments have shown that when participants are given too many choices, participants' performance will deteriorate.

Revision questions

1. Building on some of the examples introduced in this chapter, explore some examples of intrinsic motivation that you think are important to people's daily lives. Do these motivations improve behaviour, or not? Justify your answer.
2. Relative to extrinsic motivations such as money, how important are intrinsic motivations to everyday decision-making? Illustrate with some examples.
3. In terms of motivation crowding theory, explore some other examples of how extrinsic motivations can crowd out intrinsic motivations.
4. Outline the essential elements of social motivation theory. What does the empirical evidence tell us about social motivations and can this evidence be explained using insights from conventional (non-behavioural) economics? Explain your answer.
5. Is money the only extrinsic incentive? Describe and explain some examples of other extrinsic motivations and incentives.

MATHEMATICAL APPENDIX

A2.1 Mathematics of the Bolton and Ockenfels' ERC model

Bolton and Ockenfels construct two thresholds at which behaviour deviates from monotonicity which, given incomplete information, are based on experimental observables defining the thresholds of the proposer's most generous offer and the responder's minimum acceptable offer, that is:

$r_i(c)$: proposer's offer thresholds in dictator games

$s_i(c)$: responder's rejection thresholds in ultimatum games

Where c is the total payoff to all subjects and y_i is each participant's payoff – so:

$$c = \sum y_i$$

General motivation function

From these thresholds, Bolton and Ockenfels construct a general motivation function:

$$v_i = v_i(y_i, \sigma_i)$$

where y_i is i's monetary payoff; σ_i is i's relative share of the total payoff – the proportion of the total kept by player i. Each player's relative share is determined by y, c and n, giving:

$$\sigma_i = \sigma_i(y_i, c, n)$$

The total payout is:

$$c = \sum_{j=1}^{n} y_j$$

It follows that $y_i = c\sigma_i$

For example, in a two-player dictator game, the share kept by the dictator is given by σ_D and so the dictator's payoff is $c\sigma_D$ and the recipient's payoff is $(1-\sigma_D)c$.

An example motivation function

Bolton and Ockenfels' example motivation function for a two-player game – incorporating a social reference point = ½ is given by:

$$v_i(c\sigma_i, \sigma_i) = a_i c\sigma_i - \frac{b_i}{2}\left(\sigma_i - \frac{1}{2}\right)^2$$

where $a_i \geq 0, b_i > 0$

Each player's type is given by the ratio of weights to absolute pecuniary payoffs (the first term on the right-hand side) versus relative payoffs (the second term on the right-hand side), that is, a/b. Strict narrow self-interest increases as $a/b \rightarrow \infty$.

The quadratic form allows that larger deviations from equal share have proportionately larger impact in lowering utility. Weights can be assigned to different objectives depending on context and individual differences.

A2.2 Mathematics of Fehr and Schmidt's FCC model

Fehr and Schmidt (1999) develop Loewenstein *et al.* (1989)

For n players $i \in \{1, \ldots, n\}$ with monetary payoffs given by $x = x_1, \ldots, x_n$ the utility function for player i is given by:

$$U_i(x) = x_i - \alpha_i \frac{1}{n-1}\sum_{j \neq i} \max\{x_j - x_i, 0\} - \beta_i \frac{1}{n-1}\sum_{j \neq i} \max\{x_i - x_j, 0\}$$

In the two player case, this simplifies to:

$$U_i(x) = x_i - \alpha_i \sum_{j \neq i} \max\{x_j - x_i, 0\} - \beta_i \sum_{j \neq i} \max\{x_i - x_j, 0\}$$

They assume that $\beta_i \leq \alpha_i$ i.e. and $0 \leq \beta_i < 1$

Utility is maximised where $x_i = x_j$ and the utility loss from disadvantageous inequity aversion (i.e. $x_i < x_j$) is larger than the utility loss from advantageous inequity aversion (i.e. $x_i > x_j$).

Chapter 3

Heuristics and bias

A common misperception about behavioural economics is that it is all about "irrational" decision-making when, in truth, behavioural economists challenge standard economic conceptions about rationality in much subtler ways. Most behavioural economists do not often argue that people are completely irrational – why would we have evolved to behave irrationally? Instead, behavioural economists focus on the limits to extreme assumptions about rationality associated with rational choice theory and/or they develop alternative conceptions of rationality. This allows us to understand why people make and repeat mistakes. This broader understanding of behaviour raises questions about the existence and nature of rationality: are people rational? For some behavioural economists (not all) the answer is "not always" – rather than an unequivocal "no". Whether or not we are able to act in a rational way depends on the context in which we find ourselves.

This chapter explores some approaches to softening economists' assumptions about rationality, focusing in particular on Herbert Simon's insights about bounded rationality under conditions when rationality may not be about mathematical maximization and statistical reasoning, but will nonetheless involve systematic reasoning processes. In the context of bounded rationality, this chapter focuses on a range of biases and heuristics that affect decision-making under uncertainty. In understanding the influence of biases and heuristics it is useful to outline some different conceptions of rationality as seen in economic analyses. Then some key elements of Kahneman, Tversky, Thaler and others' models of quasi-rational decision-making – including biases, heuristics, cognitive dissonance and cognitive balance – will be explored.

Defining rationality

In economics, standard decision-making models focus on behaviour as the outcome of a mathematical process. This assumes "hyper-rationality" – that people are using a high level of rationality to guide their choices. Strict axioms of rationality as outlined by von Neumann and Morgenstern (1944) and Savage (1954) and in this section we will focus on analyses of rationality that have emerged since the widespread adoption of rationality axioms in economic theory.

Procedural versus substantive rationality

Herbert Simon (1955, 1972, 1979) replaces the global rationality of economic man with a model of bounded rationality. An uncertain future, bounds to rationality, including cognitive and information processing constraints as well as imperfect information, will mean that people, at best, are able to act in a broadly reasonable rather than strictly rational way. They will be satisficers rather than maximizers (Simon 1979). Simon also analyses rational behaviour as "behavior appropriate to the achievement of given goals, within the limits imposed by given conditions and constraints" (Simon 1972, p.161). It follows that a wide range of definitions of rationality can be constructed, depending on how broadly the given conditions and constraints are defined. Simon's concept of bounded rationality focuses on decision-making when there are constraints on information and cognitive capacity. Whilst much analysis of bounded rationality has focused on data inputs, rationality may also be bounded because humans are not always good at processing numerical and probabilistic information. Simon (1972) notes that rationality will also be bounded when situations are particularly complex, when it is not easy to identify the best course of action.

Simon analyses the strong assumptions about information and information processing associated with the standard economic model in which rational agents use tools of differential calculus to maximize their utility or profits. Simon describes this as substantive rationality, rationality based on an underlying mathematical process reflecting the application of a mathematical algorithm. Subjective probabilities can be consistent with substantive rationality assuming Bayesian rationality, that is, the application of Bayes's rule – described in Chapter 5 in the context of social learning. This is still substantive rationality because it is grounded on an algorithmic approach: a mathematical/statistical rule is known and applied.

Procedural rationality is a broader concept, is not dependent on the use of mathematical algorithms and reflects a response to constraints on computational capacity and the emphasis on problem-solving rather than optimizing. That means that it is harder precisely to define. Intuition guides behaviour and judgements are the outcome of "appropriate deliberation" rather than algorithmic, substantive decision-making (Simon 1955; Baddeley 2006a; Baddeley *et al.* 2004). Non-maximizing behaviour may be justified as reasonable in an uncertain world if people are deciding quickly in in a systematic way. Then, limits on human cognition will mean that judgements and decisions are prone to behavioural biases. Procedural rationality is something like Thaler's (2000) concept of quasi-rationality in which people make their decisions in a purposeful, regular way but their decisions are reasonable in the sense that the reasoning process is not consistent with the axioms seen in standard economic analyses.

Ecological rationality

Vernon L. Smith (2003) analyses the different versions of rationality that are seen in different contexts, especially to explain contrasting behaviour in experimental markets. In a vision of rationality drawing on the Austrian economists, particularly von Hayek, Smith observes "we have examples where people don't do as well as rational models predict. We have examples where they do better. And we are trying to understand why." For example, financial asset markets do not converge quickly and, in the lab, may exhibit instabilities such as bubbles and crashes even though, according to Smith, they do usually converge in the end. Experimental consumer markets on the other hand often converge quickly.

Developing concepts of rationality seen, for example, in Hayek, who argues that effective social institutions are the product of conscious deductive reason. Vernon L. Smith develops the alternative but complementary concept of ecological rationality. Ecological rationality focuses on the ecology of the environment in which decisions take place. It is less about different types of agents and their levels of rationality and more about agents responding to different incentives in different institutional environments and contexts. There is an evolutionary aspect to learning and rationality. "Social-grown" norms such as trust and reciprocity can lead to social, cooperative outcomes that are better than the market equilibria – as we saw in Chapter 2 in the context of trust games: when people trust and reciprocate then they will do better than if they choose independently of the people around them.

Heuristics and decision-making

The various conceptions of rationality outlined above allow that individual behaviour may or may not be fully rational depending on the circumstances and contexts. How do these views of rationality and behaviour translate into an understanding of everyday decision making? In real-life, people use decision-making shortcuts – referred to in the behavioural economics literature as *heuristics*. Gigerenzer *et al.* (1999) and Todd and Gigerenzer (2000) explain that the mind has an "adaptive toolbox" for decision-making involving heuristics, which are simple rules enabling smart choices to be made using minimal information and exploiting the structure of information given the environment context. Heuristics do not require careful deliberation but neither are they irrational. Heuristics are common-sense rules of thumb derived from experience and they may be procedurally rational because they are used by people to make relatively quick decisions in uncertain situations when a full assessment of available information is difficult and/or time-consuming. Imitation, for example, qualifies as a "fast and frugal heuristic" saving time and effort in social situations (Gigerenzer and Goldstein 1996).

Different classes of heuristics are characterized by "simple building blocks" capturing how the search for information is conducted. Heuristics can generally be distinguished according to how reasonable they are, although, without a clear algorithm to draw the line between what is rational and what is stupid, judging whether something is a sensible heuristic can be subjective. Generally, heuristics can be justified as procedurally rational and biases involve misjudgements of information and/or events. There may be some overlaps. Whilst heuristics are generally reasonable decision-making tools given uncertainty, if they are misapplied then they may lead us into mistakes – what behavioural economists refer to as *behavioural biases*. So, whilst heuristics can be useful devices to enable quick and efficient decision-making, their use does not always lead to the best decisions.

Most ordinary people make common mistakes in their probability judgements. This reflects bounded rationality: information is mishandled reflecting limits on the cognitive processing ability of the human mind (Gould 1970; Tversky and Kahneman 1974; Anderson 1998). Anderson (1998) asserts that the problem originates in the input format of data, and in algorithms used: if prompted by clear signals, the human brain is able to deal with probabilities more effectively (Anderson 1998). For example, if students are asked to judge the probability of two coincident events within the context of a statistics class, then they will know what to do. However, if outside their classes they are confronted with a problem requiring probability judgements in a situation in which it is not obvious that this is what is required, then they may make a judgement using instincts and intuition rather than statistical reasoning (Kyburg 1997).

Cognitive biases can be categorized into individual and group biases, and individuals will be affected by motivational biases and cognitive biases (Baddeley, Curtis and Wood 2004; Skinner 1999). Motivational biases reflect interests and circumstances and may link into principal-agent problems. They can often be significantly reduced with clearly defined tasks and incentive structures. Overall, motivational biases are less of a problem because they are under rational control and can be manipulated using incentives. Cognitive biases are problematic because they emerge from incorrect processing of the information; in this sense they are not under conscious control, a theme also explored by Herbert Simon in the context of unconscious rationality.

Tversky and Kahneman on heuristics and biases

Tversky and Kahneman (1974) pioneered the analysis of heuristics, describing them as devices to reduce the complexity of tasks and to form intuitive judgements of probability. These often useful and sensible devices can also lead us into systematic mistakes. Tversky and Kahneman draw an analogy with visual perception: we judge the distance of an object by our visual perception of its sharpness and clarity. Whilst often a useful guide, in specific circumstances it will be misleading: in fog we overestimate distances; in sunny weather we underestimate them

Tversky and Kahneman (1972, 1974) explore the connections between heuristics and biases for a range of heuristics commonly employed including representativeness, anchoring/adjustment and availability. For Tversky and Kahneman, heuristics are intuitive decision-making tools but the problem is that a range of biases can emerge from the misapplication of these quick decision-making tools. Tversky and Kahneman illustrate with some experimental examples of systematic mistakes from misapplication of heuristics. In describing their experimental evidence, they note that they encouraged their experimental subjects to be accurate and rewarded them for correct answers to deter wishful thinking and other irrational influences not associated with the application of heuristics.

Overall, a large number of heuristics and biases have been identified and we cover only a selection here but a comprehensive range of the various studies can be found in Kahneman and Tversky's (1982, 2000) edited volumes. See also Ariely (2008) for a simple introduction.

Representativeness

The *representativeness* heuristic is a principle of analogical reasoning in which people judge the similarity between events and processes to judge probability. Probabilities are judged by the degree to which A resembles B. Tversky and Kahneman (1974) use the example of Steve – if we are given information about him, information which is not objectively informative, such as that he is "very shy and withdrawn", has "a passion for detail" then we judge the probability that he is a librarian by how much he represents our stereotypes about librarians. Attribution errors and belief bias are generated when we decide according to stereotypes because personality-based explanations are over-emphasized and situational influences are under-emphasized.

Tversky and Kahneman (1974) identify six types of bias that emerge from this heuristic: insensitivity to prior probabilities (base-rate neglect), insensitivity to sample size, misconceptions of chance including gamblers' fallacy; insensitivity to predictability; the illusion of validity; and misconceptions of regression reflecting a behavioural version of Galton's fallacy – as explained below.

Base-rate neglect and probability matching

Tversky and Kahneman (1974) observe that judgements are often insensitive to prior probabilities: "when worthless evidence is given, prior probabilities are ignored". This is the problem of base-rate neglect. If people are given narrative information about an event, even if this information is essentially worthless, then it will lead people to disregard statistical rules. For example, Tversky and Kahneman describe one experiment studying the probabilistic judgements for two experimental conditions: in the first condition, the experimental subjects were given a sample of biographical/personality descriptions drawn from populations mixed of engineers and lawyers. There were two treatment conditions with different mixes of lawyers and engineers: in one condition there were 70 engineers and 30 lawyers; in the other there were 30 engineers and 70 lawyers. If the subjects were given no personal information about the sample then they correctly judged the probabilities – applying Bayes's rule the ratio of the odds should be 5.44: it is 5.44 times more likely that an engineer will be drawn from Population 1 than from Population 2. When the subjects were given a biographical sketch of each person in the sample, then they ignored the base-rate frequency.

For example, in one experimental treatment the subjects were given information about a person in the sample called Dick. Dick was 30 years old, married, highly able and motivated, successful and well-liked. In this case the subjects judged the likelihood that Dick was a lawyer to be 50% regardless of whether he was sampled from Population 1 or Population 2. Subjects ignored the base rate and judged the description as equally representative of an engineer and a lawyer. It seemed that the subjects were being distracted by narrative information, comparing their sample of subjects via judgements of representativeness and ignoring the prior probabilities.

A related bias is probability matching. Probability matching occurs when choices vary with the probability of different events. Bliss *et al.* (1995) make a distinction between probability matching and base-rate neglect: base-rate neglect involves discounting the relative frequency with which events occur and probability matching occurs when reactions reflect the probabilities of the various consequences rather than the probability of the event itself. For example, World War Two bomber pilots were allowed either a flak jacket or a parachute, but the two together were too heavy to carry so they could not have both. Strafing from enemy guns was three times more likely than being shot down. The flak jacket was better protection against enemy guns; the parachute was better protection against being shot down. Objectively, enemy gunfire was always more likely and so it was always better to take the flak jacket. Yet, on average, the pilots were observed taking flak jackets three times out of every four and parachutes on the fourth occasions (Lo 2001).

Insensitivity to sample size

Insensitivity to sample size reflects an application of the representativeness heuristics in the sense that, regardless of sample size, people judge the likelihood that a particular sample result will be seen by reference to the equivalent population parameter. For example, in a sample of men, the average height will be 6 feet and the probability that the sample would have average height greater than 6 feet was judged to be the same whether the sample size was ten men or 1,000, yet the likelihood of unrepresentative sample averages is higher in small samples because outliers are less likely to be diluted. Kahneman and Tversky illustrate another aspect with an urn experiment: one draw of five balls reveals four red and one white; a second draw of 20 ball reveals 12 red and eight white. Experimental participants were asked which was more likely to be from an urn containing two-thirds red balls and one-third white balls. People focused their judgements on the simple proportions: the draw of four red balls out of five (i.e. 80% red) was judged to be more representative than the draw of 12 red and eight white (60% red) when probability rules in fact show that a draw of 12 and eight is more likely.

Objectively, however, if probability rules are applied, then the draw of 12 balls is more likely to come from an urn with two-thirds red balls but the experimental subjects were essentially ignoring the fact that the draw of five was a smaller sample. Tversky and Kahneman also observe that judgements of posterior odds are usually less extreme than correct values, reflecting an underestimation of the impact of evidence. A simple comparison of proportions should have led the experimental participants to the second answer but the participants seemed to be concluding that a sample draw of 80% red balls is more representative of an urn with mainly red balls than a sample draw of 60% red balls.

Insensitivity to predictability

This form of bias involves people discounting the reliability of evidence. For example, Tversky and Kahneman describe an experiment in which the experimental subjects were provided with descriptions of performance of a student teacher during a practice lesson. The subjects were then divided into two groups. One group was asked to evaluate the student's performance; the other group was asked to predict the student's career performance in five years' time. The percentile scores for the evaluations and predictions were "identical": scores on career success were the same as scores on teaching performance in one lesson. Tversky and Kahneman argue that, in reality, the likelihood that performance in one lesson will properly predict future career prospects is relatively small. Tversky and Kahneman (1974) do not address the fact that, even when point estimates for predictions of a student's future career success coincide, that does not mean that doubt is absent because doubt is captured via wider confidence intervals not different point estimate for predictions of future career performance; that is, a judgement of a probability is not the same as its weight but they introduce weighting functions into their analysis of prospect theory.

Illusion of validity and overconfidence

Interviewers will often overestimate their ability to judge the calibre of a candidate from a selection interview, even if they know and/or have prior experience of unreliable interpretations of character and performance from previous selection interviews. Another illustration of this problem is that the internal consistency of a pattern is judged to have more reliability than a less internally consistent pattern. The internal consistency leads to a judgement of representativeness, for example the application of intuitive, heuristical principles leads a teacher to conclude that a student with an exam record of BBBBB is more obviously representative of a B class student than another student with an exam record of ACBAC. Tversky and Kahneman argue that this is another form of bias because highly consistent patterns are more likely to contain redundant elements and/or strong correlations between elements, for example for a student who gets two Bs in Spanish and Italian: both these scores are picking up similar things and are more likely to be correlated. Yet an A in maths and a C in history are likely to be independently determined and these independent elements combined are giving more reliable information overall that the student is on average a B standard student. Predictions based on a set of independent, uncorrelated elements are more likely to give an accurate answer than predictions based on a set of related, highly correlated elements, but people judge a set of correlated elements as being more reliable because they are more representative.

The illusion of validity may create other biases such as overconfidence (a particular problem in financial markets, as we will see in Part II) and self-serving bias. These will mean that a person will be more likely to claim responsibility for successes than for failures. Overconfidence is especially a problem for extreme probabilities (close to 0% and/or 100%) which people tend to find hard to assess.

Misconceptions of regression

Misconceptions of regression link into Galton's fallacy about regression towards the mean and Galton's (1886) empirical observation that tall men are more likely to have sons shorter than themselves. This is because there are random elements in the determination of a man's height (as well as non-random aspects such as genetic make-up, etc.). Outliers are outliers partly because of large random errors. So, if the very tall man is an outlier reflecting a large positive error component in his height, then his son's height is unlikely to reflect the same magnitude of error and the son will be shorter than his father. Mean reversion and convergence do not reflect causal mechanisms; they are just statistical tendencies.

Tversky and Kahneman apply this insight to heuristics and biases. If a child performs very well on one test then his performance in the next is likely to be disappointing just because of mean reversion, but people will assign spurious causal explanation, reflecting the fact that the output (e.g. a prediction about a child's performance) should be representative of the input (the child did well in a previous test). In reality, a bad performance after a good performance just reflects a statistical tendency, just as very tall fathers are more likely than shorter fathers to have sons who are shorter than themselves.

Tversky and Kahneman argue that there will be some worrying behavioural implications for punishment and reward. If someone is rewarded for doing well, but then is just statistically more likely to do less well, rewards will be associated with deteriorating performance. On the other hand, if someone is punished for poor performance, and their performance improves just because of mean reversion, then punishments will be mis-attributed to improving performance. Iterating to the impacts on the person who is rewarding and punishing in some sense: punishment is rewarded and reward is punished.

Representativeness and the conjunction fallacy

Another illustration of the representativeness illustrates another way in which people misapply statistical rules when judging the probability of a conjunctive event. Conjunctive events are events that are not independent of each other. For example, if an urn contains three red balls two white balls, a red ball is drawn on the second draw, and is not returned to the urn, then this will affect the chance that a red ball will be drawn on the third draw. However, if the red ball is replaced, then the draw of a red ball on the second and third draws are disjunctive events – the chances of one occurring does not affect the chances of another occurring. One behavioural bias identified by Kahenman and Tversky links to a set of conjunctive events and is labelled the conjunction fallacy. There are many illustrations of the conjunction fallacy and a classic is the "Linda problem" (Tversky and Kahneman, 1983):

> Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations. Please check off the most likely alternative:
>
> 1. Linda is a bank teller.
> 2. Linda is a bank teller and is active in the feminist movement.

In this, there is an interaction between representativeness and the conjunction fallacy. In experiments, a large proportion of people will judge it to be more likely that Linda is a social worker active in the feminist movement, than that she is an unspecified sort of social worker even though the former is a subset of the latter and therefore statistically must be at most equally probable. If this problem is framed as a statistical question then most people with a basic knowledge of probability would realize that the conjunction of two events is less probable than each event alone.

So people can sometimes answer more accurately when the problems are expressed purely in probabilistic/statistical terms: that is, is event 1 more likely or not than a conjunction of event 1 with event 2. Most people with a basic knowledge of probability would realize that two events coinciding is less probable than each event happening separately and independently. However, when confronted with the details about Linda, most people find the second option more likely than the first, simply because the description appears to be more representative of a feminist stereotype, and hence more plausible.

This is a *conjunction fallacy*: the former option is the most likely since the probability of the conjunction of two events can never be more probable than either event independently, as illustrated in Figure 3.1. One circle captures the set of those who are bank tellers; the other circle captures the set of those who are feminists. The overlap of the two sets is smaller than each set along: that is, bank tellers who are also feminists is a smaller set than all bank tellers – whether feminist or not, or whether bank tellers or not. It is more likely that Linda will be in one of these whole sets, than in the intersection between them. In other words, a more precise set of characteristics is always at best equally (and usually less) probable than a set of more general characteristics.

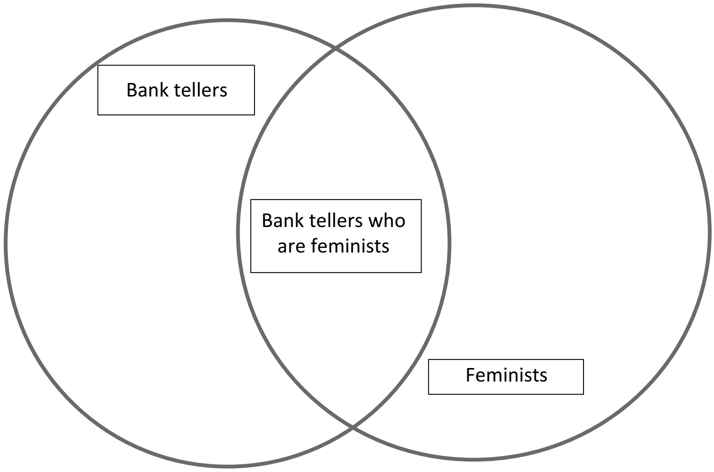

Figure 3.1 Illustrating the conjunction fallacy: the Linda problem

Availability heuristic

Availability is the heuristic of judging an event to be more likely if occurrences of the event can be easily recalled, for example large, more frequent classes of events are easier to recall (Kahneman and Tversky 1974). The availability heuristic will also lead to primacy and recency effects in which the first and last events in a series have a disproportionate impact on current judgments. The availability heuristic introduces a role for memory in economic analysis too – for example, Mullainathan (2002) analyses memory and bounded rationality. Kahneman and Tversky (1974) outline a number of biases that emerge from the misapplication of the availability heuristic including retrievability bias; imaginability bias and illusory correlation.

Retrievability bias/familiarity bias

This bias emerges from the fact that some classes of events are recalled more easily and if they are easier to recall then they will be judged as more numerous. This also links to a familiarity bias; we recall more easily people and events that are more familiar to us. For example, subjects were asked to listen to a list of names including a mixture of unfamiliar names and celebrity names. After they'd heard the list they were asked to judge whether the lists included more men or women. When there were more male celebrity names, the subjects erroneously judged that there were more males in the group; when there were more female celebrity names, the subjects erroneously judged that there were more females in the group. This was perhaps reflecting the fact that when they tried to remember the names on the list, they recalled the celebrity names more easily because they were more available.

Effectiveness of search

If people are searching for instances of events and they can identify instances quickly and easily then this effectiveness of search will lead to an upward bias in the probability judgement. For example, if people are asked to decide whether or not it is more common that words have "r" as a first letter or as a third letter, they will be able to search more effectively recalling instances of words that begin with "r" and this will lead them to judge that words beginning with "r" are more frequent than words with "r" as a middle letter, even though English words with a middle letter "r" are more common than those with a starting letter "r". Similarly, people find it easier to recall abstract words such as "love" than concrete words such as "door". Kahneman and Tversky argue that this is because people can more easily recall contexts including love than contexts including a door – and perhaps emotional salience is playing a role here too.

Imaginability bias

Events that can be generated or "imagined" are easier to recall and, via the availability heuristic, will be judged more likely. Kahneman and Tversky illustrate with an example of an adventurous expedition. When people are asked to judge the risk of an expedition, if they can imagine many dangerous, uncontrollable contingencies then they will judge the trip to be very risky. If they cannot easily conceive of the dangers involved then they will judge the trip to be less risky. The evaluation of risks will not necessarily coincide with any objective likelihood. For example, if people are comparing the likelihood of the relative risks of a trip to Antarctica or a trip to the jungle, then they may be able to imagine many more dire contingencies for the latter because more people have travelled to the jungle than have travelled to Antarctica. Therefore, they may decide that a jungle trip to be more risky than an Antarctic trip, just because they don't know much about the risks in Antarctica.

Illusory correlation

This bias occurs when people imagine correlations between events because the features of the events fit together. Tversky and Kahneman cite evidence from a study in which experimental subjects are presented with two sets of information about patients: a drawing and a clinical diagnosis. Afterwards, the subjects were asked to judge the frequency with which a diagnosis such as paranoia or suspiciousness coincided with particular features from the drawings (e.g. "peculiar eyes"). Subjects significantly overestimated the actual frequency of some coincident events: for example, if they were asked how many times they had seen a picture of someone with peculiar eyes and a diagnosis of paranoia, they would significantly overestimate that set of coincident events, but these positive correlations reported by subjects, for example between suspiciousness and peculiar eyes, were illusory. Kahneman and Tversky attribute this to an "associative bond" between events, for example suspiciousness is popularly associated with peculiar eyes.

Attention bias and the availability heuristic

Another bias emerging from the misapplication of the availability heuristic, not specifically identified by Kahneman and Tversky (1974) is attention bias. Earl (2005), in developing some axiomatic foundations for psychological economics, focuses on the impact of attention bias when attention cannot be allocated optimally. In this case, choices will be fickle, susceptible to random influences and context, for example in the case of fashions and fads. Attention bias may emerge from a misapplication of the availability heuristics leading to misjudgements based on past events and information easily recalled because they are attention grabbers, for example including primacy and recency effects – that is the first and last pieces of information that people receive.

Attention bias can also lead people into misguided predictions about the future. If events have recently caught people's attention then they will affect perceptions of the likelihood of similar events in the near future. This is why insurance companies do well after a spate of disasters. Attention bias will also affect perceptions of terrorist attacks (Gigerenzer 2004). Similarly, attention bias and the availability heuristic may cause researchers to recall the most interesting, attractive or complex field examples rather than those that are most often encountered, biasing their future interpretation. There may also be limits on attention and, for example, a limited attention bias may lead to overbidding in auctions or when supermarket shopping (Malmendier and Lee 2011).

Anchoring and adjustment

Anchoring and adjustment is a single heuristic that involves making an initial estimate of a probability called an anchor, and then revising or adjusting it up or down in the light of new information (Tversky and Kahneman 1974). This typically results in assessments that are determined by an anchor value or reference point, as explored in more detail in the next chapter – in the context of Kahneman and Tversky's prospect theory. For example, in deciding about an appropriate wage demand to make in the face of an uncertain economic environment, workers will tend to anchor their demands around their existing wage. Anchoring effects may operate in a social dimension too if one individual's judgements is "anchored" to others' opinions.

Kahneman and Tversky (1974) identify three specific biases that emerge from insufficient adjustment: biases in evaluating conjunctive events; biases in evaluating disjunctive events, and anchoring biases.

Insufficient adjustment

This bias occurs when probability judgements are anchored to prior information or events and are not adjusted as the information or context change. Kahneman and Tversky illustrate with an example of incomplete numerical tasks. Two groups of school students were given 5 seconds to estimate the answer to a numerical question: one group was given the task of estimating $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$; the other group was given the task of estimating $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$. Their time allowance of 5 seconds was not enough for most to have time for reflection. The group with the first problem estimated 512; the second group 2,250. The correct answer is 40,320. The estimate for the first expression was higher than for the second and Kahneman and Tversky argue that this reflected anchoring onto the first number: the group anchoring onto the starting value of 8 came up with higher estimates that the group anchoring on a starting value of 1. Both groups underestimated the true answer by a substantial degree, reflecting incomplete adjustment – they hadn't had time correctly to extrapolate to the large correct answer.

Evaluation biases

Tversky and Kahneman (1974) discuss biases that emerge when people are asked to evaluate conjunctive and disjunctive events, linking to the evaluative biases associated with the conjunction fallacy, as illustrated above with the Linda problem. Further problems with probability estimates from conjunctive and disjunctive events reflect anchoring and adjustment. For example, Tversky and Kahneman give an example of an experiment in which subjects could place bets on events. There were three types of event:

A: simple event of drawing a red marble from a bag containing 50% red marbles and 50% white marbles. The objective probability of this event is 0.50.

B: A conjunctive event specifically drawing a red marble seven times in a row from a bag containing 90% red marbles and 10% white marbles, with replacement of the marble after each draw. The objective probability of this event is 0.48.

C: A disjunctive event specifically drawing a red marble at least once at some stage in seven draws (with replacement) from a bag containing 10% red marbles and 90% white marbles. The objective probability of this event is 0.52.

Then the subjects were offered two sets of choices:

1. When offered a bet between the simple event and the conjunctive event, subjects preferred to bet on the conjunctive event, even though the conjunctive event was less likely.
2. When offered a bet between the simple event and the disjunctive event, the subjects preferred the simple event, even though the simple event was less likely.

The subjects' intuitive judgements of probabilities inverted the objective probability ranking. Kahneman and Tversky attribute this to anchoring and adjustment asserting that people are judging the probabilities relative to a starting point with incomplete adjustment downwards or upwards towards the reference point. In the case of choice 1 (between event A and the conjunctive event B), the probability of the elementary event in event B (a red ball) is 90%; this is the anchor point event and adjustment *downwards* from 90% to 48% (the true probability) is incomplete leading subjects to decide event B is a better bet.

For choice 2 (between event A and the disjunctive event C), the elementary event is event C (again a red ball), but in this case the bag was biased towards white balls and so the probability of the elementary event (a red ball) was 10%; adjustment *upwards* from this point is incomplete leading subjects to decide that event A is more likely.

Kahneman and Tversky describe the directions of the anchoring bias in terms of metaphors of funnels and chains: the chain-like structure of conjunctive events leads to overestimation of probabilities. The funnel-like structure of disjunctive events leads to underestimation. Bar-Hillel (1973) explains: in the same way that the probability of events compounded using the logical operator "AND" is often overestimated, the probability of events compounded using logical "OR" is often underestimated. This sort of bias leads to an unbounded probability problem: subjects tend to overestimate each probability in a set of exhaustive and mutually exclusive scenarios and do not correct their probability estimates when the set of exhaustive but mutually exclusive outcomes is augmented. These biases lead people implicitly to infer that the total probability of the set of possible events is greater than one, that is, greater than certain, which of course is impossible (Anderson, 1998, p.15). On the other hand, probabilities of disjunctive events are underestimated, and this means that people will erroneously judge that the sum of probabilities of a set of mutually exclusive and exhaustive outcomes is less than one, which – again – is impossible.

Assessment biases

Assessment biases reflect inaccurate calibration. If a person is asked to construct a subjective probability distribution around their judgements, their probability distributions will reflect overly narrow confidence intervals. If a subject is calibrating probabilities on percentiles then values below the first percentile should be seen 1% of the time and values above the 99th percentile should also be seen 1% of the time. Overall, true values should fall within a 98% confidence interval. But experimental evidence reveals large, systematic departures with subjects revealing overly narrow confidence intervals. This phenomenon is seen in naïve and sophisticated subjects and is not eliminated by incentives or scoring.

Tversky and Kahneman attribute this to anchoring. There is insufficient upward adjustment from the mean to the 99th percentile and insufficient adjustment downwards from the mean to the 1st percentile. Overall this leads to confidence intervals that are too narrow. They describe a study in which quantities, for example air distances from New Delhi, were presented to subjects who were then asked to judge the 10th or the 90th percentile. Another group were given the median judgement from the first group and asked to assess the odds that the given value exceeded the true value. The first group was too extreme: they judged a probability of 10% for an event that occurred 24% of the time. The second group was too conservative; events that they judged 34% likely occurred in only 26% of cases.

Problems also emerge with the anchoring heuristic when people anchor onto misleading or irrelevant reference points. Tversky and Kahneman give an example of a wheel of fortune experiment. For each subject, the wheel was spun to reveal a number and each subject was then asked to estimate the number of African nations in the United Nations. Their estimates were anchored on the number they span: subjects spinning a low number gave low estimates for the number of African countries in the UN; subjects spinning a high number gave high estimates. Ariely *et al.* (2003) identify similar evidence of "coherent arbitrariness" in a series of consumer experiences in which arbitrary anchors affected product valuations and hedonic experiences. Their experimental subjects were shown six products including computer accessories, wine, chocolates and books. They were asked if they would buy these products for an amount equal to the last two digits of their social security number (SSN). Then they were asked to reveal their willingness to pay (WTP). Subjects with SSNs above the median reported significantly higher WTP than subjects with SSNs below the median. For example, a subject with an SSN in the top quintile was willing to pay $56 on average for a cordless computer keyboard versus a WTP of $16 on average for subjects with bottom-quintile SSNs.

Cognitive balance and cognitive dissonance

In the sections above we have focused on Kahneman and Tversky's taxonomy of heuristics and associated bias. Their work spawned a very large literature, some of which is collected together in the edited volumes Kahneman *et al.* (1982) and Kahneman and Tversky (2000). There are other distortions in decision-making – similar to heuristics and bias but explored in separate literatures. One that is particularly relevant to behavioural economics is *cognitive dissonance*. Economic analyses of cognitive dissonance are developed by economists by bringing in insights from cognitive psychology – specifically from cognitive balance theory. Cognitive balance theory explores cognitive functioning, including interactions of cognition and emotion, and cognitive dissonance. Heider (1958) developed cognitive balance theory to analyse the extent of congruence between expectations and outcomes, an issue also of central interest in economics. People seek consistent patterns and cognitive balance. When there is cognitive imbalance people will act to return themselves to a state of psychological balance. For example, if you respect your friend but your friend likes watching *The X Factor* (which you hate), then you will adjust your perceptions so that either you respect your friend less or like *The X Factor* more.

Festinger's (1957) analysis of cognitive dissonance draws on similar themes, developed by Hirschman (1965) who defines cognitive dissonance as

> a person who, for some reason, commits himself to act in a manner contrary to his beliefs, or to what he believes to be his beliefs, is in a state of dissonance. Such a state is unpleasant, and the person will attempt to reduce the dissonance.
>
> (Hirschman 1965)

When unexpected or undesirable events occur, people reinterpret events and information to fit their prior beliefs about how the world is or should be. When people behave in a way which is contrary to their beliefs about themselves this creates cognitive dissonance between their beliefs and experience. In response, they act to try to remove the dissonance. This creates belief biases, for example when we interpret events and information to fit our preconceived notions as a device to overcome cognitive dissonance. This is done unconsciously. If we believe something then we will perceive that it has a logical basis, even if that logical basis is imagined.

A type of cognitive dissonance also affects political attitudes when perceptions of the logical basis for an assertion are determined by beliefs in the conclusion, not necessarily the objectivity of the assertion; for example, if a Republican voter believes that healthcare should be privatized then they are more likely than a Democrat to perceive that critiques of publicly-funded healthcare have a logical, objective basis. Similarly, if a person is religious and believes that God created the earth then they are more likely than an atheist to believe that the theory of intelligent design has an objective basis.

Akerlof and Dickens (1982) apply psychological insights about cognitive dissonance to an economic model based on three basic preferences: first, people have preferences not only over states of the world but also over their *beliefs* about states of the world; second, people have some control over their beliefs; and third – beliefs persist over time. The cost of the belief is the cost associated with mistakes made because of the belief. For example, people have a preference for believing that their workplace or environment is safe. The cost of their belief relates to the mistakes that emerge when reality and beliefs are mismatched. Believing that you're safe may lead people to behave in a reckless way by not wearing radiation safety badges in nuclear plants, or by failure to buy earthquake insurance when living in an earthquake zone. People in dangerous jobs must rationalize their choices: working in an unsafe place is not smart, therefore working in an unsafe place creates cognitive dissonance. This can be reconciled if the worker adjusts beliefs towards thinking that the workplace is safe.

Akerlof and Dickens describe a range of experimental evidence that supports their three basic premises. In one study, students were asked to insult other students by describing them as "shallow, untrustworthy and dull". The students making the insults adjusted their attitudes towards their victim reflecting cognitive dissonance: they believed themselves to be nice people: nice people don't insult other students without justification. So the only mentally internally consistent conclusion to reach is that the other students must have been shallow, untrustworthy and dull. People who engage in anti-social, aggressive or violent behaviour may reconcile their behaviour with their fundamental belief that it is wrong to behave violently by rationalizing and believing that they were provoked. Akerlof and Dickens cite another study of cognitive dissonance in weight reduction: if dieters are set difficult tasks for weight reduction, then they must justify these difficult tasks as worthwhile otherwise it would be foolish to undertake them. This generates persistence in beliefs. Weight-watchers with difficult goals are more likely to have sustained weight loss than groups with more modest goals because those with different goals have had to modify and reconcile their beliefs to achieve the initial weight loss, and their modification of beliefs is more likely to persist.

❖ CASE STUDY: ENERGY AND THE ENVIRONMENT

Heuristics, biases and folk wisdom in environmental decision-making

Social information is used when households anchor their energy consumption decisions around socially determined reference points. Without a reference point, information about embedded emissions is of little use to the consumer because they do not understand technical information and more easily understand social comparisons as a type of reference point; for example, efforts to introduce carbon labelling, by the French supermarket chain E. Leclerc, focused not just on information about carbon emissions per kg for specific products but also total carbon footprints for trolley-loads of food, as well as social comparisons with the average trolley footprint (Guenther *et al.* 2012).

In explaining these biases in choices related to energy and the environment, behavioural economists focus on the idea that people are limited in a world of bounded rationality because of constraints on information, knowledge and learning. Shogren and Taylor (2008) draw on Mullainathan and Thaler (2000) in identifying three aspects to limits on rational behaviour as seen in environmental behavioural economics: bounded rationality, bounded willpower and bounded self-interest. Just increasing the availability of information is not necessarily the simple solution it seems; Leiserowitz *et al.* (2012) note that often, the behaviours that would be most effective (e.g. driving cars less often) are neglected in favour of the less arduous behaviours such as switching off lights. Knowledge and belief are not enough and just because people have knowledge about the benefits of environmental actions does not mean that they will engage in those actions.

One fundamental constraint on rationality is lack of knowledge, though Stern (2000) argues that knowledge is just a necessary component in engineering environmental behaviour change; it is not sufficient in itself. Pongiglione (2011) emphasizes the role of knowledge in a behavioural analyses of climate change and individual decision-making. In risky situations, deep psychological mechanisms propel people towards inaction and apathy and this constrains pro-environmental behaviour. Behaviour change requires a combination of understanding, procedural knowledge and self-interest.

Problems emerge because self-interest interacts with subjective perceptions, limited knowledge and imperfect information. Procedural knowledge, including practical information about ways to reduce environmental impact, is particularly important as it enables people to turn subjective beliefs into concrete actions (Kaiser and Fuhrer 2003). Similarly, Reynolds *et al.* (2010) focus on knowledge deficits to explain environmental inaction and empathy gaps. Pongiglione argues however that it is not all about knowledge deficits. The main obstacles to behaviour change reflect interplaying factors. Perception, self-interest and limits to knowledge all play a role – here knowledge includes awareness, understanding and procedural practical common-sense knowledge about energy efficiency and the environment.

Biases in environmental decision-making are exacerbated by uncertainty about the future, as well as knowledge about the present. Decisions between risky alternatives will affect both firms and households: firms in their investment decisions and households in their energy consumption decisions and in purchases of lumpy consumption goods such as refrigerators and boilers. Uncertainty will have a profound impact on consumption and investment decisions. Carbon labelling can reduce consumers' uncertainty about the impact of their purchases, but labelling can provide some guidance to environmentally conscious consumers. The question of how emissions should be measured and reported remains. Best practice would involve calculating emissions over the life cycle of a product – in its manufacture as well as its end-use. For many products, however, life-cycle emissions are uncertain. How do you calculate the end-use emissions from shampoo given the variability in its use? For example, end-use emissions will depend how long someone spends in the shower and the heat of the water.

Sunstein (2006) analyses the role played by the availability heuristic in people's intuitive cost–benefit analysis of climate change. He argues that if people have recently experienced serious tangible harms from climate change then climate change will be perceived as a more salient problem. People are also affected by bounded rationality and cognitive limitations when assessing quantitative information about the environment.

Hartman, Doane and Woo (1991) explore status quo bias in energy consumption. They conducted a survey of electricity consumers who were asked about their preferences for reliability and rates. Their responses fell into two groups: those with a reliable service and another group with an unreliable service. They found that 60.2% of the high reliability group wanted to retain their current contract even when the low reliability contract came with a 30% rate decrease; 58.3% of the group with the less reliable supplier wanted to stay with their existing supplier when offered the opportunity to switch at a 30% increase in rates. Whilst to some extent their original choices may reflect underlying preferences, learning and/or habits, nonetheless Kahneman, Knetsch and Thaler predict more switching and attribute the limited switching to a status quo bias (Hartman, Doane and Woo 1991; Kahneman, Knetsch and Thaler 1991).

Status quo biases will lead people to stick with old habits and avoid change, and – to an extent – partly this may be an economically rational way of avoiding the transaction costs associated with change (Pongiglione 2011; McNamara and Grubb 2011). However, there is evidence that it is not just about transaction costs. For example, in the UK, switching energy supplier is a quick and easy process; if a customer decides to switch, the new supplier contacts the old supplier; cost comparison websites are easily accessible so overall the risks and transaction costs associated with a switch are small. Yet, even in the face of rising energy prices from the UK's Big Six energy suppliers, households do not necessarily apply competitive pressure by switching supplier. A 2011 YouGov poll commissioned by Anglian Home Improvements showed that 51% of respondents are likely to delay switching energy supplier and would prefer instead to ration energy, for example by wearing warmer clothing (YouGov 2011). This reluctance to switch may partly reflect a status quo bias/familiarity bias.

Kempton and Montgomery (1982) and Kempton, Feuermann and McGarity (1992) analyse the use of heuristics and "folk methods" in energy consumption decisions and observe that miscalculations can lead to underinvestment in energy efficiency. Information about energy efficiency is often presented in a way that is intelligible to experts but esoteric to ordinary consumers. Research has shown that, in encouraging drivers to be aware of their fuel use, gallons-per-mile is more effective than miles-per gallon (Loewenstein and Ubel 2010). Also, bounded rationality leads to reliance on heuristics – for example, people will adapt old methods to new situations when old methods will not provide the optimal solution. Consumers will use everyday reasoning including heuristics to speed up and simplify their measurement of residential energy decisions. The use of these folk methods is reasonable in the sense that it saves time and effort in computation but it does also lead to mistakes.

Kempton and Montgomery (1982) analyse folk quantification via interviews of 30 Michigan families, ten of whom were using energy-saving devices. These families also used "folk units", for example familiar absolute measures such as gallons, dollars and months to gauge their energy use. One householder conceptualized his energy consumption in terms of how many times per month he had to fill his oil tank. He did not conceptualize his energy decisions in terms of kilowatt-hours. People also focused on peak consumption, for example a woman describing to her husband that insulation had reduced gas bills noted that they were no longer getting large $100 gas bills as they had before.

Kempton and Montgomery also identified a tendency to overemphasize certain forms of consumption. People overemphasized lighting as a drain on energy and were more likely to turn the lights off than they were to use less hot water – even though the latter had a larger impact. This overemphasis on lighting could reflect historical factors (lighting always used to be the biggest energy user) and/or problems of perception and categorization. Lighting output is more salient; we notice it more. It is also an archetypal representation of the broad general category of electricity use. People also focused on first-hand experiences and experiences of friends rather than impersonal, but objective, data summaries from organizations. Kempton and Montgomery found that householders focused on the dollar amount of their energy bills, neglecting the fact that consumption measured in dollars reflects price as well as volume. They also identified biases when people did not recognize that behaviour changes had had an impact on their bills. They were not recognizing that their bills reflected not only their water consumption changes but also price increases.

Households were also using folk methods to calculate savings from reducing energy consumed, and by focusing just on dollar amounts to make comparisons they neglected the impact of rising prices. This failure to incorporate rising prices, led to underestimation of the savings from reduced consumption. These problems also affected energy investments, that is, by using simple payback methods without adjusting for price increases, folk methods led householders to overestimate how long it would take them to pay off their energy-efficient investments.

Overall, whilst heuristics are cognitively efficient in the sense that they are quick, easy to learn and useful for household budgeting, they also lead to systematic errors in quantification, ineffective energy conservation, increased vulnerability to online fraud and underestimation of benefits of investments in energy efficiency.

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The studies explored in this chapter show that human decision-making is limited by the power of human cognition. The need to make quick decisions efficiently leads to the adoption of a number of heuristics and in many cases, these can lead to systematic biases in behaviour and choice. These biases cannot be explained in terms of standard assumptions though alternative behavioural approaches to decision-making can capture some of the heuristics and biases that characterize everyday decision-making.

Earl (2005) encourages policy-makers to recognize that people do not competently use statistical techniques and whilst this can distort perception and judgement, psychological economics can play a normative role by promoting better decision-making techniques. Thaler and Sunstein (2008) also explore the fact that whilst biases can create problems for the policy-maker, often biases can be exploited to encourage more socially beneficial behaviours. For example, too few people donate their organs, give blood or save properly for their retirement but the status quo bias can be exploited using default options. If default options are constructed so that donating blood or organs is the default, then people will be less likely to opt out of donating. Overall, donations will increase and more people will donate. A wide range of policy lessons from the application of ideas about heuristics and biases is explored in Thaler and Sunstein (2008) in the context of policy nudges, as we will explore in Chapter 9.

In developing an analytical framework for heuristics and biases, Kahneman and Tversky provided a foundation for their innovative behavioural theory of risk: *prospect theory*. As we will explore in the next chapter, prospect theory provides an alternative to standard theory and can be used as an analytical framework in which key forms of bias are captured, for example biases related to loss aversion and framing effects.

Chapter summary

- Heuristics are quick decision-making rules of thumb and have been identified by many economists and psychologists – from Herbert Simon, Daniel Kahneman and Amos Tversky through to Gerd Gigerenzer and Dan Goldstein – as important tools which people use to simplify their everyday decision-making.
- Whilst heuristics often work well enough most of the time, sometimes they lead to behavioural bias.
- Daniel Kahneman and Amos Tversky develop a taxonomy of heuristics, focusing on availability heuristics, representativeness heuristics and anchoring and adjustment.
- Availability heuristics are based on using easily retrievable and engaging information, that comes quickly to the "top of the mind" – for example, recent events.
- Representativeness heuristics are based on making comparisons with similar events and phenomena.
- Anchoring and adjustment is about making decisions with respect to a reference point, and adjusting around that reference point, rather than "starting from zero", as is the focus in standard economics.
- Other constraints on choices and behaviour link to insights from psychology, for example, cognitive dissonance occurs when a person's actions seem to conflict with their beliefs, and so they adjust their beliefs to eliminate these cognitive conflicts.

Revision questions

1. Compare and contrast the different approaches to rationality seen across the behavioural and experimental literatures. In comparison with standard economic assumptions about rational choice, what are the advantages and disadvantages of these different conceptions of rationality? Explain your answer.
2. If using heuristics leads to behavioural bias, is this rational or not? Why? Why not?
3. Describe and explain some examples of heuristics and their consequences in terms of behavioural bias.
4. Which types of heuristics do you think are most important to everyday decision-making: availability, representativeness or anchoring/adjustment? Explain your answer and illustrate with examples.

Chapter 4

Prospects and regrets

In the previous chapter on heuristics and bias, we explored some of the limits on rationality explaining some of the heuristics and biases seen in everyday decision-making. This literature is discursive and intuitive in style and so vulnerable to a criticism that it lacks objective rigour. In response, Kahneman and Tverksy (1979) developed these insights to construct their own alternative to expected utility theory (EUT) – the standard approach to risky choices embedded within the standard economic model of risk. Kahneman and Tversky argue that behavioural paradoxes cannot easily be explained by EUT but these can be reconciled using their prospect theory. But what is prospect theory? Prospect theory is a framework which captures how people choose between different risky "prospects" – defined as sets of risky alternatives. Prospect theory can reconcile behavioural inconsistencies without abandoning rigorous analysis.

There are two elements to prospects – their risk and their utility. This chapter starts by exploring some behavioural paradoxes that led to rethinking of standard approaches in the evolution of Kahneman and Tversky's prospect theory. Some of the limits on statistical reasoning that might explain these behavioural paradoxes are then discussed leading into Kahneman and Tversky's critique of expected utility theory. Then, Kahneman and Tversky's prospect theory alternative to expected utility theory will be analysed, including its limits, developments and alternatives, including cumulative prospect theory, Thaler's mental accounting model and Loomes and Sugden's regret theory.

Behavioural paradoxes

Standard economic models are dependent on assumptions of rational consistent preferences and so they cannot easily explain some behavioural paradoxes: instances in which people violate basic rationality axioms. In this section, a selection of these paradoxes will be explored including the Allais paradox, the Ellsberg paradox, the Monty Hall problem and the St Petersburg paradox, as discussed by Allais (1953), Ellsberg (1961), Samuelson (1977), Bar-Hillel and Falk (1982), Nalebuff (1987) and Conlisk (1989), amongst others.

St Petersburg paradox

The St Petersburg paradox is described by Samuelson (1977): Peter and Paul are playing a coin toss game. Peter suggests to Paul that he toss a fair coin an infinite number of times. Paul will be paid 2 ducats if heads come up at the first toss, 4 ducats if he tosses a head at the second toss, 8 if he tosses a head at the third toss. Overall Paul's payment will be 2^n where n is the number of coin tosses. The paradox in this game is that Paul's reward will be infinite: assuming a fair coin, his chance of a head on the first round is ½ so his payoff for a head on Round 1 will be $\frac{1}{2} \times 2 = 1$. For Round 2 his payoff will be $\left(\frac{1}{2} \times 2\right) + \left(\frac{1}{4} \times 4\right) = 1 + 1 = 2$, and for Round 3 his payoff will be $\left(\frac{1}{2} \times 2\right) + \left(\frac{1}{4} \times 4\right) + \left(\frac{1}{8} \times 8\right) = 1 + 1 + 1 = 3$, and so on. If Paul plays an infinite number of rounds then his expected payoff will be ∞. Therefore, a fair stake for Paul to place on this game is ∞ but he is unwilling to do this. He will only be willing to make a finite bet. This paradox is resolved by assuming that marginal utility is a decreasing function of wealth, that is, by assuming that Paul is risk-averse. The dependence of EUT on the assumption of risk aversion is one of the key elements of Kahneman and Tversky's (1979) critique, as explained below.

Allais paradox

Allais's (1953) paradox describes inconsistencies in choice when people are deciding between options in two gambling games, one of which involves a certain outcome. Conlisk (1989) describes a set of gambles in which people choose between lotteries.

*Gamble 1: Choose A or A**

Lottery A	$1 million with certainty
Lottery A*	1% chance of zero; 89% chance of $1 million; 10% chance of $5 million

*Gamble 2: Choose B or B**

Lottery B	89% chance of zero; 11% chance of $1 million
Lottery B*	90% chance of zero; 10% chance of $5 million

Standard economic theory predicts that a person with consistent preferences will choose B if they chose A, and B* if they chose A*. Which of these pairs they choose will depend on their aversion to risk. The expected value for A is less than the expected value for A* but the chance of zero is eliminated. Similarly, the expected value for B is less than the expected value for B*. However, experimental evidence shows that real people commonly choose the inconsistent combinations A*B and B*A. Choices are not completely random however and Conlisk observes a systematic pattern: violations of EUT more commonly involve the combination AB* than A*B. Kahneman and Tversky (1979) attribute the violations to a "certainty effect", as we will explore below.

Ellsburg paradox

Ellsburg's (1961) paradox can be illustrated with an urn game. An urn contains 90 balls: 30 are red balls and the remaining 60 balls are some unknown combination of black and yellow balls. Subjects were asked for their preferences over two gambles.

Gamble 3: If one ball is drawn from the urn, will you bet on:

a. red?, or
b. black?

Gamble 4: If one ball is drawn from the urn, will you bet on:

c. red or yellow?, or
d. black or yellow?

Subjects were given plenty of time to make their choices. Ellsberg found that many people prefer to bet on red in Gamble 3 and black or yellow in Gamble 4.

Ellsberg observes that this is a violation of the "sure thing principle" which requires that if *a.* is preferred to *b.* then *c.* should be preferred to *d.* Ellsberg attributes this inconsistency to ambiguity aversion in the face of Knightian uncertainty. As defined by Knight (1921), Knightian uncertainty describes fundamental uncertainty about unknowable probabilities. Knightian risk describes probabilities which can be quantified because they capture observable, repeatable events which can be measured using frequency ratios or, in the case of Ellsberg's urn game, are given as prior information about proportions. In the case of Ellsberg's paradox, the subjects know that the probability of a red ball is 0.33 because they are told that 30 of the 90 balls are red. They also know the probability of either yellow or black because they have been told 60 balls are yellow or black, though they do not know exactly how many are yellow and how many are black. So estimating the chances of red, and yellow or black are Knightian risk problems. On the other hand, they are given no information about the probability of a black ball versus a yellow ball. All they know is that the remaining 60 remaining balls are either black or yellow So estimating the chances of red or yellow, or red or black are Knightian uncertainty problems. There is no objective information on which people can form an objective, quantifiable probability judgement. Ellsberg observes: "it is impossible to infer even the qualitative probabilities of yellow versus black". Abdellaoui *et al.* (2011) observe that when uncertain events are associated with probabilities that cannot be quantified something else is needed to resolve the paradox. They give a tractable quantitative method in which subjective probabilities are converted into a willingness to bet.

Bayes' rule and the Monty Hall problem

Nalebuff (1987) describes a number of other paradoxes driven by people's updating of probabilities – including a paradox often referred to as the Monty Hall problem. This paradox is interesting because its counter-intuitive natures has triggered much debate. Even some statisticians struggled to understand why the correct answer is correct because the answer is counterintuitive. To understand the correct decision, we need to use a statistical rule known as Bayes' rule – named after its inventor, the Reverend Thomas Bayes. Bayes' rule sets out how to adjust our estimates of the chances of an event when new information comes along. We start with a *prior probability* – based on all the information we currently have. Then some new information comes along and we update our prior probability using this new information to form a *posterior probability* – which takes into account the new information.

The Monty Hall version of this paradox is named in honour of Monty Hall who was the host of a TV show *Let's Make a Deal*. Contestants are shown three curtains. A large prize is hidden behind one curtain, and small prizes are hidden behind the other two. The contestant makes a choice and then Monty Hall opens the curtain to reveal what's behind one of the curtains not chosen and asks the contestant if they want to change their mind.

If people are reasoning in a Bayes rational way then they should decide to change their mind. If they don't then they are making a decision without properly updating their prior probabilities using Bayes' rule.

Bar-Hillel and Falk (1982) show why this is the case in describing essentially the same problem set in a different context – the Three Prisoners problem. Tom, Dick and Harry are held in a jail. The next day, one of them will be executed and the other two will be set free. Tom, Dick and Harry's prior probabilities of being executed are 1/3 but Dick is anxious and asks the jailor to tell him just whether Tom or Harry will be set free. No new information has been revealed about the probability that *Dick* will be executed and so his overall chance of execution remains 1/3. The fact that this result seems counterintuitive to most people reflects the fact that human intuition is not probabilistic; often people struggle intuitively to understand statistical problems. Intuitive responses to this question reflect confusion, at least in terms of Bayes' rule, about the conditional probabilities. Bar-Hillel and Falk explain the correct answer using Bayes' rule, as outlined in the Mathematical Appendix A4.1.

Expected utility theory (EUT)

A fundamental aspect of Kahneman and Tversky's analysis of prospect theory is their critique of expected utility theory. Concepts of expected value and expected utility were developed by Bernoulli and others from the 18th century onwards but only found their way into mainstream economics in the mid-20th century, most famously in von Neumann and Morgenstern's (1944) analysis of expected utility theory.

To enable an understanding of Kahneman and Tversky's critique, a summary of some of the basic principles of EUT are outlined in Box 4.1. The von Neumann and Morgenstern preference axioms include transitivity, completeness, substitution, continuity and invariance. Transitivity means that if A is preferred to B and B is preferred to C then A is preferred to C. Completeness means that in a choice between A and B, an individual will either prefer A, prefer B or be indifferent between A and B. Substitution implies that if two alternatives are identical then they can be substituted for each other – for example, if an individual is indifferent between two alternatives then they will also be indifferent between the alternatives if these are offered with equal probabilities. Continuity implies that if $A \leq B \leq C$ then B can be expressed as a weighted sum of A and C. Invariance implies that the expected utility function can be scaled up without affecting the ordering of preferences.

Overall, these EUT axioms generate a theory in which people have stable, consistent risk preferences. As noted earlier in the context of the St Petersburg Paradox, by including an assumption of risk aversion, the standard utility function becomes concave, as illustrated in Figure 4.1. Expected utility will increase at a decreasing rate and individuals will prefer averages to extremes. Given these axioms, Savage (1954) shows that expected utility is the product of a subjective utility function and a Bayesian subjective probability distribution (Savage 1954; Kahneman and Tversky 1979).

Figure 4.1 shows an example of a choice between £10 and £50. If a person is offered a choice between a 50% chance of £10 and a 50% chance of £50, then the expected value of this gamble is £30 but this gives utility at u_1 whereas a guaranteed £30 has a utility of u_2 and $u_2 > u_1$. In other words, if a person has to be paid a certainty equivalent (the amount which makes them indifferent between the gamble and a guaranteed amount) of £35 to take a gamble with an expected value of £30 then they are risk-averse. EUT assumes that

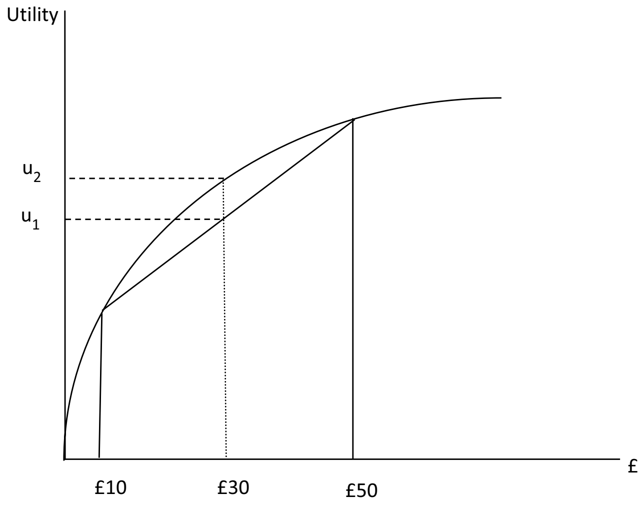

Figure 4.1 A concave utility function

people are risk-averse and the more bowed is the utility function, then the higher risk aversion will be. This is captured by the Arrow-Pratt measure of absolute risk aversion (ARA), which captures the curvature of the utility function using the change in marginal utility relative to its level. The coefficient of relative risk aversion (RRA) weights the risk parameter by consumption and further variants of ARA and RRA include constant absolute risk aversion (CARA) and constant relative risk aversion (CRRA). Ultimately, all these measures are similar in embedding stable, measurable risk preferences.

Kahneman and Tversky's critique of EUT

Kahneman and Tversky provide a critique of Savage's (1954) approach to analysing decisions between uncertain outcomes – the set of risky alternatives that Kahneman and Tversky call "prospects". They assert that people do not necessarily reason using mathematical/statistical tools and this explains some of the behavioural paradoxes described above. Kahneman and Tversky set out some of the problems with EUT and then devise their own solution in the form of prospect theory – a model which enables us better to understand various anomalies in human decision-making.

In developing prospect theory, Kahneman and Tversky (1979) start with a critique of standard expected utility theory (EUT) and explain how real-world behaviour is better explained by prospect theory. Expected utility theory is both a normative theory – capturing how rational people *should* behave; and a positive/descriptive theory – capturing how people *do* behave. Many people probably would, in principle at least, prefer not to plan their lives in an illogical, inconsistent way so, as a normative theory, EUT has more merit – even normative issues can be incorporated within it, as seen in models of inequity aversion – explored in Chapter 2. Normatively, if utility functions can be broadened properly to incorporate preferences for non-monetary sources of utility, such as equity, then most people would like to act in a way predicted by EUT.

Some of the mathematics underlying Kahneman and Tversky's critique of EUT are outlined in the Mathematical Appendix A4.2. According to Kahneman and Tversky, the most profound problem with EUT is its legitimacy as a positive theory. The problem is that people don't/can't act as predicted by EUT: EUT lacks predictive power and so its role as a positive descriptive theory is compromised. Kahneman and Tversky argue that EUT does not provide an adequate description of human behaviour in the real world.

In their critique, Kahneman and Tversky focus on the Savage axioms underlying EUT including the expectation axiom (overall utility is the sum of the expected utilities), the asset integration axiom (acceptable prospects are those which integrate with wealth to give a utility greater than the utility of the wealth alone) and the risk aversion axiom, which holds if, and only if, the utility function is concave.

The expectation and risk aversion axioms are self-explanatory. The asset integration axiom can be explained by reference to an example: if a friend suggests a poker game in which you have to put down a stake of £1 for a 10% chance of winning £10 then that poker game is an acceptable prospect for you if and only if the utility of your new wealth (£10- £1 = £9) plus the utility of a 10% chance of winning £10 exceeds the utility of £10 alone – that is your starting utility if you decided not to play the game. According to Kahneman and Tversky, a key feature of the asset integration assumption is that utility is about final stages, not changes. One of the key features of prospect theory, as will be seen below, is the assumption that utility is determined by *changes* not levels.

Kahneman and Tversky present experimental evidence showing a range of phenomena associated with real-world violations of these assumptions. They do acknowledge that reliance on evidence from hypothetical choices may not be valid. In particular, experimental results – particularly as many of the experiments use university students as subjects – may lack external validity and may not be generalizable to the wider population. However, Kahneman and Tversky defend their experimental approach on the grounds of simplicity: in investigating real choices you either need to see those choices in the field or in lab experiments and the problem with field experiments is that probabilities and utilities cannot easily be measured, whereas measurement is relatively straightforward in lab experiments because experimental conditions can be tightly controlled.

Kahneman and Tversky present evidence from Israeli, Swedish and US experiments in which students and faculty members were given a series of questionnaires in which they were asked to make hypothetical choices between a range of prospects. They found that people's choices were not consistent with EUT and this finding was similar across all the samples. Kahneman and Tversky identify some common anomalous effects in people's decisions: the certainty effect, the isolation effect and the reflection effect.

The certainty effect

This effect can be illustrated with Kahneman and Tversky's example of two sets of choices: Gamble 1: a choice between A and B; and Gamble 2: a choice between C and D. This is essentially the same as the Allais paradox choice, described above, but with the scenarios tightened as follows:

Gamble 5: Choose A or B
A: a 33% chance of 2,500, a 66% chance of 2,400, and a 1% chance of 0
B: 2,400 with certainty

Gamble 6: Choose C or D
C: a 33% chance of 2,500 and a 67% chance of 0
D: a 34% chance of 2,400 and a 66% chance of 0

Note that, for this set of gambles, the difference in the expected values for A and B is 9, and the difference in the expected values for C and D is also 9. Also, the probability of a payoff of 0 is just 1% lower for B relative to A, and for D relative to C. So, in this sense, Gamble 5 and Gamble 6 are the same and the consistent choices are to pick C if you picked A, and to pick D if you picked B. Either of these sets of choices are justifiable under EUT. Which pair you choose will depend on how risk-averse you are. However, the real choices were inconsistent. Kahneman and Tversky found that actual choices were broadly similar to Conlisk's (1989) finding as outlined above and 18% of people picked A but 83% of people picked C; similarly, 82% picked B but only 17% picked D. A substantial proportion of people picking B switched to C when they were no longer offered a certain prospect.

More precisely, for the choice between C and D, unless you are very risk-averse it would be sensible to pick C and indeed a large proportion of people (83%) did pick C; only 17% of people were sufficiently risk-averse to take the slightly reduced chance of getting nothing. You would expect a similarly low proportion of highly risk-averse people were confronting the choice between A or B. With A, there is just a very small 1% chance of getting nothing, yet many more people avoided it, suggesting extreme risk aversion. Only 18% of people preferred A to B, and 82% of people chose the certain outcome of 2,400. This suggests that people are overweighting certain outcomes – people behave very differently when offered a guaranteed outcome relative to how they behave when offered an outcome that is only slightly less likely, that is, very highly probable. Kahneman and Tversky call this effect the certainty effect and its existence is inconsistent with EUT.

The certainty effect is a violation of the substitution axiom and a further illustration of the Allais paradox, discussed above. Experimental evidence also reveals other violations of the substitution axiom. When the probability of one outcome is double the outcome of another, choices will depend on whether the probabilities are low or high. Kahneman and Tversky illustrate this with the following choice pairs:

Gamble 7: Choose A or B
A: a 45% chance of 6,000,
B: a 90% chance of 3,000

Gamble 8: Choose C or D
C: a 1% chance of 6,000
D: a 2% chance of 3,000

For Gamble 7, 85% chose B. For Gamble 8, 73% chose C. Note that the amounts are the same. The probability of B is double the probability of A. The probability of D is double the probability of C. Even if the risk aversion assumption is relaxed, EUT predicts that a risk-averse person would pick the more likely outcome; a risk seeker would pick the larger payoff but Kahneman and Tversky's evidence shows that people are not consistent in their choices between risky prospects: people's choices shift depending on whether they're choosing between low probabilities or high probabilities. When probabilities are small, 73% of Kahneman and Tversky's subjects were picking the bigger but less likely payoff; when probabilities are large, 86% were choosing the smaller but more likely payoff. This suggests a nonlinearity in the *value function* – the function that captures the relationship between expected utility and the magnitude of payoffs, as explained below.

Reflection effect

Kahneman and Tversky find further evidence of nonlinearity in the value function in experimental evidence about losses. Following Markovitz (1952) who identified the tendency to seek risk when confronting losses, Kahneman and Tversky set-up choices in which their experimental subjects are choosing between losses, not gains. These experiments provide more powerful evidence against EUT because risk preferences shift when people are choosing between losses. Preferences for losses are a mirror image reflection of preferences for gains, whereas EUT would predict a risk-averse person is just as averse when confronting losses as when looking at gains. To illustrate, Kahneman and Tversky compare the following choices:

> *Gamble 9: Choose A or B*
> A: an 80% chance of 4,000 gain
> B: a certain gain of 3,000
>
> *Gamble 10: Choose C or D*
> C: an 80% chance of a 4,000 *loss*
> D: a certain loss of 3,000

For Gamble 9, Kahneman and Tversky's experimental evidence showed that 80% of subjects chose B. For Gamble 10, 92% of subjects chose C. Preferences for negative prospects, that is, losses, were a reflection of preferences for positive prospects: Kahneman and Tversky's subjects avoided risk in the domain of gains but they were risk-seeking in the domain of losses. Kahneman and Tversky call this phenomenon the reflection effect and it reveals people taking greater risks to avoid losses, a phenomenon also linked to loss aversion – as discussed below.

Preferences for losses and gains were a completely symmetrical mirror image which is a clear violation of the EUT expectation assumption and so eliminates uncertainty aversion as the explanation for the certainty effect identified above. If people are ambiguity-averse then a certain outcome has zero variance – so no ambiguity at all, and if someone is extremely risk-averse perhaps they will avoid outcomes associated with any sort of positive variance at all, no matter how small. But the reflection effect demonstrates unequivocally that ambiguity aversion is not the explanation because people are not ambiguity-averse when confronting losses.

Isolation effect

The isolation effect is about the fact that people disregard common components in alternatives, whether those common components are the payoff or the probabilities. Kahneman and Tversky compare some choices in which preferences are altered by different representations of probabilities even though, objectively, the choices are identical. For example, they analyse choices in a two-stage game, as follows.

> *Gamble 11: Choose A or B*
> Given a 75% chance of getting nothing and a 25% chance of moving to a second stage of choices, choose between A or B:
> A: an 80% chance of 4,000
> B: a certain payoff of 3,000

Gamble 11 is a two-stage version of the following one-stage gamble:

> *Gamble 12: Choose C or D*
> C: 4,000 with probability 20%
> D: 3,000 with probability 25%

For Gamble 11, the chance of getting to stage 2 is only 25% and so all second-stage payoffs should be multiplied by 0.25 to reflect the fact that there is only a 25% chance of playing the second stage of the two-stage game. So, if A delivers 4,000 in the second stage, then the probability of 4,000 is $0.25 \times 80\% = 20\%$, and if B delivers 3,000 in the second stage then the probability of 3,000 is $0.25 \times 1 = 25\%$.

Gamble 11 and Gamble 12 are essentially the same choice yet Kahneman and Tversky's subjects approached these gambles in different ways. For Gamble 11, 22% of subjects chose A and 78% B, but for Gamble 12, 65% chose A and 35% chose B. Their preferences were inconsistent and depended on the way in which the gambles were framed. According to EUT, people should focus on the probabilities of the final states but people are treating the sequential game as if it is a standard game. In the stage game they are ignoring the first stage.

Similarly, when the same payoffs are represented in different ways, people will make inconsistent choices as illustrated with the next set of prospects.

> *Gamble 13: Choose A or B*
> Imagine that you start with a positive endowment of 1,000 and have the following choice:
> A: a 50% chance of 1,000
> B: a certain payoff of 500

Kahneman and Tversky compare Gamble 13 with Gamble 14:

> *Gamble 14: Choose C or D*
> Imagine that you start with a positive endowment of 2,000 and then choose between:
> C: 1,000 loss with 50% probability (50% chance of 2,000; 50% chance of 1,000)
> D: 500 loss with certainty (1,500 with certainty)

For Gamble 13, the net payoffs from A are 1,000 with 50% probability and 2,000 with 50% probability. The net payoff from B is 1,500 with certainty. For Gamble 14, the net payoffs from C are a 50% chance of 1,000 and a 50% chance of 2,000 and the net payoff from B is a certain 1,500. The payoffs in Gamble 13 and Gamble 14 are identical yet choices were variable. For Gamble 13, 16% chose A and 84% chose B. For Gamble 14, 69% chose C and 31% chose D. Preferences were not invariant. These experimental results were also consistent with the reflection effect because the preferences for losses were the mirror image of preferences for gains – again, inconsistent with expected utility theory but consistent with prospect theory.

Kahneman and Tversky's prospect theory

As we have seen above, Kahneman and Tversky's (1979) experimental results do not fit easily with the predictions of EUT and Kahneman and Tversky construct prospect theory to reconcile some common behavioural anomalies. They argue that choices are made as the outcome of two separate, sequential processes: an editing phase and an evaluation phase.

Editing phase

The editing phase is about simplifying the representation of prospects and there are a number of ways in which this is done including coding, combination and cancellation.

- *Coding*: When prospects are coded as either gains or losses relative to a reference point, this reference point is not necessarily set at zero. In fact, the reference point is more often set by the status quo, for example a person's current asset position.
- *Combination*: Probabiliies associated with identical outcomes are combined. If a set of prospects includes a 25% chance of 200, another 25% chance of 200 and a 50% chance of zero, the 200 payoff will be combined into a 50% chance of 200.
- *Cancellation*: Occurs when people disregard common elements in a set of choices set, for example ignoring first stages in sequentional decisions, or ignoring a common bonus as outlined in the isolation effect examples above. Other editing operations include simplifications such as rounding-up probabilities and payoffs to approximate amounts and discarding outcomes that are very unlikely. Editing will also involve the deletion of dominated prospects – that is prospects for which there is always a better alternative.

Editing does create the possibility of inconsistency and intransitivity because differences in prospects which are eliminated in the editing process may change the preference ordering of prospects, especially as the outcome of simplification will depend on the editing sequence and context. Kahneman and Tversky give the example of a choice between one prospect involving a 500 payoff with 20% probability versus a 101 payoff with 49% probability and another prospect involving a choice between 500 with probability 15% and 99 with probability 51%. The second choices in both prospects might be simplified to a 50% chance of a 100 payoff and then the first prospect will appear to dominate the second whereas it would not have dominated if the choices had not been simplified in the editing phase.

Evaluation phase

After editing the prospects, the next stage is to evaluate the prospects so that the decision-maker can choose the prospect with highest expected value. In this, Kahneman and Tversky develop insights from previous analyses, for example Markowitz (1952) who identified nonlinearities in utility functions rather than strict concavity, proposing a model in which values are assigned to changes not final states. The process of evaluation will depend on the nature of the prospects available and specifically whether the prospect is strictly positive (all choices are gains and probabilities sum to 1); strictly negative (all choices are losses and probabilities sum to 1) or regular prospects – a combination of gains and losses and/or probabilities that sum to less than 1. Kahneman and Tversky state explicitly that this will lead to a model in which choices violate normative principles of choice and choices made may be inconsistent, intransitive and/or dominated by better alternatives. This is the point of Kahenman and Tversky's theory: they are aiming to explain the anomalies in real-world choices that cannot be explained by EUT.

The value function

In prospect theory, there are two elements to the value of the edited prospect: the decision weight assigned to each probability and the subjective value of the outcomes. According to prospect theory, subjective value is determined by changes in utility and specifically the subjective value of deviations from the reference point.

The essential features of the prospect theory value function are:

1. value is determined relative to deviations from a reference point, and this is not necessarily zero
2. generally the value function is concave for gains and convex for losses
3. the value function is steeper for losses than for gains.

It follows from (2) and (3) that the value function will be steepest at the reference point and Kahneman and Tversky's hypothetical value function has an S-shape – as depicted in Figure 4.2.

Earlier points we explored about reference points and loss aversion are captured in the prospect theory value function as explained below.

Reference points

Reference points play a central role in prospect theory as the anchor of the value function. In prospect theory the reference point is the status quo, for example the current asset position, but shifts in reference points may alter a person's ordering of their preferences. If someone receives an unexpected tax bill then it may take them a while to adjust reference points and may lead to people accepting gambles that might otherwise be unacceptable, so their preferences will seem inconsistent.

Reference points link into the anchoring and adjustment heuristic explored in Chapter 3 and prospect theory can help to explain these effects. Abeler *et al.* (2011) discuss experimental evidence from subjects working on a tedious task: for example, counting the number of zeroes in tables of randomly ordered zeroes and ones. The incentives were a 50% probability of a fixed payment and a 50% probability of a piece rate payment. The differential reference points were established using two treatments – "LO" in which the fixed payment was 3 euros; versus "HI" for which the fixed payment was 7 euros. They found that effort provision was reference-dependent; the subjects in the HI treatment worked harder and for longer than the subjects in the LO treatment.

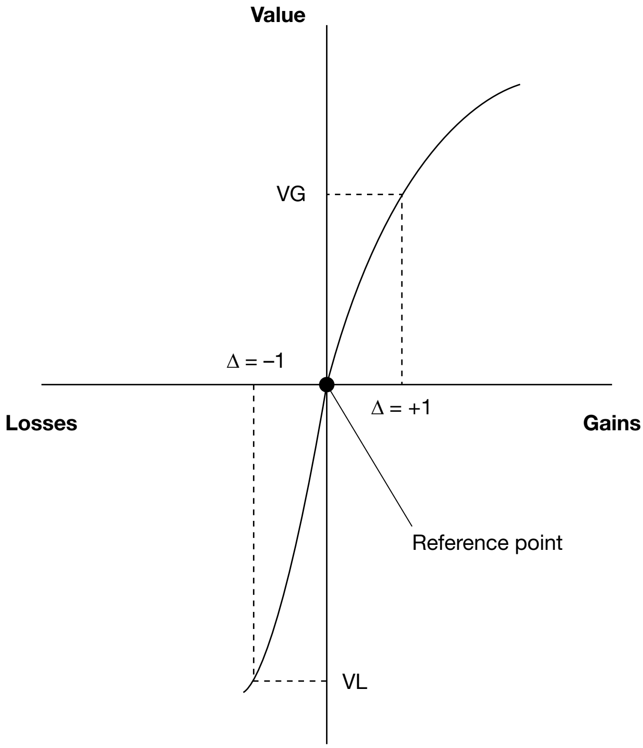

Figure 4.2 Prospect theory value function

Whilst reference points are central to prospect theory, Kahneman and Tversky do allow a role for special circumstances too. If someone needs £60,000 to pay off some gambling debts, then their evaluation of a prospect to get some money will be particularly steep around £60,000 but will flatten off beyond that point. This raises the issue of framing, addressed in developments of prospect theory, for example Thaler's mental accounting model, which we will explore in Chapter 13.

Loss aversion

Gains and losses are defined with respect to the reference point and Kahneman and Tversky emphasize that losses affect value more than gains. This means that the value function will be steeper for losses than it is for gains. This can be seen in the illustration of the prospect value function in Figure 4.2. For a positive change $\Delta = +1$, the increase in value is given by VG. With losses of the same magnitude, that is, $\Delta = -1$, the decrease in value is given by VL. In absolute terms, VL > VG; losses "loom larger" than gains.

Again, special circumstances may come into play. For example, for home-owners: aversion to losses may be particularly steep just at the point when a house is at risk of repossession because that loss will be associated with a larger, wider range of other losses. In this way, attitudes to money are not "pure"; they are complex and determined by a whole range of factors and consequences meaning that value functions can shift from concave to convex regions and may even be linear in some regions.

The weighting function

Kahneman and Tversky assign weights to the probabilities of prospects, as captured by the weighting function and the mathematics are outlined in this chapter's Mathematical Appendix A4.3. Building on empirical evidence cited in Kahneman and Tversky (1979, p. 280) five independent studies of 30 decision-makers identified concave utility functions for gains and convex utility functions for losses, with utility functions usually steeper for losses than for gains.

The weighting function is steep at its extremes and is discontinuous when probabilities are close to 0 or 1 because people do not know how to comprehend extreme events. They do not know how to weight extreme probabilities or even if they should weight them at all. This can be captured by recognizing that, in prospect theory, the scaling of the value function is complicated by the introduction of the weighting function. Decision weights can capture complexity of decision-making. They can transform linear value functions into nonlinear ones to capture risk aversion and risk-seeking. Kahneman and Tversky emphasize that their weighting function is not about degrees of belief, as is the focus in some other studies, for example, Keynes (1921), Ellsberg (1961) and Fellner (1961). Instead, decision weights measure relationship between likelihood of events alongside their probability. In EUT, the focus is on simple problems but in prospect theory, other factors beyond simple probability, such as ambiguity, determine desirability and this reflects decision weights.

