Scientific Advisory Board Review

Contributors to this issue:

- Luc Arrondel, PSE

- Marie-Hélène Broihanne, Strasbourg University

- Thierry Foucault, HEC Paris

The AMF Scientific Advisory Board

The AMF set up a Scientific Advisory Board composed of prominent figures from the academic and financial worlds to expand its research and strategic intelligence capabilities.

The members of the Scientific Advisory Board hold positions in leading universities, business schools and public and private research centres. The board includes foreign researchers of international reputation, which gives it a global perspective. It has a triple remit:

1. provide the AMF with information on ongoing academic research in the financial field,
2. identify developments that may have an impact on the AMF's areas of activity,
3. undertake research projects related to issues of concern to the regulator.

The Chairman of the Scientific Advisory Board is Gérard Rameix, AMF Chairman, and the Vice-Chairman is Christian de Boissieu, a member of the AMF Board. The other members, appointed by a Board decision, are:

Luc Arrondel, National Centre for Scientific Research; Paris School of Economics
Patrick Artus, Natixis
Bruno Biais, Toulouse School of Economics
Marie-Hélène Broihanne, Strasbourg University
Gunther Capelle-Blancard, Paris Panthéon Sorbonne University
Eric Chaney, AXA
Serge Darolles, Paris Dauphine University
Thierry Foucault, HEC
Olivier Garnier, Société Générale
Carole Gresse, Paris Dauphine University
Philippe Ithurbide, Amundi
Charles-Albert Lehalle, Capital Fund Management
Albert Menkveld, Vrije Universiteit Amsterdam
Patrice Poncet, ESSEC
Nicolas Véron, Peterson Institute for International Economics; Bruegel

To help disseminate the Scientific Advisory Board's research, the AMF organises an annual conference that brings together the financial and academic communities to examine a specific topic.

CONTENTS

Savers between reason and passion - De gustibus disputandum est
The bankruptcy of Lehman Brothers in 2008 and the financial crisis that followed have questioned the knowledge of economists, particularly the finance. This was also an opportunity for some economists to question the fundamentals of the standard theory of the rational agent (homo oeconomicus) and turn to another "paradigm", psychological economics, even proposing to abandon neoclassical finance to behavioural finance.

This controversy did not wait for the crisis since it has stimulated debates for the past thirty years. We present these two conceptions of finance illustrating this presentation from the fields of the theory of the saver.

Individual investors' behaviour: a state of the art and some teachings
This paper presents the state of knowledge on the behaviour of individual investors. We address the biases commonly observed in portfolio management (insufficient diversification, the disposition effect and overconfidence) and we provide results for French individual investors. We also explore the determinants of non-participation in the equity markets of a significant percentage of investors. The article outlines the links between financial education, investor's sophistication and portfolio management behavior. In particular, professional investors, who are expected to be more sophisticated than individual investors, exhibit the same behavioural biases. Finally, this paper presents work on the biological bases of behavioural biases. It provides recommendations to limit the biases that penalize the performance of individual investors.

High Frequency Arbitrage: Is there Cause for Concern?
High frequency traders often exploit very short lived arbitrage opportunities. In this article, I argue that high frequency arbitrageurs can harm liquidity when they exploit arbitrage opportunities due to delays in the adjustment of asset prices to information. I discuss evidence of this effect and implications for market design.

■ Savers: between reason and passion
De gustibus disputandum est

Luc Arrondel, CNRS Paris School of Economics,
Banque de France

"What this machine of genius was supposed to produce
was equations."
(The Brain of Einstein, Mythologies, R. Barthes)

Abstract

Savers between reason and passion
De gustibus disputandum est

The bankruptcy of Lehman Brothers in 2008 and the financial crisis that followed have questioned the knowledge of economists, particularly the finance. This was also an opportunity for some economists to question the fundamentals of the standard theory of the rational agent (homo oeconomicus) and turn to another "paradigm", psychological economics, even proposing to abandon neoclassical finance to behavioural finance.

This controversy did not wait for the crisis since it has stimulated debates for the past thirty years. We present these two conceptions of finance illustrating this presentation from the fields of the theory of the saver.

Résumé

La chute de Lehman Brother en 2008 et la crise financière et économique qui a suivi ont mis le savoir des économistes sur la sellette, notamment la finance. Ce choc a été aussi l'occasion pour certains, de remettre en cause les fondements de la théorie standard de l'agent rationnel (l'homo oeconomicus) et de se tourner vers le « paradigme » concurrent, l'économie psychologique, proposant même d'abandonner la finance néo-classique pour la finance comportementale.

Cette controverse « paradigmatique » n'a cependant pas attendu la crise pour s'exprimer puisqu'elle alimente les débats depuis déjà une trentaine d'années. C'est de ces deux conceptions de la finance dont nous voudrions parler ici, en illustrant nos propos à partir de l'un de ces domaines de prédilection : la théorie de l'épargnant.

The bankruptcy of Lehman Brothers in 2008, and the financial and economic crisis that followed have raised questions about economists and their knowledge, particularly finance. How did we come to this? Why economists, some notable names excepted (Maurice Allais, Nouriel Roubini, Raghuram Rajan), did not see this coming? These are the questions that many people have asked, inside and outside of financial circles.

Above all, there have been many critics outside the economists' realm. In November 2008, during a visit to the London School of Economics, the Queen of England did not hesitate to publicly ask, "*Why had so few economists foreseen the Credit Crunch?"* In 2010, directors Jean-Stéphane Bron and Charles H. Ferguson accused, first, US banks in the film *Cleveland vs. Wall Street*[1], then the "profession" in the documentary *Inside Jobs*. Closer to home, François Hollande declared on January 22, 2012 at Le Bourget: "My real enemy [...] is the world of finance," guilty in his eyes of having led us into the "great recession".

But Economic Science has also been the fundamental subject of criticism. Paul Krugman (Nobel Prize, 2008) wrote in a 2009 New York Times article (How Did Economists Get It So Wrong?): "...even during the heyday of the efficient-market hypothesis, it seemed obvious that many real-world savers weren't as rational as the prevailing models assumed." And George Soros in a 2013 interview with the Institute for New Economic Thinking stated emphatically that "the dominant paradigm of rational choice theory and the efficient market economy has led to bankruptcy, bankruptcy very similar to that of the global financial system after Lehman Brothers."[2]

Proponents of the theory of the rational agent, *homo economicus*, did not have the right glasses and therefore could not see the crisis coming. To understand the *"World"*, according to some, it would be better then to turn to the competitor "paradigm" or "approach", *behavioural economics*, which, as stated by Richard Thaler (2000), is "to leave *homo economicus* for *homo sapiens*," to abandon neoclassical finance for behavioural finance.[3]

Did the economic crisis then imperil economic science, plunging the experts into a great "depression"? The judgement of Roger Guesnerie in an article published in *Le Monde* in 2013 with the evocative title "The Economy Paralysed By Doubt" however is more nuanced and advises us not to throw the baby out with the bathwater: "Last but not least, it is true that intellectual models put forward to understand financial markets assume *too much rationality* from economic agents. But mostly they assume too much predictability in such markets (experts talk of rational expectations)."[4] In other words, you have to know how to maintain reason.

Behind these intellectual quotes and positions, the questioning of the so-called standard economic theory in favour of the so-called behavioural approach is explicitly evident. This paradigmatic controversy however was not awakened by the crisis, as it had already been fuelling debates for some thirty years. It is these two "paradigms" that we want to discuss here by illustrating our point using one of the areas of finance, namely saver theory, or to be more modern, *household finance*.

We will begin by briefly presenting the standard saver theory before explaining the behaviourist critique. We will then examine the epistemological status of this "non-standard" approach. Finally, we will analyse the consequences in terms of economic policies that challenged the neoclassical model.

---

[1] The film Cleveland vs Wall Street (August 2010) by director Jean-Stéphane Bron is about a fictional trial between the "expropriated" in Cleveland and the "bankers" of Wall Street. It perfectly illustrates these ideological oppositions in the context of the financial crisis: the social outcasts bring up the poor advice coming from credit sellers, who "pushed them to crime", and from the finance professionals, we hear of free will and individual responsibility by condemning the incompetence of some of them.

[2] The theory of market efficiency is based on the fact that prices reflect all available information (Fama, 1970). Therefore, there is no way of having an opportunity to make a decision: in a market, no one can then make long-lasting gains over medium gains (Cochrane, 2005).

[3] "*Homo sapiens* do not have "Einstein's brain" or the memory abilities of IBM's Big Blue or Mahatma Gandhi's desire" (Thaler and Sunstein, 2010).

[4] Our emphasis.

The "hardcore" of saver theory and its "dead-ends"

From the standard saver theory, we first got the life-cycle hypothesis (LCH), initiated by Franco Modigliani that has served as a reference for economists since the late 1950s, and secondly, the optimal portfolio choice theory, and its intertemporal synthesis with LCH, conceived by Robert C. Merton in the late 1960s.

The life-cycle hypothesis (LCH)

To explain the behaviour of the saver, the basic model has been since the 1950s that of the life-cycle (Modigliani and Brumberg, 1954). Individuals are only meant to derive satisfaction from the overall volumes of their own consumption during each period of their life. They can still have transmission patterns according to their degree of "altruism" (Modigliani, 1986). Economic choices are assumed independent and purely forward-looking: subjects only look forward (to the future), not back (in the past) or sideways (what the neighbours are doing).

In other words, the saver seeks to maximise the satisfaction provided by his present and future consumption plan over his life cycle under his present instantaneous budget constraint - based on current income and assets - and what is expected for the future - in terms of income, risk and returns of investments, unemployment or health risk, life expectancy, changing tastes and needs - even maintaining a share of his estate to pass on to his children.

Under certain assumptions about the utility function (time additivity and homothetic preferences) and intertemporal resources, wealth, considered as a deferred consumption, will follow the famous Harrod bell curve: the individual saves during his active period to consume his assets at old age. This wealth accumulation, proportional to the permanent income (discounted sum of future resources), will be inversely functional to the degree of *time preference*. If the environment is uncertain, the individual who is supposed to maximise his expected utility, will also save for a precautionary motive, according to his degree of *prudence*.

The saver is hypothetically considered fully "rational": his intertemporal consumption plan results from maximising, under various constraints, a well-specified utility function which represents his own preferences. Wealth serves to match the timing of consumer's needs and desires for himself or his children and the resources that exhibit systematic variations (transition to retirement) and bumps or random fluctuations. Besides performance or deferment research and meeting liquidity needs, this wealth is corresponds to three major motivations: the creation of a *precautionary* reserve for an uncertain future; the intertemporal smoothing of consumption, including *savings for old age* and intergenerational *transmission*.

As a proof of individual's rationality, his choices are also "*temporally consistent*": if expectations are verified over time (hypothesis of rational expectations), the initial consumption plan proceeds as planned and remains unchanged. Under these assumptions, the standard and relatively frugal model retains only three preference parameters relative to the amount of risk, time and lineage:

(i) Aversion (relative) to risk, including precautionary investments and the portion of portfolio assets that are non- or low-risk: the higher it is, and the more the agent is willing to pay a risk premium or for insurance (proportional), the more important it is for the individual to protect against risk;

(ii) Rate of future depreciation over the life-cycle or degree of time preference for the present, which reduces the weight given to the satisfactions of the "future me" with respect to the "present me", reduces the decisional horizon of the agent over his given life expectancy: investments for old age vary inversely to this parameter;

(iii) Degree of family "altruism", it is the weight given to the well-being of the individual's children with respect to his satisfaction derived from his own consumption, it influences the motive for transmission.

Faced with empirical evidence, this standard model that explains some facts, however, creates several puzzles.[5].

The life-cycle model cannot therefore explain the insufficient retirement savings of a portion of the population (*inadequacy of saving*)[6] or the relative disinterest in life annuity (*annuity puzzle*) even after 50 years (Davidoff et al., 2005). The discontinuity (drop) in the post-retirement consumption profile (*retirement puzzle*) also calls the model's predictions into question (Banks et al., 1998, Hurd and Rohwedder, 2003) or the limited decrease (if any) in any assets at the end of life (Davies, 1981). Finally, the accumulation of assets by the richest (the 1% who possesses approximately ¼ of global wealth), comes from the blueprint of this theory (Piketty, 2013), rendering it unsuitable to explain wealth inequality.

Of course, the second generation of life cycle models have challenged the hypotheses of the baseline model: existence of liquidity constraints (Blinder, 1976); imperfections on annuities market (transaction costs, adverse selection, Friedman & Warshawsky, 1990); diversity of motives for intergenerational transfer of assets, such as altruism (Becker, 1991), exchange (Cox, 1987 Kotlikoff and Spivak, 1981, Bernheim et al., 1985) or paternalism (Blinder, 1976); consideration of multiple risks on future income (Kimball, 1993), on health and life expectancy (Davies, 1981) giving rise to precautionary savings among prudent households. Nevertheless, while these LCH extensions considerably enrich the empirical content of the model, they cannot solve all the puzzles.

The optimal portfolio theory

Coupled with choices of assets, the expected utility model (Merton, 1971), under certain hypotheses, connects to Arrow's theory of optimal portfolios (1965)[7]. In the simplest case, regarding the choice between a risky asset whose performance has an expectation m and a standard deviation σ and a risk-free asset with return r, the share p of the risky assets in the estate equals $p = (m–r) / \sigma^2 \gamma$: it depends on the relative risk aversion γ and price expectations of the risky asset (m, σ) - even return on risk-free asset (r) - which are themselves features of their information level. A variation of the invested share p can then be derived from a modification in the relative risk aversion or in the expectations of asset prices, or both at once. Obviously, the problem becomes more complicated when one considers, for example, the risk borne by the saver on his income from work or from the existence of liquidity constraints: the invested share p will decline proportionally more when the *background risk* or constraint is important (risk substitution) and *temperance* of the agent, according to γ, is high (Kimball, 1990).

The standard theory of portfolio choices hardly explains the low diversification (limited asset market participation) of the portfolios (Guiso et al., 2002)[8]. The equity risk premium highlighting the weakness of the amounts invested in risky assets with respect to what the theory predicts (*equity premium puzzle*) remains an enigma (Mehra & Prescott, 1985 Kocherlakota, 1996) as the low participation of savers in the securities market (*stock participation puzzle*, Haliassos & Bertaut, 1995 Haliassos, 2003). Finally, the dynamics of the portfolios on the life cycle, including the demand for shares, require more sophisticated models (Guiso et al., 2003).

Moreover, biases observed in household portfolios management also question the standard model[9]: "home" bias, "naive" diversification, "disposition" effect, status quo bias, inertia, excessive trading (Vissing -Jorgensen, 2004).

---

[5] For a critical review of the main "puzzles", refer to Guiso and Sodini (2013).

[6] Arrondel and Masson (2005) estimate that 20% of French households have insufficient assets to maintain their level of consumption during their retirement (assets-to-permanent income ratio less than 2).

[7] Under the assumptions of perfect capital market and log-normality of asset prices, optimum portfolios are complete (theorem of separation), short-sighted (independent from the agent's time horizon) and only depend on the technical characteristics of assets (return-risk) and individuals' relative aversion to risk (Campbell and Viceira, 2002).

[8] For France, see Arrondel and Masson (2003).

[9] For an overview on investor's behaviour, see the article by M.-H. Broihanne in this issue.

But even if one takes transaction costs into account (King and Leape, 1998), exposure to other risks (income, human capital, housing, health, etc.)[10], future liquidity constraints (Gollier 2001), flexibility of the labour supply (Bodie et al., 1992), the specific nature of certain inherited assets (human capital is "incorporated" and housing is considered as a consumption good and an illiquid asset at the same time, Viceira 2001), incompleteness of capital markets as well as limits on access to information Lusardi et al., 2013), these models still generate much more diversified portfolios than those observed in reality.

Towards non-standard rationality…

To remedy these empirical shortcomings, but also to report on the results of experimental economics, non-standard models were brought to change the rationality of the saver and as a consequence, introduce many other preference parameters. This research programme of *behavioural finance* has been evolving for more than thirty years, although in the mid-1950s, questioning the standard framework had already led to two famous papers: from the side of behaviour towards risk, Allais (1953) criticised the postulats and axioms of the *American School* by highlighting its paradox; from the perspective of time, Strotz (1955) invoked the myopia of individuals and their lack of *self-control* as a reason for their time inconsistency, like Ulysses who tied himself to the mast of his ship so as not to succumb to the sirens' song.

In short, behavioural economics assumes that compared to the standard model, individuals "deviate" on three levels (DellaVigna, 2009): (1) non-standard preferences (challenging the theories of expected and discounted utility), (2) non-standard beliefs (rejecting the theory of rational expectations) and (3) non-standard decision-making processes. We briefly present these behavioural approach deviations so as to go beyond the neoclassic model and illustrate the saver's behaviour.

