May 2002

Behavioural finance and aggregate market behaviour: where do we stand?

By Livio Stracca*

Abstract

This paper selectively reviews the literature on behavioural finance, focusing on the aggregate market implications of the behavioural biases that this literature has identified. Advocates of behavioural economics and finance argue that economic agents behave in a way which departs significantly and systematically from the axioms of expected utility theory. The paper surveys the main "anomalies" identified by this literature in the light of their possible implications on aggregate market behaviour. In particular, the anomalies are categorised into (i) those derived from cognitive limitations (bounded rationality), (ii) those determined by the interference of agents' emotional state, (iii) those determined by choice bracketing, and (iv) those which suggest that a pre-determined set of preferences does not exist altogether. Moreover, prospect theory is surveyed in particular detail, as it has become a serious challenger to expected utility in economics and finance due to the empirical support, its mathematical tractability and its being consistent with rational expectations. Finally, the paper claims that while convincing evidence against market rationality in the beat-the-market sense is yet to be provided, many indications are now available that financial markets may indeed be "irrational" in other reasonable and relevant meanings.

Keywords: Behavioural finance, anomalies, prospect theory, market rationality.

JEL codes: D81, G14

* European Central Bank, Kaiserstrasse 29, 60311 Frankfurt am Main, Germany. Email livio.stracca@ecb.int. I am indebted to Alial-Nowaihi and to an anonymous referee for very useful suggestions. The views expressed in this paper are only those of the author and are not necessarily shared by the European Central Bank.

A drunk walking through a field can create a random walk, despite the fact that no one would call his choice of direction rational.
(Thaler, 1999b, p. 14)

Behavioural finance [...] in essence simply recognises that human beings, individually and collectively, behave as humans (having psychological qualities) and not as gas molecules (having only mass and velocity).
(Frankfurter and McGoun, 1999, p. 170)

The appropriateness of prices [due to market efficiency] protects small, possibly nonrational investors whose stock purchases may be guided by astrology, a worthless technical system, or mere whim.
(Zeckhauser, Patel and Hendricks, 1991, p. 7)

1. Introduction

Behavioural economics and finance is one of the most dynamic and promising fields of economic research and its scope and size, as measured by the number of contributions in recent years, is progressing at a stunning pace. There is an increasingly long list of phenomena which, while cannot be explained with the standard tools and approaches of mainstream economics, have found a satisfactory explanation in behavioural economics and finance (see, for instance, the papers collected in Kahneman and Tversky, 2000). Nonetheless, that the behavioural methodology will come to dominate economic research and completely supplant the mainstream approach based on expected utility maximisation and rationality is far from being a foregone conclusion, and opposite views have been expressed in this respect (in the behavioural camp, see Thaler, 2000, and Colisk, 1996; on the mainstream side, see for example Fama, 1998, and Rubinstein, 2000). Against this background, this paper will selectively touch upon recent contributions in the behavioural finance literature. The objective of this review is to provide a (tentative) answer to the following two key questions:

- What are the most important and systematic (i.e., predictable) behavioural biases which characterise economic agents that we know of?
- Are they relevant to understand aggregate market behaviour, namely do they affect prices set in large, competitive markets?

It has to be emphasised that this review has no pretence to be exhaustive, as the behavioural finance literature is simply too large and complex to be summarised in any reasonable number of pages. Thus, the review will be selective. Moreover, while this review does not aim to be always necessarily original in its interpretations compared with existing reviews (for instance, Rabin, 1998, Shiller, 1998, Shleifer, 2000, the introduction in Kahneman and Tversky, 2000, Thaler, 2000, and Daniel et al, 2002, to name just a few), it will depart from existing material in aspects of interpretation and assessment, as well as in categorising the findings of the literature. In short, this paper contains a review but also a personal view on the behavioural finance literature and on the relevance of its findings to understand market behaviour. Moreover, this review will be more

focused than existing ones (with the possible exception of Daniel et al, 2002) on the systematic aggregate market implications of agents' behavioural biases. Finally, this review is markedly non-technical if compared with the existing ones, making it hopefully easier to digest for a reader not familiar with this strand of literature.

In a nutshell, behavioural finance rejects a vision of economic agents' behaviour based on the maximisation of well-defined preferences using subjective probabilities and based on the Savage axioms, such as transitivity and monotonicity. At the root of this rejection is the overwhelming evidence available that agents, both in controlled experiments and in real life situations, behave in a way so as to violate the axioms of expected utility (Starmer, 2000). It should be emphasised at first that the focus of behavioural finance is on a positive description of human behaviour especially under risk and uncertainty, rather than on a normative analysis of behaviour which is more typical of the mainstream approach based on expected utility maximisation. Indeed, the normative optimality of expected utility maximisation is seldom challenged in the behavioural finance literature; it is conceded that an agent who is willing and able to maximise his lifetime expected utility will end up being better off on average than his peers who follow alternative, more naïve decision models (Read, Loewenstein and Rabin, 1999).

One of the key objectives of behavioural finance is to understand the systematic market implications of agents' psychological traits. The stress on the market implications is very important because the analysis of large, competitive markets with a low level of strategic interaction is at the heart of economics (Mas-Colell, 1999) – and, perhaps not surprisingly, this is the area where behavioural finance is finding hardest to challenge mainstream finance. So far, the behavioural finance literature has not reached a level of maturity which would allow it to provide a coherent, unified theory of human behaviour in market contexts in the same way expected utility and mainstream economics and finance have done. Nevertheless, cumulative prospect theory as introduced by Tversky and Kahneman (1992) is approaching a maturity so as to represent a unified theory of behaviour of agents under risk which is alternative, and possibly (in some contexts) superior, to expected utility.

This paper will be structured as follows. The ensuing section will provide a framework of analysis which will serve as a basis to categorise and interpret the contributions in the literature in a unifying manner. Subsequently, Section 3 provides the reader with a bird's eye look at the main "anomalies" identified in the behavioural finance literature. Thereafter, Section 4 will focus on cumulative prospect theory which, as mentioned above, may be considered the most serious challenger to expected utility as a general theory of human behaviour under risk. Subsequently, the debate between mainstream and behavioural finance theorists on the issue of the rationality of the market as a whole, as opposed to that of the individual market participants, is touched upon and assessed in Section 5. Finally, Section 6 will contain some suggestions for further research and some concluding remarks.

2. A framework of analysis

It is useful to identify the key elements of analysis which will turn useful in categorising and assessing the various contributions in the behavioural finance literature. As stated in the Introduction, the main purpose of this review is to understand the impact of psychological factors and of "anomalies" (see the ensuing section for a precise definition of "anomaly") on aggregate market prices. This is by no means the only reason why psychological factors may be interesting for economics[1], but it might be argued that it is the key one, and it is in any case the main objective of the review of this paper.

To introduce some simple terminology, we will refer to rational pricing as a function defined as follows:

$$P_i = f(x_i),$$

where P_i is the price of asset i set in a competitive market (i.e., a market with a low level of strategic interaction) at a certain point in time, and f is a relationship (derived from expected utility maximisation) with a "fundamental" value x. For example, if P is the price of stock i, f would be the discounted sum of the future dividends x. Or, if P is the price of an insurance, f would be a (concave) function the payoffs x of the insurance in the different states of the world. It should be emphasised that this pricing equation is the result of aggregate demand matching aggregate supply, i.e. it can mask a considerable heterogeneity as regards individual investors' preferences and expectations. The price P is essentially the one for which the number (or better, the money) of the investors who demand the asset is the same as the number (money) of those who supply it.

In a nutshell, advocates of behavioural finance claim that psychological factors and biases can often determine a deviation e from rational pricing:

$$P_i = f(x_i) + e_i,$$

where e is a pricing bias term, not necessarily white noise (it would actually be uninteresting if it were only a white noise term) and probably quite persistent. Mainstream theorists, by contrast, tend to claim that the term e is, at best, a transitory component which is bound to disappear over time due to the pressure of market forces. It is clear that, given the competitive nature of the market, psychological factors and biases can affect market prices only to the extent that they are systematic and widely spread, and they do not cancel out in the aggregate.

A second element which is key in this context is whether asset prices can feedback on the fundamentals themselves. Therefore, it makes sense also to consider a feedback relationship which can be symbolised as follows:

$$x_i = z_i + g(P_i),$$

[1] For example, Rabin (2002b) emphasises that also the allocation achieved and distributional aspects should be of interest to economists. For example, even if in a competitive market rational agents "wipe out" irrational agents, as it is often argued by mainstream theorists, economics should be also concerned with the welfare of the (wiped out) irrational agents.

where z is an autonomous component not influenced by asset prices and g is the feedback function. For instance, an increase in the stock price of firm i can increase enthusiasm and confidence in that firm, drive customers to its products, and ultimately self-fulfil the initial enthusiasm, even if the intrinsic quality of the product of firm i, i.e. z_i, has not changed. Putting the pricing and the feedback equations together:

$$P_i = f(z_i + g(P_i)) + e_i$$

Thus, it is immediate to see that, if a behavioural bias creates a deviation from rational pricing and if the feedback mechanism is non-negligible, a self-fulfilling spiral can establish itself and bring both the asset price and the fundamental behind it on a possibly totally unpredictable path. In this context, it would be clear that psychological factors and biases would have an important bearing on welfare and would therefore also be of great importance to economists.

It is interesting to note that the idea that psychological factors might be relevant for market prices and economic developments is not a prerogative of the behavioural economics and finance literature, and has a distinguished past going back at least to the Keynesian emphasis on animal spirits and the role of uncertainty and confidence in shaping economic and employment growth. In the Keynesian view, the economic agents' psychology can be easily disturbed and/or manipulated, and it is key in the economic system, in contrast with the emphasis on rationality which is typical of the (now) mainstream approach. Thus, it might be argued that the focus of the behavioural finance literature on psychological factors ultimately represents a vindication of the Keynesian ideas.

In the subsequent section we analyse the most important factors which might contribute to create a non-negligible and persistent "pricing bias" e in the pricing equation.

3. A bird's eye look at the anomalies

We define anomalies the systematic traits of behaviour of economic agents, which cannot be explained by the expected utility model.[2] The list of such anomalies identified in the behavioural finance literature, especially based on experimental evidence, is very long and only the main ones will be touched upon in this section. For a more comprehensive list, the interested reader may refer to the books by Kahneman and Tversky (2000) and Shleifer (2000). The stress on the systematic nature of such departures (biases) is crucial, as otherwise anomalies would be of little interest, as every sufficiently general theory in social sciences should be allowed to make mistakes, expected utility not excluded (Rubinstein, 2000).

In the continuation of this survey, the presentation of the most important anomalies will be structured according to four categories – bearing in mind that this taxonomy is arbitrary, that many other categorisations are possible, and that there may be considerable overlaps among the categories. The four categories are as follows:

[2] We do not use the term "anomalies" to trivialise them, but to indicate phenomena which represent an important challenge to the mainstream approach based on the efficient markets hypothesis. On the possibly derogatory use of the term "anomaly", see Frankfurter and McGoun (2001).