The weighting function has a number of properties including overweighting, sub-certainty and sub-proportionality. The sub-certainty property captures the fact that probabilistic outcomes are given less weight than certain outcomes, and this feature captures the Allais paradox. Sub-certainty will be more pronounced for vague probabilities than for clear probabilities. There is overweighting of very low probabilities and sub-proportionality captures the fact that the ratio of decision weights is closer to unity for small probabilities than for large probabilities.

Once the weighting of probabilities is incorporated into prospect theory, in contrast to the nonlinear utility functions from Markowitz, the expectation principle of EUT no longer holds. There will be violations of dominance reflecting the nonlinearity of the prospect theory weighting function. The editing phase has significant implications here: simplification of prospects during editing leads to very low probabilities being treated as if they are impossible and very high probabilities being treated as if they are certain.

Evidence from game shows

Post *et al.* (2008) note that empirically testing EUT and prospect theory against each other is complicated by the joint hypothesis problem. There are two sets of unknowns: the true probability distribution is unknown to the subject and the subjects' beliefs are unknown to the researcher. Game shows can resolve this problem in providing natural experiments that enable an experimenter to infer the players' beliefs because the subjects are told that the probability distribution and the game itself requires minimal skill and strategy.

Post *et al.* analyse evidence from Deal or No Deal (DOND) games played between 2002 and 2007 by 151 contestants from the Netherlands, Germany and the USA. The games were played in slightly different ways in the different countries but a typical version of the game involves each contestant picking one suitcase from a selection of 26 suitcases. Each suitcase contains a sum of money varying between 1 euro to 5m euros. Having selected her own suitcase, in Round 1 the contestant is invited to select one of more of the other suitcases to be opened. Once these other suitcases have been opened, the game's banker offers to buy the contestant's suitcase. The banker's offer will reflect the average value of the unopened suitcases. If the contestant agrees on a deal to sell her suitcase to the banker, then the game finishes. If not, that is if the contestant decides "no deal" in response to the offer for her suitcase, then the contestant can see the contents of more and more suitcases (except her own) and the banker continues to make offers to buy the contestant's suitcase. The game lasts up to 8 or 9 rounds and, in the final round, the choice is reduced to a simple binary choice in which the contestant faces a 50% chance of winning the larger sum when she decides between "deal" or "no deal".

Post *et al.* find that the contestants' choices reflect moderate levels of risk aversion and also exhibit reference dependence and path dependence, a result consistent with prospect theory. They predict the choices of contestants using EUT and prospect theory and then compare the predictions. EUT predicts 76% of outcomes but it fails to capture the evidence of path dependency seen in the contestants' choices. A simple version of prospect theory predicted 85% of choices and captured the reference dependence and path dependence observed in the contestants' choices. On the basis of this evidence at least, prospect theory outperforms EUT.

Cumulative prospect theory

Kahneman and Tversky admit that their theory has limitations. It cannot capture complex choices, for example in bidding games. There will be violations of dominance and also prospect theory does not give insight into more complex tasks when more than two prospects are available, for example bidding processes. It does not capture more complex factors affecting attitudes towards prospects, including social norms, security, prudence and misinformation.

Kahneman and Tversky's prospect theory was also criticized by others, for example because it led to violations of strictly rational choice. Whilst some choices can be removed in the process of editing, this does then mean that prospect theory predicts violations of the transitivity axiom, that is, suggests that people will make inconsistent choices. Whilst for some the point of prospect theory *is* to capture the fact that people are not always consistent in their choices, it does nonetheless rest uneasily with an attempt to devise a structured account of decision-making. For this reason, Kahneman and Tversky developed cumulative prospect theory incorporating rank-dependent weightings in which only extreme unlikely events were overweighted, not all unlikely events (Tversky and Kahneman 1992).

Regret theory

Loomes and Sugden (1982) formulate regret theory as a "simpler", "more intuitive" alternative to Kahneman and Tversky's prospect theory. They analyse the behaviour of an individual facing a finite number of alternative states of the world. Each of these states has a probability which can be interpreted as either an objective probability or, if knowledge is absent, as a subjective probability. The individual must choose between actions where each action is some multiple of consequences broadly defined. Loomes and Sugden develop their model in terms of consequences captured by changes in wealth but emphasize that this is not essential for their theory. An innovation relative to prospect theory is that there is a clear link between actions, consequences and states of the world, whereas the concept of prospects does not associate consequences with states of the world. In regret theory there is one consequence for each state of the world whereas in prospect theory a number of different actions may correspond with each prospect.

Loomes and Sugden's mathematical model is summarized in Mathematical Appendix A4.4. They construct a "choiceless" utility function which captures the utility, the "psychological experience of pleasure", derived from a consequence in the absence of choice. For example, the utility a person gets from housing allocated by government may differ from the utility from housing which has been chosen. Intuitively, the concept of choiceless utility introduces the possibility of regret, in a situation in which a person has a choice between two actions A and B but with consequences *x* and *y* dependent on a future state of the world which the decision-maker can neither choose nor predict in advance. If the person chooses action A then they will experience consequence x but they will nonetheless be aware that, if they had chosen B, then they would have got y. Their pleasure will depend not only on the consequences they chose via their action but also on the consequences from options not chosen. Loomes and Sugden illustrate with an example: an increase in tax rates leading to an increased tax bill of £100 is a choiceless consequence but losing £100 in a horse race is the outcome of a choice. Loomes and Sugden postulate that the decrease in pleasure will be greater in the latter case because it generates regret.

More generally, assume that a person chooses option A with a payoff *x* and rejects option B with a payoff *y*. If x is less than y then they will experience regret from choosing A and that will reduce their pleasure. On the other hand, if x is greater than y they will experience "rejoicing"; their pleasure will increase. Using these insights about rejoicing and regret, Loomes and Sugden construct a modified utility function which incorporates pairs of consequences for each state of the world. In regret theory, the utility function captures not only "what is" but also "what might have been". These insights are combined into a restricted version of their model – the regret–rejoice function, which captures the rewards from a chosen strategy and also the differential between chosen and unchosen utility.

Loomes and Sugden assume that people maximize expected modified uility but do not claim that maximization is only objective consistent with rationality. Employing Friedman's (1953) defence of positivism, they use this assumption because it gives predictions consistent with empirical evidence. Loomes and Sugden explain that experimental evidence from Kahneman and Tversky's (1979) analysis of prospect theory, including the Allais paradox, isolation effects, reflection effects and preferences for contingent insurance are all consistent with regret theory. Regret theory is also one of the early attempts to incorporate emotional factors into economic models and the role of emotions in economic decision-making are explored in more detail in Chapter 9, which is about how moods and emotions affect choices.

Expected utility theory is difficult to reconcile with some of the heuristics and biases outlined in the previous chapter and Kahneman and Tversky's prospect theory offers an alternative that captures many of the essential features of heuristics and biases. Some of the key insights include that losses are avoided more than gains are pursued and that people adjust to reference points and focus on changes rather than utility levels. Prospect theory is not without its limitations however and alternative theories including Loomes and Sugden's regret theory capture some of the features of nonstandard decision-making that Kahneman and Tversky's prospect theory does not capture.

In prospect theory and regret theory, models are constructed to capture behavioural paradoxes and limits to expected utility theory. These models suggest that human thought is not well-adapted to processing probabilistic and statistical information. As discussed in the previous chapter on heuristics and biases, research has shown that most ordinary people make common mistakes when they judge probabilities. Some biases may reflect a lack of data, an issue addressed in economic analyses that focus on incomplete and/or asymmetric information, uncertainty and risk – but mistakes may also reflect cognitive limits on processing within the human mind if human brains are not well adapted to the format of data inputs and/or algorithms needed effectively to process the data.

In terms of policy, it is important to recognize that changes are important and that people decide according to their reference points. If policies can be designed to reset these reference points then this may lead to more effective decision-making, via defaults to exploit status quo bias, for example. In addition, framing effects will have significant impacts and reference points can be reset by changing the framing of a choice, for example expressing desirable choices in terms of potential gains instead of potential losses may lead to more effective decision-making by encouraging positive behaviours. Similarly, expressing undesirable choices in terms of potential losses instead of potential gains may deter those behaviours. This connects with some of the nudge policies introduced in Chapter 9 and advocated by Thaler and Sunstein (2008) though it is important to emphasize that nudges can lead only to limited behaviour changes and deeper policy approaches will also be required.

There could also be a greater focus in policy-making on communicating information in a way that suits our cognitive capacities. Anderson (1998) analyses the impact and nature of memes. Memes are the cultural equivalent of genes and a unit of imitation (Dawkins 1976; Blackmore 1999). Successful memes survive (are remembered) and reproduce (are transmitted) effectively in three cases: when they map effectively onto human cognitive structures, incorporate a standardized decision structure and have been reinforced by dominant members of the scientific community. By drawing parallels between memes and genes, evolutionary themes can be applied to the analysis of how memes spread knowledge and information. Lynch (1996, 2003) applies these insights in his analysis of the evolutionary replication of ideas and argues that "thought contagion" affects a wide range of human behaviours and beliefs.

These insights can be incorporated into policies which enable more effective decision-making. As noted above, if students are asked to judge the probability of two coincident events within the context of a statistics class, then they know how to apply their knowledge of statistical principles. Outside their classes however, when presented with essentially the same problem they may be unable correctly to answer because they misapply heuristics using instincts and intuition in a misleading way. To overcome these problems Anderson suggests that Bayesian approaches can be refined using the advantages of a frequentist approach, for example by using more mental/visual imagery to guide decision-making. If frequency ratios could be communicated to people in a more clear and accessible way, then human cognition might be able to process subjective probabilities more effectively. For example, probabilistic information about the risks of different alternatives (taking a train versus driving, for example) could be represented in graphical or pictorial form. In the presenting information, attention could be paid to devices for cognitive interpretation. When prompted by clear signals and steers, the human brain may be able to deal with probabilities more effectively.

Chapter summary

- Kahneman and Tversky present prospect theory as an alternative to conventional economic theories of risk – namely expected utility theory – to explain a number of behavioural paradoxes that expected utility theory cannot explain.
- Prospect theory differs from expected utility theory in key ways, which reflect the special characteristics of their value function.
- In prospect theory, people balance the chances of different prospects using a reference point as a starting point, not from a starting point of zero – as is postulated in expected utility theory.
- Losses are treated differently from gains: losses loom larger than gains so that people care more about *losing* money than *gaining* an equivalent absolute amount of money.
- Risk preferences shift along the value function capturing the idea that people do not have a single risk preference. Whether a person's choices reflect risk-seeking or risk-avoiding behaviour will depend on the context and the balance of probabilities for one prospect against another.
- Prospect theory has its own limitations and some of these are addressed in alternative behavioural theories of risk, for example Loomes and Sugden's regret theory.

Revision questions

1. Why have behavioural economists and economic psychologists thought it necessary to build new models of risk to replace expected utility theory? What are the problems with expected utility theory that behavioural economists and economic psychologists are aiming to resolve?
2. Of the different theories of risk outlined in this chapter, which theory of risk do you think has the most power in explaining everyday decision-making: expected utility theory, prospect theory or regret theory?
3. What do expected utility theory, prospect theory and regret theory have in common? How do they differ?
4. What are the relative advantages and disadvantages of conventional economic and behavioural theories of risk?

A4 MATHEMATICAL APPENDIX

A4.1 Bar-Hillel and Falk's solution to the Three Prisoners problem

The events D, H and T are the hanging of Dick, Harry and Tom respectively and:

$$P(D) = P(H) = P(T) = \tfrac{1}{3}$$

The probabilities that the guard will designating Harry or Tom to be freed –$\overline{H}_g$ and $\overline{T}_g$ respectively, conditioned on events D, H and T are:

$$P(\overline{H}_g \mid D) = \tfrac{1}{2},\ P(\overline{H}_g \mid H) = 0,\ P(\overline{H}_g \mid T) = 1$$

If Dick is to be hanged then Harry and Tom are equally likely to be designated by the guard as the prisoner to be freed, i.e. $\overline{H}_g = \overline{T}_g = \tfrac{1}{2}$. This gives the conditional probability that Dick will be hanged, conditional on the guard designating Harry as the prisoner to be hanged:

$$P\left(D \mid \overline{H}_g\right) = \frac{P(\overline{H}_g \mid D)P(D)}{P(\overline{H}_g \mid D)P(D) + P(\overline{H}_g \mid H)P(H) + P(\overline{H}_g \mid T)P(T)} = \frac{\left(\tfrac{1}{2}\right)\left(\tfrac{1}{3}\right)}{\left(\tfrac{1}{2}\right)\left(\tfrac{1}{3}\right) + 0\left(\tfrac{1}{3}\right) + 1\left(\tfrac{1}{3}\right)} = 1/3$$

A4.2 Kahneman and Tversky's critique of EUT

Developing von Neumann and Morgenstern (1944) and Savage (1954), Kahneman and Tversky (1979) focus their critique of EUT on Savage axioms:

Expectation $U(x_1 p_1; x_2 p_2; \ldots; x_n p_n) = p_1 u(x_1) + p_2 u(x_2) + \ldots + p_n u(x_n)$

– total utility is equal to the expected utility of each outcome where x is the payoff and p is its probability

Asset integration $U(x_1, p_1; \ldots; x_n p_n \mid w)$ iff
$U(w + x_1, p_1; \ldots; w + x_n, p_n) > u(w)$

– a prospect is acceptable at asset position w if and only if its utility exceeds the utility of w alone

Risk aversion $u'' < 0$
i.e. total utility is increasing at a decreasing rate, total utility is concave.

The risk aversion tenet of EUT implies that people will prefer probabilistic insurance (PI) to contingent insurance (CI). Assume a person starts at a position of indifference between no insurance and contingent insurance:

$$u(w - y) = pu(w - x) + (1 - p)u(w)$$

where x is a negative prospect i.e. a loss, p is the probability of loss and y is the contingent insurance premium paid to avoid the loss.

To simplify, Kahneman and Tversky assume $u(w - x) = 0, u(w) = 1$ which gives:

$$u(w - y) = 1 - p$$

Kahneman and Tversky assume that a person will be willing to reduce their premium by a factor r to reduce the probability of losing x from p to $(1 - r)p$ and therefore:

$$(1 - r)pu(w - x) + rpu(w - y) + (1 - p)u(w - ry) > u(w - y)$$

This represents the amalgamation of risks characteristic of PI. In addition to the risk of a loss, there is also a risk with the PI policy: in the case of a loss you have some chance of being covered by insurance and some chance of facing the full loss yourself.

Again assuming $u(w-x)=0, u(w)=1$ and $u(w-y)=1-p$ gives

$$rp(1-p)+(1-p)u(w-ry)>1-p$$
$$\therefore u(w-ry)>1-rp$$

A4.3 Mathematics of prospect theory

Kahneman and Tversky (1979) define a prospect as a set of probabilistic outcomes, e.g. $(x_1, p_1; \ldots; x_n, p_n)$. To capture some the essential elements of prospect theory Kahneman and Tversky compare very simple prospects, e.g. $(x, p; y, q)$ in which a person receives x with probability p and y with probability q or nothing with probability $1-p-q$ where $p+q \leq 1$.

A strictly positive prospect involves positive outcomes, a strictly negative prospect involves only negative outcomes. A regular prospect involves both losses and gains, e.g. $(x, p; y, q)$ is a regular prospect if $p+q<1, x \geq 0 \geq y,$ or $x \leq 0 \leq y$.

Kahneman and Tversky observe that their prospect theory involves relaxing the expectation principle of EUT. The value of a prospect is captured by the subjective value of the outcome $v(x)$ and its decision weight $-\pi(p)$.

The value function

Kahneman and Tversky's value function captures the values and weights of the prospects as follows:

$$V(x, p; y, q)=\pi(p)v(x)+\pi(q)v(y)$$

This value function is illustrated in Figure 7.2. It has three main features:

(i) it captures deviations from a reference point not final states, i.e. gains and losses relative to the reference point;
(ii) it is usually concave above the reference point, i.e. for gains, and convex below it, i.e. for losses, i.e. $v''(x)<0, \text{for } x>0; v''(x)>0, \text{ for } x<0,$
(iii) it is steeper for losses than for gains, i.e. $v'(x)<v'(-x)$.

The weighting function

A probability weighting function can be described as:

$$\pi(p)+\pi(1-p)$$

It will exhibit the following properties, given $0<r<1$:

Subadditivity:	$\pi(rp)>r\pi(p)$
Overweighting:	$\pi(p)>p$ for low probabilities
Subcertainty:	$\pi(p)+\pi(1-p)<1$
Subproportionality:	$\dfrac{\pi(pq)}{\pi(p)} \leq \dfrac{\pi(pqr)}{\pi(pr)}$

A4.4 Mathematical summary of Loomes and Sugden's regret model

Loomes and Sugden start by assuming that there are many states of the world j and each state of the world j has a probability $0 < p_j \leq 1$ with $p_1 + p_2 + \ldots + p_n = 1$. People choose an action i and its consequences x (defined for the purpose of illustration as changes in wealth) are determined by j. Choiceless consequences are used as a benchmark and the pleasure from choiceless consequences is given by $C(x)$.

Given uncertainty, for actions $i = 1, 2$ if the person chooses action 1, i.e. $i = 1$ then, in addition to the direct pleasure derived from x_{1j} there are additional emotional sources of pleasure, i.e.:

$$\text{Regret when } x_{2j} > x_{1j}$$

$$\text{Rejoicing when } x_{2j} < x_{1j}$$

A modified utility function is constructed by defining $C(x_{ij}) = c_{ij}$ to give:

$$m_{ij}^{k} = M(c_{ij}, c_{kj})$$

Simplifying, the modified utility function gives a regret–rejoice function:

$$m_{ij}^{k} = c_{ij} + R(c_{ij} - c_{kj})$$

R(.) captures the differential rewards from choosing action i. $R(.) = 0$ is the limiting case consistent with expected utility theory but Loomes and Sugden assume that R(.) is strictly increasing and three times differentiable.

Chapter 5

Learning

The links between economic and psychological theories of learning have evolved along different paths – economic theories via insights from game theory, and psychological theories from a rich and varied range of sub-disciplines. Behavioural economics ties them together – specifically via links between economic models and behavioural psychology and this chapter explores how economic models of learning and behavioural psychology connect.

"To learn" is defined in the Concise Oxford Dictionary of English as "to gain knowledge of or skill in by study, experience or being taught". Teaching is a more complex activity – associated with higher animal species and it is distinct because it involves some form of self-sacrifice by the teachers. In economists' language – the teacher faces opportunity costs in their teaching activity and so it has elements of altruism. We will abstract from the complexities of teaching here and focus just on learning – as activities associated with updating knowledge. Camerer (2003a) observes, economic theory sometimes neglects questions of learning. If knowledge is perfect and people are strictly rational, then the correct choice can be identified from the start and people will jump from one equilibrium to the next only when information changes.

More recently, economic models have analysed equilibrium in the presence of imperfect or asymmetric information but Camerer (2003) argues that these models tend to focus on limit properties; if it takes a long time to reach the limiting behaviour, predicting the *path* of equilibration is potentially a lot more useful and interesting. In understanding how equilibrium is reached, experimental evidence is often more practically useful than theory but collecting reliable experimental evidence can also be problematic.

Camerer and Weigelt (1988) emphasize the importance of learning in experimental games, for example in trust games, public goods games and beauty contests. Camerer (2003) also outlines some characteristics of a good learning theory: it should be parsimonious, it should have predictive power and coherence but at the same time it should reveal new insights. Camerer (2003) describes learning models in the context of quantitative time-dependent functions of strategies known as *attractions*, which are like a stock of learning that builds up over time as new information comes along. Different learning models are characterized according to the learning rules which update these attractions, as will be illustrated below in the context of some learning theories.

Learning theories can be grouped into a few broad categories: evolutionary approaches, and reinforcement versus belief learning models (including hybrids of these, e.g. Camerer and Ho's (1999) experience-weighted attraction (EWA) model. Other learning models include anticipatory learning models, which assume sophistication, imitative learning, learning direction theory and rule-based learning. The most influential of these approaches are outlined below. In addition, there are social learning models which have some parallels in sociology and social psychology as we will explore in Chapter 6 on sociality and identity.

Belief learning

In belief learning (BL) models, attractions are built by attaching probabilities to each strategy combination from other players giving a time-dependent belief function in which beliefs about others' actions are updated as history unfolds. Players track the relative frequency of other players' strategies and these relative frequencies generate beliefs about other players' actions in the next period. This information is used to calculate expected payoffs given these beliefs.

Variants of BL models emerge depending on the weights attached to past actions. Brown (1951) develops a fictitious play (FP) model incorporating a more "appealing" assumption that players respond to the average of the observed history with previous observations counted and weighted equally. In Cournot models, following Cournot (1838) players choose the best response to opponents' most recently observed action; only the opponent's last action is counted.

Boylan and El-Gamal (1993) found in lab sessions that sometimes the Cournot model outperforms the FP model but at other times FP outperforms Cournot. To provide further comparative tests of belief learning models, Cheung and Friedman (1997) put together experimental evidence to show that equilibrium predictions lack predictive power and for most studies one of the players moved away from equilibrium initially.

A belief learning model

Assuming that beliefs are not directly observable, Cheung and Friedman construct their empirical learning rules based on a schema in which players and institutions/mechanisms generate interactions and feedbacks between actions, outcomes and beliefs. Actions interact with payoff functions to generate outcome; outcomes interact with learning rules to generate beliefs. Beliefs interact with decision rules to generate actions; and then the process starts again. They construct a 3-parameter learning model to capture these different BL approaches by postulating a set of beliefs and jointly estimate the decision rule and learning rule. They use the Cournot rule to capture current beliefs based on most recently observed actions, and an FP rule in which current beliefs based on simple averages of all previously observed states of the world. Past states are discounted with declining weights depending on how far back in time these states were, with the impact of past states captured by a learning parameter. The mathematical details of this approach are outlined in Mathematical Appendix A5.1.

A behavioural explanation can be assigned to the relative magnitude of the weights: when past observations are assigned no weight, as in the Cournot rule, then this captures recency effects which occur when recent and easily remembered information has a disproportionate impact on beliefs – possibly the outcome of applying the availability heuristic, as discussed in Chapter 3. If older observations are given a greater weight than more recent observations, then this suggests that first impressions have a disproportionate impact and this might reflect the application of anchoring and adjustment heuristics, also discussed in Chapter 3. It seems unlikely that past states would be assigned negative weights but if they are then the rule would be unstable.

The BL rule gives a decision rule based on the probability that a player will choose a given action; this will be determined by three elements. First, a player's responsiveness to the relative payoff from an action – the evidence weight; second, a player's idiosyncratic preference for that action; and third, the learning parameter. Cheung and Friedman apply their learning rules to the study of choices in experimental games.

Cheung and Friedman's experiments

In their controlled laboratory experiments, Cheung and Friedman used computerized experiments based on five groups of game: Hawk-Dove, Coordination (Stag Hunt), Prisoner's Dilemma, Buyer-Seller and Battle of the Sexes. (For those unfamiliar with the structure of these games, refer to an introductory game theory text, e.g. Dixit and Skeath 2004.) Players were matched in two ways: mean matching in which each player was matched once against each possible opponent; and random matching. Cheung and Friedman also incorporate two variants of historical data conditions: the "history" condition in which players are given information about states in previous periods; and the "no history" condition in which no historical information is given.

Using Probit techniques, they estimate the probability of a given action using relative payoffs, idiosyncratic preferences and past states of the world as explanatory variables. In some experiments, they found that play was consistent with mixed strategy Nash equilibrium and rational play. For coordination games, they find that parameters on all three explanatory variables are significantly different from zero, with a learning parameter estimated to be between 0 and 1, supporting adaptive belief learning over Cournot or FP. Overall, the findings from coordination games are broadly similar findings from the analysis of Buyer-Seller and Battle of the Sexes games too.

The implication that Cheung and Friedman draw from their analysis is that players are heterogeneous. Estimates of the parameters enable classification of players into types: Cournot players with short memories; intermediate players with adaptive BL; and long memory players using FP rules. They find that the distribution of player type is invariant to payoff but the learning parameter decreases in more informative environments and the evidence weight parameter is positive for most players. Most data are also consistent with the more sophisticated model of *anticipatory learning* in which players use information about others' payoffs not just the frequency of their choices.

Overall, Cheung and Friedman conclude that, together, their findings support belief learning models over reinforcement learning models. The support for this assertion is mixed however, and some economists have found similarly robust support for reinforcement learning models, as discussed in the following section.

Reinforcement learning

Insights from economic models of reinforcement learning parallel developments in behavioural psychology. The personality theories of Sigmund Freud and the psychoanalysts were controversial and the behavioural psychologists rejected Freudian approaches to understanding what underlies behaviour as subjective and speculative. Instead, they focused instead on analyzing objective facts viz. observed choices and the direct and indirect impacts of stimuli upon these choices. This focus on observed behaviour fits neatly with the experimental and game theory themes seen in modern behavioural economics which are about analysing choices. Behavioural psychology developed from Nobel prize-winning physiologist – Ivan Pavlov (1849–1946). Pavlov pioneered the study of classical conditioning. He was studying the digestive systems of dogs and noticed that they often started salivating before they tasted food; salivation was an unconditioned response to the unconditioned stimulus of receiving food. Pavlov hypothesized that a conditioned stimulus could induce a conditioned response and so set metronomes running a few seconds before feeding meat powder to his dogs. He found that once the dogs had learned the connection between the metronome and the food they would start salivating on hearing the metronome and before receiving the meat powder. Salivation was a learned, conditioned response and Pavlov found that the salivation response could be conditioned on a range of stimuli including rotating disks and lights (Pavlov 1904/67).

Watson and Rayner (1920) generalized Pavlov's findings about conditioned responses to humans and conducted a famously unethical study of Albert B to establish that phobias were the outcome of conditioning not early sexual conflicts, as asserted by the Freudians. Albert B was approximately 9 months old when the study commenced:

> the infant was confronted suddenly and for the first time successively with a white rat, a rabbit, a dog, a monkey, with masks with and without hair, cotton wool, burning newspapers, etc. … No one had ever seen him in a state of fear and rage. The infant practically never cried.

When Albert B reached 11 months, Watson and Rayner decided to see if they could condition a fear response by banging a bar behind Albert's head to make an unexpectedly loud and frightening sound. Their lab notes read:

> White rat suddenly taken from the basket and presented to Albert. He began to reach for rat with left hand. Just as his hand touched the animal the bar was struck immediately behind his head. The infant jumped violently and fell forward, burying his face in the mattress. He did not cry, however. Just as the right hand touched the rat the bar was again struck … Again the infant jumped violently, fell forward and began to whimper.

After an interval they again struck the bar whilst presenting the rat to Albert.

> The instant the rat was shown the baby began to cry. Almost instantly he turned sharply to the left, fell over on left side, raised himself on all fours and began to crawl away so rapidly that he was caught with difficulty before reaching the edge of the table.

They also found that the conditioned fear response endured over time and was generalized to other similar objects: to a great or lesser extent the fear response could also be elicited when a toy rabbit, toy dog, Santa Claus mask and cotton wool were produced.

Edward L. Thorndike's theory of learning developed these concepts of conditioning to focus on operant conditioning (that is conditioning based on the performance of specific actions) and the laws of effect, exercise and recency (Thorndike 1911). Thorndike's laws underlie models of learning in economics and are based on studies of animal behaviour. Thorndike's experiments included a study of 13 young cats, aged between 4 and 19 months. The cats were confined in small boxes secured via various combinations of loops, levers, bars, boards and bolts. The cats initially followed their instincts and impulses in trying to escape – Thorndike defines an instinct carefully as "any reaction an animal makes to a situation without experience" (p. 21) and impulse is "the consciousness accompanying a muscular innervation … the direct feeling of doing. [For example] hunger is the impulse which makes the cat claw … by impulse I never mean the motive to the act" (p. 22). Thorndike found that 11 of 13 cats soon learned to escape the boxes first via a process of trial and error until:

> all the other non-successful impulses will be stamped out and the particular impulse leading to the successful act will be stamped in by the resulting pleasure, until, after many trials, the cat will, when put in the box, immediately claw the button or loop in a definite way.
>
> (Thorndike 1911, p. 21).

From this, Thorndike constructed laws about how learning progresses by making associations between stimuli, actions and rewards: the law of effect is that the actions which produce pleasure give positive reinforcement and will be repeated – learning will build on pleasure and reward; the law of exercise is that the more often a positive (negative) association is made, the more (less) likely it is to be used and vice versa; and the law of recency is that recent events will be more salient and so recent responses are more likely to be repeated but impacts of prior rewards and punishments will decay over time. Insights from Thorndike's analyses are adopted in economic models of reinforcement learning and neuroeconomic theories of reward learning, both explored in Chapter 4. The law of exercise also has implications for models of habits, as explored in Chapter 9.

B.F. Skinner used Thorndike's analysis of operant conditioning/instrumental learning to inform extensive experimental studies of animal learning and focused his analysis purely on observable choices and, via rewards and punishments, using the environment to manipulate choices. He fostered an extreme version of behavioural psychology – radical behaviourism, which confines itself to studying inputs and behavioural outcomes. Whilst experimenters might manipulate the conditions under which choices are made to see how behaviour is affected, the focus is on observables: the inputs and outcomes in terms of behaviour, not the unseen underlying processes driving it (Skinner 1974). In extreme behaviourism, personality traits and individual differences are not the focus of analysis and, much as early neoclassical theorists treated the firm as a black box, focusing on observable inputs and outputs to production, similarly in radical behaviourism choices are made in a black box – information and stimuli go in, choices come out and the experimenter concentrates just on observed behaviour rather than the processes underlying it.

These insights about stimuli and reinforcement in conditioning, consistent with Skinner's radical behaviourism, underpin economic models of reinforcement learning. A lot of the work on conditioning in experimental psychology, including Skinner's experiments, concentrated on experimental testing of animal models. Harper (1982) studied mallard ducks foraging for food. Mallards live in small groups and obtain food by foraging. They have extremely small brains but still were able to exhibit rational behaviour consistent with predictions from game theory. The experiments were conducted in Cambridge University botanical gardens in 1979, with a flock of 33 mallards. Two experimenters threw bread balls: experimenter 1 throwing 2-gram bread balls every 5 seconds, the other every 10 seconds, giving a 33-duck Nash-type game assuming linear approximation of utility for range of bread ball sizes. The mallards quickly learnt to identify the mixed strategy equilibrium (of 2/3 of ducks in front of experimenter 1, and 1/3 in front of experimenter 2), though some argue that this equilibrium is also consistent with less objective factors, such as pecking order, conflict, and so on.

RL models also take from behavioural psychology the focus on observed behaviours, for example in an experimental context, rather than on underlying drivers of those behaviours. It links to the behavioural psychology concept of Pavlovian learning. The focus is on the *law of effect*: all behaviour is a learned response to previous reinforcement so RL is about conditioning. We learn to do something because of the rewards it delivers, or not to do it because of the costs it imposes. In RL models, the time-dependent value function is a weighted average of past payoffs and past attractions. RL attractions build up either via cumulative processes or as weighted averages, with probabilities of choosing a given strategy determined by past reinforcements. This impact from past reinforcement does generate anchoring on previous strategies because choices are reinforced by previous payoffs but there may also be spillovers to similar strategies. Nonetheless, a RL model will imply that behaviour exhibits some inertia, changing slowly, similar to adaptive expectations in macroeconomic theory. This insight is also incorporated into neuroeconomics in Schultz (2002) and Schultz *et al.*'s (1997) models of reward prediction error, as discussed in more depth in the neuroeconomics chapters – Chapters 11 and 12.

A reinforcement learning model

One advantage of RL models is that they imply a relatively simple form of learning that is easy to understand and model. It captures reasoning when players have no knowledge about payoffs from strategies they have not chosen and so strategies not chosen will be hard to quantify. Erev and Roth (1998) have conducted some influential analyses of RL applied to ultimatum games (UGs) and public good games (PGGs). These games are explored in more detail in the sociality chapter (Chapter 6) but essentially the ultimatum game is a game in which Player A offers Player B some share of a sum of money; if Player B refuses the offer then both players get nothing. The public goods game involves players making individual contributions to financing a hypothetical public good; if the combined contributions are insufficient then the public good is not provided.

Erev and Roth's experimental evidence shows that people converge onto uneven divisions in market games and PGGs but converge to nearly equal offers in UGs and whilst this result might seem anomalous if explained in a non-learning context, Erev and Roth claim that RL can explain this apparent anomaly.

Erev and Roth (1998) examine learning in experiments with 100 periods or more of games, with unique equilibrium in mixed strategies. They assess *ex ante* and *ex post* predictive power by simulating each experiment using parameters from the other experiments.

They develop their model from the insight that traditional game theory assumes perfect rationality and equilibrium but construct a more general model that captures learning in different types of games. They link this general model into a cognitive version of game theory, which blends economics and psychology with "forgetting" and "experimentation" incorporated to improve predictive power.

Erev and Roth start by assuming that initially players have equal propensities to play all strategies. However, over time particular strategies are differentially reinforced and so players update their learning attractions accordingly, as captured by an updating function. People are assumed to follow probabilistic choice rule: probabilities that pure strategies are played reflect the relative propensity to play the strategy. The updating function can be generalized to capture reinforcement from similar strategies and can also be adapted to incorporate adjustable reference points to address the insight from Kahneman and Tversky's (1979) prospect theory that choices reflect changes not levels of utility, as noted in the previous chapter. The mathematics of Erev and Roth's RL model is outlined in Mathematical Appendix A5.2.

The impact of experience varies. It can lead to quick convergence, have little impact or lead to initial divergences away from equilibrium. In essence, RL models have a strong link with behavioural psychology and they capture Thorndike's law of effect – outcomes in the past are more likely to be repeated in the future. Choice behaviour is probabilistic and learning follows a *power law* of practice: learning curves are steep initially, but they flatten as experience accumulates.

Erev and Roth's empirical evidence

Erev and Roth use an innovative approach to the data and empirical methodology. They study repeated matrix games with unique mixed strategy equilibria, each of which involves at least 100 rounds of play but their analysis is not focused entirely on their own data. They use data from 11 other studies (including nine studies of zero sum games) conducted by other experimenters from 1960s to 1990s. This methodology is used to escape the "toothbrush" approach: experimenters use their methods like toothbrushes, that is, they favour their own. This creates a problem because if they only use their own experiments then they may unconsciously adapt their experimental designs to fit the model that they've constructed. Using others' datasets forces them to "tie their hands" to escape this trap.

Their hypotheses are constructed around three main types of model: a 1-parameter "basic reinforcement" model; a 3-parameter model incorporating additional parameters for "experimentation" and "forgetting" and a 4-parameter "fictitious play (FP)-like" model which adds initial beliefs, assumed to be frequency of others' actions. These models are used in computer simulations of each experiment, predicting the probability of each action at each period and the predictions of 1-parameter, 3-parameter and 4-parameter models are compared using a mean-squared deviation (MSD) criterion. For the 3-parameter RE model, they add two psychological assumptions: an experimentation effect and a recency effect/forgetting.

In the FP-like model, responsiveness to others' actions is incorporated explicitly in the form of excepted value calculations to capture beliefs. The model also incorporates a "habit" parameter; the number of times a strategy played in the past influences the probability that it'll be played in the future. This is captured using an average return variable incorporating the expected value of a strategy.

Erev and Roth's (1998) empirical findings are that the 1-parameter basic reinforcement model outperforms equilibrium predictions but fails to account for late movements towards equilibrium. Their analysis suggests less responsiveness to opponents than is observed in most experiments. For the 3-parameter RE model, it outperforms the basic models, improves on the 1-parameter reinforcement model and has the lowest MSD of all models tested. For the 4-parameter FP-like model, there is no significant decrease in MSD relative to the RE model though the habit parameter contributes to the model's descriptive power.

Erev and Roth (1998) conclude that learning is an important omission from standard models. There are three relevant learning processes: encoding past events, converting knowledge into production rules and strengthening production rules. Agents pick optimal strategies and stick to them, reflecting Thorndike's law of effect seen in cats, pigeons and other animal experiments. Thorndike's laws, as explored above, incorporate reinforcement but deeper processes are relevant too. Capturing these different influences can enable the consilience of game theory and cognitive psychology to give a low-rationality version of game theory. This could better explain real-world phenomena, for example academic job markets in which employers gradually learn to advertise earlier in response to early deadlines amongst competing institutions.

Overall, Erev and Roth advocate the development of a "cognitive game theory" which combines the insights about learning from economics and psychology. They suggest developing John Anderson's ACT* theory which distinguishes production rules (strategies such as minimax, tit-for-tat are production rules) from learning. A cognitive game theory would retain a strategic approach whilst allowing bounds to rationality. These could include games in which players fail to consider all possible strategies, do not allow maximizers and/or do not allow an explicit role for preferences.

Experience-weighted attraction (EWA)

Theoretically, RL incorporates an assumption that information about forgone payoffs is ignored and BL assumes that players ignore information about past strategies. Empirically, Cheung and Friedman's (1997) evidence supports BL and Erev and Roth's (1998) evidence supports RL. A hybrid model that reconciles the two models should have superior explanatory power. Camerer and Ho (1999) provide a solution in the form of the hybrid experience-weighted attraction (EWA) model that captures updating of values in the belief-based model to generate a time-dependent value function that "nests" RL and BL, filling the gaps and limitations of both approaches. EWA is a backward-looking model of adaptive learning based on past experience either in the form of direct reinforcement or as evidence about the history of other players' strategies. EWA combines RL and weighted fictitious play (WFP) models in which past actions of other players are assigned declining weight over time, and thereby provides an encompassing model with RL and BL as boundary cases.

Thorndike's law of effect asserts that successful strategies will be repeated because past experiences are reinforced. EWA models allow for this and also incorporate a "law of simulated effect" capturing the fact that strategies that would have been successful are also repeated more often (Camerer 2003b, p. 305). The weighting from applying the law of simulated effect also has psychological interpretations. It may represent opportunity costs, counterfactuals and regret. It may be affected by imagination and/or reliability of information. By combining the traditional law of effect with the law of simulated effect, EWA models nest BL and RL models in the form of weighted fictitious play.

Experimental evidence about EWA models

Camerer (2003) sets out some empirical evidence in support of EWA stating that in studies of about 31 data sets, EWA fits/predicts out of sample more accurately than RL or WFP except in games with mixed strategy equilibria. He examines specifically the evidence from two types of games: continental divide games and beauty contests.

Continental divide games

The continental divide game captures conformity to others' strategies. For example, new media firms will locate where there are strong linkages with other local industries. A choice between Silicon Valley and Hollywood will generate an economic tug-of-war won by doing what most other firms are doing. This hypothesis is captured empirically using a simple experiment in which seven players each choose an integer from 1 to 14. The best response is to choose a low number when others choose low and high number when others choose high. If unsure, it is best to pick a number with the largest range of payoffs. Camerer (2003) concludes that the experimental data from continental divide games fits better with EWA models than alternatives because EWA captures the interaction of beliefs about what other firms are doing and reinforcement from the payoff externalities which emerge when a large number of firms do the same thing, for example all firms will benefit from other firms' investments in local infrastructure.

Beauty contests

In addition to the evidence from continental divide games, Camerer (2003) also relies on evidence from beauty contests to support EWA models. Beauty contest games are inspired by Keynes's (1936) insights. Foreshadowing the beauty contests developed by modern behavioural economists, Keynes uses a metaphor of a newspaper beauty contest. Competitors are not asked to pick the "prettiest faces" but "those which he thinks likeliest to catch the fancy of the other competitors". In beauty contests, speculators in financial markets reach a "third degree" of reasoning. They do not form beliefs about fundamental, true values or payoffs but instead are trying to guess what others think and they are trying to second-guess average opinion of average opinion:

> It is not the case of choosing those which, to the best of one's judgement, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects average opinion to be. And there are some, I believe, who practise the fourth, fifth and higher degrees.
>
> (Keynes 1936, p. 156)

Keynes postulates that financial speculators are engaged in this form of strategic thinking: they are preoccupied with forecasting average opinion of average opinion rather than with their own objective judgements about the value of an asset and this contributes to financial instability, as explored in Part II.

Using Keynes's beauty contest metaphor as a starting point, Nagel (1995) designed a form of beauty contest game – the "*p* beauty contest", to capture levels of reasoning with a prize going to player(s) who select a strategy closest to some product *p* of the average strategy. For a set of strategy choices including 1 to 100 in a game played a finite number of times, then if play is random, a naïve player might expect an average guess of 50 from the others and so will guess $p \times 50$ but more sophisticated players will realize that they cannot assume that other players' actions will be random. Sophisticated players will adopt strategic reasoning to make inferences about the strategic choices of other players because they realize that other players also know the rules of the game. Assuming complete rationality, the game is dominance solvable with inferior strategies eliminated via a process of backward induction. For example, with $p = \frac{2}{3}$, in Round 1 players will realize that choices greater than 2/3 × 100 are bound to lose because they are strictly dominated and so 68 to 100 will be eliminated leaving 1 to 67 and players will take the average of this, that is, an average of $\frac{1}{2} \times \frac{2}{3} \times 100 = 33.5$. In Round 2, players will predict that others make the same judgement and so guess that others would not select average of $\frac{1}{2} \times \left(\frac{2}{3} \times \frac{2}{3}\right) \times 100 = 22$ and so on.

A player is strategic of degree n if he/she selects a number $50p^n$, which approaches zero as n approaches infinity, assuming $p<1$. With "deep" reasoning this process will continue a large number of times until a Nash equilibrium strategy of 0 is reached. Real-life evidence from experimental beauty contests suggests however that people do not think the problem through thoroughly. In lab experiments, most people use only 2–4 levels of iterated reasoning and the iterative process is driven by naïve best replies rather than by elimination of dominated strategies. This is a robust finding and studies from Nagel, Thaler and others show that a range of players, from FT readers to business CEOs, show limited depths of reasoning (Camerer 2003). For Keynes's speculators, in modern language: if traders don't backward induct (and this may be for strategic reasons) they will not immediately sell perhaps because they don't expect others to sell. This reluctance to sell on the basis of predicting others' actions will generate persistent speculative bubbles.

The length of the game in terms of the number of iterations can be explained in a range of ways. It may reflect limits on cognitive ability and working memory. It may also reflect strategic motivations and assumptions about others' rationality: if you are a strategic thinker then you will not choose 0 because you might anticipate that others would not reason that far. Selecting 0 assumes too much about others' reasoning capacity/motivation.

In the context of learning, beauty contests are interesting because simple learning does takes place. Ho, Camerer and Weigelt (1998) conducted the first replication of the Nagel study using different values of p to assess the impact of learning. In initial rounds, players showed one to three steps of iterated reasoning but there was transfer of learning from one game to the other, evidence that the players were learning to learn. They converged more rapidly and showed greater depth of reasoning the more times they played the games.

Camerer (2003) describes p-beauty contests designed specifically to test EWA learning models. In these experiments, each player picks a number from the interval [0,100]. The player closest to a target number wins where the target is p multiplied by the average guess. By iterated deletion, if $p = \frac{2}{3}$, then numbers in range [67,100] cannot win and so are deleted. Then $\frac{2}{3} \times 67 = 44$ so numbers in range [45,67] are deleted. Iterated reasoning proceeds deleting $\frac{2}{3} \times 44 = 29$ and then $\frac{2}{3} \times 29 = 20$, and so on until, assuming strong rationality, the Nash equilibrium of 0 is reached, as in the Nagel experiments.

Camerer (2003) shows that both BL and EWA perform well in explaining beauty contest play. RL neither fits nor predicts because six of seven players each period are not earning or learning anything because the opportunities for reinforcement in the beauty contest game are very limited. If players are learning about others' beliefs, they must be forming beliefs about those beliefs and so it follows that RL models cannot explain the findings.

The results can also capture the phenomenon of sophisticated players realizing that others are learning, and these ideas are captured in models of anticipatory/sophisticated learning too. In these models, players use information about others' payoffs to reason thoughtfully about what the other player might do. They form beliefs based on best response functions (BRFs) where the BRFs include some information about others' payoffs.

Comparative econometric evidence on EWA versus RL and BL models

There has been some econometric testing of learning theory; for example, Salmon (2001) assesses the empirical evidence on learning models and concludes that it is disappointing, partly because early econometric analyses were conducted when our knowledge of the statistical properties of estimators were not so well understood. Salmon's econometric evaluation of learning models involves simulating RL, BL and EWA models and whilst model identification is generally poor, the EWA models perform relatively well allowing a sharp distinction of RL and BL models.

Overall, both RL and BL have empirical support with hybrid/encompassing models and EWA models capturing elements of both. It is difficult to separate the explanations econometrically, partly because data on observed actions do not reveal the underlying cognitive processes that enable learning. Neuroeconomic analyses may be able to capture something of what's going on behind revealed preferences and open the "black box" that underlies decision-making (Camerer *et al.* 2005).

In comparing the various models of learning, Camerer argues that they can also be compared according to the legitimacy of the underlying informational assumptions, that is, judging the plausibility of learning theories rests on the sort of information that is required. If people use information that's not captured in the theory then the theory is incomplete; if the theory demands more information than people are feasibly able to use, for example as seen in rational expectations assumptions, then the theory is too complex (Camerer 2003a,b). Information use depends not only on information available but also on cognitive capacities. Camerer (2006) explains the different levels of information needed in the different theories and the information needed ranges from the player's choice, their opponent's choice, received and forgone payoffs for players and opponents, and best response.

The different learning theories vary considerably in terms of their assumptions about minimal information needed, with evolutionary theory having the minimal information assumptions because if everything is instinctive then no information is needed. Some of the informational implications can be used to compare and contrast learning theories. People learn faster when they have full payoff information and this contradicts RL. Also, the fact that people look up information about their own previous payoffs is inconsistent with BL theory. That people behave differently when they have information about others' payoffs supports theories based on more sophisticated learning processes and also supports theories incorporating imitative learning.

Herding and social learning

Behavioural economics also explores a specific type of learning in the form of social learning, associated with the phenomenon (see Baddeley (2018) for a survey of insights from economics and other subjects). Herding is a general category of behaviours in which people follow groups of others and may do so for all sorts of reasons. It is the phenomenon of individuals deciding to follow others and imitating group behaviours rather than deciding independently and atomistically on the basis of their own, private information.

One of the pioneering studies of herding and social learning is the information cascade model developed by Bikhchandani, Hirshleifer and Welch (BHW; 1992, 1998). They focus on social learning in the context of uniform social behaviour. They identify four primary herding mechanisms encouraging people to do what others do: sanctions on deviants, positive payoff externalities, conformity preference and communication. Bikhchandani *et al.* observe however that these social influences cannot fully explain fragility of mass behaviour and changes in attitudes, for example as we see in changing attitudes towards common phenomena such as cohabitation, sexuality, communism and addiction. So BHW propose that social learning in the form of "information cascades" also generates uniform social behaviour. An information cascade occurs "when it is optimal for an individual, having observed the actions of those ahead of him, to follow the behaviour of the preceding individual without regard to his own information" (BHW 1992, p. 994).

BHW enumerate many examples of phenomena explicable as information cascades including political campaigning – for example US presidential nomination campaigns; foraging and mating behaviour (see also Danchin *et al.* 2004); medical practice, including surgical fads and "iatroepidemics", that is, epidemics of treatment-caused diseases; competing bids during corporate takeovers; and peer influence/social stigma in labour markets when the long-term unemployed are discriminated against in hiring decisions.

To complement BHW's analyses, the other seminal economic model of herding and social learning is Banerjee's (1992). Banerjee notes that people are heavily influenced by what others are doing, for example in fertility choices, technology adoption and voting patterns and this is because we learn from the herd: it is rational to pay heed to what others are doing because they may have better information. This generates inefficient outcomes because when information cascades are generated, private information becomes uninformative and a herding externality is created. Banerjee uses the example of restaurant choice. There are two restaurants A and B: Restaurant A is favoured a priori by 51%; Restaurant B is favoured a priori by 49%. Then 100 people make sequential decisions about which restaurant to choose. If 99 out of 100 people have private signals indicating that Restaurant B is better, then aggregate evidence suggests that Restaurant B should be preferred on average. This does not mean that it will be preferred in practice.

Imagine that Alice is the first person to choose but she has a misleading private signal, for example a newspaper review written by a biased restaurant critic, favouring Restaurant A. If Bob chooses next, then he must balance three pieces of information: the *a priori* probability which favours restaurant A; his correct private signal which favours Restaurant B and the social information, that is, Alice's observed choice. If he uses Bayesian reasoning then he will weight the first and second pieces of information equally, these conflicting signals will cancel out and he will rationally choose Restaurant A essentially because Alice did, even though, all things considered, it is not the best restaurant.

An information cascade is generated because the third person to choose – Chris, will choose Restaurant A because the misleading information conveyed by Alice and Bob's choices have overwhelmed Chris's private information generating herding towards a restaurant which, all information considered, is less preferable. From that point onwards, assuming that all subsequent decision-makers apply Bayes's rule, then all private information becomes uninformative. Information is used inefficiently because all private signals are ignored even though they contain information that would be useful and relevant for decision-makers as a whole.

The implication is that private information has no influence on choices of the herd. Banerjee refers to this negative consequence in which relevant private information is ignored as a herding externality. Bikhanchandi, Hirshleifer and Welch (1992) develop a similar model of informational cascades as an explanation for localized conformity emerging when it is optimal for an individual to follow the actions of his/her predecessor and to disregard his private information. Just as is seen in Banerjee's model, each sequential decision conveys no real new evidence to subsequent members of the herd and so private information becomes uninformative. To summarize: according to Bayesian theories, herding and informational cascades emerge because members of the herd are ignoring their own private signals to favour herd information about the actions of their predecessors. This means that they will potentially be ignoring a large volume of important private information.

If the herd path fosters increasing noise within the system, then the process of opinion formation will become unstable. Further research is needed to assess the extent to which herds move in either stable or unstable directions. This can be done by assessing the extent to which herd leaders (experts) are selected on objective versus subjective grounds, and by assessing the extent to which herd leaders turn out to be right in the end. This would be another direction for fruitful and useful future research.

Herding phenomena are consistent with different statistical hypotheses, for example Kirman (1993), using a Markov chain approach develops the "ants" model in which ants "convert" by copying another ant. For example, ants faced with two symmetric food sources will tend to concentrate on one or the other source rather than distributing themselves evenly across both. This behaviour pattern may be interpreted as recruitment activity by ants. With positive externalities from foraging behavior, the joint exploitation of one source will give more benefit to the group than an even distribution of effort over two different sources (Kirman 1993).

Overall, models of herding and social learning based on Bayesian updating models assume that agents are using sophisticated logical methods but the outcome can be good or bad depending on whether the decision-makers are sent down a correct or incorrect track by the actions of their predecessors.

Experimental tests of Bayesian herding

Anderson and Holt (1996, 1997) construct an illustration of how this reasoning process works and test the hypotheses experimentally using an urn experiment. Imagine that you, along with a group of other experimental subjects, are asked to participate in an experiment. You are told that there are two urns: Urn A and Urn B; Urn A contains two red balls and one black ball; and Urn B contains one red ball and two black balls, as shown in Figure 5.1

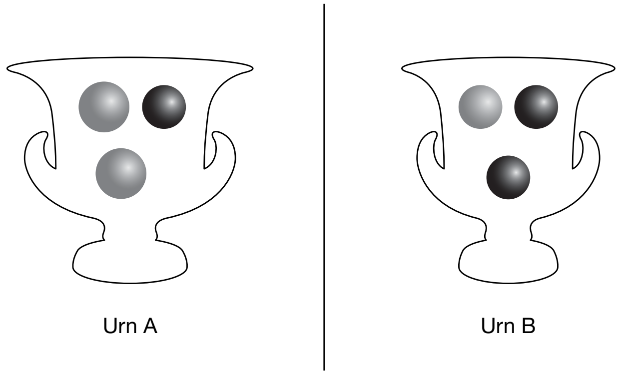

Figure 5.1 Urn of balls

Then you are asked to draw a ball from an unmarked urn and guess which urn is being used. The experimenter has concealed the urn's label so it could be Urn A, it could be Urn B. All things being equal, if you draw a red ball, then that is more likely if Urn A is being used and less likely if Urn B is being used. But your choice is complicated by the fact that you see other people making guesses too. Other subjects are taking a ball from the unmarked urn, concealing its colour from the group, replacing it in the urn and announcing their guess. According to Anderson and Holt, people judge the probability that Urn A is being used according to the choices of their predecessors, with a choice made sequentially by each subject in turn based on the application of Bayes's rule. In the first round for example, if the first person to choose guesses Urn A, then that is a signal that it was a red ball, because red balls are more likely in Urn A.

Anderson and Holt explain how a rational person would judge the probability that Urn A is being used if the choices are made sequentially with each experimental subject observing the others' decisions one by one, inferring the colour of the ball from their choices, and applying Bayes's rule accordingly updating probabilities as new social information comes along. If a person sees their predecessor picking Urn B, then they will update their probabilities to make the probability of Urn B more likely. An arithmetic analysis of Bayes's rule is summarized in Mathematical Appendix A5.3. Table 5.1 summarizes the posterior probabilities that the ball comes from Urn A, calculated using Bayes's rule.

Table 5.1 Applying Bayes's rule to judge the probability of Urn A

	Urn B chosen			
Urn A chosen	**Never**	**Once**	**Twice**	**Three times**
Never	50%	33%	20%	11%
Once	67%	50%	33%	20%
Twice	80%	**67%**	50%	33%
Three times	89%	80%	67%	50%

For example: if Alice announces that she thinks the ball comes from Urn A then the others would assume that she picked a red ball. Then Bob chooses. Perhaps he chooses a black ball but he infers that Alice drew a red ball and from this concludes that the probability that the ball comes from Urn A is 50%. He could rationally choose either urn but imagine that he guesses Urn A. Then Chris chooses and perhaps he also chooses a black ball but he assumes that both Alice and Bob had picked red balls and so, if he is using Bayes's rule, then he infers that Urn A has been chosen because red balls have been picked twice, against his single draw of a black ball. Overall, he judges that the probability of Urn A is 67% so he will also choose Urn A even though he picked a black ball. From that point onwards, if people are using Bayes's rule then the posterior probabilities of Urn A are ever increasing so the herd is led down the route of choosing Urn A and each individual will effectively ignore their private signal and private information is lost.

Anderson and Holt (1996, 1997) use this urn experiment to test the Bayesian herding as social learning hypothesis. In one set of experiments, 72 undergraduate economics students were paid fixed cash payments for correct decisions. One was selected as monitor to choose an urn and pour contents into an unmarked urn. Then the subjects were chosen in random order to draw a ball one by one and announce their prediction to the group. Each drew a ball, which represented their private signal; the others weren't allowed to see which ball they drew. The subjects announced their decision and this was a signal to the others about whether Urn A or Urn B had been used. Anderson and Holt observed information cascades in 41 of 56 periods in which there was an imbalance between private signal and previous inferred signal. They calculated the "efficiency" of decisions as the percentage of decisions consistent with the optimal expected payoff if Bayes's rule had been used and found that 2/3 of subjects made decisions with 100% efficiency, that is, in perfect conformity with Bayes's rule. Similar results have been found in a large number of studies of Bayesian social learning hypotheses. More recently, Fishman and Gneezy (2011) have tested the hypothesis using Banerjee's example of restaurant choice and found that, in situations of limited information/experience, restaurant queues were longer, which would be consistent with people deciding that longer queues signalled quality.

The outcome predicted by the Bayesian social learning hypothesis is not infallible for a number of reasons. Bob's decision was on a knife edge – he could have, legitimately and correctly, applied Bayes's Law to choose Urn B and send the herd in the right direction. Alternatively, people may apply a form of iterative thinking. They realize that they could make a choice that matches what their predecessors have done but that it conflicts with their own private signal, so they will also realize that others may be doing the same. They will realize that the others are choosing an Urn just on the basis of predecessors' choices, not because they have actually picked a red ball, for example Chris may not infer that Bob picked a red ball just because he chose Urn A and so Chris may apply a corrective factor to allow for his degree of uncertainty about why Bob chose Urn A.

Anderson and Holt's laboratory experiments generally focus on a discrete signal/action model. More recently, Çelen and Kariv (2004), amongst others, have used experimental evidence to distinguish between herding as a broad descriptive category of copying behaviours and informational cascades as a specific form of learning that arises in uncertain situations.

Empirically, herding as a Bayesian learning process is consistent with evidence from a large number of economic experiments including Anderson and Holt (1996, 1997) and many others. This evidence does not establish that a Bayesian explanation is superior to other explanations including those drawing upon ideas from other social sciences. Nonetheless, even in the Bayesian models, the basic premise is that economic decisions are in essence the outcome of a cognitive process employing a mathematical algorithm to process information and form expectations. In addition, the focus tends to be on a dichotomous division of behaviour into rational or irrational; a person is assumed to be rational if their behaviour is consistent with Bayesian updating. Sociological influences are confined to learning from others' actions and psychological and emotional factors are accorded very little role at all.

Learning themes emerge in the macroeconomic literature too. Herding theory has its roots in Keynes who focused on motivations to imitate and follow the crowd in a world of uncertainty and this may happen for a range of reasons (Keynes 1930, 1936). Topol (1991) analyses herding as the outcome of rational trading in which traders weight information about prices paid by other traders against private judgements of fundamental value. Acemoglu (1993) analyses rational learning about others' decisions via signal extraction from aggregate data. In Part III, we will explore some of these macroeconomic insights around herding in more depth.

Ideas about imitative learning are also developed in analyses from Austrian economics which explore Hayek's insights about knowledge as a path-dependent process (Hayek, 1952; Rizzello 2004). Paralleling the sequential herding theories of Bayesian theorists, social learning in Austrian economics differs from ordinary problem-solving in that serial processing of information is important, generating path dependency and propelling the acquisition of knowledge along a path determined by past beliefs.

A significant behavioural constraint occurs if people do not have the numeracy to be able to think in the sophisticated way assumed in models of Bayesian learning. Anderson (1998) argues that this is a consequence of the nature of memes, the cultural analogy of genes. The problem originates in the input format of data, and in algorithms used but if prompted by clear signals, the human brain is able to deal with probabilities effectively. For example, as we saw in the previous chapter, if students are asked to judge the probability of two coincident events within the context of a statistics class, then they will know what to do. However, if outside their classes they are confronted with a problem requiring probability judgements in a situation in which it is not obvious that this is what is required, then they may make an instinctive, intuitive judgement which may generate statistical mistakes (Kyburg 1997). Anderson suggests that Bayesian approaches could be refined using the advantages of a frequentist approach by using mental, visual imagery and graphic display. In this way, some frequentist methods could be incorporated effectively into a Bayesian framework allowing human cognition to process subjective probabilities more effectively.

Evolutionary approaches to learning

The models of herding outlined above connect closely with literatures in economic theory and are not inconsistent with economists' usual focus on rational choice, though the concepts of rationality embedded in the above herding models are softened to allow Bayesian rationality rather than optimizing behaviour. Herding as a phenomenon is also explored across the range of social and behavioural sciences, and evolution is a theme that connects these large and diverse literatures (Baddeley 2018).

Evolutionary approaches to herding build on the insight that we are born with a strategy and play it instinctively, for example strategies to provide food, escape predators and find mates, enabling the survival of the fittest. This idea is paralleled in evolutionary biology and neuroscience too. As noted by Camerer (2003b) the word "learning" in this context though may be misleading because it is not about individual learning and instead links to inherited strategies (e.g. in animals) and/or cultural evolution over long periods.

Herding behaviour is widely observed throughout the animal kingdom, in species as diverse as honeybees, ants, antelope, sheep and cows. Herding animals monitor the actions of others thus providing social information about resource availability and mating potential (Danchin *et al.* 2004). Evolutionary biology can help to explain why herding instincts are endemic. In other animals, especially our close relatives, herding may have (had) an evolutionary value in a social context; it is not just about individuals maximizing their own outcomes. For example, animals will monitor the actions of other individuals as this gives social information about resource availability and mating potential (Danchin *et al.* 2004). Imitation has been selected for amongst monkeys as a successful strategy enabling the rapid transmission of good ideas throughout a species (Surowiecki 2004). Emotional contagion is observed in children, for example when they cry.

These herding tendencies also connect to less obviously rational drivers of our behaviours, including emotions – as we will explore in more depth in Chapter 9. Emotional contagion is imitative and is, initially, a state of vicarious distress which precedes mind-reading abilities but may contribute to the development of empathetic capacities (Prinz 2005). Cohen (2005) argues that the human brain has evolved into a confederation of mechanisms that usually cooperate but sometimes compete. Proximate mechanisms such as herding, when motivated by emotional responses that appear irrational and motivated by emotions, in fact are engaging evolutionarily old but highly conserved brain mechanisms which may be locally optimal but are not necessarily universally optimal. Also, instincts that have evolved to increase chances of survival may be just that – instinctual and therefore not manifested as a deliberative Bayesian-style thought process.

Herding may have evolutionary advantages for humans too, not just because of informational influences but because the presence of more conformist individuals susceptible to intra-group pressure generates evolutionary advantages. Simon (1990) argues that, amongst social animals, the evolutionary fitness of altruists will exceed that of the selfish: "docility", that is, receptivity to social influence, is an evolved instinct that has survived and permeated the human population to serve important evolutionary purposes. Docile people have the intelligence and motivation to learn quickly from social information and do not screen social information for contribution to personal fitness. Docility allows people to believe large numbers of propositions without any direct proof. Docile individuals are also more adept at social learning, making them more able to acquire knowledge, skills and "proper behaviors", that is, the values, goals and attitudes that are useful in overcoming environmental obstacles, thus contributing to the evolutionary fitness of human populations. According to Simon, a genetic predisposition to imitate others has evolved to serve a social purpose in encouraging socially constructive empathy and altruism, helpful in overcoming dissent and conflict, though Simon does not allow that such conformism might also allow tyranny and oppression, illustrating the fact that the trait of docility may not necessarily suit a complex modern world.

These evolutionary theories can show how instincts such as herding have evolved in a social context, if not in an individual context. The way that humans make choices in risky situations (e.g. the overweighting of low probabilities, the dependence of probability judgements on context) are seen in animals too – for example in monkeys and honeybees – suggesting that human neural circuitry is "old", and adapted to basic survival instincts (Camerer *et al.* 2004a,b).On the other hand, in evolutionary terms, instinctive tendencies may be more appropriate only in primitive settings: sociability and aversion to aggression may have evolved to allow the development of the stable social structures essential to the competitive success of small communities.

Herding instincts will be counterproductive if the survival purpose of evolved instincts has been perverted by situational factors in modern "artificial" contexts. An instinct to follow others may have been important to survival in a primitive setting but that does not mean that it is an effective strategy in the heavily interconnected globalized, computerized world in which assets, information and expectations can move very quickly. If large-scale herding, for example in financial markets, reflects the overriding influence of normative influence and/or emotional factors, then maybe herding is an inappropriate proximate mechanism and is not well suited to the modern context because it can generate instability on a very large scale. This raises the question of whether the basic instincts manifested in proximate mechanisms such as herding are well-adapted to a modern, technological age.

An evolutionary approach is not inconsistent with ideas about Bayesian reasoning, if Bayesian reasoning is a skill that has evolved to serve social purposes. For example, with heterogeneity in personality types, rule-based decision-making (such as Bayesian updating) helps to ensure consensus is forged amongst divergent personalities, fostering effective societal decision-making processes despite natural heterogeneity. However, human instincts are hardwired processes that have not evolved recently enough to be necessarily useful in a modern context. An ingrained instinct to herd may be a maladaptation in modern contexts, especially fast, liquid financial markets, unlike evolved motor and perceptual abilities than enable us to read and write – a theme we shall explore in more depth in the section on behavioural finance.

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Models of learning from behavioural economics capture the fact that rational individuals do not move immediately towards equilibrium outcomes. It may take them a long time to reach equilibrium if they ever reach it at all. Learning processes are varied: we learn from our beliefs about others, based on how they have behaved in the past – an approach that is closely related to standard game theory analyses of evolutionary learning. However, psychological motivations are important too and these are developed into economic models of reinforcement learning by embedding insights from psychology about conditioning and reward learning.

Developments in neuroscience have also deepened our understanding of learning, for example the model of reward prediction error, explored in more depth in Chapter 12, captures the fact that we learn from our mistakes, an insight that links to models of expectations conventionally seen in economics, including the adaptive expectations hypothesis. Another important device for learning is social learning and this can be understood axiomatically in terms of Bayes's rule but there are broader explanations too about the impact of others on our choices. Some of these social influences will be explored in more detail in the following chapter on sociality.

In terms of policy implications, the evidence about the effectiveness of markets as equilibrating devices is mixed. Learning, by definition, cannot easily be understood in terms of static market models. In some learning experiments, players do play a rational mixed strategy equilibrium but at other times psychological factors such as memory and forgetting determine the path of learning. Also, as shown in the literature on beauty contests, there may be limits to the depth of reasoning, preventing people from reaching Nash equilibria. These insights are particularly relevant for financial markets in which social learning can have a large impact especially when speculators' rewards are divorced from long-term performance. This will mean that incentives are constructed to encourage speculators to engage in iterated reasoning and participate in beauty contests rather than trying accurately to capture the true long-term value of assets. Overall, in devising policies to promote learning, insights about the constraints and influences on the learning by households and firms should be addressed.

Chapter summary

- Different behavioural models of learning build combinations of insights from economics and psychology.
- Reinforcement learning models draw on insights from behavioural psychology experiments – including classic experiments from Skinner and Thorndike – which show how animals' learning processes are driven by their responses to rewards.
- Belief learning models draw on insights from game theory to capture learning as a strategic process of anticipating the actions of others, the consequences of the action and the best strategy given this information.

- Beauty contests are a type of belief learning model in which experimental participants try to anticipate the guesses of other participants and evidence from beauty contest experiments suggest that people have a limited depth of reasoning, i.e. they do not think deeply through the sequence of potential scenarios, in the ways predicted by rational choice theory.
- Experience-weighted attraction models are encompassing models which capture elements of belief learning and elements of reinforcement learning – and econometric evidence suggests that EWA models have a statistically more significant level of explanatory power – suggesting that learning is driven by a combination of belief learning and reinforcement learning.
- In social learning models, the new information is what a person observes others around them doing. When a person sees a lot of other people choosing one action, a restaurant for example, they will rationally infer that other people have a reason to choose one restaurant over another and will rationally update their own probability estimates as a consequence.
- These Bayesian reasoning processes provide an explanation for *information cascades*: social information cascades through the herd. As each person chooses to follow the herd, the chances of the next person joining the herd increase, and as more and more people choose, it becomes more and more likely that all decision-makers will follow those ahead of them.
- Insights from evolutionary biology suggest that evolutionarily evolved instincts and tendencies drive learning, consistent with a broader conception of learning than is the focus of belief learning models built around rational choice assumptions.

Revision questions

1. Explore the assumptions about rationality implicit to belief learning models and discuss whether these assumptions make a robust theory of learning or not.
2. What is reinforcement learning? Discuss the evidence from psychological experiments about reinforcement learning. Is this evidence compelling?
3. Compare and contrast reinforcement learning and belief learning models and discuss which you think is most crucial to economic and financial decision-making. Illustrate with examples.
4. What are the key differences between belief learning and reinforcement learning and how are the differences reconciled within experience-weighted attraction models?
5. What is a beauty contest? Outline the essential elements of the theory. The experimental evidence suggests that people playing beauty contests have limited depth of reasoning. Does this suggest that people's learning processes are irrational, or are there other explanations for limited depth of reasoning? Explain your answer.
6. What is an information cascade and how does it link with Bayesian models of decision-making? Are information cascades rational?

MATHEMATICAL APPENDIX

A5.1 Mathematics of belief learning models

Cheung and Friedman (1997) construct a BL model with revised beliefs about states of the world and the following learning rule:

$$\hat{s}_i(t+1) = \frac{s_i(t) + \sum_{u=1}^{t-1} \gamma_i^u s_i(t-u)}{1 + \sum_{u=1}^{t-1} \gamma_i^u}$$

Where $s_i(t)$ captures past states of the world for player i at time t and $\hat{s}_i(t)$ captures beliefs about the next period. Past states of the world are discounted by γ – a factor which can be interpreted as the learning parameter capturing the learning rate and/or memory length. It weights impact of historical observations with weights summing to 1. When $\gamma = 0$, the past is irrelevant and the rule reduces to a Cournot rule; and $\gamma = 1$ gives a fictitious play rule, i.e. all past observations are weighted equally and beliefs become a simple average of past states. Weighted fictitious play is described by $0 < \gamma < 1$ where u captures the lag relative to the current period.

Decision rules can be constructed from this learning rule and Cheung and Friedman construct the following decision rule for $a_i(t)$ – person i's action in period t. For a given set of beliefs, probability of a first action – a – is given by:

$$P(a_i(t) = 1 \mid \hat{r}_i(t); \alpha_i, \beta_i) = F(\alpha_i + \beta_i \hat{r}_i(t))$$

$r_i(t)$ is the expected payoff difference from the first action, β_i is the evidence weight capturing each player's subjective responsiveness to the expected payoff difference; and α_i is her idiosyncratic tendency to favour the first action.

A5.2 The mathematics of Erev and Roth's reinforcement learning model

In their RL model, Erev and Roth first specify initial propensities and these are initially equal for all strategies, where q_{nk} is player n's propensity to play strategy k.

When j = k the strategy is reinforced and the process of reinforcement is captured by a *reinforcement function*:

$$R(x) = x - x_{min}$$

where x is the payoff from playing that strategy.

Erev and Roth vary the number of parameters in their model and the *updating function* for the 1-parameter model is given by:

$$q_{nj}(t+1) = \begin{cases} q_{nj}(t) + R(x) & \text{if } j = k \\ q_{nj}(t) & \textit{otherwise} \end{cases}$$

This shows that propensity to play strategy j in the next period will increase if $j = k$ and the strategy has been reinforced in period t, but if $j \neq k$ there will be no reinforcement and the propensity to play j will be unchanged.

The probability – p_{nk} that the player will play strategy k – is given by the *probabilistic choice rule* reflecting the relative propensity to play k:

$$p_{nk}(t) = \frac{q_{nk}(t)}{\sum q_{nj}(t)}$$

For the 3-parameter model, the updating function is modified to incorporate forgetting and reinforcement spillovers from similar strategies:

$$q_{nj}(t+1) = (1-\varphi)q_{nj}(t) + E_k(j, R(x))$$

where φ is the forgetting parameter and $E_k(\cdot)$ is a spillover effect capturing the generalized experience of playing strategies k which are similar to the selected strategy j. This partly resolves a problem with RL models, as noted above, that they cannot capture reinforcement from strategies not played. With this adjustment, even if a strategy has not been played before, its updating function can be modified if *similar* strategies were played instead.

The generalized experience captured in the updating function is simplified by Erev and Roth into a "three-step" function capturing the spillover effects given various degrees of similarity between j and k:

$$E_k(j, R(s)) = \begin{array}{lll} R(x)(1-\varepsilon) & \text{if} & j = k \\ R(x) \times \varepsilon / 2 & \text{if} & j = k+1 \\ 0 & \textit{otherwise} & \end{array}$$

where ε captures experimentation/generalization and s is the payoff from playing strategy k. As noted above, E_k captures experience and includes learning spillover effects from similar strategies, moderated by forgetting (the recency effect) reducing the impact of past experience.

A5.3 Bayesian updating and information cascades

Anderson and Holt show people judge the probability that Urn A is being used according to the choices of their predecessors, with choices made sequentially by each subject in turn, and applying Bayes's rule – an amalgamation of prior probabilities, conditional probabilities and posterior probabilities.

Prior probabilities

$Pr(A)$ and $Pr(B)$ are the prior probabilities that the urn is, respectively, Urn A or Urn B and given that this is determined by the toss of a coin $Pr(A) = Pr(B) = \frac{1}{2}$.

Conditional probabilities

Each player infers from their predecessors' choice the colours of balls that they have chosen. From the social signals $(\underline{n}, \underline{m})$ they infer some combination of balls, where n is number of signals favouring Urn A, in which red balls are more likely, and m is number of signals favouring Urn B, in which black balls are more likely. $\Pr(n,m \mid A)$ is the conditional probability of signals (n,m) if the urn is Urn A and $\Pr(n,m \mid B)$is the probability of seeing the combination (n,m) if Urn B was used. The posterior probability that it is Urn A, is given by Bayes's Rule:

$$\Pr(A \mid n,m) = \frac{\Pr(n,m \mid A)\Pr(A)}{\Pr(n,m \mid A)\Pr(A) + \Pr(n,m \mid B)\Pr(B)} = \frac{2^n}{2^n + 2^m}$$

An example

If, after three rounds, a player has signals that two red balls and one black ball have been drawn then $\Pr(n,m \mid A) = 2/3 \times 2/3 \times 1/3 = 4/27$ and $\Pr(n,m \mid B) = 1/3 \times 1/3 \times 2/3 = 2/27$

Applying Bayes's Rule gives the posterior probability of Urn A:

$$\Pr(A \mid n=1, m=2) = 2/3 = 67\%$$

Chapter 6

Sociality and identity

As with other behavioural economics topics, theories of sociality and identity connect with insights from social sciences more broadly in differing degrees. Nowhere is this more apparent than in behavioural economists' analyses of sociality. In some theories, social preferences are not much more than "add-ons" to standard economic theory. In other approaches, behavioural economists head more deeply into insights explored by social psychologists. In this book, we explore three specific themes about sociality that are highlighted within the behavioural economics literature on sociality: social preferences, social influences and identity. Social preferences are our preferences about other people's outcomes – sometimes referred to as "'other-regarding" preferences. They include our inclinations towards generosity and altruism, trust and reciprocity. People are motivated by goals reflecting their interactions with people around them. Social preferences are about what we prefer to see happen to others around us – and they are reflected in some of the social incentives and motivations which we explored in Chapter 2.

Social influences

Social influences have traction because most of us worry about how others' beliefs, choices and actions affect our own beliefs, choices and actions. Sociologists divide these influences roughly into *informational influences* versus *normative influences*. We explored some of the informational influences in the preceding chapter, Chapter 5 (see also Baddeley 2018). In this chapter, we explored how we learn from the actions of others and so herding sometimes reflects our capacity for social learning. Normative influences are harder to analyze, almost by definition, because they are harder to capture in a mathematical model. Some *normative influences* emerge, for example, when we feel social pressures to conform to others' choices. Traditionally, economists have tended to focus more on informational influences and social psychologists more on normative influences. The two approaches are not mutually exclusive, however, and behavioural economics is bringing the two together. Also, questions of identity – explored in different ways in economics versus social theory – mediate these two aspects of broad sociality explored by behavioural economists. Our identities mould our social preferences and our identities are, in turn, moulded by social influences from others around us. Broader social influences will lead us to imitate others not only because of positive, informational influences from others but also because we are susceptible to normative influences such as social pressure and social norms.

Informational influences

Informational influences are captured in social learning models. In the learning models that we explored in Chapter 5, economists relax the assumption often seen in standard models that people act independently of others. Social learning models go further in incorporating others' actions as a source of information and so we imitate other people because we are inferring something from their actions. Many social learning models are based on principles of Bayesian reasoning, in which people's probabilistic judgements are updated in response to others' actions (see Chamley 2003, Baddeley 2018 for surveys). For example, if a person is facing a choice between two restaurants (Restaurant A and Restaurant B), their estimate of the likelihood that Restaurant B is better increases if they see a lot of people eating in Restaurant B. There are also alternative explanations for social learning and social influence, drawing on ideas from sociology and social psychology.

Normative influences

Normative influences are driven by our evolved social natures and determine our receptivity and susceptibility to social cues. Seabright (2004) analyses the importance of cooperation in social groups, and explores some of the evolutionary origins of cooperation, reciprocity and trustworthiness even amongst strangers. There is evidence that cognitive control has evolved within a social context; human children and chimpanzees use similar cognitive skills when dealing with physical tasks but human children have more sophisticated cognitive skills when engaged in social tasks, including social learning and empathy or theory of mind (Herrmann *et al.* 2007). There is also anthropological evidence about the role of cultural factors; some cultures have no sharing norm suggesting that sharing is a cultural construct (Henrich *et al.* 2001).

Cooperation can also be sustained by social cues such as smiling. Centorrino *et al.* (2011) explore the role of smiling in cooperation and test the hypothesis that a convincing smile is costly but has evolved to sustain cooperation and trust. Using the trust game, they conducted experiments in which people watched video clips of potential trustees who were otherwise strangers before deciding whether not to send them money. The trustors were also asked to rate how genuine they found the trustees' smile. Smiles from trustees playing for higher stakes were rated as significantly more convincing. The convincing smiles also were significantly correlated with the trustworthiness of the trustees as measured by their willingness to reciprocate by sending money back. Smiling was also found to be an honest signal: those smiling convincingly returned more money on average and this may reflect the fact that convincing smiles are costly and rewards from encouraging cooperation appear to induce effort.

Some insights from psychology can illuminate the drivers of social interaction. Economic psychologist George Katona (1975, 1951) uses a cognitive psychology approach to analyse group learning. Herding reflects "stamping-in" of simple rules of thumb and heuristics rather than problem-solving and understanding. According to Katona, learning is about relying on simple observation of others to acquire information. On the interactions between individuals and groups in a social learning context, group forces and group motives are important, reflecting not only imitation and conscious identification with the group but also group-centered goals and behaviour. Imitation and suggestion reinforce group situations and group coherence but are not necessary conditions for being part of a group. Reference groups give standards for behaviour and group-centered belonging and motivation are more likely to be important in small groups. Social learning is more selective and simple than individual learning because people adopt short cuts and follow simplifying rules of thumb and routines. Imitation qualifies as a "fast and frugal heuristic" in social situations (Gigerenzer and Goldstein, 1996; see also Chapter 3).

Nonetheless, empirically, it can be difficult to untangle group influences on individual behaviour (though neuroeconomic analyses can offer some insights, as explored in Chapters 11 and 12). The problem is that, as Manski (1993, 2000) observes in his analyses of reflection effects and social interactions, empirically it can be difficult to identify and separate group influences from contextual influences.

Insights from social psychology

To fully understand how normative influences operate in behavioural economic models, it is helpful to look closely at insights from social psychology. Social psychology blends psychology and sociology by reconciling psychological insights about the role of personality and individual differences with the sociologist's emphasis of group influence and context dependence.

Sociological forces create interdependence and encourage imitation and herding. Sociological forces interact with psychological forces and will affect individual behaviour if groups act in concert without any clear co-coordinating mechanism – explained by Carl Jung as the outcome of a collective unconscious, an inherited understanding which is universal in all of us. Early studies of social psychology also focused on the influences from crowds and group pressure on individual actions, drawing on themes from le Bon's analysis of mob psychology and the hypnotic influence of crowds (le Bon 1896). In his analyses, le Bon asserts that sometimes crowds have identities of their own, and so crowds cannot be understood in terms of the individual members who form the crowd (see also Baddeley 2018). Some themes in social psychology have also developed from the psychoanalysts who followed some of Freud's insights. Alfred Adler focused on conscious social factors and the connections between people and the world around them, including the inferiority and superiority complexes (Adler 1979). Herding as the outcome of social pressure rather than rational calculation, is seen in a wide range of human behaviours, for example in formation of mob processes (e.g. flash mobs), political choice, consumer preferences (e.g. fashion trends, dietary choices) and financial speculation.

Festinger (1957) describes strong urges to overcome cognitive dissonance (introduced in Chapter 3), that is, to establish non-contradictory belief systems and group influence can be important in reconciling dissonance. We may persuade ourselves to buy something at an excessively high price if we see others doing the same. In this way, individual differences of opinion are ignored and similarities in small parts of information are transmitted to large numbers of people. Sociocultural norms, attitudes, habits and membership of groups will influence decisions. Discussion of beliefs with friends and associates will mean that information selected is determined by the groups to which the listener belongs. Social learning will continue until the majority has a uniform belief system (Katona 1975).

Social learning theory

Social context is the focus of social learning theories as developed by Julian Rotter, Albert Bandura and Walter Mischel; these theories focus more on social influences in the context of how norms are learned and adopted – as a contrasting approach to the informational approaches associated with the economists' models of social learning reflecting informational influences. These social psychologists rejected the strict determinism of the trait theorists by allowing that learning takes place within social contexts via observational learning and influences from role models. Rotter developed elements from personality theory and behaviourism to explain that behaviour is affected by subjective expectations which are influenced by personality; and external reinforcements which are influenced by external events including social context. Loci of control have internal (individual) and external (social) dimensions. Personalities with a strong internal locus of control take responsibility for their own actions. Those with a strong external locus of control attribute events to context, including social context (Rotter *et al.* 1972).