Questioning the expected utility theory

An initial questioning of the expected utility model which helps explaining the "anomalies" in the demand for insurance, consists in giving the individual a degree of *optimism* or *pessimism*, depending on the – non-linear – way it transforms the probabilities of risky events. But the best known and most successful model is that of *loss aversion*: to assess the profitability of a risky financial operation, the individual chooses a position according to a benchmark – initial wealth in the simplest cases – from which he differently assesses gains and losses: the lack of utility arising from a loss is initially greater (in absolute value) than the utility arising from an equivalent gain (Kahneman et Tversky, 1979). Loss aversion, which requires the introduction of new parameters preferably regarding risk, is a better explanation for the limited distribution of annuities and shares. The explanation, however, remains partial.

The disaffection for life annuity is also explained by *ambiguity aversion* that individuals would exhibit when faced with poorly understood risk[11]: this new aversion would rather lead them to support less favourable, highly idiosyncratic, situations in terms of probability of survival.

In summary, numerous additional preferential parameters must be introduced in terms of risk or uncertainty to obtain more realistic predictions with respect to portfolio choices. The unique consolation, although still debated, is that it does not bring us back to the theory of the "full and total" rationality of the saver, even if non-standard rationality is more complex and more fragile.

Questioning the assumption of discounted utility

---

[10] For multi-risk management see Kimball (1993), Pratt and Zeckhauser, (1987), Gollier and Pratt (1996) and Eeckhoudt and Schlesinger (2006). For unemployment risk, see Heaton and Lucas (2000), and for "housing" risk, see Fratantoni, (2001), Cocco (2004) and Flavin and Yamashita (2002).
[11] Beginning in 1921, Frank Knight made the distinction between risk and uncertainty. Risk refers to a situation in which possible events are known and a probability can be given to each event. Uncertainty is a situation where all is unknown.

However, the models of non-standard attitudes regarding time have resulted in imposing severe limits on the rationality of savers in order to account for, among other things, insufficient retirement savings by the population. These models especially reject the hypothesis of the time consistency of choices, only giving savers a limited rationality.

The most well-known model of limited rationality is that of *quasi-hyperbolic* discounting (Laibson, 1997). This discounting leads to an additional depreciation of the immediate future, which means that some individuals are tempted by immediate over-consumption and have difficulties in following temporally consistent strategies over their life cycle.

This degree of short-term impatience reflects a *cognitive* or *volitional* deficit, which is the source of a time inconsistency of choices: if it is cognitive, the individual shows a tendency towards "procrastination" (inability for long-term planning), or constantly delaying unpleasant tasks or resolutions (such as quitting drinking or smoking, Akerlof, 1991); if it is volitional, meanwhile, the individual, through lack of will or self-control, is inclined to seek immediate gratification against his/her own long-term interest, which had nonetheless been fixed from the start (Laibson, 1997) – just like Ulysses yelling for his bonds to be removed in order to be able to join the sirens. Blocked contractual savings would seem to have the most success with these impatient individuals who are nonetheless farsighted; indeed, they would like to create self-discipline by temporarily freezing their assets or by forcing themselves to make regular payments.

More generally, savers would seem to be victims of their *emotions*. Emotions contaminate savers' attitudes regarding time, such as the general desire for improvement in the future (for growing consumption profiles), or expectation phenomena which reveal a bias towards the future, such as the pleasure of waiting for (*savouring*) a happy event, or the apprehension (*dread*) of a painful experience from which there is a desire to be quickly released. Other emotions would seem to be responsible for a systematic aversion to dispossession (*endowment effect*), or for an unjustified retrospective sensitivity to past costs, already sunk, and thus unrecoverable (*sunk costs fallacy*), etc. (see Arrondel and Masson, 2007).

Questioning the Rational Expectations Hypothesis

The 2008 financial crisis which led to the "Great Recession" has somewhat shaken the foundations of classical macroeconomics (Hall, 2010 and Stiglitz, 2011). At the heart of the debate is the role of expectations in standard macroeconomic models, particularly with respect to financial markets. These models are based on the rational expectations paradigm, in which households make use of all available information in order to construct their expectations, ensuring that, on average, they are not wrong about the future. In other words, their uncertainty is not due to their insufficient understanding of the world and the actions of others. Indeed, the rational expectations paradigm leaves only little room for a sustainable heterogeneity of beliefs. Hence, in a static environment, crises can be anticipated if they have previously occurred. This does not seem to have been the case in 2008.

Calling into question the rational expectations hypothesis, particularly the homogeneity of beliefs, seems to be an interesting field of research. It seems that an *individual* expectations theory is a new challenge for economic theory, particularly that which is concerned with financial markets. Behavioural finance is moving in this direction: "it allows people to dream of impossible returns, to refuse [relevant] information that they do not like, or agree to disagree among themselves," these psychological biases, reinforced by biased media coverage, could help explain "bubbles, cycles, crashes." The field remains concerned with the "extreme pessimism of economic agents during phases of [acute] crises", produced by a strong aversion to ambiguity combined with increasingly gloomy expectations with regards to stock prices (Gollier, 2013).[12]

---

[12] Edmans et al. (2007) also analyse the impact of sports results (in this case, football) on individuals' moods and their consequences on the price of assets.

Considering the rather disappointing applications of behavioural economics to finance, Guesnerie (2010) explores another field for research in order to understand expectations: "What is at stake here is the ability of agents to coordinate their images of the future. The optimism of many financial market models – for example, those that merge into various types of market information efficiency – are largely based on the optimism of the expectation coordination hypothesis. This should be explained, and not only assumed."

In order to judge the strong heterogeneity of expectations, it is best to measure them in surveys, as proposed by Dominitz and Manski (2011), and assess their impact on savings behaviour (Arrondel et al., 2012). To this end, Arrondel and Masson (2014a) measured French stock market expectations before and during the crisis, in 2007, 2009 and 2011, through successive waves of surveys. These surveys have covered the impact of the crisis on saver's expectations of the same savers for the three waves. Regarding the stock market, the surveys established that the expected average return decreased sharply over the period. From 5.6% in 2007, it slipped to 0% in 2011, after dropping by 2 percentage points in 2009 (3.6%). The French were thus increasingly pessimistic about the stock market, making it hardly surprising that they tended to keep away from it during this time. The second lesson from these measurements involves the strong individual heterogeneity of expectations. For example, in 2009, 48% of households expected stock market prices to rise on average over the next five years, while 20% expected a downward trend (the remainder anticipated no change). Explaining these heterogeneities is a daunting challenge for theoreticians as well as empiricists - how do households shape their expectations?

Poorly educated and uninformed savers, unable to make computations and victims of their emotions...

The standard saver theory postulates that individuals adopt forward-looking and temporally consistent behaviours, consuming according to their preferences and resources across their life cycle. It thus implicitly assumes that, in making their decisions, they know certain financial principles such as discounting, inflation, interest calculations, etc., and that they have some information about the economic environment. Information, "financial literacy" and "cognitive ability" research programmes, which have been so fashionable in recent years, suggest that this is not the case (Lusardi and Mitchell, 2014).

As such, savers suffer from a lack of financial education ("financial illiteracy") or from having limited cognitive abilities (Lusardi, 2009; Guiso and Sodini, 2012). They have not mastered the required economic principles (rational formation of expectations, discount calculation, valuation of assets, etc.), or else they suffer from insufficient knowledge of financial products or the economic environment (interest rates, stock market, retirement system, etc.). They make all kinds of "errors", from computation to strategy, but also errors of expectation in the collection and processing of information, or the shaping of their beliefs: non-Bayesian revisions and exaggerated confidence in their judgements (*overconfidence*). They are victims of "emotions" that conflict with their own interests, such as *impulsiveness*, *overconfidence*, unjustified regret or disappointment, etc.[13]

These various "biases" put forward by behavioural economics might explain inadequate preparation for retirement. Furthermore, choices can be too dependent on framing effects or mental accounting, where individuals themselves impose constraints on their spending by placing resources in various mental accounts that are more or less fungible, such as "current income", "current assets" and "future resources" (Shefrin and Thaler, 1988).

---

[13] Ariely (2008) goes further when he writes: "Emotions first play a vital role in our buying behaviour. Most of our actions are guided by emotion, rather than reason." This researcher goes on to imagine experiments in order to show that we are unable of predicting what we would or would not do when we are sexually excited. In the same vein, Daniel Kahneman (2011) separates two ways of thinking in his latest book: *system 1*, which is rapid, instinctive, and emotional, and *system 2*, which is slower, more thought out, and more logical. These two modes of thought coexist within us and make us to varying degrees like Homer Simpson (emotive) and Mr. Spock (calculating), which are two characters that are very commonly used by behaviourists as "vignettes" to make their point.

Ignorance about assets as well as the cost of information of any kind can obviously account for the observed incompleteness and diversity of portfolios. A series of indices attests to the importance of these factors in France. With a given amount of assets, the level of diversification and the probability of holding risky investments increases with age, doing so progressively as required financial information is acquired. Portfolio diversification and equity holdings also increase with the level of general education, reaching their maximum (for given assets) among those with higher education and university graduates. This role of education is strengthened by the wider *habitus* effect. Executives hold substantially more securitieseverything else being equal, than other employees. Finally and above all, holding securities, such as life insurance, seems to be "inherited", since it significantly increases when these same assets are held by the parents.

An abundance of recent literature focuses on factors related to this information that appear to play an important role in terms of participation in the stock market: *cognitive capacity* (Christelis et al, 2010; Grinblatt et al., 2011), trust (Guiso et al., 2008), "*sensitivity to the financial matters*" (Guiso and Jappelli, 2005), time spent collecting *information* (Guiso and Jappelli, 2007), *social interactions* (Hong et al., 2004) *optimism* (Jouini et al., 2006) *financial education* (van Rooij et al., 2011; Lusardi and Mitchell, 2014) or even "*happiness*" (Kaplanski et al., 2014). However, the precise mechanism by which these factors influence household financial decisions (via the pool of information available or expectations, etc.) remains to be formalised (Grinblatt et al., 2011).[14]

"Standard" vs. Behavioural economics: two "paradigms" for savers?

Questions regarding economic rationality in general and the epistemological status of *homo economicus* in particular, have a long history and have engaged the greatest minds whose thoughts continue to be relevant[15]. For Paul Samuelson[16], "*homo oeconomicus* is not a satisfactory abstraction, but remains the best possible model as long as one does not have a good theory of how our brain works"[17]. Milton Friedman's Methodological Instrumentalism (1953) suggests that the theory of rational choice should not be judged by the realism of its hypotheses but by its predictive nature. As Robert Solow proposes: "Economics is a field in which it becomes socially acceptable to pursue one's interest...", *homo oeconomicus* would be a construction suited to this scientific field. More recently, Roger Guesnerie (2011) writes: "This model, populated by rational automatons (...) enables numerous situations to be simulated. If we follow Lucas, the exploration of these worlds, which are in a sense artificial, renders this model a substitute for a natural science laboratory: the pseudo-experiences he sets up open the door to a better understanding of the real world".

The debate over the rationality of traditional choices

Regarding the saver, we have seen that standard economic models are based on a double rationality of the individual: a decisional rationality based on maximising a function of intertemporal utility under constraint, and a rationality of beliefs based on the model of reasonable expectations (beliefs of economic agents, correctly representing future uncertainty). These two hypotheses are not consubstantial but conceptually distinct (Guesnerie, 2011).[18]

As we have previously seen, based on numerous empirical deadlocks or predictive abnormalities in the standard model, behavioural economics, or the psychoeconomic approach, Rabin (1998), discusses these two postulates: in making their decisions, agents are not entirely

---

[14] An interesting approach might be to link these factors to the personality traits used by psychologists (Borghans et al., 2008): (O) openness to experiences (C) conscientiousness (E) extraversion (A) agreeableness (N) neuroticism.
[15] For French historian François Furet, *homo oeconomicus* is "a poor model of man."
[16] Cited by Guesnerie (2011).
[17] This is precisely the challenge of neuroeconomics: "The economy needs a brain" (Camerer, Loewenstein and Prelec, 2004).
[18] It is generally more neoclassical finance that is based on this double postulate: individual rationality and market efficiency.

rational and use a more complex procedure to form their expectations than the one described by the hypothesis of rational expectations.[19]

Beyond these extensions, economists' opinions begin to diverge and can be divided into two major streams.

The first considers that the non-standard extensions of the previously described basic model provide an acceptable approximation of traditional behaviour in most households; thereby we can perceive a basic rationality in their behaviour. The typical saver is, as a rule, able to foresee and plan over the long term. His choices appear to be governed by a series of personal preference parameters that define his general attitude to risk, the priority he gives to life's pleasures and the degree of devotion towards his children. Although occasionally disputed (over issues such as short-term impatience or other phenomena), a time consistency of choice remains the frame of reference for understanding long-term savings behaviour: this means that the stated preferences remain relatively stable over time. Otherwise the model loses any predictive value and the saver's rationality (in the economic sense) ceases to be an operational hypothesis. Traditionally, the time stability of preferences is also a cornerstone of economic theory.[20]

For another approach, even non-standard extensions of life cycle models do not allow the obtained results to be interpreted in a laboratory (in vitro) experiments, nor to explain the observed "anomalies": lack of savings for retirement, limited breadth of shares or insufficient invested amounts, disinterest in annuities, biased portfolio management, etc. For the proponents of the psycho-economic approach, the multiplicity of individual parameters that must be taken into account in decisions implies a greater heterogeneity of economic agents. However, the assumption of the time stability of preferences would no longer be necessary since behaviours are assumed to be driven more by emotions or gut reactions, while preferences are influenced by the effects of context or mental accounts, which are easily manipulated.[21]

These two schools pit illustrious economists against each other, as we can see in this example of verbal jousting. On the side of those who still credit savers with operational rationality, Gary Becker (1992 Nobel Prize) and Merton Miller (1990 Nobel Prize) are worth mentioning:

> "Such cognitive imperfections [in behaviours] are sometimes important, but in recent years, they may have received excessive attention at the expense of more significant weakness in standard models of rational choice for explaining actual behaviours, as opposed to experimental situations" (Becker, 1996, p. 22).
> "Behavioural science is appealing because it looks promising. But I do not think that it is, because it can do nothing more than study these occasional paradoxes" (Miller, 1998).

On the other hand, among the pioneers of the behavioural approach, there is of course Daniel Kahneman (2002 Nobel Prize) and Robert Shiller (2013 Nobel Prize):

---

[19] The methodological controversy surrounding these two conceptions of the saver is clearly summarised by Campbell (2006): "(…) behavioural finance theory describes the choices households currently make, but standard finance theory describes the choices that maximize household welfare, and that households can be educated to make" (Campbell, 2006, p. 1554).

[20] Georges Stigler and Gary Becker, both Nobel Prize winners, wrote in *De gustibus non est disputandum* (1977): "(…) tastes neither change capriciously nor differ importantly between people. On this interpretation one does not argue over tastes for the same reason that one does not argue over the Rocky Mountains – both are there, will be there next year, too, and are the same to all men."

[21] A recent example of the so-called power of emotions on behaviour is given by Guiso et al. (2011) who exploit the instability of responses to a lottery (in the same way as Barsky et al., 1997), both before and after the financial crisis, to conclude that Italian savers have become more risk-averse. This reduction in risk tolerance that cannot be explained by changes in the economic situation of individuals is attributed to "fear." To test this hypothesis, the authors conducted a "randomised" test on two samples, one including individuals having seen a horror film before responding to the lottery, the other not having seen any film. They concluded, by controlling individuals' taste in film, that those who are still in the emotional grip of the horror film are less tolerant with regards to risk. Another interpretation of this test could, however, question the validity of the measure of risk aversion used (Arrondel and Masson, 2014).

"No one ever seriously believed that all people have rational beliefs and make rational decisions all the times" (Kahneman, 2003, p. 162).

"Theoretical models of efficient financial markets that represent every one as rational optimisers can not be more than metaphors for the world around us. Nothing could be more absurd than to claim that everyone knows how to solve complex stochastic optimisation models." (Shiller, 2003).

Behavioural finance as an alternative paradigm to the standard saver theory?

According to Richard Thaler (2000), the 21st century will either be behaviouristic or not: "Our goal is that in twenty to thirty years, the expression 'behaviouristic economic sciences' will become superfluous because economic science will be, by definition, behaviouristic in its process (…)". Was Thaler's prophecy correct? Has economic science today become behaviouristic?

It cannot be ignored that there is still a long road ahead even though behavioural economics has enjoyed growing credit within the community of economists; psychological economics is also subject to both methodological and other forms of criticism. Here is a selection of these criticisms.