1. Anomalies that derive from deliberation and optimisation costs (see Colisk, 1996), with no role played by emotions and "visceral" factors. This field broadly covers the literature on bounded rationality; these anomalies may be labelled as "cognitive" departures from expected utility maximisation (cognitive behavioural biases).
2. Anomalies which are related to the role played by emotions and visceral factors (see Loewenstein, 2000).
3. Anomalies related to choice bracketing: in this category, anomalies relate to the fact that, while within a certain framed problem agents may behave as they maximised expected utility, the way problems are framed influences their decisions to a very significant extent (for a review of choice bracketing, see Read, Loewenstein and Rabin, 1999). In particular, it is commonly found that agents "edit" problems in narrower frames compared with the standard maximisation of lifetime utility popular in economics and finance models.
4. In this fourth category, we survey recent contributions which claim that a set of well-defined and deterministic preferences does not exist. Rather, stochastic and context-dependent preferences should be considered.

Subsequently, in the next section we will review prospect theory, which is consistent with most of the axioms of the expected utility school (including rational expectations), but which contains important new elements and which is consistent with, and able to give account of, most of the behavioural biases identified by the literature. As such, and owing to its mathematical tractability, prospect theory is a serious contender to expected utility as a general descriptive theory of human behaviour under risk and uncertainty. The key element of prospect theory (and the main point of departure from the expected utility model) is its reference dependence, i.e. the idea that agents' preferences are not determined in abstract terms, but depend on the specific context and the background of the decision problem at hand.

3.1 Cognitive behavioural biases

Standard economics and finance models overlook the importance of deliberation / optimisation costs and assume that agents possess absurdly high computational capabilities (Colisk, 1996). In reality, deliberation costs can be a very important element of choice. Often agents make recourse to mental shortcuts and "rules of thumb" when the problem to solve is particularly complex and far-reaching; such shortcuts are known in the behavioural finance literature as decision heuristics (Kahneman and Tversky, 1974). More often than not, such heuristics lead to poor decision outcomes and involve "blunders" which might be eliminated with a more "rational" analysis (i.e., an analysis where less weight were attributed to optimisation costs). The behavioural finance literature has identified a large number of systematic blunders that plague economic agents, and we will touch upon only a few.

A very common blunder is to mis-perceive the laws of probability, for example by systematically over-inferring from small samples ("law of small numbers") and underrate the importance of population

parameters. Framed in the context of the Bayes formula, agents tend to systematically overvalue the sample evidence and systematically undervalue the a priori probabilities. This tendency may have an aggregate market implication if agents mis-perceive fluctuations in prices which are simply due by chance with a reversion to a mean (Rabin, 2002a). For example, the excessive extrapolation of the past performance may be the reason why superior returns are earned by portfolios based on publicly available data (Lakonishok, Shleifer, and Vishny, 1994).

More in general, decision heuristics may be influenced by factors such as vividness and "representativeness", which should have little to do with an optimal decision. One of such factors is the anchoring to representative values which make it easier for agents to solve decision problems even when, if looked at carefully, should not have the influence they actually have. An example of this is the fact that in most speculative markets the prevailing price is often regarded as a "normal" or "equilibrium" price level, even if agents have no idea of what an "equilibrium" or "fair" price might be (Mullainathan and Thaler, 2000) and future developments show that the market price was plainly wrong. The same might be said of many quantities (for example, the price of any good or service vis-à-vis any other good or service), where the status quo is automatically taken as a "natural" value – the computation of a truly natural value would in fact involve too high deliberation costs.[3] It is important to stress that these anchoring effects may not be orthogonal to the way preferences are formed; for example, in prospect theory (see later in Section 4) gains and losses are defined in terms of a reference value which is in fact, in most applications, the status quo.

A key element of bounded rationality models is limited attention. Agents are confronted with a confusing array of (sometimes conflicting) information, which encourages them to focus only on salient information (Shiller, 2001).[4] This makes the average human being (the average investor) particularly subject to fads (Shiller, 2000b) and to manipulation by others (Daniel et al, 2002). At the same time, agents take time (due to limited processing capability) to digest new information, even when it is actually relevant, which may lead to conservatism bias. Barberis, Shleifer and Vishny (1998) have developed a model in which agents react in an exaggerate manner to new information due to representativeness bias, while the overreaction is tempered by conservatism. As stressed by Shiller (1998, 2000b, 2001), attention and saliency may have a social basis, which is the reason why past price increases may attract attention on a certain financial asset and determine a self-fulfilling spiral of rising price and increased optimism, until ultimately the bubble busts.

Lack of attention may also lead to investor credulity (Daniel et al, 2002), where – owing to limited computational capabilities – agent do not adequately discount for the incentives of others in manipulating and presenting information. For example, it has been documented that firms tend to present positive information in a salient way, while they normally report negative information in a highly non-salient manner,

[3] A tendency to hindsight bias – i.e., the false perception that once an event is part of history, there is a tendency to interpret the sequence as unavoidable – may be justified on similar gounds (see, for example, Kelman, Fallas and Folger, 1998). On hindsight bias in forecasting, see for example Fisher and Statman (2000).

[4] On the role of salient information and the irrelevance of a "rational" weighing of events and probabilities, see Shafir and Tversky (1993).

but investors do not seem to take this factor into account (Klibanoff et al, 1999). In general, the way information is presented matters (see also Section 3.3 below).[5]

It has been proposed that expected utility maximisation might be amended, without changing its fundamental nature, by adding a deliberation cost to the utility function, and then proceed as in the standard approach (Colisk, 1996).[6] This way of casting bounded rationality in the standard approach, however, might be problematic for two reasons. First, it is unclear what precise form these deliberation costs should have. Second, even assuming that giving a determinate form to the deliberation costs may be possible, a problem of "infinite regress" may arise. If agents have deliberation costs, then they will also have deliberation costs in assessing their deliberation costs, and thus deliberation costs on the deliberation costs on the deliberation costs, and so on ad infinitum. While a practical solution might be to stop to the first deliberation cost and neglect higher order terms, this solution might be unsatisfactory.

The application of the standard expected utility maximisation to real world problems is further complicated by the observation that probabilities are rarely known to decision-makers. The decision problem then becomes the "maximisation over a probability distribution of the probability distribution", and so on again ad infinitum. While decision problems may easily become analytically intractable, there is evidence that agents' uncertainty over the probability distribution has importance consequences. For instance, it is known that agents dislike "ambiguous" situations (i.e., situations in which there is "uncertainty over the uncertainty") more than "risky" situations (where at least the uncertainty is known); Camerer and Weber (1992) provided a very good review of the literature on such "ambiguity aversion".[7]

Overall, cognitive biases might distort asset prices and lead to a pricing bias to the extent that agents who demand a certain asset are incapable to process the information underlying a rational pricing (of the same asset). If the cognitive biases are sufficiently systematic (e.g., the tendency not to discount for "window-dressing" firms' balance sheets), the market as a whole might be subject to biases, and a pricing bias might result.

3.2 Emotional and visceral factors in decisions

In many instances it has been found that cognitive factors alone cannot explain behaviour in economic (market) contexts, which suggests that emotional and visceral factors play an important role (see Loewenstein, 2000, and Romer, 2000). A famous example, for instance, is the evidence that the weather in the trading location influences equity prices (Saunders, 1993; Kamstra et al, 2000), presumably by affecting traders' emotional state. The role of emotions may be particularly important in situations of risk and uncertainty, which are pervasive in finance (Loewenstein et al, 2001). A feature of expected utility is,

[5] For instance, when attention and processing capabilities are limited disclosing information may actually turn out to be counterproductive and decrease transparency (Daniel et al, 2002, put it as "investors can lose the forest for the trees").

[6] For a thorough review of how to model bounded rationality, see Lipman (1995).

instead, that agents face risk and uncertainty from a purely cognitive perspective, and their emotional state does not influence their decisions altogether. In reality, emotional responses are ubiquitous and may depart significantly, sometimes dramatically, from cognitive responses. In general, factors such as vividness and proximity in time play a big role in emotional responses, while they should be irrelevant in cognitive decision processes. Expected utility theorists maintain, however, that at least from a normative perspective a cognitive response should be preferable, and that learning and evolution should lead agents to increasingly make recourse to cognitive processes and to rely less on emotions. Nonetheless, a reaction based on emotions is not necessarily worse than a cognitive-based one if optimisation is costly (see Wilson and Schooler, 1991).[8]

Most anomalies related to emotional states are based on a trade-off between the need of the situation (i.e., making optimal decisions in a forward-looking manner) and the necessity to protect self-esteem and confidence as well as the emotional wellbeing. One of such anomalies relevant in a financial market context is the disposition effect, namely the reluctance to "declare" losses to oneself (fearing a loss of self-esteem), which pushes agents to hold losing assets too long (Shefrin and Statman, 1985; Odean, 1998). A similar need to protect self-esteem may lead agents to belief perseverance and confirmatory bias: as there is an emotional cost associated to the recognition of having been wrong, agents tend to look for additional support for initial hypotheses (Rabin and Schrag, 1999) and to exaggerate correlations which might be due to chance, interpreting them in the light of a preconceived theory.[9] This form of cognitive dissonance[10] is sometimes labelled as the "curse of knowledge" (Thaler, 2000): when we know something, we cannot imagine ever to think otherwise. Self-esteem may also lead to overconfidence, as agents draw some emotional gains from the perception of being smarter than others. Thus, the idea that people learn from past mistakes – a hallmark of the rational expectations school based on learning and evolutionary reasons (see Section 5 below) – may be doubted if learning implies a painful loss of self-esteem and the recognition not to be smarter than others (Griffin and Tversky, 1992). This form of self-enhancing bias may explain why trading is so large in financial markets: most market participants might think to be smarter than the average counterpart, and to be able to make money from the folly of others (De Bondt and Thaler, 1994). Of course, many of them are going to be disappointed (and to lose money due to transaction costs), but – again for the sake of their self-esteem – will attribute the disappointing outcome just to bad luck ("nature is against me") or malice from the part of others (this is unlikely in a large market, however). Moreover, overconfidence may determine

[7] The Keynesian definition of uncertainty and the related emphasis on confidence fit very well in this strand of literature. As Keynes showed, aversion to ambiguity and confidence can have a major impact on market prices and on economic developments.

[8] In this respect, bounded rationality due to deliberation costs and "gut-feeling" reactions are closely intertwined, theoretically and practically.

[9] The "law of small numbers" mentioned above might be partly related to these tendencies; again bounded rationality and emotions are closely connected.

[10] Cognitive dissonance may be defined as the bias of "fitting beliefs to convenience" (Rabin, 1994).

positive short-lag autocorrelations and negative long-lag autocorrelations, which are often observed in the data.[11] In this respect, it may affect aggregate market prices.