Albert Bandura analysed the impact of social learning and imitation, particularly on aggression in children. Imitation of aggression was tested on a sample of 36 boys and 36 girls with an average age of 52 months. The children were divided into three treatment conditions: the control group; aggressive condition; and non-aggressive condition. For the aggressive and non-aggressive conditions, the children were given prior exposure to the behaviour of an adult role model. For this prior exposure, the children and their role models played in separate corners of a room. An inflatable "Bobo" doll was placed in the adult's corner and the adult role model behaved in two ways: in the non-aggressive condition, the adult role model ignored the doll; in the aggressive condition, the adult performed a choreographed sequence of different violent acts towards the Bobo doll (striking with a mallet, kicking, punching the nose, verbal aggression, etc.). In the next stage, the behaviour of the children in the presence of the Bobo dolls (with no adult role model present) was analysed. Children in the aggressive condition were significantly more likely to engage in aggressive physical and verbal behaviours than the children in the non-aggressive and control conditions; they were imitating the range of violent behaviours exhibited by their adult role models (Bandura *et al.* 1961).

These insights about social learning connect with behavioural economic analyses of social influence via family upbringing. Developmental psychology focuses on the role of education in embedding habits from a young age and these habits can be transferred within the family structure. Families, for example, will be influenced (either via learning or via social pressure) by the recycling habits of other family members. Grønhøj and Thøgersen (2012) analyse the impact of parental attitudes and behaviour on adolescents' recycling behaviour. They focus on the fact that parents play a key role in teaching pro-environmental practices and the role of parental influence on values. Family norms take two forms: descriptive norms – normative information is conveyed via parents' actions; and injunctive norms – parental instructions to their children about pro-environmental behaviours. Nonetheless, there may be differences across families, reflecting generation gaps and differences in parenting style. Also, issues of identity will be important – the extent to which the child identifies with the parents will affect the transmission of environmental values across generations.

Grønhøj and Thøgersen (2012) analyse evidence from a stratified sample of 601 Danish households representative of the Danish population in terms of socio-economic characteristics. Families were interviewed via internet-based surveys with questions to capture the influence of individual pro-environmental attitudes versus the social influence of family norms on adolescents' pro-environmental behaviour. Families were asked about attitudes and actions with respect to specific pro-environmental practices including buying eco-friendly products; reducing electricity use; and separation of waste for recycling. Adolescents were also asked about the parents' attitudes and actions. The impacts of generation gaps, that is, the difference in age between parents and child, were also analysed alongside the relative weight of personal attitudes versus social influences.

Grønhøj and Thøgersen test three hypotheses: adolescents' behaviour depends on family norms and is more influenced by descriptive norms than injunctive norms; the larger the generation gap, the weaker the influence of norms. They find that adolescents' pro-environmental behaviour is heavily influenced by their own attitudes but also by the existence and strength of parental pro-environmental attitudes and actions. Parents' actions, that is, the descriptive norms, dominate the injunctive norms and the impact of the descriptive norms is also dependent on the child's perception of their parents' behaviour, that is, the extent to which their parents' actions are visible and unambiguous. Grønhøj and Thøgersen conclude that parents are important role models and can play a key role in moulding the pro-environmental behaviour of adolescents.

Social pressure

There is considerable evidence in social psychology that social contexts and social pressures have a significant impact on individual decisions. A famous case is that of Kitty Genovese, a New York woman who was stabbed repeatedly whilst, according to some accounts, many neighbours looked on without helping or calling the police. This case is often used to illustrate constraints on social responsibility including bystander effects, diffusion of responsibility, social passivity and obedience to authority.

Milgram on obedience to authority

Many social psychologists and sociologists focus their analysis on understanding when and why we fail to cooperate with others in such stark ways. Stanley Milgram is famous for a number of experiments assessing social factors including social influences and social interactions. Milgram's "six degrees of separation" study illustrated the density of social networks. A randomly selected "starting person" had to find a way to get a letter, via friends and acquaintances they knew personally, to a randomly selected "target person" whom they did not already know. The degree of separation was the number of people the starting person had to go through to get to the target person; the median was five intermediate persons amongst the (then) US population of approximately 200 million people (Milgram 1967). The experimental design was somewhat questionable but this study nonetheless established the close connectedness of people and inspired the growth of social network theory in mathematics and economics, for example see Watts (2003), Watts and Strogatz (1998).

Another of Milgram's studies analysed social influences, specifically obedience to authority. Experimental subjects were instructed to punish other subjects' mistakes with electric shocks. In reality, there were no shocks and the punished subjects were actors pretending to feel pain; the punishers didn't realize this but were nonetheless willing to inflict close to fatal shocks on others when instructed to do so by experimenters. Their behaviour was interpreted as reflecting obedience to authority which the subjects rationalized by putting responsibility on the authority figure as the one really making the decisions (Milgram 1963).

Milgram's shock experiment showed that people are affected by influence from others, particularly authority figures. Haney, Banks and Zimbardo (1973) extended the analysis into a study of roles and situational influences. They constructed a mock prison with students allocated into roles of prisoner and guard. Haney *et al.* found that the students fell into their fake roles very quickly with both sets of students exhibiting aggressive behaviour. The student prisoners showed signs of feeling increasingly depersonalized, for example they began voluntarily identifying themselves by their prisoner number, not their name. The student guards inflicted real humiliations on the student prisoners. The study had to be stopped after just five days for ethical reasons: the students' behaviour was becoming increasingly sadistic and pathological. The inference drawn was that people in harsh environments will react in increasingly antisocial ways because of the context in which they find themselves and not necessarily because of their personal characteristics. Zimbardo later applied this insight in his witness testimony in the Abu Graibh trials (Haney *et al.* 1973; Zimbardo 2007). Tajfel (1970) also established that identity affects social interactions and contributes to discrimination.

Asch's line experiments

Solomon Asch (1955, 1956) studied social influence in a more benign context. He devised controlled experiments in which people were asked to make simple judgements about the lengths of lines. The subjects made their decisions in a group context without knowing that all the other experimental participants were collaborating with the experimenter. These collaborators were instructed by the experimenter to make deliberately false statements about the length of the lines. A large minority of the experimental subjects were susceptible to intra-group pressure. They made mistakes in 37% of cases because they were persuaded by deliberately misleading decisions from the experimenter's collaborators and the effects increased with group size and consensus within the group. It is plausible that situational pressures operate in an economic and financial context too though perhaps for information reasons as much as social reasons, for example in financial markets, as explored by Robert Shiller (Asch 1955, 1956; Bond and Smith 1996; Shiller 1995).

This analysis of how social pressure changes people's judgements returns us to the debates about herding as the outcome of informational versus normative influences. In distinguishing social learning from social pressure, elements of Bayesian and socio-psychological theories may coincide. Herding may occur through beliefs in: first, the higher competence of the persons being observed; and second, simple group or peer pressure without necessarily higher competence. To herd for the former reason would be rational and sensible; to herd for the latter reason would not.

In untangling normative influences from the informational influences explored in the previous chapter, purely Bayesian accounts are difficult to reconcile with experimental evidence showing that people follow majority opinion even if it contradicts more accurate private information (Asch 1955, 1956). Asch's experiments demonstrated that experimental subjects have a tendency, even with very unambiguous tasks, to make the wrong choice when they see a group making a wrong choice. This finding has been replicated in a large number of sociological studies (see Bond and Smith [1996] for a meta-analysis). Shiller (1995) argues that this evidence about the impact of social influence is not necessarily inconsistent with the Bayesian hypotheses outlined above – it is just rational social learning taken to its extremes. Asch's experimental subjects were making rational judgements about the probabilities of different scenarios and concluding that a large group of other individuals was very unlikely to be wrong about a simple decision; the individuals judged that it was more likely that their own judgement was wrong. This led to a tendency to discount personal perceptions in favour of the information communicated by the group (Shiller 1995). Shiller observes that herding operates even without face-to-face interactions and so is not therefore an outcome of social pressure. Instead, he argues that the response of large groups of people is taken as valid information because it is rationally assumed that large groups of people are unlikely to be wrong (Shiller, 1995). Also, social pressure may emerge from imagined responses as well as real and direct responses – for example, there is evidence that real and imagined events are associated with a similar cognitive response. Also, tendencies to herd may reflect individual differences including personality traits, such as empathy and conformity because these might generate predispositions to follow others.

Overall, decisions to follow others reflect sociological and psychological factors and lead us away from a dichotomous conception of herding as either rational or not rational, reflecting the fact that economics incorporates a binary categorisation of behaviour as either rational or irrational depending on whether behaviour does or does not conform to Bayesian rationality. Enlarging the analysis of herding away from conceiving of it as a purely objective phenomenon also allows the possibility that herding reflects interactions between different cognitive and emotional decision-making systems, which is something that neuroscientists and neuroeconomists explore and some neuroeconomic studies of interacting neural systems are explored in the neuroeconomics chapters – Chapters 11 and 12.

Social marketing

Social psychological principles can also be seen in psychological analyses of marketing and persuasion. Robert Cialdini (2007) analyses some of the principles of influence and persuasion including reciprocation; commitment and consistency; social proof; liking; authority; and scarcity. Reciprocation is a strong tendency in human behaviour, reflecting a sense of obligation to others. Cialdini cites a study in which a researcher sent Christmas cards to strangers and received many cards in return without people asking who he was and/or why he had sent them a card. Commitment and consistency reflects the fact that we are committed and consistent in our plans and actions which can create problems when we are automatically consistent in a way that does not suit our own best interests. Similarly, we may force ourselves into thinking that we are being consistent, even when we are not – which links into issues of cognitive consistency and dissonance, discussed in more detail in Chapter 3. Social proof is about doing what others do and believing what others believe. Liking reflects the fact that when we are complimented by someone who is personable and attractive, then we will be inclined to like them and so inclined to do what they want us to do. We also like people more if they are similar to us. People are more likely to do what we want them to do if we have authority, as shown by Stanley Milgram, described above. Finally, scarcity affects our perceptions, according to Cialdini. When opportunities are limited and scarce, they seem more enticing. This can explain people's susceptibility to scams and swindles; for example the Bernard Madoff Ponzi scheme scam exposed in 2008 exploited the fact that people were willing to invest in a scheme when they were told that it was a rare opportunity available only to a few select, worthy investors.

❖ CASE STUDY: EXPERTS, SOCIAL INFLUENCES AND HERDING HEURISTICS

Experts play a crucial role in policy-making but are as prone to social influences and other forms of bias as the rest of us. Tversky and Kahneman argue that accumulation of experience does not stop people from systematically misapplying heuristics if they do not have an opportunity to discover their own mistakes. They identified some of these biases in experts as well as amongst ordinary decision-makers. Experts will be susceptible to heuristics and biases even when they have had extensive statistical training. This reflects the fact that consistency in judgements does not necessarily reduce the chance of systematic mistakes. The gambler's fallacy, for example, involves an assumption that a long run of red wins on the roulette wheel will make a black win more likely on the next spin. Gamblers do not change their minds about this fallacy and so the gambler's fallacy is not an internally inconsistent belief. The gambler's belief is not unstable and so it does not violate standard economic rationality axioms. Nonetheless, it is not compatible with the more general objective belief that a roulette wheel has no memory and so cannot deliver a black win just because there has been "too long" a series of red wins.

Curtis (2012) notes that the background and experience of geologists did correlate with their ability to successfully interpret geological information, nonetheless experts are still susceptible to a range of biases reflecting subjectivity in expert decision-making. Baddeley, Curtis and Wood (2004) and Curtis (2012) have identified a number of biases in expert judgement including overconfidence, anchoring and motivational bias. In many cases where experts are involved in the elicitation of knowledge, the experts are individually overconfident about their knowledge and multiple experts undergoing the same elicitation procedure will produce estimates of elicited parameter values which barely overlap. One way to overcome bias might be to collect a range of opinions simultaneously from a number of experts but in this setting the experts are susceptible to herding and social influences which may reflect the application of the availability heuristic as the judgements of others are often easily accessible. Polson and Curtis (2010) conducted an experiment in which experts were asked to interpret geological data and assess the probability of a geological fault. They were asked for their judgements before, during and after group meetings and opinions changed significantly through the process even though there was no change in the objective information available to the experts.

Weisberg and Muldoon (2009) use modeling techniques to assess the efficacy of different learning strategies amongst scientific experts contrasting follower strategies with maverick strategies. With the follower strategy, experts followed other experts rather than making their own tracks and as a consequence large parts of the epistemic landscape remained unexplored. Conversely, the maverick strategy, which involved avoiding the research approaches of other experts, were considerably more successful and ensured that a larger area of the epistemic landscape was explored.

Identity

Another way in which social context can influence behaviour is via its impact on identity, and this is a theme that behavioural economists have explored extensively.

Akerlof and Kranton's identity theory

Economists have taken insights from experimental studies to develop economic models of identity. Akerlof and Kranton (2000, 2011) construct a model of identity based on social categories and argue that people's identities are moulded by sociological factors. In their identity model, utility depends on identity or self-image, an individual's own actions and the actions of others. They state that since the actions of self and others determine an individual's own consumption, the elements of their utility function are sufficient to capture standard economic variables.

Within their approach, identity is endogenous and is itself determined by individuals' actions and the actions of others. Identity is also affected by social categories: this is a categorical model of identity. Finally, identity is affected by an individual's characteristics and the extent to which those characteristics match the prescribed behaviour for a particular group. People have some limited choice over their identity but the pressures to remain within a particular category are strong and ostracism often makes it difficult for people to redefine their own identities. Akerlof and Kranton (2000) use their model to analyse identity in a number of different contexts. Actions that seem irrational in a standard model make more sense in an identity model: for example, self-mutilating actions such as tattooing, plastic surgery, body piercing, starvation and steroid abuse are irrational, costly acts from a standard economic perspective but, in a model of identity, they generate utility by reinforcing a person's identity and sense of belonging to a group. The actions of others can also affect utility via identity. If a man is insulted and baited by his fellow workers, thereby undermining his masculine identity, he will experience disutility for that reason. Violating prescriptions for a particular identity will also have impacts on utility: if a person violates the prescriptive norms of their group, for example a man wears a dress, then this may have negative impact on others' utility by undermining their sense of identity. Identity has wider impacts too: with herding for example, when a person identifies strongly with a group then their perceptions of social pressure from that group can lead them more easily to lose faith in their own judgments and copy the actions of others in their group. It might be rational to submit to group pressure, to empathize and to obey rules of etiquette in a world where social context is important and when social factors enhancing status and reputation are important.

Akerlof and Kranton's approach has been criticized for its focus on the individual within social categories. Davis (2006, 2010) argues that identity is more complex than Akerlof and Kranton allow. Akerlof and Kranton embed identity into a standard framework around utility function; in essence, it is about self-image broadly defined. Identity goes beyond self-image and the Akerlof and Kranton approach does not allow for multiple identities and does not distinguish personal identity from social identity.

Davis (2006) observes that there are two main alternatives to Akerlof and Kranton's approach: Sen's (1999, 2004) commitment approach and the complexity approach. In Sen's approach, individuals recognize that groups and commitments to social groups reflect a recognition that groups and the behavioural rules that define those groups have an intrinsic value and so the value of the individual to the group is as important as the value of the group to the individual. Davis (2006) identifies another alternative to Akerlof and Kranton's identity theory, the complexity models (e.g. Kirman and Teschl 2004) which focus on individuals interacting within social groups – not market institutions. People's identities form via interactions with social groups and their social identifications with others, creating feedback effects between self-image and social context – a complexity not fully captured in Akerlof and Kranton's individualistic approach.

Social identity theory

Identity can be incorporated into economic analyses of social interactions using insights from sociology and specifically from social identity theory. Impacts from the social groups around us will however be more pervasive if they affect our preferences, utility and identity. In these cases, sociality will lead to further violations of standard assumptions about independent homogenous agents. We have preferences not only for our own utility and welfare but also for those around us, as explored in behavioural economic models incorporating other regarding preferences. Behavioural economists have investigated the impact of social preferences to explain departures from the standard assumption of self-interest. Some models incorporate sociality by incorporating social preferences as extra elements in people's utility functions. This does not involve a radical departure from standard models and from the central assumption of rationality though it can help to explain evidence that seems anomalous in terms of standard approaches. Other models are more radical, for example analyses of social identity. These analyses take a broader view of sociality, moving from the focus in social learning theories on others' actions as information into analyses of social preferences, rewards and interactions.

Sociologists have established that identities are easy to create and have a significant impact on social behaviour. Tajfel (1970) conducted a study in which he randomly assigned boys to groups using a minimal group paradigm which involves grouping people on a minimal, largely arbitrary basis. In this case, the boys were assigned to groups on the basis of whether they had underestimated or overestimated the number of dots in a visual image and whether they preferred one artist or another. Thus, identity was formed on the basis of very limited input. The boys were assessed as they played a penny game: they were asked to decide how many pennies they would give their group – the in-group; and how many pennies they would give to the other group – the out-group. The boys made offers which strongly favoured their own in-group. Tajfel (1970) and Tajfel and Turner (1979) developed social identity theory by applying these insights about the role played by social identity to analyses of intergroup conflict and discrimination.

Chen and Li (2009) found that induced group identity had a significant impact in increasing altruistic behaviour towards in-group versus out-group members. Subjects in their experiments were more generous towards in-group versus out-group members; they were also more likely to reward in-group members and less likely to punish in-group members, and showed substantial decreases in envy and increases in co-cooperativeness towards in-group versus out-group members.

As explored above, there is a large behavioural economic literature on sociality which explores experimental evidence showing that people often behave in altruistic and co-operative ways and this is broadly inconsistent with a standard economic assumption of self-interest. A range of approaches can be constructed to capture other regarding preferences and other forces generating cooperation, reciprocity and trust and these models focus on a range of assumptions about self-interest from Vernon L. Smith's hypothesis that sociality is just another form of self-interest to models that focus on the idea that helping others is genuinely rewarding and is an end in itself.

Policy can be designed to harness our social natures. Policy "nudges" that incorporate social information and cues can be very effective not only in the context of environmental problems but also in encouraging people to cooperate in other ways, for example via organ donation, by charity and philanthropy and/or by volunteering. Also, social networks, particularly via mobile and online networks, have become powerful tools for social cooperation, as witnessed by public demonstrations during the Arab Spring, the 2011 English riots and the #MeToo movement.

Chapter summary

- Social influences on economic decision-making can be divided into categories of *normative influences* versus *informational influences*.
- Informational influences are about how people acquire information by observing the choices of others in a process of social learning. Economic models of social learning are grounded in Bayes's hypothesis – which captures how people's estimates of the chances of an event are updated as new information comes along. These Bayesian models capture when and how herding can be a rational decision, at least from the individual's perspective, and were explored in more depth in Chapter 5.
- Normative influences are about how social norms and peer pressure feed into people's inclination to follow others in a less rational way.

- A range of experiments from social psychology have shown the ways in which people are inclined unconsciously to follow others, and this can explain other phenomena such as obedience to authority.
- Identity is defined in different ways across the social sciences. Economic models of identity focus on the idea that people will engage in what might seem like perverse practices like tattoos and piercings but when these are signals to others in their in-groups, then they make sense within a rational cost–benefit calculus framework.
- In social psychology, groups formed on the basis of a common identity can be formed quickly and easily – as identified by Tafjel and his colleagues in the context of the minimal group paradigm – but lead to destructive interactions between in-groups and out-groups, fuelling discrimination.

Revision questions

1. Compare and contrast normative social influences and informational social influences.
2. Explore some of ways in which economists and other social scientists empirically capture the different drivers of herding behaviour? What are some of the empirical problems with these approaches?
3. How do concepts of identity differ between economics and other social sciences, specifically social psychology? What are the implications in terms of conflicts between in-groups and out-groups?

Chapter 7

Time and plans

Standard economics assumes that people are consistent when they plan their decisions over time. For a rational, consistent person it should make no difference whether they are choosing between something today versus tomorrow or between something in a year versus a year plus a day. Modern mainstream macroeconomics embeds these assumptions and is built on assumptions such as Milton Friedman's permanent income hypothesis and Franco Modigliani's life cycle hypothesis. Both postulate that people plan consumption over their lifetimes and so their decisions about the future should not change unless information changes. From our ordinary observations, however, we can see that many people struggle making consistent plans, especially over lengthy time horizons and one of the major contributions from behavioural economics comes in theories and principles that capture these problems of what behavioural economists call *time inconsistency*. People change their minds. Their decisions today often do not take full account of the future consequences and most of us are prone to temptation and procrastination.

Exponential discount functions

In capturing the limits to people's ability to plan for the future, some behavioural economists start with adjustments to orthodox models of inter-temporal planning. In orthodox theory, our choices about current versus future decisions is driven by our rate of time preference and this is captured in economic models via a discounting assumption. Following from Fisher's impatience principle, Samuelson (1937) assumed exponential discounting with the discount rate – ρ as a stable preference parameter. Within exponential discounting, the discount rate is a positive number measuring impatience. A patient person will have a lower discount rate and so will have a larger discount factor; they will value future rewards by a larger amount. With exponential discounting, the discount function declines at a constant rate but a choice between something today and tomorrow will be the same as a choice between something in a year versus a year and a day.

In the standard economic model, People's choices will be stable over time. Deviations from the rationality come when time preferences shift, when people are impatient in the short run but patient in the long run. Samuelson explicitly emphasized that his exponential discounting assumption was not realistic but exponential discounting is now the standard discounting assumption seen in almost all modern economic theory.

Individual differences with exponential discounting

The exponential model can capture differences in preferences. If someone has a high discount rate and so values future outcomes less strongly then they can still be described as (impatiently) rational if their impatience is stable over time. For example, if someone is choosing between chocolate cake today versus chocolate cake tomorrow then their choice will be the same as if they are instead choosing between chocolate cake in a year versus a year and a day. Exponential discounting can capture impatience and if someone cannot wait even an hour for their piece of chocolate cake then that may just reflect a high discount rate. As long as they'd make the same choice for chocolate cake in a year's time then their choices are still rational and consistent.

There may nonetheless be individual differences in discount rates. One study illuminating these differences was conducted by Harrison, Lau and Williams (2002). They tested two standard hypotheses: first, discount rates do not differ across socio-demographic characteristics; second, for a given individual, discount rates do not vary over time. They used surveys conducted in June/July 1997 from a stratified sample of 268 people in the age range 19–75-year-olds, all of whom had participated in the European Community Household Panel Survey (ECHP). They also collected demographic, health and financial information. They asked the subjects to make decisions across four possible time horizons: 6, 12, 24 and 36 months with real monetary rewards allocated as a redeemable certificate. They were told that one of them would be randomly chosen to receive a large sum of money and if they won, they would choose either Option A (a smaller amount in one month) or Option B (a 'menu' of 20 possible higher payments to be made in seven months).

They analysed the responses and found an overall discount rate of 28.1%, which didn't vary significantly across the time horizons. There were no gender-significant differences, but discount rates declined with age and discount rates were lower for higher educational levels, for skilled people, for those who were not students, for people who had invested more in education, for those owning houses, people before retirement, the employed (vs. unemployed) and/or good credit risks. They estimated a distribution of discount rates that was roughly normal.

There is also evidence from natural experiments about individual differences in people's forward planning. Warner and Pleeter (2001) analysed evidence from real-world decisions about pension choice using data on US military personnel payments upon voluntary separation. Military personnel were given two contract choices: a voluntary separation incentive (VSI) giving a regular annuity over time; versus a selective separation benefit (SSB), that is, one lump sum payment. They found that 30% of officers and 90% of enlisted personnel took the lump sum, implying relatively high discount rates with a mean discount rate of 26.0%. Analysing the data using probit techniques, they found that discount rates varied inversely with size of lump sum payment (in contrast to exponential discounting models in which the discount rate is assumed to be a constant, reflecting stable preferences). They also found significant demographic variation in discount rates, with white, female, college-educated personnel being less likely to take the SSB.

Cognition also plays a role in determining time preference. Warren and Pleeter identified lower discount rates in the top two "mental groups", perhaps reflecting the fact that these groups are better able to understand/process information about inter-temporal choices and/or perhaps had just had access to better financial education. They argue that their evidence has external validity given that the military are representative of the average American. Individual differences will also lead to differences in attitudes towards social security programmes (Heckman 2001).

Personality is important too – as it is for economic decision-making more generally, as explored in Chapter 9. Personality affects people's attitudes towards time though there can be problems with separating time preference and risk attitudes (Borghans *et al.* 2008). Green and Myerson (2004) assert that risk attitudes and time preferences belong to different psychological processes and will react differently to the same effect. Increase in size of reward decreases the discount rate but increases risk aversion, for example. Risk preferences are multidimensional and people will have different risk preferences across different domains. A person may be risk-loving with financial decisions but risk-averse with health decisions or vice versa. Perceptions of the risk-return trade-off are domain-specific (Borghans *et al.* 2008).

There is also a link between personality and rates of time preference as captured by the discount rate. One of the problems with establishing a link between personality and other individual differences and the rate of time preference is that self-report measures ignore problems of overconfidence and lack of insight. Someone may think that they are more patient than they actually are and so hypothetical choices are not a reliable test of time preference. There is also evidence that time preference parameters are not constant as postulated in standard economic approaches and people often use higher discount rates for real rewards than hypothetical rewards (Kirby 1997). Frederick *et al.* (2002) explore a wide range of empirical studies of time preference and find a wide range of estimated discount rates and also identify within-subject inconsistencies.

Behavioural discount functions

Behavioural anomalies

Frederick, Loewenstein and O'Donoghue (2002) identify a number of anomalies that cannot be captured within models incorporating exponential discounting of utility: gains are discounted more than losses; small outcomes are discounted more than large ones; choices are affected by delay–speed-up asymmetry, for example when buying video recorders, people's discount rates are higher if they want speed-up delivery than if they want to delay it. People also have preferences for improving sequences, for example they prefer to see their salaries increasing over time, and this is inconsistent with a standard exponential discounting assumption but instead may reflect some of the heuristics and biases outlined in Chapter 3.

Angeletos *et al.* (2001) also give some examples of time inconsistency. Workers prefer a 20-minute break in 101 days rather than a 15-minute break in 100 days but exhibit preference reversals if they're asked to decide in the immediate future. If asked for a decision today, they prefer a 15-minute break today than a 20-minute break tomorrow. Smokers are another example: on Monday they may prefer to quit smoking on Tuesday but on Tuesday change their minds and prefer to quit smoking on Wednesday. Another example that affects almost everyone – their alarm clocks: when planning the night before an early start people will choose an extra 15 minutes of wakefulness over 15 minutes of sleep but by 5.30 a.m. the following morning, they will choose an extra 15 minutes of sleep over an extra 15 minutes of wakefulness. Overall, in many of our decisions, people exhibit more patience when they are making long-run choices.

Animal models

A large volume of experimental evidence shows that people do not show consistency of choice over time. Early evidence about the consistency of people's decisions over time comes from animal models and experiments. Early on in experimental psychology, the "Bischof-Köhler hypothesis" was put forward – that only humans can dissociate themselves from current motivations to take actions for future needs but there is significant evidence against this hypothesis. Mulcahy and Call (2006) find that animals plan over time, for example bonobos and orangutans select, transport and save tools to use one hour later and 14 hours later and they infer that planning skills may have evolved in earlier species. Raby, Alexis, Dickinson and Clayton (2007) find that scrub jays make provisions for future needs by storing food when that food/food type will not be available in the morning.

Ainslie (1974) analysed impulse control in pigeons. The pigeons were placed in a soundproof chamber with a single key illuminated by red or green lights. If they pecked when the red light was on, they got a smaller, sooner reward. If they pecked when the green light was on, they got a larger reward later. Overall, the pigeons were impulsive, choosing small short-term gains at the expense of large long-term losses and the tendency to seek shorter access to immediately available food remained strong for up to as many as 20,000 trials. The more interesting finding was that their preferences for reinforcement at different delays changed with elapsing time leading to preference shifts. Some pigeons learned to peck at a key at an earlier time if, and only if, this made them unable to obtain the smaller reinforcement, so perhaps the pigeons were binding their own future freedom of choice by learning a pre-commitment device by pecking the green light.

Behavioural discounting models

Frederick, Loewenstein and O'Donoghue (2002) outline a number of ways in which models of choice can be enriched to capture time inconsistency. A major innovation is in adjusting discounting assumptions, for example using behavioural discounting assumptions, outlined later in this chapter, in place of the standard exponential discounting assumptions.

Frederick *et al.* (2002) also explain how time inconsistency can be captured by enrichments of standard discounted utility models, for example by allowing habit formation and/or allowing utility to be affected by anticipation as well as current consumption. Similarly, given time inconsistency, temptation utility models can be constructed in which sophisticated decision-makers anticipate lack of self-control and therefore pre-commit to responsible strategies. When temptation is a problem, people have preferences for commitment.

Time inconsistency can also be explained as the outcome of interactions between multiple "selves" within each individual. Strotz (1955/6) outlines a model in which more proximate satisfactions are overvalued relative to the more distant ones. The optimal plan of future behaviour may be inconsistent with optimizing future behaviour generating an "inter-temporal tussle" and if this tussle is not recognized, spendthrift or miserly behaviour will be observed. On the other hand, these inter-temporal conflicts between an individual's different selves may be recognized and resolved via strategies of pre-commitment and/or consistent planning. Similarly, Ainslie (1991) describes hyperbolic discounting as an inter-temporal "internal prisoner's dilemma" and the best choice will depend on how far a person can predict their future perceptions. Conflict between a far-sighted responsible self versus an impetuous, myopic and shortsighted self has Freudian connotations of conflicts between the id and the ego and Ainslie and Haslam (1992) develop this interpretation in the context of Freudian themes of "ego-splitting".

Emotions and visceral factors, which we will explore in more depth in Chapter 9, will also have an impact. Bernheim and Rangel (2009) focus on the impact of "hot" emotional versus cool, rational states of mind on inter-temporal choices. Similarly, Rick and Loewenstein (2008) suggest that examples of time inconsistency may reflect trade-offs between tangible and intangible rewards. Tangible rewards tend to arrive more quickly (e.g. smoking a cigarette) whereas distant outcomes (e.g. getting healthy) are less tangible. When decisions are triggered by immediately salient emotional factors then immediate tangible rewards will be preferred to later intangible rewards. Other behavioural factors will have an impact too. Cognitive bias can generate time inconsistency if a projection bias leads people to underestimate the impacts of future changes; choice framing or bracketing leads people to consider only a small subset of choices at any one time; or if reference points mean that people's decisions are anchored to prior choices.

These insights can be incorporated into discount functions that decline more rapidly in the short-run than in the long-run and there are two main families of behavioural discount function that capture this phenomenon: hyperbolic and quasi-hyperbolic discount functions, the mathematics of which are outlined in Mathematical Appendix A7.1.

The consequences of these different assumptions for the evolution of discount factors over time, including exponential discount factors (ED), hyperbolic discount factors (HD) and quasi-hyperbolic discount factors (QHD) are illustrated in Figure 7.1.

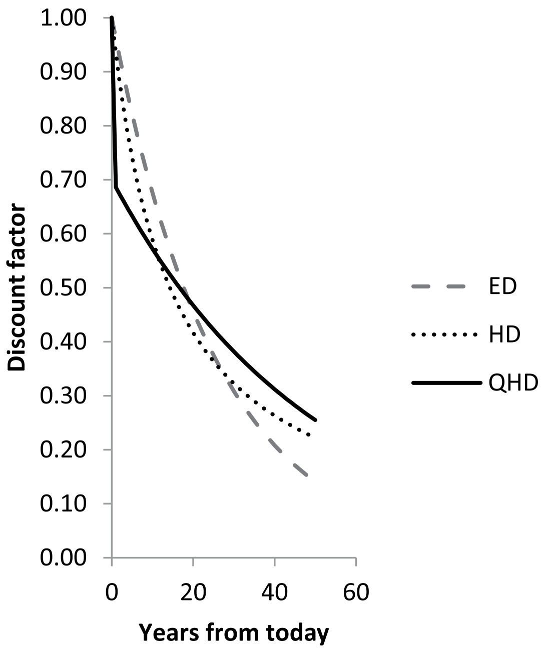

Figure 7.1 Exponential and behavioural discount functions

The discount functions depicted in Figure 7.1 embed specific assumptions about the magnitude of the various parameters and it is important to note that the paths of the discount factors are very sensitive to the magnitudes of these parameters, as shown in Figure 7.2.

Another interpretation of the evidence on time inconsistency is provided in models of sub-additive discounting – that is discounting divided up into little segments of time. Read (2001) argues that subadditive discounting can explaining declining impatience because discounting over a delay is greater when the interval is subdivided than when it is left undivided. People are less patient over shorter subintervals and so when the delay is divided into subintervals there will be more discounting than if the interval is left undivided. Using three choice experiments he found no significant evidence that impatience declines over time and he explains the apparent preference reversals often attributed to hyperbolic discounting as the outcome of subadditive discounting. Apparently anomalous choices do not reflect impulsivity, that is, desire for immediate rewards, but instead are about the delays between rewards – the issue is not whether people are choosing between today and a year's time; the same patterns would be observed if people were making choices between having something in a year versus two years. They are less patient over shorter spaces of time regardless of when the choices occur.

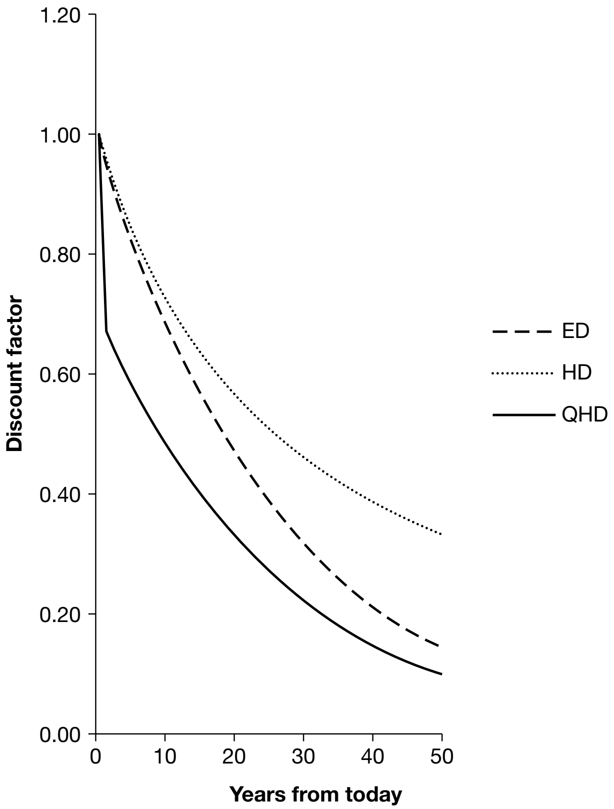

Figure 7.2 Impact of different parameter assumptions on discount functions

Time inconsistency in the real world

Time inconsistency can affect a range of real-world decision-making. Some behavioural economic analyses analyse behaviour by different types of people, defined according to how self-aware they are about potential time inconsistency problems. Two broad categories include naïfs and sophisticates. Sophisticates realise that they will have trouble with self-control. They are aware that they may be vulnerable to a time inconsistency problem, so they will bind their choices via pre-commitment strategies. For example, if a sophisticated but time inconsistent person realises that they will have trouble saving money, then they may lock up their money in investments that they cannot easily sell. Naïfs, on the other hand, will not have the self-awareness to realise that they may be prone to problems with self-control. O'Donoghue and Rabin (1999, 2001) have explored these differences in types and they illustrate the problem with the example of students balancing their social lives with study commitments. In these experiments, students are told that they must complete an important essay within four weeks, but over that four weeks they also have opportunities to go to a different movie each week. For the first week, the movie is mediocre and missable, but the movies improve each week until in the final week, when the essay is due, a good blockbuster is showing. The sophisticates amongst the students will plan effectively by getting their essay finished sooner because they realise that, if they procrastinate, they will miss the good movie. The naïfs, on the other hand, do not plan effectively. They will procrastinate about writing the essay and so will miss the best movie in order to meet their essay deadline.

DellaVigna and Malmendier (2004) explore how firms respond to consumer bias by analysing a firm's contract design incorporating partially naïve consumers with time-inconsistent preferences. DellaVigna and Malmendier compare two types of purchases: investment goods with immediate costs and delayed benefits; and leisure goods with delayed costs but immediate benefits, for example consumption funded using credit cards. This generates a number of inefficiencies including price distortions: leisure goods are priced above marginal costs and investment goods are priced below marginal cost. Empirical evidence from credit cards, gambling, life insurance, mail order, mobile phone and time-share business show that time inconsistency lowers consumer welfare for naïfs but not sophisticates. (DellaVigna and Malmendier's [2006] analysis of health club behaviour is explored in Chapter 10.)

Behavioural life-cycle models

Behavioural life-cycle models incorporate insights about time inconsistency and present bias into otherwise standard approaches to life-cycle planning, constructing models to capture households' financial planning over a lifetime, including decisions about consumption, savings, pensions and investments. Overall, hyperbolics smooth consumption and savings less successfully than is assumed in the standard economic model incorporating exponential discounting. People tend to hold high levels of credit card debt alongside high levels of retirement wealth (especially in the form of housing) and cannot account for conflicts between short-run and long-run discount rates reflecting simultaneous patience and impatience (Angeletos *et al.* 2001). Behavioural models have greater external consistency in explaining the simultaneous existence of high stocks of illiquid wealth and large credit card debts: models incorporating quasi-hyperbolic discount functions can incorporate parameters which predict that people will be more willing to hold savings in the form of illiquid wealth. At the same time, the costs of holding illiquid savings are balanced by the benefits of illiquid savings as a crude commitment technology preventing impulsive consumption splurges. Nonetheless, inter-temporal tussles will emerge because hyperbolics are holding little liquid wealth and are more tempted to take on credit card debt to fund instantaneous gratification.

Following Laibson (1997) and Harris and Laibson (2001), Angeletos *et al.* (2001) and Laibson *et al.* (2007) use the quasi-hyperbolic discount function within a structural modelling approach. They adopt a modelling approach in preference to an experimental approach because they are concerned that there are different results between different sets of experiments. Experimental studies have some advantages. They can reveal the extent of individual socio-economic and demographic differences, and they are not prone to aggregation problems. Also, they can complement other forms of evidence. But experimental findings may confound time preferences with other factors. Also, subjects may behave perversely because they doubt the trustworthiness of the experimenter. Experimental tasks can be highly abstract and realistic which means that external validity may be limited, especially as experimenters are often reliant on student volunteers – rather than a broader and more representative range of participants – when conducting their experiments.

Angeletos *et al.* focus on some stylized facts including that US households accumulate relatively large stocks of wealth before retirement yet borrow actively on credit cards and their consumption is excessively sensitive to predictable income changes. Bernheim, Skinner and Weinberg (2001) found that consumption growth rates close to retirement do not vary with retirement wealth (versus Modigliani) and that there are discontinuities in consumption at retirement (versus consumption smoothing). They conclude that there is little support for standard life-cycle models; their evidence is more consistent with rules of thumb, mental accounting and hyperbolic discounting in inter-temporal decision-making.

Angeletos, Laibson, Repetto, Tobacman and Weinberg (2001) and Laibson, Repetto and Tobacman (2007) develop these insights in constructing a structural buffer stock model analysing consumption/wealth patterns, building on Strotz (1955/6), in which inter-temporal decision-making is modelled as an intrapersonal strategic game between selves. They develop a standard economic theory of life-cycle planning (following Phelps and Pollak's [1968] analysis of intergenerational time preferences) by incorporating buffer stocks but blended with a psychological model of self-control. Rational players are engaged in intrapersonal and inter-temporal strategic tussles. They incorporate some key principles: labour income and liquidity constraints are uncertain; households can simultaneously borrow on credit cards whilst investing in illiquid investment assets (though simultaneously holding liquid assets and credit card debt is precluded). Quasi-hyperbolic discounting allows time variant discount functions in which short-term preferences favour immediate gratification whilst long-run preferences are to act patiently.

Quasi-hyperbolic discounting is consistent with predictions of quasi-hyperbolic discounting for "sophisticates" who can anticipate conflict with earlier selves' preferences so they will accumulate illiquid wealth sooner and hold it longer to protect themselves from future consumption splurges. This insight is consistent with Strotz's observations about pre-commitment devices. It is also consistent with Laibson's (1997) "golden eggs" hypothesis; it is not wise to kill the goose that lays the golden eggs; similarly illiquid assets accrue benefits only if you can hold them for a long time (Harris and Laibson 2001). Limits on liquid wealth preventing consumption smoothing and co-movements between income and consumption are particularly pronounced around retirement, which conflicts with Hall's random walk hypothesis that consumption follows a random walk and therefore exhibits no systematic tendencies or correlations. There may be high levels of credit card borrowing to fund instantaneous gratification. Whilst they focus their analysis on sophisticates, the behaviour of "naïfs" will be broadly similar, contrasting with O'Donoghue and Rabin's analysis (1999) in which naïfs and sophisticates adopt radically different behaviours.

The agents in Angeletos *et al.*'s model are assumed to be inter-temporal utility maximizers, though not necessarily with stable inter-temporal preferences. The agents are assumed to be high school graduates with a 90-year maximum life and a working life extending from 20 to 63 years old. Household size is allowed to vary over a lifetime. Labour income is autocorrelated with shocks. Liquid assets are used as buffer stocks to enable riding out of transitory shocks. Illiquid assets yield a relatively high rate of return but transaction costs of $10k + 10% of value of asset prevent easy sale making the assets illiquid, paralleling some features of housing wealth, a major source of household wealth. Transactions costs are made large enough to prevent the sale of illiquid assets before wealth is bequeathed to increase computational tractability but also because there are many partially illiquid consumers given transactions costs and delays. With quasi-hyperbolic discounting, even small transactions costs generate complete illiquidity. Illiquid assets earn interest yielding an annual consumption flow of 5% but no capital gain occurs. Credit card debt attracts higher rate of interest (but adjusted for bankruptcy and inflation). There is a credit limit on credit card debt of 30% of mean income for each age cohort.

No analytical solution can be derived from the theoretical model and so the model is calibrated and simulated in two forms to allow the comparison of predictions from two possible discounting strategies: exponential discounting versus a quasi-hyperbolic discount. Calibration involves incorporating prior information into the equations to give forecasting equations which are matched with consumption and asset allocation data from the US Panel Study of Income Dynamics (PSID) and Survey of Consumer Finances (SCF). Labour income and size of shocks are calibrated to match empirical data on labour income; the degree of present bias is assumed to be $\beta = 0.7$, as typically measured in lab experiments and, consistent with SCF data, with a discount factor of 0.944. The age-dependent survival rate is calibrated from the US National Center for Health Statistics and the willingness to save is equalized to match real savings, with quasi-hyperbolic and exponential discount factors used to ensure a match with SCF data on retirement savings stock. Stochastic elements are incorporated using random number generators. Finally, equilibrium strategies are computed numerically using these assumptions and prior information.

Angeletos *et al.* (2001) find co-movement of income and consumption in their simulations with marginal propensities to consume from predictable income changes ranging from 0.19 to 0.33 for both exponentials and hyperbolics. This contrasts with Hall's random walk hypothesis and reflects the fact that low income early in life holds down consumption because of borrowing constraints. Consumption peaks in midlife when household size is largest. "Hyperbolics" are more willing to hold illiquid wealth because whilst illiquidity is costly for both hyperbolics and exponentials, these costs are balanced by the benefits of illiquidity for the hyperbolics. In comparison with the exponentials, hyperbolics have higher discount factors in the *very long-run* and, if rational, will use a crude commitment technology to prevent splurging behaviour. This explains why they invest in illiquid assets whilst simultaneously running up credit card debt. With a perfect commitment technology, exponentials would match hyperbolics. Exponentials are better at using buffer stocks and are more likely to accumulate liquid assets pre-retirement. Hyperbolics hold little liquid wealth and more credit card debt to fund instantaneous gratification. Overall, sophisticated hyperbolics smooth consumption less successfully than the exponentials but they accumulate more illiquid assets earlier as a commitment device and because their *very long-run* discount factor is relatively high.

Similarly, in Laibson *et al.*'s (2007) analysis they impose and reject the restriction associated with exponential discounting, that is, assuming that the present bias parameter is equal to 1 ($\beta = 1$). This restriction is rejected at a 1% significance level. The model is consistent with different discount functions in the short run versus the long run, implying a high short-run discount rate (39.5%) alongside a low long-run rate (4.3%). Overall formal rejection of restricted exponential discounting case implying that short-run and long-run discount factors are not equal leads Laibson *et al.* to reject the exponential discounting hypothesis overall. Exponential discounting cannot account for high levels of credit card debt alongside high levels of retirement wealth accumulation and cannot account for conflicts between short-run and long-run discount rates reflecting simultaneous patience and impatience. Quasi-hyperbolic discounting explains why illiquid wealth is accumulated at real interest rates of about 5% even whilst some households are accumulating credit card debt at 12%.

Limitations of the Angeletos et al. behavioural life-cycle model

Whilst Angeletos *et al.* and Laibson *et al.* claim that their model fits better with real-world data, the differences in correlation are not large – using their data on the proportion of the population with relatively high liquid assets, the correlation coefficients between the exponential model and real data are 0.39 to 0.87; between the (quasi) hyperbolic model and real data are 0.44 to 0.87. Also, the finding that exponential and hyperbolic/quasi-hyperbolic discount functions intersect (implying that people are simultaneously prone to consumption splurges and patient with their "golden eggs" hyperbolic) is sensitive to the parameter values selected. Figure 6.2 shows the evolution of discount factors using parameter values for the HD and QHD functions matching more closely the parameters used in the calculation of the ED discount factors. The golden eggs result does not hold for all parameter values and sometimes HD gives consistently higher discount factors and this would be consistent with future bias not present bias. More work does need to be done in establishing the relative empirical merits of different behavioural life-cycle models and parameter estimates – potentially a rich seam for further research.

Mental effort and bracketing

The Nobel Prize-winning economist, Richard Thaler, provides an alternative behavioural view of how people deal with choices spread over time. Thaler (1981) conducted an early behavioural laboratory experiment with University of Oregon students, testing for time inconsistency by finding implicit time variant discount rates. His hypothesis was that discount rates are time variant, that they vary inversely with size of payoff because waiting for reward requires mental effort and self-control. So the implicit discount rate for losses will be lower than for gains. The experimental design involved using questionnaires; three for gains and one for losses. For gains, subjects were told that they'd won money in a lottery that was held by their bank; they could take the money now or wait and were asked to say how much they'd need to make waiting equivalent to getting payments now. For losses, they were told that they had a traffic ticket that they could pay now or later.

Thaler found very large median implicit discount rates. The median response for the equivalent of $15 in a year was $60, implying a (compounded) discount rate of 139. Implicit discount rates drop sharply with size of prize and over time. The median discount rate for early prize of $15 versus same payment in three months was 277%; for a prize in three years it was 63%. Overall, choices between a $15 prize today versus a larger prize in three months suggested implicit discount rates of up to 277%; for a $3,000 prize today versus a larger prize in three years responses suggested implicit discount rate of 12%. Thaler also found sign effects. Implicit discount rates were higher for gains than they were for losses, and this fits with Kahneman and Tversky's prospect theory (described in Chapter 4). In explaining these anomalies in inter-temporal decision-making, Thaler's interpretations included the role of arithmetic errors in exponential calculations and self-control – differences in rewards over time need to be substantial and noticeable to expend effort on self-control.

Bracketing in labour supply

Time inconsistency can also lead to violations of the standard assumption about inter-temporal substitution of labour for leisure, as seen alongside an exponential discounting assumption in real business-cycle models. Standard approaches assume that people work when wages are high and consume leisure when wages are low, reflecting the marginal rate of inter-temporal substitution. In this case, there should be a positive labour supply response with more labour supplied when wages are high. Camerer *et al.* (1997) assess this hypothesis using a natural experiment capturing the working patterns of New York City cab drivers. They argue that this is a good data set with which to study inter-temporal labour supply because there will be considerable fluctuations in wages day-to-day reflecting fluctuations in demand – on holidays or when the subway breaks down, for example.

If cab drivers are rational inter-temporal maximizers in the sense presented in standard models, then they will work harder on busy days and less hard on quiet days. Camerer *et al.* collected data from 192 trip sheets for NYC cab drivers and estimated labour supply functions from the trip sheet data. Fare rates were fixed by the Taxi and Limousine Commission (TLC). Their estimated labour supply curves were downward sloping because cab drivers made less effort on busier days giving *negative* wage elasticities. They found little evidence of inter-temporal substitution: drivers tended to stop work sooner on busy "high wage" days perhaps consistent with target-setting. They address the potential problem of measurement error using instrumental variable estimation with fixed effects, with other drivers' wages used as an instrument. They conclude that in general there are significantly negative wage elasticities for NYC cab drivers.

Camerer *et al.* list a few possible explanations but, according to them, the most compelling explanation is daily income targeting – a type of bracketing. Bracketing is used to simplify decisions by isolating them from a stream of more complex decisions so daily targeting means that people do not have the cognitive challenge of thinking over long time horizons. They don't have to worry about what it'll be like tomorrow or remember what it was like yesterday. This is also consistent with comparisons against a reference point or aspiration level and gives a simple decision-rule to use in the face of choice overload. Quitting early on some days may also ameliorate self-control problems. The cab drivers who stop early but at the same time everyday are pre-committing to a steady level of effort. Developing this habit stops them feeling tempted to quit early even on quiet days. Also, they might be tempted to fritter away the windfalls earned on the good days if they worked too hard on those days if windfall income is going into a mental account for luxuries.

❖ CASE STUDY: INTER-TEMPORAL PLANNING AND THE ENVIRONMENT

Climate change and resource depletion are problems that will intensify over time. Similarly, decisions about energy-efficient consumption/investment involve costs now for benefits in the future. Given the importance of time to decisions affecting energy and the environment, the behavioural literature on inter-temporal decision-making, offers a number of relevant insights. McNamara and Grubb (2011) observe that energy is an abstract commodity – invisible and intangible and so learning about substituting towards more energy-efficient consumption is delayed by perceptions of risk and procrastination. In resolving these problems, habits and planning will play a crucial role.

Behavioural discount functions for environmental decision-making

Environmental decisions are often taken with a view to the future and in judging future consequences, people will be affected by present bias. This links to dual-self models explored in this chapter. Thaler and Sunstein (2008) argue intrapersonal conflicts between a "Doer" self and a "Planner" self makes people unwilling to take action if the costs are immediate and the payoffs more distant, because the Doer prefers to spend less in the present. This can lead to an excessive focus on current costs/benefits relative to future costs/benefits encouraging procrastination and overindulgence. In an environmental context, it may also lead people to underestimate the benefits of environmental actions. For example, even when long-term incentives and payoffs are substantial, only 19% of Europeans opt for home insulation and only 6% opt for eco-friendly cars (Pongiglione 2011 citing Special Eurobarometer Survey 75.1).

Hepburn, Duncan and Papachristodoulou (2010) apply hyperbolic discounting to a fishery model: the fishery collapses because at minimum, the viable marginal rate of return is lower than the relatively high early-on discount rate and this may explain the demise of Canadian cod and Peruvian anchoveta fisheries. Allcott and Mullainathan (2010) also argue that environmental decision-making is affected by procrastination: attention wanders, peripheral factors subconsciously influence decisions and perceptions, though commitment devices and default options can influence constructive choices and enable effective planning.

Brutscher (2011b) analyses temporal inconsistencies in energy decision-making using data from the Northern Ireland Continuous Household Survey. He analyses prepayment in household electricity consumption and finds that upfront payments are associated with higher electricity consumption than *ex post* payment even when transactions costs are higher and feedback is given about electricity use. Using data from 10,124 households, he explores links between the top-up behaviour of households using pre-payment meters. Households will balance the costs and benefits of top-ups – topping-up is costly because of foregone interest but this is balanced by the benefit of convenience. Topping-up a pre-payment meter means that the household does not have to make a payment every time they use electricity. (See also Gourville and Soman [1998] on temporally separating payments from consumption.)

Brutscher identifies two behavioural anomalies in households' electricity consumption. People top-up more often with smaller amounts than optimal and increases in tariff do not lead to equal changes in number and amounts of top-up; they just lead to increases in the number of top-ups. These anomalies cannot be explained by learning because there is little adjustment in months following change in tariff so learning is slow or non-existent. Top-ups may be used as a pre-commitment device enabling households to save electricity and resolve the conflict between an impatient present self and a patient future self. A sophisticated agent will look for a pre-commitment device but this does not explain the asymmetric adjustment of number versus amount of top-ups. If the behaviour reflects pre-commitment then there should still be a unique optimal top-up amount but the survey evidence shows people adjusting by choosing different top-up amounts depending on the timing.

Another explanation draws on Thaler's mental accounting model (explored in Chapter 13). People perceive costs differently and whilst each £10 payment seems trivial, one larger £100 payment does not. To test these insights, Brutscher uses data from a natural experiment to analyse the impact of an exogenous increase in minimum top-up amount. An increase in minimum top-up amount from £2 to £15 was implemented in May 2009 and this did lead to decreases in electricity use: electricity consumption decreased by around 15 KWh as a result of the change in minimum top-up and this is consistent with mental accounting models in which people treat small amounts as trivial even when paid more frequently (Brutscher 2011b).

Goals, planning and feedback

Intentions do not always translate into action and often there are conflicts between declared intentions and actual action, which may reflect preference reversals and/or naïve inter-temporal decision-making. A Fondazione Eni Enrico Mattei (FEEM) survey indicated that whilst 70% of Italians surveyed are willing to increase energy savings, only 2% are currently reducing their use (Pongiglione 2011). People may want to reduce emissions but will not approve of this if it has tangible consequences for themselves. American survey evidence shows that 78% of Americans oppose gasoline tax and 60% oppose business energy taxes (Leiserowitz 2006). Even though people may express concerns about climate change, there is limited real commitment to environmental action by Americans: 52% of Americans claimed to support the Kyoto Treaty in principle but if they had to pay an extra $50 per month then they would oppose it (Sunstein 2006).

Goals modify behaviour; ambitious goals lead to greater and more prolonged effort (Locke and Latham 2002). Planning is also important because effective behaviour is not just about intention; behavioural control including self-confidence guides action (Ajzen 1991). Whilst standard economics emphasizes the role of monetary incentives, Bamberg (2002) analyses two environmental behaviours – using a new bus route and shopping in a bio-shop. He finds that forming intentions is not just about the goal itself. Intentions about implementing the new behaviours increases their likelihood and so implementation intentions can substitute for monetary incentives. Monetary incentives alone increase the likelihood of environmentally sensitive behaviour but additional implementation incentives do not increase the likelihood of environmentally sensitive behaviour any further. Intentions can be reinforced when people make concrete pre-commitments to conserving energy, and commitments may endure even when the initial incentive to commit is temporary. Cialdini (2007) describes the enduring impact of "lowball" tactics in promoting changes in habits – a lowball being a tempter offer which is later withdrawn.

Becker (1978) emphasizes the importance for inter-temporal planning of feedback alongside hard goals. He analysed the behaviour of US families in identical three-bedroom houses: 80 families were asked to set goals for reducing energy consumption during the summer: half were set an easy goal; the other half were set a difficult goal. Half of each group were given regular feedback three times per week. An additional 20 families were used as a control group. The group with the difficult goal and regular feedback was the only group to consume significantly less electricity; they reduced their electricity consumption by at least 13%.

Overall, the theories and evidence outlined in this chapter demonstrate that the standard assumption of exponential discounting has a number of limitations and does not effectively capture empirical patterns observed in natural and lab experiments. Evidence from simulations of models calibrated using some parameter estimates from experimental studies also generate predictions about consumption, savings and investment that match real-world behaviour more effectively than exponential discounting models, though these models do suffer from the limitation that they have no analytical solution and therefore the parameterization process is somewhat subjective. Time inconsistency and preference reversals can also be explained in terms of psychological factors including emotions and visceral factors, as explained in more detail in Chapter 9. The literatures on time inconsistency and emotions link up in explaining bad habits, including addictive behaviours, as explored in the following chapters.

Time inconsistency, preference reversals and present bias can distort effective decision-making in a number of domains. Overall, policies could be designed to accommodate the extent of sophistication in people's understanding of their own susceptibility to time inconsistency. If many consumers are naïfs, time inconsistency creates problems not only for the individual affected but also has implications for the allocation of resources more generally and can generate negative externalities. Policies to ameliorate time inconsistency are not just about interfering with the free choices of individuals but are about getting more efficient outcomes for the economy more widely, depending on the proportion of naïfs and sophisticates in a population.

Overall, recognizing the interplay of present bias with other behavioural biases can enable governments to design effective policies not only to enable effective financial decision-making but also in other spheres, including moderating the impact of behavioural factors on destructive behaviours and bad habits such as addiction, as explored in the next chapter.

Chapter summary

- Behavioural economic theories of time inconsistency take on the standard assumption in mainstream economics that decision-makers' rate of time preference, that is their discount rate, is stable. Behavioural economists explore the possibility that our discount rates are not stable.
- Unstable discount rates explain the common everyday problem of present bias – seen when people overweight short-term gains relative to long-term gains.
- Present bias is linked to time inconsistency: when looking at a choice over a given interval – say one – day, if people are thinking about prospects today versus tomorrow they will tend to overweight today's prospects over tomorrow's, but if they are thinking about prospects in a year versus a year and a day, they will tend to give higher weight to a year and a day.
- Some behavioural economists capture time inconsistency via alternative specifications of the discount function. In orthodox economics, the discount function embeds a fixed rate of time preference to give an exponential discount function. In behavioural economists' specifications of the discount function, including hyperbolic and quasi-hyperbolic forms, the rate of time preference is variable.
- Other behavioural economists take a different view of time inconsistency, arguing that people's choices are determined by the context and so framing and bracketing will drive people's choices.
- Problems of present bias and time inconsistency are very common and affect a wide range of everyday decision-making – for example, energy decision-making, as explored in the case study in this chapter.

Revision questions

1. How are discount functions in behavioural economics different from discount functions in standard economics? How are they similar and how can they be reconciled?
2. What is present bias? Illustrate with some everyday examples.
3. Discuss how individual differences have an impact on people's rate of time preference in behavioural economic models.
4. What are näifs and sophisciates and how do the ways they deal with present bias differ? Illustrate with some examples.

MATHEMATICAL APPENDIX

A6.1 Some mathematics of discount functions

Exponential discounting

The standard exponential discount factor D(t) is given by:

$$D(t) = \delta^t = \left(\frac{1}{1+\rho}\right)^t$$

Hyperbolic discounting

With hyperbolic discounting, the discount function is constructed to be a function only of time, in its simplest form as:

$$D(t) = \frac{\gamma}{1+\alpha t}$$

This version of hyperbolic discounting incorporates γ into the numerator but some versions assume $\gamma = 1$ which bounds the discount factors between the empirically plausible bounds of 0 and 1, and also enables meaningful comparison with other discount functions.

Quasi-hyperbolic discounting

Discounted utility is given by the following inter-temporal Euler relation:

$$U_t = E_t\left[u(c_t) + \beta \sum \delta^\tau u(c_{t+\tau})\right]$$

where τ is the number of periods of delay relative to the current period – t.

The discrete time discount function evolves over time as:

$$\{1, \beta\delta, \beta\delta^2, \beta\delta^3, \beta\delta^4, \ldots\}$$

where β captures present bias. If $0 < \beta < 1$, this discount structure mimics the qualitative features of the hyperbolic discount function but if $\beta = 1$ the discount function reverts to the standard discount function as seen in exponential discounting models.

Laibson (1997) and O'Donoghue and Rabin (1999) show that the quasi-hyperbolic discount functions generate discount factors which decline over time, as for exponential discount functions, but with the rate of decline distorted by the degree of present bias $-\beta$. Quasi-hyperbolic discount functions converge on exponential discount functions as β approaches 1.

Harris and Laibson (2001) compare exponential discount functions with quasi-hyperbolic discount functions. With exponential discounting, from the perspective of self at time t the inter-temporal marginal rate of substitution, that is, the ratio of marginal utilities between two choices with equal time intervals, should be the same. The marginal rate of substitution of consumption in period t+1 relative to t+2 will be equal to marginal rate of substitution in period t+k+1 and t+k+2. Quasi-hyperbolic discounting splices together the standard exponential discounting model with the present bias parameter. This generates models in which marginal rates of substitution differ over equivalent time intervals and the marginal rate of substitution in period t+1 relative to t+2 will be greater than the marginal rate of substitution in period t+k+1 relative to t+k+2.

Chapter 8

Bad habits

Orthodox economics is based on assumptions of rational, forward-looking agents and – within these approaches – self-destructive habits and addictions are anomalous. Behavioural economics offers some deeper insights into what motivates people to do things that adversely affect their future well-being. Potentially, bad habits and addiction can be explained via models of present bias, time inconsistency and preference reversals, as outlined in the previous chapter. So far however, the analysis in economics has tended to focus on rational addiction models based on exponential discounting assumptions.

In this chapter, we explore rational addiction models and related empirical evidence. The rational addiction analyses suggest that bad habits and addictive behaviour are rational choices but may still be associated with negative externalities and other market failures. Other models relax rationality assumptions to allow that environment and context will affect vulnerability to addictive behaviour, for example the cue-trigger consumption models of Laibson and Bernheim and Rangel. Some approaches focus on emotional, visceral and neurobiological factors, for example analyses by Loewenstein, and Tasnádi and Smith.

Evidence about smoking is covered extensively in empirical studies of addiction, perhaps because smoking is a legal activity, its consumption is easy to measure, and it has been well known for a long time that smoking is very bad for you. The health effects from smoking cost governments a lot of money. For these reasons, good data that is relatively easy to interpret is widely available. For other bad habits, more data and analysis are becoming available about bad lifestyle habits and their impacts on health.

Rational addiction models

Standard approaches to analysing addiction are associated with rational addiction models initially developed by Becker, Grossman and Murphy (BGM). Generally, these models and analyses are applied to smoking habits but similar concepts will apply to other bad habits, and some of these are explored in more detail below. Rational addiction theories confront the conventional wisdom about addictive consumption which asserts that addictive substances are not price-responsive because they reflect irrational impulses.

Becker, Grossman and Murphy's model

The theoretical background to the model of rational addiction is outlined in Becker and Murphy (1988) and also BGM (1991, 1994). BGM assume that consumers are rational and forward-looking with time-consistent preferences so addiction is not myopic. Rational consumers anticipate the future consequences of current actions and this can be captured by relaxing the assumption of separable utility instead allowing utility in each period to depend on previous and future consumption.

Addictive capital stock

A central element of the model is the stock of addictive capital and for this reason some of the analytical features of BGM's model resemble features in Solow's macroeconomic model of growth (Solow 1956). The stock of addictive capital builds up with past consumption of addictive substances and stressful life-cycle triggers such as divorce. Once the steady state is reached the stock of addictive capital will be stable, unchanging.

Adjacent complementarity, tolerance and reinforcement

Intuitively, the adjacent complementarity condition holds when consumption of goods in adjacent periods is complementary. This reflects some basic characteristics of addictive behaviour including tolerance and reinforcement. Addicts need to consume more of an addictive substance as consumption increases generating tolerance: past consumption lowers the marginal utility of consumption today and tomorrow. Reinforcement captures the fact that increases in past consumption lead to increases in the stock of addictive capital, increasing present consumption.

Putting these together, BGM outline the adjacent complementarity condition. Addiction is consistent with rational utility maximization given expectations of future harm from addiction, but only if there is adjacent complementarity, that is, only if positive impact of increased addictive stock in reinforcing the marginal utility of current consumption exceeds the negative effect of higher addictive stock on tolerance. In this case, past (current) consumption will lead to greater current (future) consumption. The mathematics of Becker, Grossman and Murphy's model is outlined in Mathematical Appendix A8.1.

Using this model, BGM predict that consumption of addictive goods is likely to be price responsive and that strong addictions imply more price-elastic responses in the long-run. Multiple equilibria and unstable steady states will mean that addiction is sensitive to initial stock of addictive capital. The mechanisms underlying BGM's rational addiction model are illustrated in Figure 8.1.

Figure 7.1a illustrates that there are multiple equilibria in the rational addiction model. There is an unstable steady state at point [0]: consumption is relatively low so addictive stock is depreciating faster than it accumulates. Even if consumption is initially positive, eventually the consumer will stop addictive consumption and return to zero consumption.

At point [2] consumption is stable. If consumption decreases it is still greater than replacement rate so the addictive stock will increase again. If consumption rises, it will be less than needed for replacement so it will fall again. Either way consumption will return to point [2].

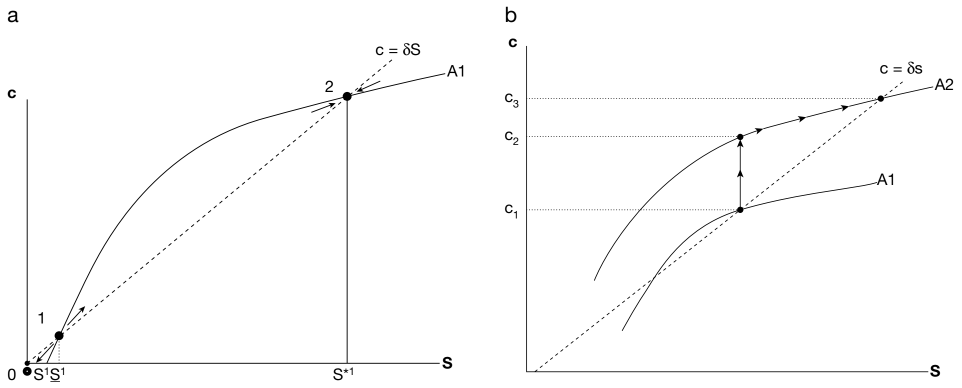

Figure 8.1 Becker, Grossman and Murphy's rational addiction model

On the other hand, [1] is locally and globally unstable: small perturbations rightwards will lead to increasing contributions to the stock of addictive capital until the consumer converges on point [2]. Similarly, decreases in consumption will lead to insufficient replacement of the stock of addictive capital and the consumer will converge on [0].

The existence of these different equilibria explains the unstable behaviour seen amongst many consumers of additive substances. In steady states, the same person can use heavily and at other times give up because impacts are multiplied; for example, if the price decreases, consumption shifts from [0]<c<[1] to c>[1] and the impacts of the price decrease will be magnified leading to increased demand as the consumer shifts to a new steady state at [2].

In terms of the dynamic, inter-temporal aspects of addictive consumption, BGM allow that addiction is more likely if the consumer discounts the future heavily, and/or pays less attention to future consequences. In this case, the effects of reinforcement will outweigh those from tolerance. If there is rapid depreciation of addictive stock, current consumption has smaller negative effects and harmful effects will disappear. There will be different responses in the short-run versus the long-run, as illustrated in Figure 71b. Given a fall in prices, demand for the addictive substance rises from A1 to A2 in two stages: in the short run, consumption rises from c1 to c2; in the long run it rises from c2 to c3. It follows therefore that long-run impacts will exceed short-run impacts. Initial increases in addictive consumption flow into stocks of addictive capital stimulating further growth in consumption.

Becker and Murphy's empirical evidence

BGM put forward a number of empirical hypotheses which follow from their model. The long-run price elasticity of demand (LRPED) of smoking consumption will be sizeable and larger than the short-run price elasticity of demand (SRPED). High future and past prices will reduce current consumption reflecting adjacent complementarity. People on lower incomes will tend to have higher discount rates and will respond more to price changes than people on higher incomes, with lower discount rates. People on higher incomes will respond more to future harmful effects and younger people will be more responsive to price changes than older people.

It follows from BGM's models that current and past consumption will be complementary and consumption in the period of time will be affected both by consumption in the last period and by consumption in the future period. Consumption in all periods will be correlated. In contrast to BGM's approach, myopic models of addiction are explored by Pollak (1970, 1976) and Yaari (1977) who explain that myopic individuals fail to consider impacts of current utility on future utility and consumption; because they ignore future effects, consumption becomes entirely backward-looking. Myopic addicts would not increase consumption in the face of expectations of price increases.

BGM construct an empirical test to separate models of rational addiction from models of myopic addiction. If the parameter on past consumption is significantly greater than zero and the parameter on future consumption is not significantly different from zero, then this confirms a hypothesis that addiction is myopic. Similarly, if the parameter estimate on future consumption is insignificantly different from zero, then future prices are not affecting current consumption, which again would be consistent with myopic addiction.

On the other hand, if the parameters on past and future consumption are both significantly greater than zero, then consumption across time periods is complementary across time. Past, present and future consumption are affected by each other and this is consistent with BGM's model. If lower prices today lead to increased consumption today and tomorrow, this again is consistent with complementarities in consumption over time, consistent with rational addiction. For rational forward-looking agents, if price falls are anticipated then consumption in the past period and the current period will both rise; similarly rises in consumption in the future period will lead to rises in consumption in future periods.

Some empirical hypotheses about permanent versus temporary price changes can also be formulated. Permanent price falls will have a larger effect on current consumption than temporary falls because they imply a fall in all future prices and therefore a rise in all future consumption; it follows – as noted above – that the LRPED will be greater than the SRPED.

BGM (1994) test these hypotheses using various econometric techniques. They make the basic rational addiction model more tractable by setting out an empirical model in which current consumption is a function of past and future consumption, current prices and life-cycle events (captured within an error term). To test their hypotheses BGM use data on cigarette sales and prices for US state cross sections from 1955–1985 for 50 US states. Some data points are missing so, overall, they have a panel data set with 1581 observations.

They capture price variability using state excise taxes; variation in tax rates leads to substantial variation in retail prices. They note a number of limitations in the data. The impact of health education will change the temporal patterns but they hope that this will be captured by the time dummies. Demographic differences may affect patterns so they assume that these do not correlate with interstate tax/price differentials. Smuggling of cigarettes across state borders will mean that sales do not necessarily correlate with consumption so they use tax differentials to construct smuggling incentive variables for exports/imports. One key problem is that they are using aggregate data and so cannot study the decision of each individual smoker and this issue is addressed in analyses of smoking using microeconomic data, for example Chaloupka's (1991) study (discussed below).

BGM do not use ordinary least squares (OLS) estimation because of potential endogeneity problems. The error term capturing life-cycle events will probably be serially correlated and even if it is not, it will affect consumption at all dates and the inclusion of both leads and lags on variables creates an additional potential source of endogeneity. Instead, they use instrumental variable (IV) estimation with lead and lagged prices as instruments. They use fixed effects with two stage least squares (FE2SLS) and incorporate the fixed effects to resolve heterogeneity bias.

Using this data set, BGM estimate SRPEDs between −0.436 and −0.355 and LRPEDs between −0.734 and −0.788. They conclude that findings are consistent with addiction generally. On the inference about myopic versus rational addiction, they note that their results are consistent with myopic addiction because lagged consumption is a significant determinant of current consumption and, whilst the future consumption parameter is significant, it has not been reliably estimated because it implies implausible discount factors of between 56.3 and 222.6%.

Overall, BGM's results were mixed; partly the findings are consistent with the hypotheses from the BGM model but the econometric problems are significant. Hausman tests suggested that the estimates were inconsistent; the data were not rich enough accurately to pin down the discount factor. A source of potential measurement error came from using actual future prices rather than *expected* future prices, which could generate another source of endogeneity. BGM admit that their results are mixed: "The conclusions to be drawn from these tests of the estimates in Tables 3 and 5 depend on one's priors".

Other econometric studies of addiction

BGM's analysis triggered a range of econometric analyses of smoking patterns and some of these studies incorporated additional elements to address some of the limitations in BGM's approach. As explained below, Gruber and Köszegi recognize that time inconsistency may play a role; Baltagi and Griffin use a wider range of econometric techniques to resolve endogeneity problems and Chaloupka uses microeconomic data to overcome potential aggregation problems. Other studies test the rational addiction model on other forms of addiction including alcoholism, caffeine addiction and gambling.

Gruber and Köszegi's analysis

In analysing addiction, Gruber and Köszegi (2001) use consumption as well as sales data. Price increases may lead to stockpiling and this leads to an implication similar to that identified by BGM: increased sales do not equal increased consumption. Whilst Gruber and Köszegi's model is about rational addicts in the sense that it incorporates forward-looking decisions, they do relax the assumption about time consistency allowing that addiction reflects time inconsistency. They note that many psychological experiments have revealed evidence of time inconsistent preferences. Also, the fact that so many people buy quitting aids is evidence that future behaviour does not always coincide with current desires.

To resolve the problems of endogeneity bias, Gruber and Köszegi assume that true exogenous variation comes from taxes and they analyse consumers' responses to tax changes using data on consumption as well as sales. Gruber and Köszegi's analysis relies on the assumption that people forecast prices in advance but policy changes aren't always *announced* in advance; only eight of 160 tax changes from 1973 to 1996 had been announced a year before. They analyse behaviour in response to legislative changes in tax rates between the time of "enactment" – when the tax rate change was enacted – and when it was "effective" to capture consumption period in the period between announcement and implementation. In this way, they test forward-looking behaviour by examining consumption in the period between enactment of legislation and when change becomes effective.

Using panel fixed effects estimation techniques incorporating time and state dummies to capture time-invariant effects and spatial heterogeneity, they examine data from 1973–1996. During this period, there were 36 tax changes enacted and effective in same month; 44 tax changes enacted and effective were in consecutive months; and 68 tax changes had at least one month between enactment and implementation. Gruber and Köszegi justify their assumption of no omitted variable bias on the basis that they are using high-frequency monthly data and preference structures wouldn't have time to change over such a short period. For consumption data, they use the Vital Statistics Detailed Natality Data 1989–1996 on mothers' smoking habits, averaged to give state average monthly consumption per capita.

Gruber and Köszegi find that the coefficient on the pre-announced rate is positive and highly significant. This suggests a hoarding effect – a type of forward-looking behaviour. These results are consistent with other analyses and partly confirm the findings from BGM's analyses of rational addiction. Consumption does jump in anticipation of tax rises also suggesting that rational hoarding is taking place, though they do note that it is difficult empirically to separate addiction models with rational time-consistent preferences from models with myopic/time-inconsistent preferences.

In terms of implications, Gruber and Köszegi emphasize that policy-makers should worry about internalities. With time-consistent preferences, smoking generates externalities. With time-inconsistent preferences, internalities are generated too: the individual smoker imposes costs on their future selves reflecting future health problems. So Gruber and Köszegi argue that policy-makers should adjust cigarette taxes to reflect these internalities as well as externalities. At standard values of life measures, internalities are estimated to be $30.45 per pack in lost life expectancy, that is, 100 times the externalities from smoking. Significant internalities mean that optimal tax rates should be at least a dollar higher even for modest time inconsistency

Baltagi and Griffin's analysis

Baltagi and Griffin (2001) are strongly critical of empirical findings from BGM given the econometric problems with their analysis. They study smoking using a dynamic panel analysis with a data set for 46 US states from 1963 to 1992 and they estimate the relationship between consumption, prices, income and prices in neighbouring states. They experiment with a range of estimation procedures and instruments to resolve the potential endogeneity problems, including combinations of 2SLS with fixed effects and generalized method of moments.

Their dependent variable is current consumption and they find that the parameters on lagged and future consumption are positive and significant. There is less evidence that prices have a significant impact – the impacts vary depending on the estimation technique used. Their estimates of the SRPED range from -0.69 to -0.42 and for LRPED between

-1.39 to -2.04 though, as BGM found, the discount rate is not sharply estimated which undermines the robustness of the results. Whilst they do use a more careful econometric approach than other studies and their results are broadly consistent with other studies, they admit that macroeconomic analyses are vulnerable to significant econometric limitations because of aggregation problems and endogeneity. Microeconomic empirical studies have the potential to deliver more reliable results.

Chaloupka's microeconomic analysis

Chaloupka's (1991) analysis is a significant advance on the previous studies because he uses microeconomic data. He assumes rationality by assuming that addicts consider the future consequences of current and past behaviour but allows discount rates will be higher for some groups. One innovation in Chaloupka's analysis is that he also incorporates a variable to capture addictive capital stock. He also introduces the concept of 'Relaxation' (the psychological and physiological benefits from addiction) reflecting tolerance (when past consumption lowers the marginal utility of current consumption, as in BGM's model) and reinforcement (when past consumption increases current consumption, also seen in BGM's model).

His econometric analyses build on microlevel data from the 2nd US National Health and Nutrition Examination Survey (NHNES) examining responses from 28,000 people from six months to 74 years over the period 1976–1980. As for other studies, he uses instrumental variable estimation to resolve potential endogeneity problems. Chaloupka finds that price impacts are negative and past prices have a greater impact than future price, consistent with rational addiction because the future price parameter incorporates a discount factor. He finds that lagged consumption is usually significant and positive. The findings are mixed so offer no clear lessons about myopia versus forward-looking addiction.

The coefficient on addictive stock is significant and positive, confirming the reinforcement hypothesis. The estimates of the LRPEDs are lower than in Becker *et al.* for current/former smokers, and are estimated to be between –0.48 to –0.35. Individual differences are significant: the less educated are more price responsive with LRPED estimates between –0.62 and –0.57. More educated smokers are unresponsive to price, as are young adults and the elderly. In middle age (the 25–64-year-olds), LRPEDs range between –0.46 and –0.31.

Other studies

There are a number of other studies of addiction which are broadly consistent with BGM's hypotheses. Lewit and Grossman (1981) and Lewit and Coate (1982) find that youths respond more than adults to price changes. Townsend (1987) and Farrell and Fuchs (1982) analyse smoking data to show that information since the 1960s about harmful consequences has had more effect on smoking by the rich/more educated than the poor/less educated.

Olekalns and Bardsley (1996) study caffeine consumption, a habit which is strongly addictive but legal so they were easily able to use data on coffee prices. They exploited the fact that the commodity price cycle leads to price fluctuations and argues that this gives a good natural experiment for analysing coffee consumption responses to price changes. Using US Data on per capita caffeine consumption from the US Dept of Agriculture

Economic Research Service, they find positive associations between current consumption and past and future consumption consistent with rational addiction. Negative associations were found between current consumption and current prices but positive association between current consumption and past and future prices. The long-run price elasticity is poorly estimated with the wrong sign, perhaps reflecting the fact that they were working with a very small sample. There are a number of econometric problems with their study but their results are broadly consistent with the other econometric studies discussed.

For other addictions, Cook and Tauchen (1982) in a 1962–1977 cross-sectional analysis of alcoholism in US states found that excise taxes lead to significant, negative impacts on cirrhosis deaths. There is also evidence about gambling. Mobilia (1990) conducted an experimental study of gambling at horse-racing tracks between 1950 and 1986. Paralleling the analysis of changes in cigarette prices on smoking, for horse-racing the demand variable is the number of bets per person (that is the "handle" per person) and the price variable is the takeout rate, which is the fraction of the bet retained by the track. Mobilia finds, with results similar to smoking results, that an increase in the takeout rate lowers the future handle per person and estimates a LRPED of −0.7 and SRPED of −0.3, not dissimilar to the estimates for the smoking studies.

Rational addiction models: summary of evidence and implications

The econometric studies explored above, including BGM's study, show that rational addiction models can be empirically distinguished from myopia by introducing lead variables to capture expectations. This empirical evidence shows that future prices/consumption have an impact on current consumption which supports rational addiction models based on assumptions of forward-looking addicts.

Overall, these studies show that in controlling addiction, money price is more important to poorer, younger people because they often place smaller value on future costs from health problems and other future harms, reflected in the fact that younger, poorer people have higher discount rates. Addicts with higher discount rates respond more to price changes and so reductions in price will have a substantial positive impact on consumption, particularly amongst the young. It follows that doubling federal excise tax on cigarettes would lead to an increase of 15% in price and therefore a 6% fall in average cigarette consumption.

For hard drug use, there is no direct evidence from the econometric studies above but, assuming that patterns are similar, if drugs were legalized then a fall in prices would expand use. Within poorer, less educated groups (where discount rates are higher), consumption is more responsive to price so drug addiction amongst the poor is likely to become more significant as prices fall with legislative change. Similarly, addiction would become more of a problem amongst younger age groups. Temporary policies won't work: the effects of "wars" on drugs are limited because only current (not future) prices rise; there will be no complementary fall in current use from a fall in future use. Addicts with lower discount rates respond more to changes in harmful future consequences and education programmes are more likely to be effective with these groups, including richer, older people.

BGM also outline some industrial policy implications, focusing on monopoly and addiction. The cigarette industry is highly concentrated with a large proportion of output produced by two firms – British American Tobacco and Philip Morris International and so these companies have significant monopoly power. A monopolist can set prices at a point where the marginal revenue is less than the marginal cost and whilst that won't lead to profit-maximizing in the short term, if consumption is addictive, then increases in current consumption in the short term will lead to increases in future consumption in the long term and then the monopolist can raise future prices to increases future profits. Lower prices get consumers hooked.