According to Pesendorfer, (2006), the main flaw in a behavioural approach is that it is always structured with reference to the standard framework and does not form a "paradigm" *per se*: "(…) behavioural economics remains a discipline that is organised around the failures of standard economics"[22]. Indeed, criticism of psychological economics has mainly to do with models based on hypotheses of discounted utility and expected utility and the anomalies detected only deal with these models. Thus, they end up completely invalidating those hypotheses that dictate savings choices in the standard theory, i.e. autonomous preferences relative to the horizon of the life of the agent that are prospective, temporally coherent and homothetic.[23]

This systematic reference of behaviouristic science to the standard theory and to the simplicity of its hypotheses have resulted in multiplying the parameters of individual preference in order to account the more realistically for behaviours observed *in vitro* and *in vivo*. A quick review of the figures shows at least a dozen additional parameters required, besides the two basic parameters of aversion to risk and preference for the present. However, this movement does not seem to be stopping. Enthusiasm for sociological or psychological economics and the development of data, with direct questions about individual preferences, may further disqualify the standard theory and accelerate resorting to new parameters. Models of choice under uncertainty can explain financial behaviours through degrees of aversion to ambiguity or uncertainty. The growing rejection of the homothetic pattern of preferences means that an individual who is more risk averse than another in his portfolio choices may be less cautious in precautionary saving (Elmendorf and Kimball, 2000).

One might then wonder if the microeconomics of savers, in their attempts to explain the diversity of accumulating behaviours, will lead to a dead-end. The solution seems to lie with a return to more discipline to prevent an unfruitful inflation of the parameters at work, especially in the case of temporal preferences, which entails the risks of confusion in identifying preference parameters as well as the contamination of measures by other factors. This also assumes that there is a need for a greater parsimony in finding an operational process that reconciles new theoretical and empirical requirements with the estimation of a restricted number of preference parameters, which are not too different from those of the standard theory.

---

[22] See Pesendorfer, (2006), p. 720.
[23] Thus, in an interview given to *Sciences Humaines* (No. 22, March-April-May, 2011), Dan Ariely, a famous experimentalist, explains what behavioural economics is for him: "It seeks to describe how people behave in real situations. Its goal is not to define an ideal of rationality, but rather to analyse how people actually act. "

Sometimes, resorting to experimental economics in order to solve puzzles, especially with regards to time preference, turns out to be a heartfelt wish[24]. To explain the failure of measuring preferences for the present (Fredericks et al, 2002), Masson (2010) emphasises the impossibility of reproducing lifetime in laboratory conditions and provides a philosophical reading of the concept of temporal preference: "(…) temporal preference for the present [is] supposed to represent the strength and extent of the subject's current project and incorporate his idiosyncratic attitude about death. This concept highlights the patent failures experienced by experimental measurements of the discount rate and tests of the life cycle model carried out in the laboratory – failures that are (wrongly) supposed to come from savers' lack of foresight and limited propensity for planning."[25]

More generally, these non-standard models tend to transform savers' lives into a pure exercise of computation by supposing that they can take on a completely external, objective and impartial point of view with respect to their own existence and actions, and by reducing people's relationship with their death to objective probabilities of survival. This means forgetting that decisions start with the present, and depend more precisely on the context they happen to be in. This also means ignoring that choices about assets involve relationships with oneself over time that depend on individuals' subjectivity. The very continuity of economic life and the ability to project oneself into the far future depend on the strength and extent of projects (marriage, career, buying a home, children's studies, retirement, etc.) all of which provide meaning and substance to existence today and which are often arranged in a tight hierarchy (Masson, 2010).[26]

Still in the domain of saver theory, the main common shortcoming to non-standard models – even the most sophisticated ones – is empirical: they hardly account for the most prominent stylised facts about asset choices . Here, we are not talking about the behaviour of experienced savers, but simply the behaviour of "ordinary" savers, which is characterised by: (i) insufficient savings for retirement (nearly one out of four cases in France); (ii) disinterest in the remaining life annuity, which despite its imperfections, is still a profitable product in the framework of life cycle savings and (iii) a limited distribution of risky products such as stocks. With these three criteria, non-standard models indeed do better than the standard version: they can thus account for certain cases of insufficient savings for old age and predict low amounts held in life annuities or stocks. Yet low levels of savings among savers with higher cognitive abilities and education levels leave them puzzled. Above all, these models still cannot manage to explain how most savers do not hold any stocks.[27]

Should we "build" a new saver? And how?

---

[24] In his critique of O'Donogue and Rabin's (1999) intertemporal model (with time inconsistency), Pesendorfer (2006) uses the metaphor of a "broken machine": "In a standard model, maximizing a utility function is simply a concise representation of how the agent behaves. But once the model is interpreted as a mental process, we must imagine that the decision-maker actually performs the optimization. Since the decision maker is systematically wrong about future behavior there is no obvious benefit from maximizing the objective function as opposed to taking some other (perhaps arbitrary) action […].Think of a car owner who operates a car with a defective power steering and yet behaves as if the steering were in perfect working condition. He spends great effort learning how to drive on a perfectly working car but ends up crashing his defective vehicle." (p. 718).

[25] See Masson (2010), p. 30.

[26] For example, the possible failure of a plan to purchase a property, which is important to the entire family, will present savers with a risk that is as existential as it is financial, also pushing them to be exposed even less and to limit their request for stocks: the criteria of risks and returns only comes in second priority (Guesnerie, 2009). However, whenever the situational context and considerations for their own lives become less significant, the agent's choices more closely resemble the models' predictions, especially with regard to requesting stocks.

[27] The only explanation that is coherent with a low distribution of stocks is based on a "narrow framing" effect: wherever the saver proceeds with integrated management, depending on overall wealth and budget constraint, out of all the risks encountered, the saver will tend to imagine the results of invested stocks separately. He cannot help but to consider the changes to his stocks portfolio separately because they are isolated investment transactions, i.e. without considering the possibility of diversification with other risks taken. Barberis et al (2006) effectively show that the combination of loss aversion and a focused "narrow framing" of the stocks may help to understand non-participation in a stock market, albeit without transaction costs. Nonetheless, we know little about the determinants of – and remedies to – this rationality bias.

In France, the 2008 crisis strengthened a recent trend, prompted by debates on the future of the welfare state, to put savers at the core of political and economic concerns: retirement and health and welfare reform projects, which aim to increase the responsibility of households in order to supplement a potential withdrawal of the welfare state with regards to seniors, have in fact put the spotlight on the behaviour of savers in general, and their rationality in particular. The "activation" or "promotion" policies for individuals are indeed currently riding high with the aim for each of us to behave as our own entrepreneurs: "*you are your own CFO [Chief Financial Officer]*"[28]. Provided you are able to fulfil that function (Castel, 2011).[29]

In fact, for some economists, savers "behaved badly" during the crisis, whether through a lack of rationality or financial incompetence. According to these economists, we should therefore improve savers' financial education or give them the "right incentive" to ensure that they do not make mistakes. Several economists have contributed to this new paternalism.

A new "paternalism"

This is, for example, the message given by Robert Shiller in his book, The Subprime Solution (2008): "The subprime crisis and the financial and economic problems that have resulted from it are due, in large part, to certain failures of the democracy, by which I mean financial democracy. Many people from the working class and first-time home buyers became over-indebted with respect to the value of their variable rate mortgages, and did not fully grasp the information about what they were doing – the type of information that is easily reachable for the richest people – and thus committed serious mistakes."[30] Hence, Shiller proposed to *publicly* fund financial education programmes.

Annamaria Lusardi, Director of the *Financial Literacy Center*, echoes this by writing in the *New York Times* on April, 24 2010: "Financial literacy is an essential piece of knowledge that every student should have. Just as reading and writing became skills that enabled people to succeed in modern economies, today it is impossible to succeed without being able to 'read and write' financially."[31]

These gaps that some would like to see filled are at the root of a new "liberal" paternalism, also called "libertarian paternalism," that is trying to change individuals in ways supposed to improve their lives, while seeking to preserve their freedom of choice.[32]. The idea is to improve the financial education of savers for their own well-being and, should this not be enough, give them a "nudge" (Thaler and Sunstein, 2003). The time inconsistency of the choices of savers could thus lead to advocacy for mandatory savings plans, as was the case in several countries, including Sweden.

Indeed, for some, the cognitive biases identified by behavioural economics justify a number of public interventions[33]: "The presumption that individuals are irrational implies that no sphere, not

---

[28] Annamaria Lusardi at the *Global Financial Literacy Summit* in 2013.
[29] This ideology of "promoting" the individual by the government is part of Michel Foucault's analyses (in *Sécurité, territoire, population*, Le Seuil, 2004) and his concept of "governmentality". This concept refers to a certain way of exercising power where governing means "with regard to inhabitants, the wealth and behaviour of each and every person, exercising a sort of surveillance and control as attentive as a father over his house and property." Its goal is to "induce people and things" to manage their relationships so as to lead them to theoretically defined goals.
[30] In a more ornate style, *Le Parisien*'s November 2011 headlines were entitled: "The French are terrible at finance."
[31] This desire to "educate" savers was already explicit in the highly political comments made in 2002 by Paul H. O'Neill, former US Treasury Secretary: "Financial Education can be compared to a road map to the American Dream. I believe that we need to teach all Americans the necessary tools to read that map, so they can reach the dream."
[32] Laibson, at the last AEA conference in 2015, summarised his speech as follows: "real people are located somewhere between Homer Simpson and the perfectly optimal/rational *homo economicus*" (illustrated by Mr. Spock). "Behavioural economists study this middle ground and sometimes attempt to help people make better choices." The character of Homer, always a victim of his emotions, is often taken as an example by economists to explain "nudging," such as Joshua Hall's recent (2014) book, *Homer Economicus: The Simpsons and Economics*. In *A Star is Burns*, Homer exclaims, for example: "Wow, I'll never drink another beer!" And yet a salesperson comes and says: "*Beer here...* ". Finally Homer, through a lack of self-control, gives in to temptation: "I'll take ten."
[33] Saint Paul (2012) describes the post-utilitarian society as based on behavioural economics (and neuroeconomics). In this approach, the individual has multiple identities: "the unity of the decision base is no longer the individual but a smaller unity: incarnation".

even the private sphere, is safe from intervention by the state" through "taxes on vice" (taxes on sodas, cigarettes, etc.), direct prohibitions or new obligations (Saint Paul, 2012). This leads to the rise of this new so-called "benevolent paternalism" or "third way" between the ideas of Milton Friedman and those of John Maynard Keynes. This trend is indeed highly popular politically: the British Prime Minister, David Cameron, created a "nudge unit," directed by Richard Thaler, as early as 2010; Barack Obama preceded him in 2009 by hiring Cass Sunstein to lead his "nudge squad." The extension of public intervention is thus a response to the many behavioural biases of individuals. This now raises the fundamental question of the limits of this new paternalism.[34]

Example: can we depend on economic science to draw the French back into the stock market?

Direct shareholding currently concerns less than 15% of French households; although we cannot always blame transaction costs, as such holdings remain limited, even for (financially) traditional high-income educated households. Certainly, the currently unfavourable economic conditions that led to a gloomier outlook regarding household expectations for share prices in coming years partially explains a low shareholder rate (Arrondel and Masson, 2014a), but this rate has never exceeded one quarter of households even in the best of times for the stock market and economic growth. Does economic theory offer solutions that encourage households to invest more in the stock market?

Non-standard theoretical developments call for improving the financial education of agents. Assisting households with managing risks associated with financial assets by developing public financial education and strengthening the regulation of professional practices is currently a subject of specific policies by several institutions (OECD, central banks, regulatory authorities, etc.): developing financial education programmes within certain populations (especially for women and children), as France does with the IEFP (Institute for Public Financial Education); developing the Markets in Financial Instruments Directive (MiFID), specifying the nature of financial advice to provide to the client[35]; creation of "economic museum", etc.

Even in the eyes of many behavioural economics advocates, this is a flight of fancy: improving an agents' financial education can only have limited results. The effectiveness of financial education programmes has yet to be demonstrated (Benartzi and Thaler, 2004 and Hastings et al., 2013), although we can welcome the increased education of savers, cultural, financial, or other[36]. These programmes would no doubt be better implemented in school during the formative years when preferences and tastes are developed.[37]

However, for proponents of behavioural economics or psychoeconomics, the activity of these institutional bodies, which are intended both to inform and protect the saver through regulation of the market, is insufficient: one cannot have total confidence that today's saver will proceed in the desired direction. We must manipulate the choices of individuals beleaguered by irrational notions and inconsistencies. In order to achieve this "libertarian paternalism", a true oxymoron that we have already mentioned, we advocate nudging policies, in which we help the saver without his full understanding, through mildly deceptive tactics, leading him to make correct decisions (according to economic rationality), while respecting his "freedom of choice". This method is currently enjoying some success with policy makers, as do many coaching techniques. By using different default options for example, as was the case in Sweden when the pension scheme was privatised in the 2000s, this paternalism actually results in an increase in

---

[34] For a liberal like Saint Paul (2012), this trend should be reversed "… reestablish individual autonomy, freedom and responsibility as the core values of our society and therefore set strict limits on state intervention".

[35] In this context, in early 2013, two authorities, one responsible for the financial markets (AMF), the other for prudential supervision (ACPR) have each published notes aimed at defining the framework and the rules regarding "the collection of information with regards to client knowledge" (AMF position No. 2013-02, 8 January 2013 - ACP recommendation 2013-R-01).

[36] The increasingly extensive economic literature on this subject (see for example Lusardi, 2009) which focuses primarily on chronic sub-investment in U.S. households rather illustrates this: it shows only modest benefits from savers' financial training.

[37] In fact, financial training and especially individual preferences, are determined early in life, especially within the family sphere. These evolve at an increasingly slower pace with age, (Arrondel and Masson, 2011). A policy of financial education and training preferences should therefore begin in the cradle and thus have tangible long-term consequences.

the number of shareholders (Thaler and Sunstein, 2003). These policies nevertheless transfer the risks to the saver, who is not necessarily aware of them and expose him to later disappointments, particularly during financial crises. In short, manipulating choices often produces temporary results.

The dream would be to intervene in the latter's psyche in order to create "new savers" who make more rational choices and have both lower risk aversion as well as a more farsighted in order for them to take more risk and be more orientated towards the long term. This desire to shape the psyche and behaviours of savers has faced a large amount of criticism, including ideologically[38]. More importantly, however, some studies have shown that it is largely wishful thinking.

In their analysis of saver behaviour during the crisis, Arrondel and Masson (2014a) show that preferences with regards to risk (and time) remained statistically stable between May 2007 and November 2011, showing a "stoic" saver amongst the turmoil, who is not more risk-averse than before. While preferences have not moved overall, during more than four years of such shocks, it is unclear, on the other hand, how socio-political interventions could affect them, at least in the short to medium term. The potential impact of the current crisis could, however, potentially be stronger on the psyche of new generations. Indeed, Malmendier and Nagel (2011) have shown that the generation of the 1929 crisis (depression babies) is less inclined to invest in risky assets and is more pessimistic in its expectations of future stock returns.[39]

The saver model, whether standard or not, does not then have any silver bullet to remedy the low diffusion of shareholding and savings in long and risky financial investments in our country. Arrondel and Masson (2014b) thus propose other solutions. From the supply side, the creation of a quasi-mandatory, or with near-automatic enrolment, capitalisation in defined contribution funds. From the demand side, the search for macroeconomic, social and financial measures which could generate less pessimistic stock market expectations. For a variety of reasons, both may be difficult to implement. However, between these two poles, there is little salvation: alternative proposals related to economic rationality appear unconvincing, except inasmuch as they are considered as complementary measures favouring one of the two previous paths.

---

[38] Activation policies have been criticised both "on the left" by the sociologist Robert Castel (2011), who condemns the fact that they lead, for the individual, to "unsubscribing" from the collective protection systems, and "on the right" by liberal thinkers like Saint Paul (2012), who rises against this post-utilitarian desire for the happiness of individuals despite themselves through "taxes on vice, direct prohibitions or new obligations" (see above).

[39] Noting that the level of financial education, and moreover the preferences of savers appear difficult to change through public policies, raises questions about the training processes. Arrondel et Masson (2014a) demonstrate that beyond social origins, credentials or religious education, intergenerational transmission and the specific influence of the home environment play a key role. Thus, in terms of financial education, the fact that the parents have or had life insurance seems the most convincing factor in explaining the apprehension towards life insurance and death insurance; the result is analogous, and almost as important for the possession of securities that "transfer" immensely between parents and children. Similarly, having (had) parents tolerant to risk, prescient or altruistic, has positive and significant effects on the individual, which proves to be substantially greater than those of religious education, social origin or credentials.