One particularly important consequence of the fact that a decision may be emotionally loaded is agents' weighing of probabilities. The idea that agents weigh states according to subjective probabilities in a linear manner is an essential feature of expected utility theory, but it has been proved wrong in countless experiments, starting with the famous Allais paradox. In reality, agents seem to weigh objective probabilities subjectively, computing what is often referred to as the subjective expected value. The probability weighing function may in turn depend to a significant extent on the agents' emotional state (see in particular Loewenstein et al, 2001), especially on whether events are "pallid" or "vivid" in agents' perception. For instance, Kahneman and Tversky (1979) noted that movements in probabilities around zero and one are normally given much more importance than movement between, say, .49 and .50, precisely because of "vividness" considerations (this is often referred to as the Allais "certainty effect"). In general, the probability weighing function tends to be flatter (i.e., changes in probabilities count less when probabilities are high) for vivid outcomes, while it approaches the linear weighing for pallid outcomes (namely, events that do not prompt an emotional response by agents). Thus, a change from 0 to 0.01 or from .99 to 1 in the probability, say, to die in a certain year (a very vivid and emotionally loaded outcome) may count much more than a change from .30 to .31, while the same .01 marginal change in probabilities would be weighted in the same manner if referred to, say, a change in government in a distant foreign country (a very pallid outcome). Much experimental evidence has been gathered in the last decade on the functional form of the probability weighing function, say $w(p)$, and it has been generally found that such function is normally sub-additive (it integrates to a number strictly smaller than one), regressive ($w(p) > p$ for small p, and the opposite for high p) and s-shaped (first concave for large p, then convex).[12] Thus, in most contexts small probabilities tend to over-weighed, while large probabilities tend to be under-weighed compared with the linear weighing of expected utility. However, for very small probabilities, the function becomes indeterminate and both an over-weighing and an under-weighing are possible (for instance, because a certainty effect is present).[13] Tversky and Kahneman (1992) and Prelec (1998), among others, have proposed quite general functional forms in which the degree of regressivity and of s-shapeness depends on a parameter or a set of parameters. Much more research is needed, however, to assess to what extent the nature of a decision problem and its being emotionally loaded influence the parameters of the chosen probability weighing function. It is clear, in

[11] Daniel, Hishleifer and Subrahmanyam (1998) and Hong and Stein (1999) have built models based on the assumption of traders' overconfidence in their private information, which leads to a (overconfident) mis-valuation and, from an aggregate perspective, to both short-run momentum and long-run reversal. Statman and Thorley (1999) posit, and find empirical confirmation of the fact, that in a bull market, where the overconfidence of most investors is high, trading increases.

[12] See in particular Tversky and Kahneman (1992), Tversky and Wakker (1995), and Prelec (1998). Wu and Gonzalez (1996) showed that the probability weighing function is nonlinear also away from the boundaries, i.e. from 0 and 1, suggesting that non-linearity is not only due to the certainty effect.

[13] In some cases very small probabilities are neglected altogher, so the decision problem is examined without regard to very unlikely events.

any case, that a non-linear weighing of probabilities may have significant market implications: for instance, a disproportionate weight attributed to a very low probability of a catastrophic fall of the stock market 1929-style (a very vivid prospect) has been proposed as a possible explanation to the "equity premium puzzle" of Mehra and Prescott (1985) – see, for example, Reiz (1988).[14] Wu and Gonzalez (1996) and Camerer (1998) regard non-linear weighing of probabilities as an essential element of any descriptive theory of choice under risk, thus including situations of relevance for finance.

One of the central tenets of expected utility is that "bygones are bygones" and the utility maximisation is always carried out in a forward-looking manner, where past experiences and risks taken do not matter altogether. Conversely, the behavioural finance literature has identified a number of situations in which past developments and experiences do matter in determining agents' preferences and therefore their decisions.[15] For instance, the endowment effect (Kahneman, Knetsch and Thaler, 1991) postulates that the dis-utility of giving up an object (or an achievement, and so on) is greater than the utility of acquiring it. Therefore, agents' optimisation not only concern utility from, say, wealth, but also utility of wealth vis-à-vis the status quo (by definition a backward-looking concept). In the same vein, risks born in the past may affect current decisions (Machina, 1989). The so-called "house money" effect (Thaler and Johnson, 1990) stipulates that agents are more risk averse following a loss, and more risk-loving (or less risk-averse) after a gain. The behavioural explanation of such phenomenon is that when agents suffer a pain deriving from a loss, have less "emotional reserves" to tolerate further losses, while they can "stockpile" a cushion of emotional strength after a gain.[16] The "house money" effect can affect aggregate market prices. For example, Barberis, Huang and Santos (2001) show that the house money effect, together with loss aversion (see Section 4 below) can explain both the equity premium puzzle and the predictability of equity returns at low frequency, phenomena that are difficult – albeit not impossible – to explain in mainstream finance. Regret theory (Loomes and Sugden, 1982) and disappointment aversion (Gul, 1991) are both based on the idea that agents value (either in a backward-looking or in a forward-looking manner) the emotional cost of being disappointed and of having made a mistake which they might have avoided.[17] The relevance of sunk costs (Thaler, 1991) is also related to this attitude: sometimes we think that we have "too much invested to quit", and this might lead to

[14] For a review of the solutions proposed to the equity premium puzzle, see Siegel and Thaler (1997).

[15] The importance of backward-looking considerations has been recently recognised also in mainstream finance and economics with the recent emphasis on habit formation (see for example Chapman, 1998, and Messinis, 1999).

[16] By contrast, Gomes (2000) proposed a model in which investors are more willing to take risks after a loss, while being more conservative after a gain. After a loss, agents are willing to "gamble for resurrection", while after a gain, they want to protect their achievement. Thus, investors tend to sell winners and to hold on to losers, consistent with the disposition effect. According to Gomes (2000), heterogeneity in risk attitudes due to past history of investors (i.e., whether they have previously experienced gains or losses) can also explain trading in financial markets.

[17] Ang, Bekaert and Liu (2000) use disappointment theory to solve the puzzle of why agents find stocks disappointing but buy lottery tickets. Returns on stocks are likely to disappoint investors precisely because they have a positive expected value, which feeds through to agents' expectations. Therefore, the probability of being disappointed by stocks is high. In lotteries, agents expect to lose money with virtual certainty and may only be positively surprised by the outcome. This mechanism would explain why lottery tickets are so much in demand.

excessive risk-taking and, more in general, to sub-optimal choices (the relevance of sunk costs increases, of course, with the emotional investment associated to these costs).

Finally, moral feelings may also influence preferences and behaviour. For instance, the role of feelings of reciprocation (when positive) and retaliation (when negative) have been studied in game theory contexts (Kahneman, Knetsch and Thaler, 1986).[18] However, while it is clear that such feelings may influence trading in strategic contexts with a low number of agents, it is doubtful that they might be relevant in the context of a market with a large number of participants and a low level of strategic interaction. The very tendency of agents to the "representativeness" heuristic (see above) – namely to consider the current market prices as "fair" – is likely to keep moral feelings out of the marketplace.[19] The same probably holds true for "caring about the others" (Rabin, 2002b).

3.3 Choice bracketing and narrow framing

A key feature of the expected utility approach, including its applications in mainstream finance, is the independence axiom: agents' preferences and their choices are independent of how a decision problem is described or presented. Conversely, the behavioural finance literature has found a number of important cases in which the way a certain decision problem is presented matters (namely, the independence axiom does not hold). Framing and elicitation effects (Tversky and Thaler, 1990) permeate the behavioural finance literature, and narrow framing is in particular one of its milestones. Framing may be a relevant factor not only at individual level, but also at a macro level; for instance, Shaffir, Diamond and Tversky (1997) explain money illusion as the tendency to frame economic quantities in nominal terms, which happens at low levels of inflation, reflecting the existence of computational costs. Conversely, at high levels of inflation agents find it optimal to measure economic phenomena in real terms. The fact that the adjustment for inflation is sometimes done incorrectly and that the error is systematic (low inflation is considered to be zero inflation) leads to the conclusion that money illusion can indeed affect market prices (in particular, interest rates might be distorted upwards).

Choice bracketing can be defined as "a series of local choices that each appear to be advantageous but which collectively lead to a bad global outcome" (Read, Loewenstein and Rabin, 1999) and it is closely related to narrow framing as introduced by Thaler (1980). Under choice bracketing / narrow framing, agents maximise utility locally in an optimal manner, but by doing so they may come to a disastrous global outcome. The most notorious form of narrow framing is procrastination. Under procrastination, agents act on the basis of rational calculations at intervals that are irrationally short. Thus, while they maximise their utility in the short-term, they may end up in very unsatisfactory and sub-optimal situations over a long horizon. One classic example is the decision of when to quit smoking: on a given day, the sacrifice to refrain from smoking will always be greater than the (negligible) utility in terms of better health on the same day. Yet,

[18] For a review of reciprocity in economics, see Fehr and Gächter (1998).

after running this optimisation over and over for thousands of days and always – locally, in an optimal manner – choosing not to quit smoking, the long-term consequences for health can become catastrophic.[20] This kind of behaviour – all too familiar in everyday life – signals that human patience is not independent of the horizon and that preferences are not time-consistent.[21] Akerlof (1991) referred to this tendency as hyperbolic discounting. In mainstream expected utility, discounting is exponential and it is independent of the horizon. The expected utility function is defined as follows:

$$E_t U = \sum_{j=t+1}^{\infty} b^{j-t} E_t U_j,$$

where U_j represents utility at time j, E is the expectation operator, and b is a number between zero and one. By contrast, under hyperbolic discounting agents' impatience is steeper for near-term tradeoffs than for long-term tradeoffs. A convenient one-parameter approximation of hyperbolic discounting is the following:

$$b_t = \frac{a}{(1+b)^{j-t}},$$

with $0 < a < 1$; for $a = 1$, exponential discounting is recovered. Thus, agents maximise:

$$E_t U = \sum_{j=t+1}^{\infty} \frac{a}{(1+b)^{j-t}} E_t U_j,$$

which leads to dynamically inconsistent preferences (I will not do tomorrow what I now assume I will do).[22] These preferences may certainly be undesirable from a normative perspective (agents should take their future preferences into account in maximising their lifetime utility), but they are descriptively ubiquitous. A quite large body of literature is developing on procrastination and on ways to overcome it (see for example O'Donoghue and Rabin, 1999a, 1999b and 2001, Brocas and Carrillo, 2000, and Fischer, 2001).

Habit formation is another area where broad bracketing would lead to optimal global outcomes and where agents often limit themselves (and their welfare) due to narrow bracketing. For example, optimal habit formation for tastes requires to bracket together past and future experiences, and the short-term cost of acquiring a taste more often than not outweighs the short-term benefits (for instance, learning to play golf involves putting up a short-term effort, which is tolerated only if our agent looks at the long-term gains from playing it).

While in some limited instances narrow bracketing may be optimal (for example, looking at a certain unpleasant task "a piece at the time" may increase the agent's determination to carry it out, without being

---

[19] This is not necessarily true in other contexts, for example the labour market (for an important application of the concept of reciprocity to explain downward nominal wage rigidity in the labour market, see Bewley, 1995).

[20] Deciding when to start a diet is, of course, another classic example.

[21] O'Donoghue and Rabin (1999b) report the example that agents may pay not to anticipate a certain unpleasant task from tomorrow to today, but they are indifferent between one day in six months time and the day before. While this behaviour is intuitively natural, it is in contrast with expected utility based on exponential smoothing. Moreover, O'Donoghue and Rabin show that small quantities are normally discounted more heavily than large quantities, and losses more than gains.