Similarly, Gruber and Köszegi (2001) argue that inelastic demand for addictive substances allows oligopolistic producers to raise prices. Adler and Freedman (1990) note the "magic trick" from production of addictive goods. Cigarette producers are able to increase profits in an industry in which demand is falling rapidly because past and present consumption interact via adjacent complementarity. This habit persistence amongst smokers explains why cigarette companies post big profits despite greater education about negative health consequences.

One overall remaining problem with the econometric analyses of rational addiction models, identified by Gruber and Köszegi, is that they cannot empirically distinguish models of addiction with time-consistent versus time-inconsistent preferences when the difference might be important. Does evidence about heterogeneity across demographic groups suggest that the younger/less educated are myopic? have time-inconsistent preferences? or just higher discount rates? Everyday observation of smokers suggests that their behaviour is time-inconsistent because many people do use quitting aids which would not be consistent with future intentions to smoke. The experimental evidence does not justify assumptions of exponential discounting and time consistency often seen in the econometric analyses. Behavioural experimental techniques including neuroeconomic studies can move beyond these constraints and, as explored in Chapters 11 and 12, can provide a richer understanding of what really propels addictive habits.

Cue-triggered consumption

Cue-triggered consumption models develop from the insight from psychology that resistance to temptation is determined by context and environment. Walter Mischel and colleagues conducted experiments on self-imposed delay of gratification, to test resistance to temptation.

Mischel and Ebbesen (1970) manipulated children's attention to delayed rewards in a number of contexts. They studied 32 preschool children waiting for a preferred but delayed reward. They were studied in four settings in which they were in a room with: 1. a delayed reward; 2. a less preferred but immediately available reward; 3. both rewards; or, 4. no rewards. Mischel and Ebeesen found that the amount of time the children were able to wait for the preferred reward before it was forfeited was affected by context. Voluntary waiting time increased substantially when they were outside the presence of the preferred rewards. This finding foreshadows cue-triggered consumption models focusing on the importance of contextual cues.

The study of contextual cues was developed further by Mischel, Ebbesen and Zeiss (1972) in the famous marshmallow experiment using a group of 92 three–five-year-olds. They were allowed to eat one marshmallow (or some other treat). Many resisted the temptation to eat the first marshmallow in order to get the second but the most interesting finding was that they were able to wait longer if they were distracted. On the other hand, thinking about the treat and also negative thoughts led to decreases in waiting times. The children used a range of techniques to distract their own attention from the treats, perhaps as a form of pre-commitment device. Metcalfe and Mischel (1999) postulate that delay of gratification involves interactions between a cool, cognitive "know" system which is slow and strategic; and a hot, emotional "go" system which is impulsive, innate and undermines efforts at self-control. (This approach also links with Kahneman's [2003] analyses of System 1 and System 2 thinking, as discussed in later chapters.)

Laibson's cue-theory of consumption

Cue-triggered consumption models develop these insights from social learning theory and also incorporate insights from behavioural psychology about the links between stimuli, reinforcement and behaviour. Laibson (2001) develops a model of cue-triggered addiction based on psychological analyses of learning and conditioning.

As explained in Chapter 5, the experimental psychologist Thorndike constructed some psychological laws to capture the progress of conditioning. He found that animals made associations between stimuli, actions and rewards and from this devised some laws of conditioning: the law of effect – actions which produce pleasure will be repeated and so behaviour responds to pleasure and reward; the law of exercise – actions are more likely to be used if they produce positive associations and less likely to be used if they produce negative associations; and the law of recency – experiences from recent events will have more salience and so we are more likely to repeat recently learned responses and the impacts of prior rewards and punishments will decay over time.

Laibson (2001) captures some of these conditioning effects in an analysis of cue-triggered consumption and the role of environmental factors in addiction. He describes the case of a man with cocaine/heroin dependence who weaned himself off drugs whilst in prison. He was able successfully to resist temptations whilst in prison but, upon his release, he was exposed to environmental cues which reminded him of his drug-addicted state. He was not able to resist those cues and so relapsed.

Cue-based complementarities are created when a cue by itself leads to increases in the marginal utility of consumption. Impulsivity plays an important role and, when exposed to immediately available rewards, cues will trigger physiological changes which prime the consumer to consume immediately. Laibson argues that his model provides biological foundations for rational addiction models: the BGM model is a special case of Laibson's more general cues model, applying when the adjacent complementarity condition holds. Laibson also embeds pre-commitment into his analysis arguing that, in a restricted cues version of his model, people may decide to reduce their set of choices in order to enable cue management.

Bernheim and Rangel on hot–cold systems

Bernheim and Rangel's (2004) analysis of addiction was foreshadowed by Metcalfe and Mischel's (1999) psychological analysis of hot–cool systems, as explained above. Bernheim and Rangel (2004) contest Becker and Murphy's (1988) models of rational addiction and form three main postulates: first, using addictive substances is a mistake; second, individuals are sensitized by exposure and hot states trigger mistaken usage; and third, addicts are nonetheless sophisticated and attempt to manage their addictions by using pre-commitment devices.

Bernheim and Rangel (2004) identify a number of behavioural patterns which cannot be explained by rational addiction models. First, addicts often try unsuccessfully to quit their addiction; second, exposure to cues is associated with recidivism; third, when describing their past drugs use addicts often describe it as a mistake; fourth, addicts attempt self-control via pre-commitment and they will voluntarily remove options to consume in the future; and fifth, behavioural and cognitive therapies, partly by teaching cue-avoidance, reduce addictive behaviour. None of these patterns are consistent with an assumption of rational addiction.

Cues in natural addiction models

Smith and Tasnádi (2007) use insights from neurobiology to construct a biological model of cue-triggered "natural addiction". They start with the evolutionary/biological foundations of addiction, for example in foraging for food we have evolved to respond to cues such as sweetness which might convey something about the nutritional value of foods. So cues become satisfying themselves. The problem is that in modern settings, where many foods have unnaturally high sugar content, these cues can lead to destructive, unhealthy behaviours.

Smith and Tasnádi focus on the role of endogenous opioids in optimal foraging. Rats will self-administer morphine to the point of addiction and administration of opiates leads to increased food intake. Smith and Tasnádi explore the biological process: opiate molecules bind with opiate receptors and activate them leading to physiological and behavioural changes.

In particular, endogenous opioids play a role in influencing perceived palatability. When endogenous opioids are released they reinforce the consumption of the food stimulating the dopaminergic pathways. Dopamine is a neurotransmitter that triggers reward-seeking. It plays a key role in the neurobiology of learning and if consumption of a good (e.g. sugar) gives pleasure by stimulating these neurobiological reward structures, then more of that good will be consumed in the future. Endogenous opioids make food taste good and the consumption of sweet foods leads to release of endorphins, producing similar effects to opioids. In this way, eating sweet things generates a "biochemical cascade" causing us to eat more, irrespective of calorific needs. This also links to drug addictions because heroin and other drugs mimic the effects of these endogenous opioids. Optimal foraging involves responding to environmental cues indicating nutritional value. In nature, very sugary foods occur rarely so in a primitive foraging environment sweetness signals highly nutritious foods. In a modern context, however, sugary foods are a lot more common and human physiology is not adapted to cope with their abundance.

In a modern version of Stigler's (1945) diet problem (which was about the volume of specific foods that would have to be eaten to satisfy a range of nutritional needs), Smith and Tasnádi construct a model of "natural" addiction which involves optimizing for a balanced diet. They postulate two states of the world: a no-cue balanced diet problem when people have to forage for food without specific cues; and a positive-cue balanced diet problem when positive cues are observed which gives clue about concentration of nutrients in an addictive good.

A simplified version of Smith and Tasnádi's model is illustrated in Figure 8.2 – showing how consumption is propelled by cues. If a positive cue is received then the consumption of the addictive good increases and consumption of other goods will fall. Increments to consumption of an addictive good will generate two effects: an ε benefit reflecting the *subjective* beliefs about the nutritional value of the addictive good –shown by area B; and an ε loss reflecting the impact on nutrient intake of a decrease in consumption of relatively nutritious ordinary good – shown by area L. If B>L then the perceived benefits of the addictive good will outweigh the perceived losses and the person will increase their consumption of the addictive substance.

Smith and Tasnádi recognize (and do not dispute) that Bayesian learning generates adjacent complementarity: a positive cue in one period increases a person's judgement of the posterior probability of positive cue in the next period. However, the process of consumption is still not fully rational. Visceral factors, and bodily responses, are important because subjective, psychological factors determine the magnitude of B relative to L. In addition, as explained above, the cues may be misleading if they stimulate the dopaminergic pathways even when potential nutritional value of an addictive substance is limited or non-existent.

Giving-up strategies might harness the learning elements of addiction: quitting "cold turkey" may stop the arrival of hedonic "false clues" about benefits of use. On the other hand, uncertainty, incomplete information and time inconsistency suggest a role for paternalism. Overall, Smith and Tasnádi suggest that conceptions of rationality should recognize that we are affected by sophisticated biological systems which are adapted to a pre-industrial environment. These systems can be "hijacked" by technological advances and we have not (yet) evolved to cope. They conclude that pleasure and satiety from smoking (and overeating, etc.) is derived from bodily effects and whilst there is a role for habits, bodily urges are an important aspect of addiction. Quitting therapies could be designed accordingly. Sensory replacements such as inhalers and de-nicotinized cigarettes could be made more cheaply and widely available to allow addicts to satisfy their bodily "needs" to smoke.

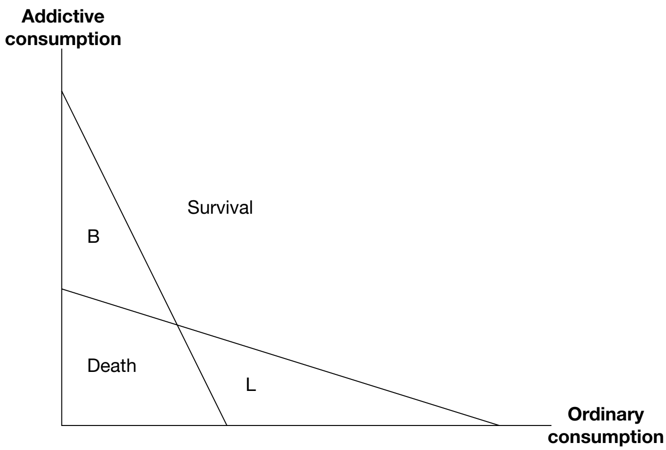

Figure 8.2 Smith and Tasnádi's rational addiction model

Visceral factors

Loewenstein (1996) offers an alternative to the rational addiction models by analysing the impact of bodily, visceral influences on addiction. He observes that discrepancies between self-interest and behaviour and from knowledge to action leads to feeling "out of control". This can be attributed to the impact of visceral factors (VFs) which are basic drives and instincts, for example thirst and hunger. VFs are not bad in themselves but self-destructive behaviour reflects the excessive influence of VFs.

Intensity is important in reconciling interactions between cognitive and affective factors and similarly for VFs: at low levels VFs can be accommodated; at medium levels they can be controlled via effortful self-control; at high levels VFs take over and rational deliberation is overridden. For example, if a driver is sufficiently tired then a visceral need to sleep will overwhelm the cognitive processes such as concentration that are engaged during driving, and the driver will fall asleep at the wheel.

Rational choice requires that VFs be taken into account and addiction occurs when VFs have excessive influence. It represents the overriding of rational deliberation by VFs. Loewenstein argues that Becker and Murphy's model does not fit the facts because it doesn't capture the hedonic aspects of addiction including the downward "hedonic spirals" observed as addictions develop when people fail to notice small incremental negative effects. Addicts don't use information aside from their personal experience even though it's widely available.

Addiction is as much about avoiding pain as pursuing pleasure. Pain from habituation comes in two forms: pain of withdrawal and cravings from conditioned associations. These are captured by two propositions from Loewenstein's schema: people underestimate the impact of future VFs and so exaggerate their ability to give up; and future pains seem unreal to the currently pain-free self. Loewenstein concludes that the problems generated by failure to embed VFs and emotions into decision-making paradigms means that the problem has been underestimated. Irrationality as failure to adhere to axioms of choice doesn't fit with our personal experiences. When VFs are overwhelming, behaviour becomes "arational: it is not a conscious decision to do something stupid.

~

Addiction and other bad habits reflect a complex interaction of economic and psychological factors. In the rational addiction models of Becker, Grossman and Murphy, addiction is a voluntary choice but does nonetheless generate externalities and other forms of market failure. Rational addiction models do not however rest easily with our intuitions about addiction. The fact that addicts are often very keen to kick their habits suggests that the roots of addiction are more complex that the rational addiction theorists allow. Addiction is more likely to be the product of present bias and lack of self-control, exacerbated by neurobiological factors which increase a person's susceptibility to visceral cues.

In terms of policy implications, the rational addiction theorists have analysed a range of policy implications. Becker, Grossman and Murphy (1994) assert that poorer and less educated groups are more responsive to prices and if legalization lowers prices then addictions will get worse, not better. Richer, more educated groups with lower discount rates are more likely to respond to information campaigns about future consequences. Wars on drugs may lead to temporary price rises but given expectations of future price falls once the war on drugs is over, policy impacts predicted will be limited. Monopolistic tobacco manufacturers should be regulated because they are able to exploit addictive behaviour to increase long-term profits. Gruber and Köszegi explain that optimal taxation should be designed to remove externalities from smoking but if "internalities" are also generated then optimal excise taxes on tobacco should be higher to reflect these internalities.

Bernheim and Rangel suggest a range of policy implications following from their analysis of cues and hot–cold systems as described above. They do not advocate limits on planned use because this reflects voluntary reasoned choice. Instead, they focus on policies which control the influence of the cue triggers precipitating impulsive consumption, particularly for people in hot, emotionally charged states. Alongside standard policy approaches focusing on reducing externalities and improving information and education about addictive substances, they advocate some more novel policy prescriptions. Uncertainty is a particularly profound problem for addicts because it is impossible to predict environmental cues that might trigger self-destructive behaviour and this generates significant monetary risks in terms of the financial consequences from random environmental events. Universal insurance policies would reduce these risks. Rehabilitation should be subsidized and distribution should be controlled via prescription. Advertising and marketing restrictions alongside controls on public use will reduce the frequency of cues and will help to reduce impulsive use of addictive substances. Counter cues, such as including photographs of diseased lungs on cigarette packaging or plain packaging, may also be effective.

Another approach is to use tools developed from standard economic approaches adapted to take into account some of the behavioural and psychological factors discussed in this chapter. Loewenstein and Ubel (2010) argue that too much is claimed for behavioural economics and suggest policies that blend insights from the rational addiction theorists with those from the behavioural economists. Behavioural economics might provide some guidance about the need to subsidize unsweetened drinks or tax sugary ones but standard economics will tell us that we need a large price difference between the two.

Different addictions and self-destructive behaviours may need different solutions. Taxation may play an important role but social influences may also have a significant influence. Policies such as smoking bans will have positive impacts for a number of reasons, not only because they reduce the incidence of passive smoking and reduce the cues that might trigger a relapse in an ex-smoker but also because smoking is removed from a social context facilitating the evolution of a new non-smoking social norm. Overall, if we can develop a deeper understanding of the complex roots and causes of self-destructive behaviours then this will enable governments more effectively to tailor policies to the particular features of specific addictions.

Chapter summary

- Addiction is explained in rational choice theory as the balancing of utility from consuming addictive substances, for example nicotine, over time – as set out by economist Gary Becker and colleagues.

- In behavioural economics, addiction and bad habits can be explained in terms of time inconsistency and creates *internalities* – that is consequences for a person's future self that the person's "future self" did not choose, as well as externalities in terms of negative impacts on others who did not choose the action – for example, passive smoking.
- Behavioural economics can provide a richer explanation for addiction and other bad habits by allowing that people are driven by emotional and affective factors associated with lack of self-control.
- Decision-makers can deal with their self-control problems via pre-commitment strategies in which they bind their current self to achieve future goals – for example via quitting aids to give up smoking.
- Smith and Tasnádi draw on insights from evolutionary neuroscience to explain why and how addictive habits have particular power in a modern context.
- The empirical evidence from economic models of addiction is mixed and more work is needed especially in constructing models that can inform the policy challenges around addressing problems of addiction and bad habits.

Revision questions

1. How do rational choice theorists explain addictive behaviour as a rational choice, and are their hypotheses explained by the econometric evidence? What are some of the problems with this econometric evidence?
2. How do behavioural economists provide an alternative explanation for addictive behaviour? Illustrate with examples.
3. What sort of pre-commitment strategies can people use when they are facing some of the self-control problems associated with addictive behaviour?
4. What is the difference between an internality and an externality and what are the implications for controlling addictive bad habits?

MATHEMATICAL APPENDIX

A8.1 Mathematics of Becker, Grossman and Murphy's rational addiction model

Becker, Grossman and Murphy (BGM) assume that consumers are rational, forward-looking with time-consistent preferences. In the rational addiction model, addiction is not myopic.

Dynamics of stock of addictive capital

Past consumption of an addictive substance (c) and life-cycle events will build up the stock of addictive capital (S), which will evolve as follows:

$$\dot{S}(t) = c(t) - \delta S(t)$$

In steady state S will be stable and the steady state condition is $c(t) = \delta S(t)$.

Addicts need to consume more of an addictive substance as consumption increases and this is associated with tolerance and reinforcement.

Tolerance

Tolerance reflects the fact that past consumption lowers current and future utility and so current utility decreases as the stock of addictive capital increases:

$$\partial u / \partial s = u_s < 0$$

Reinforcement

With reinforcement, increases in past consumption lead to an increase in the stock of addictive capital stock and this raises present consumption:

$$\partial c / \partial s > 0$$

Adjacent complementarity

With adjacent complementarity, past (current) consumption is reinforcing and leads to greater current (future) consumption. The necessary and sufficient condition for reinforcement near steady state is:

$$(\sigma + 2\delta)\, u_{cs} > -u_{ss}$$

where σ is the rate of time preference and δ is the rate of depreciation in S, where

$$u_{cs} = \frac{\partial^2 u}{\partial c \partial s}, u_{ss} = \frac{\partial^2 u}{\partial s^2}$$

When the adjacent complementarity condition holds, reinforcement (as captured by the discounted, depreciated marginal utility of consumption with respect to increments to the stock of addictive capital) will dominate tolerance and past consumption will be associated with increases in future consumption.

Chapter 9

Personality, moods and emotions

Personality, moods, emotions and visceral factors play a crucial role in our everyday decision-making, a facet of behaviour that modern economists have been slow to explore. Exploring these subjective socio-psychological influences on behaviour enriches behavioural economists' understanding of economic and financial decision-making. Embedding these influences also offers a stark alternative to orthodox models of decision-making, which – as we have seen in previous chapters – are grounded in rational choice theory. Rational choice theories in standard economic models assume homogenous, self-interested individuals using logical methods to make their choices. A representative agent captures the average behaviour of everyone and there is no obvious role for psychological factors. Many models in behavioural economics reflect this approach to some extent and the analyses in previous chapters, whilst admitting that subjectivity and behavioural bias have important impacts on beliefs and expectations, have generally focused on observable influences and choices, usually in an experimental context. Therefore, individual differences and largely unobservable phenomena such as moods and emotions have been assumed away.

This chapter deepens the analysis by exploring the impacts on economic behaviour of heterogeneity and individual differences including demographic characteristics, personality traits and cognitive/non-cognitive skills. Personality will have an impact on emotions because it determines an individual's predispositions; for example, a person with an optimistic personality will be more inclined to feel cheerful. Emotions, mood and decision-making are intertwined in the economic and financial world but, until recently, emotions have been neglected in economic analysis. As well as moods and emotions, decision-making will also be affected by visceral factors which include basic drives and urges. This chapter also outlines a range of ways in which moods, emotions and visceral factors can be incorporated into economic analysis.

In understanding how personality, moods and emotions influence economic and financial decision-making, insights from psychology provide an important starting point. Some parts of psychology share a lot in common with economics – most obviously behavioural psychology. Behavioural psychology focuses on objective information such as observed choice, for example from experimental trials. Partly it was developed as an alternative to older sub-disciplines in psychology that had focused on less easily measurable variables, including personality. More recently however, the importance of personality is being recognized because individual differences in levels of generosity can explain differing degrees of sociality; impulsivity can explain impatience and time inconsistency.

Lessons from psychology: personality theory

Starting with personality: psychologists' theories of personality analyse characteristics of individual that lead to consistent patterns of behaviour and as economists are generally interested in trying to explain consistent (or inconsistent) choices, personality theory has a number of insights to offer.

Freud's psychoanalytic theory

One of the pioneering approaches to analysing personality and traits was Sigmund Freud's psychoanalytic theory. In Freud's approach, behaviour is the outcome of interplays between basic drives, needs and conflicts (Pervin 1984). Freud analysed a very wide range of forces affecting personality, including different levels of consciousness including conscious, preconscious and unconscious thought (Freud 1899). In modern behavioural economics, there is focus on automatic versus deliberative processing, and this mirrors the Freudian distinctions of conscious, preconscious and unconscious thought. Freud identified roles for different aspects of personality and the principles driving behaviour – the interactions between the pleasure principle and the reality principle and the roles played by different elements of personality. The id is driven by the pleasure principle impulsively to seek gratification of basic instincts. The ego is driven by the reality principle to delay gratification in a rational, practical way. The superego is the rigid, sometimes judgemental moral compass that guides ethical attitudes. According to Freud, childhood development proceeds as the child's ego learns to delay gratification (Freud 1921, 1949). Nonetheless, the ego plays a subordinate role in the sense that it is a victim not only of the competing pressures from the id and superego but also of reality. As economists are interested in consistent choices, the personality traits that propel those choices can illuminate our understanding of economic behaviour. Freud analysed identification – the process via which we integrate the characteristics of others into our personality. Freud thought that identification with a same-sex parent develops during the phallic phase and other forms of identification include narcissistic identification – identifying yourself with similar people; goal-oriented identification – identification with successful people; object-loss identification – identifying with lost objects and people; and aggressor identification – identifying with authority figures (Pervin 1984).

Although, for some, Freud's theories are discredited as scientific theories because there is no objective evidence to support them, Freudian themes can still be found in modern behavioural economics – for example, Nobel-Prize winning economist George Akerlof explores a number of Freudian themes in his analyses of cognitive dissonance, illusion and identity. Some Freudian themes resonate with new insights from neuroscience, as we will see in Chapters 11 and 12.

Jung's archetypes

Carl Jung developed a psychoanalytic approach grounded in the analysis of individual psyches. Whilst he split intellectually from Freud, his approach was grounded in tools and approaches from psychoanalysis, focusing on unconscious, sometimes irrational drives as well as conscious, rational thoughts with layers of personality comprising the conscious, the personal unconscious and the collective unconscious. He developed Plato's concept of archetypes – universal symbols resting in the collective unconscious and envisaged these as elements of our personalities, for example "Mother" – the nurturing part; "anima" – the feminine part; "animus" – the masculine part. The archetypes rest in the collective unconscious and are universal and so are seen throughout history in culture, folk tales and literature (Jung 1991). Jung also identified different psychological types reflecting attitudes (extraversion versus introversion), perceptions (intuition versus sensing) and judgements (thinking versus feeling) and his analysis of personality types was the foundation of the Myers-Brigg Type Indicator (MBTI) developed by Katharine Cook Briggs and Isabel Briggs Myers, as explained below (Jung 1923; Grigorenko and Sternberg 1995).

Modern personality theory

More recently, theories of personality have concentrated on the analysis of personality traits. George Kelly (1955) developed the construct theory of personality, which is built upon the analysis of the bipolar constructs (e.g. good vs. bad) which enable us to categorize people and events to interpret and make sense of the world around us by understanding their similarities and differences, thus generating a structure into which we fit our experiences. Kelly identified a range of constructs from essential core constructs through to peripheral, inessential constructs. This interpretation of the world is inherently subjective and Kelly identified the problem that our understanding of the world is shaped by the way in which we construct our understanding of it, and this foreshadows recent analyses of personality in economics, including Borghans *et al.* (2008). It also links to the framing effects and context dependence identified by Kahneman and Tversky and others.

Gordon Allport's trait theory analysed the impact of traits on habitual thought patterns, both cognitive and emotional. Allport observed that traits are relatively stable for the individual but variable across individuals. He saw personality traits as unifying features and divided traits into various categories. Central traits are essential to an individual. Secondary traits are seen just in certain circumstances and contexts. Cardinal traits are the traits that define individuals and make them distinctive; and common traits, which are specific to particular social and cultural contexts (Allport 1937). Allport asserted that all these traits are interconnected and important to the formation of identity (Allport 1955).

Measuring cognitive skills

Individual differences link to cognitive capacity and there is a wide range of ways to capture how individual differences affect cognitive functioning and intelligence. Intelligence can be defined as the ability to solve problems and this gives some objectivity to the concept. Nonetheless, difficulties in measurement will emerge because intelligence is not a monolithic characteristic. Early tests of cognitive skills were developed by Alfred Binet, Théodore Simon and William Stern who devised the intelligence quotient (IQ) test. Early

IQ tests tended to focus on intelligence – one, overarching characteristic. More recently, general intelligence has been characterized as reflecting a hierarchy of cognitive skills. Two of the major factors underlying general intelligence include fluid intelligence – the ability to think laterally and problem-solve, and crystallized intelligence gained from learning and experience (Cattell 1971). Someone with high levels of crystallized intelligence may perform less well in certain tasks than someone with high levels of fluid intelligence and vice versa.

It is important to note that measuring cognitive skills cannot be completely objective. Performance can be determined by factors not related to cognitive functioning, for example performance in IQ tests is dependent not only on cultural factors and linguistic difference but also on incentives and non-cognitive skills such as conscientiousness and motivation (Borghans *et al.* 2008). Intelligence can also be difficult to define because it has many facets.

Personality tests

Capturing non-cognitive skills and personality traits is even more complicated than measuring cognitive skills. It is difficult to establish an objective basis for individual differences in personality. Kelly developed an early personality test in the form of the Role Construct Repertory Test (Rep Test). This test drew on some features from Jung's insights and subjects were asked to list key figures (e.g. mother, father, teacher) and make connections between them on the basis of similarities and contrasts. The Rep Test is no longer widely used but a number of personality theories and tests have evolved since including Gordon Allport's (1961) trait theory, and personality tests evolving from Hans Eysenck's analyses of traits.

More recently, tests have evolved that focus on a single or small number of traits, for example Barratt's impulsivity scale, the Baron-Cohen-Wheelwright empathy quotient and Hans Eysenck's multifactor personality tests of impulsiveness, empathy, conformity and psychoticism (Eysenck 1967, 1975, 1991; Eysenck and Eysenck 1975, 1976, 1978). Some tests are commonly used today including the Myers-Briggs Type Indicator (MBTI), mentioned above, and the Big Five personality test.

Myers-Briggs Type Indicator (MBTI)

In order to capture the insights of the personality theorists in real, clinical contexts, a number of personality testing methods developed. Jung's structure, as described above, inspired the Myers-Briggs approach to capturing personality styles, where the styles reflect a person's interaction with their environment. The MBTI captures aspects of conscious mental activity according to the following features: introversion versus extroversion; intuition versus sensing; thinking versus feeling; and judging versus perceiving, giving 16 types of personality styles. The MBTI taxonomy is similar to Jung's structure, though Myers is more tightly organized (Myers 1981; Grigorenko and Sternberg 1995).

Big Five theory

Another method of personality testing often used in economic analyses, for example Heckman's analysis of personality and the life cycle, is the Big Five personality test. These tests were developed originally by Tupes and Christal (1961) and subsequently by McCrae and Costa (1987, 1989) and Costa and McCrae (1992, 2005). The Big Five captures aspects of personality along five dimensions, given the acronym OCEAN, capturing five dimensions linked to five broad, higher-level traits of Openness to experience, Conscientiousness (versus 'undirectedness'), Extraversion (versus introversion), Agreeableness (versus antagonism) and Neuroticism (versus emotional stability). This taxonomy is used either in self-report questionnaires or in peer ratings of a person's personality. The five dimensions, assessed according to polar adjectives, reflect Kelly's bipolar constructs, as described by McCrae and Costa (1987). For example, Openness is captured by dimensions such as simple–complex, conforming–independent, unanalytical–analytical. Similarly, Conscientiousness is captured by adjectives including lazy–hardworking, stupid–intelligent, unfair–fair; Extraversion by timid–bold, retiring–sociable, inhibited–spontaneous; Agreeableness by ruthless–softhearted, critical–lenient, callous–sympathetic; and Neuroticism by unemotional–emotional, patient–impatient, objective–subjective (McCrae and Costa 1987).

The Minnesota Multiphasic Personality Inventory and the Rorschach test

Some personality tests have been designed specifically to capture psychopathologies and the one that is commonly used by mental health professionals is the Minnesota Multiphasic Personality Inventory (MMPI) originally devised by Hathaway and Kinley (1943). Modern versions of the test incorporate a wide range of test items which capture the thoughts, feelings and behaviours of the subjects. Interpreting the answers can be problematic because it is not possible to establish whether respondents are being truthful, or reading the questions properly so additional items are included to capture the validity of answers, for example a "lie" scale designed to judge how honest the respondent is. Also, the focus is not on the individual scores on specific test items but instead on the whole personality profile constructed when collections of items are interpreted as a whole.

Overall, the tests used specifically by mental health professionals are designed to enable assessment of psychopathologies so might be less relevant to economists who are interested in the behaviour of "normal" experimental participants. Nonetheless, insights from tests traditionally used by mental health practitioners may have some value. For example, there has been a revival of interest in the Rorschach "ink blot" test amongst behavioural economists. These tests assess experimental participants' responses to random inkblot patterns – because some aspects of this test correlate with intellect and cognitive functioning (Meyer *et al.* 2011).

Personality and individual differences

Personality can be defined as "patterns of thought, feelings and behaviour" (Borghans, Duckworth, Heckman and Ter Weel 2008). Personality can affect economic decision-making in a number of ways. Some personality traits affect cognitive functioning via their impact on cognitive skills. Personality traits may also be associated with standard economic preference parameters including time preference, social preferences, risk aversion and preferences for leisure. For example, personality will be a determinant of a person's rate of time preference and so will have an impact on life-cycle choices such as savings: a conscientious person is inclined to be more patient, for example, and so is more likely to save for the future and/or invest in their own human capital. Personality traits also determine emotional predispositions and so are a crucial link between emotion and behaviour: if an impulsive person is more likely to feel anger quickly then they are also more likely to act aggressively. The links between personality, cognitive/non-cognitive skills and preference parameters is explored below and the relationship between personality, predispositions and emotions is explored in Chapter 9.

Introducing personality traits into economic analysis is complicated by the difficulties in clearly defining personality traits in economic terms. If personality traits are constraints then standard economic preference parameters can be conceived as the product of those constraints. They can also be described as goods and/or inputs and Borghans *et al.* analyse the public good and private good aspects of traits. Some traits may be excludable and rivalrous and if more of a trait is devoted to one task then this means that there may be less available for another. A person may devote their conscientiousness to their work and so will be less able to be conscientious about their social life, for example.

There is substantial empirical evidence that individual differences and personality traits predict socio-economic outcomes including academic achievement and job performance. Borghans *et al.* (2008) present a comprehensive analysis of the economics and psychology of personality traits and individual differences using the Big Five model to capture personality traits. The Big Five trait of conscientiousness, perhaps because it links to self-control and perseverance, is a good predictor of academic achievement and also many other aspects of socio-economic performance including years of education, job performance, leadership and longevity (Borghans *et al.* 2008).

The concept of comparative advantage can be applied to personality traits in the workplace. Individuals differ in their capacities and this may reflect the role of specific traits. Some traits including trustworthiness, perseverance and extraversion are generally valuable in the workplace (Osborne, Gintis and Bowles 2001). Technological changes have increased the importance of social skills and these will be affected by personality traits and individual differences (Borghans, ter Weel and Weinberg 2006). The value of specific characteristics will vary across tasks and occupations and some personality traits will be more important to specific jobs, for example extraversion is a desirable trait for a salesperson (Borghans *et al.* 2008).

These differences will affect job matching too. Dohmen and Falk (2011) use the Big Five model to assess the impact of individual differences on worker self-selection. Using lab experiments, they assess the impacts of different incentive schemes including piece rate, revenue sharing and tournament schemes. They find that the different incentives attract different personality types with gender, social preferences and risk preferences also playing a role.

Statistical problems such as endogeneity, reverse causality and measurement error will affect econometric estimations incorporating personality. Measured traits will be imperfect proxies for actual traits. It will be difficult to untangle cause and effect. Measurement errors will emerge because of the subjectivity involved when personality assessment is based on the observations and judgements of others. An additional problem is self-report bias, reflecting deception, overconfidence and/or lack of self-insight in tests involving self-assessment (Borghans *et al.* 2008).

Personality and economic preference parameters

There are a number of potential links between personality traits and economic preference parameters. Personality traits such as empathy will affect social preferences such as altruism, for example. Experimental evidence using Eysenck's personality tests shows that psychological traits associated with sociability including conformity and extraversion, along with personality traits associated with time preference including impulsivity and venturesomeness, will interact to affect subjects' susceptibility to social influence in financial decision-making (Baddeley *et al.* 2007). Dohmen, Falk, Huffman and Sunde (2008) analyse the links between trust, reciprocity and the Big Five. Personality will also affect risk attitudes, time preference (as seen in Chapter 7) and preferences for leisure.

Dohmen and Falk (2011) analyse the relationships between risk aversion, ambiguity aversion, cognitive skills and personality traits and find that higher IQ is associated with more risk tolerance (see also Dohmen *et al.* 2007). Gender may also play a role and some studies show that women are more risk-averse and less ambiguity-averse (Barsky *et al.* 1997). Measured risk tolerance is positively related to risky behaviours, including smoking, drinking, failing to have insurance, and holding stocks rather than Treasury bills. These relationships are both statistically and quantitatively significant, although measured risk tolerance does not capture a large proportion of the variance in behaviour.

Personality and motivation

In Chapter 2, we explored some of the behavioural drivers and constraints affecting motivation; some of these will be moderated by personality traits and individual differences are key determinants of motivation. Some psychological analyses have explored the role of cognitive functioning over the life cycle. Walter Mischel and colleagues rejected the view that personality traits are always stable and consistent and found that behaviour was dependent on situational cues. In a series of studies, they demonstrated that self-control correlates with individual differences and better cognitive functioning leads to better life chances in adulthood.

Children's behaviour in a residential camp setting was observed in one study and the situation–behaviour profiles of the children were analysed. The stability of these profiles varied across individuals, for example levels of aggression varied depending on whether a child was approached by a peer versus an adult; one child would be more aggressive in response to an approach from a peer; the other might be more aggressive in response to an approach from an adult. Behavioural differences were attributed to the different extents to which individuals could access cognitive-affective mediating units, for example competencies, beliefs, goals; over time, experience leads to the development of situation–behaviour relations reflecting dispositions and cognitive-affective processing so cognition and emotion affect social information processing in different ways in different people (Mischel and Shoda 1995).

Mischel and his colleagues are famous for the "marshmallow experiment" to test self-imposed delay of gratification in children: nursery school children were shown sets of two treats (e.g. marshmallows); they waited with one treat and were told that if they managed to resist the temptation to eat that one treat then they would get both at the end of some predetermined period (Mischel, and Ebbesen 1970; Mischel, Ebbeson and Zeiss 1972). The same children were studied at 14 years old; those who had shown more evidence of self-control in early childhood had better emotional and cognitive functioning and, later in life, were more socially and academically competent than those who had exerted less self-control in the early tests (Mischel *et al.* 1989). Results from Mischel and his team, link to the behavioural economics literatures on present bias and self-control, including implications for future well-being, reflecting Mischel's finding that behaviour in early childhood correlates with future performance.

Personality and cognition

The interplay between personality and cognition has an impact on a range of socio-economic phenomena including wages, education, crime and longevity. Borghans *et al.* (2008) define cognition as the use of thought to overcome obstacles. It is determined by a person's ability to understand, adapt and learn. There are different aspects to cognition and different ways of measuring it but it is important to allow for the impact of personality traits on cognition, particularly "quasi-cognitive" traits including emotional intelligence.

Common tests of cognitive ability, including IQ tests, do not capture maximum potential intellectual performance. Cognition is enabled by reflection and impulsivity will lower performance in tests of cognitive reflection (Frederick 2005). Performance incentives are important too and Borghans *et al.* (2008) cite studies showing that performance on IQ tests increases when people are offered incentives including money or candy. These findings can be attributed to the impact of personality traits on a person's response to incentives: cognitive test performance reflects interplay of intellectual ability and personality traits. This is because IQ tests require effort and so poor performance may reflect a lack of motivation as much as a lack of ability. Anxiety may also affect performance and so a person with a high neuroticism score may do less well because of that aspect of their personality and not because of lower intelligence. In terms of the impact of incentives on cognitive test performance, these will increase motivation for some personalities but those with high emotional stability and conscientiousness are less likely to be affected by external incentives.

Moods and emotions

Mood and emotion are considered as separate phenomena because there are crucial differences between them. In some ways, mood can be understood within a standard approach because sometimes it can affect all people equally, for example if mood is affected by weather. Individual differences do not necessarily complicate the analysis of moods. Behavioural economists and economic psychologists distinguish mood from emotions. Elster (1996, 1998) describes emotions as having "an intentional object or target" whereas moods are more diffuse in character: they are "undifferentiated and untargeted states of contentment or discontentment". Moods are more general phenomena, often experienced collectively, in which case they will be unaffected by differences in personality and predisposition.

Elster (1996, 1998) explains that whilst there is no single feature that distinguishes moods from emotions, most emotions do have the following features: they are formed on the basis of cognitive antecedents and beliefs, they involve intentional objects and are associated with physiological arousal and expression. They have valence – that is they may be positive or negative. Psychologists make a distinction between emotions and affect. Emotions are biological, innate and instinctive responses to stimuli and involve the recall and cognitive processing of affect. Affect is the experience of *feeling* an emotion. Elster (1996, 1998) also distinguishes emotions and visceral factors with the former being triggered by beliefs and the latter reflecting basic drives and instincts. However, visceral factors are biological, innate and instinctive. Incorporating an evolutionary perspective, visceral factors reflect basic, primitive responses. Emotions, especially social emotions, are more highly evolved.

Psychologists tend to focus on "action tendencies". In focusing on these tendencies to act they identify the *cause* of emotions rather than the impact of emotions on behaviour (Elster 1998). Generally positive emotions are passively undergone and not chosen though negative emotions can be blocked or the situations which cause them can be avoided. This reflects a distinction between "occurrent emotions" – emotions which occur in a particular situation and "emotional dispositions": for example, the occurrent emotion of anger is more likely if a person has an irascible predisposition. The occurrent emotion can be avoided, assuming a person has some insight into their own irascibility, if a person can avoid situations which might trigger an angry response. Some of these features are difficult to establish empirically but physiological responses can be measured during economic experiments, for example Smith and Dickhaut (2005) use heart rate data to infer emotional states in auction experiments.

Elster (1996) argues that emotions do not necessarily interfere with rationality. Emotions may be important "tie-breakers" when outcomes are indeterminate and reason is an insufficient guide to decision-making. Emotion "serves as a functional equivalent for the rational faculties it suspends" (Elster 1998, p. 60). Visceral factors and emotions are often very efficient because they can operate quickly and with minimal cognitive intervention but people may nonetheless underestimate their influence leading to self-destructive behaviours such as addiction (Le Doux 1996; Loewenstein 1996, 2000), an issue which is addressed in Loewenstein's analysis of visceral factors and also in some analyses of addiction (see Chapter 8).

Emotions and incentives

Building on some of the insights around incentives and motivations, which we explored in Chapter 2, some experimental analyses have focused on how incentives are affected by emotional factors – specifically how emotions affect performance. For example, Ariely *et al.* (2009b) postulate that generous incentive schemes can have unintended emotional impacts. Too much arousal can impair performance. Generous incentives may shift attention from automatic to controlled systems, for example people tend to play sports better if they are not thinking too hard about their movements. Increased incentives also narrow people's focus and dampen creativity. Drawing on these insights from psychology, Ariely *et al.* (2009b) postulate that generous payments can lead to "choking under pressure". They conducted a set of experiments in the USA and in India. Subjects worked on different tasks and received performance-contingent payments varying in amount from small to very large relative to their typical levels of pay. One set of experiments was conducted in Indian villages and the villagers performed a series of cognitive tasks involving memory, creativity and motor skills. The villagers were sorted into three incentive conditions: one group was offered small incentives of up to 4 rupees (Rs); another moderate payment group received up to 40 Rs; the high payment group received up to 400 Rs. As 400 Rs is the average monthly wage, the latter group was playing for a significant sum of money.

Within each condition, good performance was rewarded with a relatively high level of reward: very good performance led to high rewards; good performance to substantial reward and average performance gained no reward at all. Ariely *et al.* identified a perverse impact from large incentives: higher rewards adversely affected performance. In terms of the shares of average earnings relative to maximum earnings for each treatment group, these were 35.4% in the lowest group; 36.7% in the medium group and 19.5% in the highest payment group. They attributed this to choking under pressure and identify similar results from US studies. With some important exceptions, very high reward levels had a detrimental effect on performance, perhaps because emotional responses to generous rewards lead to choking under pressure, perhaps reflecting conflicts between affect and cognition.

Emotions and heuristics

Emotions and affect may also have an indirect impact via availability heuristics: emotions are more available than objective facts and figures because they are often highly salient, vivid and easily recalled. Emotional factors can dominate cognition especially as it is associated with quicker, more automatic responses. Emotions and affect influence decision-making directly via the *affect heuristic*.

Affect is the experience of feeling an emotion and will have an impact on decision-making via the affect heuristic in which emotions are used to guide decision-making. Sometimes, as Antonio Damasio explains in the context of his somatic marker hypothesis, emotions can be a reliable guide. At other times, emotions can lead to significant biases if they distort objective perceptions. Emotions and affect may also have an indirect impact via availability heuristics: emotions are more available than objective facts and figures because they are often highly salient, vivid and easily recalled.

Finucane, Alhakami, Slovic and Johnson (2000) observe that the affect heuristic can distort judgements of probability and risk: when people are feeling optimistic about a situation, this will lead to misplaced perceptions of lower risk and larger benefits. For example, emotional responses from the public to journalistic accounts of murder arrests can lead to significant injustices when people's emotional responses interact with a misapplication of heuristics including the representativeness heuristic. For example, journalists' treatment of Christopher Jefferies during the hunt for the murderer of Jo Yeates in 2010: in disseminating emotionally charged opinions about someone's guilt, journalists sometimes describe traits that are associated with the stereotype of a murderer rather than objective facts.

Emotional salience also affects retrievability and availability. It will also interact with the attention bias outlined above. Someone watching a car crash scene will draw on these emotionally salient images, affecting their perception: they will judge it more likely that *they* will be involved in a car crash even though objective information about the frequency of car crashes has not changed. Similarly, headline news of airplane crashes will be brought to mind more readily than bike accidents because of vivid reports from air crash sites, even though bike accidents are far more frequent.

So, whilst availability enables quick decision-making it will lead to biases if the prominence of recent events does not reflect the actual frequency with which events usually occur, especially if the events are associated with vivid emotional cues.

Emotional responses impact on other heuristics too. When people are in a happy mood they are more likely to use heuristics associated with top-down processing, relying on pre-existing knowledge with little attention to precise details. By contrast, people in a sad mood are more likely to use bottom-up processing heuristics, paying more attention to precise details than existing knowledge (Schwarz 2000, p. 434). Minsky (1997, p. 519) analyses some of the emotional constraints in the case of expert knowledge, arguing that the "negative knowledge" associated with some emotional states may inhibit whole strategies of expert thought.

The somatic marker hypothesis (SMH)

Emotions provide important physiological cues that can help decision-making. Damasio's early study focuses on the fact that damage to emotional processing circuits impairs people's ability to make wise financial decisions, for example brain lesions associated with damage to emotional processing lead to constraints on rational behaviour (see also Bechara and Damasio 2005). As we explored above, the affect heuristic involves using emotions to guide decision-making. This can lead to bias because emotions may distort objective judgements. For example, hopefulness can lead people to underestimate risks and overestimate benefits and despondency can lead them to overestimate risk and underestimate benefits (Finucane, Alhakami, Slovic and Johnson 2000). Emotions are also very vivid and salient and so can have a disproportionate impact, for example if people have witnessed horrific car crashes then that will affect their perceptions of the risk of driving a car.

Damasio (2006) developed the somatic marker hypothesis to capture the impact of emotions on decisions. Damasio (1994, 2006) extends the role of emotions well beyond the affect heuristic. He postulates that emotions and affect are integral to all decisions and not just to decisions in emotionally charged contexts. In the interplay of cognition and emotion, affect gives important physiological cues enabling efficient thinking. These cues are based on somatic markers – the bodily signals we perceive as affect/emotion, provide important guides to action complementing rational action. Somatic markers may be the outcome of conscious thought – for example the gut feel of entrepreneurs represents conscious feelings about choices and plans. Knowledge communicated via emotions, either explicitly or implicitly, enables people to make fast and efficient decisions (Damasio 2006; Bechara and Damasio 2005).

In developing the SMH, Damasio and his colleagues focus their research on patients with brain damage and they find that damage to specific neural areas usually associated with emotional processing can adversely affect decision-making. The most famous lesion patient study was of Phineas Gage, a railroad manager who suffered a non-fatal accident in 1848 when an iron rod was pushed through his brain. A famous image of the impact was drawn by Phineas Gage's physician – Dr John M. Harlow in 1868 – as depicted in Figure 9.1. It shows an iron rod passing above the left eye and up through the top of the head, probably damaging the frontal lobe on both sides.

Whilst Phineas Gage initially seemed to be largely unaffected by his accident and he recovered relatively quickly, people soon noticed significant changes in his behaviour.

Figure 9.1 Phineas Gage's injury

Previously, he'd been responsible, hard-working and sensible. After the accident he became impulsive and unreliable, and he soon lost his job. His changed behaviour has been attributed to the damage caused to his frontal lobes, areas associated with cognitive processing (Harlow 1868; Ratiu *et al.* 2004).

Damasio (2006) describes a range of similar lesion patient cases from modern times, for which records are more accurate and objective than the records from Phineas Gage's case. One example is Damasio's own patient Elliot who had suffered damage to the frontal lobes after an operation to remove a brain tumour. As a consequence, Elliot suffered a reduction of affect and emotion and whilst tests showed that he retained a wide range of cognitive functions these did not enable him to make wiser or more judicious decisions. Instead, he became obsessed with the details of specific tasks, hampering his ability to manage his job. Damasio observes that the reductions in his ability to process emotions made Elliott unable to differentiate between different options: "his decision-making landscape [was] hopelessly flat … cold-bloodedness made his mental landscape too shifty and unsustained for the time required to make response selections".

Adolphs *et al.* (1995) find similar absence of affect in patients suffering amygdala damage. They analysed the behaviour of a group of 18 lesion patients and seven normal patients. For the subjects with brain lesions: six had suffered amygdala damage and the remaining 12 with brain damage to other areas were used as experimental controls alongside the seven normal subjects. Adolphs *et al.* asked their experimental subjects to judge facial expressions from a series of black and white slides; for example, they were shown a face and asked "how happy does this person look?" They found small differences between the controls and the subjects with unilateral amygdala damage but one particular patient (Subject SM-046) had suffered severe bilateral lesion damage as the result of the genetic Urbach-Wiethe disease leading to bilateral calcification and atrophy of her amygdala. SM-046's ratings for "afraid" faces were significantly lower than the ratings from the other subjects. When asked about her responses to the fearful faces she said that she was aware that an emotion was being expressed but was unsure what that emotion was.

The subjects were also asked to draw representations of various emotional states, including fear. The patients with unilateral amygdala damage, whilst experiencing difficulty relative to the control subjects, were able to represent fear, anger and disgust. For patient SM-046, most of her drawings were skillful and effective representations of the various emotions but she represented fear as a crawling baby. In explaining her responses, she explained that "she did not know what an afraid face would look like". Adolphs *et al.* conclude that the amygdala plays a key role in processing emotions, particularly fear, and this may impair social decision-making. Subject SM-046 also experienced some difficulties with social decision-making confirming findings from other studies showing that the amygdala is activated during social interactions. The amygdala may play a role in interpreting social cues and/or processing fear of social sanctions.

Loewenstein's visceral factor model

The emphasis in the SMH on emotions as bodily cues links into analyses of visceral factors reflecting basic instincts though the visceral factors (VFs) that were introduced in Chapter 8. VFs play a less constructive role than emotions. VFs can propel individuals towards acting in ways which are contrary to their own self-interest but Elster (1996) emphasizes that VFs are a-rational because they are not the outcome of choice and they can operate efficiently at low levels of cognitive intervention.

Loewenstein (2000) develops a visceral factor model and his main premises are that visceral factors crowd out all other goals and people underweight or ignore their own past/future VFs as well as other people's VFs. VFs have direct hedonic impacts even when actual consumption is unchanging so they resemble consumption, not tastes, and also often generate an aversive experience (e.g. fear, pain). Changes in VFs correlate predictably with external circumstances and do not reflect a permanent change in people's dispositions. VFs change more rapidly than tastes because tastes are much more stable in the short run. Tastes and VFs draw on different neurophysiological mechanisms: VFs are associated with stable steady states and homeostasis whereas tastes draw on memory and experience.

Loewenstein develops his model to put forward seven main propositions:

1. Discrepancies between actual versus desired rewards from consuming a particular good increase with the intensity of the VFs immediately relevant to the consumption of this good.
2. *Future* VFs produce little discrepancy between the value we plan to place on a good and its desirable value.
3. Increasing VFs, by creating vividness, for example, increase the rewards from immediate consumption relative to delayed consumption.
4. Current VFs will have a mild effect on future decisions.
5. People underestimate impact of VFs on their future behaviour.
6. People forget the influence of past VFs and so may be perplexed by past behaviours driven by VFs.
7. Drawing a parallel between interpersonal and intrapersonal interactions: VFs affect interpersonal (self versus others) and intrapersonal comparisons (current self versus delayed self) in the same ways. We are more short-sighted and selfish when VFs take hold, for example:
   a. We are less altruistic when VFs are intense.
   b. When deciding for others we ignore/underweight their VFs.
   c. Parallel increases in VFs in oneself and another leads to decreased altruism.
   d. We imagine others experience VFs when we experience them.
   e. People underestimate the impact of others' VFs on others' behaviour.

Visceral factors and emotions will also affect the trade-offs people make in pursuing different goals. Visceral factors will compromise the stability of preferences particularly in the short term because internal bodily states can change so rapidly. Whilst visceral factors are essential to human survival and basic daily functioning, they may conflict with higher-level cognitive processes. The extent of the conflict between cognition and VFs will depend on the intensity of the VFs. VFs are overwhelming in "hot" states but in "cold" states cognitive factors will exert more influence. Misjudgements can occur when individuals underestimate the impact of visceral factors in a cold state.

VFs are often neglected in standard economic models because these tend to focus on rational motivators of behaviour. More recently, there has been an increasing recognition of VFs, for example in models of addiction and in analyses of emotional factors such as fear in situations of risk and uncertainty (see, for example, Loewenstein 2000; Laibson 1997; Bernheim and Rangel 2004).

Social emotions

In Chapter 6 we explored some of the social influences on behaviour and choices, and emotions in the form of social emotions are strong influences on our sociality. Social emotions are associated with more highly evolved decision-making systems. Simon (1967) emphasizes the role of emotion in social interactions. Humans are socialized to acquire sophisticated sets of cues enabling appropriate responses to interactions with others. Given the complexity of these human interactions, there will be a large number and range of social stimuli and these will increase the emotionality of social situations. Emotions will also interact with social motivations and preferences, including inequity aversion: social emotions may reinforce external sanctions by inducing negative emotional states when behaviour is antisocial (Elster 1998). In this way, social norms will regulate and sustain certain emotions, in encouraging conformity to particular social and economic norms.

Social emotions may also be associated with collective behaviour, for example herding in financial markets. Acting with a group may moderate fear but has the unintended consequence of generating speculative bubbles. Responses in uncertain social situations will differ from responses in isolated situations and/or when outcomes are more certain. Uncertainty in financial markets, for example, will generate unconscious, non-rational herding as an instinctive response to endogenously generated volatility. When individual panics precipitate "social panics" this may reflect interplay between risk, anxiety and fear (Loewenstein *et al.* 2007). Markets will fluctuate erratically, reflecting social mood and contributing to financial instability (Prechter and Parker 2007).

Emotions are affected by social context, although there is some evidence that emotional responses are suppressed in extreme circumstances. Erber *et al.* (2004) postulate social constraints affect mood regulation and processing. Social norms may constrain the expression of usual human emotions in extreme institutional settings. In the degrading conditions of Abu Graib or the Stanford prison experiment as described in earlier chapters, the dehumanization of prisoners was exacerbated by the prisoners' suppression of their own socio-emotional responses – pity, for example – thus compromising the essence of their own "humanness" (Haney *et al.* 1973; Zimbardo 2007).

Personality can play a role, too. For the Stanford prison experiment, individual predispositions were shown to affect preferences for antisocial opportunities. The students participating in the experiment were initially asked to volunteer for a prison treatment versus a control treatment and those who had self-selected into the prison treatment scored less highly in measures of sociability such as altruism and empathy. They scored more highly in measures of antisocial tendencies such as Machiavellianism, aggression, authoritarianism, narcissism and social dominance (Carnahan and McFarland 2007).

Lee, Amir and Ariely (2009) test the relationship between emotions and quick decision-making within a dual-system model using experimental evidence. Experimental subjects were given a set of binary product choices alongside the name, picture and a short description of the products they were offered. Emotions and affect were manipulated in different ways. First, pictures were given in colour versus black and white photos, assuming that coloured images are more vivid and therefore more emotionally salient. Second, the subjects were asked to remember two versus ten occasions when their feelings and emotions gave them the right instincts and this was done in order to prime the subjects to have either high trust or low trust in their feelings. It was assumed that those subjects given the more difficult task (remembering ten occasions) would be more doubtful about the trustworthiness of their feelings. Third, subjects were primed to form beliefs about their cognitive capacity by being asked to remember ten versus three numbers. Using the same insight as for the second treatment, this was done to manipulate the subjects' judgements of their own cognitive ability: it was assumed that if the subjects found it hard to recall positive examples of cognitive success then they would have less faith in their cognitive capacity.

The results consistently indicated that greater reliance on emotional reactions during decision-making is associated with greater preference consistency and less cognitive noise. Additionally, the results of a meta-analysis based on data from all five experiments show that products that elicit a stronger emotional response are more likely to yield consistent preferences. For all the manipulations, greater reliance on emotions led to increased preference consistency. When subjects had low trust in their cognitive capacity, they relied more on emotions. When they had high trust in their feelings, they relied more on emotions. When they had colour photos, they relied more on emotions. The positive impact of emotions on preference consistency supports dual-system models and also models emphasizing the positive impact of emotions in decision-making.

We have seen in this chapter that personality, mood and emotions affect economic and financial decision-making in a wide range of ways. Personality traits, together with individual differences such as age and gender, will have an impact on economic preference parameters including risk attitudes, time preference, social preferences and preferences for leisure. Personality will also interact with cognitive ability to determine socio-economic outcomes including educational ability, job performance and unemployment history. Emotions and personality will interact when specific personality traits create predispositions making some people susceptible to specific emotions and moods.

The impact of personality can be quantified though there are important limitations. Personality tests may give imperfect proxies for personality traits meaning that quantitative analyses will be prone to measurement errors. Unravelling cause and effect between personality traits and socio-economic outcomes can be difficult too, especially as some personality traits may be affected by events and experience, creating problems of reverse causality. Overall, the literature on personality in economic decision-making is underdeveloped and so there are many opportunities to further economic understanding in this area.

Emotions are more difficult to measure than personality though neuroeconomic studies have illuminated some of the neural correlates and identified ways in which cognition and affect can interact. Emotions can have an overwhelming impact on decision-making and sometimes that impact is positive. They can play a positive role in guiding decision-making as they may enable people to make decisions quickly and efficiently. They also play an important role in social decision-making and the various manifestations of sociality explored in Chapter 6 can be understood as the product of social emotions. In other circumstances, however, emotions – together with visceral factors – can have a destructive impact and they are often implicated in impulsive, unwanted behaviours such as addiction, as explored in Chapter 8.

Introducing personality, mood and emotions into economic analysis leads to some relatively novel economic policy implications. The insight that personality is malleable in early childhood but becomes more rigid in adulthood suggests that more resources could be devoted to early childhood interventions because those interventions can have an impact, not only in developing cognitive ability but also in enabling children to acquire the skills to enable them to maximize their potential in adulthood. At a microeconomic level, recognizing that traits and predispositions can create comparative advantages suggests that when employers pay attention to personality as well as skills then this will enable them to operate more efficiently because they will be effectively matching their employees/potential employees to specific jobs and tasks.

When moods, emotions and visceral factors undermine people's best long-term intentions then policies based on models incorporating an assumption of strict rationality are less likely to be effective. In some cases, policies should focus on limiting the role of emotional factors in specific situations – for example, taxes to limit impulsive, risk-seeking behaviours such as rogue trading on financial markets, consumption of addictive substances and/or gambling.

There have also been policy initiatives focused on designing gadgets to help people to recognize when emotions are overwhelming reason; for example, Thaler and Sunstein (2008) describe the Ambient Orb technology which glows a specific colour depending on energy use; it glows red for high levels of energy use, giving a quick, emotionally salient signal to the householder to reduce their energy use. This sort of technology is now commonly used in domestic "smart" meters. Similar technology is available to monitor trading decisions: General Electric and ABN-Amro have developed the Rationalizer which monitors traders' physiological states and produces alerts when a trader is overexcited.

Overall, recognizing that personality, moods, emotions and visceral factors can have a profound impact on behaviour leads to the implication that firms' and governments' policies should allow for the fact that people are not always making reasonable, logical calculations. Policies which are designed to slow decision-making down in situations when people are likely to be misled by mercurial moods and emotions are likely to be as effective, if not more effective, than standard policy tools.

Chapter summary

- Building on literatures from standard economics, behavioural economists explore individual differences in personality traits to explain differences in behaviour – drawing on a range of insights from personality theory in psychology.
- Personality traits are measured in a wide range of ways in psychology but economists commonly use the Big Five "OCEAN" measures – where OCEAN = Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism.
- Some of these differences in personality traits have been associated with life chances – conscientiousness particularly links with job performance, employability and life satisfaction generally.
- Economists have traditionally neglected the role of emotions in decision-making, but behavioural economists are now starting to fill the gap – drawing on insights from psychology.
- Moods and emotions are different from each other. Moods are more diffuse and determined by exogenous factors, for example the weather. Emotions tend to be context-specific and sometimes reflect individual differences: a person's predispositions, for example their personality traits, will affect their emotional responses. Aggressive personalities are more likely to feel the emotion of anger, for example.
- Using emotions to guide behaviour is not necessarily irrational and is consistent with softer forms of rationality in which the *affect heuristic*, that is, a quick decision-making rule of thumb driven by emotional responses, drives choices – but is commonly associated with behavioural biases.
- Antonio Damasio's *somatic marker hypothesis* captures how emotions give physiological cues that can be a useful guide to decision-making. When people suffer damage to emotional processing areas, their economic and financial decision-making is impaired. This approach is developed and applied specifically to behavioural economics in George Loewenstein's *visceral factor model*.

- Emotions have important implications in a social context, and social emotions help to explain some of the behavioural experimental evidence from, for example, ultimatum games – introduced in Chapter 2.

Revision questions

1. How are insights from personality theory used by behavioural economists to explain how personality affects economic decision-making? Give some examples.
2. Define emotions and explain the difference between emotions versus moods.
3. How are personality and emotion connected? Give some examples in the context of economic decision-making.
4. Set out Loewenstein's visceral factor model. What are the advantages of Loewensteins's approach versus Damasio's somatic marker hypothesis versus other analyses of emotion in economic decision-making?
5. How can behavioural economists' models of emotions be used to explain some of the apparent anomalies in social decision-making identified in behavioural experimental evidence, for example from studies of the ultimatum game and related games introduced in Chapter 2?

Part II

Extensions

Policy, neuroeconomics and behavioural finance

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Chapter 10

Behavioural public policy

Behavioural economics has many insights to offer policy-makers across a range of areas and there is currently a great interest in behavioural techniques and designing policies to facilitate behaviour change – including policy questions ranging across energy decision-making, environmental behaviour change, through to pensions policies and policies to reduce poverty in developing countries. In this chapter, we will explore how behavioural insights can and have been applied to resolve a range of pressing policy problems.

Behavioural public policy is heavily influenced by contributions from the partnership between behavioural economist Richard Thaler and legal scholar – Cass Sustein. They outline some of the key facets of behavioural public policy in their 2008 bestseller *Nudge: Improving Decisions about Health, Wealth and Happiness*. Both have had a substantial influence on government policy – Cass Sunstein advised former US President Barak Obama and Richard Thaler advised former UK Prime Minister David Cameron's Behavioural Insights Team – now commercialized and the prototype for the growing number of (what are now nicknamed) 'Nudge Units' around the world.

A key focus in behavioural nudging policies is on social influences. The emphasis on social preferences and attitudes in economic behaviour paralleled a revival of interest in social themes in politics in 2010 – in the UK led by UK Prime Minister David Cameron. His conception of a Big Society – a "third sector" based in small social communities – drew on themes of sociality. The hope was that the social connections that characterize the Big Society can enable communities to overcome economic, social and political problems obviating the need for top-down governance from Whitehall. Ironically, in some ways this Big Society concept develops insights from Keynesian economist Ernst Schumacher's left-leaning analysis of the benefits of small communities and decentralization, as elucidated in *Small is Beautiful* (1973). In a similarly ironic way, left-leaning Maurice Glasman has recently developed conservative themes in his conception of "Blue Labour", a model which rejects the focus on centralization traditionally associated with left-wing thought.

The modern concept of a Big Society reshuffled the political cards in a number of ways. Traditional conservative ideology focuses on the importance of free markets in allowing the invisible hand of the price mechanism to allocate resources efficiently. The economic analysis underlying this ideology is based on an assumption of self-interest.

Market failure justifies government intervention and left-wing ideology has tended to focus on the importance of governments as a reflection of the failure of self-interest in efficiently allocating resources when markets fail. The Big Society concept turns all of that inside out: a Big Society will not work unless people are altruistic, cooperative and helpful. If people are selfish then the Big Society will not go far in resolving economic and social problems and governments will be needed to intervene. Whether or not the Big Society third sector has a useful role to play will depend on our social natures. The origins of cooperation and self-interest are often very deep-seated and so policy initiatives to harness our instincts for cooperation must reflect a deep understanding of the behavioural and evolutionary roots of cooperation.

A central concept to Thaler and Sunstein's analysis of behavioural public policy is the concept of *libertarian paternalism*. Libertarian paternalism has two facets designed to address the perennial policy-making tension in liberal democracies – of allowing people the freedom to choose for themselves whilst also ensuring that governments play a role in improving peoples' lives via the provision of public goods, ensuring an equitable society and economy, and in stabilizing economies and financial systems. Thaler and Sunstein's concept of libertarian paternalism relies on guides to behaviour in the form of *nudges*. Nudges push people towards better, more constructive behaviours. They are designed to combine freedom with government intervention. The idea is that governments intervene by designing policies to nudge people in a more constructive direction, but people are free to resist the nudge. Nudges are libertarian because people still have freedom to choose but governments are intervening in designing and implementing nudges and nudges are paternalistic in that sense.

Nudges are advocated by some as an alternative to traditional economic policies such as taxes and subsidies – focusing on the idea that nudges can encourage behaviour change, thus reducing some of the unproductive biases in decision-making, some of which we explored in previous chapters. Nudges also have a social purpose when they resolve problems of externalities – when the actions of one individual have impacts on others around them in ways that are not captured by markets and prices. Costs (and sometimes benefits) are inflicted on other people who are not compensated for these negative impacts. If nudges can be designed to encourage people towards more pro-social behaviour then externalities will be reduced – we explore some examples below.

Nudges can also help to ameliorate what some behavioural economists have called internalities – a concept we introduced in Chapter 8 – in the context of bad habits and addiction. One person's actions – for example impulsive actions associated with addictive behaviours – has negative impacts for their future selves. To illustrate with an example: a person who smokes today imposes negative impacts – negative internalities – on their future self who has to deal with the health consequences of past unhealthy habits. Nudges can be designed to help people's future selves by encouraging people to change their bad habits today.

A key building block of Thaler and Sunstein's nudging approach is the design of good *choice architecture*. Building on a solid understanding of the architecture of choice, in other words understanding fully how people choose and decide using insights from psychology and sociology as well as economics, policy-makers can design their nudges in ways that fit well with real-world decision-making, by designing nudges that simplify complex choices, and enable quick and easy learning via clear feedback. If well designed, behaviour changes engineered via nudges will be "sticky" – that is, people will not return to their old "bad" behaviours once the nudge goes away. There are pitfalls in the nudging approach and we will explore some of those at the end of this chapter, but for now we will concentrate on explaining how, why and when nudging works – specifically in the context of some influential types of nudges. Some of the pioneering nudges from Thaler and Sunstein were designed to leverage people's susceptibility to status quo bias meaning that policy-makers can set default options to leverage status quo bias – by requiring people to make the effort to "opt out" of the most constructive forms of behaviour. For example – to increase incidence of organ donation, policy-makers can set the default so that people automatically donate unless they opt out. Given that people will need to exert effort to opt out, this nudge helps to increase rates of organ donation. Other common forms of nudge include social nudges and nudges designed to reduce problems of present bias, as we explore below.

Nudging policies for energy and the environment

Energy and environmental issues and problems are a particular focus of nudging policies. One way in which nudges can have an impact is via a better design of the choice architecture, for example by focusing the design of choice architecture on effective feedback. Thaler and Sunstein (2008) emphasize the importance of salient and frequent feedback in energy planning. Hargreaves, Nye and Burgess (2010) found that information feedback on electricity consumption leads to decreased use. Darby (2006) also emphasizes the importance of direct feedback with information presented clearly, using computerized tools; indirect feedback is more effective in addressing larger impacts, for example seasonal impacts on energy consumption. Direct feedback via self-meter reading, direct displays, consumption displays and interactive feedback lead to savings of up to 15%; indirect feedback, including frequent bills and information leaflets, can generate up to 10% savings (Darby 2006, Brophy Haney *et al.* 2009a,b).

A very commonly used nudging policy to resolve environmental and energy problems is to leverage social influences, including social learning and social pressure - explored in Chapter 6. Most of us tend to want to do what others are doing most of the time. Behavioural public policy-makers use this insight to design a range of social nudges – very commonly applied in the context of energy and environmental decision-making. In terms of informational influence, social learning about energy efficiency can take place effectively within group settings. Nye and Hargreaves (2009) and Nye and Burgess (2008) outlined evidence from two UK experiments conducted by Global Action Plan in which environmental information was communicated in a social setting. One (the Environmental Champions Programme) was office-based and focused on 280 people with a team of energy champions drawn from different departments. These champions engaged in a three-month communication campaign, providing practical information about environmentally friendly behaviour leading to a 38% reduction in waste production and a 12% reduction in energy consumption. The second programme – the Eco-Teams Programme, focused on household habits and involved neighbourhood meetings to inform communities about energy use. There were a number of positive impacts: 16% adopted green energy tariffs, 37% installed energy-efficient light bulbs and 17% reduced domestic heating. Participants observed that the scheme worked because, whilst they were environmentally aware before participating, the EcoTeams Programme enabled practical knowledge to be communicated to participants.

Social nudges linked to reputation effects have also been shown to have power to change behavior, for example when people's actions are publicized. Pallak *et al.* (1980) analyzed the gas consumption behaviour of a sample of Iowan households. A control group of households were given some energy-saving tips but the advice had no significant impact on their energy use. Then a matching sample of households was told that they would receive positive publicity for their efforts; they would be identified as energy-saving citizens in local newspaper articles. The publicity treatment had a significant, positive effect with each homeowner saving on average 422 cubic feet of natural gas equivalent to savings in the first month of 12.2% in gas consumption. But the most interesting result occurred when the households were sent a letter telling them that they would not receive any positive publicity after all – yet, on average, these households increased their fuel savings to 15.5% in the second month. Pallack *et al.* found similar results in an analysis of air-conditioning use. These apparently anomalous results have been attributed to the fact that the initial promise of publicity encouraged householders to pre-commit to energy reduction and this commitment did not disappear when the promise of positive publicity was withdrawn.

Similar nudges are used to improve people's environmental decision-making. Social norms will drive public-spirited behaviour and conditional contributions to public goods and these norms and pressures will be affected by the values and attitudes outlined above – for example, attitudes towards environmentally responsible choices such as recycling. Schultz *et al.* (2007) analyse these questions from the perspective of norms – which are like rules and standards for behaviour. Norms include descriptive norms providing points of comparison – commonly social norms describing other people's choices; and injunctive norms which incorporate instructions. To illustrate the difference between descriptive norms and injunctive norms, Goldstein *et al.* (2008) analysed hotel towel reuse and tested the impact of different types of information. Hotel guests were given cards asking them to reuse towels either to help the hotel as an injunctive norm; or – for the descriptive norm – some information about what the guests' fellow guests usually chose to do. In the third control condition, the card did not include any specific reasons for towel reuse. Goldstein *et al.* found that the card appealing to the descriptive social norm led to significant increases in towel recycling.

Norms can also be categorized according to their impacts. Norms can be constructive, for example descriptive norms can encourage people who are consuming too much relative to others to consume less in the future; but descriptive norms can also be destructive if they generate a "boomerang effect", that is, if they encourage people who are consuming less than others to move consumption towards the average by consuming more. Norms can also be reconstructive: for example, injunctive norms such as a pictogram of a smiley faces versus a frowny face can reinforce normative signals.

Schultz (1999) notes that descriptive social norms can be communicated in written information. Conformity does not require the direct observation of others. He investigated participants' awareness of causal relationships between descriptive social norms and behaviour and found that normative information about average recycling by neighbourhood families increased the amount and frequency of recycling.

Schultz *et al.* study these norms by analysing the energy consumption behaviour of 290 households in San Marcos, California. All households had visible energy meters which were read before, during and after the interventions. The households were left written messages. Half were just given descriptive information about consumption in other households; the other half were given the descriptive information plus an injunctive visual signal indicating social approval/disapproval in their energy consumption. Below average consumption was rewarded with a smiley emoticon – ☺. Above average consumption was "punished" with a frowny emoticon – ☹. Schultz *et al.* found that the descriptive norm message about average neighbourhood use did lead to energy savings but there was a boomerang effect dependent on whether the household's consumption was relatively high or relatively low. When the injunctive message was combined with the injunctive emoticons to indicate social approval/disapproval the boomerang effect was eliminated.

Nolan *et al.* (2008) extend these findings using two studies aimed at assessing the weight that people ascribe to social norms as factors affecting their energy conservation decisions. The first study surveyed 810 Californians to explore stated reasons for engaging in energy conservation and to test actual factors influencing conservation behaviour. Respondents were asked a series of questions about their energy conservation beliefs, motivations and actual behaviour. Self-reported beliefs were assessed according to answers to questions such as: how much will saving energy benefit society/the environment? How much money can you save? How often do your neighbours try to conserve energy?

Behaviour/intentions were judged by the answer to the question, "How often do you try to conserve energy?" Motivations were assessed by questions about reasons for trying to save energy, for example using less energy saves money, protects the environment, benefits society, other people are doing it. Responses were rated on a 4-point scale from "not at all important" to "extremely important". The findings revealed an inconsistency between the stated motivations and actual behaviour: "because others are doing it" was judged to be the least important reason at the self-reported motivation stage but the highest correlation with actual conservation behaviour was a person's beliefs about whether their neighbours were doing it.

Nolan *et al.*'s second study was a field experiment involving 981 Californian households in San Marcos assessing participants' awareness of the extent to which their behaviour was affected by different messages. The experimental design was similar to Schultz *et al.*'s (2007) and Goldstein *et al.*'s (2008) study. Normative information was circulated in the forms of messages on door hangers; each message was illustrated with a graphic icon. The messages urged the householders to conserve energy via specific conservation behaviours (e.g. taking shorter showers, turning off lights/air conditioning). There were four appeal treatments, each appealing to different motivations: three appeals used non-normative messages: protecting environment (environmental responsibility), benefiting society (social responsibility) and saving money (self-interest). The fourth appeal was based on a descriptive norm with factual information given about the energy conservation behaviour of recipients' neighbours. There was also an information-only control treatment – people were just told that they could save energy by taking the various actions without appealing to any specific motivation.

Actual energy use in home was the dependent variable and electricity meter readings were taken before and after the intervention. This reliance on objective information from meter readings prevented inaccuracies from self-reporting and/or imperfect memory bias. The data showed that normative social influence had a direct impact on conservation behaviour and the social norm condition led to the biggest reduction in energy consumption; people conserved more energy under the social norm condition than under the control condition or the other informational conditions; however, the householders did not detect the influence of these messages; they did not appear to realize that they were affected by the descriptive norm. Nolan *et al.* conclude that these findings suggest that naïve psychology-based beliefs about energy conservation are inaccurate. Trying to encourage people to be socially responsible/protect the environment rarely succeeds in increasing pro-environmental behaviours – perhaps because people have already adjusted their behaviour to these factors. In changing the behaviour of the recalcitrant, new motivations and messages are needed so that normative messages can reach new populations who might not otherwise want to conserve energy.

Allcott (2011), drawing on research from Goldstein *et al.* (2008), Schultz *et al.* (2007) and Nolan *et al.* (2008), focuses on the role played by social norms in guiding energy conservation strategies and identifies three pathways via which social norms play a role: a tournament pathway via which people gain utility from outperforming their neighbours' frugality; a conditional cooperation pathway via which people contribute to a public good if others do too; and a social learning pathway. Allcott notes that boomerang effects can be explained most easily in terms of the second and third pathways though he does also emphasize the role of feedback.

Allcott analysed data from a randomized natural field experiment using Home Energy Reports (HERs) in collaboration with OPOWER – electricity utility in Minnesota. The electricity consumption of 80,000 treatment and control households was analysed. Each household was sent a HER with two features: an Action Steps Module giving energy-saving tips; and a Social Comparison Module – comparing a household's energy consumption with that of its 100 geographically closest neighbours. The monthly programme lead to decreases in energy consumption of 1.9–2.0% but with decay effects; impacts decreased in the period between receiving one monthly report and the next but then increased again once the next report was received.

Allcott infers that this reflects an interaction of social norms and bounded rationality/heuristics, in particular the availability heuristic. There is an "attention channel". People do know about energy conservation strategies but they need reminders because attention is malleable and non-durable. Receiving a HER reminded people about the strategies that they should be taking. Given bounded attention to social norms, social norms will only affect behaviour when norms are at the top of the mind.

Nudges for healthy living

One of the key policy issues of our time is declining health reflecting lifestyle choices including bad eating habits, excessive alcohol consumption and insufficient exercise. These problems reflect the fact that we are not always good at doing things that are unpleasant in the short term to deliver good outcomes in the long run. We are susceptible to present bias, lack of self-control, temptation and procrastination. Healthy lifestyle involves exercise and eating nutritious foods and an increasing volume of behavioural research is focusing on when and why these good habits can be uncommon.

Parkin, Boyd and Walker (2011) estimate the fraction of cancers in the UK in 2010 which could be attributable to exposures to lifestyle and environmental risk factors and therefore were to some extent preventable. Tobacco was the major risk factor but diet and lifestyle factors, including low consumption of fruit and vegetables, excessive consumption of alcohol, salt and red meat together with insufficient exercise and being overweight/obese were also major risk factors.

Healthy food

Chapter 8 explored the ways in which economists and behavioural economists explain bad habits and addictive behaviour. We all know which bad habits we should avoid: smoking, eating too much fat and sugar, drinking too much alcohol and/or caffeine; not getting enough exercise – a sedentary habit. There have been numerous studies of unhealthy behaviours that have significant impacts on people's lives. These behaviours reflect the impact of a range of behavioural factors. Social norms play a key role, for alcohol and marijuana consumption as well as cigarette smoking (Haines and Spear 1996; Hansen and Graham 1991; Thombs *et al.* 1997).

Adler and Stewart (2009) identify a range of factors affecting obesity including an "obesogenic" environment: areas where healthy, fresh food is difficult to find but unhealthy takeaway food is quickly available. In addition, this unhealthy food is often advertized using cues designed to exploit impulsive visceral instincts. These insights add weight to Laibson, Loewenstein, and Smith and Tasnádi's analysis of the impact of environment cues on addictive behaviour, explored in Chapter 8. Solutions focus on making healthy food more widely available, particularly for children. A range of initiatives have emerged including healthy school meals campaigns in the UK and US – championed by UK chef Jamie Oliver and focusing on providing children with access to healthy school food.

Belot and James (2009) analyse the impacts of Jamie Oliver's campaigns by studying the impact of diet on educational performance. They compared the performance of primary school children at schools in Greenwich, London. Jamie Oliver's "Feed Me Better" school meals campaign was launched at some Greenwich schools. The quality of school meals was improved by reducing the volume of processed foods and increasing the provision of fruit, vegetables and water and healthy, freshly cooked food. The performance of children at these schools was compared with performance by a control group of children at schools not participating in the Feed Me Better campaign. For children in the treatment group, educational outcomes improved significantly and absenteeism fell. Jamie Oliver's campaigns had similar beneficial effects elsewhere including in the US and not only focused on increasing the quality of food but also on changing some of the social norms surrounding people's attitudes towards food and healthy eating.

Understanding bad health habits: not going to the gym

For most people, getting enough exercise is one aspect of a healthy lifestyle that can be particularly hard to maintain – and encouraging more exercise is one promising route for a combination of economic insights and nudging policies. Encouraging gym membership can be done by designing gym membership offers in ways that harness some of the behavioural decision-making styles outlined in previous chapters. Standard economic approaches to contract choice assume that people choose from a "menu" of contracts using a rational, optimizing approach incorporating exponential discounting. But DellaVigna and Malmendier's gym evidence shows that this does not happen in the real world. DellaVigna and Malmendier's (2006) study of gym membership/use shows people paying far more for annual and monthly gym membership plans than is justifiable given their infrequent attendance. They analyse a natural experiment on gym membership which showed that people seem to be willing to pay not to go the gym.

DellaVigna and Malmendier assess data from three New England health clubs including detailed attendance data for 7,752 and 8,273 enrolment spells focusing their analysis on the first enrolment spell. They also assess survey evidence from 97 health clubs. They analyse three choices facing people signing up for gym membership: pay as you go; an annual flat rate contract; or a monthly flat rate contract. Standard theory would predict that price per expected attendance should be lower for those signing up to a flat rate contract than for those using pay-per-visit. The expected number of visits under the annual contract should exceed expected number of visits under the monthly contract; average forecasts of attendance should equal average actual attendance; low attenders should delay cancellation for at most a few days; people signing up for an annual contract should have larger survival probabilities, remaining as gym members for longer.

From their analyses of health club data, DellaVigna and Malmendier found limited evidence in support of the predictions of a rational gym-goer. The average price per visit was over $17 for monthly contracts and $15 on annual contracts, yet the pay-per-visit fee was significantly lower at $10. So, consumers choosing monthly membership pay on average 70% more than if they were on the pay-as-you-go contract. Average attendance in months 2–4 was 10% higher under the annual contract than the monthly contract. The average forecast of attendance was more than twice as large as actual attendance for monthly contracts. The average cancellation lag was 2.31 months between last attendance and cancellation for monthly members. Survival probability (share still enrolled at 15 months) was estimated using Probit (conditioned on gender, age, etc.). People on a monthly contract were 17% more likely to stay enrolled beyond a year even though they were paying higher fees (than for the annual contract) for the option to cancel each month. Most of these findings were inconsistent with a rational optimizing approach.

DellaVigna and Malmendier suggest a number of behavioural explanations for the apparently anomalous behaviour of gym goers. Their decisions may have reflected risk aversion: a flat-rate contract minimizes variance of payments. Transaction costs of daily payments may have created a preference for flat-rate contracts. For flat-rate contracts there were additional membership benefits including psychological benefits. Preferences were varying over time and whilst there was rational updating, it was slow. Limited memory might have meant that people forgot to cancel their memberships. If health-club employees are incentivized to sell the more expensive flat-rate contracts, then persuasion might also have had an impact on the gym-goer's choices.

The behaviour can also be explained using different assumptions about inter-temporal decision-making. Seemingly paradoxical choices may reflect pre-commitment strategies. Sophisticated consumers realized that they were vulnerable to problems of time inconsistency and so tied themselves using a pre-commitment device. By paying relatively large sums of money upfront they were hoping to encourage their future selves into going to the gym more often in the future. Time inconsistency may also explain the results for the naïve gym-goers. If initial attendance was high, overconfidence about future self-control meant that they overestimated net benefits, perhaps reflecting projection bias and the anchoring heuristic.

