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# Behavioral decision-making in finance: An overview and assessment of selected research

*El comportamiento humano en la toma  
de decisiones financieras: panorama  
y valoración de algunos trabajos  
de investigación seleccionados*

**Werner De Bondt.** DePaul University

**Rosa M. Mayoral.** University of Valladolid

**Eleuterio Vallelado** \*. University of Valladolid

**ABSTRACT** Everyday financial decisions are the product of diverse factors, including instinct, habit, emotion, reason, and social interaction. Psychologists have long aspired to unravel the determinants of intuitive judgment and choice. Slowly but surely, they have identified various psychological mechanisms that cause predictable decision biases. This survey puts special emphasis on behavioral research in finance that investigates information overload, emotion, social influence, and ambiguity aversion. It also discusses selected cognitive models that attempt to integrate the way individuals interpret and act upon information. In general, behavioral research casts serious doubt on the validity of some of the key insights of mainstream finance such as portfolio theory, the positive risk-return trade-off, and efficient markets.

**KEYWORDS** Behavioral finance; Decision making; Cognitive bias; Emotional bias; Social interaction; Ambiguity.

**RESUMEN** Las decisiones financieras cotidianas son producto de diversos factores, entre los que se incluyen el instinto, los hábitos, la emisión, la razón y la interacción social. Los psicólogos han aspirado, desde hace tiempo, a desentrañar los determinantes del juicio y la elección intuitivos. Despacio pero con firmeza han ido identificando los diferentes mecanismos psicológicos que causan sesgos predecibles en la decisión. La panorámica que sigue pone un énfasis especial en la investigación sobre el comportamiento financiero que versa sobre la sobrecarga de información, la emoción, la influencia social y la aversión contra la ambigüedad. También discute ciertos modelos cognitivos seleccionados que buscan integrar la manera en que los individuos interpretan y actúan sobre la información. En general, la investigación sobre el comportamiento aporta serias dudas sobre la validez de algunas de las líneas maestras de las finanzas como la teoría de cartera, el balance entre riesgo y rentabilidad y los mercados eficientes.

**PALABRAS CLAVE** Comportamiento financiero; Toma de decisiones; Sesgo cognitivo; Sesgo emocional; interacción social; Ambigüedad.

\* **Corresponding author:** Eleuterio Vallelado González, Departamento de Economía Financiera y Contabilidad, Universidad de Valladolid, Avda. Valle de Esgueva, 6, 47011, Valladolid, España, Tel.: +34 983 423387, Fax: +34 983 183830, E-mail: teyo@eco.uva.es.

## 1. INTRODUCTION

In his 1919 Tarnier lectures delivered in Trinity College, Alfred North Whitehead, the renowned English mathematician and philosopher, stated that «the aim of science is to seek the simplest explanation of complex facts», but he also cautioned against the error of thinking that facts are simple. He firmly believed that our guiding motto should be to «seek simplicity and distrust it» (1920: 163).

Whitehead's aphorism elegantly describes the development of financial economics over the decades. Following the influential work of Franco Modigliani and Merton Miller about fifty years ago, the minimal assumptions of frictionless markets and rational man became the orthodox foundation of much theorizing in finance. Alas, the magnificent insights that were produced by this research program could not be squared with much of what was empirically observed. Relative to what the theory implied, the complex world of investors, corporate managers and bankers was overflowing with «anomalies». That unhappy reality plus concurrent advances in psychology, specifically, a better understanding of pervasive shortcomings in human judgment, were the beginning of behavioral finance.

The aim of this article is to discuss a selection of recent research papers on behavioral decision making in finance. For a decade or longer now, much of the controversy about whether human intuition and decision bias have a bearing on finance has softened. But it is less clear-cut which biases dominate, above all in a natural environment (i.e., outside the laboratory). In recent years, overconfidence and the affect heuristic have received a great deal of consideration from scholars. Personality, cognitive style and social influence are separate forces of interest. Many agents are exposed to the same news reports or share similar mental frames. Also, amateur investors may sensibly want to imitate experts. The dependability of a source of information is a situational variable of special concern. Besides, reliable information may be missing altogether. These circumstances engender ambiguity or pure uncertainty.