Conclusion

The recent crisis has underscored the weaknesses in a financial system established since the 1980s. It has also called into question certain dominant methodological options for economic analysis, the rationality of the individual, and the rational expectation hypothesis at the basis of the theory of efficient markets. "Behavioural" economists are therefore proposing the abandonment of this neoclassical financial system—which is guilty, according to some, of causing the "great recession"—in favour of behavioural finance.

The criticism of the standard theory of rationality does not however date from just yesterday; back in the 1950s Maurice Allais, for the choices in an uncertain universe, and Robert Strotz for intertemporal decisions, had already criticised the postulates of the expected utility theory for the former and reduced utility for the latter. But it is during the last thirty years that behavioural economics has seen increasing success, particularly with the pioneering work of several Nobel Prize winners, notably Daniel Kahneman and Robert Shiller. Some, such as Richard Thaler, have predicted that in the very near future, economics as a science will be largely "behavioural". Nevertheless, others (Wolfgang Pesendorfer particularly) have shown themselves to be more sceptical and do not consider psychological economics to be an alternative paradigm, its main flaw being that it always has to be structured in reference to the standard framework. The criticism of the hypothesis of rational expectations is more recent but for a smaller number of economists (Roger Guesnerie among others) forms a more promising path than psychological economics, with research being notably carried out on the coordination of anticipation modes.

The success of behavioural economics has gone beyond simple academic circles, since bringing cognitive distortions to prominence can be useful to justify, in the name of "libertarian" paternalism, large numbers of public interventions, such as "nudging", financial education programmes, taxes on "vices", etc. Certain politicians, from all parties, have become attached to the ideas of the behaviourists to reflect upon what they call the "third way," thus situating themselves between the liberalism of Milton Friedman and the interventionism of John Maynard Keynes. But these policies of "activating" the individual also encounter criticism as much from the left, because they lead to "unsubscribing" from the systems of collective protection, as well as from the liberal side, because the State should not have to make individuals happy in spite of themselves. The more ideological debate is then more on the limits of public intervention, particularly in the private sector, rather than the status of *homo economicus*.

References

Akerlof, G.A. (1991), « Procrastination and Obedience », *The American Economic Review, AEA Papers and Proceedings*, 81(2), p. 1-19.

Allais, M. (1953), « Le comportement de l'homme rationnel devant le risque: critique des postulats et axiomes de l'école Américaine », *Econometrica,* 21(4), p. 503–546.

Ameriks, J., A. Caplin et J. Leahy (2003), « Wealth Accumulation and the Propensity to Plan », *Quarterly Journal of Economics*, 118(3), p. 1007-1047.

Ariely, D. (2008), *C'est (vraiment ?) moi qui décide*, Flammarion.

Arrondel, A., H. Calvo Pardo et D. Tas (2012), « Subjective Stock Market Expectations, Information and Stock Market Participation: Evidence from France », *NBER Summer Institute Economic Fluctuations and Growth Working Group on Aggregate Implications of Microeconomic Consumption Behavior.*

Arrondel, L. et A. Masson (2003), « Stockholding in France », in *Stockholding in Europe*, Guiso L., Haliassos M. et T. Jappelli (eds), Palgrave Hampshire, p. 75-109.

Arrondel, L. et A. Masson (2007), *Inégalités patrimoniales et choix individuels. Des goûts et des richesses...,* Economica, Paris.

Arrondel, L. et A. Masson (2011), *L'épargnant dans un monde en crise : ce qui a changé*, Editions rue d'Ulm, Paris.

Arrondel L. et A. Masson (2014a), « Mesurer les préférences des épargnants : comment et pourquoi (en temps de crise) ? », *Économie et statistique*, n°467-468, p. 5-49.

Arrondel L. et A. Masson (2014b), « Allocation de l'épargne et investissement de long terme », *Opinions et Débats*, Labex Louis Bachelier, septembre, n° 6.

Arrondel, L., A. Masson et D. Verger (2005), « Préférences face au risque et à l'avenir : types d'épargnants », *Revue Économique*, n°56(2), p. 393-416.

Arrow, K.J. (1965), *Aspect of the Theory of Risk Bearing*, Yrjö Johnson Lectures, Helsinki.

Banks, J., R. Blundell et S. Tanner (1998), « Is There a Retirement-Savings Puzzle? », *The American Economic Review*, Vol. 88(4), p. 769-788.

Barberis, N., M. Huang et R. Thaler (2006), « Individual Preferences, Monetary Gambles, and Stock Market Participation: A Case for Narrow Framing », *American Economic Review*, 96, p. 1069-1090.

Barsky, R.B., M.S. Kimball, F.T. Juster et M.D. Shapiro (1997), « Preference Parameters and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Survey », *Quarterly Journal of Economics*, 112(2), p. 537-580.

Becker, G.S. (1991), *A Treatise on the Family*, Enlarged Edition, Harvard University Press.

Becker, G.S. (1996), *Accounting for Tastes*, Harvard University Press, Cambridge.

Benartzi, S. et R. Thaler (2004), « Save More Tomorrow: Using Behavioral Economics to Increase Employee Savings », *Journal of Political Economy*, 112, Part 2, p. S164-S187.

Bernheim, B.D., A. Schleifer et L.H. Summers (1985), « The Strategic Bequest Motive », *Journal of Political Economy*, 93, p. 1045-1076.

Blinder, A.S. (1976), « Intergenerational Transfers and Life Cycle Consumption », *Papers and Proceedings of the American Economic Review*, 66, p. 87-93.

Bodie, Z., R.C. Merton et W.F. Samuelson (1992), « Labor supply flexibility and portfolio choice in a life cycle model », *Journal of Economic Dynamics and Control*, 16(3-4), p. 427-449.

Borghans, L., A.L. Duckworth, J.J. Heckman et B. ter Weel (2008), « The Economics and Psychology of Personality Traits *», Journal of Human Resources*, 43(4), p. 972-1059.

Camerer, C., G. Loewenstein et D. Prelec (2004), « Neuroeconomics: Why Economics Needs Brains », *The Scandinavian Journal of Economics,* 106(3), p. 555-579

Campbell, J., et L. Viceira (2002), *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors*, Clarendon, Lectures in Economics, Oxford University Press.

Campbell, J. (2006), « Household Finance », *The Journal of Finance*, 61(4), p. 1553-1604.

Castel, R. (2011), « Les ambiguïtés de la promotion de l'individu », in *Refaire Société*, P. Rosenvallon (ed.) Paris, La République des idées.

Cocco, J. (2004), « Portfolio Choice in the Presence of Housing », *Review of Financial Studies,* 18(2), p. 535-566.

Cochrane, J.H. (2005), *Asset Pricing*, Princeton, NJ: Princeton University Press.

Cox, D. (1987), « Motives for Private Income Transfers », *Journal of Political Economy*, 95(3), p. 508-546.

Christelis, D., T. Jappelli et M. Padula (2010), « Cognitive abilities and portfolio choice », *European Economic Review*, 54, p. 18–38.

Davidoff, T., J.R. Brown et P.A. Diamond (2005), « Annuities and Individual Welfare », *American Economic Review*, 95(5), p. 1573-1590.

Davies, J.B. (1981), « Uncertain Lifetime, Consumption and Dissaving in Retirement », *Journal of Political Economy*, 89, p. 561-77.

DellaVigna, S. (2009), « Psychology and Economics: Evidence from the Field », *Journal of Economic Literature*, 47(2), p. 315-72.

Dominitz, J. et C. Manski (2011), « Measuring and Interpreting Expectations of Equity Returns », *Journal of Applied Econometrics*, 26, p. 352-370.

Edmans A., D. García et O Norli (2007), « Sports Sentiment and Stock Returns », *Journal of Finance*, 62(4), p. 1967-1998.

Eeckhoudt, L. et, H. Schlesinger (2006), « Putting Risk in its Proper Place », *American Economic Review,* 96(1), p. 280-289.

Elmendorf, D.W. et M.S. Kimball (2000), « Taxation of Labor Income and the Demand for Risky Assets », *International Economic Review*, 41, p. 801-32.

Fama E.F. (1970), « Efficient Capital Markets: A Review of Theory and Empirical Work », *The Journal of Finance,* 25(2), p. 383-417.

Flavin, M. et T. Yamashita (2002), « Owner-Occupied Housing and the Composition of the Household Portfolio », *American Economic Review,* 92(1), p. 345-362.

Fratantoni, M. (2001), « Homeownership, committed expenditure risk, and the stockholding puzzle », *Oxford Economic Papers* 53, p. 241-259.

Frederick, S., G. Loewenstein et T. O'Donoghue (2002), « Time Discounting et Time Preference: a Critical Review », Journal of Economic Literature, 40, p. 351-401.

Friedman, M. (1953), *Essays in Positive Economics*, Chicago.

Friedman, B. et M.J. Warshawsky (1990), « The cost of annuities: implications for savings behavior and bequests », *Quarterly Journal of Economics*, 104(2), p. 135-154.

Gollier, C. (2001), *The Economics of Risk and Time,* MIT Press, Cambridge.

Gollier, C. (2013b), « Édito », *Les cahiers Louis Bachelier*, n°8, février.

Gollier, C. et J. Pratt (1996), « Weak Proper Risk Aversion and the Tempering Effect of Background Risk," *Econometrica,* 64, p. 1109-1123.

Grinblatt, M., M. Keloharju et J. Linnainmaa (2011), « IQ and Stock Market Participation », *The Journal of Finance,* 66(6), p. 2121-64.

Guesnerie, R. (2009), « Commentaires », in Garnier O. et Thesmar, *Epargner à long terme et maîtriser les risques financiers*, Rapport n° 86, Paris, La documentation Française, p. 105-107.

Guesnerie, R. (2011), « Rationalité économique et anticipations rationnelles », *idées économique et sociales*, n°165.

Guiso, L. et T. Jappelli (2005), « Awareness and Stock Market Participation », *Review of Finance*, 9, p. 537-567.

Guiso, L. et P. Sodini (2012), « Household Finance: An Emerging Field », CEPR Discussion Papers 8934.

Guiso, L., P. Sapienza et L. Zingales (2011), « Time Varying Risk Aversion », *mimeo.*

Guiso, L., P. Sapienza et L. Zingales (2008), « Trusting the stock market », *The Journal of Finance*, 63, p. 2557-2600.

Guiso, L., M. Haliassos et T. Jappelli (2002), *Household portfolio*, MIT press.

Guiso, L., M. Haliassos et T. Jappelli (2003), *Stockholding in Europe*, Palgrave, Hampshire.

Guiso, L., M. Haliassos et C. Bertaut (1995), « Why Do So Few Hold Stocks? », *Economic Journal,* 105(432), p. 1110-1129.

Haliassos, M. (2003), « Stockholding: Recent Lessons from Theory and Computations », in Guiso, L., M. Haliassos, et T. Jappelli (Eds.), *Stockholding in Europe*, Palgrave Macmillan Publishers, p. 30-51.

Hall, R.E. (2010), « Why Does the Economy Fall to Pieces after a Financial Crisis? », *Journal of Economic Perspectives*, 24(4), p. 3-20.

Hasting, J.S., B.C. Madrian et W.L. Skimmyhorn (2013), « Financial Literacy, Financial Education and Economic Outcomes », *Annual Review of Economics, Annual Reviews*, 5(1), p. 347-373.

Heaton, J. et D. Lucas (2000a), « Portfolio Choice and Asset Prices: The Importance of Entrepreneurial Risk », *Journal of Finance* 55:3, p. 1163-1198.

Hong, H., J.D. Kubik et J.C. Stein (2004), « Social Interaction and Stock Market Participation », *The Journal of Finance*, 59, p. 137-163.

Hudomiet P., G. Kezdi et R.J. Willis (2011), « Stock Market Crash et Expectations of American Households », *Journal of Applied Econometrics*, 26(3), p. 393-415

Hurd, M. et S. Rohwedder (2003), « The Retirement-Consumption Puzzle: Anticipated and Actual Declines in Spending at Retirement », *NBER Working paper 9586*.

Jouini, E., S. Benmansour et C. Napp (2006), « Is there a « pessimistic » bias in individual beliefs ? Evidence from a simple survey », *Theory and Decision*, 61(4), 345-362.

Kahneman, D. (2003), « A psychological Perspective on Economics », *American Economic Review*, 93(2), p. 162-168.

Kahneman, D. (2011), *Système 1, système 2. Les deux vitesses de la pensée*, Flammarion.

Kahneman, D. et A. Tversky (1979), « Prospect Theory: An Analysis of Decision under Risk », *Econometrica*, 47, p. 263-291.

Kaplanski, G., H. Levy, C. Veld et Y.V. Veld-Merkoulova (2014), « Do Happy People Make Optimistic Investors? », *Journal of Financial and Quantitative Analysis*, forthcoming

Kimball, M. (1990), « Precautionary Saving in the Small and in the Large », *Econometrica* 58(1), p. 53-73.

Kimball, M. (1993), « Standard Risk Aversion," *Econometrica,* 61:3, 589-611.

King, M. et J. Leape (1998), « Wealth and Portfolio Composition: Theory and Evidence », *Journal of Public Economy* 69:2, 155-193.

Knight, F. H. (1921), *Risk, Uncertainty and Profit*, Houghton Mifflin, New-York.

Kocherlakota, N. R. (1996), « The Equity Premium: It's Still a Puzzle », *Journal of Economic Literature,* 34 (1): 42–71.

Kotlikoff, L. et A. Spivak (1981), « The Family as an Incomplete Annuities Market », *Journal of Political Economy*, 89, 372-391.

Laibson, D. (1997), « Golden Eggs and Hyperbolic Discounting », Quarterly Journal of Economics, 112, p. 443-477.

Lusardi, A. (ed.) (2009), *Overcoming The Saving Slump: How to Increase the Effectiveness of Financial Education and Saving Programs*, Chicago, University Of Chicago Press.

Lusardi, A. et O. Mitchell (2014), « The Economic Importance of Financial Literacy: Theory and Evidence », *Journal of the Economic Literature*, 52 (1), p5-44.

Lusardi, A., P.C. Michaud et O.S. Mitchell (2013), « Optimal Financial Knowledge and Wealth Inequality », National Bureau of Economic Research Working Paper 18669.

Malmendier, U. et A. Nagel (2011), « Depression Babies: Do Macroeconomic Experiences Affect Risk-Taking? », *Quarterly Journal of Economics*, 126(1), p. 373-416.

Masson, A. (2010a), « La vie pour l'épargnant ne se réduit pas à un exercice de calcul : 1. Les impasses des approches du cycle de vie standard et psycho-économiques », *Revue française d'économie*, XXV (1), p. 117-173.

Masson, A. (2010b), « La vie pour l'épargnant ne se réduit pas à un exercice de calcul : 2. Les apports d'une approche existentielle du cycle de vie », *Revue française d'économie*, XXV (2), p. 3-57.

Mehra, R. et E.C. Prescott (1985), « The Equity Premium: A Puzzle », *Journal of Monetary Economics* 15 (2): 145–161.

Merton, R.C. (1971), « Optimal Consumption and Portfolio Rules in a Continuous Time Model », *Journal of Economic Theory*, 3, 373-413.

Miller, M.H. (1998), « Some Reflections On Recent Monetary Turmoil In Eastern Europe », *Journal of Applied Corporate Finance*, 11(3), 49-54.

Modigliani, F. (1986), « Life Cycle, Individual Thrift and the Wealth of Nations », American Economic Review, vol. 76 (3), 297-313.

Modigliani, F. et R. Brumberg (1954), « Utility Analysis and the Consumption Function: an Interpretation of Cross-section Data », in *Post-Keynesian Economics*, K.K. Kurihara ed., Rutgers University Press, 388-436.

O'Donoghue, T. et M. Rabin (1999), « Doing It Now or Later ». *American Economic Review*, 89(1): 103-124.

Piketty, T. (2013), *Le capital au 21e siècle*, Editions du Seuil.

Pratt, J. et R. Zeckhauser (1987), « Proper Risk Aversion », *Econometrica*, 55, p. 143-154.

Matthew, R. (1998), « Psychology and Economics », *Journal of Economic Literature*, 36(1), 11-46

Shefrin, H.H. et R.H. Thaler (1988), « The Behavioral Life-Cycle Hypothesis », *Economic Inquiry*, 26, 609-643.

Pesendorfer, W. (2006), « Behavioral Economics Comes of Age », *Journal of Economic Literature*, 44(3), 712-721.

Saint-Paul, G. (2012), « Liberté et société post-utilitariste », TSE Working Papers 12-339.

Shiller, R.J. (2003), « From Efficient Markets Theory to Behavioral Finance », *Journal of Economic Perspective*, 17(1), 83–104

Shiller, R.J. (2008), *The Subprime Solution: How Today's Global Financial Crisis Happened, and What to Do about It*, Princeton University Press.