At the same time, there may be heterogeneity in overconfidence. Users paying a high price per visit on monthly contract are also the ones with a longer cancellation lag. Overall, DellaVigna and Malmendier's findings suggest that observed health choices do not match actual behaviours, generating biases in decision-making. In designing nudges to encourage people to go to the gym more often, insights from DellaVigna and Malmendier's research can be used in devising contracts that fit Thaler and Sunstein's criteria for good choice architecture. An important policy implication is that, in the fight against obesity, it isn't enough just to subsidize health clubs – whether via public subsidies or health insurance schemes. There is no guarantee that just because people have a gym membership they will actually go to the gym. Social nudges are likely to have an impact too – not just via giving people information about the exercise of their neighbours but by encouraging people to engage in exercise as a social activity. Devices for regular feedback and reminders are likely to tap into people's quick decision-making responses, so apps and other technology can be effective in this context. Other more standard economic insights can be used in combination with behavioural nudges, for example if people can build exercise into their daily route then the transaction costs and inconveniences associated with exercise will be reduced. Combinations of nudges will work, for example social exercise opportunities offered within the workplace and lunchtime group exercise, are likely to be effective.

Behavioural development policy

Behavioural public policy tools are applied particularly widely in development policy-making, to reduce problems of severe poverty in developing countries. Often these policies are tested using large-scale randomized controlled trials, the principles of which are explored in Chapter 1. Some of the main forms of behavioural public policy used in development policy include nudges leveraging present bias and social nudges.

Present bias and farming habits

An influential study of pre-commitment tools is Duflo *et al.*'s (2011) study exploring nudges to encourage farmers to use fertilizer to improve yields (see also Duflo and Banerjee 2011). Duflo *et al.* (2011) link time inconsistency to procrastination in agrarian working capital investment. They hypothesize that the failure of Kenyan farmers to buy fertilizer reflects not only liquidity constraints but poor inter-temporal planning reflecting time inconsistency and procrastination. Duflo *et al.* constructed a randomized control trial to test the differential policy impact of a Savings and Fertilizer Initiative Program (SAFI). Farmers were offered access to SAFI in two ways: in the simple version of SAFI, the farmer was offered fertilizer on the spot at harvest time; in the second version of SAFI, the farmers were visited before the harvest season and were offered the option to buy fertilizer at a later point in time. Both versions of SAFI led to a significant increase in fertilizer use. If farmers were rational in a standard sense then, for the second version of SAFI, they would order the fertilizer for a future date and invest their money in the meantime. If they were time-inconsistent and naïve, then they would overestimate their ability to save for a future fertilizer purchase and would agree to buy it at a late delivery date. A way to overcome this problem is to offer small, time-limited subsidies for fertilizer purchases as a way to overcome inefficient farming practices, such as those emerging from problems of procrastination.

Social nudges in Indian villages

We explored above how social nudges can be used in addressing policy questions around energy and the environment. Similar nudges have been used in behavioural development economics too. Social learning and peer effects from observing the actions of others can have a particularly profound impact, particularly because social capital and social networks can be vital when market institutions are not well developed. One area in which social pressures and social learning in networks can improve living standards is in the area of health and sanitation, a particular problem in rural, underdeveloped regions with high levels of infant mortality. Pattanayak *et al.* (2008) explore the "shame or subsidy" debate: experts disagree about the relative impacts of monetary incentives/public goods provision versus shaming and social pressure as emotional motivator to encourage the development of healthy social norms. They hypothesized that social pressure and peer monitoring could be as effective as subsidies in encouraging people to develop healthier habits. Learning will also play a role and Pattanayak *et al.* explored the effectiveness of sanitation campaigns focusing on information, education and communication (IEC) about good sanitary practices.

They tested their hypotheses using randomized experimental design to explore the effectiveness of sanitation campaigns in the Indian state of Orissa. They selected 20 villages for a treatment trial and another 20 villages as a control group, with 1,050 households in total. The villages in the treatment group were exposed to an IEC campaign to educate people about sanitation, safe water and hygiene. In addition, all 40 villages (i.e. the control group as well as the treatment group) were given access to subsidies to enable villagers to buy latrines. Pattanayak *et al.* postulated though that knowledge was not enough and that behaviour would not change without emotionally salient triggering events. They incorporated Community Led Sanitation into their experimental design including three tools: a walk of shame – a community walk during which examples of poor hygiene were identified to the group; defecation mapping – in which villages participated in identifying the spatial distribution of defecation and its effects; and fecal calculations – in which the volume of fecal matter and its likely impacts were discussed.

They found that the IEC campaign had a strongly significant impact in increasing the adoption and use of latrines in the villages; latrine ownership increased from 6% to 32% in the treatment villages. They also found that shame and subsidies together were more effective than subsidies alone. There was significant heterogeneity across villages: lots of people participated in some villages; in others, very few participated, perhaps reflecting social complementarities. The more people in your network are choosing an action, the more likely you are to choose it too. They found that learning did not generalize however and there were no other significant sanitation behaviour changes. Having more latrines did not lead to hand washing for example. They concluded that sanitation worldwide can be improved via the implementation of "social marketing" tools such as social pressure and peer monitoring in policy design.

Identity, in-groups and out-groups

In behavioural development economics, insights about social preferences – as outlined in Chapter 6 – are applied to the analysis of post-conflict behaviours. For example, Bauer *et al.* (2011) explore egalitarian motives in children exposed to armed conflict and find that intergroup conflicts had significant impacts on children's cooperative behaviour. They studied children soon after the 2008 war between Georgia and Russia for control of South Ossetia. They asked them to play variants of dictator games and envy games, with sweet treats as rewards. Envy games disentangle advantageous and disadvantageous inequity aversion, introduced in Chapter 2, by exploring what happens when players are facing higher total payoffs both to themselves and to the other player, but at a relative disadvantage to themselves. For example, a child choosing between offering two sweets to another child and keeping two for themselves versus offering four sweets to another child and keeping three sweets for themselves. Bauer *et al.* find that the children's experience of conflict during the Ossetia war had impacts on their other-regarding preferences, and was associated with increased egalitarianism and decreased competition when playing games with their in-group but parochialism and increased competition when playing games with the out-group. They find similar results for adults in Sierra Leone.

Alexander and Christia (2011) also analyse sociality in a post-war setting using evidence from public good experiments. These were conducted on religiously diverse Catholic Croat and Muslim Bosniak communities in post-war Mostar, Bosnia-Herzegovina. Alexander and Christia found that cooperation could be achieved using sanctions but that the effectiveness of these sanctions depended on whether the communities were segregated or integrated. In mixed but segregated communities, participants contributed low amounts whether there were sanctions or not, but in integrated mixed communities, contributions were more than doubled even without sanctions and with sanctions, contributions were more than tripled. This evidence suggests that institutional environments play an important role in reintegrating post-war communities perhaps suggesting that post-war reconstruction should focus on building institutions designed to moderate ethno-religious differences in identity.

Behavioural public policy: challenges and pitfalls

Whilst behavioural nudging seems seductively simple, there are problems with the nudging approaches. Nudging is advocated as providing a blend of freedom and government intervention – but this makes it susceptible to criticism from two perspectives. Libertarians criticize the approach because they believe governments should limit their interventions in private decision-making and nudging seems, to them, to increase government control. From the opposite political perspective – nudging may be a weak instrument in enabling people to achieve a better situation for themselves. For these critics of nudging, nudging is a "cop-out" and an excuse for governments to reduce their commitments to intervention by putting the responsibility for reducing internalities and externalities in the hands of individuals. In this, nudging is somewhat contradictory in that it makes individuals responsible for their decisions whilst at the same time being grounded in assumptions about how people are not good at choosing for themselves.

This raises the additional question of, if people don't choose well for themselves, then how can behavioural public policy-makers know what's best, if people don't know themselves?

Another key challenge for behavioural policy-making is to design policies that are both sustainable and scalable because behavioural public policy relies on engineering behaviour change at the microeconomic level of each individual decision-maker. This is both an advantage and disadvantage. Top-down macro policy applies to whole groups simultaneously. There is no need to worry about the individual.

Some nudges are superficial, quick fixes that may not lead to deep and lasting behaviour change. For example, in the context of the social nudges to encourage reductions in energy consumption, as highlighted above, some behavioural biases lead some consumers to use too much electricity, for example, but in controlling energy use it is not enough just to switch off some lights when heating is the major energy drain. Similarly, sometimes policies will just change a single behaviour when whole sets of behaviours need to adapt. The studies of sanitation in India show that people will install more latrines but the awareness of the need for good sanitation does not necessarily generalize to other behaviours to improve sanitation, such as hand washing (Pattanayak *et al.* 2009).

The problem for policy-makers in designing 'scalable' nudges, that is, nudges that positively affect as many people as possible, is that individual preferences and attitudes will be affected by differences in age, gender, education, socio-economic status and political affiliation. Nudges may not be easily scalable if it is difficult to nudge large segments of a population to change their behaviour. Political attitudes can be a particularly strong barrier. Costa and Kahn (2010) postulate that political opinions play a role reflected in rising polarization in environmental attitudes across political groups: they report that liberals and environmentalists are more responsive to environmental nudges than average and their econometric estimates indicate a 3–6% reduction in energy consumption in Democrat households, against a 1% increase in consumption in Republican households, which may reflect the fact that nudges encourage Republican households to use more energy either because they are "defiers" or because of a boomerang effect. Fairness can be incorporated into individual utility functions – for example see Fehr and Schmidt (1999) on inequity aversion – but turning these theoretical and philosophical questions into guidance for practical policy makers is difficult, especially as subjectivity is still problematic as the question remains of how to assign weights to inequity aversion. Distributive preferences cover accountability, efficiency, need and equality (Gowdy 2008). Equality raises moral questions and accountability implies that polluters should pay proportionally to emissions.

More generally, given the growing influence of behavioural economics in policy-making, it is important for policy-makers to recognize not only behavioural economics' insights but also its limitations. Sometimes, more traditional policies will be more effective in dealing with specific types of policy problem, for example traditional policy tools such as regulation and taxation might be better ways to encourage households and businesses to use energy more efficiently and/or to dissuade large retailers and manufacturers from exploiting impulsive, visceral reactions to food advertising and cigarette packaging. The key is a good balance between innovative but effective policy tools based on insights from behavioural economics alongside more traditional styles of policy-making.

A final limitation is that nudging policy has not yet addressed pressing problems of macroeconomic decision-making. Nudging is based around changing individuals' behaviour. It follows that behavioural insights have not found their way substantially into macroeconomic policies and systemic financial regulation. We will explore some of these macroeconomic policy-making issues in the chapters on macroeconomics and financial instability, explored in Part III.

❖ CASE STUDY: BEHAVIOURAL POLICIES FOR AN ONLINE WORLD

One key area which needs new behavioural public policy designs is online privacy and security. People are not good at balancing risks is their online decision-making. Heuristics and biases – explored in Chapter 3- affect a wide range of real-world decision-making by households and firms and this case study focuses on lessons from online nudging approaches for controlling online problems of privacy and security. For computing decisions, absence of meaningful and available information about security threats leads to over-optimism and underestimating risks of privacy and security breaches. These misperceptions of risk increase vulnerability to problems such as identity theft. For security and human behaviour, Acquisti (2004) and Acquisti and Grossklags (2006) explore a number of other misperceptions of risk specifically affecting online behaviour including status quo and familiarity biases when people prefer the current situation generating status quo bias – a bias captured within prospect theory in which the status quo acts as a reference point (Acquisti 2004; Acquisti and Grossklags 2006; Thaler and Sunstein 2008). Some of these biases can be manipulated to encourage people to engage in more efficient behaviour – for example, status quo bias, which is about the fact that when online, people tend to favour the existing situation and will tend to avoid the effort involved in changing their choices. Setting online default options cleverly can exploit this misperception of risk. If the default option applies the maximum privacy protection then a large number of consumers may procrastinate in changing these options, thus protecting them from security violations.

For cybersecurity policies, understanding why and how people misperceive risks may lead people to decide that security is not a problem because they haven't had a problem with it in the recent past. On the other hand, if recent news stories have focused on security risks then people may be disproportionately focused on protecting their security. Stories about destructive viruses and malware and/or perils of cloud computing/unsecured information sharing might encourage more people to be careful about how they use privacy settings on Facebook and Twitter.

Anchoring around the reference point may also be relevant: if someone's friends and colleagues are all talking about the benefits of some new software, then a person's judgement of that software may be anchored around these opinions. Another type of decision-making bias that deserves particular attention is the present bias, introduced in Chapter 7. People's behaviour may be inconsistent over time: plans to do something to enable their computing (e.g. backing up files) in the future change as the future becomes the present because people procrastinate and they lack self-control.

Bias is not necessarily irrational and may reflect a softer style of rationality than that traditionally associated with economics, for example if people are treating different financial decisions in different ways using different "mental accounts", for example if online buying is put into the fast account. Acquisti and Grossklags have analysed the implications of bias for people's choices about privacy and security (Acquisti 2004, Acquisti and Grossklags 2006). They also build on the behavioural economics literature on procrastination and self-control (e.g. see O'Donoghue and Rabin 1999; O'Donoghue and Rabin 2001 and DellaVigna and Malmendier 2006). When using the internet, people will procrastinate about setting up effective security systems in much the same way as many ordinary people procrastinate about backing up files. Procrastination is potentially a key policy issue particularly if the most effective privacy and security solutions are to be driven by individual choices. Assuming that people suffer biases but are sophisticated enough to realize that this might generate security and privacy problems in the future, then they can be encouraged to set up pre-commitment devices such as identity verification systems and/or computer default options which exploit the status quo bias. Employing these devices enables sophisticated users to pre-commit to protecting themselves from security violations in the short term when they might be tempted to act impulsively.

The problem for internet security is that people do not necessarily learn fast about their biases. Emotions have an impact because they are quick and impulsive and engage automatic decision-making systems. To enable faster learning, if group leaders can be identified and encouraged to adopt appropriate online protections then others will follow their example. Alternatively, if information about the adoption of safeguards by others is prominent then this normative influence will encourage people to do what others are doing. Cooperation between self-seeking individuals will lead to the evolution of new social norms (Axelrod 1990). For security and human behaviour, decisions are made in a multidimensional space and reflect contradictory goals and so trust and control are central; effective security and privacy systems will allow transparent communication between trusted parties but will be closed to the "bad guys" (Clark 2010). Attitudes to privacy and security are changing; for example, it is widely believed that the younger generation is more vulnerable to identity theft because they are far more willing to reveal important personal information. In terms of policy implications, perhaps people can be encouraged to take more care in their online decision-making if learning leads to new social norms via advertising, social networking and other forms of social interaction.

Chapter summary

- Behavioural public policy in economics is based around concepts of libertarian paternalism and choice architecture.
- Libertarian paternalism captures the idea that nudging policies can be both paternalistic – advocating government intervention via nudges to reduce internalities and externalities – whilst also preserving liberty by allowing individuals freedom to choose about whether they want to go along with these nudges or not.
- Effective nudging relies on good design of choice architecture to ensure that nudges are easy and simple to navigate, enable learning via effective feedback and are sticky so that nudges are not just quick fixes.
- Behavioural public policy suffers from a number of limitations and so nudging is most useful when it is used as a complement to, not a substitute for, conventional economic policies such as taxes and subsidies.

Revision questions

1. What is libertarian paternalism? How does it address some of the problems commonly associated with traditional policy debates?
2. What is a nudge? Illustrate with examples.
3. Explore some of the challenges, successes and pitfalls of behavioural public policy applied in an economic context.
4. Why have behavioural public policy-makers not progressed far in applying some of the microeconomic behavioural principles explored so far in this book to the design of behavioural macroeconomic and financial policies?

Chapter 11

Neuroeconomics I

Principles

In the exploration of microeconomic principles, so far we have focused on relatively conventional experimental and econometric evidence to illustrate how social and psychological influences interact with economic incentives and motivations. A problem with this type of evidence is that it necessarily focuses just on observed actions and choices. These types of data are relatively objective, as much as any scientific study is objective, at least. But in fully exploring the drivers of behaviour we need to know more about what propels people's actions. One reason for this is that it is not easy objectively to measure thoughts and feelings.

Until recently, economists have analysed our decision-making focusing on what we do without looking too deeply at empirical evidence about how and why people behave as they do. Partly this is because economists have traditionally assumed that asking people how and why they reached their decisions was fraught by subjectivity and, for personal reasons experimental, participants have incentives to conceal their true motivations. As Camerer, Loewenstein and Prelec (2005) observed, standard economics treats the brain as a "black box". Information goes in and decisions come out but we do not know what happens in between. Neuroscience is, however, changing this because it allows scientists to see more about how our brains are processing information. More generally, tools and insights from cognitive neuroscience are now being amalgamated with those from economics to give a much richer account of what underlies our decision-making and, in this and the next chapter, we will explore some of the neuroscientific evidence and its underpinnings.

Principles of neuroscience

To see how neuroscience can be applied to the study of economic and financial decision-making, we need to outline some of the key principles of neuroscience.

Neuroscience is the scientific study of the nervous system, its anatomical structure and physiology and in the past was regarded as just a branch of biology. However, in the last 50 years it has become an interdisciplinary science which now includes neurochemistry, medical neurology and surgery, psychology, linguistics, logic, electronics, computer science and neuroimaging. Neuroscientific methods are used in the analysis of cognitive psychology including studies of perception, memory, comprehension, judgement and action, and neuroeconomics is emerging as a new member of the family of neurosciences.

What are nerves and how do they work?

The human nervous system comprises the central nervous system; the brain and spinal cord within the cranium and vertebral spinal canal, and the peripheral nervous system of nerves that extend throughout the body. The nervous system carries signals from sense receptors in skin, ears and other tissues to the cord and brain. It also delivers motor signals from the brain to muscles and glands throughout the body.

The basic unit of the nervous system is the neuron, or nerve cell which transmits electrochemical signals as nerve impulses. The human brain is a complex neural network comprising billions of neurons. Neurons are discrete cells but they are linked to one another by synapses, or neural junctions. Nerve impulses travel down neuron fibres as waves of electrical depolarization known as action potentials but are not able to cross synapses between neurons. Instead, the nerve impulses travel from one neuron to the next, triggering a response in an adjacent neuron.

Neurons have four structural features; dendrites, cell bodies, axons and axon terminals. Dendrites are multiple slender fibres which transmit impulses towards the cell body. The cell body is an integration zone where signals in the form of action potentials from many different dendrites are integrated. Axons are fibres that conduct signals from the cell body to axon terminals adjacent to synapses. When a nerve impulse from one neuron arrives at a terminal it triggers the release of a chemical neurotransmitter into the synapse. This attaches to the receptors in the dendrites of the next neuron and initiates a nerve impulse (action potential) in the postsynaptic neuron. Synapses link axonal fibres to dendrites within a neuronal network, as shown in Figure 11.1, a schematic diagram of a neuronal network.

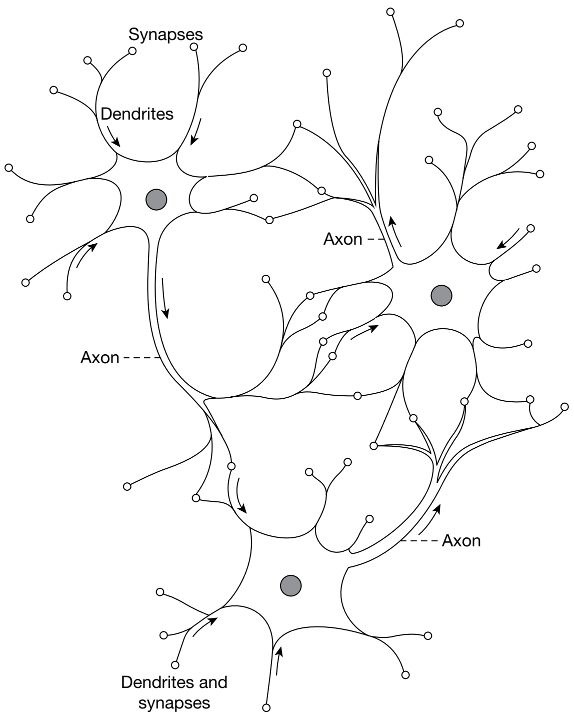

Figure 11.1 Schematic diagram of a neuronal network

The neurotransmitters released into synapses can be either excitatory or inhibitory. If excitatory, they will promote the ongoing nerve impulse; if inhibitory, they will stop it. Different neurotransmitters are associated with different functions, as outlined in Box 11.1. Most synapses in the nervous system release acetylcholine but specific parts of the brain use other neurotransmitters such as serotonin, dopamine, or noradrenaline which affect emotional behaviours – all of which are important drivers of our behaviour.

Box 11.1 Neurotransmitters and hormones

Neurotransmitters are released into the synaptic gap, as explained above. Some of the neurotransmitters and impacts relevant for decision-making include:

Neurotransmitter	Implicated in
Dopamine	Reward processing, reward prediction error
Serotonin	Well-being, happiness
Acetylcholine	Attention, arousal, reward
Noradrenaline	Stress, attention, fight-or-flight impulses

Hormones are chemical messengers secreted from the glands of the endocrine system into the blood stream in order to modulate bodily functions. The ones probably most interesting to economists include:

Hormone	Implicated in
Oxytocin	Trust, social bonding
Testosterone	Risk tolerance, aggression
Cortisol	Stress, fear, pain

Some of these substances have a dual function, e.g. oxytocin is a hormone released into the blood stream from endocrine glands and is also a neurotransmitter.

To summarize: signals pass through the neural networks of the brain and cord, mediated by a combination of electrochemical impulses modulated by each neuron and by the release of synaptic neurotransmitters.

Anatomy of the brain

The anatomy of the brain, spinal cord and peripheral nerves is very complex. The human nervous system can be divided into three structural and functional levels:

1. The higher brain or cerebral cortex.
2. The lower brain and brain stem.
3. The spinal cord and peripheral nerves.

The brain is also divided into lobes including frontal, parietal, occipital, temporal lobes and cerebellum – as illustrated in Figure 11.2.

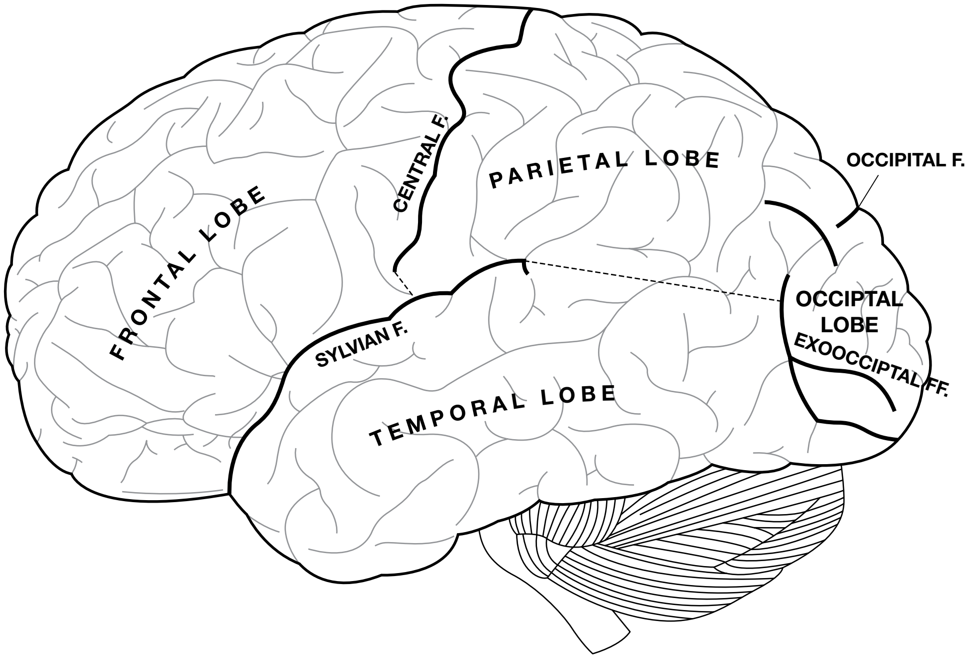

Figure 11.2 Lobes of the brain
Source: *Gray's Anatomy of the Human Body*, 20th US edition, originally published in 1918.

The cerebral cortex and the subcortical nuclei are of greatest interest for cognitive studies and psychological investigations including those used by neuroeconomists.

It has been estimated that there are approximately 100 billion neurons in a healthy human brain. The brain shows regions mainly of two kinds, comprised of either grey matter or white matter.

Grey matter is composed of numerous nerve cell bodies, interconnecting dendrites, short axons and supporting cells called neuroglia. It is rich in synapses and very active metabolically requiring a constant supply of glucose and oxygen, so it is well supplied by blood vessels and is highly vascular. The most striking grey-matter region of the human brain is the folded outer covering of the cerebral hemispheres called the cerebral cortex, containing six layers of cells and measuring 2 to 5 mm in thickness.

A prominent cerebral cortex is evolutionarily a feature of mammal brains. If a human cortex were unfolded it would cover an area of a quarter of a metre. Packing this into the cranium produces folds, known as convolutions or gyri, with fissures or sulci between them. The two largest cortical fissures on each side are between the temporal and parietal lobes of the cerebrum – the Sylvian fissures, and between the frontal and parietal lobes – the fissures of Rolando. These are important because the motor areas lie in front of, and sensory areas behind, these fissures. The prefrontal lobes are those portions of the frontal lobes that lie in front of the motor areas.

Grey matter is also present in subcortical areas of the brain, such as basal ganglia, nuclei in the brain stem, hind brain and extending into the spinal cord. The limbic system of nerve tracts and nuclei lies closely adjacent to the cortex and includes basal nuclei and tracts connecting with the hypothalamus and the amygdala.

White matter is composed mainly of myelinated long axons which connect different regions of the brain and spinal cord. These long axons are coated with a whitish myelin sheath which insulates the axon from surrounding neurons and improves transmission of nerve impulses (electrical action potentials). White matter is much less metabolically active than grey matter and so is less vascular.

Given the complex confusion of anatomical structures in the human brain, some conventions have emerged to enable identification of specific areas. Korbinian Brodmann devised maps of the cerebral cortex and key neural structures are now often categorized using Brodmann's areas, some of which are noted below. Often, a neuroscientist will be interested in identifying specific regions of interest (ROIs), for example in functional magnetic resonance imaging (fMRI) studies, as explained below.

Brain areas and functions

Evolutionary biologists focus on the rough division of brain regions reflecting evolutionary development. In these approaches, the brain is divided roughly into three main areas – the triune division into reptilian, mammalian and hominid parts. The triune anatomical division can be loosely associated with some broad functions: the reptilian parts of the brain are often associated with basic instincts and impulses; the mammalian parts associated with basic perception and social interaction; and the hominid part associated with higher cognitive function (Jerison 1973, MacLean 1990; Camerer *et al.* 2005).

As noted above, a prominent cerebral cortex is a feature of mammalian brains and the significant enlargement of the cerebral cortex is most developed in hominid brains and the prefrontal cortex is often associated with deliberative thinking in neuroeconomic studies. Reflecting the triune division, some neuroeconomic insights about brain structure reflect evolutionary themes, for example some neuroeconomists postulate that violations of standard utility theory have been replicated with animals perhaps because behaviour is propelled by older, less evolved circuitry rather than more highly evolved cognitive structures.

A list of some key brain areas and functions are set out in Box 11.2.

Box 11.2 Some brain areas and functions

Area	Function
Amygdala	Represents negative emotions, e.g. fear
Anterior cingulate cortex (ACC)	Executive function, conflict resolution
Caudate nucleus/putamen, in the striatum	Reward processing
Cerebellum	Attention and timing, pleasure, fear
Insula	Hunger, disgust, social snubs
Hippocampus	Memory and learning
Nucleus accumbens	Pleasure and reward, addiction
Occipital cortex	Visual processing
Parietal cortex	Motor action, mathematical reasoning
Prefrontal cortex (PFC)	Planning, cognition
PFC – Brodmann area 10	Theory of mind, mind reading
Temporal cortex	Memory, recognition, emotion

The prefrontal cortex (PFC) is associated with planning and cognition, the parietal lobe with motor action, and the occipital lobe with visual processing, the temporal lobe with memory/recognition/emotion. There is also evidence that areas in the PFC are associated with social cognition, for example Brodmann area 10 in the PFC is associated with 'mind reading' and empathy. Limbic structures are associated with emotional behaviour, subconscious motivations and sensations of punishment or pleasure. A number of neuroeconomic studies, particularly studies exploring interactions between cognition and emotion, have identified a role for limbic structures, including the amygdala, insula, nucleus accumbens (which forms the main part of the ventral striatum) and the anterior cingulate cortex. The amygdala is implicated in the processing of fear and the insula with pain, disgust, and also social snubs, inequality and unfairness; the anterior cingulate (ACC) performs executive functions and resolves conflicts. Some of these neuroanatomical structures are identified in Figure 11.3.

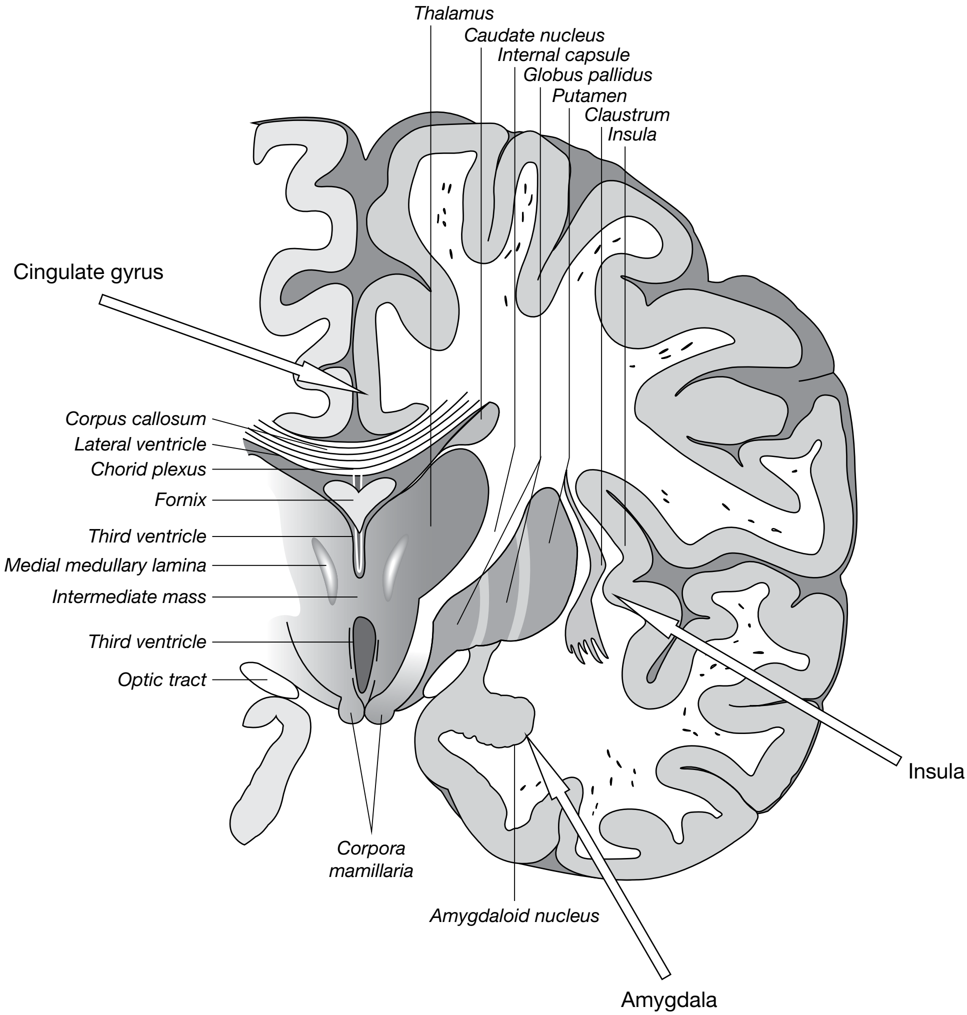

Figure 11.3 Neuroanatomical structures

Modularity

Some neuroscientists focus on modularity in the brain – certain functions are associated with specific anatomical areas, though many of these functions will interact and overlap. The visual system is, perhaps surprisingly, particularly important in decision-making because it is integral to accumulating and processing information and stimulating the motor system to make "winner takes all" binary choices. Areas associated with language, religion and humour have been identified (Camerer *et al.* 2005). Another area of potential interest to economists is the mirror system and "mentalizing" modules, activated when observing other persons recreate similar internal states in the observer. Studies have shown that mirror neuron systems in the premotor cortex of monkeys are activated when the monkey makes a movement and are also activated when the monkey observes another monkey making the same action. If mirror neurons are responding to internally generated representations of actions and not to the actions themselves, then potentially they are also implicated in sympathetic responses to social situations (Rizzolatti *et al.* 2002).

Functions may also be coordinated. In many cases, a number of areas will be implicated in specific neural processes, for example brain imaging studies have identified a distributed network involved in arithmetic reasoning, including the lateral and ventral prefrontal cortex, posterior parietal lobe, and subcortical regions such as the caudate nucleus and cerebellum. There may be interactions between automatic versus controlled functions and between cognition and affect. Cognition may dominate in "top-down sense-making", when we use our cognitive powers to fit the world to our expectations, impose order, imagine patterns, miss unexpected changes and overwrite old information. This can explain hindsight biases. For example, experimental subjects watched a video of basketball passes made by one team. In the video, a gorilla walks on for 40 seconds. One half of the subjects were oblivious to this (Simons and Chabris 1999, cited in Camerer *et al.* 2004a). O'Shea (2005) explains that we engage unconsciously in top-down sense, making using of our experience to recognize patterns that, on strictly objective terms, should be unfamiliar. For example, we can see a paragraph in which all the words are jumbled – with only the first and last letter retained in the right place, and still we can understand it. O'Shea illustrates with an example: "I cdnulot blveiee taht I cluod aulaclty uesdnatnrd waht I was rdgnieg. It deosn't mttaer in waht oredr the ltteers in a wrod aer, the olny iprmoatnt thing is taht eth frist dan lsat ltteer be in the rghit pclae…" (O'Shea 2005, p. 7).

Neuroscientific data and techniques

Economic decisions and choices can be analysed using a range of neuroscientific techniques including psychopathology, neuroimaging and brain stimulation, physiological measurement and genetic studies, as explored below.

Psychopathology studies

Psychopathology, the study of psychiatric disorders, can be used to make inferences about how the absence of normal function is related to particular neural systems and responses. The sort of abnormalities studied include brain lesions; mania (which leads to more unconventional behaviour if people are ignoring social signals); eating disorders, which link with testosterone – associated with risk tolerance; Huntington's Disease and Parkinson's Disease are associated with damage to dopamine neurons and reward structures; Alzheimer's, associated with loss of memory function; and autism, associated with constraints on empathy, amongst others. Insights about depressive illness have also been linked by economists to stock market performance, for example Kamstra *et al.*'s (2003) and Hirshleifer and Shumway's (2003) studies of the links between stock market performance, seasonal affective disorder and weather patterns.

Lesion patient studies analyse the behaviour of patients with lesions to specific brain structures in order to make some inferences about the function of that area. If a lesion in a specific area impairs decision-making in particular contexts, then it is inferred that this area is implicated.

As explored in Chapter 9 in the context of emotions and decision-making, lesion patient studies are particularly important to neuroeconomics because early studies by neuroscientists including Antonio Damasio established a link between brain damage and impaired financial decision-making function. He used these insights to develop the somatic marker hypothesis asserting that bodily signals guide action. Somatic markers are links between stimuli and somatic (in the body) emotional responses. Emotions become associated with past events and in new situations these learned emotional responses will guide behaviour. Antonio Damasio and colleagues have studied a range of lesions including lesions similar to Phineas Gage's (Damasio *et al.* 1996). For example, Adolphs *et al.*'s (1995) study of lesion patients revealed that amygdala lesions were associated with impairments of emotional processing, particularly fear processing. More recently, the amygdala is an area studied by neuroeconomists interested in negative emotional processing in risky situations, for example fear in financial markets, as explored in Chapter 15.

Neurometrics

Many neuroeconomic studies use neuroscientific techniques to map and measure brain function. Shibasaki (2008) analyses a range of neuroscientific tools used to capture brain activity in conscious subjects, either at rest or when undertaking cognitive tasks. Some, like electroencephalography, are more than 60 years old. In the last ten years, highly sensitive electronic, computer and imaging techniques have improved in accuracy, making non-invasive functional assessments of conscious brains an exciting and expanding area of neuroscience. These techniques can be divided into two groups reflecting different physical aspects of the functioning brain – electrophysiological and haemodynamic.

Electrophysiological methods draw on the fact that neurons transmit nerve impulses as electrochemical action potentials. Modern electroencephalography (EEG) can detect cerebral electrical activity (action potentials) as impulses pass to different brain regions. It can do so with great accuracy and with a temporal resolution of milliseconds. Sets of EEG scalp electrodes are easy to apply, subjects are comfortable and the equipment is relatively cheap. However, spatial resolution is poor so it can be difficult to map electrical activity to brain regions precisely.

Magnetoencephalography(MEG) is not dissimilar to EEG but requires a magnetically neutral environment which can be difficult to create in a behavioural experimental laboratory. More recently, it has become possible to stimulate brain areas non-invasively, using transcranial magnetic stimulation (TMS).

Haemodynamic techniques capture blood flows. The brain takes 15% of the blood supplied from the heart to the whole body in basal conditions. It uses a disproportionately large amount of energy compared to other organs, to support neuronal and synaptic activity, especially in grey-matter areas like the cortex and basal ganglia. Therefore, brain activity requires a constant supply of glucose and oxygen to maintain its metabolism. In turn, this requires an efficient system of arteries, capillaries and veins to provide blood at constant pressure and temperature. Reduced cerebral blood flow, low blood oxygen or glucose, and hypothermia quickly lead to loss of consciousness.

Functional brain imaging techniques map either blood flow, glucose and/or oxygen usage in different brain regions as experimental subjects are performing specific tasks. The maps can be superimposed on anatomical brain scans to give spatial resolution of active areas. For example, positron emission tomography (PET) depends on the emission of characteristic positron gamma rays from radioactive tracers within the brain. Special gamma cameras are needed to detect these gamma rays and radioactive material has to be injected intravenously during the scan. Positron-emitting water (15 oxygen H_2O) can be used to map cerebral blood flow and a positron-emitting glucose analogue (18 fluorine-deoxyglucose) can map areas of markedly increased brain metabolism. PET has the advantage that it can make quantitative measurement of activity in specific regions however, whilst it has good spatial resolution its temporal resolution is poor because of the rapid decay of radioactivity. Newer PET compounds, which bind to neurotransmitter receptors, can demonstrate the distribution of serotonin or dopamine in the brain. Though valuable for specific uses, PET is time-consuming, expensive and requires close access to a cyclotron to produce the short-lived positron radioactive tracers. Its use for cognitive studies is therefore limited (Shibasaki 2008).

Functional magnetic resonance imaging (fMRI) is another technique designed to capture brain activity whilst subjects are engaged in specific tasks. It has developed dramatically over the last ten years. It depends upon the physical principle that oxygenated haemoglobin in red blood coming from the lungs is magnetically different to deoxyhaemoglobin in blue blood whose oxygen has been used up. The change in signal from red to blue blood demonstrates the parts of the brain which are metabolically active and receiving larger amounts of blood oxygen. Functional MR images of the brain are therefore blood oxygen level dependent (BOLD). Functional images can be mapped easily onto standard anatomical images of the brain, which can be made in any plane, so that it is easy to identify activity in small brain regions such as the amygdala and hypothalamus as well as localized cortical areas. Functional MRI scans need high field magnets which are expensive, claustrophobic and noisy, so that it is initially difficult for the subject to perform cognitive tasks. Also, it can be difficult to interpret the data because a BOLD signal response may be capturing an inhibitory response, not an excitatory response. However, fMRI is safe and does not use X-rays or radioactive tracers, so scans can be repeated.

In brain-imaging studies information is usually communicated visually in the form of a brain "map" identifying significant areas based on the average of structural images from all subjects in the sample. An example of an fMRI scan is shown in Figure 11.4

This scan captures fMRI differential activation in the visual cortex in response to a complex moving visual stimulus versus a rest condition (viewing a black screen).

Brain images can also be mapped from the specific plane or perspective of the scan, as illustrated in Figure 11.5.

The planes are named using visual associations. The sagittal plane captures the direction of an arrow flying into the face (from sagitta, the Latin for arrow) and is the vertical plane through or approximately parallel to the nose towards the back of the head. The coronal (=crown) plane slices vertically through the crown of the head from the top of

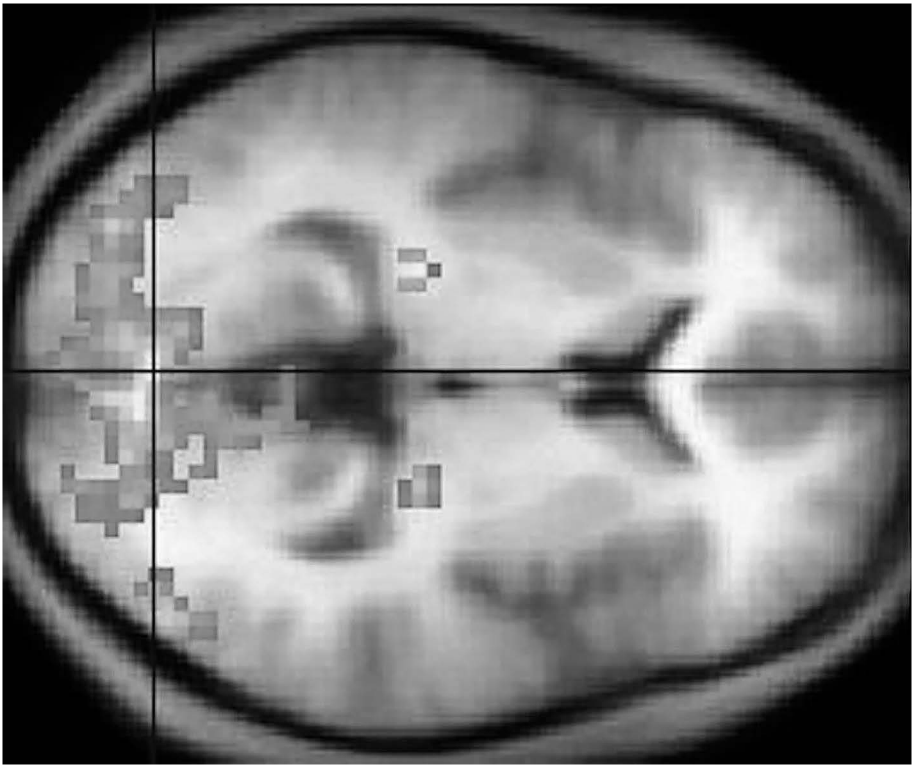

Figure 11.4 An fMRI scan
Source: Washington Irving on Wikipedia, copyright disclaimed

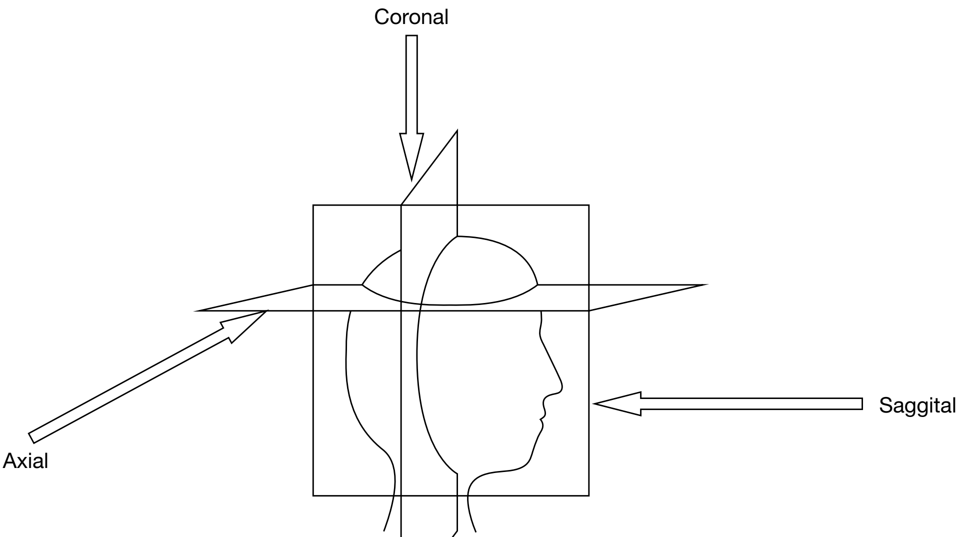

Figure 11.5 Planes of the brain

the skull towards the spine and perpendicular to the tip of the nose. The horizontal or axial (=axe) plane is from the front to the back of the head, as if the top of the head has been cut off with an axe.

Overall, despite their sophistication, brain imaging techniques are not infallible. Some critics observe that just because an area of the brain is picked up within a scanner does not mean that it is the primary area responsible for functioning. There may be other areas, systems and processes involved and it can be difficult precisely to attribute causality using some neuroscientific techniques. Choosing which neurometric techniques to use will depend on the questions to be answered and the availability of equipment. For cognitive psychological studies, such as those used in neuroeconomics, a combination of EEG or MEG studies mapped onto fMRI scans might represent a good compromise in terms of accuracy and cost-effectiveness.

Brain stimulation

It is difficult to establish causality with brain imaging techniques but other neurophysiological techniques including brain stimulation, are less susceptible to this limitation. Brain areas can also be directly stimulated in a number of ways. Transcranial magnetic stimulation (TMS) involves electromagnetic induction to temporarily activate specific areas of the brain and has been used in neuroeconomics to study empathy and trust (e.g. Baumgartner et al. 2011). The brain can also be studied directly using electrical brain stimulation (EBS) – the direct stimulation of neurons using electrodes. EBS studies show that rats and drug addicts will work hard for EBS and will trade other rewards for EBS (Camerer et al. 2005).

Physiological techniques

Psychophysiological measurement includes measurements of involuntary bodily responses including eye movements or "saccades", heart rate, blood pressure, galvanic skin response (GSR), sweating response, pupil dilation and facial musculature. Neurophysiology can also be used to inform the use of drugs, for example alcohol affects specific neurotransmitter systems associated with stress and reward. Impacts of administering or measuring hormones can also reveal some of the neural correlates of decision-making, as identified by Zak and colleagues in their studies of oxytocin (for example Zak et al. 2005) and by Coates and Herbert in their studies of testosterone and financial risk-taking (for example Coates and Herbert 2008; Herbert 2018) – as we will explore in more depth in Chapter 12

Genetic analysis

Economists are increasingly interested in the genetic correlates of behaviour. With the human genome project, our knowledge of genes and their make-up has grown rapidly, and Blumenthal-Barby et al. (2015) have highlighted how important it is to bring insights from behavioural economics into genetic research. Before then, the main method for testing genetic influences was twin studies, which exploited the fact that some twins are identical or monozygotic (twins from the same egg and sharing the same DNA) and others are non-identical or dizygotic (from different eggs). When identical twins are separated at birth it is possible to make inferences about the influence of genes versus environment according to differences later in life. There are limitations with twin studies however, and the perennial question of whether to attribute these differences to nature or nurture remains unresolved.

With the human genome project, it became possible to investigate the genetic correlates of behaviour in a lot more depth and to link phenotypes and polymorphisms, including individual characteristics such as personality traits and risk preferences, with a person's genotype or genetic make-up. Another way to correlate behaviour with genetic information is via gene "heat maps" which capture the level of gene expression. Genotypes determine the level of gene expression and give rise to phenotypes depending on the level of gene expression and gene heat maps pick up the level of expression of genes, for example by linking features of DNA with observed behaviour such as risk-taking. Studies have also been done linking genotypes to neural activations. Haynes finds that variability in risk preferences is associated with particular genotypes which, in turn, are associated with differences in amygdala activation (Haynes 2011).

What is neuroeconomics?

Now that we have set out some of the relevant principles and techniques from neuroscience, we can start to explore how neuroscience and economics come together in the relatively novel sub-discipline called *neuroeconomics*.

Neuroeconomics brings neuroscientific tools and insights together with behavioural economics. As a discipline, it has emerged from recognition by behavioural economists and economic psychologists that cognition and perception amongst real people does not fit the strict model of rational behaviour, especially when perception does not match an objective reality. The problem can be to establish an objective scientific basis for cognition and perception and neuroeconomics offers a solution. Whilst behavioural economics is distinct and perhaps less controversial than the growing field of neuroeconomics, neuroeconomics is, in essence, a development of behavioural economics but one which focuses (largely) on insights and techniques from positivist, objective analyses of neuroanatomy and neurophysiology. Some would argue that the approach is too reductionist – human behaviour is more complex than can be captured just by studying brain function; others argue that neuroeconomics isn't really economics, as explored in the controversies section below.

Camerer *et al.* (2004a, 2005) give some good early surveys of the essential ideas, tools and techniques. Neuroeconomics applies the tools, insights and findings from neuroscience and biological psychology to the analysis of economic decision-making. It is an eclectic approach combining and extending methods from behavioural and experimental economics with those from neuroscience and psychology, including experimental, evolutionary, cognitive, ecological and social psychology.

Neuroeconomic data

Neuroeconomics offers an answer to the economist William Stanley Jevons' scepticism about capturing feelings. Neuroeconomics offers methods of measurement – blunt ones, admittedly, at this stage, but as techniques increase in sophistication finer measurement will become easier (Camerer *et al.* 2005; Camerer 2007). Rustichini (2005a,b) agrees that neuroeconomics provides new data and methods to test useful predictions about various aspects of economic behaviour including incentives, preferences and feasibility constraints, and to explain deviations from the axiomatic theory of subjective expected utility.

Neuroscience offers alternative *objective* methods of measurement. Money as a measure has limitations: it has its own utility and various neuroscientific studies have shown that it is directly rewarding in itself, which raises the question of how to separate the utility of money from the utility of the things that money buys. Studying neural responses can illuminate questions of value that may be less prone to some of the contradictions implicit in using monetary measures of value.

Neuroscientific measurement is also more direct and therefore more reliable than self-report (Camerer *et al.* 2005). Neuroeconomics can identify empirical links between games and choices and can provide more insight than revealed preference theory provides.

Neuroscientific techniques can add precision because knowing the neural mechanisms helps to explain the behaviour. For example, the fact that raising oxytocin "exogenously" increases trustworthy behaviour enhances our understanding of how hormones affect moods and behaviour. The recognition in neuroscience that choices are not predetermined, and that biological states affect choices, deepens our understanding of choices especially as choices do not necessarily reflect preference.

Neuroscience can also deepen our understanding by identifying when the same brain circuitry is involved in apparently distinct economic and financial decisions. If there is a common neural correlate, then this may reflect the fact that similar systems are engaged in different types of decisions. For example, the insula is activated when people feel that they have been treated unfairly in experimental games. It is also activated with ambiguous gambles and with poor strategic thinking. Some common mechanism may be unifying seemingly distinct behaviours.

Whilst the prospects for neuroeconomics and its tools may look promising, it is nonetheless important to recognize the limitations. The field is young. Tools are new and relatively crude. Just because we can measure neural activations does not necessarily imply that we can directly measure thoughts and feelings (Huang 2005).

Neuroeconomic models and theories

Whilst neuroscientific tools offer neuroeconomists new measurement methods, neuroeconomics offers more than a toolkit. It may help us to understand the links between brain and economic behaviour. Neuroeconomists emphasize, in particular, the importance of consilience and dual systems thinking, as explained below.

Consilience

Consilience represents the fact that neuroeconomics is an eclectic approach bringing neuroscience together with economics, evolutionary psychology, cognitive psychology, behavioural psychology/ecology and social psychology to form a general theory of human behaviour, possibly allowing the development of a unified approach. Glimcher (2011) and Glimcher and Rustichini (2004) envisage neuroeconomics as a unifying mathematical theory. Economics brings the analytical structure of decision theory, psychology brings the deeper understanding of cognition and emotion, and neurobiology the study of mechanism. Similarly, Camerer et al. (2004a, 2005) suggest that neuroeconomics has the power to unite apparently disparate subjects: "Anthropologists emphasise acculturation. Psychologists emphasise cognition and contexts. Sociologists emphasise social norms and constraints. [Most] Economists emphasise rationality. Neuroscience has the power to unify them all" Camerer et al. (2005).

Glimcher, Dorris and Bayer (2005) focus on understanding how the neural architecture generates decisions. Just as neuroscience can illuminate economic questions, economics gives ideas and theories for neuroscience, for example the insights from microeconomics and game theory about models of strategic thinking, mixed strategy equilibrium and subjective expected utility theory. Overall, Glimcher et al. (2005) conclude that is a two-way exchange filling important gaps: economists have overly simplistic views of brain function; neuroscientists have underestimated the complexity of human decision-making. Unifying economics and neuroscience may provide better answers if the disciplines can engage in effective dialogue.

Empathy and theory of mind

In developing these theories, one theme that receives a lot of attention in neuroeconomics is the role of empathy in economic decision-making, and this links to literatures on social motivations and models from behavioural game theory, as well as theories of social influence, as explored in Chapter 8. A key concept in these models is the concept of *theory of mind* (ToM). ToM involves making inferences about the beliefs, feelings and action of others (Frith and Frith 2003; Camerer *et al.* 2005). 'Mentalizing' involves guessing what others will do. Social emotions such as empathy play a role in theory of mind. Theory of mind may be associated with a special "mentalizing" area controlling reasoning about others' beliefs and actions are associated with increased activation in Brodmann area 10 when playing games involving trust, cooperation and punishment (McCabe *et al.* 2001). Autistic patients are thought to have deficits in Brodmann area 10 and about a quarter of autistic adults offer nothing in ultimatum games, perhaps because of empathetic deficiencies (Sally and Hill 2006). There is also evidence that cognitive control has evolved within a social context. Research shows that human children and chimpanzees use similar cognitive skills when dealing with physical tasks but human children have more sophisticated cognitive skills when dealing with social tasks, including social learning and theory of mind (Herrmann *et al.* 2007).

A lot of economic action, especially in a strategic context, involves mentalizing. Similarly, empathetic behaviour may lead to herding and imitation when people make decisions on the basis of mentalizing responses and there is some experimental evidence to support this. Singer and Fehr (2005) argue that mentalizing and empathizing explain people's responses to situations involving incomplete information. Singer *et al.* (2004) reveal that empathizing with the pain of others activates areas associated with the affective processing of pain. They also confirmed that individual differences can play a role. They found heterogeneity in empathetic abilities across people.

It is possible that humans have a "mirror system" that helps us to understand the actions of others and the analysis of mirror mechanisms parallels elements of the analysis of sympathy and empathy in Adam Smith's (1759) *Theory of Moral Sentiments* (Sugden 2005). There are different conceptions of sympathy: Smithian sympathy draws on insights from *The Theory of Moral Sentiments*, especially ideas about the role played by feeling sympathy in ensuring societal stability. Introspection in games can also be explained in terms of sympathy: sympathy allows the individual introspectively to consider the actions of others.

Experiments on monkey imitation show that monkeys' socialized instincts are propelled by the activity of mirror neurons. These ideas have been extended to describe human instincts to follow others as the outcome of mirror neuron activity (Rizzolatti *et al.* 2002; Rizzolatti and Craighero 2004; Iacoboni 2005) though analysis of the role played by the mirror system in a human context is limited by the fact that the single neuron experiments required to verify mirror neuron theories cannot easily be conducted on human subjects for ethical reasons. Rustichini (2005a) focuses in particular on sympathy, drawing on ideas from neuroscience about mirror neuron systems, as explored above. Sympathy is an affective state but it is also sophisticated, not naïve (see also Glimcher *et al.* 2005).

Dual systems thinking

Neuroeconomic theories make an important general contribution to economic theory in offering alternative ways of modelling behaviour that are less dependent on the strict, monolithic versions of rationality seen in standard mainstream approaches. Neuroscience is not dependent on simple distinction between rational and irrational – a limitation that has in many senses plagued the development of economic theory. Glimcher uses a metaphor of a clockwork digesting duck, constructed by 18th-century French inventor Jacques de Vaucanson. Glimcher observes that mainstream economics often assumes that we process information as if we are mathematical machines, as if we were Vaucanson's clockwork duck (Glimcher, 2003). In reality, human cognition is more complex.

One way to capture this complexity is to take a multiple systems approach focusing on the insight that the brain is composed of different interacting systems. Some neuroeconomic analyses take Plato's metaphor from classical philosophy. Behaviour is like a chariot pulled by two horses of appetite and spirit, guided by the "charioteer" of reason (Glimcher 2003). Neuroeconomics abandons the strict dichotomy between the rational and the irrational, for example neuroscientists recognize the important role played by emotions in guiding decisions, an issue explored in the context of Damasio's somatic marker hypothesis (Damasio 1994/2006). Overall, neuroeconomics presents a model of the interconnected mind in which choices are not strictly dichotomous and the world is not understood in terms of black and white. Rather, there are shades of grey as different functions and areas interact and interconnect. The brain is not just the sum of its parts.

Daniel Kahneman – whose work with Amos Tversky on heuristics, bias and prospect theory forms an important foundation for behavioural economics, as we explored in Chapters 3 and 4– sets out some important insights about how cognition and emotion come together. Kahneman's cognitive maps are a development of his collaborations with Tversky on heuristics and biases (e.g. Tversky and Kahneman 1974) and prospect theory (e.g. Kahneman and Tversky 1979). If behaviour is strictly rational in a standard economic sense, then fast thinking in the form of heuristics has no place and biases are ruled out.

Dual-system models: System 1 versus System 2 thinking

These ideas from Kahneman form the foundation for his influential analyses of System 1 versus System 2 thinking. Kahneman's structure of how different thinking systems interact links to Romer's (2000) distinctions between decisions based on thoughts and decisions based on feeling. Kahneman draws on early psychological analyses of systems thinking – including interactions between cognition and emotion, and between controlled versus automatic systems. Schneider and Shiffrin (1977) Stanovich and West (2000). Building on his maps of bounded rationality in Kahneman (2003), Kahneman (2011) maps a structure for thinking processes which blends elements that fit relatively well with standard economic conceptions of rationality with emotional drivers to set out an architecture of thinking systems. Kahneman (2003) maps the brain into two different brain systems: System 1 (automatic, quick, intuitive) and System 2 (cognitive, deliberative, controlled). There are different systems for emotion and deliberation and these are associated with automatic versus controlled processing. Emotions are the low-level physiological processes that rapidly elicit stereotyped and valenced behavioural responses, engaging different neural structures than those engaged during cognitive processing. Sanfey *et al.* (2006) also argue that economic behaviour can be understood in terms of "dual process models" which make a distinction between emotion and deliberation.

The essence of each system is that System 2 is about thinking via reasoning and System 1 is about deciding via intuition. System 1 includes cognitive operations which are spontaneous, effortless and fast. They operate automatically and are often affected by emotions and habit. System 1 processing is not deliberative in nature and this, together with the impact of emotions and visceral influences, means that System 1 operations are difficult to control. System 2 processes are effortful and rule-governed. They reflect deliberation and control and, whilst they operate more slowly than System 1 processes – because they are the outcome of careful conscious thought, they are more flexible and adaptable. Automatic functions are quicker and therefore more neurologically efficient. Controlled functions are slower but more deliberative and careful. On a basic level there will be primacy of affect: "affect gets there first" because affective systems are designed to ensure survival and therefore evolve in response to selection pressures. Emotions and visceral factors will play varying roles depending on the level of emotional intensity. At low levels of emotional intensity, affect is advisory. At medium levels, conscious conflict is resolved via effort (e.g. self-control). At high levels, affect is overpowering. However, in the battle between affect and cognition, the winner takes all and whether the winner is affect or cognition will be determined by the context.

The interactions between these different systems is not a manifestation of irrationality: emotional and cognitive systems can operate together and emotional systems may have evolved as effective adaptations to past environments and circumstances. Insights about these interacting systems are important in understanding choices and behaviour. There will be coordination of affect and cognition reflecting the interaction of different neural areas in economic decision-making. For example, lesions to the anterior cingulate cortex (ACC) are associated with dampened emotional responses, for example in card gambles, perhaps because the coordination of affective and cognitive processes has been disconnected (Bechara *et al.* 1997). Other evidence that emotional and cognitive systems interact is seen in social decision-making. When people feel that they have been treated unfairly, this creates conflicts between cognition and emotion. Neural tussles have also been observed in brain imaging studies of inter-temporal and social decision-making, as we will explore in Chapter 12. Specifically, in neuroeconomic analyses of decision-making, dual systems approaches have been developed to reflect emotional intensity in economic decision-making, for example Bernheim and Rangel's models of "hot" versus "cold" systems in addiction, and Brocas and Carillo's (2008) conception of the brain as a dual system prone to conflicts in the face of asymmetric information, impatience and misaligned incentives.

Cognition dominates with effortful cognition and studies show that emotional reactions can be blocked by deliberative thinking. Experiments exploring students' preferences for posters have shown that students will appreciate the posters on their walls less if they've had to think too carefully about why they like them; emotions will affect memory and dominate cognitive processes in wishful thinking (Wilson and Schooler 1991; Camerer *et al.* 2004a, 2005; Urry *et al.* 2006). Also, cognition often dominates in perception in top-down sense-making. We fit the world into our expectations of it, sometimes imagining order where there is none and missing unexpected changes (Camerer *et al.* 2005).

Dual systems: evolutionary influences

Why have these dual systems evolved? Evolutionary themes are particularly relevant to dual-systems models and neuroscience more generally too. They can explain why the instinctive affective system interacts with the deliberative cognitive system. Human behaviour is often a compromise between highly evolved animal emotions and instincts and more recently evolved human deliberation and foresight (Loewenstein 1996). Dual systems can also be understood in evolutionary terms by analysing which areas of the brain are associated with specific functions – linking to the insights about the evolution of brain structures, as introduced earlier in this chapter. Higher-level, recently evolved cognitive functions are more general and flexible and are used in reasoning and planning. These may be a "critical substrate for the standard economic conception of a rational '*homo economicus*'" (Cohen 2005). Cohen also postulates that increased capacity for reason and control was associated with the development of specific areas of the brain, in particular the prefrontal cortex, and this reflected adaptations to profound changes in the social as well as physical characteristics of human environments.

Ironically, this may have generated social and evolutionary instability because ancient emotional responses were less well-adapted to modern conditions than ancient environments: the development of technologies may have accelerated the maladaptation of old emotional processes. For example, limbic structures in the brain are often associated with impulsive emotional responses and these may have been appropriate in a world in which immediate rewards were important. In primitive environments, basic resources were scarce and perishable and so quick, instinctive action was essential to avoid starvation; but in a modern context, these instincts may not serve a useful purpose and may in fact generate perverse behaviour such as addiction. Cohen argues that more recently evolved areas of the brain, including the prefrontal cortex, have developed to interact effectively with older structures in circumstances in which our emotional mechanisms are not well-suited. In this way, we can override inappropriate emotional responses using control and reasoning. Evolution has "vulcanized" the brain, increasing its strength and resilience. Reason and control have balanced primitive emotional responses, for example by allowing humans to develop pre-commitment devices such as savings plans and nicotine gum, to moderate the influence of impulsive, self-destructive emotional decision-making (Cohen 2005).

Dual systems thinking in neuroeconomic analyses

A number of neuroeconomic models and theories develop the idea that economic decisions can be explained in terms of dual systems processing, focusing on the neural correlates of interactions between deliberative/cognitive and automatic/affective systems (e.g. see Camerer 2007; Camerer *et al.* 2004a, 2005; Rustichini 2005a,b; Loewenstein and O'Donoghue 2004). Also, Glimcher and Rustichini (2004) focus on the dual roles of emotion and reason as manifested in the consilience of economic and neuroscientific approaches to decision-making. Frith and Singer (2008) develop ideas about the interaction of reason and emotion in a socio-economic context. When social motivations and emotions compete, they propel our sense of fairness, altruistic punishment, trust and framing effects.

Distinguishing between automatic emotional systems and deliberative cognitive systems is also an essential theme in neuroeconomics, particularly in neuroeconomic analyses of emotional processing. Concepts from neuroscience can be used to capture these interacting neural systems and to reconcile emotional versus cognitive and controlled versus automatic processes (Camerer 2007; Camerer *et al.* 2004a, 2005; Cohen 2005):

> The neuroeconomic theory of individual replaces the (perennially useful) fiction of a utility maximising individual which has a single goal, with a more detailed account of how components of the individual – brain regions, cognitive control, and neural circuits – interact and communicate to determine individual behaviour.
>
> (Camerer 2007)

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The main lesson to be taken from this chapter is that psychology and neuroscience have a lot to offer in extending economists' understanding of these influences. Interdisciplinary approaches bringing together psychology, neuroscience and economics remain controversial amongst economists, however. Whilst neuroeconomics as a discipline is growing rapidly, it has confronted significant scepticism, particularly initially. Perhaps this reflects the fact that economists used to working with abstract, parsimonious mathematical models regard neuroeconomics as rather too alien and quirky in its approach. Some economists working within a standard approach argue that embedding a deeper understanding of what underlies observable choices and decisions is an anathema. For them, the focus should be on objectively measurable data and for many mainstream economists this is observed choice.

This point is debatable however, especially as the increasing sophistication of neuroscientific techniques means that simple choices are no longer the only phenomena which can be measured objectively. There is an enormous, highly regarded neuroscientific literature on decision-making. Neuroeconomists are just drawing parallels between the neural responses seen whilst people are making *economic* choices with established neuroscientific evidence about what people are doing when making other sorts of choices. Neuroscientists have established that rewards such as food, addictive substances, and so on, activate dopamine pathways. It is not such a leap to infer that money, as a reward, is activating similar pathways, allowing neuroeconomists (carefully) to consider similar inferences about making money that a neuroscientist might make about eating food. At their best, models and data collection techniques from neuroscience allow us rigorously and scientifically to test hypotheses about the cognitive and/or emotional decision-making systems implicated in economic decision-making.

Gul and Pesendorfer (2008) make a case for "mindless economics", justifying approaches that treat the brain as a black box and concentrate just on observed choices. They criticize (their perception of) the focus in neuroeconomics on physiology and psychology and neglect of utility and choice. Ironically, this seems essentially to be a *normative* critique from a *positivist* perspective. There *are* neuroeconomists, and an increasing number of them. Are Gul and Pesendorfer saying that there *shouldn't* be? Camerer (2008) responds by making a case for "mindful economics" justifying the role of non-choice data in developing analytical models of choice. He illustrates with a range of examples and argues that boundaries between disciplines do not need to be as sharp as Gul and Pesendorfer suggest.

In resolving some of these tensions, Glimcher (2011) observes that neuroscience and economics can appear to have little in common because they focus on different "primitives": the primitives in neuroscience are brain activations, neurons and synapses; primitives in economics include choice, preference and utility. Links between them can be forged however because, potentially at least, there are common elements, for example neural activations in the medial prefrontal cortex can link choice to expected utility. Behaviour is the unifying phenomenon. Neuroeconomists are starting to make some inroads with approaches that combine the primitives from the difference disciplines, for example Fehr and Rangel's (2011) analyses of the links between choice, experienced utility and neural responses. There is significant added value to be found in combining theoretical and empirical insights from neuroscience, psychology and economics.

Caplin and Dean (2008b) also defend neureconomics against Gul and Pesendorfer's critique which they interpret as having two elements: first, the assertion that economic models are only designed to illuminate choice and so data which is not about choices is not a good test of economic models; and second, the assertion that economists are interested in choice and so won't be interested in models that cannot be differentiated on the basis of choice data.

Caplin and Dean argue against this conception of neuroeconomics via a couple of illustrations. First, in models of information search, any set of choice data can be reconciled using a simple model of information search. Standard models cannot differentially capture observed choices. On the other hand, a behavioural model incorporating inconsistencies and biases from behavioural economics can discriminate different choices. Second, Schultz *et al.*'s (1997) analysis of reward prediction error can be used to construct an objective neuroeconomic model of choice. Dopamine neurons encode reward which can be linked to utility and thus to a model of choice.

Neuroeconomic models of reward prediction error from Schultz onwards provide the basis for testable predictions about choice. Also, many economists from a range of perspectives would probably agree that an economist should not be forced exclusively to focus on observed choices, especially as neuroscientific techniques are developing to enable objective measurement of the physiological processes propelling decision-making. If economics is to be useful, understanding that the same choices may be propelled by different factors is important. Adjusting an example from Romer (2000) and Camerer *et al.* (2005), if I offer someone a peanut and they choose not to take one, it is important that I know whether their choice merely reflects a dislike of peanuts versus the knowledge that it will induce a life-threatening allergic reaction. The difference is important. Just observing choices, as is the tradition in mainstream economics, misses out important information that could guide us in making good decisions. Data from neuroeconomic experiments can start to fill these gaps.

Unifying scientific disciplines does have a better historical pedigree than Gul and Pesendorfer admit. Other disciplines also have more in common than their separation into silos might imply. Glimcher (2011) notes the development of consilience between chemistry and biology in the early 20th century. Also, whilst there has always been an objective link between our physiology and the physics of the material world around us, historically, physicists and medical physicians operated independently until the development of medical technologies, particularly imaging technologies, enabled the integration of physics and medicine (H. Baddeley 2008). So the path of scientific analysis can and does change as research technologies evolve. Similarly, as the techniques for monitoring our neural responses improve we will be able to link economic decision-making with brain function and that will allow us properly to break down the barriers between economics and neuroscience.

Chapter summary

- Neuroeconomics brings together insights from neuroscience and economics to construct a transdisciplinary subject, i.e. a subject that blends together different insights from existing subjects into a whole new subject.
- Economics contributes an analytical structure around which insights from neuroscience can be tested.
- Neuroscience contributes tools and techniques for the measurement of neural activations during economic and financial decision-making, opening the "black box" of the brain so that economists no longer have to rely just on observed choices for evidence.
- There are a wide range of techniques used – the most well-known is probably neuroimaging but there are a number of other techniques too, varying in expense and sophistication.
- Theoretical insights from neuroscience have also been used to enhance economists' models – especially by analysing emotions more comprehensively in multiple-system models.

Revision questions

1. What is neuroeconomics and how does it blend insights from economics and neuroscience?
2. What are some of the advantages and disadvantages of combining two such disparate disciplines?
3. Why has economics traditionally and historically been forced to analyse the brain as if it is a "black box"? Explain how neuroscientific tools can be used to resolve these limitations.
4. Many economists are critical of neuroeconomics specifically and behavioural experimental economics more widely. Do you agree? Explain your answer.

Chapter 12

Neuroeconomics II

Evidence

How do neuroeconomists use neuroscientific tools to explore what drives our decision-making? In the previous chapters, we set out some of the techniques that neuroscientists use, and the links between insights from neuroscience and economics. How useful are these insights in practice? Neuroeconomics can do much to unravel how our brains process complex decisions – especially when we are faced with conflicts between cognitive and emotional influences. To illustrate some of the ways in which neuroeconomists explore these themes, in this chapter we will outline some case studies – including neuroeconomic analyses of prospect theory, time inconsistency, addiction, learning, social preferences and social emotions.

Neuroeconomic analyses of prospect theory

As we saw in Chapter 4, reference points are a key element of Kahneman and Tversky's prospect theory and some neuroeconomic studies have focused on the neural activations associated with reference points. In these studies, insights from neuroscience can be embedded into the analysis to improve our understanding of some of these characteristics of decision-making under risk, as explored in prospect theory. Using biological/physiological metaphors and physiological principles, Kahneman and Tversky argue that, physiologically, we are adapting all the time to change. Biologically, homeostasis, the internal bodily equilibrium, is the reference point. Generally, physiological responses are a concave function reflecting diminishing marginal responses. If we hold our hand in cold water, for example, then the initial impact on our comfort of a degree change in temperature is likely to be large. As the water gets warmer, however, our comfort will increase at a decreasing rate, at least until the shape of our utility function shifts again, for example when the water temperature starts to approach boiling point. Feelings of pleasure and pain reflect departures from the homeostatic setpoint. Perception adjusts to restore homeostasis via a process of alliesthaesia – the temporary distortion of preferences which occurs as the body attempts to restore equilibrium, for example placing a hand in warm water feels good when it's cold weather but uncomfortable in very hot weather (Camerer *et al.* 2004a, 2005). Overall, biological principles of homeostasis and alliesthesia reflect the fact that perceptions are relative and Kahneman and Tverksy argue that the same principles apply to people's evaluation of monetary changes. Economic choices are driven by changes in the same way that perception and judgement are driven by changes. Kahneman and Tversky are saying that a similar phenomenon affects thinking and decision-making which means that changes are more important than levels.

Other neuroeconomic analyses of prospect theory have analysed the evolutionary roots of decision-making by exploring the behaviour of our close relatives. Chen *et al.* (2006) examine the behaviour of capuchin monkeys exploring whether or not they behave according to the law of demand and also assessing the degree of reference dependence and loss aversion in their choices. The capuchins were given a fiat currency in the form of coin-like disks which they were conditioned to associate with food rewards; they could exchange these coins for rewards. They found that the capuchins did adjust their purchases to wealth and price shocks and, in this, the capuchins' behaviour fitted with standard economic models.

However, when the information was framed in terms of gains and losses, the capuchin monkeys' choices exhibited signs of reference dependence and loss aversion, as predicted by prospect theory. They chose gambles in which payoffs were framed as gains but rejected gambles in which payoffs were framed as losses – even though the actual payoffs were identical in both scenarios. A similar study identified a reflection effect. When presented with a potential gain in terms of food rewards, the monkeys preferred to avoid risk but when facing a potential loss they were more prepared to gamble and take risks (Santos and Chen 2009). The fact that monkeys and humans behave in similar ways suggests that some common evolutionary mechanisms underlie behaviour in both species.

Windmann *et al.* (2006) studied the Iowa Gambling Task (IGT) in standard and inverted form. For the standard IGT, subjects are presented with decks of cards and each time they pick a card they usually win a small reward but for some cards they incur a punishment. The decks are constructed so that there are some bad decks (incurring a net loss in the long run) and some good decks (awarding a net gain in the long run). Normal subjects usually learn to identify the good decks reasonably quickly. Windmann *et al.* studied subjects playing the standard IGT (in which good decks involved taking small constant rewards to avoid large punishments) and also an inverted IGT (in which the good decks involved taking large constant punishments for large rewards).

They used fMRI to capture activations and identified asymmetries in orbitofrontal cortex activations. For the inverted IGT incorporating large constant punishments to obtain large rewards, orbitofrontal cortex activations, associated with emotional processing of reward, were greater for the rewards than punishments. In some cases, for the standard IGT, the activations were reversed with differential orbitofrontal activations for rewards versus punishments. This suggests similar value responses for rewards in the inverted IGT and punishments in the standard IGT and this result is consistent with the S-shaped form of Kahneman and Tversky's prospect theory value function, as illustrated in Chapter 4 in Figure 4.2.

Neuroeconomic analyses of time inconsistency

We set out the key principles of different behavioural models of time discounting in Chapter 7, and some of the key principles from these models of time inconsistency can be captured using neuroeconomic analyses. In this context, neuroeconomists have used a series of brain imaging studies – though the findings from these studies can be interpreted in different ways, as we shall see.

One of the seminal neuroscientific studies of choices over time is McClure *et al.* (2004). They look at fMRI evidence on the neural correlates of time discounting. Experimental subjects were offered a series of monetary reward choices varying by delay to delivery. McClure *et al.* test for the involvement of two separate neural systems: first, the limbic system including the midbrain dopamine system, particularly the paralimbic cortex which is preferentially activated for decisions involving immediately available rewards; second, the lateral prefrontal cortex and posterior parietal cortex activated for all inter-temporal choices (irrespective of delay). They find greater relative activation of fronto-parietal cortex when subjects choose longer-term options.

In constructing their analysis, they draw on one of Aesop's fables – the story of the ant and the grasshopper. The ant works hard all summer long collecting food for the winter whilst the grasshopper sings away the summer amusing himself. This fable illustrates the conflict between impulsive desires to consume now versus recognizing the future benefits of patience. As explained above, existing evidence shows large discrepancies between time discounting in humans versus other species. There is limited evidence that other animals make inter-temporal choices deliberatively (according to McClure *et al.*). Consumers behave impatiently today but are prepared to plan for the future: if given the choice between \$10 today and \$11 tomorrow, most choose the former; but given a choice between \$10 in a year and \$11 in a year and a day, most choose the latter. As introduced in Chapter 7, this generates dynamic inconsistency: inter-temporal choices are not discounted exponentially and rewards available in the immediate future are valued disproportionately consistent with impulsive preference reversals

In terms of background neuroeconomic evidence, lesion patient studies show damage to the prefrontal cortex is associated with more impulsive behaviour. As explained in Chapter 7, quasi-hyperbolic discounting functions that splice together two different discounting functions by incorporating the present bias parameter β into an exponential discounting specification provides a good fit to experimental data. McClure *et al.* develop this approach to assess the role of different neural systems involved in inter-temporal decision-making. They set out their $\beta-\delta$ model following Phelps and Pollack (1968) and Laibson (1997). The present discounted value of a future reward is equal to the standard discount factor multiplied by the present bias parameter β. This means that more immediately available rewards are valued relatively highly. Their neuroeconomic evidence shows how the discrepancy between short-run and long-run preferences reflects differential activation of distinguishable neural systems and they hypothesize that distinct neural processes are interacting in the following way: short-run impatience is associated with a *beta* system and is mediated by limbic structures; long-run patience is associated with a *delta* system and is mediated by the lateral prefrontal cortex and associated structures – with higher cognitive functions associated with evaluation of trade-offs between abstract rewards.

They test their hypothesis using an fMRI imaging study in which they scan participants making inter-temporal choices between early and later monetary rewards. Immediate rewards activate the beta areas, that is, the classic limbic structures associated with the midbrain dopamine system – including the ventral striatum, medial orbitofrontal cortex and medial prefrontal cortex, also implicated in processing reward expectation/delivery. Choices involving delayed rewards, that is, the delta system, are associated with activations in the lateral prefrontal cortex and also in the primary visual and motor cortices. These delta areas were differentially activated for longer-term choices but not for more immediate rewards. As expected, visual/motor cortices were activated, as in most decisions.

McClure *et al.* also screened delta areas for the difficulty of tasks by comparing activations when the inter-temporal differences in monetary amounts were relatively small and so harder to process. They identified differential activations in the frontal and parietal cortex – areas implicated with higher-level cognitive functioning. This is consistent with findings about the role of the prefrontal cortex in deliberation and the parietal cortex in mathematical processing. They also found significant activations of the inferior parietal cortex and this is an area also engaged during numerical processing.

Their interpretation draws on insights from evolutionary biology and suggests that inter-temporal decision-making in humans, our unique capacity to postpone reward, is associated with higher cognitive functioning engaging the delta system. Overall, inter-temporal choice is the outcome of competition between lower-level, automatic processes reflecting evolutionary environmental adaptations (engaging the *beta* system) and a more recently evolved, uniquely human capacity for abstract planning (engaging the *delta* system).

Glimcher *et al.* (2007) present an alternative neuroeconomic interpretation to McClure *et al.* They analyse hyperbolic/quasi-hyperbolic discounting and agree with McClure *et al.* that it gives a better understanding of inter-temporal choice than exponential discounting models but reject McClure *et al.*'s $\beta-\delta$ model arguing that inter-temporal decision-making is not the outcome of an intra-personal conflict between a patient's long-term self and an impulsive short-term self.

They conduct two experiments. For their first experiment, they use ten human subjects, making 576–720 binary inter-temporal choices between payments with different waiting times. The responses were used to construct individuals' indifference curves and Glimcher *et al.* (2007) found that these were consistent with hyperbolic discounting. Glimcher *et al.* arranged payment via debit cards because these are nationally accepted, it is easy to monitor consumption with debit card information and transaction costs are negligible. One set of data was for three behavioural sessions per subject each offered 144 choices between certain, immediate gain of $20 versus a larger gain but with a delay of between six hours and six months. They scanned 1–2 additional sessions in a brain scanner.