The remainder of the paper is organized as follows. The next section reviews the competing paradigms that inspire financial research. Section 3 discusses some pertinent cognitive and emotional biases. Section 4 concentrates on social interaction. Section 5 reviews decision-making under risk, ambiguity and uncertainty. Section 6 introduces a few cognitive models that portray the intricate relations between agents and context. The final section offers concluding remarks and lists unanswered questions.

## 2. FINANCIAL ECONOMICS: COMPETING INTELLECTUAL TRADITIONS

Mainstream finance starts from the presumption that the representative economic agent is «rational». Rationality, as it is commonly defined in economics, implies at least two things. First, when receiving information, people update their beliefs

in a correct manner, living up to Bayes' law. Second, given their beliefs, agents make decisions that are consistent with subjective expected utility theory. They maximize. Many standard models assume not only that individuals process information correctly but also that they have easy access to all the data necessary to make informed decisions (Sargent, 1993). The concept of efficient capital markets maintains that, while it may be true that the actions of non-rational agents (so-called noise traders) distort prices, expert traders take full advantage of arbitrage opportunities. That is, arbitrageurs close the gap between price and value and market inefficiencies disappear. Still, there is much empirical research demonstrating that market anomalies such as the size, value and seasonal effects in stock returns persist over long periods. Besides market anomalies, there are a variety of decision puzzles in the behavior of individuals and business organizations that appear to lower the quality of their performance.

Different paradigms try to make sense of the troubling empirical facts. For example, the theory of limited rationality abandons the notion of consistent beliefs. In this case, it is assumed that market participants learn in a rational, Bayesian way but that they do not know the true underlying probability distributions. Simon (1945, 1979) introduces the concepts of bounded rationality and satisficing. Decision-makers, he argues, often pursue solutions that are good enough for the circumstances at hand but that are not optimal (see Conlisk, 1996, for a survey of research in this area). In contrast to other theoretical frameworks, models in behavioral finance typically emphasize the combination of investor psychology and limits to rational arbitrage (see, e.g., Shleifer and Summers, 1990; Hirshleifer, 2001; Barberis and Thaler, 2003; De Bondt, 2005).

The essential point is that human intuition matters in financial decisions. Investors have less than perfect information about business fundamentals. They also have to guess what other people know. Data about the state of the economy or the state of the market do not always reach them in a timely way. Moreover, the news may be complex and hard to put into context. Agents may also be under time pressure to reach a decision. The amount of available information is often so vast that individuals are forced to focus on a few major factors. In recent years, computer-based trading and financial innovation of all kinds have dramatically increased data overload (Merkle, 2007).

In sum, behavioral finance accepts that cognition is not free<sup>(1)</sup>. Equally importantly, individuals' restricted information processing capabilities and limited attention lead them to rely on mental heuristics that are useful but that may generate

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(1) Researchers in finance often assert that the neoclassical framework does not permit any «free lunch». This declaration is false, however, since it does not apply to the costs of interpreting information! In traditional finance, the representative economic agent is an atomistic, emotionally balanced individual with truly divine (i.e., infinite) cognitive power. Sure enough, some theorists like George Akerlof, Michael Spence or Joseph Stiglitz do consider the costs of collecting information and the effects of information asymmetry. But for the most part they still ignore the mental difficulties of deciphering data, or the effects of social influence, gut feelings and lack of self-discipline.

predictable errors in judgment and choice (Kahneman, 1973, 2011; Tversky and Kahneman, 1974; Arthur, 1994). Systematic error constitutes bias.

Human intuition and systematic error also matter in financial markets. When one considers the many stumbling blocks that prevent easy decisions, it is not unexpected that traders frequently «agree to disagree» about what the latest news bulletins mean for asset value. These differences of opinion, as well as the human shortcomings mentioned earlier, prevent sophisticated traders from implementing the arbitrage strategies that are needed to correct mispricing. In the end, «limits to arbitrage» refers to the coming together of business risk, noise trader risk and the costs of collecting and interpreting information.