[22] See Caillaud and Jullien (2000).

scared off), it generally leads to sub-optimal outcomes. The next natural question is thus why agents tend to frame their decision problems so narrowly and to neglect the correlations among different aspects or time horizons in their lives. Presumably, cognitive limitations and deliberation costs as referred to above play a major role in explaining narrow framing (see Read, Loewenstein and Rabin, 1999).

Is narrow bracketing relevant from an aggregate market perspective? There is some indication that it might be so. Most notably, Benartzi and Thaler (1995) provided what is by now one of the most convincing explanations of the equity premium puzzle of Mehra and Prescott (1985), by relating the high risk premium requested on equity to a myopic loss aversion of equity holders. Instead on focusing on their lifetime utility and noting that over the long-term equity is the most profitable investment by a wide margin (see Siegel and Thaler, 1997), agents frame their investment decision more narrowly to an horizon of approximately one year, at which the risk that stocks under-performs bonds is indeed high. As agents are also highly averse to losses, this leads to a high risk premium and a sub-optimal under-investment in equity, a tendency with important consequence from a macroeconomic standpoint.[23] Barberis and Huang (2001) provided a further refinement of this analysis, by distinguishing narrow framing on the equity portfolio and on individual stocks.[24]

3.4 Stochastic and unknown preferences

Some contributions in the behavioural finance literature have pointed out that postulating the existence of predetermined, well-defined preferences underlying agents' decision in a variety of contexts and situations may be far-fetched, if not plainly false. In a number of experiments as well as in real world situations preference reversals have been observed, and in general preferences seem to depend to a large extent on the way a certain (economic) decision problem is presented to agents (Starmer, 2000). Preference reversals may imply that the principle of transitivity (if x is preferred to y and y is preferred to z, then x is preferred to z) may be violated (x is preferred to y and y is preferred to z, but z is preferred to x, for instance if it is presented in a different manner than x).

The concept of utility in mainstream economics and finance is also seen as unclear. Kahneman (1994) in particular emphasised that it needs to be distinguished at least between hedonic experience (ex post) and the ex ante concept of decision utility. Not necessarily, and actually quite seldom, is the latter a good predictor of the former because agents may be poor at forecasting their own tastes. One commonly observed tendency, for instance, is for agents to systematically underestimate the degree to which they will adapt to a new situation, leading them to exaggerate the utility gain or loss deriving from a certain outcome different from the status quo (hedonic mis-prediction). Remembered utility may play an important role in forecasting future

[23] Myopic behaviour would also solve the celebre "fallacy of large numbers" of Samuelson (1963).

[24] Shefrin and Statman (1994, 2000) have proposed a "behavioural portfolio theory" based on the idea that people keep their portfolios in separate mental accounts: some money is retirement money, some is fun money, some is downside protection, some a shot at becoming rich. These mental accounts are considered in isolation and covariances among

tastes (thus in decision utility), but memory can also play tricks on agents. Furthermore, utility may be derived from memory in itself (Elster and Loewenstein, 1992), again imparting a backward-looking orientation to agents' decisions. In general, this literature emphasises the linkages between the past (memory), the present (decision utility) and the future (future experienced utility). The expectation of future experienced utility is not always assessed only cognitively, but is also accompanied by strong anticipatory feelings such as anxiety (Caplin and Leahy, 2001).[25] Moreover, preferences evolve over time, for instance with age, but agents seldom take this factor into account in their decisions (again, a deliberation cost may be at the root of this tendency).

One interesting approach, which is however seldom followed thus far especially owing to computational costs, is to postulate that preferences, especially future preferences, are stochastic for the agent who must take a decision (see for example Hey, 1995, and Loomes, 1995). Harless and Camerer (1994) deal with the issue of how to estimate (reveal) preferences when an error term is included in them. However, it is likely that uncertainty over own preferences – especially future ones – is much more pervasive and deeply rooted than the mere inclusion of an error term would imply. Nonetheless, stochastic preferences represent an interesting step forward as they highlight the idea that forecasting future tastes and linking them to memory is a key element in individual decision-making, as basic psychological intuition would suggest.

Are stochastic preferences relevant in a market context? Especially the evidence on preference reversals reviewed in Tversky and Thaler (1990) does suggest so. It has been found experimentally that different methods of eliciting preferences often give rise to systematically different orderings among possible alternatives. For instance, a systematic tendency has been observed to overprice low probability / high payoff lotteries over high probability / low payoff lotteries (compared with the ordering obtained through a direct comparison between these alternatives). As Tversky and Thaler (1990) put it, "if option A is priced higher than option B, we cannot always assume that A is preferred to B in direct comparison". In simpler words, market behaviour does not necessarily reflect the maximisation of well-defined preferences; indeed, it is thinking in monetary terms which changes those very preferences. The consequences of these findings for economics and finance can be of crucial importance, as it is easy to figure out. For instance, the idea that the market allocates resources to their best possible use would be undermined if agents' preferences are affected by the market mechanism itself.

---

mental accounts are ignored. In this respect, there is no unified portfolio theory as in mainstream finance, but rather many portfolio theories according to the narrowly framed portfolio selection problem (Statman, 1999).

[25] Caplin and Leahy (2001) put forward the idea that anxiety might be the root of risk aversion. At the same time, anxiety can drive decisions in a very different way than in standard expected utility models, for instance by causing extreme forms of nonlinear weighing of probabilities.

4. A challenger to expected utility: cumulative prospect theory

According to leading behavioural finance theorists such as Thaler (2000) and Camerer (1998), cumulative prospect theory is a key contender to expected utility as a descriptive theory of behaviour under risk. Developed by Kahneman and Tversky in the seventies, the theory was honed in the early nineties (Tversky and Kahneman, 1992) and has received a great deal of empirical support especially in experimental economics (Kahneman and Tversky, 2000). One major advantage of prospect theory over expected utility is that it has no aspirations as a normative theory of behaviour; it simply describes in the most parsimonious and analytically tractable manner agents' observed behaviour (Barberis and Thaler, 2001).[26]

Prospect theory is firmly grounded as a key pillar of the behavioural finance literature, but it departs somewhat from the behavioural biases literature for its being consistent with rational behaviour as normally defined in the mainstream approach. The key new element of prospect theory compared with expected utility, as already noted above, is its reference dependence. Preferences are not represented by an immutable utility function but rather depend on the situation and the agent's expectations and norms.

While prospect theory has received a great deal of empirical support, its origins come from basic psychological intuition. The theory is based on three axioms:

1. Organisms habituate to steady states (adaptation);
2. The marginal response to changes is diminishing;
3. Pain is more urgent than pleasure.

The first axiom states that agents do not look at wealth – or variables of similar economic significance – per se, but rather compared to a reference point, which is often the status quo to which they are used (to which they have adapted themselves[27]). Therefore, changes rather than levels in wealth matter in agents' utility – this is indeed the single most important difference between prospect theory and expected utility. In particular, gains compared with the reference point are carriers of positive utility, while losses are carriers of negative utility.

A consequence of the second axiom of the theory is that agents evaluate departures from the reference point in either direction with diminishing sensitivity. For example, a 1% marginal change in wealth at the reference point is more important than a marginal change 30% away from the reference point (in other words, agents perceive more strongly a change from 0% to 1% – positively or negatively – than a change from 30% to 31% if the reference point is zero, irrespective of whether the change is a loss or a gain). In expected utility there is no reference value, but if one takes the status quo as a (pseudo-)reference point, the concavity of the utility function implies the opposite tendency for losses, namely a marginal loss from 30% to 31% is – unlike in prospect theory – more serious than a marginal loss from 0% to 1%. Thus, while expected utility agents are

[26] On the other hand, the fact that prospect theory is closed to normative analysis might also be interpreted as a limitation of the theory.

[27] See Samuelson and Zeckhauser (1988) on adaptation and the status quo bias.

implicitly risk averse for losses, prospect theory agents are generally risk seeking for losses. This is again an important difference between prospect theory and the standard approach.

Finally, the third axiom postulates than losses loom larger than gains in agents' utility, which is normally referred to as loss aversion. In many experiments it has been found that losses are carrier of a dis-utility of approximately two times the utility of a gain of the same size. In the standard approach, gains and losses cannot be defined because of the absence of a reference value against which to measure them. Nevertheless, the mean-variance utility function commonly used in theoretical finance implicitly assumes that agents care about deviations from the expected return on a certain asset (or portfolio of assets), which de facto plays the role of a reference point, as already hinted above.[28] The mean-variance utility function, however, does not distinguish between gains and losses and assumes an increasing, rather than decreasing sensitivity to departures from the expected value.

In prospect theory, the choice is represented by a two-stage process. First, the problem is "edited", possibly using a form of decision heuristic and in the context of a narrow framing. For example, the agent will narrow-frame the problem "how to invest a certain amount of money" and construct a reference point around which to evaluate gains and losses (for instance, the initial level of wealth). The agent will not look at the correlations between this particular decision and other aspects of his life, because of deliberation costs. In a second stage, the agent takes the decision (e.g., how much wealth to invest in equity) so as to maximise the prospective value function (Kahneman and Tversky, 1979).

To be able to build and maximise the prospective value function, the agent must first consider his value function $V(x)$, which is defined as follows:

$$V(x)=\begin{cases} x^{a}, x \geq 0 \\ -b(-x)^{a}, x < 0 \end{cases},$$

where x is a departure of the variable of interest from the reference point, and a and b are real scalars such that $0<a<1$ and $b>1$. A value of the parameter b greater than one captures the idea that losses are more important than gains (loss aversion), while $a<1$ captures the property of diminishing sensitivity to gains and losses. Thus, the value function is concave on gains and convex on losses (i.e., it is not concave everywhere as in expected utility theory). Thus, this value function posits that agents are risk averse for gains and risk lover for losses. These features of the value function have been generally confirmed in laboratory experiments (see, for instance, Tversky and Kahneman, 1992).

In order to obtain the prospective value function, the agent must weigh the value function in different states of the world according to some measure of probability associated to these states. In the original version of

[28] On the other hand, it is worth stressing that prospect theory may be rewritten as a function of the level of wealth (see Ang, Bekaert and Liu, 2000). Moreover, disappointment aversion as in Gul (1991) implies an endogenous reference point given by the certainty equivalent of the lottery. Under disappointment aversion, the idea that agents value differently gains and losses is maintained, but unlike in prospect theory the reference point is determined endogenously. Despite this attractive feature, disappointment aversion theory has not gained the same popularity of prospect theory thus far.

the theory (Kahneman and Tversky, 1979), agents consider a nonlinear weighing function of the probability density of the outcome. The prospective value function (PVF) is thus obtained as follows:

$$PVF = \int V(x)w(p(x))dx$$

As mentioned above, the probability weighing function put forward in the behavioural finance literature ($w(p)$) is generally regressive and s-shaped.