From the behavioural sessions, they identified the amount of money at which each subject was indifferent versus an immediate reward of $20. Hyperbolic discount functions gave a better fit for these choices. They found considerable variation, up to an order of magnitude in rates of discounting between the most patient and most impatient subject. They used their estimates of the discount function to calculate the discounted utility of each delayed option for each subject. This was correlated with brain activation and they found clear correlation between estimates of discounted utility and brain activation in the medial prefrontal cortex, the ventral striatum (associated with processing reward) and the posterior cingulate cortex. But they found no evidence of differential activation in the beta areas identified by McClure *et al.*

Glimcher *et al.* conducted another experiment to investigate further. They used the same design as for their first experiment but with a 60-day front-end delay to prevent impulsive decision-making. The results from both the behavioural and scanning data were the same as for their first experiment showing significant activations in the ventral striatum and anterior/posterior cingulate cortex but no differential activation in the limbic system. Immediate, potentially impulsive choices were no more hyperbolic than choices involving delayed rewards of at least 60 days. Contrary to McClure *et al.*'s findings, they argue that their study does not support the hypothesis that discount functions are the product of multiple selves within the human brain. Glimcher *et al.* argue that dynamic inconsistency is not about impulsiveness, it's about getting things as soon as possible – perhaps reflecting temptation rather than impatience. More generally, they argue that neurobiology is most useful in helping us to understand the revealed preference approach in terms of the algorithmic structure of the brain.

Neuroeconomic analyses of addiction

In Smith and Tasnádi's (2007) study, presented in Chapter 8, they emphasized the role of dopaminergic pathways. They also noted that insula plays a role in conscious feeling by anticipating bodily effects of emotional events so the insula may play a role in propelling addiction by anticipating the bodily effects of addictions such as smoking. Animal studies show that addiction in rats resembles human addiction and this suggests that human addiction is propelled by primitive reward circuitry engaging the dopaminergic pathways. Evolution may also play a role, raising the question: do addictive substances hijack primitive reward circuitry to create phenomena of reinforcement, tolerance, craving and withdrawal? There have been a range of neuroeconomic studies of addiction which illuminate some of these issues.

Naqvi *et al.*'s lesion patient study

McClure *et al.* (2004) (whose study of the neural correlates of time inconsistency we've explored above also) make the connection between present bias and addiction. Immediacy, impulsivity and drug addiction lead to similar activations of dopaminergic limbic structures.

This is explored in more detail in a neuroeconomic study of lesion patients by Naqvi *et al.* (2007). They argue that addiction reflects long-term adaptations. Many brain systems are implicated in addiction, such as the amygdala and nucleus accumbens. Citing fMRI evidence, Naqvi *et al.* observe that exposure to drug-associated cues activates the anterior cingulate cortex, the orbitofrontal cortex and the insula. They hypothesize that the insula is a critical neural substrate to addiction and therefore damage to the insula will disrupt addiction. Their focus on the insula is justified by the fact that it plays a key role in processing emotion and is associated with representation of bodily states/conscious urges/emotional feelings. Also, activity in the insula is shown to correlate with subjective cue-induced drug urges.

To test their hypotheses, Naqvi *et al.* conduct a lesion patient study of 69 lesion patients, all smokers, 19 of whom had insula damage – six patients with right insula damage and 13 with left insula damage. The remaining 50 smokers had lesions but no insula damage. From patients' responses to questionnaires about their habit they found that there were significant disruptions to smoking in four situations: first, if the subject had reported quitting less than a day after lesion onset; second, if they did not start smoking again after they quit; third, if they had low ratings on difficulty of quitting; and fourth, if they reported no urges to smoke since quitting. They estimated the probability of smoking disruption for insula damage patients and non-insula damage patients and estimated an odds ratio of 22.05 with a probability value of p=0.0005 so quitting smoking was 22 times more likely if a patient in their study had an insula lesion versus a lesion elsewhere.

Specifically for the extent of smoking disruption in quitters: 12 of 13 insula patients had smoking disruption; 4 of 19 patients with non-insula damage had smoking disruption giving an odds ratio of 136.46 [p=0.00008]. The insula damage patients were 136 times more likely to give up smoking. Some patients also had damage to adjacent areas and there were also significant effects if they had suffered damage to the dorsal striatum (putamen). There were no similar results for other behaviours such as eating, perhaps because smoking is a learned response and people have to learn to overcome the aversive effects. Overall, patients with insula damage were significantly more likely to quit smoking easily and to remain abstinent. One patient observed that he quit because his "body forgot the urge to smoke". Naqvi *et al.* conclude that the insula is a critical neural substrate in nicotine addiction.

Post-mortem studies

Hope *et al.* (2007) analysed post-mortem brain tissue from human smokers and former smokers and looked at enzyme levels in different areas of the brain; they found elevated levels in the nucleus accumbens (part of the ventral striatum) and ventral midbrain dopaminergic regions. Specific enzymes are associated with activation of the reward system by stimulating dopamine receptors in the nucleus accumbens and with learning processes. They found higher enzyme levels in ventral midbrain dopaminergic regions for smokers and former smokers which suggests that repeated use of addictive drugs caused changes in the dopamine system and target neurons in the nucleus accumbens. This also suggests that smoking-induced brain neuro-adaptations can persist for long periods of time, which would explain frequent relapses in former smokers.

Neuroeconomic analyses of learning

Neuroeconomic studies can illuminate the biases that underlie decision-making in uncertain situations by identifying the neural correlates of analytical thought and assessing the extent to which these areas are engaged during ordinary decision-making and learning. For example, Yoshida and Ishii (2006) use fMRI techniques to analyse how people navigate under uncertainty and how they adapt their existing beliefs using Bayesian reasoning. They find that areas of the prefrontal cortex are engaged during Bayesian updating and this evidence is consistent with standard models of Bayesian decision-making.

Neuroeconomics can help illuminate some of the connections between belief learning, reinforcement learning, social learning and other learning models explored in Chapter 5. Tools such as fMRI can be used to establish links between learning and differential brain activation, exploiting parallels with research in economics, experimental psychology and neuroscience. In addition to providing new research tools, neuroeconomics may offer new theoretical approaches that blend insights from different economic models and escape the binary classification of herding into rational versus non-rational.

Belief learning and reinforcement learning

Neuroeconomic testing of belief learning models is more difficult because of the problem of empirically capturing the belief learning function. Nonetheless, Lohrenz *et al.* (2007) have associated fictive learning with activations in the caudate nucleus, an area implicated in neural processing of reward. In working-shirking games, Hampton *et al.* (2008) identified neural correlates of sophisticated learning/strategic reasoning in the superior temporal sulcus, an area implicated in perception and emotion. Bhatt and Camerer (2005) found that poor strategic thinking in the second stages of beauty contest games was associated with differential activations in the insula, an area implicated in self-awareness as well as negative emotional processing, perhaps reflecting the fact that self-focus harms strategizing.

Reward learning and reward prediction error

Reward learning (RL) models from economics are broadly associated with rewards and link to insights about reinforcement from psychology, including Thorndike's laws of effect, recency and exercise – explained in Chapter 5. Schultz *et al.*'s (1997) study of reward prediction error is developed from the same psychological insights about reinforcement learning and captures the adaptive nature of learning (see also Schultz 2002, 2006, 2008 and Schultz *et al.* 2008). Neuroeconomic insights about learning develop from an application of neuroscientific models of reward learning and reward prediction error to economic scenarios.

Reward prediction error is similar to adaptive expectations in macroeconomics: neural activations correlate not with a stimulus but with the difference between prediction and actual occurrence of an event. This enables reward learning when events are unexpected. Learning from "mistakes", that is, the divergence between the predicted and actual outcome, triggers reward mechanisms. Single neuron experiments on monkeys have shown that dopaminergic neurons in the ventral striatum, a neural area associated with reward processing, also encode reward prediction error. There is also evidence of cue-conditioning. Initially, neurons fire when rewards are received but over time responses become cue-conditioned so that neurons fired with the cue not with the reward. The inference is that the dopamine neurons are not simply encoding the rewards but are also capturing predictions about the likely time and magnitude of the reward. Caplin and Dean (2007, 2008a, 2008b, 2009) have applied these insights from neuroscience in developing a neuroeconomic theory of learning based on rigorous analytical foundations.

Observational learning

Insights from the neuroeconomic analysis of reward learning have also been applied to observational learning following models of reward prediction error in which prediction errors are used to increase the accuracy of predictions in the future via a process of learning (Schultz 2006). Burke *et al.* (2010a) conducted an imaging analysis of social learning to identify subjects' neurological responses to observed actions and outcomes from others versus their individual actions and outcomes. Burke *et al.* postulate that, in social learning, individual prediction errors are supplemented by observational prediction errors. This approach has elements of RL in its focus on individual action and outcome prediction errors and also captures social learning from observing the actions and outcomes of others. This connects analyses of observational action and outcome prediction errors, linking into BL models and neuroscientific models of fictive, vicarious learning, as explored in Chapter 5.

In this experiment, there is a two-stage learning process: observing others' actions allows the player to imitate that action and observing others' outcomes allows the player to refine the values associated with each stimulus. These hypotheses were analysed using fMRI and a simple "two-armed bandit" game incorporating one "good" stimulus generating a reward and one "bad" stimulus giving no reward. If, for example, stimulus A is associated with an 80% probability of reward and stimulus B is associated with a 20% probability of reward then the subjects' task is to learn to choose the best stimulus. Behavioural findings showed that more observable information about others' outcomes as well as actions (versus actions alone) led to more correct choices and higher earnings. Imitation was observed in 66% of trials even when only others' actions (not outcomes) were observed. Imitation was observed in 41% of trials when both outcomes and actions were observed because players were able to observe when others were getting it wrong.

The individual outcome prediction error was correlated with activity in the ventral striatum, associated with processing reward (as mentioned above), the dorsolateral prefrontal cortex (DLPFC) which is associated with cognition and attention, and the ventromedial prefrontal cortex, implicated in risky decision-making (VMPFC). This links with other studies identifying DLPFC activations with prediction error, conflict and uncertainty over which action to select. For the action prediction error, there was no response in the ventral striatum.

Observational action prediction error correlated with activity in the DLPFC. Observational outcome activations came from observing others' outcomes and may reflect vicarious or fictive learning about rewards that have not been experienced but could have been experienced. Observational outcome prediction error correlated with positive activations in the VMPFC. In other studies the VMPFC has been implicated in processing of reward expectations derived from diverse sources of information and the VMPFC may be one of the areas involved in the mirror system that allows us to understand others' intentions. A particularly interesting finding was identified for observational outcome prediction error when negative activations in the ventral striatum were identified: when the subjects observed others' actions delivering losses, the ventral striatum was activated. Whilst this finding may suggest that observing others' losses drives a process of prediction error learning, it is also possible that watching another person lose is rewarding in itself. This would be consistent with other studies suggesting that the ventral striatum is implicated in social competition, punishment of others and in situations of advantageous inequality when a person sees someone else receiving less money. Behavioural models of inequity aversion can capture some of these phenomena, as explored in Chapters 2 and 6.

More broadly, neuroscientific insights may illuminate some of the counterbalancing influences driving herding behaviour, including social learning versus peer pressure. Social pressure may emerge from imagined and empathetic responses as well as real and direct responses. Singer and Fehr (2005) and Singer *et al.* (2004) analyse the motivations for responding to others and suggest that imagining experiences of others is associated with a similar neurocognitive response to direct experience itself. This suggests that unravelling some of the neurocognitive foundations of social behaviour may illuminate how much of our copying and herding behaviours are driven by more impulsive and instinctive socio-psychological processes, versus more cognitive and deliberative learning mechanisms (Baddeley 2018).

Neuroeconomic studies of social preferences

There has been a relatively large number of neuroeconomic studies of social decision-making. This reflects the growth of social neuroscience, the increasingly successful collaborations between neuroscientists and social economists and also the fact that behavioural game theory can give a clean and tight experimental context in which relevant social factors can be controlled to study their neural correlates. For example, Sanfey (2007) observes that the study of social decision-making can be enhanced by using formal mathematical approaches from economics constrained by known neural mechanisms.

Cohen (2005) also argues that the evolution of the brain has been formed by social influences; with smaller groups, the chances of repeated interaction were greater. As sociality evolved, strong emotional responses to selfish and exploitative behaviour increased fitness; worrying about reputation was a necessary adaptation to a world in which individuals had a high chance of repeated interaction with a small group of people. As we saw in Chapter 2, evidence for the operation of ancient emotional structures in the context of social influence includes evidence from ultimatum games, in which altruistic behaviours are associated with activations in areas associated with emotional processing, for example the insula (Sanfey *et al.* 2003). Evidence from neuroscientific analysis of economic games suggests that social rewards are associated with activations in areas associated with processing of rewards, for example the ventral striatum, and these activations are in addition to activations from financial rewards. Also, activations are particularly pronounced when cooperation is reciprocated (Rilling *et al.* 2002, Sanfey 2007).

De Quervain *et al.*'s analysis of altruistic punishment in the trust game

As explored above, players who violate social norms and defect in trust games inspire in their opponents a desire to punish altruistically. A classic neuroeconomic study of altruistic punishment (AP), is de Quervain *et al.*'s (2004) brain imaging study. They focus on the social brain and associated moral emotions noting that human cooperation has evolved without modern law enforcement institutions, occurring even between unrelated individuals who will never meet again, and so therefore reflects mechanisms encouraging strong reciprocity.

De Quervain *et al.* identify a role for altruistic punishment and reward. 'Altruistic' punishment (AP) occurs when people voluntarily incur costs when they punish defectors for violating social norms and models incorporating AP give better predictions than models assuming self-interested preferences. AP can help to explain evolutionarily unprecedented levels of cooperation in human societies but where does it come from? De Quervain *et al.* focus on evolutionary roots. They define biological altruism as costly acts for the individual in the present which confer economic benefits on others in the future. This enables the survival of the species. But why would someone be biologically altruistic if there's no direct personal gain? The answer is that we have evolved to feel pleasure from

AP and here de Quervain *et al.* make a distinction between biological and psychological altruism: if we derive real psychological satisfaction from altruistic punishment (AP), then it is not psychological altruism but it does mimic the effects of biological altruism. In this way, de Quervain *et al.* argue that AP has deep evolutionary roots and has evolved as a proximate mechanism. Proximate mechanisms are the present, immediate factors responsible for a given behaviour and reflect the evolution of internal physiology in response to natural selection. AP bestows social benefits and so is a proximate mechanism that has been selected to ensure that people get hedonic/psychological rewards from AP. If punishment gives relief/satisfaction to the punisher then that is a beneficial action for the species in evolutionary terms.

In structuring their neuroeconomic study, de Quervain *et al.* outline a series of hypotheses. Norms evolve to encourage cooperation, reciprocity and fairness even between unrelated individuals. In trust games, norms encourage A to trust B by sending money to B. B reciprocates, demonstrating trustworthiness when he/she sends money back. Social norms between genetically unrelated individuals are enforced through altruistic sanctions and these have a neural basis. Satisfaction from AP will be associated with activation of brain areas associated with goal-directed reward processing, including the striatum.

De Quervain *et al.* incorporate punishment into an experimental design based around a trust game similar to Berg *et al.*'s (1995) trust game (described in Chapter 2). Two human players, a trustor (A) and a trustee (B) interact anonymously in a trust game. They are rewarded with real monetary payoffs converted into monetary units (MUs). Each player starts with 10 MUs and if A gives 10 MUs to B, the experimenter quadruples the amount so that B receives 40 MU. Then B can either keep all 50 MUs, or can send 25 MUs back to A.

Extending the Berg *et al.* experimental design, de Quervain *et al.* also incorporate a third stage into the game in which if A perceives B to be an untrustworthy defector then A is given the opportunity to punish the violation of the reciprocity norm using up to 20 punishment points (PPs). Two types of punishment affected the punished defectors: symbolic punishment in which the PPs had no monetary equivalent and so did not reduce the defector's payoffs. Effective punishment led to a real reduction in defectors' payoffs of 2MUs per PP. For the punishers, there were two scenarios: costly punishment for which the punishers had to pay 1 MU per PP and free punishment in which the PPs incurred no monetary cost on the punisher.

There were four different treatment conditions used in a randomized sequence, covering scenarios in which B's choice to defect was made freely determined by a random device; and punishment was/was not costly for A and B. These treatment conditions were:

a. Intentional, costly (IC): B is intentionally untrustworthy and A can use PPs to punish B with effective punishment. In this case, punishment is costly for both A and B. Twelve of 14 A subjects punished B subjects.
b. Intentional, free (IF): A does not have to pay to punish defectors. All 14 A subjects punished B if he/she kept all the money.
c. Intentional, symbolic (IS): for intentional defections by B, punishment was symbolic and was free for both A and B.
d. Nonintentional, costly (NC): B's decision determined randomly and punishment was costly. Only three of 14 A subjects punished B in the NC scenario.

The experiment was run with 15 healthy, right-handed male subjects. Each player A played the game seven times with different player Bs and 14 out of 15 times A trusted B, so these findings broadly confirm Berg *et al.*'s finding that people generally exhibit trust. However, for all players A, B was trustworthy in three of seven trials and untrustworthy in the remaining four so there is less evidence of trustworthiness and reciprocity than there is of trust. Questionnaires were completed during the ten-minute interval between brain scans: player A indicated on a 7-point Likert scale (from -3 to +3) whether he perceived B's action in the previous trials to be fair or unfair.

De Quervain *et al.* (2004) use PET scans to test their hypotheses. As explained above, positron emission tomography (PET) brain scans monitor blood flow following injections of substances (usually glucose) containing radioactive isotopes. These emit gamma rays as they decay and the radiation is monitored by the PET scanner. Brain scanning was used only to analyse the trials in which player A trusted but player B did not reciprocate leading A to punish untrustworthy behaviour; de Quervain *et al.* were interested specifically in subject A's neural responses whilst deciding whether or not to punish B for being untrustworthy so scans were done of subject A for the one-minute deliberation period when he/she decides whether or not to punish B. In brain imaging studies, contrast conditions are used to allow quantitative comparisons of brain activation under different scenarios and if the differential activation in a particular area is large enough then it is inferred that that area of the brain is implicated.

The main hypotheses were that there would be differential activation in reward-related areas in the brain for five 'contrast' conditions:

1. IF–IS contrast between free versus symbolic punishment when B has defected intentionally. Effective punishment is likely to be more satisfying than symbolic punishment because it is perceived to be fairer and more just than symbolic punishment. Those with the strongest activation in reward-related areas for the IF–IS condition should also be those who incur the largest punishment costs.
2. IC–IS contrast between costly and symbolic punishment when B has defected intentionally. If punishment is satisfying, then subjects should be willing to incur punishment costs leading to greater differential activation for the IC–IS contrast.
3. IF–NC contrast: NC condition shouldn't stimulate any desire to punish because B's behaviour is determined randomly by factors outside their control and so has not defected intentionally so in that sense is not at fault.
4. IC–NC contrast: again, B's behaviour is unintentional and so would not be perceived as unfair.
5. Combined contrast [IC+IF]-[IS+NC]: this captures the coincidence of the desire and opportunity to punish captured by [IC+IF] versus no opportunity to punish in IS and no desire to punish in NC. [IS+NC] will not be satisfying and so will not activate reward-processing structures.

The PET imaging results revealed that the caudate nucleus played a prominent role with a lesser role for the thalamus and prefrontal/orbitofrontal cortex.

Caudate activations

For all five contrast conditions there was increased blood flow to the caudate nucleus of the dorsal striatum (an area of the basal ganglia system associated with goal-directed reward processing). There were below average activations in IS and NC conditions in which there was neither opportunity nor desire to punish and a positive correlation between brain activation and actual punishment in the IC condition.

The caudate nucleus is known to play a prominent role in processing rewards and in particular reward expectation. One pathway for dopaminergic cells is through basal ganglia including the caudate nucleus. This is connected by dopamine pathways to the orbital cortex, and areas associated with higher-order planning of action. Caudate activations have been identified in lesion experiments with rats (Martin-Soelch *et al.* 2003), single-neuron recordings in non-human primates (Apicella *et al.* 1991; Hikosaka *et al.* 1989), neuroimaging studies (e.g. Koepp *et al.* 1998) and studies of cocaine consumption (Breiter *et al.* 1997) and nicotine (Stein *et al.* 1998).

To capture expected satisfaction from punishment, de Quervain *et al.* compared caudate activations for the IF versus IC condition for 11 of the subjects who all punished at the same level. In the IF condition, because these 11 subjects punished at the same level (the maximum punishment) it follows that differences in caudate activations must reflect expected satisfaction from punishment; it cannot reflect differences in punishment because punishment levels were the same. If higher activation in the IF condition predicts larger investment in punishment in the IC condition, this is consistent with the hypothesis that activations in the dorsal striatum reflect expected satisfaction. If so, these subjects will be willing to invest more in punishment. Results confirm this hypothesis: higher caudate activation in the IF condition correlates with higher activation in the IC condition too. Other neuroimaging studies with positive correlations between caudate activations and increases in monetary rewards suggest that the positive correlation between caudate activation and size of punishment in this study is explained by expectations of greater satisfaction from punishment. This is consistent with the caudate's role in integrating reward and behavioural information in goal-directed behaviour.

Other neural activations

Other significant activations were found including higher activations in the thalamus in IC and IF conditions relative to the IS condition, but no significant differential thalamus activation when IC and IF are compared to NC, when the desire to punish should be absent. There were also significant differential activations in the prefrontal and orbitofrontal cortex. In the IC condition, punishers face a trade-off between the emotional satisfaction versus the monetary cost of AP. Reconciling this conflict requires integration of separate cognitive operations in the prefrontal and orbitofrontal cortex. Significant activations were found in Brodmann's area 10, associated with integration of different cognitive operations in achieving higher behavioural goals and difficult choices requiring reward value coding. The role of the orbitofrontal cortex indirectly supports the idea that punishment is satisfying. If it were not, no benefits and costs would have to be weighed against each other in the IC condition, and so the orbitofrontal cortex would not be activated.

Overall, de Quervain *et al.* conclude that their findings are consistent with the ideas about proximate mechanisms: evolution has ensured that we respond in biologically altruistic ways even though we experience no objective benefits ourselves. These results also support tests of social preference models, e.g. from Rabin (1993), Fehr and Schmidt (1999) and Camerer (2003a,b).

Neuroeconomic studies of social emotions

Neuroscientific evidence can help us to understand the roles played by socio-psychological factors in economic decision-making and, developing ideas from psychology, evolutionary biology and neuroscience, neuroeconomists argue that understanding brain organization and function can help us to understand economic and financial behaviour. As explained above, Damasio (1994/2006) pioneered the neuroscientific analysis of the role of emotion in economic and financial decision-making, arguing that the impact of emotional factors does not necessarily preclude rational thought. Mood and emotion do not necessarily work against reason, instead they may work in concert with it. Lesion patient studies established that brain lesions associated with damage to emotional processing led to constraints on rational behaviour.

One of the pioneering neuroeconomic studies of links between social preferences and social emotions was Sanfey *et al.*'s (2003) study of the neural basis of decision-making in the ultimatum game. Incorporating experimental design elements from Güth *et al.* (1982) and linking this into social utility models outlined in Chapter 2 – including models from Fehr and Schmidt (1999) and Bolton and Ockenfels (2000), Sanfey *et al.* study the ultimatum game using fMRI imaging to investigate neural substrates of cognitive and emotional processes involved. As explained in the previous chapter, functional magnetic resonance imaging (fMRI) captures changes in the blood oxygenation level-dependent (BOLD) signal, as blood passes through an area of the body and the signal variation is detected by the fMRI scanner.

We introduced the ultimatum game in Chapter 2 and Sanfey *et al.* draw on the experimental evidence from ultimatum games showing modal offers by "proposers" of around 50% of the total amount, with moderately low offers rejected by respondents in approximately 50% of cases. But why would people knowingly reject monetary reward? It's not a failure to understand or conceptualize because the ultimatum game is very simple. Sanfey *et al.* hypothesized that emotional responses to unfair treatment are fundamental adaptive mechanisms but they generate conflicts between motivations: cognitive processes push towards acceptance; emotional processes push towards rejection. So, the interaction of these processes when respondents reject unfair UG offers will be represented in brain areas associated with cognition, emotion and mediation of conflicting goals. Sanfey *et al.* are careful to use the intuitively accessible word "cognitive" rather than "rational" because they argue that emotional responses may have a rational basis too, mirroring some of Antonio Damasio's insights about the somatic marker hypothesis, as explained above. A fear response is often rational in the face of physical threats, for example. They acknowledge that tighter, consistent use of terminology must develop as the field develops.

A neuroeconomic study of the Ultimatum Game

Sanfey *et al.*'s experiment was designed so that 19 subjects met ten people before playing in the scanner. They were playing for a split of $10. Subjects were told that they would play a one-shot game and each subject completed 30 rounds with three "treatments" (of ten rounds each). In the first round they would play against the humans whom they'd met earlier. In the second round they would play against a computer. The third treatment was the control treatment; the subjects received money just for pressing buttons. This was to capture responses to monetary reinforcement independent of social interaction. For all treatments (including those against humans), offers made were the same and were in fact determined by an algorithm designed to generate offers mimicking those typically made in an ordinary experimental context. For each round, the offer algorithm generated fair splits of \$5:\$5 for five offers and uneven splits for the remaining five offers in each round. The uneven splits were further divided into two offers of \$9:\$1, two offers of \$8:\$2 and one offer of \$7:\$3.

Sanfey *et al.*'s fMRI study is somewhat controversial (for experimental economists at least) because it uses a contrived offer algorithm involving limited deception. Subjects were told that they were responding to decisions from real people when they were responding to offers artificially generated by the experimenters. In experimental economics, incorporating deception is often regarded as taboo because of fears that it might lead to "dirty" experiments. Deception is more likely to be seen in psychological experiments and may be essential in neuroeconomic studies. Sanfey *et al.* argue in defence of their experimental design that their deception was necessary given the "heavy logistic demands" of fMRI studies and demonstrate that their limited deception has not affected the interpretation of results. As noted in Chapter 1, limited deception may be unavoidable in neuroimaging studies because of the technical, logistical and financial constraints.

Behavioural results

The behavioural results (ignoring the fMRI findings for the moment) showed unfair offers from human proposers were rejected more frequently than unfair offers from computers, perhaps reflecting a stronger response during human interaction. Participants' reports from the debriefing stage revealed that standards of fairness were salient: when participants were asked what they thought would have been an unfair offer: 58% said that an offer less than 50% would be unfair; 42% said that an offer less than 30% would be unfair. Subjects reported feeling angry when they were made an unfair offer and they were prepared to sacrifice financial gain to punish their partner.

For the fMRI analysis, Sanfey *et al.* specifically study three main areas of potential activation and for these they find that unfair offers elicited activity in the bilateral anterior insula – a brain area often associated with emotional processing; the dorsolateral prefrontal cortex (DLPFC) – an area often associated with cognitive processing; goal maintenance and executive function; and the anterior cingulate cortex (ACC) – an area associated with conflict resolution.

Insula activations

The magnitude of activation in the insula was significantly greater for unfair offers from humans versus computers, perhaps because activations were not solely a function of amount of money offered but were also sensitive to the context (perception of unfair treatment). The responses in the bilateral anterior insula were also sensitive to a degree of unfairness in the offer. There was greater activation for unfair offers and the magnitude of activation scaled monotonically: activations for \$9:\$1 were stronger than for \$8:\$2 which were stronger than for \$5:\$5. Insula activation also correlated with subsequent decisions to reject; participants with stronger insula activations rejected a significantly higher proportion of unfair offers. The left anterior insula showed the strongest reaction to the most unfair offers. Overall findings from analysing insula response are consistent with a general hypothesis that neural representations of emotional states guide behaviour. Activation of the anterior insula is associated with negative emotional states such as pain, distress, hunger, thirst, anger and disgust and Sanfey *et al.* suggest that there may be links between the physical and social catalysts to emotional states. Unfair treatment including insultingly low offers in the ultimatum game generate "moral" disgust and anger, and engage the same neural structures in the anterior insula as are engaged when someone smells a bad smell.

DLPFC activations

In the DLPFC, there was activation to unfair offers but not to fair offers and DLPFC activation was relatively constant across the unfair offers. There was no significant simple correlation with acceptance rates so DLPFC activation is not sufficient to explain acceptance of unfair offers but a differential comparison of brain areas leading to unfair offers subsequently rejected have relatively greater anterior insula activation relative to DLFPC activation. Unfair offers subsequently accepted have relatively greater DLFPC activation versus anterior insula activation. Overall, heightened DLPFC activation when playing the ultimatum game suggests that unfair offers are more difficult to accept and so impose higher cognitive demands to overcome the emotional tendency to reject.

Sanfey *et al.* emphasize that it is not possible to make meaningful *quantitative* comparisons across different brain regions but they nonetheless analyse the patterns *qualitatively*. There are no significant simple correlations with acceptance rates for DLPFC activation. DLPFC activation alone cannot explain accepting unfair offers. However, a differential comparison of brain activations for unfair offers subsequently *rejected* shows relatively high anterior insula activation relative to the DLFPC activations. Unfair offers subsequently *accepted* have relatively greater DLFPC activations relative to the anterior insula activations. Overall, heightened DLPFC activation in response to unfair offers in the ultimatum game may suggest that unfair offers are more difficult to accept because they impose higher cognitive demands in overcoming the emotional tendency to reject.

Anterior cingulate cortex activations

There were also significant activations in the anterior cingulate cortex (ACC), an area associated with conflict resolution – as noted above. Sanfey *et al.* suggest that this may reflect a conflict between the twin goals of resisting unfairness and accumulating money. The ACC may be implicated in resolving the conflict between the twin goals of resisting unfairness – associated with emotional responses and insula activation; and accumulating money – associated with cognitive processing and DLPFC activation.

Overall Sanfey *et al.*'s findings suggest that emotional influences are an important, vital, dynamic component of decision-making. Sanfey *et al.* conclude that the evidence from neuroeconomic studies provides a quantitative analysis that "may be useful in constraining the social utility function" but more research is needed on characterizing emotional responses, their neural substrates and the social context.

Linking to the neuroeconomic studies of social preferences explored above, sociality in decision-making is propelled by empathy and trust. Economic action is often about "mentalizing", that is, guessing what others will do. Theory of the mind involves making inferences about the beliefs, feelings and action of others (Frith and Frith 2003; Camerer *et al.* 2005). It is possible that herding emerges from such empathetic behaviour if people make decisions on the basis of mentalizing responses. Empathy and theory of mind are connected with emotional processing and so these aspects are also explored in Chapter 9 on moods, emotions and happiness.

Some experimental studies are surveyed in Singer and Fehr (2005) who argue that mentalizing and empathizing can explain how people respond to situations involving incomplete information. Singer *et al.* (2004) uncover evidence revealing that empathizing with the pain of others activates areas associated with the affective processing of pain. They also found heterogeneity in empathetic abilities across people. Avenanti *et al.* 2005 use transcranial magnetic stimulation (TMS) techniques which, as explained in Chapter 11, involve stimulating specific neural areas to find out how this affects behaviour. Using TMS, Avenanti *et al.* identified motor responses associated with empathetic inferences about others' pain. Previous research shows that children with autism or Asperger's syndrome have trouble understanding emotions and social cues. This inability to empathize has been linked to relatively low levels of activation in the medial prefrontal regions and higher levels of activation in the ventral prefrontal cortex (PFC) of Asperger patients, with higher activation in the ventral PFC suggesting perhaps that some sort of compensation is being made in patients who realize that their ability to empathize is constrained (Camerer *et al.* 2005; 2003a,b).

To investigate the hormonal dimensions of trust on social settings, a number of researchers have studied the impact of oxytocin associated with social bonding. For example, Zak *et al.* (2005) analysed a trust game with 212 individuals, males and females. Blood levels of dihydrotestosterone (DHT) were measured and significant sex differences were found: men responded to distrust with increased levels of DHT, women didn't. In other studies, higher oxytocin levels are found during online social networking; the 5% of people who do not release oxytocin on stimulus are likely to be less trustworthy. Testosterone may also play a role in altruistic punishment by inhibiting oxytocin release. Zak came to identify oxytocin as the "morality" hormone and the role of oxytocin was established either by measuring its levels or by administering it using nasal sprays.

Kosfeld *et al.* (2005) analysed the trust game and risk experiments with 194 healthy males who were given intranasal doses of oxytocin in spray form. The experimenters also measured demographic and psychological characteristics. They found that administering oxytocin significantly increased the average transfer levels in the trust game, inferring that oxytocin is involved in prosocial behaviour. Conlisk (2011), whilst sympathizing with the overall approach of these studies, does however identify a number of empirical shortcomings in the analyses and, similar to Binmore and Shaked's (2010a,b) critique of Fehr and Schmidt's analyses described above. Conlisk concludes that Zak and colleagues are forming strong conclusions on the basis of limited evidence.

King-Casas *et al.* (2005) conducted a hyperscanning experiment to capture the neural correlates of trust for repeated games. They found significant differential activations in the caudate nucleus which, as explained in Chapter 11, is implicated in the processing of reward expectation. King-Casas *et al.* postulate that trust is just about expectations of future reward and the concepts of reward expectations and trust are connected because the caudate nucleus modulates thinking about both.

Interactions between fairness and self-interest can also be captured using neuroeconomic techniques. For example, Baumgartner *et al.* (2011) explored social norms around decisions relating to fairness using transcranial magnetic stimulation (TMS), a noninvasive brain stimulation technique – as explained in Chapter 11. They used TMS to generate a "deviant" case and found that the deviant subjects were less likely to reject unfair offers in an ultimatum game. They compared the deviant subjects' neural activations with those from normal subjects. When there was a conflict between fairness and self-interest, normal subjects had significantly greater activations in the dorsolateral prefrontal cortex (DLPFC) and the ventromedial prefrontal cortex (VMPFC).

Neuroscience can provide a quantitative analysis that is useful in constraining social utility functions but more research is needed on characterizing emotional responses, their neural substrates and social context. However, as noted above, it is important to be cautious when interpreting imaging results, especially as there may be many systems and processes involved, not just the neural regions of interest selected by the experimenters and for this reason it may be difficult precisely to attribute causality.

Neuroeconomic studies of empathy and theory of mind

Another aspect of social emotions is capacity for empathy, and this connects with models of theory of mind and mentalizing explored above, where we also introduced the neuroanatomical structures – mirror neurons. There have been a number of neuroeconomic studies of mirror neurons. Mirror neurons are located in the premotor areas of primate brains. They are activated without conscious control and generate imitative behaviour in primates. The discovery of human mirror neurons has lent some scientific support to biological explanations for imitative behaviour (Rizzolatti *et al.* 2002). If so, then the mirror system may be the neural basis for Smithian sympathy: observing others involves internally reproducing the mental processes of the observed person. Single-cell recordings in monkeys have identified mirror neurons in the premotor cortex (PFC) which fire as monkeys perform grabbing movements themselves, and when they observe similar movements performed by experimenters (Rizzolatti *et al.* 2002). Baddeley *et al.* (2005) suggest that such mirror neuron activity may explain imitation and herding in socio-economic contexts. There is evidence that socialized instincts to imitate in humans are associated with mirror neuron activity (Iacobini 2005; Rizzolatti and Craighero 2004). The fact that similar responses are seen in our primate ancestors may indicate that herding behaviour is automatic and "hard-wired" and the outcome of primitive emotions such as impulsiveness.

Functional magnetic resonance imaging (fMRI) and transcranial magnetic stimulation (TMS) studies have tested hypotheses about theory of mind and empathy: empathy allows us to understand and share emotions and theory of mind allows us to understand others' beliefs and desires. When experimental subjects observe their partner receiving painful electrical shocks, their empathetic responses engage automatic, emotional processing circuits such as the insula. Furthermore, empathetic responses seem to be generated by making representations of our own internal feeling states in response to pain observed in others and heterogeneity in brain activation across subjects is strongly correlated with heterogeneity in the responses to empathy questionnaires (Singer *et al.* 2004; Singer and Fehr 2005).

Chapter summary

- Neuroeconomic studies of key behavioural influences explored earlier in this book have demonstrated that complex interactions of reason and emotion are implicated in many of our everday decisions and choices.
- Neuroeconomic studies of prospect theory verify that shifting risk preferences are associated with neural processing in key areas.
- Neuroeconomic studies of time inconsistency show that there are specific areas of the brain associated with the impulsive, impatient dimensions of inter-temporal choices and separate areas associated with the more forward-looking and patient drivers of choices.
- Neuroeconomic studies of addiction confirm the hypothesis from behavioural economics that addiction is not the outcome of rational deliberation.
- Neuroeconomic studies of social learning, social preferences and social emotions suggest that complex interactions of System 1 and System 2 decision-making underlie our social decisions, perhaps reflecting the influence of different areas of the brain that have developed at different stages of human evolution.

Revision questions

1. Does the neuroeconomic evidence show that behavioural bias is irrational? Explain your answer.
2. Explain how different neuroeconomic studies can test the idea that time inconsistency is about impulsive and/or emotional decision-making, or not. Explain your answer.
3. How do neuroeconomists explore the ways in which different areas of the brain interact in social decision-making? Explain your answer.
4. Do you think the neuroeconomic studies explored in this chapter add useful objective evidence to other behavioural experimental evidence or are these types of studies unnecessary and uninformative? Explain your answer.

Chapter 13

Behavioural anomalies in finance

As we saw in Chapter 3, the literature on heuristics and bias is a dominant theme in behavioural economics, and much of the early work came from specific studies of anomalies in financial decision-making – and these formed the foundation of the new subject of behavioural finance. In fact, it could be argued that behavioural finance predated a substantial proportion of behavioural economics. A pioneer in behavioural finance was the behavioural economist Richard Thaler – who won the Nobel Prize in Economics in 2017. With a selection of his colleagues, he pioneered a series of studies of "anomalies" – violations of traditional assumptions that economists used to make about how well and efficiently financial markets process information, as explained below. The Anomalies series was published in the American Economic Association's journal *Journal of Economic Perspectives*. In this chapter, we will introduce behavioural finance by focussing on some of these anomalies and related studies.

Behavioural finance provides an alternative to the microeconomic assumptions used by economists to capture financial decision-making based around key hpotheses:

a. The *rational expectations hypothesis*: in standard financial theory, rational agents are assumed to use all currently available information efficiently and without making systematic mistakes. This means that their expectations of the future follow a random path and fluctuations in asset prices are unpredictable because any useful information currently available is factored very quickly by rational agents into their expectations about the future.
b. The *efficient markets hypothesis* that current asset prices fully reflect all currently available information and so asset prices follow a random walk, that is, they are not predictable because any predictable changes in asset prices would be arbitraged away.

An important point to clarify to prevent confusion is that, whilst behavioural economics and behavioural finance are often treated as separate albeit related disciplines, the distinction between them is largely artificial. This mirrors the parallels between more general theories in economics and finance. Both disciplines draw on the same basic economic assumptions. Similarly, many of the fundamental insights of behavioural economics such as prospect theory, are applied widely in behavioural finance. Financial factors have profound impacts on economic decision-making, for example in planning for the future households will need access to financial institutions to enable borrowing or saving; financial instability has consequences for the broader macroeconomy. Also, a lot of interesting new research covered in this book explores financial decisions as well as economic decisions.

The origins of this separation of behavioural economics and behavioural finance reflect developments in mainstream neoclassical economics developing from Jean-Baptiste Say's conception of money as a "veil" over real activity which includes assumptions such as the neutrality of money – that monetary and financial factors do not have long-term impacts on the real side; and the Modigliani-Miller theorem of financing neutrality – given perfect capital markets, firms' valuations are unaffected by financial structure because the financing costs associated with different financial instruments (loans, equity, bonds) are equalized. Given these assumptions, neoclassical economists is founded on the idea that finance is not a crucial variable in understanding investment and capital accumulation.

More recently, especially with the arrival of a series of serious financial crises in the OECD, there is increasing recognition that real decisions are intertwined with financial decisions. One lesson the fallout from financial crises has taught us is that it is misleading to treat economics and finance as separate subjects; economic decisions affect financial decisions and vice versa – and it is important to understand how the two interact. Therefore, as much as is feasible in one book, key developments in behavioural finance will be analysed in Part II, to complement the behavioural economics concepts we have already explored in Part I. For readers who are interested specifically in behavioural finance, key readings that focus on financial themes are outlined in the reading list in Chapter 1.

Heuristics in financial decision-making

Whilst, as we have noted, it can be difficult to disentangle decisions that are "economic" from decisions that are "financial" – we will focus in this chapter on some of the heuristics and biases that build on Thaler's "anomalies" tradition – starting with some heuristics that have particular resonance when people are deciding about money and finance. As we saw in Chapter 3, Kahneman and Tversky identified a range of heuristics and related biases, and they divided the different types of heuristics into three broad categories of representativeness, availability and anchoring/adjustment.

Availability heuristics

Gigerenzer and Goldstein's (1996) insights about fast and frugal heuristics, introduced in Chapter 3, also have resonance for financial decision-making. When thinking about buying/selling shares from their portfolio, a potential investor may have little real knowledge about what is going to happen to share prices in the future and given this limited information, they will adopt the heuristic of following the crowd. They will buy when the market is rising and others are buying and they will sell when the market is falling and others are selling.

This links to the availability heuristic which is about the fact that we tend to make our decisions on the basis of information that is easy to retrieve and recall. There is therefore a crucial interplay between memory and decision-making in people's use of heuristics.

The role of memory in decision-making has been studied extensively by cognitive psychologists including Alan Baddeley (2002), and some of these insights have been applied specifically in the context of financial investment: Goetzman and Peles (1997) studied mutual funds investors' perceptions of their performance. Using questionnaires, they explored the investors' recollection of their performance and found a positive bias in investors' recollections: the investors overestimated their own performance. The degree of bias also reflected previous choices, suggesting a degree of cognitive bias in investors' assessments as well as their recollections.

Representativeness, gambler's fallacy and the illusion of control

Kahneman and Tversky also identify a number of biases reflecting "misconceptions of chance" and they link these to the representativeness heuristic because these biases emerge from making spurious comparisons between events. With misconceptions of chance, people judge that even very small segments of larger sequences are representative of the whole sequence, and this has an impact on gambling choices – a simple form of financial decision-making. Naïve gamblers expect the short sequence to represent the essential characteristics of a process and so will also expect to see those characteristics of the process locally – in each part of the sequence. For a series of coin tosses: they are asked to judge the relative likelihood of a series of coin tosses: for example, H-T-H-T-T-H versus H-H-H-T-T-T. In reality, small sequences that are locally representative, for example H-T-H-T-T-H, will contain too many alternatives and too few runs than would be expected from a random process. The representativeness heuristic also leads to a misconception of chance known as gambler's fallacy. The gambler's fallacy is the belief that when a series of trials have all had the same outcome then the opposite outcome is more likely to occur next time, since random fluctuations seem more representative of the sample space. If there has been a long run of reds on a roulette wheel, then a gambler will often predict a black ball without reflecting that the roulette wheel has no memory and is not self-correcting so will not know that it's time to have a black ball win after a lot of red ball wins. Gamblers are ignoring the fact that each trial is independent of the next. As we explored in Chapter 3, this bias is seen even amongst scientists in what Tversky and Kahneman call the "law of small numbers". Small samples are falsely assumed to be as representative of a population as large sample and so results from small samples will be overvalued and overinterpreted. The gambler's fallacy also links to another form of bias: the illusion of control. This occurs when people act as though they can influence a situation over which they have no control. If lottery ticket holders have chosen their own numbers rather than using random number selection then they will value their lottery tickets more highly even though the probability of a win is identical in both cases.

Loss aversion, endowment effects and status quo bias

Thaler (1980) identified the endowment effect as a loss of utility from giving up a valued good greater than the gain in utility from acquiring the same good. This creates divergences between willingness to pay (WTP) and willingness to accept (WTA). Knetsch (1989) conducted an experiment to capture endowment effects. Students were asked to choose between mugs and pens. Imagine a choice in which you won a mug and then were given the chance to trade it for five pens and you decided to keep the mug. Imagine if this choice is reversed: you have five pens and are offered a mug; if your preferences are consistent and reversible then you will again choose the mug.

Knetsch found students' choices were not consistent and reversible. He divided a group of students into two groups which essentially captures different incarnations of their indifference curves: a WTA curve and a WTP curve. In standard theory, these curves should coincide. The WTP group started with $4.50; the WTA group started with five pens. The students were offered a series of trades: the WTP of the first group was assessed by giving the students opportunities to buy a pen at a range of prices; the WTA of the second group was captured by giving the students opportunities to sell their pens at a range of prices. Knetsch found that the preferences were determined by initial endowments: those who started with more pens on average valued pens more highly than those who started with money. The WTP and WTA versions of the indifference curves were intersecting, violating the standard assumption of transitivity. This behaviour could not be attributed to subjective preferences for pens because those who started with pens did not rate pens more highly than the group who started with money. Valuations will also be affected by disparities between willingness to pay (WTP) and willingness to accept (WTA). Knetsch observes that in valuing the loss of duck habitat WTP is only appropriate if the duck habitat is absent; stated WTP will undervalue environmental resources and WTA should be used instead (Knetsch 2010; Brown and Hagen 2010).

Divergences between WTP and WTA have been attributed by some behavioural economists to an endowment effect. People value things they own much more than things they do not own. This creates problems in markets because what a seller is prepared to accept may be much higher than what a buyer is willing to buy – a problem that has been explored in the context of housing markets. This can be explained as an *endowment effect*: people disproportionately value things they already own. Lakshminaryanan *et al.* (2008) find that capuchin monkeys are prone to endowment effects when trading treats given in the form of chunks of fruit. The monkeys required higher compensation to forgo a treat they already had than an equivalent treat that they did not have. Lakshminaryanan *et al.* postulate that this evidence may show that biases may be evolved behaviour.

Endowment effects link to status quo bias. This is a phenomenon identified by Samuelson and Zeckhauser (1988) capturing preferences for the current state of affairs. Samuelson and Zeckhauser use an example of an economist who owns an expensive bottle of Bordeaux wine. He does not want to buy another bottle, nor does he want to sell the bottle he has. Kahneman *et al.* (1991) explore these effects in the context of car insurance in New Jersey and Pennsylvania: two policy options are offered – a cheap option with restricted right to sue; and an expensive option with unrestricted right to sue. In New Jersey, the cheap policy was the default option. In Pennsylvania, the expensive policy was the default option. When offered the chance to buy the right to sue, only 23% of people in New Jersey took that option; they preferred to stay with the status quo. On the other hand, 53% of Pennsylvanians retain the right to sue and Kahneman *et al.* also attribute this inconsistency to status quo bias.

Kahneman *et al.* (1990, 1991) and Kahneman and Tversky (1991) develop this analysis linking endowment effects to status quo bias and loss aversion. They did a range of experiments to test the endowment effect. In one set of experiments they divided a group of 77 students randomly into three treatment conditions: Seller, Buyer or Chooser. The Sellers were given mugs and asked if they were prepared to sell those mugs at a range of prices from \$0.25 to \$9.25. The Buyers were offered the mugs at the same set of prices. The Choosers were given a choice, at the same prices, between the money and the mugs, for example at p = \$0.25 they could either have a mug or keep \$0.25. The Sellers and Buyers are, in objective terms, in the same position yet there was a large divergence in reservation prices: the Sellers' median price was \$7.12 and the Choosers' median price was \$3.12. They attribute this inconsistency to the endowment effect.

Aside from loss aversion and status quo bias, Kahneman *et al.* (1991) assert that loss aversion and related endowment effects can affect a wide range of decision-making including job choice. They designed experiments in which people chose between two main aspects: commute time and social opportunities for contact with others. If people start a job that has many social opportunities then they will be reluctant to lose the job even if continuing the job involves significant extensions to their commuting times; if people start a job with shorter commute times then they are averse to losing this even at considerable cost in terms of social life.

Kahneman *et al.* (1991) link status quo bias and endowment effects together as manifestations of the deeper tendency towards loss aversion, arguing that people are adjusting to *changes* from a reference point given by the current status quo. The links between reference points and loss aversion, as we have explored in more detail in Chapter 4.

Thaler (1980) identifies other manifestations of divergences between WTA and WTP including the fact that people are willing to pay for a vaccine to eliminate a small chance of death from a virus but less willing to accept money by participating in medical experiments when there is the same small chance of death. Viscusi *et al.* (1987) describe an experiment in which consumers are shown cans of insecticide and asked about their WTP to eliminate health risks, for example from poisoning. Then they are asked about their WTA if the insecticide was fine initially but they could have a price reduction if they were prepared to take an increased risk of poisoning. Divergences reflect more complex motivations – legal distinctions between risk and failures of omissions versus commission, is an aspect that can be captured to an extent within regret theory, explored in Chapter 4. See also Plott and Zeiler (2005, 2007, 2011), and Isoni *et al.* (2011) on gaps between WTP and WTA.

Some studies attribute the endowment effect to experience, learning and context rather than to bounds on rationality and cognitive capacity. For example, List (2003) explores the impact of market experience on the endowment effect finding that behaviour converges to standard predictions as market experience increases. He concludes that market experience plays a significant role in eliminating the endowment effect and his findings are robust to institutional change. Endowment effects reflect people treating opportunity costs and monetary costs in different ways: "foregone gains are less painful than perceived losses". This focus on actual losses rather than potential gains fits with legal principles: in tort law, a loss in expenditure is often given more legal weight that the failure to make a gain.

Neuroeconomic studies have used some of the techniques outlined in Chapter 11 and 12 to capture how we seem to think around biases in willingness to pay versus willingness to accept. Different neural responses are associated with divergences between willingness to pay and willingness to accept. Knutson *et al.* (2007) used fMRI techniques to analyse buyers' decisions when they were exposed to a range of prices. They found that items purchased were associated with greater activations in the ventral striatum (associated with reward processing) and the ventromedial prefrontal cortex (associated with risk and decision-making). Anterior insula activations were lower for items purchased. This evidence suggests that reward processing and risk profiles are interacting when people experience conflicts between their willingness to pay and their willingness to accept.

Mental accounting and framing

Some of the financial anomalies outlined above can be understood within Thaler's mental accounting framework – which captures decision-making specifically in the context of how we think about money and finance in different ways, depending on the context. This links to Kahneman and Tversky's (1982) insights about *framing*, relevant in the context of prospect theory. Kahneman and Tversky introduced the notion of "psychological accounts" to capture the processes via which people frame and evaluate different outcomes. Thaler (1990, 1999) builds on this insight and also on other elements of Kahneman and Tversky's prospect theory including reference points, loss aversion and the non-linear value function, to propose a model of mental accounting which analyses how people economize on time and thinking by framing and bracketing their decisions and choices. Thaler (1999) connects mental accounting and framing arguing that people's perceptions of different types of transactions will depend on the context in which they are made.

Mental accounting

Thaler (1985, 1999) defines mental accounting as "the set of cognitive operations used by individuals and households to organize, evaluate, and keep track of financial activities". The mental accounting approach captures the cognitive process via which people think about their transactions and sort them in their minds, depending on the type of expenditure involved. Thaler notes that individuals and households record and analyse their spending as businesses do, in order to track their money and keep spending under control. In the mental accounting model they do this not only using conventional methods such as computer and written records but also using psychophysical methods via which they sort expenditures into different mental accounts.

Mental accounts provide a hedonic frame for "coding, categorizing and evaluating events" and this framing of choices means that decision-making is piecemeal and topical, affected by context. Mental sorting means that not all spending is perceived in the same way: "mental accounting matters" because the allocation of expenditures to different mental accounts has a significant impact on decisions and utility. Household spending violates the standard assumption of fungibility: expenditure in one mental account is not a perfect substitute for expenditure in another; and money cannot be costlessly reallocated between the mental accounts. The process of mental accounting is not neutral and will affect the utility gained from choices.

Thaler postulates three aspects to mental accounting, all designed to promote hedonic efficiency and maximize utility. The first aspect captures the process of evaluating decisions and outcomes using both *ex ante* and *ex post* cost–benefit analyses. Expenditures are grouped into categories, sometimes constrained by explicit or implicit budgets. The second aspect involves the assignment of expenditures to different accounts and involves labelling and sorting spending into categories, and sometimes the different types of spending are constrained by implicit or explicit budgets. Stocks of cash, wealth and housing equity, are separated from flows of regular income and windfall gains. The third aspect relates to the frequency with which accounts are balanced and the bracketing of choices.

In terms of evaluating decisions and outcomes, people distinguish acquisition utility from transaction utility. Acquisition utility is similar to the concept of consumer surplus and captures the difference between the value of a good and its price. It is separated from transaction utility, which will be affected by perceptions of the value of a deal. In a sale for example, people will buy things not so much on the basis of their acquisition utility but because of transaction utility; they derive utility from snaffling a bargain.

Thaler gives an example of a woman buying a quilt; she finds that quilts are on sale and all quilts (double, queen and king size) are on sale for the same price. The woman buys the biggest quilt even though it is too large for her bed. Some expenditures will be assigned to the mental equivalent of petty cash: framing a person's choice, for example a charity donation, in terms of pennies per day rather than annual fees will mean that a cost will be less salient and therefore perceived as more manageable. Mental accounts are managed to maximize the utility of consumption and minimize the pain of expenditure. For example, a colleague of Thaler's set up a charity account; he assigned a target donation to this regular account but then, when he experiences unforeseen losses, he draws from his charity account. In this way, unexpected costly expenditures seem less painful than if they came out of regular expenditure accounts.

In sorting expenditures into mental accounts, choices may be bracketed broadly or narrowly. Choice bracketing draws on insights from Read *et al.* (1999) who analyse the way that people combine choices either broadly, by assessing the consequences from groups or narrowly, by assessing each choice on its own. In gambles, the attractiveness of two bets may be increased if they are bracketed together. Thaler gives the example of Paul Samuelson offering a colleague a bet by suggesting that they toss a coin and if the colleague wins the toss then they get $200; if they lose the toss they pay $100. The colleague offered to take the bet, but only if it was offered 100 times. This counter-offer does not make sense in terms of EUT but it can be explained in terms of mental accounting, bracketing and prospect theory. If the bets are combined then the expected value of losses will be reduced and, given loss aversion, this will reduce the disutility of losses. Similarly, narrow framing, focusing on each potential loss in isolation will lead to myopic loss aversion and inhibit risk-taking.

Choices will be updated and evaluated over different periods of time (daily, monthly, annually). The frequency of evaluation can explain share market anomalies such as the equity premium puzzle of persistent differences between the rate of return on equities versus bonds. Thaler argues that this reflects the fact that investors evaluate their stock purchases and update their reference points too frequently preventing them from adopting suitably long-term financial strategies.

The mental accounting model is closely related to prospect theory and Thaler formulates some "hedonic editing" hypotheses to capture how gains and losses are sorted. Given the concavity of the value function in the region of gains, he hypothesizes that it will be hedonically efficient to segregate gains to increase the sum of marginal value from separate gains. Similarly, it would make people happier to integrate losses because, given the concavity of the value function in the region of losses, the sum of negative marginal values from losses will be less than if the losses are separated. Evidence shows that these hypotheses are supported for gains, for example people prefer to win two lotteries paying $50 and $25 over winning one lottery paying $75. Separation of gains did seem to produce more happiness. However, people are also happier to separate losses and Thaler postulates that this is because loss aversion is even more pronounced than prospect theory allows: prior losses make people more sensitive to future losses and intensify the feeling of disutility.

Mental accounts are opened and closed to minimize the pain of loss, and this explains the fact that investors are more likely to sell rising stocks than losing stocks. Sunk costs influence future decisions. Spending on an expensive pair of shoes will affect how many times the shoes are worn, how long they are stored unused and how long it takes before someone throws them away. Payments may be decoupled to reduce the perceived cost of a transaction and this explains credit card usage: paying for something using a credit card disconnects the buyer from the cost of the transaction by temporally separating purchase and payment and also because a credit card bill represents an amalgamation of many payments for different things, again reducing the salience of the cost of each particular purchase.

The violations of fungibility seen in mental accounting can reflect complex motivations. For example, people may underspend on particular categories for complex reasons such as to enable self-control. Consumers may pay premiums for smaller quantities of luxuries such as wine. People will accumulate money in funds that they mentally consider to be "off limits" thereby accumulating illiquid wealth whilst simultaneously running-up credit card debts in order to prevent consumption splurges, as explored in Chapter 7. Sources of income will affect how it is spent. Windfall income from a lottery win is often spent in a more frivolous way, on holidays for example, than income earned from work.

Understanding some apparent inconsistencies in choice can be enabled by recognizing that different expenditures are being assigned to different mental accounts depending on people's perceptions of the context in which the transaction was made. Thaler (2000b) gives an example of Mr and Mrs L. and Mr and Mrs H. who went on a fishing trip, caught some fish and air-freighted them home but the fish were lost by the airline and so the airline gave them $300 compensation, which they spent on a dinner in a fancy restaurant at a cost which would be beyond their normal budget. In this case, the $300 was put into the "windfall account" and so could be spent in a way that the couples would not spend from normal expenditure account. Mental accounting approaches can also explain some apparent anomalies in inter-temporal decision-making, including in the context of present bias and time inconsistency – as explored in Chapter 7.

Framing and bracketing

We introduced framing and bracketing in Chapter 6 and these play a special role in Thaler's mental accounting model, in which decisions about money and finance are evaluated relative to a person's value function and its reference point – capturing the person's perceptions of pleasure. The process of mental accounting is affected by context but at the core is Kahneman and Tversky's value function from prospect theory. As explained in Chapter 4, this value function is assessed in terms of gains and losses relative to a reference point and assuming that people exhibit loss aversion. Then events are coded into a frame reflecting whether the transaction refers to the present or the future, whether it is a windfall gain, and so on. Thaler introduces the concept of hedonic framing in which people code joint outcomes to make themselves as happy as possible. They segregate gains and losses, as explained above. They separate acquisition utility from transaction utility. They may be reluctant to open and close these mental accounts depending on the context, for example traders are reluctant to close accounts that are in the red because of loss aversion. Opening and closing accounts also affects advance purchases; sunk costs and payment depreciation are treated separately. For example, people do not treat sunk costs in the way predicted by standard economics. Arkes and Blumer (1985) ran an experiment in which people could buy theatre season tickets: one group paid full price, another group got a 13% discount and another got a 47% discount. Those who paid full price attended more plays in the first half of the season but all groups attended approximately the same number of plays in the second half of the season. Thaler interprets this as people taking time to adjust to sunk costs.

Framing effects are a key source of cognitive bias and capture how people's responses will be determined by the way/context in which questions or problems are framed. For example, people may exhibit disproportionate aversion to losses relative to their appreciation of gains and so if warnings about the consequences of careless behaviour are framed in terms of the losses of irresponsible behaviour rather than the gains from being responsible, then they may be more effective. Also, there will be individual differences in personality traits and other characteristics leading some people to be overconfident about their knowledge and overoptimistic about future events.

Kahneman and Tversky (1991) analyse endowment effects in the context of reference dependence: they argue that utility judgements are made with respect to changes from a reference point and perceptions of advantages and disadvantages. Kahneman and Tversky (1984) fit framing effects within a critique of standard assumptions but they find that choices from sets of gambles will depend on whether the gamble is framed as a gain or a loss, for example disease outbreaks. This violation of EUT rationality assumptions is seen in sophisticated as well as naïve subjects.

❖ CASE STUDY: BUYING INSURANCE

In theory, insurance can be offered in two forms: probabilistic insurance (PI) and contingent insurance (CI). An example of probabilistic insurance would be an insurance policy for which you pay a lower premium but the probability that the insurance company will cover your losses is reduced. For example, you pay half the regular premium and in return there is a 50% chance that the insurance will cover your loss, regardless of how that loss occurred. Your policy might cover you for any sort of loss but only on odd days of the month and not on even days of the month, for example. Kahneman and Tversky argue that people generally don't want probabilistic insurance; they prefer contingent insurance. They want to be covered for losses contingent on a specific set of events. You insure your car in case of fire and theft and so if your car gets stolen, you are covered but this does not eliminate risk. There is still a chance that you'll lose your car. For example, you might have an up-to-date fire and theft insurance policy but if your car rolls down the hill and crashes because you forgot to put the handbrake on, then that contingency is not covered. You bear the losses yourself.

In expected utility theory (EUT), which we explored in Chapter 4, people insure themselves against a wide range of risks involving both small and large losses and this reflects general risk aversion and a concave utility function, but this cannot explain why people would prefer to insure themselves against a small set of specific contingencies. As explained in Chapter 4, Kahneman and Tversky (1979) argue that EUT together with the assumption of risk aversion leads to the prediction that people should prefer probabilistic insurance (PI) to contingent insurance (CI). In terms of risk, CI is no more of a guarantee against loss than PI yet experimental evidence shows that real people seem to prefer CI.

Kahneman and Tversky asked 95 students at Stanford University about their preferences for CI versus PI. To test their hypotheses, they gave the students some information about a standard CI policy which covered the policy-holder against losses from fire and theft. The students were also given information about the premiums and risks of particular events. The students were asked to start by imagining that they were at their indifference point, that is indifferent between taking out CI or no insurance at all.

Then they were asked to consider an alternative PI deal. They would pay a 50% premium upfront and if they suffered a loss then two possibilities followed:

A: A 50% chance that the insurance company would request the remaining 50% of the premium and cover the loss, regardless of how that loss occurred.
B: A 50% chance that the insurance company would refund the premium and not cover any of the loss.

The experimental results revealed that 80% of students rejected the PI offer, preferring to stick with a CI policy. Kahneman and Tversky argue that these choices cannot be explained using EUT. Kahneman and Tversky argue that the preference for CI over PI reflects a nonlinearity in preferences for risk and insurance captured within the prospect theory probability weighting function. Overweighting of probabilities of loss leads people to prefer CI over PI.

The preference for contingent insurance of probabilistic insurance can illustrate a number of the biases and heuristics explored in Chapter 6. People may buy CI because they are suffering an illusion of control and believe that they have more control over some contingencies than others. It might also reflect a status quo bias because CI is the standard policy and people are more familiar with it. It may also link to availability and affect heuristics. People can imagine losing their car or house through theft or fire because the news is full of stories about fire and theft. Similarly, they can imagine being involved in accidents when they have been exposed to emotionally salient images of planes crashing and boats sinking.

Overall, people can draw on examples of the contingencies offered in standard CI policies but are not affected by the thought that there might be causes of loss that they can't imagine.

On the other hand, they may suffer from choice overload. For example, the wide range of uncertainties surrounding health insurance including the chances of getting a wide range of different illnesses, and uncertainties about the monetary and non-monetary costs involved, means that it is difficult for people to form a clear judgement about whether they need health insurance and if so what sort of insurance is needed (Liebman and Zeckhauser 2008). This sort of choice overload can lead people to decide that they want a simple, transparent policy that is easy to understand.

Trading puzzles

In the sections above, we have explored how some insights from behavioural economics can be used to explain anomalies in financial decision-making generally – the sort of financial decisions that ordinary people make every day. These anomalies have much more impact once we take into account their role within financial systems, especially if they distort financial trading and speculation – that is, if they distort trading behaviour on financial markets for stocks, shares, commodities and currencies, and so on. Speculative bubbles and financial instability reflect an incomplete process of *arbitrage*: assets do not trade and markets do not clear at prices reflecting assets' fundamental values. There are a number of observed market phenomena confirming that excess returns are not arbitraged away including seasonality effects, January effects, Monday effects, Labor Day effects, and so on. Specifically, in the context of equity markets, Barberis and Thaler (2005) describe a series of puzzles that characterize the historical performance of US stock markets: the equity premium puzzle – stocks have earned disproportionately high returns and yet investors are relatively unwilling to hold them; the volatility puzzle – stock returns are very variable with large dispersions; and the predictability puzzle – stock returns are predictable suggesting that persistent profits are not being eroded by arbitrage.

These puzzles would not persist if financial markets were efficient because asset price changes would be inherently unpredictable. A rational arbitrageur would spot opportunities for profit, would buy assets that were undervalued and, because financial markets move so quickly, any potential gains would quickly disappear leaving asset prices to follow a random walk.

Overall, limits to arbitrage can be explained in terms of misapplied heuristics and/or prospect theory.

Anufriev and Hommes (2007) explore bounded rationality in financial trading experiments and observe that traders use a small set of simple heuristics, including adaptive expectations, trend following and anchoring/adjustment. With learning, selection of simple forecasting heuristics evolves reflecting the forecasting performance of those heuristics and this generates path dependence. Developing these insights, Thoma (2013) finds that increases in herding parameters generate speculative bubbles.

Thaler and others analyse behavioural financial anomalies using insights from Tversky and Kahneman's (1974) analysis of heuristics and biases and Kahneman and Tversky's (1979) prospect theory. There is a wide range of heuristics and biases specifically affecting financial markets and some of the more commonly identified financial biases are explored below. For a fuller analysis of heuristics and biases in financial markets, see Thaler (2005, 2016) for a comprehensive compilation of analyses.

Overreactions and under-reactions

De Bondt and Thaler (1985) identify empirical evidence about overreactions in financial markets. They analysed monthly returns between 1926 and 1982 for portfolios of 35 New York Stock Exchange common stocks. They sort these portfolios on the basis of historical performance into winner and loser portfolios. Standard assumptions of rational agents and efficient markets generate a prediction that there should be no systematic tendency for either a winner or loser portfolio to outperform other portfolios because all relevant information should already be captured by asset prices. Yet de Bondt and Thaler identified that loser portfolios outperformed the market by 19.6% on average and winner portfolios earned 5% less than the market on average. The overreaction observed was asymmetric and was larger for loser portfolios than for winner portfolios. Also, de Bondt and Thaler found turn-of-year effects and seasonality, consistent with other analyses and overreaction was most common in the second and third years of the test period. They conclude that these anomalies reflect overshooting of fundamental values as a reaction to dramatic and unexpected news about particular stocks, with the overshooting followed by a gradual reversion to mean.

Overconfidence and overreactions

In Chapter 3, we introduced the problem of overconfidence in the context of representativeness heuristics. Overconfidence has particular traction in financial decision-making – for example, it is particularly problematic in the context of financial speculation. Camerer and Lovallo (1999) analyse overconfidence in the context of business planning mistakes, particularly excessive business entry. In experiments in which success depends on relative skills, most participants expect total profits to be negative but their own profits to be positive – without seeming to recognize that someone has to lose if total profits are negative. Overall, this inconsistency remains even when financial incentives are offered for correctly judging their own skill levels and skills are defined more clearly. Their hypothesis is that the high rate of business failure reflects overconfidence and also reference group neglect: everyone knows that payoffs depend on skill and they know that everyone else knows that too. They should infer that others are self-selecting into the projects because they perceive their own skill levels are high and yet there is still excess entry. This phenomenon could also link into emotional reasons for participating, for example as captured by Keynes's entrepreneurial animal spirits: the "spontaneous urge to action", explored in more detail in Chapter 16.

Hong and Stein (1999) draw on attribution theory in attributing overreactions to overconfidence and self-attribution biases. People tend to ascribe success to their own talents and ability, but will attribute adverse events to "noise and sabotage". Paralleling these general insights, Barberis and Thaler (2005) identify two aspects to overconfidence in financial markets: people underestimate the variance of asset returns leading to confidence intervals which are too narrow; and probabilities are poorly calibrated with people overestimating the probabilities of events that are very likely and underestimating the probability of events which are relatively improbable. Barberis and Thaler also note that overconfidence can reflect hindsight bias as well as self-attribution bias: after an event, people believe that they had predicted it beforehand (a common phenomenon in the fallout from recent financial crises). Barberis and Thaler also observe that confirmation biases may lead people to falsely assess contradictory evidence as confirmation of their prior hypotheses; in academic finance, people start with a belief in the efficient markets hypothesis and continue to believe it even in the face of contradictory evidence. Tuckett (2009, 2011) also addresses this type of effect in the context of a psychoanalytic approach to emotional finance.

Overreaction and overconfidence is observed not only in the decisions of financial traders but also amongst householders when householders overestimate their future ability to repay mortgages/payday loans/credit card bills even though they are struggling to pay their bills today. When this pattern is repeated on a macroeconomic scale and interacts with other financial market rigidities then it can precipitate financial instability, as was seen during the US subprime mortgage crisis.

Under-reactions and the representativeness heuristic

Barberis *et al.* (1998) also analyse *under-reactions* to good news and attribute them to conservatism and/or misapplications of Tversky and Kahneman's (1974) representativeness heuristic. With conservatism, people are slow to change their beliefs in response to new information and so whilst individuals may use Bayes's rule to adjust their expectations, they adjust too slowly. Conservatism may lead people to disregard publicly available information, especially if it contradicts their private beliefs. As explained in Chapter 3, the representativeness heuristic can also lead people into gambler's fallacy and/or neglecting sample sizes and base-rate probabilities, exacerbating biases in financial decision-making. Barberis *et al.* (1998) identify the representativeness heuristic as a source of under-reaction occurring when people focus disproportionately on recently observed prices or prices paid by others because they perceive them to be more representative of expected future prices. As well as leading to under-reactions, representativeness may lead people into a gambler's fallacy in which they expect a particular asset to "win" just because it's been a loser in the past. Sample size neglect may encourage traders to focus on spurious patterns in very short series or small samples of financial data; for example, people may overrate the advice of a financial analyst who has picked a small, unrepresentative number of winning stocks (Barberis and Thaler 2005).

Diversification biases and the availability heuristic

Financial instability may also be exacerbated by misapplications of Tversky and Kahneman's (1974) availability heuristic, also described in Chapter 3. People base decisions on recently available information and forget more distant, less salient events. During speculative episodes, they may only remember recent high prices, intensifying speculative euphoria. The availability heuristic and related familiarity biases can also lead to insufficient diversification and a common manifestation of this is home bias – the tendency for investors to hold a disproportionate number of domestically denominated assets in their portfolios. Various studies have identified home bias. French and Poterba (1991) found that Japanese, UK and US investors held 98%, 82% and 92% respectively of their equity investments in domestic equities. Barberis and Thaler (2005) attribute home bias to the role played by familiarity in the availability heuristic: information about domestic markets is more immediately available, familiar and salient.

Diversification biases can also emerge from choice bracketing. Thaler (1999) describes an experiment exploring children's behaviour during Halloween trick-or-treating. Children were offered opportunities to pick two treats either simultaneously at one house or sequentially at two different houses. More diversification was observed if the children were picking two treats simultaneously. Thaler concludes that when choices are bracketed together, people will opt for diversification. Benartzi and Thaler (2001) assert that a similar approach of naïve diversification characterizes financial markets when people apply the "$1/n$ heuristic". When there are n investment opportunities, people will spread their budgets evenly with $1/n$ of their funds allocated to each opportunity; the relative merits of the opportunities and/or investor's initial preferences will often be ignored.

In financial decisions, when people are offered a range of investment vehicles then they will apply the 1/n heuristic by dividing their funds evenly across the investment vehicles even when one consistently outperforms the others. Bernatzi and Thaler (2001) analyse the 1/n heuristic using experimental techniques. They ask their experimental subjects to make choices in three different experimental treatments. In the first treatment, subjects chose between a stock fund and a bond fund; in a second treatment, they chose between a stock fund and a balanced fund, the latter comprising 50% stocks and 50% bonds; and in the third treatment, the subjects chose between a bond fund and a balanced fund. Bernatzi and Thaler observed naïve diversification across the two choices offered regardless of what those two choices were and so the proportion of funds allocated to stocks varied depending on the pair of choices offered. With a simple choice between stocks and bonds, 54% was invested in stocks; with a choice between stocks versus a balance of stocks and bonds, 73% was invested in stocks; with a choice between bonds and a balance of stocks and bonds, 35% was invested in stocks. Standard financial theory predicts that people's stock allocations will be determined purely by a person's preference for stocks and whilst these preferences will be shaped by risk attitudes they should not be affected by the spurious pairing of choices.

Momentum trading

Bounds on rationality may lead traders to adopt simple heuristics in their trading decisions and this can fuel momentum trading in which traders respond to market momentum rather than fundamental values, for example by buying into rising markets. Hong and Stein (1999) analyse momentum trading assuming two types of traders: news-watchers who make their decisions on the basis of private information and news, ignoring past prices; and momentum traders who engage in positive feedback trading and buy assets in response to increasing prices in those assets. With positive news stories, momentum may start to develop in the market, partly reflecting the impact of good news on the trading of news-watchers; however, given the presence of momentum traders, price rises will be magnified and will last long past the point at which prices attain fundamental values. Once doubt sets in amongst the momentum traders, the bubble will burst and price reversals will precipitate destabilizing overreactions as traders rush to sell.

Applications of Prospect Theory in behavioural finance

Some of the biases seen in financial markets can be explained in the context of Kahneman and Tversky's (1979) prospect theory. Tversky and Kahneman (1974) analyse anchoring and adjustment around reference points. This insight is incorporated into Kahneman and Tversky's (1979) prospect theory, as we explored in Chapter 4. Prospect theory postulates that perceptions of value are affected by changes relative to a reference point. Anchoring to subjectively determined reference points will mean that people's expectations will be slow to adjust leading to sustained speculative episodes. Subjective perceptions will also be prone to framing effects: choices are determined by the context or frame within which decisions are taken, and this is consistent with Thaler's (1985, 1999) analysis of framing within mental accounting models and Shefrin's (2002) analysis of frame dependence in financial markets.

Loss aversion and the equity premium puzzle

In prospect theory, loss aversion occurs when judgements made relative to a reference point and losses are disproportionately painful relative to the pleasure from gains. Kahneman and Tversky's prospect theory value function reflects the fact that losses are overweighted relative to gains and, in financial markets, this may lead investors and traders to hold onto assets even as asset prices are falling in order to avoid loss. When the current state of the world is used as a reference point, loss aversion will interact with anchoring generating status quo bias and familiarity bias favouring the current state of the world and/or things that are already familiar. Endowment effects will also distort people's valuations of objects, as explained earlier in this chapter. People will overvalue things that they already own leading to divergences between willingness to pay and willingness to accept: they will pay less for an object that they don't yet own than they will accept when selling the same object that they already own.

Loss aversion and endowment effects will have impacts on sale decisions within financial markets and also in housing markets. Traders/speculators will not sell shares and homeowners do not sell their houses even when, financially, it would be wise to do so (Odean 1998; Genesove and Mayer 2001). Shefrin and Statman (1985) also identify a tendency for people to sell winning stocks too easily whilst riding losers for too long, which may be a reflection of loss aversion. Benartzi and Thaler (1995) analyse short-termism together with loss aversion in an analysis of myopic loss aversion as an explanation for the equity premium puzzle, defined above as the persistence of relatively high returns on equities. Mehra and Prescott (1985) observe that, over the period 1889–1978, the average yield on the Standard and Poor 500 Index was 7%, six points higher than the yields on short-term debt which were less than 1% over the same period.

Thaler *et al.* (1997) analyse myopic loss aversion arguing that it reflects a disproportionate sensitivity to losses relative to gains combined with frequent evaluations of outcomes. They formulate two hypotheses. First, with myopic loss aversion, investors will accept risks more willingly if the frequency with which they can evaluate investments is limited and they may accept more risk if they evaluate their investments less often. Second, if all payoffs are gains and losses are eliminated then investors will accept more risk.

Thaler *et al.* test these hypotheses experimentally using a task in which investors have the opportunity to learn from experience. They find that investors who can access feedback and information more frequently are more likely to avoid risk, but these risk-averse investors earned the lowest returns. Gneezy and Potters (1997) also argue that myopic loss aversion can explain the equity premium puzzle and the marketing strategies of fund managers. When investors evaluate returns more frequently they become more risk-averse. This is consistent with myopic loss aversion: people focus on short-term patterns when evaluating outcomes over time and are loss averse in the sense that they are more sensitive to stock market losses than to stock market gains – this provides a behavioural explanation for the equity premium puzzle.

Ambiguity aversion and the Ellsberg paradox

Ambiguity aversion and the Ellsberg paradox (introduced in Chapter 4) can also be captured within prospect theory. In the probability weighting function of Kahneman and Tversky's prospect theory, ambiguity is discounted, certain probabilities are overweighted and low probabilities are underweighted. Barberis and Thaler (2005) observe that ambiguity aversion will be a particular problem for financial markets because the probability distribution of asset returns is unknown. Condie and Ganguli (2011) analyse ambiguity aversion in the context of Knightian uncertainty using simulation techniques. Ambiguous information is often ignored within financial markets because traders exit or various forms of bias lead traders to ignore ambiguity in the data.

Condie and Ganguli (2011) explore models incorporating ambiguity aversion when partial information is revealed. These insights can be applied to show that ambiguity aversion in financial markets leads to phenomena not observed in standard models including increased trading volume and volatility, large price swings and "bad" signals not revealed to the market.

Overall, the range of biases and heuristics identified above will mean that financial markets do not automatically correct to fundamental values in the face of shocks. Various behavioural biases will lead to persistence and path dependency in asset prices. DeLong *et al.* (1991) show that noise traders can dominate markets and their errors are not necessarily corrected. This means that they can have a strong impact because there will be no tendency for real-world traders to correct their errors. These biases may interact with socio-economic factors such as herding as explored above, and also with psychological and emotional influences on financial markets, as we will explore in the following chapters.

Time inconsistency and financial decision-making

Time inconsistency is particularly problematic in the context of financial decision-making and pension planning because time plays a crucial role in these decisions and, as explored in Chapter 7, people who realise they are susceptible to self-control problems will implement pre-commitment strategies to limit their impulsive behaviours. For savings, Ashraf *et al.* (2006) discuss the role of pre-commitment strategies in banking: they examined savings decisions in an experimental treatment allowing people an option to open a savings account at the same time that they started a bank account. They were paid the same interest rate on the money in their savings account but their money was locked in. People who opted for this increased savings rates by 82%. This evidence suggests that pre-commitment devices may be an essential part of enabling people to save.

The issue of present bias over long time horizons is particularly pressing in the context of pension provision. To properly prepare for retirement, people may have to make decisions which will not affect their standard of living for 40 years (or more as retirement ages increase). Increasing pressures on government finances alongside increases in life expectancy mean that most governments will struggle to help their ageing populations and individual responsibility will become a stronger theme in pension provision. Whilst governments may not be able to provide retirement incomes to people, Thaler and Sunstein (2008) argue that governments could nonetheless adopt an approach of "liberal paternalism": allowing people the freedom to choose whilst also nudging them in a constructive direction. With greater attention to the "architecture" of choice, people may be able to plan more effectively over their lifetimes. In planning for retirement, present bias and time inconsistency may interact with others forms of bias, including status quo and familiarity biases.

The current standard default for many people is that they make no contributions automatically; they have to opt in to make pension contributions. Madrian and Shea (2001) analyse the impact of adjusting these pension defaults. The architecture of choice could be adjusted to set default options so that individuals do contribute automatically and if they'd prefer not to contribute then they have to opt out. Madrian and Shea found that pension participation increased by 65–98% with opt-outs rather than opt-ins. Similarly, Thaler and Benartzi (2004) show that their Save More for Tomorrow scheme – in which people allocate a set proportion of their salary rises towards their pension – can also be very effective in encouraging people to save for retirement.

Chapter summary

- Key insights from behavioural finance form the foundation for the analysis of heuristics and bias in behavioural economics, developing from pioneering analyses by Richard Thaler of behavioural anomalies in financial decision-making.
- Some financial anomalies can be explained by divergences between willingness to pay and willingness to accept – linking to endowment effects.
- Thaler's mental accounting model captures how seemingly irrational financial decisions can be explained by relaxing the assumption of fungibility. Instead, people think about different financial decisions in different ways depending on the context – framing and bracketing different financial decisions into different mental "accounts", including windfall accounts, income accounts and asset accounts.
- Specific anomalies affect financial speculation in asset markets including myopic loss aversion, endowment effects, and so on.
- Some financial anomalies are an amalgamation of different biases – for example, myopic loss aversion, a potential explanation for the equity premium puzzle, reflects an interplay of time inconsistency and loss aversion.

Review questions

1. Define Thaler's concept of a financial anomaly and illustrate with some examples.
2. What is mental accounting? Set out the model including the different types of mental accounts and how people use them differently in their everyday financial decision-making.
3. How do behavioural economists explain the fact that people will simultaneously save money and incur debt, and not use their savings to pay off debt even though they would save money by doing so. Are there any non-behavioural explanations for this behaviour?
4. What is myopic loss aversion and how does it affect financial decision-making?

Chapter 14

Corporate investment and finance

In the previous chapter, we explored how individuals' decisions about money and finance are affected by behavioural influences. In this chapter, we shift our focus to the firm to explore the question: How are firms' financial decisions affected by behavioural influences? Firms are affected by complexities that consumers do not have to worry about, so firms' finances are more complex than householders' choices, and behavioural influences magnify this complexity.

A key issue for businesses is financing their investment decisions so to fund fixed asset investments that generate profits for the future. In exploring how all these decisions come together, we will start with a long-established literature on the behavioural theory of the firm to capture some of the basics of how behavioural economics is applied in analysing firms' decision-making, and then we will turn to the issue of financing investment by introducing novel approaches to investment appraisal, drawing on insights from behavioural economics – specifically by incorporating behavioural assumptions about discount rates into investment appraisal tools.