Since market inefficiencies persist, it is important for economists to examine in more detail how decisions come about. One of the central findings of behavioral finance is that decision processes tell us something about decision outcomes<sup>(2)</sup>. Among many others, De Bondt (1998) and Barberis and Thaler (2003) survey some of the idiosyncrasies and foibles in individual's financial decisions. These peculiarities include the tendency to detect patterns in asset prices, over- and underreaction to news, an unwillingness to take losses, insufficient and/or naive diversification, and much more.

In sum, behavioral finance studies key psychological aspects of investor decision-making. Some factors that shape decisions are situational; others are related to personality (Holden, 2010). Some are related to what is occurring in markets (e.g., short-term trends in prices). Others are entirely non-economic and associated with, say, weather (Hirshleifer and Shumway, 2003) or sports events (Edmans *et al.*, 2008).

Brennan and Lo (2009) emphasize how human decisions in general are the product of instinct, habit, emotion, and reason. The exact mix depends on time, place and circumstances. Perhaps it should not surprise us that, notwithstanding centuries of study and discussion, there is no scientific consensus on how to model economic decisions<sup>(3)</sup>.

### 3. DECISION ERRORS AS THE END RESULT OF COGNITIVE AND EMOTIONAL BIASES

To repeat, many authors have studied the intuitive decision-maker (Gilovich *et al.*, 2002, offer a comprehensive review). Papers in psychology usually aim to identify specific decision-making tendencies in experimental settings. The great advantage of experiments is that they discipline our thinking. (Note that skeptical

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(2) Indeed, this is the central (policy) message of Thaler and Sunstein (2008). It is also why behavioral research is highly relevant to law, regulation and economic policy. For example, automatic enrollment in U.S. tax-advantaged 401(k) savings plans can promote retirement saving (Benartzi and Thaler, 2007). Posner (2001) discusses what behavioral studies have to offer to law and economics.

(3) Even so, William James (1890) remains a classic reference. The works of George Katona (1951; 1975) are also noteworthy. Katona specifically addresses the psychology of *economic* decision-making.

onlookers are free to reproduce any experiment they become familiar with.) Other behavioral scientists in management, law, medicine, or economics commonly refer to decision bias in attempts to explain, *ex post*, behavior that is observed in a natural environment. (In this case, the assumed bias of interest may motivate new hypotheses and tests.)

Some observers worry whether the behavioral approach has *bona fide* predictive power. In other words, do the experimental findings have ecological validity? A further question of interest is under what conditions one type of bias dominates another. Behavioral theories evidently offer economic theorists extra degrees of freedom (Hirshleifer, 2001). The danger is that a modeler who cannot rationalize particular empirical or experimental findings may still be able to make a judicious selection among several biases in order to «behavioralize» what is observed.

Oberlechner and Hocking (2004) state that psychology contributes to decision research by taking into account the attitudes of individual market participants. In practice, this is not so easy to pull off. Many authors capture individual characteristics by demographic variables such as age (DaSilva and Giannikos, 2006), gender (Powell and Ansic, 1997; Robert and Cox, 2001), wealth (Vissing-Jorgensen, 2003; Peress, 2004), intelligence and occupation (Christiansen *et al.*, 2008). Yet, these authors also appeal to psychology. It may be more appropriate to introduce cognitive or emotional variables directly (see, e.g., Santos *et al.*, 2011).

Overconfidence (see, e.g., Lichtenstein *et al.*, 1982) is a cognitive bias and also personality trait that is of special interest since it helps to explain several irregularities seen in financial markets. Forbes and Kara (2010) study how confidence interacts with knowledge to shape the ability of investors to achieve their goals. One effect of overconfidence is excessive trading (Odean, 1998; Statman *et al.*, 2006). Traders overestimate either the accuracy of their information (Daniel *et al.*, 1998) or their pure trading ability (Glaser and Weber, 2007; Deaves *et al.*, 2009; Graham *et al.*, 2009). Another consequence of overconfidence is lack of diversification in investment portfolios (Goetzmann and Kumar, 2008).