Stigler, G.J. et G.S. Becker (1977), « De Gustibus Non est Disputandum », *American Economic Review*, 67 (2), p. 76-90.

Stiglitz, J. E. (2011), « Rethinking Macroeconomics: What Went Wrong and How to Fix it », *Journal of the European Economic Association*, 9(4): 594-645.

Strotz, R.H. (1956), « Myopia and Inconsistency in Dynamic Utility Maximization », *Review of Economic Studies*, 23, p. 165-180.

Thaler, R. (1998), "Giving Markets a Human Dimension." in The Complete Finance Companion and Financial Times, section Mastering Finance, (1998).

Thaler, R.H. (2000). « From Homo Economicus to Homo Sapiens ». *Journal of Economic Perspectives*, 14(1): 133-141.

Thaler, R. et C. Sunstein (2003), « Libertarian Paternalism », *The American Economic Review*, 93, 175-179.

Thaler, R. et C. Sunstein (2010), *Nudge : la méthode douce pour inspirer la bonne décision*, Vuibert, Paris.

Viceira, L. (2001), « Optimal Portfolio Choice For Long-Horizon Investors With Non- tradable Labor Income », *The Journal of Finance* 56:2, 433-470.

Vissing-Jorgensen, A. (2004), « Perspectives on Behavioural Finance: Does Irrationality Disappear with Wealth? Evidence from Expectations and Actions", in M. Gertler and K. Rogoff eds., *The NBER Macroeconomics Annual 2003*, Cambridge: MIT Press.

Van Rooij, M., A. Lusardi et R. Alessie (2011), « Financial literacy and stock market participation », *Journal of Financial Economics*, 101, p. 449-472.

Yamashita, T. (2003), « Owner-occupied Housing and Investment in Stocks: an Empirical Test », *Journal of Urban Economics* 53:2, 220-237.

■ The behaviour of individual investors: a state of the art and some teachings

Marie-Hélène Broihanne, LaRGE, EM Strasbourg, Strasbourg University

"A full understanding of human limitations will ultimately benefit the decision-maker more than will naïve faith in the infallibility of his intellect."
Paul Slovic, Journal of Finance, 1972

Abstract

Individual investors' behaviour: a state of the art and some teachings

This paper presents the state of knowledge on the behaviour of individual investors. We address the biases commonly observed in portfolio management (insufficient diversification, the disposition effect and overconfidence) and we provide results for French individual investors. We also explore the determinants of non-participation in the equity markets of a significant percentage of investors. The article outlines the links between financial education, investor's sophistication and portfolio management behaviour. In particular, professional investors, who are expected to be more sophisticated than individual investors, exhibit the same behavioural biases. Finally, this paper presents work on the biological bases of behavioural biases. It provides recommendations to limit the biases that penalize the performance of individual investors.

Résumé

Cet article présente l'état des connaissances sur le comportement des investisseurs individuels. Nous abordons les biais communément observés en matière de gestion de portefeuille (biais de diversification insuffisante, biais de disposition et excès de confiance) en mettant l'accent sur les résultats obtenus pour les investisseurs individuels français. Nous explorons également les déterminants de la non-participation aux marchés d'actions d'un pourcentage non négligeable d'investisseurs. L'article expose les liens existant entre éducation financière, sophistication de l'investisseur et comportement de gestion de portefeuille. En particulier, les investisseurs professionnels, censés être plus sophistiqués que les investisseurs individuels, sont victimes des mêmes biais comportementaux. Enfin, cet article présente des travaux portant sur les fondements biologiques des biais comportementaux. Il fournit des préconisations visant à limiter les biais qui pénalisent les performances des investisseurs individuels.

Introduction[40]

Conventional finance relies on Von Neumann and Morgenstern's axioms of rationality (1944). These hypotheses on behaviour have been questioned on multiple occasions over the last sixty years, which has led to the development of "Behavioural finance" (the title of our work published in 2004). We now know that investors resort to shortcuts in reasoning (called heuristics) during their decision-making processes. Furthermore, they have a biased perception of their abilities that leads them to demonstrate overconfidence. The consequences are, on the one hand, excessively frequent trades which diminish performance (Odean 1999, Glaser and Weber 2007) and, on another hand, excessive risk-taking (Barber and Odean, 2001).

These behavioural problems are accentuated today by online brokering that pushes investors to make "useless" trades. This tendency to overtrade is also explained by self-attribution bias[41] and the illusion of knowledge and control (Barber and Odean, 2002). Finally, investors under or over-react to certain information (DeBondt and Thaler, 1985). They believe they can spot the trend in a completely random change in price, which Kahneman and Tversky call the law of small numbers.

This article presents the current understanding of the behaviour of individual investors. Their trading behaviour and the mistakes that they make when managing their portfolios are largely documented in academic literature. In the first section of this article, we analyse the lack of diversification that characterises the majority of individual investors across the world. We also explain the determining factors of non-participation in the stock market by a non-negligible percentage of investors (which constitutes an anomaly in conventional finance theory). The second section of the article explores the links between financial education, investor sophistication and portfolio management behaviour. The works of Lusardi and his co-authors in the field of financial literacy[42] are essential in this domain. Regarding French individual investors, our works have demonstrated that financial sophistication reduces the disposition effect, which is the tendency to sell winning shares too quickly and to hold on to losing shares for too long. In the second part of this section, we demonstrate that professional investors, who are supposed to be more sophisticated than individual investors, exhibit the same behavioural biases. The last section studies the biological bases for behavioural biases observed in financial decision-making. Our recent works relate to children as well as several species of non-human primates. Our results demonstrate that loss aversion,[43] which explains a number of financial anomalies, is also a behavioural characteristic of other species. This observation leads us to question the ability of financial education to remove behavioural bias. We conclude this article with a series of recommendations aiming to limit behavioural biases that hinder the performance of individual investors.

1.   Individual investors Biases, heuristics and decision-making under risk

Academic literature has long considered individual investors as "noise traders" (Black, 1986, DeLong *et al.*, 1990) who trade for uninformed reasons and therefore distance prices from their basic values. Recent empirical studies also demonstrate that these investors' activity increases market volatility. In particular, Foucault *et al.* (2011) show that removing the end-of-month settlement ("Règlement mensuel") on the French market is leading to a significant drop, by approximately 20 basis points, in the idiosyncratic volatility of the daily returns of shares affected by the reform. This drop in volatility is the consequence of the automatic exclusion of individual investors after removing the RM.

---

[40] The author would like to thank P. Roger and M. Merli for proofreading this work with care and attention.
[41] The self-attribution bias refers to the fact that "I'm winning because of my ability but I'm losing because of the market which is unfavourable for me".
[42] This is a concept that overlaps financial sophistication and financial education.
[43] It is a fundamental concept in Kahneman and Tversky's Prospect Theory.

It is generally understood that individual investors buy shares whose prices have dropped and sell those whose prices have risen[44]. Such behaviour should, all things being equal, contribute to reducing the volatility of the market. Inversely, institutional investors generally adopt "momentum" behaviour consisting in following trends.

Graph 1 (extract from Kaniel *et al.* 2008) shows that individual investors achieve positive excess returns in the short term, approximately twenty days after buying and negative excess returns over the same period after selling. According to Kaniel *et al.* this phenomenon is the consequence of concessions on prices by institutional investors in search of immediacy. Individual investors therefore provide institutional investors with liquidity. In other words, individual investors are buyers (sellers) of shares when the pressure to sell (buy) exerted by institutions pushes the price down (up). When prices go up, the individual investors that hold them then achieve positive excess returns in the very short term. In particular, Kaniel *et al.* show that the premium offered by institutional investors is higher for less liquid shares.

While the work of Foucault *et al.* (2011) demonstrates that individual investors' trades create volatility (the theory of noise traders), the result of Kaniel *et al.* (2008) on the liquidity they provide for institutional investors can seem contradictory. The response is given by Foucault *et al.* (2011) who suggest considering another category of very sophisticated individual investors who trade during periods of high volatility to offer liquidity when it is particularly low. In this case, the impact on volatility of *momentum* strategies adopted by sophisticated individual investors is stronger than that of *contrarian* strategies.

More recently, Kelley and Tetlock (2013) analysed the orders of American individual investors over the period 2003-2007. This database is considerable in size, covering nearly one third of trades on this market, and in terms of depth, given that it makes it possible to identify the type of order as well as the information concerning listed companies on a daily basis. Kelley and Tetlock show that orders from individual investors predict returns within one month, thereby excluding the possibility that these investors are *noise traders.* In the same vein, for France, Roger (2014) proposes an index of market sentiment relying on the diversification decisions of individual investors and therefore highlights their importance. To conclude, these new results indicate that previous studies were carried out on a single category of not very sophisticated individual investors. The academic literature has, therefore, recently considered that individual investors do not constitute a homogeneous group in terms of sophistication. An optimistic view of this observation is that individual investors have improved their skills over time.

---

[44] This is "contrarian" behaviour, see Grinblatt and Keloharju, 2000 and Kaniel *et al.* 2008.

Graph 1: Adjusted cumulative returns up to 50 days after intense activity by individual investors
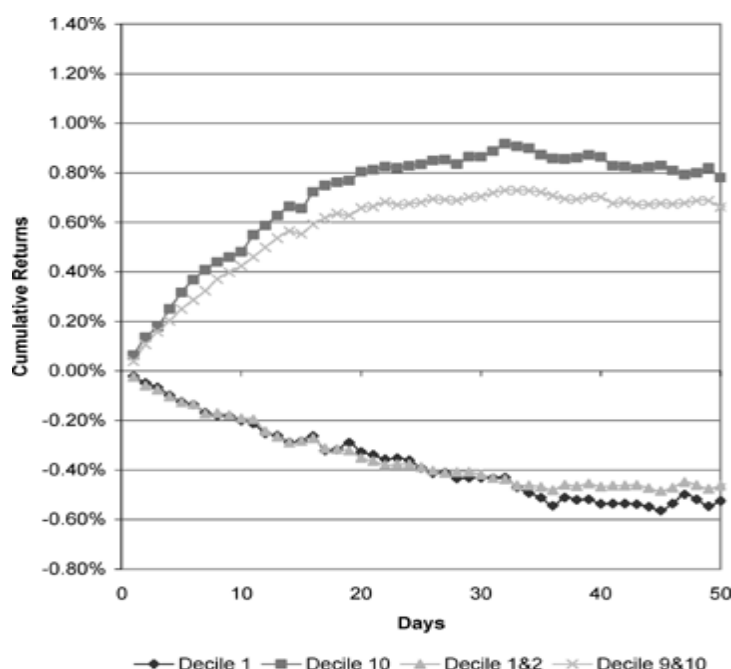
Note to the reader: This graph shows cumulative returns, adjusted by the returns of the weighted portfolio of all shares in the sample, over the days following the significant buying or selling of individual shares, this being 2000 shares listed on the NYSE for the period 2000-2003. The net activity for each share makes it possible to categorise the shares in deciles: decile 1 (10 respectively) includes shares with stronger net negative activity (positive respectively), indicating sales (buys respectively). Only extreme deciles (1, 1&2, 10, 9&10) are shown
Source: Kaniel et *al.*, 2008.

The academic literature gives increasing importance to individual investors, in particular because their financial behaviour differs from the predictions of standard models. Consequently, one of the first questions we will attempt to answer in this section is: are the portfolios owned by individual investors optimal? We demonstrate that individual investors neglect the correlations between the returns of assets and hold under-diversified portfolios: this relates to the bias of insufficient diversification. Individual investors are prone to numerous other biases in their investment decisions. In addition to the bias of insufficient diversification, the disposition effect and overconfidence are very common among individual investors. In the case of the French retail investors, these are discussed in the first section.

A second observation is that of very low participation by individual investors in markets across the world. For example, Bucks *et al.* (2009) show that in 2004, only 48.6% of American[45] households held shares directly in 401(k) plans or Individual Retirement Accounts (IRAs). This rate is low compared to the performance of shares over the period but, above all, this "participation puzzle" cannot be explained within the standard theoretical context by for example, modifying individuals' aversion to risk, or by taking into account the heterogeneity of their beliefs. More generally, this low participation in the stock market could have significant consequences on determining the risk premium, market volatility and household spending (Mankiw and Zeldes, 1991, Heaton and Lucas, 1999, Brav *et al.*, 2002 and Vissing-Jorgensen, 2002). In the second sub-section, we present works that have identified individual characteristics, institutional factors as well as social factors encouraging participation in the markets.

---

[45] This work was conducted using the results of the Survey of Consumer Finances on the financial behaviour of American households in 2001 and 2004.

1.1 The sub-optimal nature of individual portfolios

Trading behaviour of individual investors reflects numerous errors in terms of portfolio management. Certain biases are commonly observed among individual investors across the world. We show that the bias of insufficient diversification, the disposition effect and overconfidence lead to portfolios that are sub-optimal with regard to classic portfolio theory.

1.1.1 The bias of insufficient diversification

Contrary to what Markowitz's (1952, 1959) portfolio theory predicts, portfolios held by individual investors are not diversified. Lease *et al.* (1974), Blume and Friend (1975), then Kelly (1995) are the first to illustrate this point. Based on a large database of trades made by individual investors in the US[46], numerous more recent works have demonstrated that portfolios contained no more than five shares on average (Odean 1999, Mitton and Vorkink 2007, Kumar, 2007 and Goetzman and Kumar 2008). This insufficient diversification has been documented all over the world, for example, in Sweden by Calvet *et al.* (2007) and in France, using data covering the period 1999-2006 by Broihanne, Merli, Roger (2015). In particular, the median number of shares held in French individual investors' portfolios varied from 3 to 4 over the period, while the average fluctuated between 5.5 and 6.8.

The sub-optimal diversification of individual portfolios takes different forms. Firstly, investors, prone to the familiarity bias (Huberman, 2001), hold overly-high proportions of shares in companies whose headquarters are close to their home ("home bias", for example, Coval and Moskowitz, 1999, 2001, Ivkovic and Weisbenner, 2005 and Massa and Simonov, 2006) or companies in their country ("national bias", particularly Kilka and Weber, 2000, Grinblatt and Keloharju, 2001 and Bodnaruk, 2009). In the same vein, this belief in better understanding which seems familiar compared to which is less familiar leads to the "employer bias", that is to invest an excessive proportion in the shares of the company that employs the individual (Benartzi, 2001).

Secondly, the diversification of individual portfolios is sub-optimal because it is "naive" in reference to the study by Benartzi and Thaler (2001). The authors suggested that employees of the University of California spread their investments over two funds with different characteristics in terms of risk. The options tested were the following:
  ▹ Fund A: 100% shares or fund B: 100% bonds;
  ▹ Fund A: 100% shares or fund B: 50% shares, 50% bonds;
  ▹ Fund A: 50% shares, 50% bonds or fund B: 100% bonds.
Whatever the choice offered, the individuals automatically allocated 50% of their investments to each of the funds A and B. In other words, the diversification was naive in the sense that it appeared to be independent of the risk/return tradeoff.

Finally, individual portfolios contain few lines and favour shares with a high level of skewness in their returns. More accurately, investors are attracted by shares with positive skewness, meaning shares that, like lotteries, offer the potential of "jackpots" with low probabilities. Such shares are, most of the time, associated with low prices and large return variances.

Explanations for the sub-optimal diversification of individual portfolios point to an attraction to positive skewness (Brunnermeier and Parker, 2005, Brunnermeier *et al.*, 2007, Barberis and Huang, 2008 and Boyer and Vorkink, 2014) or to the existence of solvency constraints or high trading costs (Liu, 2014). According to Liu (2014), the number of shares in portfolios increases with the amount invested in risky assets. For France, Broihanne, Merli and Roger (2015) show that the under-diversification of individual portfolios leads to skewness and variance in returns. However, the link between skewness and portfolio diversification is only significant in bullish periods. During bearish periods, this link is not significant and the degree of diversification is explained by the value of the portfolio of risky assets held by individual investors.

---

[46] The database used in these works is provided by an American broker. It contains the monthly portfolios of nearly 78,000 households over the period from January 1991 to November 1996.

To conclude on under-diversification, it must be noted that the studies on individual portfolios presented below concern direct management. Individual investors also resort to collective investment products with high degrees of diversification because they are managed, within the framework of a mandate, by a professional (company savings schemes, funds, life insurance, etc.) In these situations, the choice of allocations is largely subject to regulatory constraints specifically aiming for optimal diversification.