In the advanced version of prospect theory, cumulative prospect theory (Tversky and Kahneman, 1992), the weighing function is defined on the cumulative probability density of gains and losses separately, rather than on the probability density. Thus, events are rated according to their rank (rank-dependent; see Quiggin, 1982) in the possible range of events. The probability weighing function is evaluated separately on gains and losses, and varies between 0 and 1 separately for gains and losses, integrating to one in the domain of gains and in the domain of losses separately. In experimental studies it has been often found that the probability weighing is symmetric between gains and losses; namely, the weighed probability assigned to a gain with a certain cumulative probability over gains is the same as that assigned to a loss with the same cumulative probability over losses (Tversky and Kahneman, 1992). This property is called reflection.

The property of diminishing sensitivity is conceptually similar to, although used in a different context from, the idea of "first order" risk aversion as put forward by Epstein and Zin (1990) and Segal and Spivak (1990). The common denominator of these two concepts is the fact that the utility function exhibits aversion to small shocks. In expected utility, agents are practically risk-neutral over small shocks and only care about large shocks ("second order" risk aversion). Diminishing sensitivity seems to be a key advantage of prospect theory as it avoids the feature of the global concavity of the utility function which, as shown by Rabin (2000b), leads to an empirical absurdity of expected utility. Rabin (2000b) shows in a calibration theorem that under expected utility, assuming any level of risk aversion towards a lottery with stakes of moderate size, agents have to be absurdly risk averse towards lotteries involving large stakes. At the same time, there may be situations in which diminishing sensitivity becomes implausible. For instance, diminishing sensitivity (risk seeking) is unlikely to hold in the domain of losses if the agent risks poverty – the marginal dollar lost which throws him into poverty is likely to carry a high dis-utility despite its being away from the agent's reference point.[29]

Is prospect theory really a serious challenger to expected utility, and does it help to explain market behaviour better than expected utility theory? According to Camerer (1998), the evidence in its favour is such that cumulative prospect theory should be put at least on an equal footing with expected utility. One important asset of cumulative prospect theory vis-à-vis other behavioural theories is certainly its not being inconsistent with "rational" behaviour as defined in the rational expectations approach. This should make it easier for the

[29] As noted by Fennema and van Assen (1999), diminishing sensitivity "has nothing to do with our evaluation of money but it is purely a matter of perception of numbers". In the neighbourhood of poverty, it is likely that our perception of money becomes more important than our perception of numbers. In such a situation, a concave utility function over losses is presumably more appropriate.

theory to be incorporated in asset pricing models based on no-arbitrage conditions that are pervasive in the finance literature. Moreover, the theory is intuitively appealing, as it is based on much stronger psychological foundations compared with expected utility and yet is mathematically tractable. Finally, prospect theory can lead to a pricing bias in aggregate market prices, to the extent that assets are priced with respect to gains and losses vis-à-vis an arbitrary reference point which gains salience for economic agents, but which might be totally irrelevant in an expected utility framework.

It is sometimes mentioned that a serious problem of the theory is that it assumes away how the reference point is determined. While the reference dependence feature of the theory certainly makes sense – reference points may be determined by non-economic factors such as social norms –, it should make it more difficult for advocates of prospect theory to build general asset pricing models with the same degree of generality as mainstream finance theorists have done. This limitation, however, should not be overemphasised. As noted above, much of mainstream finance theory is built on the mean-variance utility function, which implicitly assumes the existence of a reference point, namely the current level of wealth. It should be feasible to develop asset pricing models based on prospect theory taking the same reference point of mainstream finance, current wealth. In addition, Rabin (2000b)'s calibration theorem lays bare the empirical absurdity of expected utility, which is likely to encourage further work on alternative models in the finance literature, especially in contexts where the assumption of risk neutrality over moderate stakes is not appropriate (as it seems to be often the case in finance problems). Prospect theory appears to be a very good candidate to start with.

5. Is the market "rational"? The debate between behavioural and mainstream finance

Few, if any, mainstream finance theorists contend that individual agents cannot behave in an irrational way and that the homo economicus is anything else than a gross simplification that does not describe accurately any human being (including the theorists themselves). At the same time, economists normally maintain that the functioning of markets may be well described and predicted "as if" agents were all homo economicus. The analysis of the functioning of markets is the core task of economics, and economics does not – and should not – deal with the psychology of economic agents as an objective per se (Mas-Colell, 1999), but only (or at least mainly) with the market implications of it. Harry may erroneously believe in the "law of small numbers", but does this affect his demand for financial assets? Sam derives utility from memory, but does this affect his inter-temporal allocation of consumption and leisure over the lifetime to any significant extent? Most important of all, do individual behavioural biases cancel out in the aggregate, either because they are of opposite signs or due to learning and evolutionary forces?

In essence, the debate between behavioural and mainstream finance revolves around the "as if" hypothesis. Most of the debate concerns, in particular, whether prices set on speculative and highly competitive / developed financial markets are "rational" or whether a pricing error arises. Both behavioural and

mainstream finance theorists agree that studying these markets should be the main task of finance. The fundamental problem, however, is that no agreement is reached on the very definition of "rationality".

The concept of rationality normally maintained by mainstream finance theorists is normally in the beat-the-market sense. Do the anomalies determine exploitable profit opportunities for a cunning arbitrageur? Initially, the publication of the paper by De Bondt and Thaler (1985) – according to whom the stock market displays a systematic tendency to overreact to news – seemed to deal a blow to the market rationality even in the restricted (and favoured by mainstream theorists) beat-the-market sense. However, in subsequent years several instances of market under-reaction were also detected. This has led Fama (1998) to claim that over- and under-reaction anomalies are simply due to chance, and that market efficiency prevails on average (thus, no ex ante exploitable excess profit opportunity arises). Moreover, Fama (1998) stressed that most anomalies are fragile and do not withstand a closer scrutiny and/or a reasonable change in the statistical methodology (Barber and Lyon, 1997). Today, there seems to be almost a consensus that the market is most of the times rational in this beat-the-market sense. The most solid proof of this is that portfolio managers, and in general active investment strategies, do not outperform passive investment strategies (especially when transaction costs are considered; see for example Malkiel, 1995). In this beat-the-market sense, mainstream finance seems to have resisted the "attack" by behaviourists (as behavioural finance advocates such as Thaler, 1999b, and Statman, 1999, conceded). Homo economicus is still alive here.

It is important to stress, however, that market rationality in the beat-the-market sense is not necessarily inconsistent with the idea that anomalies are a pervasive and systematic behaviour of agents and that lead to a pricing bias. It simply signals that it is not easy to make money out of these anomalies, for example because there are limits to arbitrage activity (see Shleifer and Vishny, 1997). As pointed out by Mullainathan and Thaler (2000) and Barberis and Thaler (2001), it is impossible to arbitrage away many instances of "irrationality", simply because there is no speculative market on such matters or because arbitrage is risky.[30] Thus, a pricing bias term might be impossible to arbitrage away, and the existence of a pricing bias is fully compatible with rational expectations and random walk behaviour of asset prices.

Moreover, the argument initially attempted by mainstream finance theorists to reconcile the overwhelming evidence in favour of the anomalies with rationality of the market on learning and evolutionary grounds has proved to be slippery.[31] Certainly the long-lasting, repetitive environment of the financial market should prima facie provide agents with good opportunities for learning and possibly correct behavioural biases over time. Yet, learning is made easier by a number of conditions such as repeated opportunities for practice, small deliberation costs, availability of good feedback, and unchanging circumstances. That the financial market provides all these conditions is doubtful. For example, it can hardly be defined as an environment

[30] Colisk (1996) expressed this concept forcefully as follows: "... we commonly read in the financial pages that firms fail for lack of profits, but we seldom read in obituary pages that people die of suboptimisation" (p. 684). (However, not quitting smoking due to irrationally narrow framing as discussed in Section 3.3 may indeed lead to "dying of suboptimisation"!) Barberis and Thaler (2001) state that "no free lunch can also be true in an inefficient market" (p. 6).

with unchanging circumstances (Thaler, 2000). And while market forces may provide powerful incentives so as to attenuate behavioural biases, they are unlikely to do so completely (see Smith, 1991, and Smith and Walker, 1993). Thus, the idea of a convergence to rational expectations via learning on the market is a difficult route for mainstream theorists (see, for instance, Timmerman, 1994, who showed that it would have been virtually impossible for market participants to "learn" in real time the law of motion of the U.K. stock market). Moreover, learning is closely related to experimentation. In some context of importance for finance, the cost of experimentation may be extremely high (Mullainathan and Thaler, 2000); for instance, deciding on whether to take on a house mortgage does not leave much space for experimentation (and learning).[32] In such situations, we should expect the behavioural biases to apply in full force. Overall, the evolution / learning argument has proved difficult for mainstream finance advocates.[33] It is nevertheless of the greatest importance to understand how behavioural biases so widespread at the individual level are allegedly converted into rationality in the marketplace, and – if this is indeed the case – such convergence to rationality should be ascribed as a major achievement of the market mechanism and not neglected as it is currently the case (Rabin, 1998 and 2002b).[34] Overall, it seems that a great deal of research is needed in this field.

Most advocates of behavioural finance, in any case, contend that the beat-the-market definition of market rationality is too narrow and not relevant from a welfare perspective (Barberis and Thaler, 2001). The ultimate function of the financial market is not to allow agents to speculate over future movements in prices, but rather (over time) to allow them to allocate consumption in the lifetime in an optimal manner and (at a certain point in time) to allocate funds to the most productive investment opportunities. There is very little research on whether behavioural biases lead to mis-allocations of capital and to lower economic growth in the long run, despite the obvious importance of this matter.[35]

At times, the evidence seems compelling that market prices are simply absurd. A famous case is given by the shares prices of the Royal Dutch-Shell group. Although the interests of the Royal Dutch and the Shell corporations were merged on a 60-40 basis, the ratio between their share prices deviated by more than 35% from the theoretical value of 60/40 depending on the location of trade (Froot and Dabora, 1999).[36] Another possible key example is the crash of the New York Stock Exchange on 19 October 1987, which occurred in the absence of any relevant news which might have justified a collapse of more of 20% of the stock index

---

[31] For example, De Long, Shleifer, Summers and Waldman (1992) show that agents who fail to maximise their expected utility survive markets better than expected utility maximisers.

[32] Brav and Heaton (2002) refer to "rational structural uncertainty" to show that f(x) (the "fundamentals") may not be learnable at all, even by rational agents with unbounded computational capabilities. In this respect, they point out that the distinction between behavioural and rational theories becomes blurred in the presence of structural uncertainty.

[33] For example, Nyarko (1991) has shown that learning models can be used to explain price developments which are ex post inconsistent with rational expectations.

[34] On this matter, see also Evans (1997) and Starmer (2000).

[35] Wurgler (2000) provided interesting evidence in favour of market rationality defined as the ability to allocate funds to the most profitable investment opportunities, finding in a cross-country analysis that "financially developed countries boost investment more in their growing industries and cut it more in their declining industries".

[36] Lamont and Thaler (2001) report similar episodes.

value. Given that the stock market index ultimately represents the value at of the U.S. corporate sector, how could this value fall so dramatically in a matter of hours and without any new information?[37] More fundamentally, the "excess" volatility of equity prices as stressed by Shiller (1981) and the large amount of trading in financial markets world-wide are difficult (albeit nor impossible) to justify on purely "rational" grounds. And finally, why agents trade so much (Odean, 1998)? It seems difficult to eschew the explanation that each trader thinks to be smarter than the average counterpart, although this is clearly impossible and "irrational" (Thaler, 1997).