Emotion—or, more generally, affect—influences economic behavior. Affect is not a heuristic in the classic sense of, say, availability or anchoring-and-adjustment. The notion of affect describes how intuition retrieves sentiments from memory that are related to decision stimuli. Dual models of information processing distinguish between the affective and the cognitive systems (Epstein, 1994; Finucane *et al.*, 2000; Kahneman, 2002, 2011; Sloman, 2002; Slovic *et al.*, 2004; Camerer *et al.*, 2005). Affective processing is effortless. It operates reflexively, without thinking, at high speed. Affect functions through images, associations and experiences. It has an essential role in human motivation. In contrast, the cognitive system is analytical, slow, and consciously governed by rules and normative thought (Kahneman and Frederick, 2002). Kahneman (2002) states that intelligence, exposure to statistics, and incentives improve our cognitive ability to identify biases produced by the affective system. In contrast, Isen, her co-authors and others find that time pressure and multi-tasking reduce the power of the cognitive system (see, e.g., Isen and Geva, 1987).

The affect heuristic is activated once the affective meaning of a stimulus exceeds a given threshold level. There are noticeable differences in this regard between individuals (see, e.g., Hogarth *et al.*, 2011). People use emotions to deal with information overload and complexity (Shiv and Fedorikhin, 1999; Merkle, 2007). For example, emotions help individuals to discern what is more relevant and what is less (Anderson, 2007). This is especially relevant in the context of asset valuation since both the process and the final outcome are stressful and ambiguous (Statman *et al.*, 2008; Arnold *et al.*, 2010)<sup>(4)</sup>.

Emotions may be classified in many ways, e.g., on their valence (positive vs. negative), and whether they are actually experienced or merely anticipated (Gilovich and Medvec, 1995; Mellers *et al.*, 1998; Elster, 1999). Both *ex ante* and *ex post*, regret (or its positive counterpart, elation) and other counterfactual emotions color what people experience and what they decide to do. Gambetti and Giusberti (2012) find that anger favors the willingness to assume risks, a preference for medium or long-term investments, a tendency to wait before selling assets, and a tendency to discern predictable trends in stock prices. On the contrary, anxiety reduces the willingness of assume risks, the preference for hold interest-bearing accounts and for selling investments when its value change and with low predictability of stock trends<sup>(5)</sup>.

An intensification of positive or negative affect can produce a rise or fall in stock prices. It changes expected future returns (Statman *et al.*, 2008). In an affect model of risk and return, high return and low risk go together; so do low return and high risk. In other words, there is a negative risk-return trade-off. Ganzach (2000) documents this phenomenon in an experimental context. Hong and Kacpercyk (2007) and Statman and Glushkov (2008) study U.S. data. They find higher returns for stocks with negative affect to social responsible individuals (e.g., firms that produce tobacco, alcoholic drinks, firearms, nuclear power). Likewise, it is interesting to see how nowadays many people think that investments in publicly traded companies located in Spain, Italy or other Mediterranean countries are very risky. Yet, people are reluctant to supply funds, presumably because they fear low or negative returns. Evidently, this lack of enthusiasm goes against the standard theory that assets are priced as if there is a positive risk-return trade-off in financial markets.

#### 4. DECISION ERRORS, SOCIAL INTERACTION AND NEWS

Other than cognition and emotion, the behavioral literature often refers to social psychology. Perhaps starting with Hofstede (1980), countless studies have examined

(4) Gigerenzer and Selten (2001), Lo (2002) and Lucey and Dowling (2005) further link affect to decision-making under risk and satisficing behavior.

(5) Anger is positively related to proactive behavior. It varies in intensity from mild irritation or annoyance to fury and rage (Spielberger and Sydeman, 1994). Anxiety is a blend of tension and worried thoughts, prompting avoidance and conventional behavior (Wilt *et al.*, 2011).



the role of “corporate culture” in decision-making. A set of shared mental beliefs guide understanding in organizations and define what behavior is appropriate. «Sensemaking» is the process by which people, individually and collectively, give meaning to experience (Weick, 2001). A recent example that has received much press is the collision between Anglo-Saxon and Swiss investment banking cultures at Credit Suisse and UBS. Most Swiss journalists believe that, compared to London or New York, «things go slower but work better» in Zurich (see, e.g., Schmid, 2012)<sup>(6)</sup>.