Neoclassical theory of the firm

To capture how behavioural economics brings in new, different perspective, we can start by outlining the key elements of conventional, neoclassical theory of the firm. Neoclassical theory of the firm is built around principles of constrained optimization, in which businesses make their decisions given a specific form of production function – conventionally a Cobb-Douglas production function (CDPF). In their production, firms are assumed to minimize cost functions subject to the production technology they are using, as captured in the specification of the CDPF where simple cost functions include the total cost of all labour inputs and all capital inputs. There are many conceptual problems with this constrained optimization approach – some of the most profound raise issues around what is capital and how do we measure it. These fundamental conceptual limitations are not essential to explore here. Instead, we will focus on elements of neoclassical theory that are important to understanding behavioural theories of the business investment and finance.

A central issue is how businesses deal with uncertainty because, as we have seen in previous chapters, behavioural biases, and so on, have more traction when the paths for "correct" decision-making are not so clear. In building up productive capacity for the future, firms undertake fixed asset investment. In standard neoclassical versions of investment theory, the representative firm invests until the marginal productivity of capital is balanced by the user cost of capital which captures the relative cost of capital inputs (Jorgenson 1963). In the neoclassical world, the firm is a black box: inputs go in, outputs come out and what happens in between is not of interest. Firms are assumed to have easy access to finance and will borrow at rates that match their profit expectations. Standard models focus on the combinations and relative factor costs of capital and labour. Investment will also be determined by expectations of the future and in standard models, investment is the product of complex, forward-looking investment appraisal strategies. Whilst standard approaches allow subjectivity in entrepreneurs' expectations it is assumed that these subjective judgments coincide, on average, with some objective probability distribution ensuring that mistakes are not systematic.

Another problem with standard neoclassical theories of production and investment is that they do not address very well the issue of how firms form expectations of the future. Tobin and Brainard's (1977) q models of investment provide a solution by postulating that entrepreneurs form rational expectations of their future profits on the basis of stock market valuations. This requires an additional assumption that financial markets are efficient with asset prices responding instantaneously to news and reflecting all currently available, relevant information about the profitability of firms.

A further problem, plaguing Tobin's q models as well as the early neoclassical models is that they do not allow for uncertainty. The real options theories of Dixit and Pinyck (1994), for example, address this limitation by allowing that uncertainty and irreversibility interact to constrain investment. Only when uncertainty and irreversibility occur together is there a problem for a rational entrepreneur running a business: if there is complete reversibility but uncertainty, then there is no problem because the business person can costlessly change their mind. At the opposite extreme, if there is no uncertainty then a rational business person will get their decisions right the first time and so would never want to change their minds.

All this assumes that firms are run by perfectly rational agents who do not make systematic mistakes. Behavioural theories explore what happens when the people running businesses are not super-rational in the ways assumed in neoclassical economics.

Alternative behavioural assumptions

The entrepreneurs in standard neoclassical theories of production and investment are characterized by 'substantively rationality', defined by Simon (1979) as the achievement of objective goals given objective constraints (Simon 1979). Standard approaches also imply organizational rationality: if a firm is monolithic then it can be treated as an individual and so the organizational rationality of the firm coincides with the individual rationality of a monolithic entrepreneur (Simon 1972). In this way, the firm in standard economic analyses is treated as a single simple entity.

The standard neoclassical theories focus on the use of complex mathematical techniques and algorithmic styles of decision-making as opposed to the heuristical styles of decision-making seen in behavioural economics. Algorithmic approaches assume that investors, using the same information set, will form identical expectations centred around some objective probability distribution of outcomes. They will be forward-looking in incorporating discount rates into their investment appraisal techniques. If these methods are used correctly, then the firm will be optimizing some objective function, given constraints and investment will take place to the point at which the manager maximizes his/her profits by undertaking all investments with a net present value greater than or equal to 0. The discount rate used to derive the net present value will be equal to the real cost of borrowing, adjusted for risk. Algorithmic approaches are outlined in detail in conventional analyses of fixed asset investment activity, for example in Jorgenson's (1963) neoclassical model, in Abel (1983) and others' q theories; and in Dixit and Pindyck (1994) and Pindyck's (1991) real options theories of uncertainty and irreversibility in investment. Despite some differences in analysis, these approaches can be understood as refinements of Jorgenson's basic model with each refinement incorporating more thorough and complex approaches to the analysis of expectations and uncertainty into a basic model of substantively rational profit-maximizing firms (see Baddeley 2003 for a survey).

Real options investment appraisal

If investors are concerned about uncertainty then they will be more reluctant to invest – and so there will be a negative relationship between investment and uncertainty. The uncertainty constraint is particularly pressing for industries experiencing rapid technological change, and when lags between planning and delivery are long and complex. Innovative energy businesses are an example – energy technologies are changing all the time and how can energy businesses build a business case to enable them to access finance?

Dixit and Pindyck draw an analogy with financial options: exercising an option to invest involves an opportunity cost. In the case of real options, this is the value of new information forgone when the option is exercised sooner rather than later. In an uncertain world, and when decisions are irreversible because of large sunk costs, the opportunity cost of investment is large, giving investors a rational reason to delay their decisions. When uncertainty and irreversibility are so intertwined, timing is crucial and the infrastructure investor's question transforms from "Should I invest? Yes or no?" to "When should I invest? Sooner or later?" It may be in the best interest of the investor to postpone their investment whilst they collect more information. Dixit and Pindyck note that these investment opportunity costs can be large and so standard NPV investment appraisal tools, although almost universally applied by larger investors, may lead to large errors in decision-making.

Uncertainty problems are most pronounced for investments characterized by high degrees of irreversibility – when sunk costs are large. For reversible investments, with low sunk costs, uncertainty is less of a problem because an investor can change their mind and retrieve most of their costs – for example, a small business investing in a utility vehicle can relatively easily and costlessly reverse their decision by selling their vehicle. On the other hand, when there is no uncertainty, irreversibility is not a problem because the rational investor knows what to do from the start. If an investor is dedicating millions to a large-scale project but knows what will happen in the future (impossible in reality of course) then they will make the best decision from the outset; they will not want to change their mind. So, the essence of the problem comes when uncertainty and irreversibility interact. With uncertainty, the best investment strategy is not obvious; with irreversibility, the opportunity costs of poor decisions are large.

Public infrastructure projects are exemplars of this interacting problem. Large-scale energy and transport infrastructure projects escape neither uncertainty nor irreversibility. They are characterized by very high sunk costs. When rapid technological change and technological risk are added to the mix, the problems created by interactions of uncertainty and irreversibility are magnified. Innovative energy and transport infrastructures are often fixed in place, specialist and unlikely to find an alternative user. Even if there were alternative uses, standard asymmetric information problems around adverse selection and the "lemons principle" create difficulties for fixed asset investors. In order to sell their second-hand capital equipment, they face a challenge in convincing potential buyers that the capital equipment they are trying to sell is in good working order.

Together, uncertainty and irreversibility are a particularly significant barrier for large-scale investment. Yet, in the real world, problems of uncertainty and irreversibility are not often addressed in investment appraisal. The standard investment appraisal techniques used in practice – even for large-scale infrastructure projects – are based around discounted cash flows – specifically net present value (NPV) investment rules. NPV is used ubiquitously in public infrastructure project appraisal, but it suffers serious limitations. One question is how to accurately identify an appropriate discount rate to use in an NPV calculation. But even if an appropriate and accurate discount rate can be identified, NPV rules do not explicitly allow for uncertainty, including uncertainties created by new innovations and technological risk (Baddeley 2003). NPV rules implicitly assume that investments are a "now or never proposition": if the decision-maker does not invest in the project now, they will never do so (Dixit and Pindyck 1994, p. 6). NPV captures neither the potential benefits of staging or postponing irreversible investment projects with large sunk costs nor the value of information forgone when decisions are made sooner rather than later.

The basic economic theory links to the literature of fixed asset investment appraisal. Firms can use a range of techniques, from simple rates of return, payback period rules, net present value and related techniques through to real options theory (Harcourt 1968; Baddeley 2003, 2006a). Simpler techniques are most widely used by small businesses. For large government and government-sponsored infrastructure projects, discounted cash-flow methods are preferred: projects with the highest benefit-to-cost ratio, as measured in terms of NPV, are prioritized for funding (Ehlers 2014). NPV appraisal techniques can capture some of the complexities of infrastructure investments in terms of externalities and social/environment impacts, but these methods do not capture the interacting problems of uncertainty and irreversibility as identified above. Real options (RO) techniques fill this gap by extending the discounted cash-flow methods associated with NPV into a world in which investment decisions are not simple "one-off" decisions, where timing is important and where interactions between uncertainty and irreversibility act as a substantial brake on innovative investment.

Economic theory has identified a number of problems with investment appraisal techniques that assume both that the future is somehow knowable and that the timing of fixed asset investment projects is not perturbed by fluctuations in uncertainty and imperfect information. Essentially, the problem with NPV techniques is that they do not allow for uncertainty and irreversibility, and this gap is a significant oversight especially for big public infrastructure investments for which timing is often a crucial dimension – for example, the ability to delay an energy or transport investment is especially important when the impacts of irreversible investment are difficult to predict in an uncertain world.

Behavioural theories of the firm

In the real world, entrepreneurs' decisions will be affected by a multiplicity of factors and a crucial role is played by subjective factors such as business confidence and animal spirits. Keynes argues that profound uncertainty and fragile business confidence compromise the expectations-formation process, exacerbating volatility and pessimism in investor behaviour. Behavioural microeconomic analyses of real-world firms draw on themes from behavioural economics. Austrian analyses of entrepreneurship and investment draw on similar concepts to animal spirits, for example Kirzner's (1973) analyses of entrepreneurship as the product of alertness directed by interest. Behavioural concepts such as attention bias are introduced into some theories of the firm. Entrepreneurial and empire-building activities may involve attempts to manage the attention of others, as with the setting of agendas at meetings and via the design of advertisements and shopping malls (Earl and Potts 2000, 2016; Earl 2005). Similarly, Hart and Moore's (1990, 2008) theory links with Kahneman and Tversky's (1979) prospect theory, for example reference points are constructed around predetermined competitive contracts. Similarly, Fehr *et al.* (2011) incorporate prospect theory into a model of firm behaviour by focussing on long-term contracts; using a market experiment which separates responses to rigid versus flexible contracts and good versus bad states they find empirical support for Hart and Moore's (1990, 2008) theory of the firm.

Evaluation biases will also distort firms' decision-making – for example, when people are judging the likely success of investment strategies. Some investment strategies involve a step-by-step process of success or failure – an example would be new product development in the pharmaceutical industry in which there is a chain-like series of events: a trial is successful, the drug is successfully patented, then it is effectively marketed, and so on. This series of events is conjunctive and Kahneman and Tversky predict that investors will be overoptimistic because they overestimate the likelihood of this series of related events. However, if it is a disjunctive event then there will be numbers of unrelated risks which do not develop sequentially over time. The new technology of "fracking" or rock-blasting to extract shale gas is an example. There are a series of risks involved in fracking. Fracking might cause an earthquake. It might contaminate groundwater. There may be industrial accidents. These events are not sequential and chain-like and together they form a disjunctive event. So, applying Tversky and Kahneman's analysis, the overall risk may be underestimated.

Entrepreneurs' heuristics

For businesses' investment strategies, heuristics can outperform complex algorithmic methods of decision-making, an insight also confirmed in the analysis of investment decision-making: simple rules of thumb in investment project management approximate more complex algorithmic tools incorporating discounting methods and so, given the ease of the simpler methods, they are preferable in terms of economizing on information search and decision-making effort (Baddeley 2006a). Specifically, some heuristics create problems for businesses. Evaluation biases emerging from anchoring and adjustment heuristics were introduced as one of the biases explored in Chapter 3. Evaluation biases occur when people do not fully adjust their estimates of the chances of success for one strategy over another because they are distracted by prior information.

For investment theories, problems emerge in unifying the approaches to capture the essence of investment behaviour. One of the differences is in the styles of decision-making. A key distinguishing characteristic of behavioural approaches relative to standard approaches is that behavioural approaches are more consistent with Simon's (1979) definition of procedural rationality: decision-making as the outcome of problem-solving, intuition and "appropriate deliberation" than with substantive rationality which is associated with perfectly informed, utility/profit maximising decision-making. For entrepreneurs and investment, this implies that entrepreneurs will use heuristical methods rather than algorithmic methods in making their investment decisions (Baddeley 2006a).

Simon (1972) focuses on bounded rationality affected by constraints and limits to rationality. He also emphasized the importance of other goals; entrepreneurs are not necessarily aiming to maximise. When complexity and uncertainty make global rationality impossible, firms will satisfice and settle for what's satisfactory rather than what's best (Simon 1972). Behavioural biases emerge at one or more of the three key stages of the investment decision-making process: gathering information; predicting future events (e.g. likely sales); and investment project appraisal. At each of these stages, businesses may make mistakes: information may be missing or misinterpreted; information may be processed inefficiently to give misleading predictions. If inappropriate appraisal techniques are used, then even accurate predictions may be misused (Simon 1979).

Procedurally rational entrepreneurs will use heuristics and simple rules of thumb based on experience to guide their investment decisions. They will use simple heuristics (or common-sense rule of thumb based on experience) in deciding whether or not to invest in particular projects. In judging the value of investments, a procedurally rational entrepreneur will calculate how long it takes to pay off an investment project, that is, they use payback period (PBP) calculations. If they judge the value of a project in terms of its likely (undiscounted) cash flow relative to its cost, then they will use the accounting rates of return (ARR) as an investment appraisal tool. PBPs and ARRs are based around simple assumptions about likely future events and do not require discounting methods (Baddeley 2006a).

Entrepreneurs will also use gut feel and common sense rather than complex mathematical techniques in assessing investment plans. Different investors, faced with the same information, may form different expectations reflecting arbitrarily assigned margins of error. These errors will not cancel out because entrepreneurs' judgements may be affected by herding and social learning (discussed in Chapter 6). In a world of incomplete information, it will be procedurally rational to follow the crowd, as explained in Topol (1991), and/or to learn from past output signals about what other investors are doing (Acemoglu 1993). Herding and mimetic contagion will lead to non-random errors in expectations generating systematic trends and path dependency in aggregate investment.

The use of algorithmic techniques is problematic because net present value calculations require judgements about discount rates. Making these judgements about the value of expenditure today over income tomorrow are likely to be difficult in a world constrained by endemic and immeasurable uncertainty about the future. Given these problems with algorithmic techniques, identifying simple and reliable proxies for IRRs and/or NPV is important. A procedurally rational investor may decide not to incur the costs involved in identifying a discount rate either because they are ignorant that the value of money changes over time or because they judge that current information is fallible and that the future is too uncertain for calculations based around discounting procedures to be of much use. The use of simple heuristics can be effective in an investment setting and Baddeley (2006a) shows that, given some simplifying assumptions, applying heuristics such as the ARR and PBP give approximately the same result as from algorithmic calculations including net present value and the internal rate of return. Judgements about complex and uncertain things such as discount rates may be unnecessary in some settings.

Risk and uncertainty in firm decision-making

Entrepreneurs' investment decisions will also be profoundly affected by immeasurable, Knightian uncertainty. This will prevent the application of clear and objective mathematical rules to guide their expectations of profit. Uncertainty creates a number of specific problems. First, information is incomplete and the data-generating processes dictating economic outcomes are often unknown; an investment decision is not like dealing a card from a pack of 52 cards or buying a lottery ticket when you know that one million tickets are being sold. Second, investment decisions are often about non-repeatable and unprecedented events and this means that information about past outcomes (e.g. as might be captured by frequency data) will be of little use. Third, endogeneity means that economic realities are complex and mutable; expectations affect economic events that determine expectations (e.g. stock prices go up because people believe they will go up because stock prices are going up).

Future outcomes will be affected by current decisions based on expectations of the future formed today: inter-temporal feedbacks between past, present and future will determine reality. Given these three sources of complexity, the objective basis for probability judgements may be missing or unknowable and the third source of complexity will undermine, in the investment context, even the more subjectively-based Bayesian probability concepts. Furthermore, cognitive limits on human information processing mean that individuals' subjective probability estimates are fallible (e.g. see Tversky and Kahneman 1982; Baddeley, Curtis and Wood 2004).

Entrepreneurial decision-making: survey evidence

There have been many survey analyses of firms' real-world behaviour which provide some insight into whether firms and entrepreneurs are either procedurally rational or substantively rational. A lot of the survey evidence focuses on the use of investment appraisal techniques investigating the real-world use of complex algorithmic techniques versus simple heuristics such as PBP and ARR (Gordon 1955; Harcourt 1968; Sarnat and Levy 1969; Ramsey 1970; Dudley 1972; Gronchi 1986). Survey evidence reveals that heuristics such as the payback period technique and average rate of return are the techniques most commonly used, especially by small businesses (Drury *et al.* 1992; Neild 1964; Baddeley 1995, 2003, 2006a).

Neild (1964) found that only 3% of engineering firms used discounting algorithms (Neild 1964). The majority (88%) relied on heuristics such as pay-off periods (67%) or flat rates of return (21%). Baddeley's (1995, 2006a) survey evidence shows that firms have a range of goals including maximising sales or profits, industry leadership and growth; many mentioned the personal satisfaction of running a business, which chimes with the emphasis on animal spirits in behavioural macroeconomics, and the entrepreneurs in this survey were more likely to rely on heuristics such as ARR and PBP (81% of respondents). Not only were the firms not using the algorithmic techniques but even if they were, they weren't necessarily using them properly: in one survey, 45% of the large firms using DCF methods did not realize the importance of a suitable discount rate, for example claiming that the question was 'not applicable'.

In Baddeley's (1995, 2006a) survey, gut feel was identified as a key factor, especially for smaller firms which were using gut feel as a substitute for mathematical algorithms' reliance on business skills and common sense. This is consistent with a procedural rationality hypothesis. Gut feel was used by 28% of large businesses, 50% of medium sizes and 63% of small businesses. These findings suggest that psychological motivations are likely to have a significant impact on firms' decision-making.

In assessing the relative optimism or pessimism of investment activity, businesses were asked whether past investments had matched expectations or not. Business experience, instincts and gut feel are important when entrepreneurs are forming expectations and making the final decisions about whether or not to invest in a project. In a face-to-face interview, one MD commented that,

> It is difficult to assess the right approach – you would like to rely on mathematical calculation but don't believe that you can – although as a tool it's a great asset. But there will always be a gut feel, business experience element as gut feel will tell you to base future expectations on historic information. The future is multifaceted, with many possible interactions and there can be no model to predict. Can you can come up with a model more predictable than people just pooling their gut feel reactions?

Businesses were not always good at judging their performance, perhaps reflecting problems of overconfidence and underconfidence. Underperformance of investment projects was a function of firm size: 8% of large firms, 14% of medium-sized firms and 32% of small firms underperformed relative to their expectations. In contrast, 10% of large firms and 14% of medium-sized firms and no small firms overperformed with their investments (Baddeley 1995, 2006a).

Behavioural investment appraisal

An alternative to these approaches to investment appraisal is to incorporate some behavioural insights into standard models. Just as NPV techniques suffer from their neglect of the uncertainty–irreversibility problem, addressed in RO approaches, in turn the RO approach suffers from a neglect of behavioural biases – specifically shifting risk and time preferences.

As Keynes observed:

> It would be foolish, in forming our expectations, to attach great weight to matters that are very uncertain ... The outstanding fact is the extreme precariousness of knowledge ... we have to admit that our basis of knowledge for estimating the yield ten years hence of a railway, a copper mine ... an Atlantic liner ... amounts to little and sometimes to nothing.
>
> (Keynes 1936, pp. 148–150)

This is an enduring insight. Today too, investment performance forecasts must be made on the basis of assumptions about an inherently unknowable future. If investors are concerned about uncertainty, then they will be more reluctant to invest – and so there will be a negative relationship between investment and uncertainty. The uncertainty constraint is particularly pressing for industries experiencing rapid technological change, and when lags between planning and delivery are long and complex.

One approach to incorporating insights from behavioural economics into the analysis of businesses' investment and financing decisions is to incorporate key elements from behavioural economics directly into investment appraisal tools. One way to do this is to use discount functions from behavioural economics, as explained in Chapter 7, and incorporate these into corporate investment and finance strategies.

These insights can be used to analyse more deeply what constrains investors' willingness to invest, especially in innovative investments, for which uncertainty will be a particular problem – and the range of biases and socio-psychological influences we've covered in this book all have more traction when uncertainty is profound. There are many barriers but the most complex is uncertainty. Fixed asset investment is all about the future. We postpone consumption today to invest our money in productive capacity for a future we cannot know and so fixed asset investment is plagued by uncertainty.

Added to this neglect of the uncertainty–irreversibility problem, is a problem not addressed in economic theories of fixed asset investment – the problem of behavioural bias. Real options theories are grounded in a rational choice framework – in which fixed asset investors are assumed to systematically and rationally use the information that they do have in forming robust and unbiased decisions. Rational choice models embed the assumption that decision-makers have stable time and risk preferences. Theoretically, the strict assumptions about rationality associated with rational choice theory are convenient for model-building and enable abstraction, but by assuming away the behavioural biases associated with shifting time and risk preferences, the conventional rational choice frameworks can lead infrastructure investors and policy-makers to overlook significant distortions in real-world behaviour. Behavioural economic theorists, drawing on insights from psychology and sociology, have comprehensively explored how rational decision-making is impeded by shifting and unstable time and risk preferences. These shifting preferences create problems of time inconsistency, present bias, loss aversion and reference dependence, leading to inefficient and distorted decision-making.

The current literature on behavioural bias in investment, particularly large-scale infrastructure investment projects, comes from project management – namely the literature on "mega-projects". Whilst this does address some behavioural insights, these are not framed within a robust analytical model. Nonetheless, it identifies some important insights. Cost overruns are much more likely than not, either because of "lowball" tactics or other gaming behaviours by potential contractors at tender stage.

This links to a key form of bias affecting business investment and financing – optimism bias. Optimism bias can be a particular problem for construction businesses where it is difficult to predict and plan for future contingencies. Optimism bias is a particular theme in the academic literature on mega-projects and is defined in this literature as "a tendency to over-estimate benefits and under-estimate costs" (BITRE 2014). The Sydney Opera House is one of the most famous examples of mega-project blowouts – coming in at nearly 1,400% over budget. In their review of 258 large transport infrastructure investments spread across 20 countries, Flyvbjerg *et al.* (2014) found that costs were underestimated on average by 20 to 45%, depending on the project.

The problem is that the behavioural economic theorists have not explored these insights within the framework of fixed asset investment theory. For investment decisions, when these distortions interact with the distortions created by the uncertainty–irreversibility problem, then the biases and inefficiencies in infrastructure investment are likely to be large and complex. Better models of investment decision-making, which explicitly incorporate departures from rational behaviour, are needed, so that governments can better understand how potential investors might respond to changes in public policy, and what the public sector can do to encourage desirable investment outcomes.

To capture some of the complexities it is possible to combine insights from investment theory with behavioural economics, in providing an original theoretical framework in which forms of bias created by unstable time and risk preferences are drawn together with insights from real options theories about uncertainty and irreversibility to capture aspects of behaviour not fully addressed in standard NPV appraisal techniques, which incorporate unrealistic behavioural assumptions about how investors plan for the future based on a rational expectations approach. This way impacts on fixed asset investment of interplays between uncertainty and irreversibility as explored by Dixit and Pindyck and others can be blended with behavioural insights.

In fact, time inconsistency has been addressed within some of these literatures, it has been addressed in a limited way as an institutional or regulatory failure, rather than as a behavioural phenomenon. Whilst some analysts have identified a problem of time inconsistency, specifically in the context of energy infrastructure, these analyses look at time inconsistency from an industrial–regulatory perspective (e.g. Helm 2009), and not by drawing on insights from behavioural economics, even though behavioural models of time inconsistency could also be used to explain the optimism bias.

Chapter summary

- Neoclassical theories of business investment finance are based around the idea that businesses maximize profits by minimizing costs, subject to the production technologies they are using but this approach is problematic because it does not allow for behavioural bias and other insights from behavioural economics.
- More nuanced models of business investment and finance draw on behavioural theories of the firm which replace the input–output approach associated with standard economic theory with a wider analysis of business motivations and incentives.
- Another way to conceptualize these differences is via Herbert Simon's distinction between substantive versus procedural rationality, where procedural rationality is about a more complex, less mathematical style of decision-making.
- Survey evidence suggests that small firms use simpler techniques such as payback periods and simple profit rates and larger firms are more likely to use net present value and other discounted cash-flow techniques – though under certain assumptions these different techniques will give the same answer.
- Standard investment and finance models can embed behavioural insights by incorporating behavioural discount functions embedding hyperbolic or quasi-hyperbolic discounting in place of standard discount functions which embed exponential discounting.

Review questions

1. What are some of the limitations of standard (neoclassical) approaches to investment and finance?
2. How can behavioural insights be embedded within investment appraisal tools?
3. Do you think most real-world businesses are run on principles of substantive rationality or procedural rationality? Explain your answer.
4. For real-world businesses' investment appraisal decisions, how do uncertainty and irreversibility constrain decision-making, and how can behavioural versions of real options theory improve investment and finance decisions for real-world businesses?

Chapter 15

Emotional trading

As we saw in Chapter 13, mainstream financial theory is grounded in assumptions of rational expectations and efficient financial markets. In standard financial models, market fluctuations are the outcome of decisions by rational agents in free markets, using objective information. These theories focus on a view of people as atomistic, independent, forward-looking and self-interested agents. These agents do not make systematic mistakes and they use all available information efficiently. It is difficult fully to reconcile these models with the behaviour of financial traders and speculators in the real world, when different traders' decisions come together to magnify financial instability on an aggregate scale – for example, speculative bubbles – as we'll see in Chapter 17. In this chapter, we will concentrate on the individual traders and specifically how these individuals are affected by moods and emotions in their trading behaviours.

There is plenty of evidence that emotions are an important driver for individual traders' decisions. This builds on the ideas explored in Chapter 9: that decision-making, emotion and feelings are all intertwined in the economic and financial world, even though – until recently – economic and financial theorists have neglected the role of emotions in economic decision-making (Elster 1996, 1998). As we saw in Chapter 9, Elster (1996) and Loewenstein (1996) emphasize that emotions and visceral factors are neither rational nor irrational because they cannot be chosen. The role of emotions in economic decision-making has been confirmed by other neuroscientific evidence which shows that emotional circuits in the brain operate in response to ambiguity and during learning/information processing (Glimcher and Rustichini 2004; Houser *et al.* 2005; Shiv *et al.* 2005; Naqvi *et al.* 2007). Emotions do not necessarily interfere with rationality but may be important "tie-breakers", for example when outcomes are indeterminate in rational choice models. The influence of visceral factors varies in intensity, exerting overwhelming influences when in a "hot state" but with cognitive factors exerting more influence during "cold" states (Bernheim and Rangel 2004). This dominance of emotions may reflect interactions between decision-making systems. Financial traders are often making decisions at great speed which involve very high stakes and in this sort of context hot, intuitive, automatic emotional systems are more likely to prevail over cold, reasoning, deliberative cognitive systems.

Some of the most fascinating evidence about what drives individual traders comes from neurofinance – applying the tools and insights explored in the neuroeconomics chapters (Chapters 11 and 12) specifically to financial traders' behaviour. The role of emotions in economic decision-making has been confirmed by other neuroscientific evidence which shows that emotional circuits in the brain operate in response to ambiguity and during learning/information processing (Glimcher and Rustichini 2004; Houser *et al.* 2005; Shiv *et al.* 2005, Naqvi *et al.* 2007). In this chapter, we will explore some of the evidence specifically about how emotions affect emotional trading and assess these ideas in the light of evidence from a range of neurofinance studies. As we have explored in previous chapters, emotions are difficult to measure using economists' traditional tools, which are based around studying decisions they can observe and measure. Neuroscience offers some solutions, however, as we saw in Chapters 11 and 12. Some of the tools and insights from neuroeconomics can add depth and detail to our understanding of how emotions drive financial trading and speculation specifically. For example, neuroeconomics can add some valuable additional information to these debates because tools are developing which enable us to identify specific neural areas associated with emotion. Ultimately, if these studies show that people do not necessarily use objective information in a systematic way then rational expectations and efficient markets will no longer be at the core of theoretical analyses of financial markets. On the other hand, if the behavioural economists and neuroeconomists can show that economic and financial decision-making is associated with logical, rational, cognitive responses, then we could conclude that the emphasis on rationality and market efficiency may be justifiable, at least as an approximation.

Emotions and trading performance

An overarching theme in studies of how emotions influence traders' performance reflects the idea that cognition and emotions are interacting when we make financial decisions. This focus on interactions of cognitive and emotional decision-making systems links to Keynes's early insights about decision-making as a reflection of interactions of deliberation and emotion:

> It is our innate urge to activity which makes the wheels go round, our rational selves choosing between the alternatives as best we are able, calculating where we can, but often falling back for our motive on whim or sentiment or chance.
>
> (Keynes 1936, pp. 162–163)

In terms of the impact of emotion on financial decisions, some of the earliest neuroeconomic studies of emotion analysed financial decision-making by lesion patients, that is, patients with localized damage to specific areas of the brain known to be associated with processing specific emotions. The role of emotions in economic decision-making has also been confirmed by recent neuroscientific evidence showing that emotional circuits in the brain operate in response to ambiguity and during learning/information processing (Glimcher and Rustichini 2004; Houser *et al.* 2005; Naqvi *et al.* 2007).

One of the easiest and cheapest ways to capture emotional responses when traders are taking risks in buying and selling financial assets is to use relatively old-fashioned physiological measurement equipment to capture simple things such as heart rate, sweat response and skin conductance. One pioneering set of studies was implemented by Lo and Repin (2002). They used neurophysiological techniques to monitor the responses of ten professional derivatives traders by measuring skin conductance, heart rates, muscular responses, blood pressure, respiration rates and body temperature and EMG. They analysed the differences in physiological response between traders with high levels of experience versus traders with a low to moderate level of experience. In most cases, the experienced traders were better at controlling emotions though Lo and Repin do emphasize that this does not suggest that emotions are not valuable inputs to decision-making. Similarly, Lo *et al.* (2005) in a study of 80 day traders find that the trading performance was significantly hampered for those with more intense emotional reactions. Also, there is evidence that more primitive emotions, in the form of visceral factors, are implicated in some self-destructive behaviour, as explained below.

The fact that emotions influence traders does not mean that emotions are a problem that needs to be fixed. As we explored in Chapter 9, emotions are often valuable guides to effective decision-making. From some of the lesion patient studies mentioned above, Bechara and Damasio (2005) and Damasio (1994/2006) developed the somatic marker hypothesis: emotions provide important physiological cues that can help decision-making. Lo and Repin postulate that experienced professional traders often draw on intuition in decision-making. Intuitive decision-making rules are often propelled by emotions. The implication of their findings therefore is that experienced traders have learnt not to overreact emotionally which does not imply that they shouldn't react emotionally at all.

In support of this idea that emotions are an important guide to good decision-making, some lesion patient studies suggest that damage to emotional processing areas can improve performance in restricted scenarios. Shiv *et al.* (2005) studied the performance of lesion patients with damage to emotional processing areas in the brain in 20 rounds of investment decisions and they compared the performance of the lesion patients with performance by normal subjects. The normal subjects learnt quickly to select more conservative, less risky strategies but for the lesion patients, the disconnection of emotional responses enabled the lesion patients to perform better. They earned significantly greater rewards from the investment games because they did not feel risk. Shiv *et al.* interpret this as evidence that when the processing of negative emotions, including fear of loss, is disconnected people are more likely to adopt risk-seeking strategies which earn them higher returns.

Emotions and risk-taking

A key theme in behavioural finance and neurofinance focuses on how emotions feed into traders' perceptions of risk. Emotions play a key role in driving risk-taking. The emotions most commonly identified as contributing to financial fragility and irrational exuberance include greed, hope and fear (Shefrin 2002). Slovic *et al.* (2004), Slovic (2010) and Loewenstein *et al.* (2001) characterize risk as a feeling and argue that the risks that traders feel during their financial transacting can be characterized as a feeling of fear – with feedback effects and intensifying fear responses and precipitating panics. Other emotions will affect financial decisions more broadly, the irrational exuberance of traders, commonly seen in bullish markets, may reflect an interaction of hope and greed (Shiller 2000, 2003).

The role played by affect and emotions in driving financial decision-making has been confirmed in functional magnetic resonance imaging (fMRI) studies showing that risk-seeking and risk-aversion mistakes in financial decision-making are associated with activation of neural circuits associated with affect and emotion (Kuhnen and Knutson 2005). Similarly, Slovic (2010) connects the feeling of risk with impulsivity and addiction. Neuroscientific evidence has established that money stimulates the same dopaminergic reward-processing systems as are activated with more basic rewards including food, sex and drugs. Reflecting evolutionary processes, hardwired instinctive emotional responses may dominate even though they are not well adapted to modern conditions. The rapid development of technologies such as computerization may have accelerated the maladaptation of ingrained emotional processes. For example, primitive limbic structures in the brain are often associated with impulsive emotional responses appropriate in a world in which immediate rewards were important. In primitive environments, basic resources were scarce and perishable and so quick, instinctive action was essential to avoid starvation. In a modern context, these instincts may not serve a useful purpose and may in fact generate perverse behaviours such as gambling addictions.

In financial markets, risk-seeking by financial traders may reflect interactions between neurological systems. If emotional systems encourage risk-prone traders to take impulsive decisions, then the amplification of impulsivity in modern computerized markets will increase the fragility of the financial system. As explained in Chapter 8, in some contexts, impulsive behaviours such as overconsumption, for example of addictive substances, can be overridden by pre-commitment devices but with traders' returns focused very much on short-term performance there is little incentive for traders to rein in impulsive instincts if institutional safeguards limiting impulsivity are not in place.

As we explored above, emotions including fear and greed are significant drivers of financial traders' decisions – and these connect with traders' attitudes towards risk. Lesion patient studies have been used to explore links between traders' risk-seeking behaviours and their tendencies towards impulsivity. Shiv *et al.* (2005) studied the behaviour of lesion patients with amygdala, orbitofrontal and insula damage and found that damage to neural emotional circuitry was associated with an increased willingness to take risks. Patients with lesions in areas associated with emotion were more willing to take risks by investing money in gambling tasks and were able to make larger profits than normal controls, perhaps because decreased affect ameliorates the problems of myopic loss aversion.

Some of these influences have also been captured using brain imaging techniques, for example functional magnetic resonance imaging (fMRI). Christopoulos *et al.* (2009) used fMRI to study traders' risk aversion. They used fMRI to analyse participants' choices between risky and safe options. As explained in Chapters 11 and 12, fMRI is based around the measurement of the blood's magnetic properties using the blood oxygenation level dependent (BOLD) signal. Specifically for traders' risk choices, Christopoulos *et al.* found that responses in the striatum increased with the probability of a risky choice and inferior frontal gyrus responses decreased with the probability of a risky choice. They also found increased BOLD responses in the inferior frontal gyrus, an area commonly implicated in risk aversion.

Using similar techniques, Kuhnen and Knutson (2005) and Knutson and Bossaerts (2007) explore the role of affect in financial decision-making using event-related fMRI techniques. Kuhnen and Knutson examined the behaviour of 19 volunteers offered safe stocks and risky stocks. The subjects had to learn which were riskiest choices and Kuhnen and Knutson identified two types of mistake associated with risk-seeking and risk-aversion.

These correlated with activations in neural circuits associated with emotion and affect. They found that distinct anticipatory affect circuits are associated with different types of financial choices. Activations in the nucleus accumbens, which forms the main part of the striatum and is associated with reward learning, were correlated with risk-seeking mistakes. Conversely, activations in the anterior insula, associated with negative emotions and fear of failure and loss, are associated with risk-aversion mistakes.

Another way to capture neural responses to risk-taking is to study the impact of hormones on financial decisions. Coates and Herbert (2008), Coates *et al.* (2010) and Herbert (2018) identify a role for steroid hormones including testosterone – often associated with risk-taking, and cortisol – often associated with stress. They postulate that cortisol encodes risk and testosterone encodes rewards. They study hormonal profiles by taking saliva samples from 17 day traders from a London trading floor. They correlate the hormonal data with traders' profit and loss (P&L) accounts and also with market events and find that when a trader's morning testosterone level is relatively high then this correlates with better P&L performance over the day. In addition, average daily cortisol levels correlate with the volatility of traders' P&L accounts and also with market volatility overall. These findings are mirrored in Coates *et al.*'s (2009) study of prenatal androgens, associated with success in competitive sports. Finger length, specifically the 2D:4D ratio capturing the ratio of the lengths of the second finger and fourth finger, are markers of prenatal androgen levels. Coates *et al.* (2009) measured the 2D:4D ratio for high-frequency traders and found that traders' long-term profitability correlated with their 2D:4Ds.

Emotions, heuristics and prospect theory

Insights about heuristics and bias, and concepts from prospect theory (as outlined in Chapters 3 and 4), can be applied to give us a deeper understanding of how and why attitudes towards risk connect with financial decision-making; including links with emotional processing. Damasio (1994/2006) emphasizes that emotions play a valuable role in a lot of decision-making, they may also intensify some of the behavioural biases discussed above. Emotional factors will play a role via heuristics, particularly the availability heuristic which, as we explored in Chapter 3, is about how people make decisions using the information they have which is easiest to access and remember quickly. Emotions are prime candidates in this context. They are often at the top of minds so exert a strong influence on our decisions. Similarly, emotions have a powerful influence on our memories and so will determine what is remembered and what is forgotten. In financial markets, this powerful role played by emotions is magnified by the fast speed at which trading decisions are often made.

In a fast-moving environment, the vividness of emotions will make them more salient. This is the essence of a specific type of availability heuristic – the *affect heuristic*. Emotions also connect with forms of bias including ambiguity aversion, described by Shefrin as fear of the unknown (2002).

Some of the gambling behaviours associated with financial trading can be explained in terms of key insights from prospect theory – and some neurofinance studies have focused specifically on testing hypotheses from prospect theory using neuroscientific tools. For example, Fox and Poldrack (2009) explore a range of methods for eliciting the parameters of the value function from prospect theory and review some of the key neuroeconomic findings from the application of prospect theory. De Martino *et al.* (2006) in an fMRI study of reference dependence in gambling tasks analysed the responses of people offered a choice between a sure loss versus a gamble and a sure gain versus a gamble. The reflection effect was observed confirming the predictions of prospect theory. In addition, the fMRI imaging results showed differential amygdala activations for sure gains and risky losses suggesting that amygdala is associated with the coding of value.

Emotions have a place in prospect theory and there are important lessons in understanding financial markets. Reference points dictate our choices and this links to frame dependence, introduced in Chapter 13: how we frame our decisions is determined by our reference points. This suggests a link between framing, emotions and financial decision-making: Shefrin (2002) argues that frame dependence means that decisions will be affected by the context in which they are taken and this will reflect interplay of cognitive and emotional factors. Emotion and cognition also interact in responses to ambiguity aversion – a feature of our behaviour that can be captured within prospect theory but not expected utility theory. Ambiguity aversion links to emotions; Shefrin analyses it as fear of the unknown.

Emotional trading and personality

Lo *et al.* (2005) separate the impact of mood and personality on financial decision-making by day traders by correlating responses to daily surveys of emotions and personality with traders' profit and loss records. Subjects with more intense emotional reactions to monetary gains and losses performed less well. Lo *et al.* conclude that extreme moods impair trading performance but that good trading performance is not significantly associated with specific personality traits. They focus on mood as a reflection of exogenous factors rather than individual differences and conclude that any individual can be a good trader if they have the appropriate training and experience.

Theoretically, the influence of personality on traders' behaviour can be captured using psychoanalytical principles, for example, in David Tuckett's Emotional Finance Model. Tuckett (2009, 2011) analyses traders' emotions using a psychoanalytical approach, bringing together some of these insights about the role of emotion in financial decision-making using psychoanalytical principles and insights from psychological interviews of real-world fund and portfolio managers. He argues that financial instability is created by emotional conflicts. Financial assets are perceived as something much more than a store of value. Traders pursue them as "phantastic objects" – objects imbued with superlative qualities. In pursuit of phantastic objects, whether these be tulip bulbs, houses or dotcom shares, traders are susceptible to divided state of mind and emotional conflicts because the excitement of potential gains is separated from the anxiety, panic and fear induced by potential losses. In a euphoric phase, traders quickly forget the losses from previous busts. During a speculative bubble, traders forget quickly about the losses from previous busts and construct stories to rationalize their impulsive behaviours. Bubbles and busts are generated as path-dependent emotional sequences. Euphoric booms are followed by emotional oscillations concluding in spectacular collapses of confidence as bubbles burst.

In their divided state, traders construct stories to exaggerate positive potential and rationalize negative experiences. This generates biases of over-optimism leading to underestimation of risk and overvaluation of opportunities. Speculative frenzies may be propelled, at least partly, by these unconscious instincts – generating bubbles, booms and busts as path-dependent emotional sequences in which euphoric booms are followed by a period of emotional oscillation during which people struggle to reconcile reality with their beliefs, culminating in "spectacular" collapses of confidence as the bubble bursts.

These tendencies are exacerbated by "groupthink" within a "basic assumption group", that is, a group formed around a common belief in some fundamental assumption(s); for financial markets, where the basic assumptions are rational agents and efficient markets. Mirroring psychological insights about cognitive dissonance, Tuckett postulates that the basic assumption group in financial markets does not challenge assumptions of rational expectations and efficient markets. Instead, contradictory information is rationalized or dismissed as noise; stories are constructed to ameliorate doubt and distrust. This means that no one takes responsibility for past failures and so learning from past mistakes is limited or non-existent.

Tuckett emphasizes that the impact of emotional factors does not reflect irrationality. The problem is that financial market institutions have been distorted by emotional conflicts and this partly reflects the essential characteristics of financial assets. Financial markets are volatile. Financial assets are abstract and intangible; and it is difficult for a trader to judge their own performance. Leveraging, that is gearing up purchases of financial assets with borrowings to magnify the net returns, has exacerbated the potential for overinvestment during euphoric phases. Also, a lot of financial market activity has been directed towards securing comfort and reassurance rather than identifying the real reasons why things went wrong. Tuckett suggests solutions that focus on extracting the glamour and excitement from people's perceptions of financial trading. Developing statistical barometers of financial market temperature can be used to restrict financial innovations or increase capital ratios during fragile times when markets are heating up.

Financial herding

One key channel via which emotions affect traders' decisions is via the phenomenon of herding. Financial traders are as prone to social influences (introduced in Chapter 6) as any other decision-maker – perhaps more so because they are dealing with scenarios in which outcomes are fundamentally uncertain. Partly, traders' susceptibility to following the crowd, as for anyone's susceptibility to social influence, may reflect the fact that tendencies to follow the crowd reflect socialization: from childhood onwards, we learn to respond to others around us, building on our hardwired evolved instincts to imitate – an essential part of our character as social animals. These responses manifest themselves in financial markets too, meaning that social emotions encourage traders to respond to group pressure (Baddeley 2018). In financial markets, emotions have particularly strong power, partly because modern financial markets move so fast and also because of uncertainty about what might happen next with asset prices – will they go up or down? Most of the time this is impossible to predict, and so what others are doing has a disproportionate impact.

In volatile markets, when an individual trader panics then their panic can precipitate "social panics", reflecting an interplay between risk, anxiety and fear (Loewenstein *et al.* 2007).

Neuroscientific techniques can enable the identification of the neural correlates of these social influences. Various studies have tested hypotheses about the theory of mind and empathy and these have implications for understanding herding in financial markets. There is evidence that socialized instincts to imitate are associated with mirror neuron activity (Iacobini 2005; Rizzolatti and Craighero 2004). This may suggest that herding responses are automatic and "hardwired" and the outcome of impulsiveness. Single-cell recordings in monkeys have identified mirror neurons in the premotor cortex (PFC) which fire not only when monkeys perform grabbing movements but also when the monkeys observe similar movements performed by experimenters (Rizzolatti *et al.* 2002). Extending this finding, experiments show that monkeys' *socialized* instincts are also propelled by the activity of mirror neurons and these insights have been extended to describe human instincts to follow others (e.g. see Iacobini 2005; Rizzolatti *et al.* 2002; Rizzolatti and Craighero 2004). Baddeley *et al.* (2005) suggest that mirror neuron activity may explain imitation and herding in socio-economic contexts too.

Herding can also be conceptualized as the outcome of interacting thought processes linking into neuroeconomic insights about the interaction of the cognitive, controlled, emotional and automatic responses (Baddeley 2010). Learning from others using Bayes's rule would be an objective way of deciding but a cognitive impression formed via Bayesian reasoning may interact with less objective emotional processing. If economic behaviour, herding and other forms of social influence included, reflect interactions of different neurological systems then a neuroeconomic approach, which blends economics, psychology and evolutionary biology with social neuroscience, will provide an explanation of herding as the product of both cognition and emotion. An interdisciplinary approach is essential to understanding how and why herding and social influence evolve in an economic and financial context.

In distinguishing social learning from social influence more generally, there are a number of neuroeconomic studies that explore some of the neural correlates of social influence. Berns *et al.*'s (2005) functional magnetic resonance imaging (fMRI) studies of visual mental rotation tasks incorporate Asch's ideas about social conformity (described in Chapter 6). Berns *et al.* found that conformity is associated with activation in the occipital-parietal network, particularly when following incorrect signals from others. On the other hand, amygdala and caudate activation is associated with independent decision-making.

Klucharev *et al.* (2009) identify a link between social conformity and learning using an fMRI study to show that conformity draws on mechanisms that reflect reinforcement learning principles. They found that conflict with social opinions led to differential activations in the rostral cingulate and the ventral striatum, areas also activated in models of reward prediction error, as explored in Chapter 5. Klucharev *et al.* (2011) extend these insights in a study of social influence applying transcranial magnetic stimulation (TMS) techniques. As explained in Chapter 11, these techniques involve applying electromagnetic induction for temporary, benign stimulation of specific neural areas.

Klucharev *et al.*'s subjects were sorted into three groups: a control group; a "sham" TMS group receiving sub-threshold levels of TMS; and a TMS group. Then, they were asked to participate in a two-stage "seeing beauty" task: they were asked to record their perceptions about the attractiveness of a series of photos of female faces. In the first stage, they were asked for an initial rating of the attractiveness of the faces on an 8-point scale. They were then given social information about others' perceptions of attractiveness using the average ratings from all the experimental subjects. In the second stage, the subjects were asked again to rate the attractiveness of phases. The TMS group received TMS inhibiting the activity of the neurons in the posterior medial frontal cortex – an area involved in reward prediction – before they gave their second-stage ratings. Overall, Klucharev *et al.* found that the ratings from the control and sham groups were responsive to the information about average perceptions; however, the TMS group experienced significant reductions in conformity in their ratings of attractiveness after receiving TMS. Klucharev *et al.* conclude that this confirms the link between social conformity and reinforcement learning.

Burke *et al.* (2010b) develop these neuroeconomic analyses of social learning and conformity specifically in the context of financial herding. They use fMRI techniques to analyse social influence in financial decision-making. They show that when subjects are offered the opportunity to buy versus reject a stock, the ventral striatum is differentially activated if subjects' decisions coincide with decisions of a group. Furthermore, when subjects were balancing social information about a group's decisions against private information in the form of stock charts capturing a stock's historical performance, the probabilities of buying conditioned on social information correlated with differential activations in the ventral striatum – an area associated with emotional processing of reward.

Other fMRI studies have been used to capture social influences on traders' decisions. Burke *et al.* (2010b) analysed neural activations when players were deciding between social information about a group's opinion and private information about the recent performance of a financial stock. Related analyses also suggested that amygdala and ventral striatum activation might correlate with conformist decisions (buying a stock when a group is buying it) versus contrarian decisions (buying a stock when the group *is not* buying it) depending on an individual's characteristics and personality traits. As explained above, the ventral striatum is implicated in reward processing. Other studies have shown that the amygdala is implicated in aversive learning, that is, when people are feeling fearful.

Weaker rationality assumptions can be maintained if traders' herding behaviours are still the outcome of calculations based on mathematical algorithms. In Bayesian models, for example (as we saw in Chapter 6), prior probability judgements are being updated systematically and logically using others' actions as new information arrives (e.g. see Banerjee 1992; Bikhchandani *et al.* 1992; Chamley 2003). From a Bayesian perspective, a rational agent will use every bit of available information, including social information about the actions of others. Herding can be understood as an extension of principles of rational behaviour whilst nonetheless allowing that human actions are not necessarily independent. Bayesian models explain herding in the form of information cascades as a process of sequential learning on a microeconomic scale with people updating probabilities sequentially as the decisions of other individuals are revealed.

Emotions play a key role in traders' susceptibility to social influences. Some neurofinance studies have shown that brain areas associated with the processing of fear are activated when financial decisions are affected by herding influences. Burke *et al.* (2010b) and Baddeley *et al.* (2010), again using fMRI evidence, analyse differential activations for herding decisions (decisions to buy a stock when the group buys and reject it when the group rejects) versus contrarian decisions (decisions to reject when the group buys and buy when the group rejects). As shown in Figure 15.1, financial herding is associated with differential activations in the amygdala and anterior cingulate cortex.

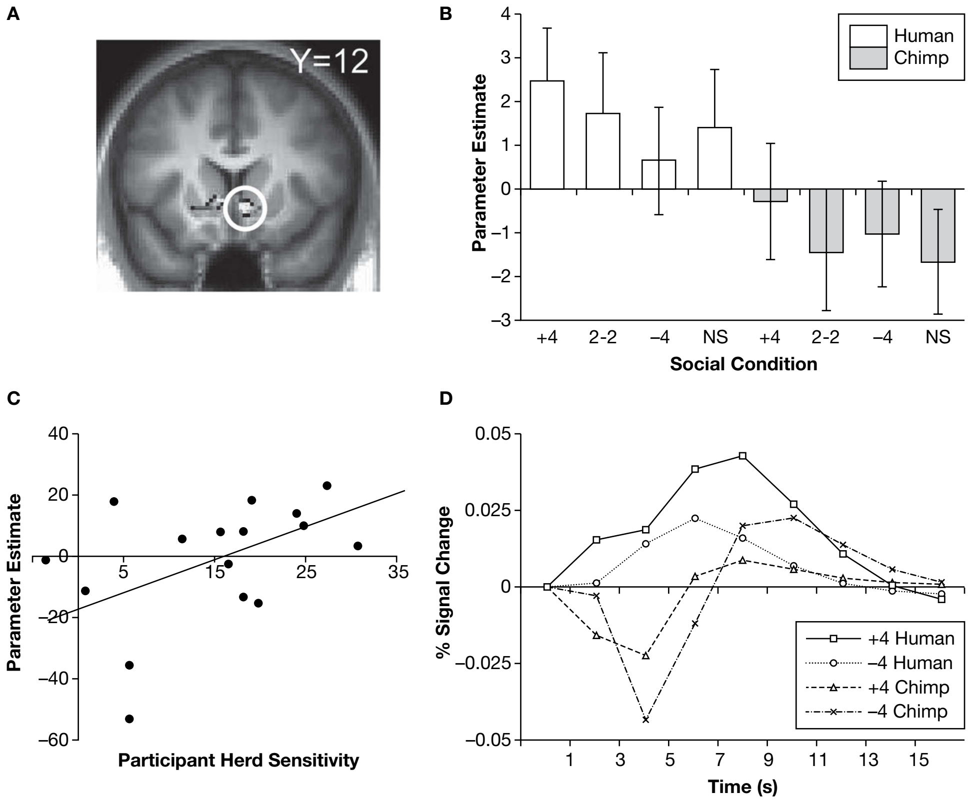

Figure 15.1 Neural activations during financial herding

These differential activations suggest a role for fear because the amygdala is commonly associated with aversive learning and the emotional processing of fear. Overall, the evidence about the differential activations in the ventral striatum and amygdala suggest that there may be interactions between fear, social reinforcement learning and reward in financial decision-making.

~

In this chapter, we have explored the various ways in which emotions affect financial traders' decision-making – and the impact of emotions is particularly pronounced for traders because they are often making decisions in the context of profound uncertainty and limited information. This means that emotions may be an important guide for them and if these emotional responses are capturing something of their implicit knowledge and intuition, then the role played by emotions in driving trading is not necessarily a bad thing. When emotions distort perceptions of risk, however, their role will be less benign. When the negative impacts of emotions – for example, in magnifying risk-loving or risk-avoiding behaviours in the context of fear and greed – are significant and particularly when magnified further by the social influences that encourage traders to follow the crowd, then there will be significant negative consequences. These negative consequences will affect not just traders and speculators themselves but will also have an impact on financial markets generally – a theme to which we will return in Part III.

Chapter summary

- The financial trading decisions of individual traders and speculators are often driven by interactions between reason and emotion.
- The impact of emotions on trading does not necessarily mean that trading will be poorly informed as – consistent with Antonio Damasio's somatic marker hypothesis introduced in Chapter 9 – emotions can be a good guide to decision-making.
- Emotions such as greed and fear determine traders' perceptions of risk and this affects their trading patterns.
- Heuristics and bias in traders' decision-making can reflect emotional influences, for example via the affect heuristic which is about how decision-makers use emotions as a decision-making guide because emotions are quick and easy to remember.
- Traders' emotions are also determined by social influences – specifically financial herding which often has a powerful influence in situations where the future prospects for financial assets are uncertain and hard to predict.

Review questions

1. When a trader's financial decisions are affected by their emotions, is this rational or irrational or neither? Explain your answer.
2. Describe some of the different channels via which emotions affect financial trading decisions, explaining whether or not each of these channels is about the positive versus negative impact of emotions on decision-making. Illustrate with examples.
3. How and why are financial traders driven by social influences and why might these social influences be more destabilizing when the information to which traders have access is poor and uncertainty is endemic?
4. Explore some of the different tools and techniques used in neurofinance to capture the impact of emotions on trading behaviour. How reliable do you think this evidence is and what are the pros and cons of neurofinance evidence versus data conventionally used by economists, for example historic data from financial databases?

Part III

Macroeconomics and financial systems

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Chapter 16

Behavioural macroeconomics

Behavioural economics is mostly about microeconomic phenomena and the concepts focus on the motivations underlying individual behaviour. Applying these microeconomic principles to macroeconomic analysis is complicated by the limits to aggregation. Whilst standard models aggregate, by assumption, from atomistic representative agents, behavioural economics focuses on individual differences, social interactions, behavioural biases and non-rational forces including emotions and visceral factors which are difficult, if not impossible, to aggregate. Behavioural influences mean that the macroeconomy cannot be a simple sum of its parts.

Whilst little has been done on behavioural macroeconomics it is nonetheless important to understand how and why behavioural factors affect macroeconomic outcomes. This chapter attempts to put together some ideas and insights from behavioural economics to enable a better understanding of how and why the psychology of individuals affects the macroeconomy. To understand how and why behavioural insights are so important in developing a stronger foundation for macroeconomic theory and policy, it is important to understand why and how mainstream macroeconomics is constrained by its theoretical structure once psychological influences are brought into the analysis. So, we will start with an exploration of some of the foundations of the dominant paradigm in macroeconomics – built on the microfoundations of neoclassical economics, which we explored in previous chapters.

Mainstream macroeconomics

As we explored in Part II in the context of financial decision-making, behavioural economics offers alternatives to the microeconomic assumptions usually embedded in economic theory. In orthodox macroeconomic theory, stringent assumptions are used to construct aggregate models and these are needed because otherwise it is not easy to capture how the actions of different "agents" – the constituent parts of the macroeconomy – come together in the macroeconomy as whole. By embedding some assumptions, all the workers/consumers and employers/producers in the economy can easily be added together. To enable this aggregation, macroeconomists make some more assumptions, including:

a. The *rational expectations hypothesis* – which we explored in Part II in the context of financial decision-making. This is about very clever, well-informed agents responding quickly and efficiently to the arrival of new information so they do not make systematic mistakes.
b. The *representative agents hypothesis* (RAH) that the average behaviour of all agents within a group can be described by the behaviour of one representative agent. For example, if the representative household is a utility maximizer then this describes the behaviour of all households. For example, if the RAH works well then aggregate consumption across the whole macroeconomy can be calculated just by multiplying the behaviour of a representative household by the number of households in the macroeconomy as a whole.
c. *Consumption smoothing*, that is, people aim for a steady stream of consumption over their lifetimes and are enabled in this by an ability to save or borrow via perfect financial markets.
d. *Ricardian equivalence*: rational agents view different forms of government finance as equivalent. If governments finance spending via borrowing to keep taxes low today, then rational agents will realize that today's relatively large disposable incomes are ephemeral and government borrowings will have to be repaid via higher taxes in the future. A rational consumption smoother will plan for these future tax rises by cutting consumption today and saving more for tomorrow.

In macroeconomics, aggregation does introduce additional problems for standard models and, in developing a good behavioural theory, we confront the same dilemma. Whilst behavioural economics almost by definition abandons the representative agents hypothesis this does still generate questions about how we can understand the macroeconomy and financial markets if there is heterogeneity amongst people, though this problem can be addressed to some extent via agent-based modelling in which sub-populations of agents are characterized using different behavioural assumptions.

Keynes's psychology of the macroeconomy

One of the pioneers in bringing psychological influences into macroeconomic analysis was renowned 20th-century economist, John Maynard Keynes. Keynes's major work was *The General Theory of Employment, Interest and Money* but some of the key insights were developed much earlier in his career, specifically in his *A Treatise on Probability* (Keynes 1921), which was based around his undergraduate dissertation. In this book, rather than constructing a model of rationality and assuming that all economic agents behave accordingly, Keynes explores the limits of individual rationality and the impact of socio-psychological forces on macroeconomic phenomena. Psychological motivations mean that different people will behave in different ways. Some economists conclude that Keynes's analysis is based on an underlying assumption of rationality given uncertainty, reflecting themes developed in *A Treatise on Probability* (Littleboy 1990, Bateman 1990, Skidelsky 1992, and Dow and Dow 1985). In contrast, Shackle (1955, 1967, 1972), Winslow (1986) and Mini (1990) emphasize the subjectivism of economic behaviour and, to them, Keynes presents the volatile characteristics of the economy emerging as a result of "irrational forces, vicious tendencies, destructive fetishes and dangerous human proclivities".

Some analyses reconcile these views, arguing that Keynes describes behaviour which is not strictly rational in a standard sense but is nonetheless reasonable in a broader sense and consistent with Herbert Simon's concepts of bounded and procedural rationality, explored in Chapter 14 (Minsky 1975; Lawson 1981; Carabelli 1988; Littleboy 1990; Runde 1997; Davidson 1991; Crotty 1992; Baddeley 1995; and Howitt 1997, amongst others). For example, expectations and conventions are sensible and reasonable rather than strictly rational or irrational; they are not like customs/habits, they reflect rational, purpose-oriented behaviour under uncertainty and they promote coherent behaviour (Littleboy 1990).

Keynes's fundamental psychological laws

Keynes was unusual amongst economists in that he constructed a model of the macroeconomy that focused on the impact of psychological forces. Keynes (1936, 1937) argued that economic and financial decision-making is driven by a series of "fundamental psychological laws": the propensity to consume, attitudes to liquidity and expectations of returns from investment. Psychological forces are important when the world is uncertain: decision-making is fragile because uncertainty and knowledge are very precarious and it is difficult to form reliable predictions of future events.

Expectations and the state of confidence

Expectations are central to Keynes's psychological analysis of the macroeconomy. He argues that entrepreneurs, when making decisions about the scale of their production, do not have just one expectation about future production and profits but a bundle of expectations held with varying degrees of probability and weight. When it comes to choices however, the entrepreneur will act as if his/her behaviour is the outcome of one undoubting expectation held with certainty and will utilize the expectation with the greatest weight (Keynes 1936, p. 24). Aside from some esoteric differences, Kahneman and Tversky's (1979) concept of weight in the prospect theory weighting function parallels the concept of weight in Keynes (1921, 1936). Keynes (1936) argues that rational judgements of weight underlie the convention of assuming that current events and recent results can proxy for short-term expectations (Keynes 1936, p. 51).

Weight also determines the state of confidence – a global, diffuse force similar to Prechter and Parker's (2007) socionomic concept of social mood. The state of confidence affects a number of macroeconomic phenomena. It plays a crucial role in determining investment indirectly because it affects profit expectations and demand for money. A weakening state of confidence is associated with lower weights and higher liquidity premiums. When the state of confidence is buoyant, judgements of weight are possible. When the state of confidence becomes more fragile, judgements of weight are more difficult. In the latter case, there will be no guide to rational action and non-rational forces will predominate. The state of confidence is not analysed in much detail in standard economic analyses and Keynes argues that our understanding of it must be based on empirical observation rather than *a priori* theory.

Keynes's analysis also links to Tversky and Kahneman's (1974) analysis of heuristics and biases, in particular the anchoring and adjustment heuristic. Keynes observes that recently realized results will be weighted heavily when expectations are formed because using more rigorous but complicated methods of forming forecasts of the future will be disproportionately costly. In this way, Keynes uses the concept of weight to explain the heuristics that determine business confidence:

> It is reasonable, therefore, to be guided to a considerable degree by the facts about which we feel somewhat confident, even though they may be less decisively relevant to the issue than other facts about which our knowledge is vague and scanty.
>
> (Keynes 1936, p. 148)

Macroeconomic conventions

In Keynes's model, conventions play a key role in determining the state of long-term expectation, a force that has significant impacts on entrepreneurship and investment (Keynes 1936, pp. 152–153) According to Keynes, conventions may be rational, non-rational or irrational/psychological depending on the nature of belief underlying them; for example, the convention of assuming that the existing situation will persist appears to combine rational and non-rational elements because it is based in knowledge:

> We are assuming, in effect, that the existing market valuation... is uniquely correct in relation to our existing knowledge of the facts which will influence the yield of an investment, and that it will only change in proportion to changes in this knowledge.
>
> (Keynes, 1936, p. 152)

Keynes argues that the "conventional valuation which is established as the outcome of the mass psychology of a large number of ignorant individuals is liable to change violently" (Keynes 1936, p. 154). Keynes's conventions have both a reasonable and a psychological element: they become self-fulfilling prophecies and therefore to assume that they will continue becomes the most reasonable thing to believe, once the convention is established (Lawson 1995). Also, it is reasonable for an ignorant individual to rely on conventions because other economic actors may be acting on better information and "we endeavour to fall back on the judgement of the rest of the world which is perhaps better informed" (Keynes 1936, p. 217). This links to the social learning theories analysed in Chapters 4 and 15. Conventions are maintained by psychological factors: people prefer stable routines; conventions lull anxiety created by uncertainty about the future (Lawson 1995; Earl 1983).

It is difficult to analyse conventions because they reflect the overlap between individual and aggregate behaviour and are associated with feedback effects: aggregate behaviour affects individual behaviour and vice versa. It may not be rational for one individual to believe in isolation that the current state of affairs can be projected into the future, but outcomes are determined by aggregate behaviour and so a conventional belief held by many that the current situation is a sensible guide to the future does have a reasonable basis. What is individually rational and what is socially rational are different things, an insight also offered by Vernon L. Smith in his analysis of the links between social rationality and individual irrationality in ecological rationality (Smith 2003a).

Keynes also explained how conventions and behavioural biases affect money markets and attitudes towards money. For example, in the determination of interest rates: although the rate of interest is established by convention, dealers nonetheless perceive it to have an objective basis. The belief that the interest rate has its roots in objective grounds may lead to an inappropriate complex of interest rates prevailing due to these mistaken beliefs. This may lead to suboptimal levels of employment being maintained over periods of time as the conventional, relatively stable but high long-term rate of interest prevails. Some psychological analyses of money draw on Freudian psychodynamic themes in Keynes. For example, Winslow (1986) applies money-loving instincts and Freud's analysis of the anal personality, characterized by a triad of traits including miserliness, orderliness and cleanliness. In this way, Winslow blends ideas from Freud and Keynes to explain attitudes towards money.

Entrepreneurial animal spirits

In Keynes's analysis, psychological factors also propel business entrepreneurs facing uncertainty. Entrepreneurs have "sanguine temperament and constructive impulses" embarking on "business as a way of life". It is impossible to predict the long-term future prospects of a new enterprise so those that do start up new businesses are not preoccupied with quantifying profit expectations. The psychological force of "animal spirits" takes over "so that the thought of ultimate loss which often overtakes pioneers… is put aside as a healthy man puts aside the expectations of death". The problem comes because entrepreneurs are easily discouraged by crises of confidence and adverse economic, political and social changes will slow entrepreneurial investment; thus, slumps and depressions are exacerbated.

According to Keynes, entrepreneurs will be guided by conventions in the same way that speculators are guided by them, but they will also be affected by broader socio-psychological forces too, in particular animal spirits. The existence of animal spirits was postulated by Galen, an ancient Roman physician, who asserted that "*spiritus animalis*" had origins in the brain and mediated nerve function.

Linking Galen's animal spirits with economics, Keynes introduced animal spirits in his analysis of entrepreneurship: entrepreneurs cannot properly calculate the future benefits of investments because the future is not easily quantifiable. Keynes describes entrepreneurial animal spirits as a spontaneous urge to act and intervene, even when there is no rational basis for action. He observes that most decisions:

> to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as a result of animal spirits – of spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities. Enterprise only pretends to itself to be mainly actuated by the statements in its own prospectus, however candid and sincere. Only a little more than an expedition to the South Pole, is it based on an exact calculation of benefits to come.
>
> (Keynes 1936, pp. 161–162)

Keynes's analysis of animal spirits also emphasizes the role of emotions including hope and fear:

> Thus if the animal spirits are dimmed and the spontaneous optimism falters, leaving us to depend on nothing but a mathematical expectation, enterprise will fade and die; – though fears of loss may have a basis no more reasonable than hopes of profits had before.
>
> (*ibid*, p. 162)

Entrepreneurs' reliance on animal spirits reflects uncertainty and limits on quantification.

As Dow and Dow (2011) emphasize, Keynes did not describe animal spirits as an irrational phenomenon and so the concept does not fit easily into economists' dichotomous categories of rational/irrational. For entrepreneurial investment decisions in particular, a large number of alternatives exist and none are obviously more rational than the others. If it is not possible to rank alternatives, then entrepreneurs will be driven by motivations which are not rational in the sense of being evaluated in terms of consequences but are instead determined by psychological forces:

> Generally speaking, in making a decision we have before us a large number of alternatives, none of which is demonstrably more 'rational' than the others, in the sense that we can arrange in order of merit the sum aggregate of the benefits obtainable from each. [Therefore] we fall back... on motives of another kind, which are not rational in the sense of being concerned with the evaluation of consequences but are decided by habit, instinct, preference, desire [and] will.
>
> (Keynes 1979, p. 294)

Agents are nonetheless doing the best that they can in the circumstances and this conception of rational behaviour is consistent with Simon's concept of procedural rationality in which agents' actions are the outcome of appropriate deliberation (Simon 1979).

In terms of the concepts in *A Treatise on Probability*, if animal spirits are a desirable force, then they can be justified as a form of rational *action* even though they do not emerge from a rational belief, that is, a probability judgement. With uncertainty, knowledge will be vague. There may be no information available on which entrepreneurs can base their expectations. Two courses of action are available: they can rely instead on non-rational forces to drive behaviour or they can do nothing. Doing nothing delivers nothing. Often, it is better to rely on animal spirits and spontaneous urges to act. Relying on animal spirits will not necessarily be an irrational *action* even though there is no basis for rational *belief*.

A behavioural analysis of macroeconomic interactions

The assumptions of macroecnoomic theory outlined at the beginning of this chapter, and Keynes's analysis of psychological forces in the macroeconomy are very different ways of thinking about macroeconomic phenomena, so how can we reconcile them? Keynes's concepts of conventions and animal spirits are a crucial link developed in behavioural macroeconomic theory. Often, behavioural macroeconomics starts with something like the microeconomic foundations from orthodox macroeconomic theory. These mainstream approaches have been influential in macroeconomic policy-making and are often grounded in dynamic stochastic general equilibrium (DSGE) models. These models are dynamic because they capture decisions over time and they are stochastic because they incorporate a random element. Perhaps more importantly, they are founded on the rigorous microfoundations of general equilibrium theory in which firms and workers/households interact in supplying labour and producing goods/services. General equilibrium models rest on a range of assumptions about rational maximizing agents, perfect information, perfectly functioning markets and full employment, amongst other assumptions – as noted above. One crucial behavioural assumption to this, that we introduced at the start of this chapter, is the representative agent hypothesis: macroeconomic outcomes are understood in terms of interactions between homogeneous workers and firms – with individual differences and interactions generally relegated to stochastic error terms. This reflects a general characteristic of standard macroeconomic models. They often describe the behaviour of a very small number of representative individuals – multiplied.

Behavioural economics and DSGE models do not rest easily together. In addition, whilst the standard macroeconomic approach is prone to aggregation problems (the whole is not necessarily equal to the sum of its parts, even if the parts are the same on average), behavioural macroeconomics faces substantial additional challenges. It is inconsistent with the essence of a behavioural approach to use one representative agent to describe general behaviour. Individual differences, not only in risk aversion and time preference, but also in cognitive skills, personality traits and emotional predispositions, are central to behavioural economics. And, even if representative agents can be described, it is not consistent with behavioural economics to assume that they act independently: they will interact with each other in response to social learning, social pressures and social preferences. These problems mean that behavioural macroeconomic theory will have to take a different approach.

Akerlof (2002) assessed the progress towards the development of behavioural macroeconomic theory, arguing that the standard approaches did not convincingly address macroeconomic problems such as involuntary unemployment and under-saving. He assessed the progress of behavioural macro in terms of relaxing assumptions of perfect information (in literatures on asymmetric information), capturing involuntary unemployment in terms of social preferences such as fairness and reciprocity, using cognitive psychology to capture monetary policy-making, introducing prospect theory into the analysis of nominal wage resistance, incorporating time inconsistency into savings models using hyperbolic discounting function, and developing analyses of heuristics and biases to capture irrational exuberance in asset markets. Akerlof's assessment of behavioural macro, along with insights from Keynes, led to the development of Akerlof and Shiller's model of animal spirits in the macroeconomy, as described in more detail below.

Following from Keynes, in behavioural macroeconomics, actors can be divided in four key sets of players – equivalent to the agents in standard macroeconomic models: firms, households/workers, speculators and government. But whilst the agents and actors are roughly divided in the same way, the behavioural assumptions made about their motivations and interactions are very different in behavioural macroeconomics. In standard macroeconomics, agents are like mathematical machines – looking just at the economic drivers. By contrast, in behavioural macroeconomic models, the actors will each be affected by the range of psychological/behavioural influences – paralleling some of Keynes's insights about psychological drivers. Different agents within the macroeconomy – whether consumers, entrepreneurs, investors, speculators, employers or workers – will be affected by moods and emotions in different ways, partly reflecting the fact that moods and emotions correlate with risk-taking. An employee may – on average at least – be less likely to take risks than a speculator, for example. Effective decision-making will be constrained by cognitive biases and time inconsistency. Social influences have strong impacts human decision-making and people will tend to herd behind conventional wisdoms and actions.

Different groups will be affected in different ways. At a household level, individual differences such as age, education, income and socio-economic background will affect people's susceptibility to psychological constraints. Psychological factors and individual differences will partly explain the vulnerability of some households/individuals to financial fraud and exploitation. Households, speculators and entrepreneurs will interact and their psychologies will coalesce to affect the general state of confidence, generating self-fulfilling speculative episodes and financial fragility, especially when regulatory institutions are not designed to take account of these vulnerabilities.

For business, entrepreneurs will be affected by fluctuations in mood and emotion, loosely categorized as animal spirits. They will be less susceptible to time inconsistency and herding because they will be more far-sighted than speculators and households. Speculators will be strongly affected by emotions such as fear and greed; there will be differences between professionals and amateurs with amateurs more susceptible to herding tendencies, time inconsistency and other forms of cognitive bias. Households will be particularly susceptible to cognitive bias and time inconsistency.

A key contribution to the behavioural macroeconomic literature that captures some of these interactions is George Akerlof and Robert Shiller's book *Animal Spirits: How Human Psychology Drives the Economy, and Why It Matters for Global Capitalism* (2009). Akerlof and Shiller develop Keynes's analysis of the psychological forces in the macroeconomy to build a macroeconomic analysis based on the animal spirits of workers, savers, speculators and governments as well as entrepreneurs. In this, they extend Keynes's concept of animal spirits in order to capture a wide range of macroeconomic phenomena including financial crisis, depression and involuntary unemployment. They define animal spirits broadly, as the psychological factors affecting human behaviour (Akerlof and Shiller 2009).

They define five animal spirits: confidence, fairness, corruption, money illusion and storytelling – the narratives that shape our sense of self and others. Many of these non-rational forces are caught up with socio-psychological motivations and whilst these are woolly concepts and therefore difficult to analyse, there is increasing evidence that they are relevant. Akerlof and Shiller argue that non-economic motivations, such as irrationality and the animal spirits, are central to human decision-making. "You pick the time. You pick the country. And you can be fairly well guaranteed that you will see at play in the macroeconomy the animal spirits that are the subject of this book" (Akerlof and Shiller 2009, p. 171).

Akerlof and Shiller's animal spirits will interact. If the state of confidence is strong and people are optimistic, then the macroeconomy will be vulnerable to waves of euphoria, optimism. Some of these ideas about optimism have empirical support from neuroscientific studies. Sharot *et al.* (2007) used fMRI methods to examine overoptimism whilst subjects imagined the contrast between positive and negative future events. They found that optimism is associated with differential activations in the amygdala (associated with emotional processing) and the anterior cingulate cortex, both areas associated with emotional processing. Abnormalities in these areas are also associated with depression and pessimism.

The downside of optimism is that it is linked to speculators' overconfidence, which can precipitate herding and speculative bubbles. Optimism bias in the macroeconomy also has its mirror image when macroeconomies tip over towards pessimism bias. When the state of confidence is weak and people are pessimistic, the macroeconomy will be prone to slumps and financial crises. These forces will spread via storytelling, word of mouth and false intuitions – for example, the false intuition that house prices can't fall – feeding herding and contagion, all perturbed by anything from dramatic news stories to sporting events. Asset prices will be susceptible to feedback loops, with instability further magnified by leverage with knock-on effects for the real economy as herding and speculative bubbles exacerbate instability, affecting wealth, investment, and the availability of finance. In this way, Akerlof and Shiller's animal spirits determine market trends.

Akerlof and Shiller also identify other social influences as the product of animal spirits because market confidence is a form of social information and stories including the form of naïve folk wisdoms about financial market trends are communicated via social interactions. Akerlof and Shiller use an example of house prices: the story that spread before the collapse in US housing markets was that house prices could only go up; they could never go down. Markets fluctuate erratically; reflecting social mood, and waves of euphoria, optimism and overconfidence will be followed by slumps of pessimism and crises of confidence, all spreading through the economy via herding and contagion. These are fed by word of mouth and false intuitions (such as that prices don't fall) and perturbed by a wide range of catalysts from dramatic news stories to unexpected sporting results.

Overall, Akerlof and Shiller acknowledge that psychological and sociological analyses are often eschewed in standard macroeconomic analysis because they are arbitrary and difficult to quantify but nonetheless they advocate a move away from economists' typical antipathy towards socio-psychological explanations. They emphasize the importance of history and stories, and of qualitative alongside quantitative analysis (see also Dow and Dow 2011).

Consumption and saving

Akerlof and Shiller (2009) apply their conception of animal spirits specifically to the puzzle of consumption and savings. In standard macroeconomic models, consumption and saving by individual households are key driving variables. Consumption drives aggregate demand and can help to contribute to economic growth within an economy. Households' savings help to support businesses' investment in building their capital stock – as we saw in Chapter 14. The importance of consumption versus savings differs across the different approaches to economic theory. Keynesian economists, drawing on essential insights from Keynes, tend to highlight the importance of consumption over saving in driving macroeconomic demand. Orthodox macroeconomic theories often focus on savings as the ultimate driver of macroeconomic growth. This is not the book to explore the macroeconomic debates within economics about the relative importance of savings versus consumption. Here we will focus on how behavioural influences affect consumption and savings. Akerlof and Shiller draw on experimental evidence from the application of the mental accounting models (introduced in Chapter 13) which analyse the limited fungibility of money: money will be perceived in different ways in different circumstances. Experiments show that people experiencing a windfall gain of $2,400 will consume different proportions depending on the circumstances and context in which the windfall is received. If they receive a windfall as a sum to be spread over a series of monthly payments, then they will spend $1,200. If it's a single lump sum then they spend £785. If it is received as an inheritance then they spend nothing. Rather than treating economic decisions together as one gigantic maximization problem, people assign different events to separate "mental" accounts. These insights help to explain why people accumulate credit card debt at high interest rates whilst simultaneously saving at low interest rates – perhaps explained by ideas about mental accounting developed by Richard Thaler and the broader behavioural literature about how people's decisions are affected by cues and frames. In terms of mental accounting: if people are using different mental accounts for debt versus savings, then it is not so surprising that they hold debt and savings at the same time – especially once liquidity constraints are taken into account too.

As we saw in Chapter 7, a large volume of experimental evidence from experimental psychology as well as economics shows that individuals' discount functions are not stable and people tend to exhibit disproportionate impatience in the short run. The standard exponential discounting model predicts that if a person is making a choice in two situations then those choices should be stable over time. Experimental evidence shows people preferring to take rewards sooner when choosing for the short term than when deciding over longer time horizons. For example, as we saw in Chapter 7, Warner and Pleeter's (2001) study of financial choices by US military personnel shows those preferences for lump sum payments over annuities reflect present bias. Warner and Pleeter also find that different choices correlate with individual differences in age, education and military rank.

Behavioural life-cycle models

A more analytically rigorous way to explore these consumption and savings behaviours have been developed in behavioural business-cycle models of Angeletos *et al.* (2011) and Laibson *et al.* (2007). Some of these insights connect to other themes from behavioural economics that we have already explored – for example, the issue of instability in time preference, which we explored in Chapter 7. Saving is by its nature a forward-looking process and so people's attitudes towards the future, specifically their time preferences, have a crucial impact on their savings decisions. As also explored in Chapter 7, behavioural economics postulates that people use hyperbolic or quasi-hyperbolic discount functions in making judgements about the present value of future rewards.

Embellishing the DSGE models with some insights about behavioural economics, Angeletos *et al.* (2001) and Laibson *et al.* (2007) use behavioural discount functions to construct macroeconomic simulations, similar in empirical style to DSGE models including calibrated, real business-cycle models. Whilst these analyses suffer from similar limitations to standard calibrated models, for example in terms of objective, reliable methods for identifying the parameters used to calibrate the model, they do match real-world patterns of consumption and savings and can help to explain why people accumulate credit card debt at high interest rates whilst simultaneously holding assets that earn low interest rates. Behavioural life-cycle models replace standard economic assumptions about exponential discounting with an assumption of "hyperbolic" or "quasi-hyperbolic" discounting – as explored in Chapter 6 (see also Frederick *et al.* 2002; Angeletos *et al.* 2001; Laibson 1997; Thaler and Shefrin 1981). Angeletos *et al.* (2001) construct behavioural life-cycle models based on quasi-hyperbolic discounting capturing the fact that people hold onto large stores of illiquid wealth (often in the form of housing) whilst simultaneously running up large credit card debts at punitive interest rates.

Another aspect of consumption and savings which is addressed more effectively in behavioural macroeconomic models than in standard models is consumer sentiment, building on seminal insights from George Katona who pioneered macroeconomic consumer sentiment surveys in the US – now the US Consumer Sentiment survey hosted by the University of Michigan.

Consumer sentiment, and its implications for the macroeconomy, has been analysed in a number of ways (Ludvigson 2004). In a macroeconomic context, consumer sentiment is significantly affected by non-economic variables (Earl 2005; Katona 1951). Where consumer confidence is a function merely of conventional economic indicators, it can be modelled without any recourse to psychology but aspects of "the news" draw on emotions such as fear, anxiety and home and can make people nervous or euphoric, producing shifts in aggregate demand which are not generated directly by economic variables (Katona 1951). In this way, the psychological side of expectation formation operates as an "intervening variable".

This proposition is especially significant in affluent societies, particularly when there is widespread access to credit. When income and/or loans are available to spend on luxuries, macroeconomic forces will affect the timing of consumer durable purchases and adoption of new products (Smith 1975). When consumption is also affected by Veblen effects (conspicuous consumption of high-priced goods) interacting with demonstration effects (for example, people observing others' consumption when deciding what to consume themselves), macroeconomic consumption has a different nature to microeconomic consumption and so a macroeconomic analysis needs to do more than aggregate the consumption and savings decisions of one representative household.