It would be desirable that research focuses in the future on a proper definition of market rationality around which to structure the debate between advocates of behavioural and mainstream finance. A very interesting and promising distinction is between exogenous and endogenous rationality (Rubinstein, 2000). By exogenous rationality we may define a situation in which the market price optimally reflects some exogenous objective quantity (e.g., the profitability of the U.S. corporate sector), i.e. the pricing bias e should be zero. The case of the Royal Dutch-Shell group (and possibly also the crash of the New York Stock Exchange in 1987) indicates that the market is not (always) exogenous-rational. This also underpins Shiller's (1981, 1998) claim that stock prices have moved too much to be explained by subsequent changes in dividends, although an explanation based on market efficiency (i.e., time-varying stochastic discount factors) cannot be ruled out either. At the same time, there may be a form of endogenous rationality according to which each market participant possesses an unbiased estimate of the (future) market price, even if such market price is completely detached from fundamentals (for example, there is a bubble in equity prices and everybody acknowledges this, but each market participant expects the bubble to continue, which further increases the probability that the bubble continues).[38] The distinction between endogenous and exogenous rationality is, however, more complicated if the fundamentals the market should depend on are themselves affected by the market evaluation – take, for example, a self-fulfilling attack on an exchange rate peg and the consequent deterioration of the terms of trade. There is often a tendency (probably because economists are themselves affected by hindsight bias) to see a certain development caused by market developments as unavoidable (supporting the idea of exogenous rationality), but it can sometimes be the result of a self-fulfilling spiral in which the prime mover is indeed an "endogenous" market whimsical move.

Much research has focused in recent years on why large deviations of market values from fundamentals occur in the first place. Studying herd behaviour (for a survey see Devenow and Welch, 1995, and Bikhchandani and Sharma, 2000) has been the object of considerable effort in recent years for its possible role in amplifying price fluctuations and determine market prices which dramatically deviate from fundamentals. However, there is no clear consensus in the profession whether speculative bubbles are due to

[37] Of course, computer-based trading and stop-loss automatic rules are often quoted as the main culprit of the 1987 crash. However, it is doubtful that such rules may be considered as being consistent with rationality.

[38] This is what Shleifer (2000) refers to as "smart" money following "dumb" money. Of course, this is nothing else than the classic "beauty context" of Keynes. This is, again, an interesting similarity with the Keynesian approach to economics.

irrational excesses or to the "pathological" aggregation of rational behaviour at the individual level (Zeckhauser, Patel and Hendricks, 1991). "Rational" herding behaviour (i.e., rational in the sense of maximising the individual market participant's utility) may create "information cascades" with market participants possibly transmitting false information, thus creating a negative externality (Banejeree, 1992). This may happen, and can be explained in an expected utility framework, when agents estimate that the information that they receive (from other traders) is better than their private information. Thus, not necessarily is herd behaviour inconsistent with rationality – not surprisingly, herding is actually a topic more researched in the mainstream field than in the behavioural finance camp. Several factors may reinforce a tendency to herding and conformity, including reputation in a principal-agent context if the performance of the portfolio manager (the agent) is costly to monitor (Scharfstein and Stein, 1990), and the fact that compensation is often computed comparing with other investors' performance, pushing risk-averse traders to conform to the "average" assessment of the market. In spite of notable theoretical developments, the empirical literature has thus far failed to provide convincing evidence of herd behaviour at least in financial markets of developed countries, which is not surprising as one should ideally separate price movements which reflect fundamentals from price movements merely reflecting the mood of the market, and this is obviously very difficult to do (see for example Lakonishock, Schleifer, and Vishny, 1992, and Wermers, 1999).[39]

Optimal (rational) herding might become a key topic in research as far as the overall assessment of market rationality is concerned. The possibility that herds – however rationally formed – might drive prices away from fundamentals might be interpreted by some as a strong sign that financial markets are fundamentally irrational and that pricing biases are the rule. The issue is particularly important and difficult to sort out in financial markets which essentially do not have a "terminal condition" (such as the stock market and the foreign exchange market), namely an exogenous yardstick against which the market price must be evaluated at some predetermined point in time (and with which it is possible to make arbitrage). To put it simply, an price with a "blurred" and non arbitrage-able f and a "strong" feedback g is bound to become an attractor of "irrational" tendencies, while assets with a clearly identified fundamental (a "clear" and arbitrage-able f) and a "weak" feedback g are not likely to be a fertile ground for "irrational" movements, however defined.

Summing up, is the controversy about market rationality going to be sorted out any time soon? This is unlikely because, as Fama (1998) pointed out, market efficiency is per se un-testable. In fact, testing the hypothesis that the market is efficient requires a model of expected returns, which is actually tested together with the hypothesis. Only the evidence that it is possible to systematically beat the market would be a bullet-proof way to discredit the hypothesis of market efficiency. Thus far, behavioural finance has failed to provide such evidence.

[39] Herding behaviour has been postulated also for investment analysts (Graham, 1999), again on reputational grounds. Risk-averse investment analysts will tend to cluster on the average and be very conformist, for the loss of being wrong may be higher if the other investment analysts were right.

A final remark is due on whether the alleged influence of behavioural biases on financial markets calls for a policy response. Daniel et al (2002) are the only ones to deal with this issue directly. According to these authors, governments are likely to be affected by behavioural biases as well, with the difference that they would not be subject to the powerful disciplinary force of competition. Thus, their involvement in setting market prices would probably be counterproductive (Wurgler, 2000, reports empirical evidence that government intervention reduces the economic efficiency of financial markets). At the same time, governments could make investors more aware of their psychological biases and of the incentives that others have to exploit them, creating some room for policy intervention in terms of reporting rules and disclosure. Moreover, policy-makers should be at least aware that markets may at times display irrational tendencies and that pricing biases may exist. Apart from the difficulty in implementing policy measures aimed at correcting these biases, this awareness might at least increase policy-makers' understanding of the world, which might be beneficial in itself.

6. Concluding remarks

Behavioural finance is a rapidly growing area of research and one of the most promising fields of economics. The fertilisation of finance (and economics in general) with psychological ideas and evidence makes it a very interesting and lively field. At the same time, it could be argued that behavioural finance is running the risk of being un-parsimonious (Wachter, 2002; Tirole, 2002). While the list of anomalies discovered is now impressive, convincing evidence is still to be provided that expected utility is a flawed analytical framework to study the behaviour of agents in a (financial) market context, which is at the core of the economics discipline.[40] A bullet-proof evidence that the market is not rational in the mainstream finance sense is yet to be provided, although many hints that the market may not be rational in other reasonable senses have indeed been provided.

Against this background, the key challenge for behavioural finance seems to be to study in more detail the market implications of the widely documented agents' behavioural biases. In particular, to study how prices are determined in large competitive markets more recourse to social, rather than individual psychology might be warranted. As noted, behavioural biases can affect aggregate market outcomes only to the extent that they do not cancel out on aggregate. Thus, "social" seem a better candidate than "individual" behavioural biases to understand market behaviour. The work on synchronisation of expectations, fads and the role of communication (see, e.g., Shiller, 2000a, 2000b) seems to be most promising in this respect.

In addition, a more thorough analysis of the possible definitions of market rationality from a welfare perspective would be greatly beneficial. Does it support social welfare that it is impossible to beat the market? Does it hamper welfare that a large stock market can fall by 20% in a matter of hours without any

[40] Moreover, the large number of approaches followed leaves it open to the criticism of "reverse engineering" (Zin, 2002). By making marginal utility state-dependent, behavioural theories could explain every phenomenon. A good theory must instead be able to explain the moments that it was not designed to match (Wachter, 2002). However, prospect theory is certainly a very parsimonious theory.

news? The answers to these questions are likely to shed some light on the relative merits of behavioural and mainstream finance. The two approaches need not to be seen necessarily as antagonist; it may well be that both are useful to explain their part of reality, depending on the problem under investigation and the definition of rationality that it is appropriate for the issue at hand.

Another key issue on which more research is needed is whether, even assuming that behavioural biases do distort asset prices in large and competitive markets, there are significant implications for the quality of the allocation of capital and ultimately for long-term economic growth. Thus far, there has been no systematic attempt to address the issue of the feedback, and only some informal speculations have been provided (see Shiller, 2000a, and Daniel et al, 2002).

Finally, one further intriguing area of research is represented by the study of possible behavioural biases of large actors such as policy-makers (for example central bankers; see al Nowaihi and Stracca, 2002). Because of their size and role, these actors have a direct influence on financial markets and their alleged behavioural biases may certainly have repercussions on market outcomes. In addition, learning and evolutionary forces are deemed to apply less forcefully than for atomistic agents participating in a large, competitive market. However, an analysis of the systematic psychological traits of economic policy-makers is yet to be developed, and represents a challenge for future research.

References

Ali al-Nowaihi, A. and L. Stracca (2002): "Non-standard central bank loss functions, skewed risks, and certainty equivalence", European Central Bank working paper n. 129.

Ang, A., Bekaert, G. and J. Liu (2000): „Why stocks may disappoint", NBER working paper n. 7783.

Akerlof, G. A. (1991): "Procrastination and obedience", American Economic Review Papers & Proceedings, 81, 2, pp. 1–19.

Banejeree, A. (1992): "A simple model of herd behaviour", Quarterly Journal of Economics, 107, pp. 797–818.

Barber, B. and J. Lyon (1997): "Detecting long-horizon abnormal stock returns: the empirical power and specification of test statistics", Journal of Financial Economics, 43, pp. 341–372.

Barberis, N., Shleifer, A. and R. Vishny (1998): "A model of the investor sentiment", Journal of Financial Economics, 49, pp. 307–343.

Barberis, N., Huang, M. and T. Santos (2000): "Prospect theory and asset prices", Quarterly Journal of Economics, 116, pp. 1–53.

Barberis, N., and M. Huang (2001): "Mental accounting, loss aversion, and individual stock returns", Journal of Finance, 56, 4, pp. 1247–92.

Barberis, N. and R. Thaler (2001): "A survey of behavioural finance", working paper.

Bekaert, G., Hodrick, R. J., and D. Marshall (1997): "The implications of first-order risk aversion for asset market risk premiums, Journal of Monetary Economics, 40, pp. 3–39.

Benartzi, S. and R. H. Thaler (1995): "Myopic loss aversion and the equity premium puzzle", Quarterly Journal of Economics, pp. 74–92.

Bewley, T. (1995): "A depressed labour market as explained by participants", American Economic Review Papers and Proceedings, 85, pp. 250–254.

Bikhchandani, S. and S. Sharma (2000): "Herd behaviour in financial markets: a review", IMF working paper n. 48.

Blume, L. and D. Easley (1992): "Evolution and market behaviour", Journal of Economic Theory, 58, pp. 9–40.

Bowman, D., Minehart, D., and M. Rabin (1999): "Loss aversion in a consumption-savings model", Journal of Economic Behaviour and Organization, 38, pp. 155–178.