1.1.2 The disposition effect

The disposition effect is the tendency of investors to sell winning shares too soon and hold on to losing shares for too long, which proves to be a losing strategy ex-post (Shefrin and Statman, 1985 and Odean, 1998). This effect is common to all investors throughout the world and has been identified outside the United States: in Israel (Shapira and Venezia, 2001), Finland (Grinblatt and Keloharju, 2001), China (Chen *et al.*, 2004), Taïwan (Shu *et al.*, 2005) and in Australia (Brown *et al.*, 2006).

On the French market, Boolell-Gunesh, Broihanne, Merli (2009) obtained similar results when applying Odean's (1998) methodology to a large sample of individual investors. This involves comparing the degrees of making gains and losses. Each day, an investor's portfolio includes "paper" gains and losses that become "realised" gains and losses when they sell. We note N_{RG} (N_{PG} respectively) the number of gains realised (respectively the number of "paper" gains, therefore not realised) and N_{RL} (N_{PL} respectively) the number of realised losses ("paper" losses respectively). From this we deduct the proportion of gains and losses realised in the form:

$$PGR = \frac{N_{RG}}{N_{RG} + N_{PG}}$$
$$PLR = \frac{N_{RL}}{N_{RL} + N_{PL}}$$

The disposition effect (*DE*) is then measured as follows:

$$DE = PGR - PLR$$

The aggregate results obtained on 4,011,991 sales are presented in Table 1.

Table 1: Disposition effect

	Whole year	Jan.-Nov.	December
PGR	0.124	0.125	0.124
PLR	0.073	0.073	0.079
PGR/PLR	1.68	1.71	1.57
DE	0.050***	0.051***	0.044***

Note to the reader: This table contains the results obtained on 4,011,991 sales over the period 1999 to 2006; 1,998,924 disposition effects are calculated for 57,153 investors. Three different periods of the year are presented: entire year, January-November and December. *PGR* (*PLR* respectively) is the proportion of gains realised (the proportion of losses realised respectively). DE is the "disposition effect" defined as PGR - PLR. *** indicates that the disposition effect is significant at the 1% threshold.
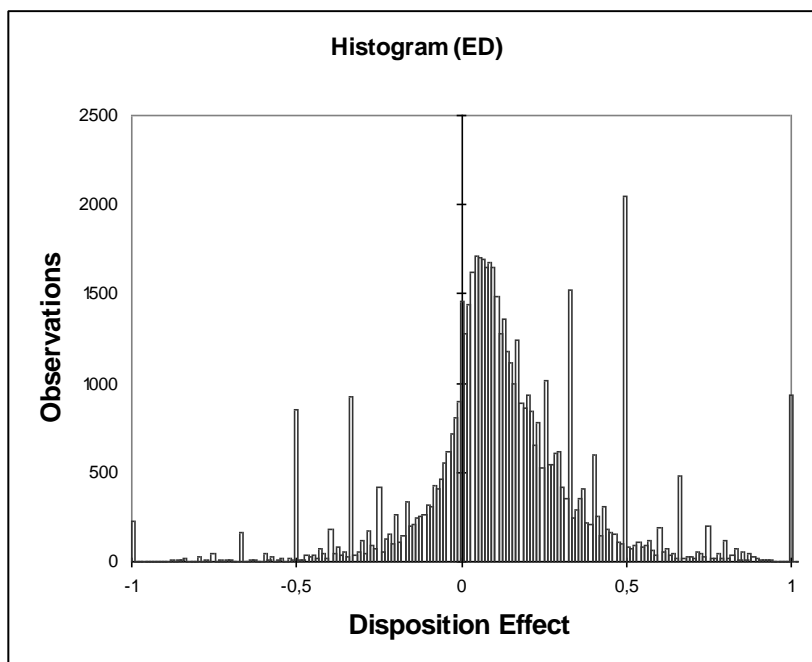Source: Boolell-Gunesh, Broihanne, Merli (2009), page 67.

For the whole sample ("Whole year" column) the disposition effect of 5% is very significant. On average, a winning share is 68% more likely to be sold than a losing one (PGR/PLR=1.68). These results are consistent with those obtained in the literature: Odean (1998) and Weber and Welfens (2006) found a ratio of 1.5 while the results from Brown *et al.* (2006) and Chen *et al.* (2007) are in the order of 1.6. The tax implications (consisting of realising "paper" losses at the end of the year) seem more moderate in France than in other countries because the disposition effect is not significantly different when it is calculated in the month of December compared with the rest of the year (columns 3 and 4 of Table 1).

Investors therefore have a marked preference for realising their gains rather than their losses. Furthermore, our work demonstrates that this bias is the same for sophisticated investors[47]. Additionally, the French capital gains tax system (tax exemption beyond five years in an Equity Savings Plan (PEA)) appears to have no impact on the disposition effect. In the same way, other "rational" explanations of the effect (the need to reallocate a portfolio, the desire to minimise trading costs, for example) are also different in the case of France.

To conclude on the disposition effect, it is important to note that this effect can be determined using another methodology. By considering that realised gains and losses are independent, not on a trading level, but on an individual investor level, it is possible to characterise the disposition effect of each individual and to show that nearly 20% of investors are not prone to this effect or have an inverse effect[48] (Graph 2). Similar results, obtained for American individual investors (Dhar and Zhu, 2006) show that certain individual characteristics, namely age, are liable to reduce the disposition effect. Individual determinants and the reduction in the disposition effect in the case of France are tackled in the section 2.2 of this article (Boolell-Gunesh, Broihanne and Merli, 2012).

Graph 2: Distribution of the disposition effect for all investors

Source: Boolell-Gunesh, Broihanne, Merli (2009), page 77.

---

[47] Sophisticated investors are identified by the use of the Deferred Settlement Service, or by the use of two means of carrying out trades: a securities account and a PEA account.
[48] Talpsepp (2011) also observes an inverse disposition effect among certain investors.

1.1.3 Overconfidence

Individual investors trade too actively, which leads to realising losses (Barber and Odean, 2000 and Grinblatt and Keloharju, 2000). Classic finance theory fails in explaning these very costly, excessive trades which are associated with low risk-adjusted returns. The explanations of this phenomenon rely on the overconfidence of investors (Odean, 1999, Barber and Odean, 2001, 2002 and Glaser and Weber, 2007) and research into sensations (Grinblatt and Keloharju, 2009). Overconfidence is frequent among professionals in different disciplines, including fund managers, analysts and investment advisers (Moore and Healy, 2008, Menkhoff et *al.*, 2006 and Törngren and Montgomery, 2004).

Overconfidence manifests itself in different ways. Firstly, it takes the form of miscalibration of the probabilities. Miscalibration is generally estimated using questionnaires asking participants to indicate bounded intervals containing quantities with a defined degree of confidence (90% for example). The degree of miscalibration is then measured by the number of correct responses situated within the intervals given by the respondent. For a confidence interval of 90%, a "well-calibrated" individual must get a score of nine correct answers out of ten.

Secondly, individuals that demonstrate overconfidence are also prone to a BTA (Better Than Average) effect meaning that they consider themselves better than their peers and have a very positive impression of themselves (Taylor and Brown, 1988 and Cooper et *al.*, 1988). This effect is identified by asking the respondents to indicate the number of correct answers achieved by all participants. This BTA effect is intensified by bullish periods in the markets during which investors attribute themselves good performance and become overconfident (Statman *et al.* 2006, Glaser and Weber 2010 and Deaves *et al.* 2010).

Thirdly, overconfidence manifests itself through the illusion of control regarding a random event (for example, the results of a roll of the dice). Finally, this bias can be reflected by unrealistic optimism. In this latter form, overconfidence leads to an over-estimation of one's own abilities[49].

Overconfidence leads to an increase in risk-taking for three reasons. The first relies on under-estimating risk. The second relates to an overconfident individual's choice of risky shares, meaning shares in small, little-known companies. Finally, overconfident individuals have portfolios with little diversification.

The different works carried out on this issue (Barber and Odean, 2000, 2001), demonstrate that single men hold more risky portfolios, followed by married men, married women and finally single women. In other words, single men predominantly hold shares in small companies, and their portfolios are those that are most volatile and have the highest number of poorly performing shares.

Overconfidence also affects trading volumes. In particular, women trade fewer shares, take fewer risks and consequently achieve better performance than men (Barber and Odean, 2000, 2001). The link between overconfidence and excessive trading has also been studied for online orders by Barber and Odean (2002) and Glaser and Weber (2007). Barber and Odean's (2002) work shows that investors achieve lower returns after switching to an online trading platform. Previous success develops the illusion of control among these investors and this manifestation of overconfidence is exacerbated by online trading. Research by Glaser and Weber (2007) shows that the BTA effect among clients of a German broker is positively correlated with the volumes traded. This result confirms the close link between overconfidence and excessive trading. The overall performance of individual investors as a group is therefore regularly under-estimated by the over-representation of particularly active investors.

---

[49] It is appropriate to distinguish between optimism and unrealistic optimism. Optimism is a positive perception of events on which the individual is not acting directly (the general state of the economy, for example). Unrealistic optimism is a manifestation of overconfidence that leads to over-estimating favourable events on which the individual can act. In a differentiated formal approach to these concepts, Barone-Adesi et *al.* (2013) considers that the over-estimation of means is an indicator of optimism while the under-estimation of expected volatility is interpreted as overconfidence.

However, for Linnainmaa (2011), excessive trading by individual investors is justified by the desire to learn more about their own abilities. Such an argument relies on the acquisition of confidence (and not on overconfidence) by individuals concerning their own abilities on the financial markets. Nicolosi *et al.* (2009) studied the share trading of nearly 3,000 households from 1991-1996 by distinguishing between shares that gave positive excess returns over the month following the purchase. Nicolosi *et al.* (2009) believe that investors who bought these shares have a higher level of confidence in their financial abilities. Their article establishes that this growth in confidence explains the performance of later purchases and the increased intensity of trades. In the same way, investors' experience, measured by the length of time in months since opening the account, is positively linked to the performance of the managed portfolio. These two results therefore illustrate investors' ability to learn through experiencing market activity. They also show that the gap between the confidence acquired by experience on the one hand, and overconfidence on the other, is difficult to grasp and has opposite consequences in terms of performance.

1.2 The low participation of individual investors on stock markets

According to the TNS Sofres/Banque Postale barometer[50] 8.3% of people over 15 years of age held shares in December 2012 (direct ownership or otherwise) while this percentage was 13.8% in December 2008. So, in four years the stock market has lost nearly 2.4 million individual shareholders. This scepticism is in large part due to the different crises over the period. Since, the last TNS Sofres barometer[51] has not indicated any revival in individual shareholdings and a fall in direct shareholdings (4.5% of total assets owned by French households mid-2013 compared to 8.3% mid-2007). Listed financial instruments therefore continue to be perceived as particularly risky by investors: shares are considered risky by nine out of ten questioned (91%). The opinion with regards to bonds has also remained distrustful following the subprime and public debt crisis: 78% believe bonds to be "risky" while this figure was 63% five years ago...

On an academic level, the low participation rate has been documented in the United States (for example, Mankiw and Zeldes, 1991 and Poterba and Samwick, 1995) and in different countries (Guiso, Haliassos, and Jappelli, 2001). This phenomenon is generally explained by the presence of fixed participation costs (Haliassos and Bertaut, 1995 and Vissing-Jørgensen, 2003) which excludes less-wealthy households. More recently, Barberis, Huang and Thaler (2006) offer an explanation that relies on the combination of loss aversion and the narrow framing of investors. This explanation is consistent with the observation by Dimmock and Kouwenberg (2010) of a positive correlation between loss aversion and the probability of not investing in shares. In other words, investors do not participate in stock markets for fear of potential losses.

A certain number of individual characteristics affect investor participation in stock markets. Age and gender significantly affect investment in shares (see section 1.2.1). Biological-type determinants, or even genetic, have also been identified (see section 1.2.2). Social relations between investors significantly affect participation in the markets (see section 1.2.3). Finally, experience of the stock market, meaning investor familiarity or expertise, or even confidence in regulatory bodies play a leading role (see section 1.2.4). Other aspects, on a supply side, such as the effects of financial product presentation or investment options, are well known in marketing to attract demand and find applications in financial matters (see section 1.2.5).

1.2.1 Individual determinants

The article by Ackert *et al.* (2002) relates to the study of survey results by the *Stanford Research Institute* (SRI) on consumption and investment decisions by American households. The impact of four demographic variables (gender, ownership of the main residence, age and wealth) is documented on the allocation of shares, bonds, liquid assets and pension plans.

---

[50] http://sofia.tns-sofres.com/

[51] See the letter from the AMF's (Financial Markets Authority) Observatoire de l'épargne (Observatory for Savings), number 7 dated 7 March 2014 and number 9 dated 9 June 2014.

Ackert *et al.* show that only age has any significant influence on the mix of risky assets (the ratio of shares/(shares + bonds)). In particular, young households favour investment in shares.

While age affects the type of financial decisions, gender seems to have an impact on the perception of risk and therefore on risky investments. According to Jacobsen *et al.* (2014), women have a more conservative approach in terms of investment decisions than men because they see the financial markets as being more risky than men do. This difference in behaviour is clearly established in the literature (Jianakoplos and Bernasek, 1998) and the explanation most frequently put forward is that risk-aversion is stronger among women. Jacobsen *et al.* (2014) suggest an alternative explanation. According to them, differences in both genders' optimism[52] helps to explain the differences in risk perception and allocations of risky assets.

1.2.2 Genetic factors

An important[53] amount of literature establishes links between participation in stock markets and other characteristics that have a large genetic component such as risk-aversion (Charles and Hurst, 2003), social interaction (Hong, Kubik and Stein, 2004), confidence (Guiso, Sapienza and Zingales, 2008) or even cognitive skills (Grinblatt, Keloharju and Linnainmaa, 2012).

Barnea *et al.* (2010) analyse the portfolios of twins in order to decompose the variance of three measures of individual investor behaviour (participation rate, proportion invested in shares and portfolio volatility) in its two genetic and environmental components. Genetic effects play an important role in market participation and in the allocation of assets by explaining one third of the total variance[54]. Environmental factors are essentially those outside of the family context. In particular, environmental effects eliminate family effects as individuals get older and acquire investing experience. These results take into account wealth, education and different control factors in the risk-taking of individuals (for example, state of health, marital status or even entrepreneurial activity[55]). In other words, the genetic component of the investment decisions may justify non-participation through the existence of a participation cost specific to each individual. In the same way, differences in the proportion invested in shares and in the volatility of the portfolio are attributed to genetic differences in attitudes towards risk.

Work carried out in Finland with very precise individual data taken from tests conducted during obligatory military service offers a number of original results. For example, Grinblatt *et al.* (2012) use the results of the tests on intelligence quotient and the trading data of individuals over eight years to establish relationships existing between intellect and financial decisions, performance and trading costs. Investors with higher IQs are less prone to the disposition effect. Furthermore, the similarity of investment behaviour is clearer between individuals with closer IQs than between individuals with different IQs.

A more recent example is given by Gamble *et al.* (2014) which show that financial abilities decline in the same way as cognitive abilities after 60 years of age, while the individuals concerned are not aware of it. This work explains why older individuals make bad financial decisions in terms of choice of investment or requests for credit, for example (Korniotis and Kumar, 2011 and Agarwal *et al.*, 2009).

1.2.3 The impact of social relationships

Following the work of Hong *et al.* (2004), an important amount of literature has established the impact of social factors or that of peers when allocating assets, in particular, the implication of mimetic behaviour. Hong *et al.* (2004) analysed the results of the *Health and Retirement Surveys* to show that households claiming to have a high number of social relationships

---

[52] The degree of optimism is measured in surveys on perceptions of the economy and financial markets and the Index of Consumer Sentiment of the University of Michigan's

[53] For other references on these points see, in particular, Table 1 in the article by Barnea *et al.* (2010).

[54] Interestingly, these effects continue with age, and are identical for twins no longer in touch with one another or who have been raised separately.

[55] On these points, see in particular Love (2010) and Cooper *et al.* (1988).

(relationships with neighbours, attending church, etc.) have a strong tendency to invest in shares. However, belonging to any community for any individual is probably not random: the impact of social variables on participation in the stock market may simply reflect a stronger tolerance to risk, for example. This endogeneity problem is dismissed by Hong *et al.* (2004) because they show that the positive social effect on participation is accentuated in American states where the level of participation in the stock market is initially higher. In other words, social variables are not proxies of other variables linked to participation.

For Brown *et al.* (2008) the fact that an individual belongs to a community (determined by geographic proximity) influences the decision to hold shares. To get round the endogeneity problem in belonging to a community, Brown *et al.* (2008) measured the proximity of an individual native to a state with neighbours who are not native to the same state. The argument put forward in this work is that reliance on the advice of friends and family reduces the cost of participation in the markets (Vissing-Jorgensen, 2002). Furthermore, discussing financial issues among friends and colleagues triggers a need for conformity which encourages participation in the markets, in particular, when that of the peer group is high. The results obtained indicate that a 10% increase in average shareholdings by members of the community results in a 4% increase in the probability that the individual member of this community will invest in shares. In other words, and according to Brown *et al.* (2008), this means an equivalent probability to that of an initially non-participating individual participating for the first time one year later.