Of course, social interaction also matters a great deal in financial markets. Investor decisions may be conceptualized as the result of a process of «problemistic search» (Greve, 2003). Some people know more than others. As a result, it makes sense for investors to take into account the decisions of other market participants, especially if others are thought to be better informed.

One way to overcome informational problems is to copy the behavior of other people. Imitation on a large scale amounts to mass herding. The phenomenon is linked to bubbles, sentiment and capital market inefficiency (see, e.g., Katona, 1979; Shiller, 2000; or Brunnermeier, 2001). Herding does not have to be irrational. It may be based on reason<sup>(7)</sup>. Devenow and Welch's (1996) discussion is centered on externalities. Consider a bank run. In this case, what an intelligent person ought to do is intensely influenced by guesswork and fear. Behavior that is individually rational may turn into dysfunction from the perspective of the bank and even the financial system as a whole. An abundance of studies of the conduct of professional fund managers and financial analysts, of their need to maintain a strong reputation for competence and integrity, and of compensation systems (Scharfstein and Stein, 1990; Zeckhauser *et al.*, 1991; Bikhchandani and Sharma, 2001) lead us into the same quandary.

The non-rational view of herding concentrates on aspects of macro-psychology. The man-on-the-street is probably convinced that today's (2012) economic and financial troubles cannot be talked about without reference to business, consumer, investor or voter confidence. The fact is that in many instances agents follow one another more-or-less blindly either because they are exposed to the same information and share the same mental frames, or because they do not know what else to do. Fernandez *et al.* (2011) links this type of herding to feelings of ambiguity and uncertainty. High uncertainty favors herding behavior regardless of the other cognitive and motivational biases that individual investors are subject to.

In other circumstances, stock market investors rely on a simple «expertise heuristic» (Chaiken, 1987). For example, when facing the news of an acquisition, investors may imagine that top managers must somehow know what they are doing and that they are making sensible decisions (Schijven and Hitt, 2012). Investors

(6) Interestingly, Schmid (2012) quotes a banker of British descent as saying: «Es ist die Umwelt, die das Individuum formt» (the environment shapes the individual).

(7) Or it can be both rational and irrational. Herding has multiple causes that are not mutually exclusive.



may also look for indirect signals of what managers believe (Zhang and Wiersema, 2009). One major piece of information is the premium that the acquiring company pays. Evidently, the premium can be in excess of what is gained by synergy or restructuring. There are many possible causes of excessive premia including hubris (Roll, 1986), foolish escalation of commitment (Duhaime and Schwenk, 1985), and narrow self-interest (Jensen, 1986)<sup>(8)</sup>. Thus, investors must also draw on a variety of additional pieces of information if they want to assess management. For example, they may consider the strategic fit between the firms involved; the particular sources of value creation; whether the acquirer pays in cash; the role of investment bankers and other deal advisors; and whether the board of directors of the target firm initiates a string of defensive tactics.

To repeat, many investors carefully watch what other people say and do (actions do not always match words!) Thus, the reliability of an observation or a source of information is a situational variable of significant interest (see, e.g., Beaulieu, 2001). If a decision problem is perplexing, if there is a great deal of data to make sense of, or if time is short, people may opt to assess the quality of the information by means of the reliability of the source. This is a sensible simplifying tactic (Chaiken, 1980) even if it is indirect. After all, financial news providers (e.g., accountants, security analysts and investment bankers) play a crucial role in the financial markets by producing and disseminating information (Shiller, 2012). They reduce information asymmetries and they command our trust<sup>(9)</sup>.