Brav, A. and J. B. Heaton (2002): "Competing theories of financial anomalies", Review of Financial Studies, 15, 2, pp. 575–606.

Brocas, I. And J. D. Carrillo (2000): "The value of information when preferences are dynamically inconsistent", European Economic Review, 44, pp. 1104–1115.

Burness, J. and W. Neilson (2000): "A further examination of cumulative prospect theory parametrizations", working paper, Texas A&M University.

Caillaud, B. and B. Jullien (2000): "Modelling time-inconsistent preferences", European Economic Review, 44, pp. 1116–1124.

Camerer, C. F. and M. Weber (1992): "Recent developments in modelling preferences: uncertainty and ambiguity", Journal of Risk and Uncertainty, 5, pp. 325–370.

Camerer, C. F. (1995): "Individual decision making", in J. H. Kagel and A. E. Roth, eds., Handbook of Experimental Economics, pp. 587–703, Princeton University Press.

Camerer, C. F. (1998): "Bounded rationality in individual decision making", Experimental Economics, pp. 163–183.

Campbell, J. Y. (2000): "Asset pricing at the millennium", Journal of Finance, 55, 4, pp. 1515–1567.

Caplin, A. and J. Leahy (2001): "Psychological expected utility theory and anticipatory feelings", Quarterly Journal of Economics, February, pp. 55–79.

Chapman, D. A. (1998): "Habit formation and aggregate consumption", Econometrica, 66, 5, pp. 1223–30.

Chateauneuf, A. and P. Wakker (1999): "An axiomatization of cumulative prospect theory for decision under risk", Journal of Risk and Uncertainty, 18, 2, pp. 137–145.

Christie, W. G. and R. D. Huang (1995): "Following the pied piper: do individual returns herd around the market?", Financial Analyst Journal, July/August, pp. 31–37.

Cicchetti, J. C. and J. A. Dubin (1994): "A microeconometric analysis of risk aversion and the decision of self-insure", Journal of Political Economy, 102, pp. 169–186.

Colisk, J. (1996): "Why bounded rationality?", Journal of Economic Literature, 34, 2, pp. 669–700.

Daniel, K., Hirshleifer, D. and A. Subrahmanyam (1998): "Investor psychology and security market under- and overreactions", Journal of Finance, 53, pp. 1839–1885.

Daniel, K. and S. Titman (1999): "Market efficiency in an irrational world", Financial Analysts Journal, 55, pp. 28-40.

Daniel, K., Hirshleifer, D. and S. H. Teoh (2002): "Investor psychology in capital markets: evidence and policy implications", Journal of Monetary Economics, 49, pp. 139–209.

De Bondt, W. and R. H. Thaler (1985): "Does the stock market overreact?", Journal of Finance, 40, pp. 793–805.

De Bondt, W. and R. H. Thaler (1994): "Financial decision-making in markets and firms: a behavioral perspective", National Bureau of Economic Research Working Paper No. 4777.

De Long, J. B., Shleifer, A., Summers, L., and R. Waldman (1990): "Positive feedback investment strategies and destabilising rational speculation", Journal of Finance, 45, pp. 379–395.

De Long, J. B., Shleifer, A., Summers, L. and R. Waldmann (1991): "The survival of noise traders in financial markets", Journal of Business, 64, 1, pp. 1–19.

Devenow, A. and I. Welch (1996): "Rational herding in financial economics", European Economic Review, 40, pp. 603-615.

Ellsberg, D. (1961): "Risk, ambiguity, and the Savage axioms", Quarterly Journal of Economics, 75, pp. 643-669.

Elster, J. (1998): "Emotions and economic theory", Journal of Economic Literature, 36, pp. 47-74.

Elster, J. and G. Loewenstein (1992): Choice over time, Russel Sage Foundation Press.

Epstein, L. (1988): "Risk aversion and asset prices", Journal of Monetary Economics, 22, pp. 179-192.

Epstein, L. and S. Zin (1990): "First-order risk aversion and the equity premium puzzle", Journal of Monetary Economics, 26, pp. 387-407.

Evans, D. A. (1997): "The role of markets in reducing expected utility violations", Journal of Political Economy, 105, pp. 622-636.

Fama, E. F. (1998) "Market efficiency, long-term returns and behavioural finance", Journal of Financial Economics, 49, pp. 283-306.

Fehr, E. and S. Gächter (1998): "Reciprocity and economics: the economic implications of homo reciprocans", European Economic Review, 42, pp. 845-859.

Fehr, E. and K. Schmidt (1999): "A theory of fairness, competition and cooperation", Quarterly Journal of Economics, 114, pp. 769-816.

Fennema, H. and M. van Assen (1999): "Measuring the Utility of Losses by Means of the Tradeoff Method", Journal of Risk and Uncertainty, 17, 3, pp. 277-295.

Fischer, C. (2001): "Read this paper later: procrastination with time-inconsistent preferences", Journal of Economic Behaviour and Organization, 46, pp. 249-269.

Fisher, K. L. and M. Statman (2000): "Cognitive biases in market forecasts", Journal of Portfolio Management, Fall, pp. 72-81.

Frankfurter, G. M. and E. G. McGoun (1999): "Ideology and the theory of financial economics", Journal of Economic Behaviour and Organization, 39, pp. 159-177.

Frankfurter, G. M. and E. G. McGoun (2001): "Anomalies in finance: what are they and what are they good for?", International Review of Financial Analysis, 10, pp. 407-429.

Froot, K. A. and E. M. Dabora (1999): "How are stock prices affected by the location of trade?", Journal of Financial Economics, 53, 2, pp. 189-216.

Gomes, F. (2000): "Loss aversion and the demand for risky assets", working paper, London Business School.

Graham, J. R. (1999): "Herding among investment newsletters: theory and evidence", Journal of Finance, 54, pp. 237-268.

Griffin, D. and A. Tversky (1992): "The weighing of evidence and the determinants of confidence", Cognitive Psychology, 24, 3, pp. 411-435.

Gul, F. (1991): "A theory of disappointment aversion", Econometrica, 59, pp. 667-686.

Haan, M. (1997): "Where are the motives? A problem with evidence in the work of Richard Thaler: reply", Journal of Economic Psychology, 18, 6, pp. 705–709.

Harless, D. W. and C. Camerer (1994): "The predictive utility of generalized expected utility theories", Econometrica, 62, 6, pp. 1251–1289.

Hey, J. D. (1995): "Experimental investigations of errors in decision making under risk", European Economic Review, 39, 4, pp. 633–40.

Hirshleifer, D. (2001): "Investor psychology and asset pricing", Journal of Finance, 56, 4, pp. 1533–1597.

Hong, H. and J. Stein (1999): "A unified theory of underreaction, momentum trading, and overreaction in asset markets", Journal of Finance, 54, pp. 2143–2184.

Jullien, B. and B. Salanie' (2000): "Estimating preferences under risk: the case of racetrack bettors", Journal of Political Economy, 108, 3, pp. 503–530.

Kahneman, D. and A. Tversky (1974): "On the psychology of prediction", Psychological Review, 80, pp. 251–273.

Kahneman, D. and A. Tversky (1979): "Prospect theory: an analysis of decision under risk", Econometrica, 47, pp. 263–291.

Kahneman, D., Knetsch, J. L., and R. H. Thaler (1986): "Fairness as a constraint on profit seeking: entitlements in the market", American Economic Review, 76, 4, pp. 728–741.

Kahneman, D., Knetsch, J. L., and R. H. Thaler (1990): "Experimental tests of the endowment effect and the Coase theorem", Journal of Political Economy, 98, pp. 1325–1348.

Kahneman, D., Knetsch, J. L., and R. H. Thaler (1991): "Anomalies: the endowment effect, loss aversion, and the status quo bias", Journal of Economic Perspectives, 5, 1, pp. 193–206.

Kahneman, D. (1994): "New challenges to the rationality assumptions", Journal of Institutional and Theoretical Economics, 150, pp. 16–36.

Kahneman, D. and A. Tversky (2000): Choices, Values and Frames, Cambridge University Press.

Kamstra, M. J., Kramer, L. A., and M. D. Levi (2000): "Losing sleep at the market: the daylight-savings anomaly", American Economic Review, 90, pp. 1005–1011.

Kelman, M., Fallas, D. and H. Folger (1998): "Decomposing hindsight bias", Journal of Risk and Uncertainty; 16, 3, pp. 251–69.

Kirman, A. P. (1992): "Whom and what does the representative individual represent?", Journal of Economic Perspectives, 6, 2, pp. 117–136.

Klibanoff, P., Lamont, O., and T. A. Wizman (1999): "Investor reaction to salient news in closed-end country funds", Journal of Finance, 53, pp. 673–699.

Lakonishok, J., Shleifer, A. and R. W. Vishny (1992): "The impact of institutional trading on stock prices", Journal of Financial Economics, 32, pp. 23–43.

Lakonishok, J., Shleifer, A. and R. W. Vishny (1994): "Contrarian investment, extrapolation, and risk", Journal of Finance, 49, pp. 1541-1578.

Lamont, O. and R. Thaler (2001): "Can the market add and subtract? Evidence from tech stock carve-outs", University of Chicago, working paper.

Lattimore, P. K., Baker, J. R. and A. D. Witte (1992): "The influence of probability on risky choice: a parametric examination", Journal of Economic Behaviour and Organization, 17, pp. 377-400.

Lewin, S. B. (1996): "Economics and psychology: lessons for our own day from the early twentieth century", Journal of Economic Literature, XXXIV, pp. 1293-1323.

Lewis, K. K. (1995): "Puzzles in International Financial Markets", in G. Grossman and K. Rogoff, eds., Handbook of International Economics, North Holland, pp. 1913-1971.

Lewis, K. K. (1999): "Trying to explain home bias in equities and consumption", Journal of Economic Literature, 37, pp. 571-608.

Lipman, B. L. (1995): "Information processing and bounded rationality: a survey", Canadian Journal of Economics, XXVIII, 1, pp. 42-67.

Loewenstein, G. F. (2000): "Emotions in economic theory and economic behaviour", American Economic Review, 65, pp. 426-432.

Loewenstein, G. F. and D. Prelec (1992): "Anomalies in intertemporal choice: evidence and interpretation", Quarterly Journal of Economics, 107, 2, pp. 573-597.

Loewenstein, G. F., Weber, E. U., Hsee, C. K., and N. Welch (2001): "Risk as Feeling", Psychological Bulletin, in press.

Loomes, G. and R. Sugden (1982): "Regret theory: an alternative theory of rational choice under uncertainty", Economic Journal, 92, pp. 805-824.

Loomes, G. and U. Segal (1994): "Observing different orders of risk aversion", Journal of Risk and Uncertainty, 9, pp. 239-256.

Loomes, G. (1995): "Incorporating a stochastic element into decision theories", European Economic Review, 39, pp. 641-648.

Loomes, G. and R. Sugden (1995): "Incorporating a stochastic element into decision theories", European Economic Review, 39, pp. 641-648.

Lux, T. (1995): "Herd behaviour, bubbles and crashes", Economic Journal, 105, 431, pp. 881-896.