The strength of this result is, however, modified slightly by the work conducted by Heimer (2014) who shows that social interactions are essentially engaged in between individuals who actively manage their portfolios. For individuals whose portfolios have high turnover ratios (active strategies), the variance in returns is significant and highlighting their financial successes (while omitting their mistakes) becomes a recurrent subject of conversation. The individuals on the receiving end of this communication are then prompted to invest more heavily. In the same vein, Kaustia *et al.* (2012) highlight peeks in stock market participation during the Internet and dot-com bubbles (five times the normal level) which may be explained by *success story* effects which then spread between peers. Kaustia *et al.* (2012) study the trades of Finish individual investors and group households according to their post codes to identify social effects. They establish that the increase in standard deviation of monthly returns leads to an increase in the rate of participation from 9% to 13%. This effect is specific to increases in returns which corroborates the hypothesis of selective communication.

1.2.4 Stock market experience

The degree of participation is also explained by familiarity and experience acquired by individuals in the stock market. These determinants have been mentioned in recent works that also show that cultural effects have a significant impact on investment in shares.
For Guiso *et al.* (2008), individual's confidence, i.e. believing in the continued growth of the economy, is essential for participation in the stock market. Guiso *et al.* (2008) show that the rate of (direct) participation differs from one country to another[56], indicating a non-negligible cultural effect (see Graph 3). They define confidence as the subjective probability that individuals attribute to the possibility of being misled. This depends on objective factors, such as protection for individual investors, for example, but also on subjective factors specific to each individual, strongly linked to their familiarity with the financial markets, education and even their religion. Guiso *et al.* (2008) suggest a theoretical model in which, even in the absence of participation costs, the lack of confidence explains the low participation. The theoretical predictions were tested on the results of a questionnaire given to Dutch households. In particular, households with greater confidence in others invest the most in shares. They also establish that confidence in financial intermediaries also affects participation.
In the same vein, Osili *et al.* (2008) study the responses to SIPP surveys[57] on a population of investors who migrated to the United States. In doing so, they can distinguish the impact of

---

[56] For recent data in Europe, see *The Eurosystem Household Finance and Consumption Survey*, 2013 (https://www.ecb.europa.eu/home/html/researcher_hfcn.en.html).
[57] *Survey on Income and Program Participation.*

formal rules and cultural/behavioural ones on their investment decisions. Formal rules are common to everyone as they govern the institutions of the destination country and are different from cultural and behavioural rules of their country of origin. They show that individuals from countries with major property protection systems in place are those with the higher propensity to hold shares (outside of obligatory pension plans) in the United States[58]. Therefore, while it may be relatively easy to change the institutional rules in a country, changing more informal rules shaped by culture and behavioural norms is more difficult. Such an argument poses the question of how the amount of time living in an economic system impacts participation in the financial markets.

Finally, Malmendier and Nagel (2011) establish the existence of cohort effects among individuals belonging to generations who have experienced specific macro-economic conditions during their lifetime. For certain age categories, experience of economic crises is a major contributing factor to non-participation.

Graph 3: Rates of participation in stock markets throughout the world
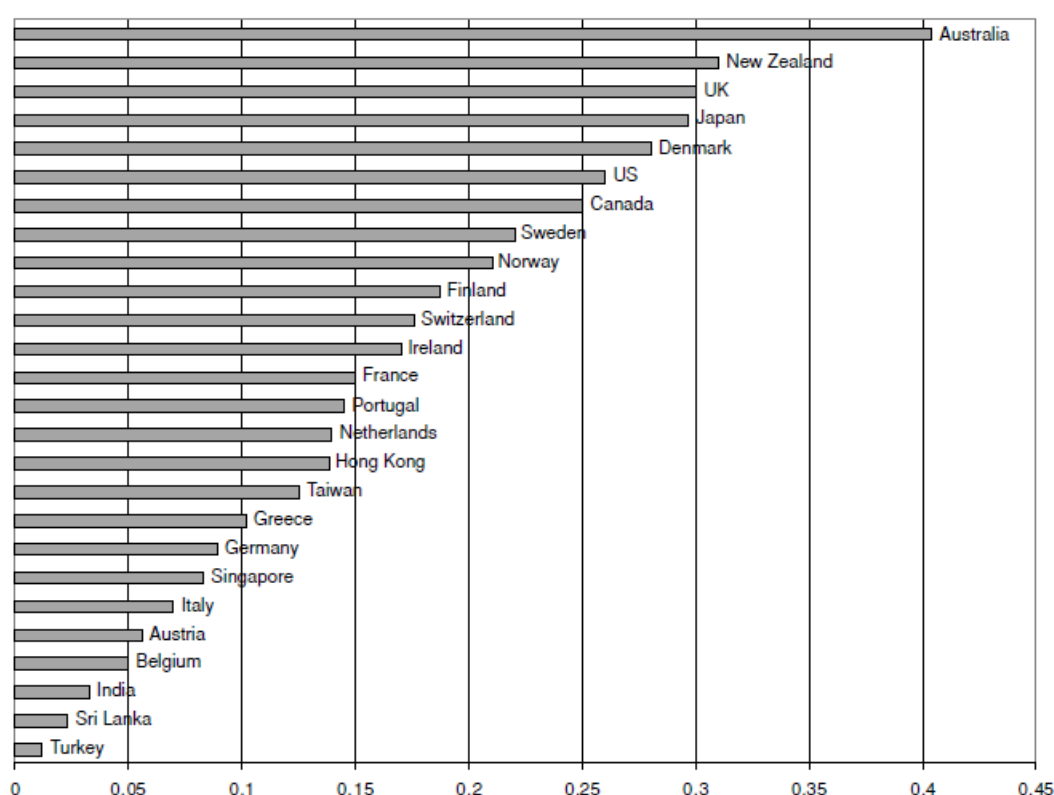
Source: Guiso et *al.* (2008), data by Giannetti and Koskinen (2005).

1.2.5 <u>Framing effects</u>

From a supply perspective, when financial intermediaries take into account the influence of framing of investment plans, market participation can increase (Choi *et al.*, 2004 and Thatcher and Benartzi, 2004). For example, the number of options available has an impact of investment decisions. In this respect, Jiang and Huberman (2003) have demonstrated that an increase in the number of funds offered in 401(k) pension plans reduces participation in these investments. In the same way, individuals generally choose the default option when a choice of allocation in an investment plan is offered (Agnew and Szykman, 2005). These authors show that this behaviour is the consequence of minimal selection effort when faced with an amount of information considered too high (*information overload*).

---

[58] On average, 8.5% of immigrants in the database own shares compared to 20% of natives.

In their experience, Agnew and Szykman (2005) monitor the financial knowledge of individuals. They then show that for individuals with little knowledge, the frame choices or the number of options offered has no influence on their decisions. For knowledgeable individuals, decreasing the number of options reduces information overload and increases satisfaction in the decisions taken. Reducing the number of options available and thinking about the framing of the default option are, consequently, important factors to consider from the point of view of the investment plan services.

2. Financial sophistication and reducing individual mistakes

In this section we present optimistic results on the ability of financial knowledge to reduce mistakes of individual investors. First of all, we define the concepts of financial literacy and sophistication before recalling that it is a current matter of concern for the OECD. We then illustrate the impact of financial sophistication on reducing the disposition effect of individual investors in France. Finally, we contrast these arguments by tackling less encouraging results obtained among finance professionals, by nature more sophisticated than individual investors.

2.1 Financial literacy

According to Lusardi and Mitchel (2014), financial literacy is a concept that covers the ability of individuals to handle economic information, make financial forecasts and make decisions in terms of wealth accumulation, debt and retirement. Recent academic works tackle the role of financial knowledge and its impact on the behaviour of individual investors. It stems from literature concerning financial sophistication. In this literature, the most sophisticated individuals are those who are more knowledgeable financially and have better aptitude but also those who are most familiar with the financial markets. Academic literature regularly demonstrates significant heterogeneity in the level of financial knowledge of individual investors (Campbell, 2006 and Lusardi and Mitchel, 2007). This heterogeneity has consequences on the behaviour and choices of investors (Kimball and Shumway, 2006). However, measuring levels of financial knowledge remains tricky given the absence of academic consensus on the definition[59] of financial knowledge (Huston, 2010) and the great diversity of objectives raised in literature (Remund, 2010).

These questions were recently the subject of concern for the *Consumer Financial Protection Bureau* (CFPB)[60] but above all for the OECD, particularly with the setting up of the *Program for International Student Assessment* (PISA)[61]. In 2012, this programme added a financial culture module to the mathematical, scientific and reading comprehension skills assessments. PISA defines financial culture as "knowledge and understanding of financial concepts and risks, and the skills, motivation and confidence to apply such knowledge and understanding in order to make effective decisions across a range of financial contexts, improve the financial well-being of individuals and society, and enable participation in economic life".

The first global PISA test was conducted in 2012 in 18 countries in order to test the level of financial knowledge and understanding of young people aged 15. The questions related to their ability to manage a bank account, use a credit card, make forecasts and understand the elementary concepts of tax, saving, risk and consumer rights in the context of financial contracts. Following the results published in July 2014, only one student in ten achieved the highest level in financial culture, meaning being able to analyse financial products and solve financial problems not usually encountered by young adults, including, in particular, identifying income tax bands and a bank account balance net of fees. On the other hand, on average 15% of young people can at least make simple decisions with daily expenses and are able to identify the subject of common financial documents such as bills. France ranked 9th with an average

---

[59] For example: Does financial knowledge relate to elementary economic and financial concepts (interest rates, in particular) or concepts relating to the performance of investment choices, like Sharpe's ratio?
[60] See http://www.consumerfinance.gov/
[61] See http://www.ocde.org/pisa/

score of 486 points, lower than the average for OECD countries (500 points) including China, represented by Shanghai, which topped the category (603 points). This global lack of financial culture is not automatically linked to the level of mathematical ability and reading comprehension of these young people. In France, for example, the results for financial culture are very low compared to the average level achieved in general skills while it is the opposite for Australia or the Flemish community in Belgium.

The countries studied adopt very different educational strategies in terms of financial culture. As a minimum, these fall within the scope of strengthening general skills and some go as far as introducing financial education into the curriculum. However, no result allows us to come up with clear recommendations for this field[62]. The debate remains open while the need for better financial culture in terms of making investment decisions is recognised by numerous studies. As an example, Lusardi, Schneider and Tufano (2011) show that one in four Americans claim they would be unable to handle an unexpected expense of $2,000 in the next 30 days.

Another debate concerns the relationship between financial knowledge and financial advice. Some authors suggest that financial advice could be the solution to a lack of financial knowledge among individual investors (Bucher-Koenen and Koenen, 2010 and Georgarakos and Inderst, 2011). Financial advice and financial knowledge would therefore be substitutes. In the opposite vein, another approach involves considering financial advice and financial knowledge as complementary (Calgano and Monticone, 2015). Hackethal *et al.* (2012) therefore suggest that financial advice should be more closely associated with experienced and sophisticated investors. Finally, Calvet *et al.* (2009) argue that the level of financial wealth is a solid determinant of the financial sophistication of an individual investor.

In terms of performance, Bergstresser *et al.* (2009) and Hackethal *et al.* (2012) show, using data obtained from a German brokerage firm, that returns net of fees from portfolios "recommended" by financial advisers are lower than those of portfolios managed by the investor, where the difference is due to the fees. On the same type of data, Bhattacharya *et al.* (2012) find that, on the contrary, financial advice is associated with improved performance for the few investors that choose to follow it. This latest result is obtained within the scope of monitored experience in which clients of the brokerage firm are able to receive free personalised advice in order to improve the profitability of their portfolio. Beyond the relevance of the advice, the refusal to use it by some non-sophisticated clients raises the question of how to deliver advice, or even financial education.

The measures in financial literature are essentially based on three questions (Lusardi and Mitchel, 2008, 2011b) which were put to (and sometimes adapted to) individuals residing in different countries. For example, an initial question helped to judge the ability of the individuals to calculate compound interest:
"Suppose that you have $100 in a savings account whose annual interest rate is 2%. At the end of 5 years, how much would you have in this account (without taking any out in the meantime)? "
  ▸ More than $102;
  ▸ Exactly $102;
  ▸ Less than $102;
  ▸ I don't know;
  ▸ I refuse to answer.

The other two questions concerned inflation and the diversification of risk. Table 2 below taken from Lusardi and Mitchell (2014) indicates that the levels of financial knowledge evaluated by these questions are very low across the world.

---

[62] Students in Shanghai, who do not often encounter financial problems in their education system, still achieved the best scores.

Table 2: Financial knowledge evaluated by 3 questions

Studies	Countries	Dates	A. Interest rates		B.Inflation		C.Diversification		A&B&C	(1 to -)	No. Obs
			% Corr.	% Dnk	% Corr.	% Dnk	% Corr.	% Dnk	% Corr.	% Dnk	
Lusardi & Mitchell (2011a)	USA	2009	64.9	13.5	64.3	14.2	51.8	33.7	30.2	42.4	1,488
Alessie, VanRooij & Lusardi (2011)	Holland	2010	84.8	8.9	76.9	13.5	51.9	33.2	44.8	37.6	1,665
Bucher-Koenen & Lusardi (2011)	Germany	2009	82.4	11	78.4	17	61.8	32.3	53.2	37	1,059
Sekita (2011)	Japan	2010	70.5	12.5	58.8	28.6	39.5	56.1	27	61.5	5,268
Agnew, Bateman & Thorp (2013)	Australia	2012	83.1	6.4	69.3	13	54.7	37.6	42.7	41.3	1,024
Crossan, Feslier & Hurnard (2011)	N. Zealand	2009	86	4	81	5	27	2.0*	24.0*	7	850
Brown & Graf (2013)	Switzerland	2011	79.3	2.8*	78.4	4.2*	73.5*	13.0*	50.1*	16.9*	1,500
Fornero & Monticone (2011)	Italy	2007	40.0*	28.2*	59.3*	30.7*	52.2*	33.7*	24.9*	44.9*	3,992
Almenberg & Säve-Söderbergh (2011)	Sweden	2010	35.2*	15.6*	59.5	16.5	68.4	18.4	21.4*	34.7*	1,302
Arrondel, Debbich & Savignac (2013)	France	2011	48.0*	11.5*	61.2	21.3	66.8*	14.6*	30.9*	33.4*	3,616
Klapper & Panos (2011)	Russia	2009	36.3*	32.9*	50.8*	26.1*	12.8*	35.4*	3.7*	53.7*	1,366
Beckmann (2013)	Romania	2011	41.3	34.4	31.8*	40.4*	14.7	63.5	3.8*	75.5*	1,030

Note to the reader: This table contains the proportions of correct answers (% Corr.) obtained by different studies for each of the 3 questions making it possible to evaluate financial literacy (A. Interest rate, B. Inflation, C. Diversification), the proportion of individuals having answered three questions correctly (A&B&C) or at least one question (1 to -). For each answer it also indicates the proportion of individuals that claim to not know the answer (%Nsp). In the table, * indicates questions formulated in a slightly different way than the reference questions.
Source: Lusardi and Mitchell, 2014.

Beyond this observation, measures of financial literacy are disputable because numerous studies demonstrate a significant gap between the measures obtained in an indirect way using these questionnaires and those obtained when asking participants to evaluate their level of financial knowledge directly using a scale. For example, Lusardi (2011) obtained a score of more than four out of seven for 70% of respondents while only 30% of them answered correctly to the three previous questions. In the same vein, the answers to the questionnaires evaluating financial literacy are highly dependent on the way in which the questions are phrased (Lusardi and Mitchell, 2009, van Rooij, Lusardi and Alessie, 2011).

2.2   Financial sophistication and reducing the disposition effect

In section 1.1.2 we identified significant heterogeneity in the disposition effect of French individual investors. This heterogeneity seems to stem from investors' demographic differences, trading behaviour and financial sophistication[63]. Thus, age (Dhar and Zhu, 2006) and gender (Barber and Odean, 2001) have a significant impact on individuals' investment decisions by reducing the disposition effect in older individuals and men. Investors' experience and trading behaviour are other determinants in the disposition effect. For example, using stop-loss orders (Bellofatto *et al.*, 2014) helps to reduce the disposition effect[64].
Several works (Feng and Seasholes, 2005, Dhar and Zhu, 2006 and Chen *et al.*, 2007) suggest that financial sophistication may explain the individual differences in the disposition effect. In the same way as trading experience, financial sophistication is often measured using indirect measures such as professional activity, income (Dhar and Zhu, 2006 and Chen et *al.*, 2007) or even the type of home and location (e.g., cities, etc.) (Chen et *al.*, 2007); however, direct measures of financial sophistication are rarely used[65].