Pornpitakpan (2004) and Schwarzkopf (2007) review empirical studies relating to the reliability of an information source and its impact on persuasion. Rather unsurprisingly, the evidence indicates that, in general, high credibility sources have a greater impact on decision making than low credibility sources. However, this is not the case every time. It depends on the interaction of source credibility with other variables such as message content, message destination and media channels<sup>(10)</sup>. When the information is technical and characterized by risk, as it is in financial markets, the credibility of the source increases its impact on decision making.

Schwarzkopf (2007) reports that the reliability of an information source appears to be more relevant for (subjective) earnings estimates than for non-financial measures of performance. The author studies people with uneven levels of investment experience<sup>(11)</sup>. Interestingly, a small proportion of investors use auditor reports and financial statements in their assessments of firm performance. Further, internet chat rooms are not thought to be trustworthy. Time and again, investors believe chat rooms are sources of wild rumors, perhaps designed to distort asset prices.

(8) The CEOs of bidder and target firms commonly receive huge bonuses to complete a merger or acquisition.

(9) A more cautious statement is that their business reputation depends on it. Further, archival studies do show that the shares of publicly listed companies are more likely to be priced correctly when security analyst coverage is high (see Hirshleifer, 2001, for details).

(10) Low credibility sources may be more persuasive than high credibility ones when individuals have positive attitudes towards a brand, or when the product has existed for a long time (Pornpitakpan, 2004).

(11) This variable does not shape the results, however.

As a rule, rumors are assertions that are passed along accompanied by doubts and limited (or no) evidence (Allport and Postman, 1947; DiFonzo et al., 1994). In a bewildering financial environment, rumors can play a sense-making role (DiFonzo and Bordia, 1997) but they are looked upon with skepticism. (Much earlier, in 1989, Shiller and Pound had found that individual investors that purchase an asset are often drawn to it through interpersonal communication).

Many individuals have a psychological need to «confirm» the wisdom of a previous investment decision and subsequently forgo a certain amount of credibility in the information they use (Thayer, 2011). It goes without saying that this weakness twists the search for information and the quality of decisions. This is related to the fact that people persist in their beliefs. They give too little weight to signals that imply that their opinions are in error (Lord *et al.*, 1979). Finally, there is evidence that investor trading behavior is also sensitive to the sources of information that are used. It is well-known that many people trade too much and that the intensity of trading of individual investors is linked to how much effort they devote to gathering and analyzing information. However, all else equal, overconfident investors trade somewhat less when they receive information from family and friends (Abreu and Mendes, 2012).

## 5. RISK, AMBIGUITY AND UNCERTAINTY

We return one more time to the trade-off between risk and return, a pivotal aspect of financial decisions. Prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) is intended to describe how «real people» handle the problem. Importantly, the theory also explains why individuals methodically choose to violate the normative axioms of expected utility theory. Prospect theory and its successor theories state that people may be risk averse, risk neutral and risk-seeking depending partly on the situation in which they find themselves and partly on their personality (Lopes, 1987; Baltussen, 2009).

Most people want safety, i.e., they fret about downside risk, but others are focused on the upside potential of risky projects. In general, target outcomes—or alternative reference points such as the status-quo—play a key role in decision-making. People avoid danger if they can realistically hope to achieve their goals. At the same time, people abhor below-target results or «losses». This tendency explains risk-seeking by otherwise cautious individuals. Risks are usually evaluated in isolation, one-at-a-time, and over fairly short time periods. (Few decisions are final.) This kind of narrow framing contradicts portfolio theory (De Bondt *et al.*, 2009). It promotes excessive conservatism, e.g., myopic loss aversion (Benartzi and Thaler, 2003, and Haigh and List, 2005). Further complexities in dynamic decision-making include the house-money and break-even effects (Thaler and Johnson, 1990).

Ambiguity is an additional key factor in financial decisions. It surfaces when we lack enough information to assess the probabilities associated with different future outcomes (Frisch and Baron, 1988; Ghosh and Ray, 1997). Measures of ambiguity

tolerance capture how an individual faces incongruent, unfamiliar data. Most people find ambiguity objectionable<sup>(12)</sup>. The aversion results in several decision paradoxes (Ellsberg, 1961).