Labour markets and unemployment

In standard economic models, labour markets are described in terms of interactions between profit-maximizing firms buying labour/selling goods and utility-maximizing households selling labour/buying goods. The explanatory power of these approaches is limited though introducing asymmetric information into analyses does increase the external consistency of macroeconomic labour market models. Behavioural economists introduce a range of psychological phenomena into the analysis, focusing in particular on the role of social preferences including trust, reciprocity and fairness. Akerlof and Shiller (2009) apply their animal spirits to labour markets. Most markets trade goods which are inanimate and emotionless but labour markets function differently.

Workers can adapt and change with repercussions for work effort. Psychological and sociological factors play a key role. Workers want fair wages (Akerlof and Yellen 1990), they resent their employers if their take-home wage falls, even if the fall in nominal wage is balanced by falling prices. Whilst this behaviour is attributed to money illusion in standard economics, Keynes (1936) explains it in terms of workers wanting to preserve their wages relative to other groups' wages (see also Shafir *et al.* 1997 for a survey of psychological explanations for money illusion). Similarly, workers reciprocate good treatment by trusting their employers. When wages fall, this sparks anger and resentment; workers' morale and sense of duty are offended. Work effort will decline and even as wage costs fall, employers' profit will fall too because worker productivity is eroded.

Heuristics, bias and wages

In Part III we introduced status quo bias – bias that occurs when people focus on the current situation as a reference point and adjust their beliefs and expectations around this reference point, meaning that they are slow to change their mind. This has implications in the macroeconomy via the labour market. Kahneman *et al.* (1996) also study status quo bias in the context of money illusion in wage adjustment. Subjects were asked to consider a scenario in which a company is making a small profit. Subjects are asked to consider two options:

A: Given no inflation, a company manager decides to decrease wages and salaries by 7%.
B: With inflation at 12%, a company manager decides to increase salaries by only 5%.

More subjects (78%) thought that Option B was acceptable whereas only 37% thought that Option A was acceptable. This is a classic nominal wage resistance result seen in macroeconomics – used by some economists as an example of money illusion but explained by Keynes (1936) as reflecting the fact that workers are worried about their relative not absolute positions. In terms of real wages, everyone suffers equally from inflation but nominal wage falls may affect one group disproportionately relative to others.

Unemployment and efficiency wages

One standard explanation for unemployment is efficiency wages. Hiring workers involves a range of costs including costs involved in the process of hiring, firing and training workers as well as other payroll costs. All this means that the cost of a worker is not just the wage that they are paid. So, a profit-maximizing firm, by raising wages, can increase profits by raising labour productivity and/or lowering other labour costs and the efficient wage is the wage that minimizes unit labour costs, that is, total labour costs per unit of output. Efficiency wages involve paying workers a wage in excess of their marginal productivity and this means that the standard labour demand/labour supply relationships will break down. Labour markets will not clear and involuntary unemployment emerges: workers are willing and able to work at the prevailing real wage but can't find a job.

Some efficiency wage models develop a standard approach by focusing on the impact of asymmetric information on hiring and search and analysing the consequences in terms of involuntary unemployment. Firms pay workers a relatively high wage to prevent shirking by making other opportunities seem relatively less attractive, but paying workers a wage above their marginal productivity leads to excess labour supply and involuntary unemployment. It is this involuntary unemployment (rather than the high wage) which disciplines workers in reducing their propensity to shirk because with high levels of involuntary unemployment workers will worry that they won't find a new job if they are fired for shirking (Shapiro and Stiglitz 1984). Other asymmetric information models focus on the role of high wages in overcoming problems of adverse selection; for example, if higher-productivity workers self-select into more highly paid jobs.

Behavioural models of efficiency wages move beyond the problem of asymmetric information analyses to focus on the deeper socio-psychological motivations underlying employer attitudes and worker effort. Akerlof (2002) identifies three psychological and sociological aspects to efficiency wages: reciprocity, fairness and social norms. Akerlof and Yellen (1990) develop some of the themes of fairness and inequity aversion in behavioural economics, as outlined in Chapter 5, in a sociological model of the labour market, based on an effort-fair wage hypothesis. Effort is proportional to the wage paid less subjective perceptions of the *fair* wage – which is determined by the average wage and reflects wages to high- and low-paid workers alike. If the wage paid is relatively low, effort will be disproportionately lower and this explains why unemployment is higher for low-paid groups.

Reciprocity also plays a role in the labour market. Reciprocity is a feature of gift exchange models developed from anthropology. Workers will reciprocate the "gift" of a higher wage by working harder. Higher wages encourage effort and also loyalty and with loyal staff, a firm can reduce its labour turnover costs. Fehr *et al.* (1993) analyse gift exchange games using experimental methods to show that players in experimental markets will offer prices about market clearing levels. They interpret this as evidence in favour of fair wage theories of effort (Fehr *et al.* 1993). Other experimental evidence shows that workers will not play the dominant strategy of minimal effort.

Behavioural macroeconomics is a young discipline and has yet to develop a coherent structure. As more insights are developed within microeconomic analyses of behaviour, these may be constructed convincingly into a theory of behavioural macroeconomics but how effectively to address problems of aggregation remains a problem.

In terms of robust analytical approaches, it is unlikely that mathematical methods can be employed to give behavioural macroeconomic models with analytical solutions. The use of calibration, simulation and agent-based modelling (ABM) could be extended to capture the complexities of macroeconomic interactions but calibrating these models with appropriate parameter estimates remains a problem, and the subjectivity involved means that, even with these technically sophisticated methods, there will be an element of ad hockery.

One potential solution might be to build a model which separates out the various actors within the macroeconomy – identifying specific traits and constraints affecting that group, and bring the actors together using agent-based modelling (ABM). An ABM approach could draw on some robust findings from the analysis of economic behaviour and psychology at a micro scale. Different actors in the economy could be described differently either reflecting their socio-economic context, their roles and/or their basic traits and other individual differences. Another approach would be just to treat the macroeconomy as an organism in itself and focus on the phenomena that emerge without trying to unravel the behavioural microfoundations. Either way, some attention does need to shift towards moving the many useful behavioural insights from the microeconomy to the macroeconomy, and a lot more work needs to be done in finding ways to blend intuitive understandings of how macroeconomies operate with empirical techniques in order to guide policy-making.

Behavioural macroeconomic policy

In current debates, behavioural public policy is generally assumed to refer to microeconomic policies – designed to change the behaviour of consumers and firms. Whilst it is much neglected, it is also important to apply some of the lessons from behavioural economics to macroeconomic policy-making. In Chapter 10, we explored some of the ways in which behavioural insights can be applied to the design of public policy-making – specifically in the form of "nudges", as popularized in Richard Thaler and Cass Sunstein's 2008 book *Nudge*. But whilst some of the insights have been applied to microeconomic decisions with macro implications, mainly they are designed for microeconomic decision-making for households, consumers and individual businesses.

Nudges used in a micro context can have some impact in a macro context, in reducing financial pressures that might be magnified across an economy. In a computerized world, people may procrastinate in protecting themselves from exploitation and fraud, for example they may procrastinate about setting up proper protections when using the Internet for financial transactions. In terms of saving for the future, a person may have good intentions but, in the short term, are unable to resist immediately available alternatives, reflecting problems of temptation and procrastination. The problem will be magnified when present bias reacts with other forms of bias, particularly overoptimism, leading people to be tempted into financial choices that are too good to be true, such as payday loans. The problem is that these microeconomic interventions are unlikely to be enough, especially in the face of global financial crises and recessions, and a lot is needed to bring clear and robust behavioural insights to macroeconomic policy-making.

Less has been done to explore how behavioural economics can come together with macroeconomic policy-making, even though effective macroeconomic policy-making is central to a successful economy and society. There has been a limited focus in behavioural economics on the psychology of policy-makers.

Some policy implications can be derived from contrasting the essentials of behavioural economics with the foundations of the standard DSGE models that we have explored earlier in this chapter. These DSGE models were developed in response to the 'New Classical' economist Robert Lucas's critique of government policy. Lucas and other New Classical economists argued that discretionary fiscal and monetary policy is ineffective because it is undermined by rational expectations: rational agents anticipate discretionary policies and raise their inflationary expectations and wage demands in anticipation of higher inflation. Behavioural economics undermines this analysis because it provides a fundamental challenge to the rational expectations hypothesis – not necessarily in asserting that people are irrational but in suggesting that people's rationality takes a form quite different from the mathematically tractable type of rationality seen in orthodox macroeconomic theory. Given systematic behavioural biases, people's mistakes are unlikely to balance out on average, especially if people are susceptible to herding and social learning.

Akerlof and Shiller's (2009) analysis is a fundamental challenge to the Lucas critique because their focus on the importance of psychological factors in the macroeconomy implies that governments *do* have an important role to play in complementing capitalism, as we will see below.

Another set of policy implications drawing on insights from behavioural economics links to assumptions around time preference, as introduced in Chapter 7 and explored in the context of macroeconomic theory earlier in this chapter. Other mainstream macroeconomists, including Finn Kydland and Edward Prescott, and Robert Barro and David Gordon, have developed the Lucas critique in focusing on the macroeconomic problem of dynamic inconsistency. Policies which are optimal in one period will generate endogenous changes in expectations and a new optimal policy will emerge in the next period, which will change expectations again. Then a different optimal policy will be appropriate but this will change expectations again, and so on and so on. Overall, any discretionary policy will generate unstable shifts in expectations. The policy implication is that governments should not intervene. However, these approaches are based on assumptions not only of rational expectations and perfect information but also of exponential discounting. Incorporating behavioural discount functions into macroeconomic models of policy-making may deliver different results and implications, particularly once political considerations are added into the mix. Political business cycles, and perhaps the Euro crisis and financial crisis too, are partly the product of politicians' present bias. Long-term strategies are undermined by short-term political contingencies and impulses in much the same way that a smoker's plan to give up is undermined by a stressful domestic event. Policy-makers need pre-commitment devices and perhaps central bank independence can be better justified on the basis of behavioural insights about present bias.

More broadly, Akerlof and Shiller (2009) argue that governments play an important role in complementing capitalism and "capitalism must live within certain rules" (p. 173). Given the overwhelming influence of animal spirits "the government must set those rules" (p. 173). Our old financial system is a Humpty Dumpty – it's broken, cannot be fixed and must be replaced and, to moderate the current slump, Akerlof and Shiller advocate that governments adopt a two-target approach in which fiscal and monetary stimuli are complemented by targeting financial flows, for example via lending and capital injections, to ensure that they are consistent with full employment.

To summarize the broad implications of behavioural economics for macroeconomic policy-making: in orthodox macroeconomic analyses – exemplified in the models of the New Classical economists – rational agents are continuously undermining systematic policy-making. The conclusion from the New Classical economists is that policy-makers should stand back and focus on a hands-off, transparent approach. These diktats have softened as New Keynesian macroeconomic theory – which combines the rational expectations assumptions of New Classical economics with a Keynesian approach in which unemployment persists and markets don't clear – came to the fore in the 1980s onwards. Nonetheless, the New Keynesian focus on inflation targeting and central bank independence as essential ingredients to effective monetary policy is still founded on the idea that people are rational maximizers and governments do not need to intervene. Behavioural economics, if it can be effectively embedded within macroeconomic theory, has the potential to transform this approach to policy-making by bringing in a richer and more nuanced understanding of how people's real decisions affect the macroeconomy. Behavioural economics also brings in new insights about the policy goals that governments should be worrying about – including policies to boost happiness and well-being at a macroeconomic scale – a theme we will explore in more detail in Chapter 18.

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Overall, behavioural economics has made less progress in macroeconomic analysis than in microeconomic analysis – but this is true of orthodox macroeconomic theory too. Macroeconomies are complicated by interactions and feedbacks between individuals, firms and industries and these are all difficult to capture within one parsimonious model. In addition, testing the different macroeconomic theories against each other is complicated by the difficulties of collecting data to capture how individual decision-making and interactions between people feed through into macroeconomic phenomena. Without a strong and robust macroeconomic theory, it is difficult effectively to design robust macroeconomic policies – especially when financial instability is added to the standard macroeconomic policy goals framed around boosting employment and stabilizing inflation. New methodological tools – for example, agent-based modelling and other computational modelling techniques – are adding new insights. All these gaps and shortcomings represent an opportunity, however. Of all the areas of behavioural economics and finance, macroeconomics is perhaps the area which still leaves the most to be explored and discovered.

Chapter summary

- Developing a behavioural macroeconomic theory is limited by aggregation problems and complex interactions between different macroeconomic actors.
- Behavioural macroeconomics can offer important insights to explain some of the key themes traditionally explored in conventional macroeconomics, structured into decision-making around consumption–savings, employment, unemployment, fixed asset investment and business cycles.
- Conventions and animal spirits are key influences in many behavioural macroeconomic models – drawing on John Maynard Keynes's original insights about how conventional decision-making drives financial markets and animal spirits, seen in the form of entrepreneurs' urge to act and drive fixed asset investment decisions.
- Akerlof and Shiller have broadened Keynes's concept of animal spirits to extend to a number of drivers of macroeconomic fluctuations, including the five influences of confidence, fairness, storytelling, money illusion and corruption.
- In behavioural alternatives to dynamic stochastic general equilibrium (DSGE) theory, animal spirits are used to capture random shocks driven by behavioural influences, and these models often use agent-based modelling techniques to capture these divergences.
- Behavioural macroeconomic models of consumption–savings draw on key insights about time inconsistency.
- Behavioural insights for macroeconomic policy-making have been limited and this is one area of behavioural economics that needs much more research and analysis.

Review questions

1. What are some of the key constraints and methodological challenges for macroeconomists wanting to build good behavioural models of the macroeconomy? What do you think are some of the solutions to these constraints and challenges?
2. How does Keynes's concept of animal spirits differ from the concept outlined in Akerlof and Shiller's writings? Are animal spirits a useful concept for designing good behavioural macroeconomic theories? Explain your answer.
3. Of the various behavioural insights explored in this chapter, which do you think have the most power to revolutionize our understanding of how macroeconomies work?
4. How are insights from behavioural macroeconomics useful to policy-makers, and are they more useful than insights from conventional macroeconomic theory? Are there other behavioural insights, not covered in this chapter, that you think could be useful in building robust behavioural macroeconomic theories? Explain your answer and illustrate with examples.

Chapter 17

Financial instability and macroeconomic performance

Financial instability is one of the most pressing problems of our time and is affected by a complex nexus of financial, economic and political forces. In the previous chapter we introduced behavioural economics, focusing on the "real side" of the macroeconomy, that is, fixed asset investment, employment, production and output, without saying too much about the financial system. Yet, as the 2007/8 financial crisis and subsequent global recession illustrated, financial instability can have seismic and systemic impacts on macroeconomic outcomes – affecting jobs and production as well as the profits from financial trading. Without understanding how financial decision-making at a microeconomic level feeds through into the real economy, it is difficult properly to capture all the complexities of macroeconomic phenomena. In this chapter, we apply some of the insights about behavioural finance explored in previous chapters, and use them to explain financial instability on a systemic scale. Then we explore impacts on the macroeconomy, to explain how and why unstable financial systems create problems for the "real side" of the macroeconomy, in terms of slowing growth and rising unemployment, and what can be done about it.

Financial market (in)efficiency

From the 1960s onwards, mainstream economic and financial theory highlighted assumptions of rational expectations (Muth 1961) and efficient financial markets (Fama 1965). In these models, the actions of homogenous, independent, self-interested individuals are assumed to be coordinated effectively via the "invisible hand" of the price mechanism. Alongside this smoothly functioning price mechanism, financial markets were also working smoothly because financial speculators are assumed to use information efficiently, systematically and consistently, forming expectations rationally by avoiding systematic mistakes. New information rather than group behaviour influences changes in asset prices (Fama 1965; Muth 1961) and so, in this perfect world, asset prices equilibrate towards the true fundamental values, where the fundamental value is defined as the discounted stream of expected future returns, for example in the case of a stock/share this is the discounted stream of expected future dividends. Given the liquid, fast-moving nature of financial markets, it was also assumed that speculative noise trading would have no significant impact because arbitrage would eliminate it and asset prices would adjust fully to reflect all currently available information. Allowing for differences in risk across assets, an asset's price was assumed to be an unbiased indicator of its fundamental value given its risk profile.

If markets are efficient and people are rational then mistakes should cancel out on average and asset prices will track fundamental values. But this simple story does not easily match real-world experiences of frequent financial crisis. Financial crises have always been common and are difficult to reconcile with these assumptions of rational expectations and efficient markets. So, from the 1990s onwards, a growing number of economists were working on innovations to financial theory particularly focusing on asymmetric information and principal agent problems. But these models still embedded assumptions about people's capacity for rational decision-making. Other economists – including Kindleberger, Shiller and Shleifer – were taking a different perspective in presenting a different view of decision-making in financial markets, analysing problems of mob psychology, panics and irrational exuberance to explain the roots of financial crisis, focusing on phenomena such as herding alongside problems of policy mismanagement (Kindleberger and Aliber 2005; Shiller 2000; Shleifer 2000). These endeavours were given extra momentum following the bailout of Northern Rock in 2007, the collapse of Lehman Brothers in 2008 and the ensuing financial crises. Strict assumptions of rational expectations and efficient markets are unlikely to deepen our understanding of financial crisis and analysis shifted to focus on a wider range of explanations for financial crises including regulatory failures, leveraging enabled by excessive liquidity, asymmetric information and fundamental uncertainty.

In this context, insights from behavioural finance had a particularly powerful role to play in providing a richer explanation in which the psychology of financial speculation, alongside some of the institutional failures in which financial instability was incubated, became an important thing to explain. Behavioural and psychological factors place limits on rational trading, allowing financial instability to spread. Erratic financial market fluctuations can be captured more easily when restrictive behavioural assumptions associated with rational expectations are relaxed at the same time as restrictive assumptions about markets, that is, the efficient markets hypothesis, are relaxed. Behavioural and psychological factors place limits on rational trading.

Time and instability

One way to explain financial instability is via the problem of time inconsistency – introduced in Chapter 7. Partly this reflects short-termism in household decision-making, specifically their savings and consumption decisions. In addition to other forms of bias, financial instability will be exacerbated by present bias and distortions to inter-temporal preferences. In mainstream analysis, short-termism/impatience can be captured by high discount rates but recent developments in behavioural economics and finance have developed a richer understanding of preference reversals and time inconsistency. Present bias can be captured by replacing the conventional assumption of exponential discounting with an assumption of "hyperbolic" or "quasi-hyperbolic" discounting, as explored in Chapter 7 (see also Frederick *et al.* 2002; Angeletos *et al.* 2001; Laibson 1997; Thaler and Shefrin 1981). Angeletos *et al.* (2001) construct behavioural life-cycle models based on quasi-hyperbolic discounting capturing the fact that people hold onto large stores of illiquid wealth (often in the form of housing) whilst simultaneously running up large credit card debts at punitive interest rates.

In explaining financial instability at an aggregate level, a key point is that the consequences of short-termism are not confined to householders and will have consequences for financial stability more generally. With speculative bubbles, financial traders' decisions are disproportionately focused on short-term outcomes: the long-term value of an asset is unimportant if you intend to sell the asset quickly (Keynes 1936, p. 156). If time horizons are short, discount rates are high and financial markets are very liquid, then speculative bubbles mean that the social costs of liquid financial markets may be disproportionately high relative to the benefits in terms of providing quick and easy forms of financing for business investment and consumption. Short-termism, time inconsistency and cognitive bias may limit people's ability to make judicious financial decisions and if macroeconomic factors further undermine their ability to service their debts, either because they lose their jobs and/or they have take on unsustainable forms of debt such as payday loans, then this will exacerbate and prolong household financial problems making default more likely. As householders default, the contagion spreads to their lenders and financial institutions more widely, with negative impacts for the financial system and macroeconomy, as was seen in the fallout to the subprime crisis in the US and also in housing bubbles bursting in other OECD countries during the credit crunch of 2007/8 onwards.

Speculative bubbles

One of the key features of an unstable financial system is its susceptibility to speculative bubbles. But what precisely is a speculative bubble? Speculative bubbles are, by definition, violations of the efficient markets hypothesis because they are about persistent deviations in asset prices away from assets' fundamental long-term value – where the fundamental value is defined as the present value of the discounted stream of expected future returns on that asset. The fundamental value of a share, for example, will be what shareholders expect that share to deliver as dividends (essentially the shareholder's chunk of a firm's net profits), measured in terms of the present value of dividends, if they were to hold the share forever. A speculative bubble in a share occurs when the share's price rises much beyond what the shareholder could expect that share to earn in the future.

Speculative bubbles are an essential feature of financial instability. If markets are efficient and people are rational then mistakes should cancel out on average and asset prices will track fundamental values. When they do not, speculative bubbles emerge and insights from behavioural finance can help to explain how and why speculation emerges and spreads to create financial instability.

Tulipmania was one of the most famous speculative bubbles, as well as one of the more colourful episodes in financial history. For three to four short months from November 1636, demand for tulip bulbs in Holland spiralled out of control and tulip bulb prices exploded; price rises of up to 6,000% were recorded for the rarer tulip bulbs. At the height of tulipmania, a single bulb from the exotic Semper Augustus tulip cost as much as a three-storey house in central Amsterdam (Baddeley and McCombie 2004; Baddeley 2018). Speculative bust followed the speculative frenzy in a way which was just as dramatic. By February 1637, most bulbs became impossible to sell at any price and many tulip speculators lost their fortunes. There are many more recent examples of speculative bubbles, for example the dot.com bubble of the late 1990s, the South Sea Bubble and the global/regional financial crises that predominant today. These, and many other speculative episodes throughout history, have undermined standard financial theories grounded on assumptions of rational expectations and efficient financial markets. Whilst there are models of rational speculative bubbles, these cannot fully explain systematic trends in financial markets. Behavioural finance helps to fill the gap.

Animal spirits in financial markets

A powerful explanation for speculative bubbles and unstable financial markets is the influence of animal spirits. In the last chapter, we explored Keynes's concept of animal spirits in the context of real activity in the macroeconomy, where the real side is about physical, non-financial/monetary outputs and output. Some of these insights can be applied to the financial side too. Originally, Keynes analysed animal spirits just in the context of entrepreneurship arguing that uncertainty about the future prevents entrepreneurs from properly calculating the future benefits of their business decisions. In the absence of a basis for rational calculation, entrepreneurs' decisions will be propelled by spontaneous urges to act and to do something positive (Keynes 1936, 1937).

Keynes did not apply the animal spirits concept to financial markets. As explained in Chapter 16, Akerlof and Shiller take the concept of animal spirits from Keynes but define it more broadly. Their animal spirits include confidence, fairness, corruption, money illusion and storytelling. Also, whilst Keynes focused his analysis on the animal spirits of entrepreneurs engaged in fixed asset investment, Akerlof and Shiller extend the definition of animal spirits to include a broad range of psychological influences. In the context of financial instability, they also explore the influence of animal spirits from entrepreneurs to all economic agents, including financial speculators.

Another way in which Akerlof and Shiller's analysis of animal spirits differs from Keynes is that they applied their analysis of animal spirits to financial systems too, arguing that they have profound impacts on financial instability. Akerlof and Shiller analyse emotional factors in this context, in contrast to the conventional approaches which we outlined above, which assume rational expectations and efficient processing of information in financial markets. Akerlof and Shiller observe that pretending that asset prices reflect rational expectations of future payoffs is like "hiring a weather forecaster who has gone berserk" (Akerlof and Shiller 2009, p. 132). In the place of standard assumptions of rationality and efficient markets, Akerlof and Shiller argue that financial instability is driven by forces of spontaneous optimism and pessimism in financial markets.

All Akerlof and Shiller's animal spirits have the potential to play a role in magnifying financial instability. If confidence is high and people are optimistic, then financial systems and the macroeconomy more generally will be vulnerable to emotions of euphoria, optimism and overconfidence precipitating herding and speculative bubbles. When confidence is weak and people are pessimistic, then the macroeconomy will be prone to slumps and financial crises. Asset prices will be susceptible to feedback loops, with instability further magnified by leverage. The real economy will be affected too as herding and speculative bubbles exacerbate instability, depressing wealth, the availability of finance, investment, employment and consumption.

Animal spirits associated with corruption are a particularly strong theme in Akerlof and Shiller's analysis of financial instability. Akerlof and Shiller suggest that financial instability is associated with the erosion of social preferences around trust, trustworthiness and reciprocity, the dampening of cooperative social norms and other aspects of sociality. Corruption grows during boom times, perhaps when evidence of inequality is less available and salient, but it also creates fragility within the financial system and exposures of fraudulent activity can exacerbate financial downturns. Throughout history, corruption has accompanied the business cycle – from the Prohibition and the Great Depression of the 1930s, to the Savings and Loan crisis associated with the 1991 recession, to the Enron scandal associated with the 2001 recession and to the subprime mortgage crisis which precipitated recent recessions around the world (Akerlof and Shiller 2009).

Some of the other animal spirits identified by Akerlof and Shiller also have the potential to play a role in magnifying financial instability, and their different animal spirits interact with each other. If confidence is high and people are optimistic, then financial systems and the macroeconomy more generally will be vulnerable to emotions of euphoria, optimism and overconfidence precipitating herding and speculative bubbles. When confidence is weak and people are pessimistic, then the macroeconomy will be prone to slumps and financial crises. Asset prices will be susceptible to feedback loops, with instability further magnified by leverage. The real economy will be affected too as herding and speculation exacerbate instability and depress wealth, the availability of finance, investment, employment and consumption.

Moods and weather

Related to animal spirits are the psychological influences reflecting mood, which is a more diffuse influence than emotions which tend to be person- and context-specific. We saw in Chapter 15 that emotions will affect financial decision-making and will contribute to volatility if they weaken the link between asset prices and the fundamental value, that is, the "real" value of assets, and thereby increase susceptibility to bullish asset bubbles and bearish busts. Feedback effects can intensify fear responses to evaluations of risk, precipitating panics. Emotional factors such as nervousness or euphoria can induce shifts in aggregate demand in a way that cannot be explained just using economic analysis (Katona 1951). When all this comes together across groups of traders and speculators, then this can have significant impacts on financial markets as a whole.

One way to capture the influences of mood on financial markets is to unravel some of the drivers of mood – specifically weather. One section of behavioural finance focuses on exploring how financial markets are affected by exogenous weather-induced changes in mood and the knock-on effect of mood in financial markets. The impact of moods on markets has been explored by analysing moods in financial markets.

Kamstra *et al.* (2003) analyse links between depressive moods, risk aversion and financial market activity focusing on the analysis of data on seasonal depression – what is known as "seasonal affective disorder" (SAD) – a depressive state linked to the fewer hours of sunlight experienced during winter seasons. Kamstra *et al.* hypothesize that SAD is associated with increased risk aversion. They adopt the insight from prospect theory that people respond more to changes than to levels and hypothesize that changes in risk aversion prompted by the changing seasons will translate into changes in stock market returns. Returns will be lower in the fall as hours of sunlight decline and higher in the winter when days are starting to get longer again. Kamstra *et al.* estimate stock market returns for markets at different latitudes using lagged returns, an autumn/fall dummy variable, a SAD measure capturing hours of darkness, plus a range of weather variables (e.g. cloud cover, precipitation, temperature) as explanatory variables. They find that their SAD variable has a strongly significant impact on stock market returns and attribute this pattern to the impact of seasonal depression on risk aversion.

Similarly, Hirshleifer and Shumway (2003) have analysed the relationships between mood, sunlight and financial trading activity, making a general prediction that hours of sunlight are associated with a positive mood. They analyse weather data, specifically hours of sunshine and its impact on stock market returns between 1982 and 1989 for 26 international stock exchanges. Similarl to Kamstra *et al.*, they find that daily stock returns correlate positively with hours of sunshine but other aspects of the weather, for example snow and rain, do not correlate with stock market returns. They suggest that weather derivatives could be devised to exploit this weather-related pattern of returns.

Financial herding

In the context of financial instability, in a world of fundamental Knightian uncertainty, emotional factors will interact with socio-economic forces increasing the susceptibility of financial markets to fluctuations in optimism and pessimism. Financial herding is a key channel for some of these social forces, and a strong driver of speculative bubbles. Financial herding is about the inclination of traders and speculators to copy each other – and financial herding models build on some of the drivers of individuals herding – as introduced in Chapters 6 and 15. At an aggregate level, herding in financial markets generates speculative bubbles because traders are responding to what their predecessors have done. For example, if a share trader sees another trader paying a high price for a share then they will pay a high price too, and so the share price builds momentum and spirals up and beyond the fundamental value of the share. More generally, as asset traders follow along behind each other, this creates momentum sending financial asset prices up and up, until the bubble because too big to last, and it bursts. But what explains the tendency for groups of traders to group together and drive instability in this way?

Herding is endemic within financial markets, especially during uncertain times. In standard financial theory, new information rather than group behaviour influences changes in asset prices (Fama 1965; Muth 1961). This problem is particularly stark when information is poor and uncertainty is endemic, leading to asset bubbles/trending in asset prices because traders and speculators have little objective information on which to base their decisions. When these socially-driven behaviours come together across a financial market, this is a key driver of speculative bubbles on a wider scale and this financial instability tips over into the macroeconomy more generally.

This herding behaviour can also reflect present bias if speculative decisions are disproportionately focused on short-term outcomes: the long-term value of an asset is unimportant if you intend to sell the asset quickly (Keynes 1936, p. 156). This insight is important because it suggests that if time horizons are short, discount rates are high and financial markets are very liquid then the speculative bubbles generate negative herding externalities, in which case the social costs of liquid financial markets may be disproportionately high. Returning to the efficient markets hypothesis, herding will stop financial markets efficiently processing information when a financial market is dominated by traders who are worrying what others think, and not worrying about the fundamental, long-term value of assets. This will mean that changes in asset prices will become random – in other words, financial asset prices will follow random walks.

Some of the explanations for herding in financial markets have their roots in Keynes's analysis of speculation. Keynes focused on the relationships between psychological forces and instability including psychological waves of optimism and pessimism that affect financial markets and the social conventions that anchor speculators' expectations. Keynes analysed speculators responding to sociological forces. When uncertainty prevents speculators from using information to form their own clear judgements, conventions will take hold and will encourage speculators to believe what others believe and to do what others do.

Keynes (1936, 1937) pioneered the study of social influences in financial markets perhaps partly a reflection of his financial trading expertise. He blended economics, psychology and finance, explaining financial instability as the outcome of socio-psychological forces, Keynes explained speculation and financial instability as the product of socially-propelled conventions which anchor speculators' expectations and generate psychological waves of optimism and pessimism – thus driving financial market fluctuations. When uncertainty prevents speculators from using information to form their own clear judgements, conventions will take hold and will encourage speculators to believe what others believe and to do what others do.

Financial instability is magnified by a range of social interactions between financial speculators, both amateur and professional. When a financial market is characterized by traders copying each other, then what Keynes calls a conventional valuation will dominate. The market will be driven not by fundamental values but by social conventions. Rational economic agents may have an incentive to follow the crowd and herding will result as a response to individuals' perceptions of their own ignorance. Keynes focused on three main reasons for financial markets to be dominated by conventional valuations and herding: social learning, beauty contests and reputation. These insights endure today in modern theoretical analyses of information cascades (introduced in Chapter 6), beauty contest models of iterative thinking (introduced in Chapter 5) and reputation models.

Social learning

Social learning is about traders using information they gather from observing the actions of other traders. If they see lots of other traders prepared to pay a high price for an asset then they will pay a high price themselves – because they assume that other traders know what they are doing. This herding will be rational if an individual has reason to believe that other agents' judgements are based upon better information than their own: other people's judgements become a data set in themselves. In this way, people will incorporate others' opinions into their prior information set and their posterior judgements may exhibit herding tendencies.

As explained in Chapter 6, Bayesian models explain herding in the form of information cascades as a process of sequential learning on a microeconomic scale with people updating probabilities sequentially as the decisions of other individuals are revealed. On a macroeconomic scale, financial herding cannot easily be explained as the outcome of a sequential Bayesian process and is a more general phenomenon occurring when people respond to social influences by following the group or herd. This will necessarily generate a violation of strict forms of the efficient markets hypothesis because this hypothesis precludes the systematic trends generated by herding in assuming that all changes are unpredictable and asset prices follow random walks.

Keynes (1930, 1936, 1937) described herding in financial markets as a response to uncertainty and individuals' perceptions of their own ignorance. Herding will be the outcome of social learning when people follow the crowd because they think that the rest of the crowd is better informed. In this way, market fluctuations are driven by conventional beliefs rather than fundamental values. Instability emerges because herding affects the general state of business confidence and also generates self-fulfilling prophecies and speculative episodes. Keynes argues that during financial speculation, people will purchase an asset at a seemingly exorbitant price not because they independently believe that the object is worth the cost but because they believe that other people think that it is.

Reputation

Protecting reputations is another social driver of financial herding and financial market instability. If a trader takes risks and performs poorly then they will be less likely to lose their job and/or bonus if other traders have been taking the same risks. There is job security in numbers. Keynes postulated that it is rational to follow the crowd and herd if it helps you to maintain a good reputation, observing that it is better to fail conventionally than to succeed unconventionally (Keynes 1936, pp. 157–158).

Reputation is not about learning from others; it has a broader interpretation. Keynes observed that following others may help individuals to maintain good reputations; it makes sense to follow the crowd because there is safety in numbers.

Scharfstein and Stein (1990) incorporate this insight about social influence into their analysis of herding in fund managers' decisions. Fund managers have to convince people that they are investing wisely and, as short-term performance is not a good indicator of skill, they rely for their reputations on comparisons with peers, building upon Keynes's (1936) insight that it is better to be conventionally wrong than unconventionally right. This will provide incentives to follow others and disregard private information in order to build their reputations. Managers will have an incentive to disregard private information in a world in which reputation matters.

Beauty contests

A third driver of financial herding, according to Keynes, is beauty contests. A financial market trader may spend time second-guessing other traders in a market. If a trader believes that others will buy (or sell) then they will buy (or sell) too because the increases in demand will lead to rising prices, from which you will benefit. This phenomenon is captured in what Keynes (1936) first described as a *beauty contest*. Keynes originally described beauty contests in terms of a newspaper competition: competitors are asked to select from a series of photos not who they think is prettiest but who they think others will think is prettiest, or who they think others will think others will think is prettiest. It is a metaphor for the iterated reasoning that characterizes financial speculation. Speculators are not worrying about what they think an asset is worth; they are more interested in tracking short-term judgements of others and so are more focused on average opinions of average opinion.

The beauty contest competition has its parallels in financial markets. Given the fast, liquid nature of financial markets, speculators have no reason to worry about the long-term fundamental value of an asset because they intend to sell it quickly. To make money out of speculation in highly liquid and fast-moving markets, it is important to judge what the crowd is thinking and to follow it when you think that market valuations of assets are going to increase in value, even though you may privately think that they are overpriced. So, people buy assets at seemingly exorbitant prices not because they independently believed that the asset is fundamentally worth its price but because they believe that they can sell it to someone else for an even higher price. This helps to explain why, throughout history, people have frequently been observed buying seemingly overpriced assets, whether tulip bulbs during tulipmania, houses during housing booms, or dotcom shares during Internet bubbles.

Beauty contests have been used in microeconomic models of learning to capture the links between imitation and iterative thinking, for example see Camerer and Weigelt (1991); Ho *et al.* (1998); Bhatt and Camerer (2005) and Camerer (1997, 2003a). Similar models of imitation explain irrational imitative behaviour as an outcome of the expectation that *others* will behave irrationally (Porter and Smith 1995). With beauty contests, financial instability will increase because asset prices will be susceptible to feedback loops and, if borrowings are used to fund asset purchases, instability will be magnified by leverage, i.e. borrowings. Leveraging can have a destabilizing impact even on experienced traders. Porter and Smith (2008) devise experiments that incorporate increases in liquidity and dividend uncertainty as shocks to the environments of experienced subjects. By introducing credit into asset markets in this way, experienced subjects can be repeatedly jolted away from equilibrium rekindling and sustaining speculative bubbles.

Beauty contests can also be linked to payoff externalities and reflexivity. When a person buys an asset, this contributes to rising demand and increasing prices and these generate payoff externalities for all holders of the asset, including the buyer. Reflexivity describes a related phenomenon characterizing systems affected by feedback loops and simultaneity. Cause and effect cannot be separated and markets will be prone to endogenously determined market fluctuations. Soros (1987) applies the concept of reflexivity to financial markets; in financial systems, reflexivity is manifested in speculative episodes in which rises in asset prices lead to further rises. When financial traders herd behind others, trends will develop propagating mistakes through financial markets and changing individuals' perceptions of market fundamentals. Mistakes will not be random but instead will feed on themselves generating self-fulfilling prophecies. When speculators follow trends, these biases will spread, for example share prices fall because speculators believe they will fall and so they do fall.

Macroeconomic impacts

Financial herding has significant negative impacts for financial markets as a whole. Whilst herding means that conventional beliefs will hold sway for sustained periods of time, during episodes of extreme uncertainty financial markets will become very fragile. Investors and speculators will respond in a volatile way to ephemeral changes in information because decisions and choices do not have a substantive basis (Keynes 1936, pp. 153–154). This generates social costs: whilst it may be rational for individuals to copy others, if copying and herding spreads through large groups of people then volatile speculative episodes will become more likely. Given uncertainty, if people are learning about financial assets from looking at others' trades then herding may be the outcome of a rational learning but it may also be irrational if it is propelled by blind convention and unreasoning speculative frenzies.

Social mood in socionomics

A novel approach to analysing links between unstable financial markets and macroeconomic impacts brings together insights about financial herding with the analyses of weather and mood. Socionomics, an approach to financial analysis pioneered by Robert Prechter from the Socionomics Institute in Gainesville, Georgia. Prechter and Parker (2007) identifies social mood as the ultimate independent variable, affecting trends in all markets, from financial markets to the macroeconomy, which builds on insights about mood and emotion in decision-making more generally. In socionomic analysis, mood is the ultimate causal factor and is experienced collectively in the form of "social mood".

Socionomic analysis is developed by Prechter (2002) and Prechter and Parker (2007) from Elliott's wave principle, which focused on deterministic cyclical fluctuations (see also Prechter 2016). Insights have been applied specifically to financial and macroeconomic fluctuations by Prechter and Parker (2007). Casti (2010) surveys the socionomic literature and outlines some of the key facets of socionomic analysis. The central hypothesis focuses on interactions between individuals. Social networks and herding link to a collective "social mood" which has impacts on events depending on the "mood polarity". A negative, pessimistic mood polarity will lead to financial instability, conservatism in fashion and consumer purchases and insularity in government policy leading governments to favour policies such as protectionism. With a positive social mood polarity, people will be optimistic and hopeful. Fashions will reflect the positive mood – hemlines will go up and politicians will do well. As support, Casti notes that 911 had a minimal impact because overall the social mood was positive. Attributing causality to these events is complex but Casti rules out feedback effects between events and social mood. Mass psychology determines events but no event can feed back into social mood because mood is the ultimate independent variable.

Minsky's financial fragility hypothesis

Socionomics is not specifically an economic theory, but it links to key insights from behavioural macroeconomics. Shiller (2000, 2003) analyses these ideas in the context of feedback theories of endogenous opinion formation in which beliefs about the system determine the path of that system, for example as is seen in stock markets (see also Topol 1991, Shleifer 2000, Brunnermeier 2001 and Sornette 2003, amongst others). As we saw from the analysis of financial herding models, outlined above, socio-economic forces affect traders, for example via the socially-propelled conventions that, in times of uncertainty, encourage speculators to believe what others believe and to do what others do

(Keynes 1930, 1936, 1937). Following this approach other economists, most famously Hyman Minsky, analyse emotional contagion identifying the speculative euphoria that spreads through groups of investors during manic phases as a crucial catalyst in economic and financial booms. In turn, excessive pessimism and extreme risk aversion precipitate bust phases (Minksy 1978, 1986).

What does all this have to do with the macroeconomy more generally? Following in Keynes's footsteps. Minsky (1975) and Kindleberger and Aliber (2005) and Shiller (1995, 2000) have analysed how the socio-psychological impacts of financial instability have wider impacts as emotional contagion generates financial fragility. Key insights around these themes come from Hyman Minsky – a 20th-century economist whose *financial fragility hypothesis* received renewed attention in the aftermath of the 2007/8 financial crises.

Minsky analysed the speculative euphoria which spreads through groups of investors during booms, generating manic phases as a crucial catalyst in economic and financial booms; in turn, excessive pessimism and extreme risk aversion precipitate bust phases. These socio-psychological influences have traction when finance is structured in particular ways. In Minsky's analysis, financial structure is composed of three main elements: hedge finance, speculative finance and Ponzi finance units. Hedge finance units fund investment projects that are sustainable in the long term because both interest payments on debt and repayments of the principal sums borrowed will be recouped via earnings from the assets funded by hedge finance. Speculative finance units are sustainable in the short term: profits accruing from the asset funded by the speculative finance units will be enough to repay the interest accumulating on debt. Ponzi units, however, create significant financial fragility and are unsustainable both in the short term and the long term, and are justifiable only by assuming future bonanzas. The profits from the asset funded by the Ponzi units are not enough even to cover the interest accumulating on debt, let alone repay the principal.

Given this financial structure, Minsky explores how financial instability is generated from an interplay between financial fragility created, as described above, and the operation of socio-psychological influences and emotional trading, as explored in Chapter 15. Waves of optimism and pessimism drive these financial and investment decisions. These fluctuations in sentiment help to explain how the business cycle is driven by financial fluctuations and financial fragility.

At the beginning of the business cycle, a euphoric boom phase starts to build up. Excessive optimism leads entrepreneurs to borrow too much to fund their fixed asset investment projects. Banks and other lenders are keen to lend, and in a euphoric boom phase lend too much. Eventually, the overinvestment becomes unsustainable and banks start to realize it and so add risk premia onto interest rates, and so interest rates on debt start increasing. This generates what Minsky terms *present value reversals*: projects with a positive net present value (the discounted stream of expected future profits minus initial investment costs) at low interest rates transform into projects with a net present value at high interest rates. This means that some hedge finance units are transformed into speculative finance units: the profits from the asset that the finance units are funding is no longer sufficient to cover the principal repayments. Similarly, some speculative finance units are transformed into Ponzi units: the profits are no longer sufficient even to cover the interest repayments. Then some Ponzi units go into default: the profits are no longer sufficient to cover either interest repayments or repayment of principal.

What has all this got to do with the real economy? As entrepreneurs go into default, this is when financial fragility creates problems for the real-side – overoptimism is replaced with excessive pessimism. Bank lending dries up, fixed asset investment slows down, employment and production go into reverse. In this way, the financial fragility set up by the structure of financing as outlined above, generates real-side consequences, leading to recession. Socio-psychological influences interact with the structure of finance to set up an unsustainable financial structure – essentially because of emotional overreactions – and the consequences tip over into the real economy.

Controlling financial instability

Minsky's financial fragility hypothesis suggests some acute challenges facing policy-makers trying to control financial instability and this partly, though not entirely, explains perennial problems of financial policy mismanagement (Kindleberger and Aliber 2005; Shiller 2000; Shleifer 2000). This raises the question: what can be done about this financial instability – in terms of institutional solutions and also solutions that might redress some of the socio-psychological, emotional and behavioural factors?

A greater understanding of how psychological traits affect economic and financial decision-making will inform policies designed to control financial risk-taking at a microeconomic level. Excessive risk-taking can be controlled if firms can construct incentives to encourage traders to take a more long-term view. Rogue trading can be reduced if people work within teams and traders have to report to a manager who takes a longer-term view. Other policy suggestions have included hiring more women or older men because they have lower testosterone levels and are less inclined to take risks (Coates *et al.* 2010). Technical innovations have also been devised including the emotional-sensing "Rationalizer" system – a machine promoted by Royal General Electric and ABN-Amro and designed to provide an "emotional mirror" by monitoring online traders' galvanic skin response, a measure of skin conductance reflecting sweat rates, producing alerts when a trader is overexcited.

It is not clear how feasible these microeconomic solutions might be, particularly as it would be difficult to enforce their adoption by private firms. Designing effective macroeconomic policies is crucial, especially as financial instability can be a socially-driven, aggregate phenomenon. Effective macroeconomic policies are also important because of financial instability's impact on the macroeconomy more generally. Externalities from financial instability have implications for the real economy and growing, bursting asset price bubbles affect wealth, investment and the availability of finance. There will be feedback effects between speculation and entrepreneurship via equity markets because, as identified within Tobin's q models of fixed asset investment, asset market valuations will affect new investment directly if market capitalization is used as a proxy for future profitability. There will also be indirect impacts if stock market buoyancy is interpreted as a signal of wider business confidence. Overall, if financial markets are struggling then this will lead to declines in fixed asset investment with knock-on effects for employment, consumption and growth.

Designing effective financial policies will be difficult and Keynes's analysis of financial markets identifies the central policy dilemma. On one hand, unregulated financial markets encourage a liquidity "fetish", exacerbating financial instability. Whilst speculation does no harm as "bubbles on the steady stream of enterprise" a problem emerges when "enterprise becomes a bubble on a whirlpool of speculation. When the capital development of a country becomes a by-product of the activities of a casino, the job is likely to be ill-done" (Keynes 1936, p. 159). On the other hand, Keynes writes that the,

> spectacle of modern investment markets has sometimes moved me towards the conclusion that to make the purchase of an investment permanent and indissoluble, like marriage, except by reason of death or other grave cause, might be a useful remedy.... But a little consideration of this expedient brings us up against a dilemma, and shows us how the liquidity of investment markets often facilitates, though it sometimes impedes, the course of new investment.
>
> (Keynes 1936, p. 160)

In reconciling this dilemma, Keynes believed that financial markets should be supported but with government intervention to control and slow market excesses (Keynes 1936; see also Backhouse and Bateman 2011).

One potential policy solution receiving a lot of attention recently is the Tobin tax, initially proposed by James Tobin as a way to "throw sand in the wheels" and moderate volatility in currency markets (Tobin 1974, 1978). It has also been developed as a potential solution to restraining short-termism in financial markets in order to promote macroeconomic stability, but it is problematic because it would require a high level of international policy coordination to prevent the shift of financial services to tax havens. Domestic political constraints are likely to compromise international attempts to coordinate policy. Returning to Akerlof and Shiller (2009), they emphasize that the impact of their psychological drivers in the form of animal spirits, and the impact of these on financial markets means that governments have an important role to play in complementing capitalism. As noted in Chapter 16, the government has a responsibility to set the rules within which capitalism should exist. To control real and financial instability, fiscal and monetary stimuli are not enough. Also, financial flows should be targeted and smoothed via injections of lending and capital. This will ensure that financial stability does not undermine an economy's path towards full employment.

Other financial policies designed to ensure a stable financial system and thus a stable macroeconomy include government regulations – particularly those involving stress testing of banks, capital controls to limit international movement of capital, minimum capital reserve ratios and institutional changes to separate retail and investment banking. These restrictions will limit the spread of consequences if traders are engaging in impulsive risk-taking at a systematic level – especially when this risk-taking is magnified across financial markets, with macroeconomic impacts. These policy insights have been the focus of recent changes in financial policy, for example in the UK and in response to Basel III.

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This chapter has explored the wide range of psychological factors and behavioural biases driving financial instability, with macroeconomic impacts – including social influences, biases and heuristics, animal spirits and emotions. With herding and reflexivity, these biases can spread through financial markets via speculative trading generating financial instability.

In terms of broader implications, if herding and speculation are rational responses to uncertainty and informational constraints, then policies to ensure the quick and efficient dissemination of information will be justified. But if herding were the outcome of more emotional and impulsive responses, then there would also be a role for government in controlling financial instability. Baseline versions of standard models based on assumptions of rational expectations and efficient markets will have limited relevance though adaptations to standard models which incorporate asymmetric information and principal-agent problems do offer some useful insights about encouraging transparency, improving information transmissions and correcting misaligned incentives.

From a modern behavioural finance perspective, if economic behaviour is the outcome of psychological forces such as impulsive risk-taking rather than logical, objective decision-making thought processes, then government intervention has a particularly important role to play, particularly as computerization, globalization and increased leveraging enabled by financial deregulation in the 1980s and 1990s have amplified the speed and liquidity of financial markets today relative to Keynes's time.

Chapter summary

- Assumptions from mainstream financial theory, about rational expectations and efficient financial markets, are overturned in behavioural finance – in which financial instability is explained as a product of emotional and socio-psychological influences as well as market and institutional failures.
- Financial markets are inefficient when asset prices are susceptible to speculative bubbles, that is, they do not follow the fundamental value of assets – defined as the present value of the discounted stream of expected future returns on that asset.
- Behavioural finance suggests a range of socio-psychological reasons for financial market inefficiency and speculative bubbles, including time inconsistency, animal spirits, impacts from mood and weather, financial herding and social mood.
- Akerlof and Shiller's analysis of animal spirits can be applied in financial markets to capture financial instability – with corruption playing a key role as a driver of financial instability and macroeconomic impacts.
- Keynes analysed three main drivers of financial herding: social learning, beauty contests and reputation.
- Approaches building on Keynes's insights have been used to explain how financial instability has negative impacts on the real economy – most famously Hyman Minsky's financial fragility hypothesis.
- Insights from behavioural economics and finance can be used to advocate additional policy instruments to control financial instability and its deleterious macroeconomic impacts – including capital controls and stress testing of banks.

Revision questions

1. Behavioural finance focuses on numbers of reasons why real-world financial markets do not fit with the assumptions about efficient financial markets. Explain what is meant by an efficient financial market and discuss *two* reasons for financial market inefficiency.

2. What are Keynes's social influences on financial herding? Which of these influences do you think has the most impact on modern financial markets and thus on the macroeconomy? Illustrate with examples.
3. Explain how Minsky's financial fragility hypothesis captures the interaction of emotional and psychological influences and their impacts on financial structure. What are the potential consequences for the macroeconomy?
4. What policies could be implemented to control financial instability emerging from behavioural factors and socio-psychological influences? What are the pros and cons of these types of policies relative to conventional policies to control financial instability? Are these more important than some of the conventional macroeconomic policies introduced in Chapter 16?

Chapter 18

Happiness and well-being

In Chapter 16, we explored how insights from behavioural economics can be embedded into conventional macroeconomic models, building on the idea that macroeconomic success is driven by economic growth and employment. Behavioural economists' perspectives on macroeconomic performance are shifting, however, as psychological and sociological influences come more directly into behavioural economic models as macroeconomic goals in themselves. This brings us to the happiness and well-being literature. We will explore in this chapter how ideas about happiness and well-being can connect with key insights from behavioural economics to give a whole new picture of what we want and need within modern economies.

Happiness

Happiness is a subjective feeling and therefore is affected by some of the moods and emotions that we explored in Chapter 9. It will also be affected by individual differences, for example some evidence shows that the French claim to be unhappier than Americans even though, as objectively measured, their standard of living is greater. A wide range of socio-economic decisions will affect an individual's happiness including marriage, divorce, criminality and addiction, amongst others. In *A Treatise on the Family* (1991), Becker applies rational choice principles to everyday decision-making asserting that these reflect a rational, maximizing balancing of economic benefits and costs. For example, people marry and divorce when they perceive that the overall benefits from entering into or breaking the marriage contract outweigh the costs.

A lot of behavioural economics focuses on the ways in which these rational choice principles are violated in the real world. Antisocial and self-destructive behaviours may be the product of a complex range of motivations, including behaviours that are associated with irrational and/or ill-informed decision-making. Rather than balancing benefits and costs in a symmetric and systematic way, people will prefer avoiding losses to making gains, and happiness will be affected by changing situations not the status quo. In this way, hedonic psychology, the psychology of well-being, can be brought into the analysis of happiness. Anchoring effects will operate when people's decisions and choices reflect what they have experienced already: if they are happy with a given situation then they will anchor their expectations of future happiness to what they are currently experiencing. Framing effects will also bring the psychological context into people's reported perceptions of personal issues. When students were asked: "Are you happy?" and "When did you last have a date?" the students' answers were affected both by which question is asked first and by how things had gone the night before.

Utility and happiness

Kahneman and Tverksy's (1979) critique of expected utility theory (EUT), explored in Chapter 4, does not focus specifically on problems with the basic concept of utility, though Loomes and Sugden's (1982) regret theory does start to unravel some of the limitations of a stark conception of utility. In later work however, broader concepts of utility are addressed by Kahneman (2003, 2011). Utility is, in essence, about happiness, satisfaction and pleasure. Whilst standard approaches make utility seem like quite an objective concept it is inherently subjective – the subjectivity is acknowledged in a mathematical sense in EUT but in the process stripping out the emotional aspects of utility for reasons of tractability. Some areas of behavioural economics aim to develop a deeper understanding of utility and its complexities. Also, later analyses incorporate ideas and insights from psychology.

Standard conceptions of utility focus on one homogenous quality, revealed through choice. Behavioural economists have a more nuanced view and distinguish between different sources of utility including decision utility and experienced utility. Decision utility is about outcomes, and fits with a standard conception of utility. Experienced utility can be subdivided into instant utility which is about current, real-time experiences and remembered utility which is retrospective and because it focuses on current evaluations of past experiences is susceptible to some of the biases and heuristics outlined in Chapter 3, particularly biases emerging from the misapplication of the availability heuristic (Kahneman *et al.* 1997). Kahneman *et al.* 1997 develop a normative theory of utility focusing on the experienced utility from outcomes which are extended over time. They also allow a role for learning, noting that learning may bring different types of utility together. They also propose a neuroeconomic approach postulating that remembered, chosen and experienced utility will each be associated with neural areas. Conflicts will emerge because the different forms of utility may not coincide, for example addicts anticipate utility and so choose to consume a drug but then find that experienced utility is not so pleasurable, a conflict which is explored in more detail in Chapter 8.

Kahneman and Tversky's research propelled a whole new approach to economics – hedonic psychology – the psychology of well-being. In one sense, hedonic psychology is a modern development of utilitarianism – a moral doctrine, associated with the English economist and philosopher Jeremy Bentham, asserting that actions should be assessed according to their impact on utility, that is, on pleasure, satisfaction and happiness. Pareto (1906) focuses on a narrower concept, namely ophelimity – measuring just economic satisfaction to separate it from broader moral, political and religious aspects of utility. In hedonic psychology, people are making subjective judgements about their own happiness, for example in the context of decisions such as to marry or divorce, and these judgements will not necessarily tie in with monetary measures. In marriage and divorce for example, it is the change in circumstances that affects people's perceptions of their own happiness.

People will judge their own happiness against a benchmark of what they've experienced in the past. For married couples, their experience of marriage and divorce is determined by the recent past so happiness peaks at the point of marriage but falls rapidly until after (on average) two years of marriage it stabilizes at a level equivalent to (and sometimes below) premarital happiness levels (Layard 2005). Stutzer and Frey (2006) develop these ideas analysing marriage using German survey evidence: their analysis suggests that happy singles are more likely to select into marriage and unhappy people are likely to self-select into divorce. Different life events may not be separable in terms of their impacts on happiness; for example, Rowthorn (1999) notes that contagion effects may operate in marriage if attitudes and expectations influence the likelihood of divorce. DeNeve and Cooper (1998) in a meta-analysis of personality traits find that personality traits, including the Big Five factors of extraversion and agreeableness, were significantly correlated with happiness, life satisfaction and positive affect, though the correlations with negative affect are less significant.

So, overall, happiness is about more than the balancing of monetary benefits and costs. There will be spillover effects and socio-psychological factors will have an impact too. Layard (2005) analyses the paradoxes that underlie the pursuit of happiness, particularly issues of status, security and trust. Rising incomes in the advanced nations have coincided with increasing income disparities, declining job security and rising crime rates, all of which have compromised status, security and trust. Similarly, Frey (2008) focuses on the hedonic consequences of unemployment emphasizing that employment offers more than an income. Subjective well-being is also compromised and so unemployment involves not only the direct effects but also indirect impacts: he roughly and cautiously estimates that the unemployed suffer a 0.33% fall in happiness.

Happiness is a specific mood but other moods will affect decision-making too. The recognition of differences between anticipated, experienced and remembered utility, as mentioned above, leaves a role for moods and emotions, for example weather has an impact on mood and through that on financial markets, as explained in Chapter 17 (Kamstra *et al.* 2003; Hirschleifer and Shumway 2003). Happiness will affect other aspects of standard of living too. Wilson and Oswald (2005) find positive associations between marriage and health (both physical and psychological) identifying health gains from being married. Edlund (2005) focuses on the impact of marital decisions on labour mobility and migration and hypothesizes that females will move to urban areas because they are attracted by the higher incomes of the richer urban men. Gautier *et al.* (2005) assert that singles are more likely to pay higher property prices in cities because there are better marriage markets in cities.

Ifcher and Zarghamee (2011) analyse self-reported levels of happiness from the US General Social Survey and find that positive affect increases patience and makes people less likely to "live for today". They confirm the association with a random assignment experiment: a "positive affect" treatment group was shown a mood-enhancing film clip, for example a clip from a stand-up comic routine, and moods were measured to confirm the effect of the film clip. A "neutral affect" control group was shown clips of landscapes and wildlife. Both groups were asked to state their present value equivalents of a payment in the future and the subjects in the positive affect group were significantly more patient.

Human capital investment

Individual differences in personality traits and cognitive skills have implications for human capital investment. Identifying when and if traits can change is an important question. The returns from investment in education, for example, will depend on the relative impact of nature and genes versus nurture and the environment on a child's development. If environmental factors play a significant role then parental investment in a child's learning environment can enable the evolution of productive traits. Early childhood interventions may also play a role because developing complex skills requires effort, practice and exposure to productive learning opportunities.

One of the relevant issues is the extent to which personality traits and cognitive skills can change over a lifetime. Are personality and cognition plastic and flexible? Or are they rigid and set in plaster? If personality is rigid then the returns to investment in enhancing cognition and social skills are likely to be relatively low, with knock-on effects for life satisfaction and well-being more generally. The malleability of personality can be captured empirically by exploring mean level changes and rank order stability. Mean level changes are generally thought to reflect the impact of environmental factors and genetic factors are thought to be responsible for the stability of traits, though there are some key exceptions.

Borghans *et al.* (2008) explore the evidence on mean level changes and rank order stability and identify and a number of significant mean leave changes in traits over lifetime. Different traits evolve at different speeds over the life cycle with cognitive processing speed developing rapidly to peak in late adolescence. Conscientiousness, social dominance (part of extraversion) rise, and emotional stability increase steadily over a person's lifetime. Social vitality (another aspect of extraversion) and openness rise then fall. Personality change in adulthood also reflects social roles. Female workforce participation increases confidence and identity may also play a role in this.

Rank order stability in traits increases steadily over a lifetime and although stability is often attributed to heritability, environment also plays a role. A range of individual differences can be ascribed to genetic factors. Cesarini *et al.* (2009*a*) use evidence from twin studies to show that genetic differences capture about 20% of the variation in preferences for giving and also risk-taking. Cesarini *et al.* (2009b) use another set of twin studies to show that overconfidence in cognitive ability, measured as the difference between perceived and actual rank scores in a general intelligence test, is affected by both genetic and environmental differences with genetic factors explaining 16–34% of the variation in overconfidence. Cesarini *et al.* (2010) also identify a genetic component to risk-taking: they analyse evidence about the pension fund choices of Swedish twins and find that genetic variations empirically capture around 25% of the variation in portfolio risk. IQ also reflects an interaction of genetic and environmental factors. It is a relatively stable trait with strong genetic links but gains in IQ between generations suggest that environmental factors also play a role (Dickens and Flynn 2001).

Personality and cognition are particularly malleable in very early childhood. An early critical period for intellectual development may reflect neurobiological factors and the development of neural connections (Borghans *et al.* 2008). Children adopted by high socio-economic status parents have larger gains in IQ points also suggesting that environmental factors are important (Borghans *et al.* 2008). Early interventions such as enriched childcare centres and home visits can alleviate disadvantage. Whilst they were designed primarily to improve cognitive skills, their success came mostly in boosting personality skills.

Heckman *et al.* (2010a,b) analyse evidence from a controlled childhood intervention via the HighScope Perry Preschool Program (PPSP). For the children in the treatment group, the scheme was designed to educate children from disadvantaged African American backgrounds by exposing them to a curriculum tailored to facilitate the development of cognitive and socio-emotional skills via active, open-ended learning and problem-solving. The participants were selected on the basis of IQ scores and family socio-economic status. This reflected not significant gains in IQ, but improvement in other areas. Treatment and controls were followed to age 40 and included academic achievement and social skills, both of which are crucial to life satisfaction more generally. Heckman *et al.* conclude that personality and motivation are as crucial to early success as cognitive ability and IQ.

Cunha and Heckman (2007) and Cunha *et al.* (2010) have used insights about the role of personality and cognitive skills on attainment to develop production models which incorporate the technology of skill formation. Using these models, they determine the optimal level of targeting for interventions. Returns to investment in cognitive/non-cognitive skills formation decline as children develop and marginal returns are higher for disadvantaged groups. This suggests that investment in skills formation should be targeted towards very young children from underprivileged socio-economic groups.

Overall, these findings suggest that investment in early childhood interventions can generate benefits not only for the individuals involved but also for society as a whole. Heckman *et al.* estimate that the overall social rate of return for the treatment group – in terms of reduced criminality and benefit dependency together with increased educational attainment, earning power and employability, was around 7–10%.

Well-being

The literatures on well-being – across psychology as well as economics – are burgeoning. What's the difference between well-being and happiness? General well-being is the macroeconomic manifestation of general happiness. Well-being is about standards of living and happiness plays a part in well-being but so do other outcomes, for example access to healthcare, educational attainment, longevity, Internet access, and so on. General aspects of the quality of life are captured in measures such as the human development index (HDI) and the quality of life index (QLI) and well-being is a broader concept and captures not only GDP/GNP and physical standards of living but also the hedonic aspects. Well-being is a global concept capturing incomes, physical standards of living and happiness. There is increasing interest in measuring well-being and behavioural economics offers some insights into how to capture the psychological, hedonic nature of happiness and to build this into a macroeconomic measure of aggregate well-being. Well-being has both intrinsic and instrumental value: instrumental because happiness promotes learning, productivity, creativity and health which all have impacts on social welfare. But it also has an intrinsic value of its own which partly links it with utilitarianism. Time is important: it takes time to build communities to sustain well-being (Huppert and So 2011).

Analyses of well-being often focus on relationships, physiology and opportunities. Many aspects of everyday life affect our feelings of well-being: employment/unemployment, environment, commuting, social activities, environmental quality, illness and treatment, and new technology. It is not always obvious what will be good for our well-being: Facebook may be good if it allows us to build online social networks for those who don't have other social opportunities but if it is at the expense of real relationships then the net impact is less clear. On the other hand, whilst the common conception may be that computer games are bad for well-being, studies of prosocial computer games have shown that these can enhance well-being particularly as they link to social influence and the environment.

Well-being is not just about mood. Mood and personality together play a role, for example optimists are more likely to be happy and are also likely to have better life outcomes – as shown in a study of ageing and longevity which identified longer life-spans amongst those with a positive disposition (Kato *et al.* 2012). Huppert argues that well-being concepts are complex. They focus on flourishing and "functionings" and relate to Sen's capabilities, for example see Sen (2004a,b). Functionings are enhanced by resilience, strong relationships and social networks, as well as feelings, moods and emotions. In conceptualizing well-being, it is important to focus not just on the hedonic aspects associated with individual physical pleasures but also on more eudaemonic aspects associated with a full and active life.

Seaford *et al.* (2011) outlines five well-being imperatives: connect, be active, take notice, keep learning and keep giving. The relative importance of different drivers will vary across groups and areas and behavioural concepts such as loss aversion will be relevant. For example, loss of income is hedonically disproportionately worse than a gain in income, as explained in Chapter 4 on prospect theory. This loss aversion, specifically aversion to losing time, might explain why people report that commuting substantially decreases their life satisfaction. Loss aversion also connects well with the intuition that job security is important and negative correlations between well-being and unemployment have been identified. Part-time workers are also less happy than full-time workers. This was demonstrated in a Canada case study on the Canadian Community Innovation Project which explored the impact on perceptions of satisfaction in moving from income assistance (i.e. focus on money) to employment insurance (i.e. focus on jobs). Other factors that affect well-being include social capital. Well-being is also about social groups and networks. Baumeister and Leary (1995) discuss well-being as being about the need for connections. Personal resources such as sleep and physical activity also contribute to well-being.

Looking at it from the other direction, barriers to well-being include external barriers (for example, time, money) and internal barriers (for example, pessimism). There are also psychosocial barriers including habits, social norms, powerlessness feelings and exclusion. Overall well-being depends on social activity as well as economic activity (Halper 2014).

Halpern (2014) also discusses aspects of well-being in terms of conflicts between goals and outcome, for example being healthy and having a healthy lifestyle are not necessarily the same and being healthy is more important to well-being than having a healthy lifestyle. This raises the question of the extent to which well-being drivers are under individual control. What externalities are created that can affect the well-being of others? Driving a Porsche is an example: it generates negative externalities for some, in the form of envy. On the other hand, social relationships can generate positive externalities. There will also be unintended consequences, for example the "school gate phenomenon": some institutions generate positive externalities even though that wasn't the original intention; the school gate is a place where families can meet other families and build connections generating positive externalities even though the school gate was not designed for this purpose.

Well-being and the environment

One aspect of well-being which is developing a pressing importance is the relationship between well-being and the environment. Environmental problems will have an impact on people's well-being, particularly if they create concerns amongst individuals. The European Commission (2002) conducted 7,500 interviews for 15 member states of the EU and found that 89% of respondents were concerned about environmental pollution; 86% about natural resources and waste generation and 82% about trends relating to nature and wildlife; 72% are concerned about climate change; 73% believe that the environment influences the quality of life very much or quite a lot relative to 64% for economic and social factors. These attitudes are relatively robust over recent time with not much change since the global financial crisis and recession. The 2011 Eurobarometer Surveys on the environment and climate change found that 95% of EU citizens feel that protecting the environment is personally important to them and 76% believe that environmental problems have a direct impact on their lives though only 69% believe that they should be personally responsible for using natural resources more effectively. For climate change, 68% support environmental taxes but just 53% had taken some sort of action to combat climate change; 66% reduced and recycled waste. This survey evidence reveals some inconsistencies between the significance of climate change and actions taken to combat climate change. In addition, some respondents seem not to realize that recycling is an activity that can help to combat climate change (European Commission 2011a).

Gowdy (2008) rejects the standard rational actor view that there is a trade-off between material consumption and environmental protection. Increasing per capita income does not increase well-being beyond a certain point and drastic reduction in fossil fuel use will mean a reduction in production of consumer goods but if welfare policy goals can shift from income to well-being more broadly defined then this will be a positive development, that is there will be no trade-off. Similarly, developing countries that are reorienting policies towards living a full life rather than income creation may also experience benefits in terms of alleviating environmental pressures.

Weber (2011) notes the importance of voluntary reductions in energy consumption but most Western households fail to install energy-saving technologies even if they'd save money in the long term if they did. They also seem reluctant to make personal sacrifices in terms of lifestyle and some argue that this is because they have not experienced the consequences of climate change, with implications for well-being more generally. However, empirical evidence does not suggest that lack of experience reduces motivations to act. Actions to reduce energy use not related to uncertainty about climate change existing, has more to do with whether or not they think that their behaviour will be effective.

Desires to maintain current quality of life will also lead to inertia especially as conspicuous consumption can signal social status. The sacrifices that people are prepared to make will reflect their socio-economic conditions, for example a Pennsylvania survey analysed the role of wealth and environmental attitudes in environmental action and found no significant association between personal economic conditions and environmental concerns, though people on lower incomes were less willing to incur monetary costs and richer people were less willing to sacrifice living standards and comforts (Pongiglione 2011). Other factors affecting positive environmental action include knowledge, an internal locus of control (taking personal responsibility), and perceived threats to personal health (Fransson and Gärling 1999).

To assess the impact of socio-economic status and environmental attitudes, Baddeley (2011b) analyses survey responses from 2,764 respondents to Northern Ireland's Continuous Household Survey 2009/10, using ordered probit techniques. The data suggests that apathy (low levels of reported concern about environmental issues) is associated with reduced environmental action. Environmental awareness (familiarity with common phrases about environmental conservation etc.) correlates positively and significantly with the number of environmentally sustainable actions taken, though this survey may be susceptible to self-reporting biases given the positive normative connotations of positive environmental action. Larger household size also has a positive significant impact, perhaps because social pressure increases when observed and/or encouraged by others. Owner-occupiers also are more likely to engage in environmental action. Socio-economic status (as measured by whether or not the household depended on benefits), number of children, the age of housing and whether or not the householders were public-rental tenants were insignificant suggesting that poverty does not constrain environmental actions and the presence of children does not either.

Leiserowitz (2006) also notes that people claim to be very concerned about climate change, ranking it highly on lists of global threats; but when it comes closer to home and people are asked to judge more proximate threats, climate change is low on lists of priorities. Leiserowitz argues that people do not perceive climate change as a direct threat; this links to the impact of vividness and emotions on behaviour – people do not have vivid, concrete, personally salient affective images of climate change and so environmental behaviour change is a low priority.

The evidence about the impact of first-hand (and devastating) experiences of environmental calamities is mixed. Spence *et al.* (2011) analyse UK survey data from 1,822 individuals and find that flood victims were more concerned about climate change and were more confident that their actions would have an effect. Other studies suggest that direct experience of the impacts of climate change may restrain action if it leads to cognitive suppression of frightening realities (Pongiglione 2011). Lorenzoni *et al.* (2007) observe that motivation depends on people believing that their actions will be effective but a 2004 BBC poll shows that only about a half of people think that behavioural changes will impact on climate change. This may link to feelings of powerlessness. Experience of detrimental consequences of climate change does not necessarily link to mitigation efforts and responses to questions about willingness to change behaviour to protect the environment. Whitmarsh (2008) reports survey evidence showing that the salience of risk does not predict behaviour: those who had experienced floods were no more likely to think that the problem could be solved. UK flood victims felt unable to control their situation during the floods and so did not expect to be able to take effective action against climatic events in the future; there are no significant differences in the responses of UK flood victims and non-victims in attitudes towards combating climate change (Pongiglione 2011, Spence *et al.* 2011, Whitmarsh 2008).

Direct experience may in fact restrain action if cognitive dissonance/cognitive suppression take hold; fear and helplessness may be paralysing (Pongiglione 2011, McNamara and Grubb 2011).

Strauss (2008) analysed responses from a Swiss rural community: 95 residents were interviewed and most acknowledged that climate change was taking place but felt helpless and preferred to focus actions on things they could control. Norgaard (2006) interviewed people in a Norwegian rural community and found that people recognized climatic changes and had a high level of knowledge about the climate but made no mitigation efforts, instead associating climate change with fear and helplessness. These feelings of helplessness may be exacerbated by a social organization of denial because motivation is harder if people feel that they are acting alone and that there is no impetus to collective action.

Yates and Aronson (1983) emphasize salience and vividness and argue that there is too much emphasis on initial costs; more vividness is needed in energy-saving advice. Similarly, Bazerman (2006) asserts that one of the problems is that environmental damage is not a vivid threat: it does not engage emotional, visceral responses and this encourages apathy. This could also link to salience and the availability heuristic: people form perceptions and decisions on the basis of recent experience but if people have not experienced the consequences of environmental damage then they are less likely to worry about it (see also Sunstein 2006, discussed above).

Thinking about happiness

Some of the new tools from neuroeconomics (as we explored in Chapters 11 and 12) – a new subdiscipline of behavioural economics which blends economics with neuroscience – have given behavioural economists new insights about how people think about happiness. As for other areas of macroeconomics, there are significant methodological constraints on using neuroeconomic insights for macroeconomic analyses of well-being. Almost by definition, neuroeconomics is a microeconomic tool and although "hyper-scanning" technology is being developed to enable the analysis of neural activations across groups of people, there is a limit to what neuroeconomics can contribute when it comes to aggregate behaviour on a macroeconomic scale. There are, however, a number of studies exploring the neural correlates of well-being and happiness in individuals.

Lykken and Tellegen (1996) studied identical twins and found that genetic inheritance accounts for half of variance in happiness levels. Urry *et al.* (2004) used EEG to analyse the responses of 84 people to questions about mood and happiness. They found more activity in the left cortex associated with higher happiness levels. Davidson (2004) used fMRI techniques to establish that emotional stress leads to activations in the amygdala and right prefrontal cortex, confirming some of the findings outlined in Part III about the neural correlates of emotions. Davidson constructed a bell curve of people in resting state and found that the ratio of right and left prefrontal activations predicts a person's happiness

Habel *et al.* (2005) used fMRI techniques to analyse the responses of 26 male, healthy subjects experiencing positive and negative emotional experiences. They found that, relative to a control task, sad and happy moods were associated with significant activations in the amygdala and hippocampus extending into the prefrontal cortex and anterior cingulate. Sadness was associated with stronger activations found in the ventrolateral prefrontal cortex (VLPFC), anterior cingulate cortex (ACC) and the temporal gyrus, whereas happiness was associated with stronger activations in the dorsolateral prefrontal cortex (DLPFC), the cingulate gyrus, the inferior temporal gyrus and the cerebellum. This suggests that mood valence is affected by specific neural pathways.

Lutz *et al.* (2004) identified significant increases in gamma rhythms (neural oscillations associated with consciousness) during meditation and also found significantly higher left prefrontal cortex activity in Himalayan monks meditating. Davidson *et al.* (2003) also analysed the impact of medication in exploring the relationships between well-being, affective style and mindfulness. Mindfulness involves being attentive to thoughts, as a means of reducing stress. They analysed highflying employees from a biotech firm who were enrolled in a two-month meditation course. The responses of this treatment group were compared with a control group. For the treatment group after meditation, the left prefrontal cortex was more active, perhaps reflecting the benefits from meditation. Strengthened neural circuits in the left pre-frontal cortex perhaps enabled more effective inhibition of amygdala activity which, as explained in Chapters 11 and 12, is active in processing negative emotions. The effects endured and the experimenters could still see changes four months after the course had concluded.

Measuring well-being

One of the problems with a policy focus on well-being is its measurement. Even if goals are clear, effective and reliable, measurement tools are needed to assess whether or not these goals are being met. Maximizing growth in GDP/GNP implies a monetary measure of happiness and whilst it has many limitations it is relatively easy to calculate. Standard macroeconomic measurement also has problems because whilst it appears that we have an objective unit of account in the form of money, if money has a value in itself then it cannot capture the value of other things. Nonetheless, it is probably even more difficult to construct a behavioural measure because there is a clear place to start in constructing an equivalent for broader measures of well-being. The main insights about well-being often start with the Easterlin paradox (Easterlin 1974, 1995): cross-sectional analyses of reported happiness do not show that happiness increases with rising incomes.

One of the problems with well-being is how to effectively capture and measure it over time and across space. Subjective well-being is usually measured via surveys of life satisfaction measures. Some data also concentrates on outcomes in terms of "ill-being", that is, mental health outcomes as a measure of the inverse of well-being and this has some resonances with behavioural stocks of capital, for example as seen in Becker *et al.*'s (1991) concept of addictive capital – introduction in Chapter 8. Survey data does complicate cross-sectional comparisons of well-being. Value judgements can distort comparisons especially if the focus is on simple rankings because these do not take into account different expectations (e.g. the fact that Denmark was recently ranked first in terms of well-being and France was much lower down may reflect different cultural expectations). Different speeds of adaptation to expectations will also affect survey measures of well-being and simple rankings do not capture the spread and dispersion of outcomes. Separating relative versus absolute well-being is problematic without some basic unit of account, though, in the other direction, monetary measures of inequality do capture more about general well-being than a simple absolute measure of income.

Spatial distributions of things which generate well-being have impacts too, complicating well-being measurement: a tree planted in a city has more positive impacts and externalities than a tree planted in the country because even though either will contribute to environmental quality via carbon capture and storage, in a city a tree will increase well-being more because of its hedonic impacts. This phenomenon is difficult to capture, even using green GDP measures. It would also be useful to have ways of weighting well-being, for example the well-being of children and young people is especially important to examine because they have more time ahead of them on average.

There are alternatives to happiness surveys including surveys concentrating on particular aspects of well-being, for example the Happy Planet Index, national accounts of well-being and measuring progress. Also, some survey analyses have identified interesting links between economic and financial events and broader evaluations of well-being. Deaton (2011) links financial crisis to well-being and used a range of self-reported well-being measures from the Gallup polls to capture the impact, in the USA, of financial crisis and recession on people's emotions and their evaluation of their circumstances. Following the collapse of Lehman Brothers in 2008, Americans reported sharp declines in their evaluations of their circumstances accompanied by sharp increases in worry and stress, and declines in positive affect. The American population proved to be remarkably resilient however and by the end of 2010 many of the survey measures had improved.

Some researchers have also measured happiness using semantic methods, for example examining twitter feeds. There are similar ways to measure confidence, for example by counting Google searches for gold prices to capture when people are feeling pessimistic about the financial situation. Another way to capture empirically some aspects of happiness and well-being is to use case studies, for example of marriage and divorce, religion, and so on. Some data collection initiatives have recognized the limitations of some of these approaches and have adopted more complex approaches, for example psychometric factor analysis which is used in the European social survey. The European social survey incorporates three sets of factors: hedonic appraisal including feelings and emotions; positive functioning including competence and positive relationships; and positive attributes, including resilience, optimism and self-esteem.

The Office for National Statistics (ONS) in the UK is developing new initiatives too, emphasizing links with equality/sustainability, that is, multidimensional aspects of well-being. In 2011 the ONS released its first report on life satisfaction and well-being (see ONS 2011) and four questions have now been incorporated into the ONS integrated household survey, focusing on householders' happiness, satisfaction, anxiety and worthiness (that is, worthwhile things done), with rankings on a 0–10 scale. There are also plans to elaborate the data collection by including questions on opinions surveys. The problem with self-report surveys is that respondents might not be honest and/or may lack insight into their own circumstances. Nonetheless, measuring well-being does provide richer information about people's standards of living than the standard policy analysis of goals and data focused on employment/unemployment, inflation and growth.

Well-being in macroeconomic policy

As we explored in Chapter 16, boosting growth and employment have been the key macroeconomic policy goals for most governments until recently. Now the focus is starting to shift away from macroeconomic goals framed around monetary measures of macroeconomic performance, towards goals that reflect more directly the psychological well-being of a society. Insights about happiness and well-being are changing profoundly the ways in which we think about the characteristics of a successful economy, shifting the emphasis away from an exclusive focus on economic performance towards a more holistic understanding. The goals of macroeconomic policy are changing. Governments are shifting focus away from standard monetary measures of economic progress such as GDP and GNP towards more broadly defined socio-economic goals. Whilst broader measures of economic progress, including indexes such as the Human Development Index, have been around for some time, governments and policy-makers are increasingly interested in targeting other aspects of macroeconomic performance, using some of the new data sources outlined in the previous section.

Behavioural economics extends the range of goals towards conceptualizing and measuring well-being and happiness on a macroeconomic scale. Policy-makers are focusing on the quality of life increasingly, in recognition of the Easterlin paradox and other similar analyses which demonstrate that monetary gain does not necessarily translate into improved macroeconomic welfare. In terms of behavioural approaches to defining and measuring macroeconomic goals relating to well-being and happiness, there is a substantial literature, though future advances could be made by moulding the disparate bits and pieces of this literature into a coherent whole.

Chapter summary

- Replacing macroeconomic models of growth based on human capital accumulation, behavioural economists such as James Heckman, have developed alternative behavioural human capital accumulation models which bring a personality dimension into the accumulation of human capital – allowing a role for behavioural influences.
- These insights offer an alternative to the measures of macroeconomic performance focused on monetary measurement of gross domestic product/gross national product.
- New concepts and measurements of happiness and well-being require new insights about utility – replacing economists' traditional conception of utility as one, fungible thing with different conceptions of utility, for example remembered utility versus experienced utility versus anticipated utility.
- Alternative approaches to understanding and measuring macroeconomic performance are evolving – based on wider measures of well-being, happiness and life satisfaction.
- Neuroimaging experiments have confirmed that happiness and well-being have a multifaceted nature mediated by different neural areas, and welfare is not just about monetary measures but reflects complex interactions of cognitive and emotional influences.
- New insights about happiness and well-being are finding their way into governments' sets of policy goals – with an increasing number of governments now targeting well-being and life satisfaction as macroeconomic policy goals, alongside more traditional macroeconomic policy goals such as reducing unemployment, controlling inflation, balancing fiscal and national accounts and stabilizing currencies.

Review questions

1. What is the difference between well-being, life satisfaction and happiness? Illustrate with some examples.
2. Outline the key elements of Heckman's human capital accumulation model. What are the pros and cons of this approach relative to standard, non-behavioural models of capital accumulation? Discuss the implications, including for public policy.
3. What does the neuroeconomic evidence tell us about the nature of well-being and happiness?
4. Discuss the advantages and disadvantages of measures of macroeconomic performance based around behavioural insights versus conventional measures of gross domestic product.

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