Machina, M. (1989): "Dynamic consistency and non-expected utility models of choice under uncertainty", Journal of Economic Literature, 27, pp. 1622-1668.

Malkiel, B. G. (1995): "Returns from investing in equity mutual funds", Journal of Finance, 50, 2, pp. 549-572.

Nyarko, Y. (1991): "Learning in mis-specified models and the possibility of cycles", Journal of Economic Theory, 55, pp. 416-427.

Markowitz, H. (1952): "Portfolio selection", Journal of Finance, 7, pp. 77-91.

Mas-Colell, A. (1999): "The future of general equilibrium", Spanish Economic Review, 1, pp. 207–214.

Mehra, R. and E. Prescott (1985): "The equity premium puzzle", Journal of Monetary Economics, 15, 2, pp. 145–161.

Messinis, G. (1999): "Habit formation and the theory of addiction", Journal of Economic Surveys, 13, 4, pp. 417–42.

Mitchell, M., Pulvino, T., and E. Stafford (2002): "Limited arbitrage in equity markets", Journal of Finance, forthcoming.

Mullainathan, S. and R. H. Thaler (2000): "Behavioural Economics", NBER Working Paper n. 7948.

O'Donoghue, T. and M. Rabin (1999a): "Incentives for procrastinators", Quarterly Journal of Economics, 114, 3, pp. 769–816.

O'Donoghue, T. and M. Rabin (1999b): "Doing it now or later", American Economic Review, 89, 1, pp. 103–24.

O'Donoghue, T. and M. Rabin (2001): "Choice and procrastination", Quarterly Journal of Economics, 116, 1, pp. 121–60.

Odean, T. (1998): "Do investors trade too much?", American Economic Review, 89, pp. 1279–1298.

Odean, T. (2000): "Are investors reluctant to realize their losses?", Journal of Finance, 53, pp. 1775–1798.

Prelec, D. (1998): "The probability weighting function", Econometrica, 66, 3, pp. 497–527.

Quiggin, J. (1982): "A theory of anticipated utility", Journal of Economic Behaviour and Organization, 3, pp. 323–343.

Rabin, M. (1994): "Cognitive dissonance and social change", Journal of Economic Behaviour and Organization, 23, 2, pp. 177–194.

Rabin, M. and J. L. Schrag (1999): "First impressions matter: a model of confirmatory bias", Quarterly Journal of Economics, 114, 1, pp. 37–82.

Rabin, M. (1998): "Psychology and economics", Journal of Economic Literature, 36, 1, pp. 11–46.

Rabin, M. (2000a): "Diminishing marginal utility of wealth cannot explain risk aversion", in Choice, Values and Frames, D. Kahneman and A. Tversky (eds.), New York: Cambridge University Press.

Rabin, M. (2000b): "Risk aversion and expected utility theory: a calibration theorem", Econometrica, 68, 5, pp. 1281–1292.

Rabin, M. and R. Thaler (2001): "Anomalies: risk aversion", Journal of Economic Perspectives, 15, 1, pp. 219–232.

Rabin, M. (2002a): "Inference by believers in the law of small numbers", forthcoming, Quarterly Journal of Economics.

Rabin, M. (2002b): "A perspective on psychology and economics", Alfred Marshall Lecture, European Economic Review, 46, pp. 657–685.

Read, D., Lowenstein, G. and M. Rabin (1999): 'Choice bracketing', Journal of Risk and Uncertainty, 19, pp. 171–197.

Reiz, T.A. (1988): "The equity risk premium: a solution", Journal of Monetary Economics, 22, pp. 117–131.

Romer, P.M. (2000): "Thinking and feeling", American Economic Review Papers and Proceedings, May, pp. 439–443.

Rubinstein, M. (2000): "Rational markets: yes or no? The affirmative case", Financial Analyst Journal, May/June.

Samuelson, P. (1963): 'Risk and uncertainty: a fallacy of large numbers', Scientia, 98, pp. 108–113.

Samuelson, W. and R. Zeckhauser (1988): 'Status quo bias in decision making', Journal of Risk and Uncertainty, 1, 1, pp. 7–59.

Sandroni, A. (2000): 'Do markets favour agents able to make accurate predictions?', Econometrica, 68, pp. 1303–1342.

Saunders, E.M.J. (1993): 'Stock prices and Wall Street weather', American Economic Review, 83, pp. 1337–1342.

Scharfstein, D. and J. Stein (1990): „Herd behaviour and investment", American Economic Review, 80, pp. 465-479.

Segal, U. and A. Spivak (1990): 'First order versus second order risk aversion', Journal of Economic Theory, 51, pp. 111–125.

Shaffr, E. and A. Tversky (1993): "Reason-based choice", Cognition, 49, pp. 11–36.

Shaffr, E., Diamond, P., and A. Tversky (1997): 'Money illusion', Quarterly Journal of Economics, 112, pp. 341–374.

Shefrin, H. and M. Statman (1985): "The disposition to sell winners too early and ride losers too long: theory and evidence", Journal of Finance, 40, pp. 777–790.

Shefrin, H. (2000): Beyond greed and fear: understanding behavioural finance and the psychology of investing, Harvard Business School Press.

Shiller, R.J. (1981): "Do stock prices move too much to be justified by subsequent changes in dividends?", Journal of Finance, 36, pp. 291–304.

Shiller, R.J. (1998): 'Human behaviour and the efficiency of the financial system', NBER working paper n. 6375.

Shiller, R.J. (2000a): Irrational Exuberance, Princeton University Press.

Shiller, R.J. (2000b): "Measuring bubble expectations and investor confidence", Journal of Psychology and Financial Markets, 1, pp. 49–60.

Shiller, R.J. (2001): "Bubbles, human judgement, and expert opinion", Cowles Foundation discussion paper n. 1303.

Shleifer, A. and L. Summers (1990): "The noise trader approach to finance", Journal of Economic Perspectives, 4, pp. 19–34.

Shleifer, A. and R. W. Vishny (1997): "The limits of arbitrage", Journal of Finance, 52, 1, pp. 35–55.

Shleifer, A. (2000): Inefficient markets: An Introduction to Behavioural Finance, Oxford University Press.

Shefrin, H. and M. Statman (1994): "Behavioral capital asset pricing theory", Journal of Financial and Quantitative Analysis, 29, 3, pp. 323-49.

Shefrin, H. and M. Statman (2000): 'Behavioural portfolio theory", Journal of Financial and Quantitative Analysis, 35, 2, pp. 127–151.

Siegel, J. J. and R. H. Thaler (1997): "Anomalies: the equity premium puzzle", Journal of Economic Perspectives, 11, 1, pp. 191–200.

Simon, H. A. (1986): "Rationality in psychology and economics", Journal of Business, 59, 4, pp. 209–224.

Smith, V. L. (1991): "Rational choice: the contrast between economics and psychology", Journal of Political Economy, 90, 4, pp. 877–897.

Smith, V. L. and J. M. Walker (1993): "Monetary rewards and decision cost in experimental economics", Economic Inquiry, 31, 2, pp. 1119–1151.

Starmer, C. and R. Sugden (1989): 'Violations of the independence axiom in common ratio problems: an experimental test of some competing hypotheses", Annals of Operational Research, 19, pp. 79–102.

Starmer, C. and R. Sugden (1993): 'Testing for juxtaposition and event splitting effects", Journal of Risk and Uncertainty, 6, pp. 235–254.

Starmer, C. (2000): 'Developments in non-expected utility theory: the hunt for a descriptive theory of choice under risk", Journal of Economic Literature, 37, pp. 332–382.

Statman, M. and S. Thorley (1999): "Investor overconfidence and trading volume", working paper.

Thaler, R. H. (1980): "Toward a positive theory of consumer choice", Journal of Economic Behaviour and Organization, 1, pp. 39–60.

Thaler, R. H. and E. J. Johnson (1990): 'Gambling with the House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice", Management Science, 36, pp. 643–660.

Thaler, R. H. (1991): Quasi-rational economics, Russel Sage Foundation Press.

Thaler, R. H. (1995): Advances in Behavioural Finance, Russel Sage Foundation Press.

Thaler, R. H. (1997): 'Giving markets a human dimension", Financial Times, 16 June.

Thaler, R. H. (1999a): 'Mental Accounting Matters", Journal of Behavioural Decision Making, 12, pp. 183–206.

Thaler, R. H. (1999b): "The end of behavioural finance", Financial Analyst Journal, 55, 6, pp. 12–17.

Thaler, R. H. (2000): 'From Homo Economicus to Homo Sapiens", Journal of Economic Perspectives, 14, 1, pp. 133–141.

The Economist (2001): "Averse to reality", 11 August.

Tirole, J. (2002): "Rational irrationality: some economics of self-management", European Economic Review, 46, pp. 633-655.

Tversky, A. and D. Kahneman (1981): "The framing of decisions and the psychology of choice", Science, 211, pp. 453-458.

Tversky, A. and D. Kahneman (1986): "Rational choice and the framing of decisions", Journal of Business, 59, 4, pp. 251-278.

Tversky, A. and R. H. Thaler (1990): "Anomalies: preference reversals", Journal of Economic Perspectives, 4, 2, pp. 201-211.

Tversky, A. and D. Kahneman (1991): "Loss aversion in riskless choice: a reference dependent model", Quarterly Journal of Economics, 107, 4, pp. 1039-1061.

Tversky, A. and D. Kahneman (1992): "Advances in prospect theory: cumulative representation of uncertainty", Journal of Risk and Uncertainty, 5, pp. 297-323.

Tversky, A. and P. Wakker (1995): "Risk attitudes and decision weights", Econometrica, 63, 6, pp. 1255-1280.

Tversky, A. and C. Fox (1995): "Weighing risk and uncertainty", Psychological Review, 102, 2, pp. 269-283.

Wachter, J. A. (2002): "Comment on: Are behavioural asset pricing models structural?", Journal of Monetary Economics, 49, pp. 229-233.`

Wakker, P. and A. Tversky (1993): "An axiomatization of cumulative prospect theory", Journal of Risk and Uncertainty, 7, 2, pp. 147-175.

Wermers, R. (1999): "Mutual fund herding and the impact on stock prices", Journal of Finance, 54, pp. 581-622.

Williamson, P. (1997): "Learning and bounded rationality", Journal of Economic Surveys, 11, 2, pp. 221-230.

Wilson, T. D. and J. W. Schooler (1991): "Thinking too much: introspection can reduce the quality of preferences and decisions", Journal of Personality and Social Psychology, 60, 2, pp. 181-192.

Wu, G. and R. Gonzalez (1996): "Curvature of the probability weighting function", Management Science, 42, pp. 1676-1690.

Wurgler, J. (2000): "Financial markets and the allocation of capital", Journal of Financial Economics, 58, pp. 187-214.

Wurgler, J. (2002): "Comment on: Investor psychology in capital markets", Journal of Monetary Economics, 49, pp. 211-214.

Zeckhauser, R., Patel, J. and D. Hendricks (1991): "Nonrational actors and financial market behaviour", NBER working paper n. 3731.

Zin, S.E. (2002): "Are behavioural asset-pricing models structural?", Journal of Monetary Economics, 49, pp. 215–228.