The economic consequences of ambiguity and its limiting case, pure uncertainty, have been examined ever since the immortal scientific contributions of Frank Knight and John Maynard Keynes. In further seminal research, Williams (1938) and Miller (1977) link ambiguity to investor disagreement, overoptimism and the long-term overpricing of small company stocks. Arnold *et al.* (2010) draw a distinction between soft, non-numerical, difficult-to-interpret information and «hard data» in the context of initial public offerings of equity (IPOs). The authors report that companies whose prospectuses are more ambiguous suffer added underpricing at the time of the IPO. In other words, the market price of these stocks shoots up more relative to the offering price. It may take years to sort out the initial doubt and divergence of opinion (Ahmed *et al.*, 2009).

Interestingly, changes in confidence under ambiguity are not equivalent to changes in estimation risk under Bayesian learning (Epstein and Schneider, 2007). Ambiguity-intolerant investors act as if they assume the worst about stock quality. They react more strongly to bad news than to good news. This may induce skewness in returns (Epstein and Schneider, 2008). Garlappi *et al.* (2007) present a theoretical analysis of optimal portfolio choice by ambiguity-averse investors. The core problem is parameter uncertainty. The authors show that ambiguity-averse portfolios are more «stable» than portfolios that rely on traditional mean-variance optimization.

To manage ambiguity, investors try to assess information quality. These appraisals are linked to salience, attention, and familiarity (Taylor and Fiske, 1978; Logan, 1992) and ultimately to stock returns. Salient information facilitates recall and improves perceptual readiness and information-processing. When investors buy shares, they are inclined to choose among those issues that have already caught their attention, maybe owing to their prior performance (Hirshleifer, 2001). This tendency may cause excessive trading that hurts the bottom line (Odean, 1999).

People also like to invest in familiar assets. They believe that they are more able to judge the «true value» of firms with which they are familiar. For instance, employees often invest a bizarrely large fraction of their retirement monies in the shares of companies where they work (Benartzi, 1997). Additionally, familiarity bias explains home bias, e.g., portfolios that are not geographically diversified.

Information quality, i.e., the precision with which knowledgeable investors can estimate firm value, often aggravates investor overconfidence and limits rational arbitrage. In the cross-section of stocks, firms earn lower returns if information quality is poor. Also, price and earnings momentum are much stronger for firms

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(12) Ambiguity tolerance is linked to a person's cognitive profile, e.g., self-confidence (Einhorn and Hogarth, 1985; Ghosh and Ray, 1997). Some individuals see ambiguous situations as threats (Sully de Luque and Sommer, 2000; Ling *et al.*, 2005). Others accept it (McNally *et al.*, 2009).

with high information uncertainty (Jiang et al., 2007).<sup>(13)</sup> Related results that have to do with assessments of earnings uncertainty appear in Baginski *et al.* (1993). Finally, Veronesi (2007) links information quality to stock risk premia.

## 6. COGNITIVE MODELS

In a nerve-racking, frantic situation, it sometimes happens that people «shoot first» and «aim afterward». We would all agree that this type of behavior does not meet the high standards of rationality. It is fortunate that, as a rule, decision-makers think before they act (for example, corporate strategy moves from knowledge to action). Still, what occurs in financial markets is often less about genuine economic facts than it is about the particular way in which news is perceived and interpreted by market participants (Oberlechner and Hocking, 2004). Mental frames matter and human beings are influenced by the manner in which choices present themselves. Broadly speaking, «perception» is the mental process by which individuals collect and filter information from newspapers, television, the internet and so on. Basically, people create an image of their environment.

Some behavioral researchers describe the decision-making process and analyze the interactions between context and individual traits by means of detailed cognitive models (see, e.g., Sloman, 2001; Warren, 2006; García-Ayuso and Jiménez, 1996). Over the years, this literature has become fairly large. In general, cognitive models are attempts to specify the different stages of the judgment and choice process and to identify the major factors that drive action. Below, we briefly describe three models.

Ozcan and Overby (2008) study the effect of partner diversity on stock market reactions to corporate alliance announcements. Their model has two stages: selection and encoding of data. Attention is by definition selective. Inevitably, much information is ignored. Encoding involves comparing alternatives and putting data into categories and so forth. In the first stage (selection), investors ask how similar or different the alliance partners are. Extreme similarity and extreme dissimilarity tend to produce a great deal of trading and large price movements. The remaining cases in the middle are associated with less trading and stable prices. In the second stage (encoding), information clarity becomes an issue. Specifically, medium diversity produces ambiguity. This may lead to status quo bias and/or negative sentiment. On the other hand, extremely high or low diversity generates investor overconfidence (the data send a bright and clear message!). The upshot is a U-shaped relationship between partner diversity and excess stock returns<sup>(14)</sup>.

(13) Whether these findings can be reconciled with Nelson *et al.* (2001) is open to question. Nelson *et al.* suggest that clear information signals also generate overconfidence.

(14) In addition, Ozcan and Overby find that firm size and analyst coverage moderates the diversity-stock return relationship. Overconfidence is particularly strong for small firms and firms with low analyst coverage. For large firms with high analyst coverage, the U-shape is inverted.

People often go beyond the information given, e.g., when they match events with well-known stereotypes (Bruner, 1957; Gilovich, 1981). Thus, different individuals often perceive different realities (Fahey and Narayanan, 1989). Also, there is no single, perfect and complete picture of reality. Kodia *et al.* (2010) acknowledge this issue. The authors study an artificial stock market and simulate its dynamics. They explore the interface between the individual and his environment. The model proposes that people (i) perceive, (ii) reason and (iii) act. Each investor is characterized by a given level of experience and three attitudes: pessimism or optimism, speculation or caution, and mimetism or leadership.

Lovric *et al.* (2008) develop a descriptive model that consists of three stages: (i) perception, (ii) interaction, and (iii) action. The authors take into account a series of psychological variables, e.g., time preference, risk attitude, personality, motivation, etc. They build upon the dual system of information processing discussed earlier. "Interaction" deals with peer influence, contagion (Topol, 1991) and other social factors such as the fundamental attribution error. «Action» also includes a number of things, e.g., the purchase or sale of specific assets, the amount traded, the type of order, and so on.

In sum, cognitive models are structured representations of a vast body of behavioral research findings. They encapsulate the interplay between social, situational and personality factors, and they single out what is most important.

## 7. CONCLUDING REMARKS

At this time, it is widely acknowledged that the nature of intuitive judgment and choice influences the quality of financial decisions made by individuals and organizations. It is also beyond dispute that experimental psychologists have identified a range of forces that cause predictable decision biases.

The aim of this paper was modest. We looked at selected studies of information overload, emotion, social influence, and ambiguity, as well as all-embracing cognitive models. These topics have received a great deal of attention of late, and they are extremely relevant to what happens in financial institutions and markets.

Evidently, our survey invites numerous problematical questions that we are not ready to answer. Here is a condensed list:

- First and most basic, what are the neurological *causes* of the regularities that are observed in intuitive judgment and choice? Is it imaginable that someday we will achieve better decision outcomes through medication, more or less in the way that people drink several cups of coffee to stay alert?
- Second, if it is true that the human brain generates systematic decision error, what is the *severity* of the problem? Notably, do social institutions, including norms, rules and regulations, often get us back on track? (after all, forgetful

people use notepads and day planners. Beyond that, they may visit libraries or cruise the internet).

- Third, *who* suffers more? Who suffers less? Is it a matter of education? Is cognitive ability a major predictor? Is age? (Forgetfulness can be a normal part of aging.)
- Lastly, *can we trust people to know and to do what is in their own self-interest?*

We end with the ritual cry for further research. Still, we are convinced that behavioral research has already casts intense doubt on the validity and the practical usefulness of some key insights of mainstream finance, such as portfolio theory, the positive risk-return trade-off, and efficient markets. In addition, and more significantly, behavioral research has laid the foundation for a new and improved finance.

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