Boolell-Gunesh, Broihanne, Merli (2012) show how the individual disposition effect is diminished among sophisticated investors. In this work, unlike previous works by Boolell-Gunesh, Broihanne, Merli (2009), a disposition effect is calculated for each individual. Investor sophistication is measured directly by their use of derivative products (Warrants), investment in bonds (*Bonds*), international diversification (Foreign Trade) and investment in a PEA account and a securities account (Two Accounts). Among the 20,379 investors for whom the level of the disposition effect can be calculated over time, 86% trade foreign assets, 12% trade bonds, 24% warrants and 61% use a PEA and a securities account to carry out trades.

---

[63] Other works shows that market conditions, i.e., bullish or bearish, have an impact on this effect (Leal *et al.*, 2006 and Cheng *et al,* 2013).
[64] Furthermore, using limit orders (Linnainmaa, 2010) creates similar characteristics to the disposition effect.
[65] Feng and Seasholes (2005) use the initial portfolio diversification (number of shares) and the number of trading rights (specific to China).

The results obtained by Boolell-Gunesh, Broihanne and Merli (2012) are presented in Table 3. By relying on the results of the literature, the authors verify that personal characteristics of investors explain the individual differences in the disposition effect. For example, older individuals and men demonstrate a lower disposition effect. The authors add two variables that characterise trading behaviour: the size of trades in euros (*Trade Size*) which is generally considered as a proxy for the wealth of investors (Chen et *al.*, 2007) and trading intensity which is measured by the average time between two consecutive sales (Delay)[66]. These two variables are also indirect measures of investor sophistication. In particular, the frequency of trades is likely to be linked to familiarity with financial markets. Frequent trades allow a progressive adjustment of gains and losses which should reduce the disposition effect.

Table 3: Results of the panel data regression of individual disposition effects

Variables	Panel data regressions (random effects)
Constant	0.318***
	(19.29)
Gender	-0.021***
	(-5.72)
Foreign trade	-0.019***
	(-7.95)
Warrants	-0.023***
	(-10.93)
Two Accounts	-0.012***
	(-5.77)
Bonds	-0.011***
	(-4.53)
Ln(Age)	-0.109***
	(-31.94)
Ln(Trade Size)	0.023***
	(19.76)
Ln(Delay)	0.024***
	(34.47)
R^2 *within*	0.025
R^2 *between*	0.059
R^2 *overall*	0.037
Wald	2,695.12***
N	114,747

Note to the reader: This table presents the results of the panel data regression (random effects) of 114,747 individual disposition effects measured each year. The standard deviation coefficients are indicated in brackets. *** indicates that the results are significant respectively at the 1% threshold.
Source: Boolell-Gunesh, Broihanne and Merli (2012)

The results in Table 3 indicate that individual investor sophistication (whatever the variable used to measure it) helps to reduce the disposition effect. The dynamic panel data analysis (presented in Boolell-Gunesh, Broihanne and Merli (2012)) confirms the ability of investors to reduce their mistakes over time.

In summary, financial sophistication seems to be able to reduce the biases to which individual investors are particularly prone. However, research into financial behaviour relates mainly to individual investors and studies into the decisions of professional investors are rare.

---

[66] The average size of trades is approximately €3,030 and the average delay is two months (51 days) for the data studied.

2.3   The case of finance professionals

The premise according to which finance professionals are sophisticated and that their knowledge and competences are not worth studying seems to be imposed quite naturally. Finance professionals are not, however, exempt from behavioural bias. In the field of professional portfolio management, academic literature has, for example, demonstrated that fund managers are prone to the disposition effect (Jin and Scherbina, 2011), anchoring bias (Kaustia *et al.*, 2008) and overconfidence (Puetz and Ruenzi, 2011). Kaustia *et al.* (2008) conducted three identical experiments among students and professionals (financial advisers, institutional investors, analysts and fund managers). In the experiments, professionals demonstrated an anchoring bias on past returns in their predictions of future returns. The bias is less significant than that observed in students, but surprisingly, the professionals are not aware of this phenomenon which appears to be an automatic cognitive process as suggested by Tversky and Kahneman (1986) or Wilson *et al.* (1996).

In France, Broihanne, Merli and Roger (2014) studied the impact of overconfidence on the risk-taking behaviour and on the predictions of finance professionals (fund managers and also treasurers, finance directors, etc.). They demonstrated that professionals also show overconfidence in their price predictions and that these judgement mistakes affect their risk-taking on markets. More precisely, risk perception plays a determining role in risk-taking on the markets, as demonstrated by Nosic and Weber (2010). On the other hand, the anticipated volatility had no significant impact on this risk taking. This second result is particularly interesting from the point of view of questioning the way conventional finance theory is taught. It also lets us question once again the risk measures used by professionals (volatility, for example).

This last point is directly linked to issues relating to the knowledge and competences of finance professionals. For them, traditional tests are inappropriate and other indirect measures of their degree of sophistication, like the degree obtained or a score on a financial aptitude test, are used. Studies conducted by Chevalier and Ellison (1999) and Gottesman and Morey (2006) observe that funds' performance is linked to the average score achieved in the *Scholastic Aptitude Test* (SAT) for managers holding an undergraduate degree or the average score achieved in the *Graduate Management Admission Test* (GMAT) if the manager has an MBA. In the same vein, Andreu and Puetz (2012) show that the type of qualification (CFA or MBA) and the fact of holding both these qualifications, or not, also play a role in the performance of managers. Finally, average SAT or GMAT scores from the University that awarded the manager's degree affect performance. They also reflect the significant impact that belonging to a network has on manager performance (Cohen, Frazzini, and Malloy, 2008).

To conclude, these works among professionals raise several doubts about the ability of investor sophistication to reduce biases. This question is subject to other objections. In particular, for all works on financial sophistication, a causal link with improved performance has not been demonstrated. More specifically, *Cole et al.* (2014) highlight that only positive correlations have been established between different degrees of financial education and the performance of individual investors. Their work is original because it studies the impact of changes in mandatory school length in American States on the participation in financial markets. Cole *et al.* (2014) therefore measure the causal link between education and performance. For example, they show that an additional year of compulsory learning increases the probability of achieving financial income by 7% and of holding shares or funds by 4%.

These encouraging results are nuanced by the meta-analysis conducted by Fernandes *et al.* (2014). Relying on more than 160 works, they demonstrate that policies related to financial education have a negligible and limited impact on financial behaviour over time. Their approach, like that of Cole *et al.* (2014) takes into account the direct effects, not covered by other studies, of competence and/or personality traits (numeracy, cautiousness, the ability to focus on the long term, etc.) on financial literacy by using instrumental variables. The work of Fernandes *et al.* (2014) also offers an enlightening discussion on policy choices in relation to financial education.

In particular, we believe that to be effective, financial education must be offered in a targeted way and at a specific time, i.e., at the time of making financial decisions (the opportunity to invest in a pension plan, for example).

The following section tackles the more general question of the ability of individuals to improve their financial decisions in regard to their biological aptitudes. The objective here is to tackle these questions by excluding contextual effects (the lack of a market or cultural effects), those of knowledge or competences or more generally that of learning.

3.   The biological bases of financial decisions

Long considered sociocultural, behavioural heuristics are not specific to humans and rely at least in part on quantifiable biological foundations. Recent works aim to understand all aspects of imperfect individual decisions, including their origins. In particular, this means determining the biological part of decision making. Studies conducted on children and non-human primates enable us to answer the following questions:

> ▸   Are our biases systematic and observed among other species?
> ▸   At what stage of cognitive development do they appear?
> ▸   Are behavioural biases factors of species survival?

Studies in this direction have demonstrated that non-human primates, when trained, are capable of exchanging food items with human beings in exchange of tokens (Westergaard *et al.*, 1998, 2004), to wait to receive more numerous rewards or that of a higher quality (Amici *et al.*, 2008, Dufour *et al.*, 2007, Heilbronner *et al.*, 2008 and Steelandt *et al.*, 2011). They are also capable of making lottery choices over gains or losses and changing the offered amounts in these lotteries enable us to study their behaviour under risk.

These questions are fundamental in finance. Indeed, although humans do not manage to accurately calculate the probability of winning or losing, such an ability is not available to the majority of animals. However, among animals, experience of the markets, cultural effects and economic competences are absent. These contextual elements excluded, studying risk-related decisions enables us to accurately characterise the biological determinants of behavioural heuristics.

Classic decision theory in situations of risk relies on the principle of expected utility and the hypothesis of decreasing marginal utility (von Neumann and Morgensten, 1944). These concepts lead us to assume that agents are risk-averse. However, Expected Utility Theory (EUT) is a normative theory which is not able to explain all observed phenomena. Firstly, while agents' risk-aversion prevails in the majority of situations, risk-taking behaviour is observed in certain contexts and, in particular, that of gambling (Roger and Broihanne, 2006, 2007). Secondly, numerous empirical and experimental studies (Kahneman, Slovic and Tversky, 1982) demonstrate that individuals' preferences do not check the property of linearity in probabilities. Finally, the nature of uncertainty is important because individuals prefer lotteries for which the probabilities are known (situations of risk) to those where the probabilities are not clearly identifiable (situations of uncertainty or ambiguity)[67].

Observation of these phenomena has led to the development of alternative models for decision-making (Quiggin, 1982, Yaari, 1987, Tversky and Kahneman, 1992, Brunnermeier and Parker, 2005 and Bordalo, Gennaioli and Shleifer, 2012). In practice, we note that individuals often transform objective probabilities when evaluating risky choices (for participating in lotteries, for example). The first models suggested to transform probabilities such that agent preferences would be determined jointly by the subjective value of the consequences of choices (measured by the utility function) and by the attitudes of individuals under risk (measured by a weighting function). This probability distortion was also integrated into *Cumulative Prospect Theory*, (CPT) for which D. Kahneman was awarded the 2002 Nobel prize in economic sciences (Tversky and Kahneman, 1979, Kahneman and Tversky, 1992)[68]. Cumulative Prospect Theory distinctly models the preferences of individuals faced with gains and losses relative to a reference point.

---

[67] According to Knight (1921), risk is defined as a situation in which the probabilities are known, while ambiguity refers to cases where probabilities are only partially identifiable or not at all. (Knight, 1921, Luce and Raiffa, 1957 and Ellsberg, 1961)
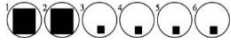
[68] More recently, probability distortion is also an important ingredient in the *Saliency Theory* by Bordalo *et al.* (2012).

It also introduces the concept of loss aversion according to which losses are twice as powerful, psychologically, as gains. These alternative models make it possible to rationalise empirical and experimental observations by showing that individuals' behaviour depends on the probability levels of the consequences of their choices, but also on the type of these consequences (gains or losses). CPT offers a common way of modelling the preference for risk for low probability gains and high probability losses, and risk-aversion for high probability gains and low probability losses. Supported by the concept of loss aversion, CPT also makes it possible to give reasonable explanations for certain anomalies to the efficient-market hypothesis (Fama, 1970) like, the equity premium puzzle, (Benartzi and Thaler, 1995, or Barberis *et al.*, 2001) or the disposition effect (Odean, 1998, Barberis et Xiong, 2009).

Within the framework of the project entitled "The biological bases of economic decisions" funded by the *Agence Nationale de la Recherche*, Pelé *et al.* (2014) demonstrate that judgement mistakes modelled in these alternative theories probably have a very old origin relating to the theory of the evolution of species, because they are also found among children (Steelandt *et al.*, 2012, 2012a, 2013) and species of non-human primates (Chen *et al.*, 2006 and Yamada *et al.*, 2013).

In recent works (Steelandt *et al.*, 2013, Romain *et al.*, 2015 and Romain *et al.*, 2015a), we present the results obtained in terms of decision-making in situations of risk among children aged from 3 to 8 and different species of non-human primates. A similar experiment was conducted on 120 children (50% boys and girls) and 31 monkeys from different species capuchins, macaques, gorillas, chimpanzees, bonobos and orang-utans). The experiment is a task involving the exchange of food items in which the subjects evaluate the probabilities of different results. In the experiment, an initial reward is offered to the subjects (safe option), they can keep it to eat it or exchange it for another random reward (risky option). All of the risky options are presented to the subjects in six cups, the contents of which offer a reward of a medium (like the initial reward), small or large-sized food item. In the cases where items were exchanged, the reward is determined by picking randomly one cup out of six. The expected value of the lottery offered this way is manipulated by offering amounts of food larger, smaller or equal to the amount of food in the safe option (see Table 4).

Table 4: Presentation of lotteries

Lottery	Content of the cups (6 rewards)	Probability of winning	Expected value	Lottery	Content of the cups (6 rewards)	Probability of winning	Expected value
1*		1	8	10*		0.33	3
2*		0.67	6	11*		0.17	3
3*		0.67	5.5	12		0.17	2.75
4		0.5	5	13		0.17	2.5
5*		0.5	4.5	14*		0.17	2.25
6		0.33	4	15*		0.17	2
7		0.33	3.75	16		0	2
8*		0.33	3.5	17*		0.17	1.75
9		0.33	3.25	18*		0	0.5

Note to the reader: Each lottery consists of six possible rewards, presented in cups. The sign * indicates lotteries common to tests on children (11 lotteries) and monkeys (18 lotteries). In column 2, the size of each square corresponds to the size of the rewards. The largest reward volume is 8 (4 x 4 x 0.5 cm), it is 2 for the average rewards (2 x 2 x 0.5 cm) and 0.5 for the smallest (1 x 1 x 0.5 cm). The initial reward offered has a volume equal to 2. Column 3 indicates the probability of winning, meaning obtaining a large item. The last column presents the expected value of each lottery.

Source: Romain et *al.*, 2015a.

In the experiment conducted on children, 11 lotteries are tested under three conditions: random order, order of increasing expected value, order of decreasing expected value. Only the results in random order are presented[69] here in order to provide a comparison with the results among the monkeys. Children under 5 are unable to discriminate between the probabilities of the lotteries, except in the case of lottery 1 (sure gain) and 18 (sure loss) while above 5 years of age, the exchange rates of the different lotteries are significantly different, which was the case in each of the three conditions tested. In Table 5, we present the results of estimating coefficients of Cumulative Prospect Theory for children over 4 years of age. Whatever the age, the estimated coefficients of loss aversion (coefficient λ) are significantly higher than 1 and the degree of probability distortion (coefficient γ) is significantly lower than 1. In other words, children are subject to biases like adults since they demonstrate loss aversion and distort the probabilities (over-estimation of the probabilities of rare events and under-estimation of high probabilities).

Table 5: Results of estimating parameters for Cumulative Prospect Theory among children

Coeff.	All	4 years	5 years	6 years	7 years	8 years
λ	2.0451	2.2042	2.7158	1.7287	2.0977	1.5105
	***	***	***	***	***	***
	-0.1245	-0.3076	-0.3825	-0.2088	-0.2703	-0.2129
γ	0.8493	0.8494	0.8235	0.8746	0.8547	0.8624
	***	***	***	***	***	***
	-0.0132	-0.0172	-0.0329	-0.0322	-0.0366	-0.0414
Log L	-4,791.31	-1,523.2	-1,206.4	-821.68	-600.63	-590.65
No. obs.	2,640	528	528	528	528	528

Note to the reader: This table presents the estimated coefficients for the parameters of Cumulative Prospect Theory among children aged over 4. The standard deviations (adjusted by the subjects' individual differences) are in brackets. *** indicates a significance level of 0.1%. Log L is the pseudo log-likelihood of the estimation.
Source: Romain et *al.*, 2015a.

In the experiment conducted among non-human primates, each subject is tested over 18 repetitions of each of the 18 lotteries; these are presented in random order and spaced over time to maintain an equivalent satiation level in all the tests. The decisions made during the experiments (a total of 10,278 observations on all subjects) show that the preference for a risky option decreases with the probability of loss and with the frequency of previous losses, while they increase with the probability of a gain. The decisions made by animals are consistent with the criterion of stochastic dominance, except in the case of capuchin monkeys[70]. The experiment also made it possible to identify the hot-hand effect (playing again when you have been winning) also common in humans. Finally, Cumulative Prospect Theory helps to understand decisions better than through Expected Utility Theory. In particular, among great apes with closer proximity to humans, the estimated loss aversion coefficients (coefficient λ) are the same as those observed in humans (see Table 6); for example, Zeisberger *et al.* (2012) obtain a coefficient of loss aversion of 1.42 among students, Abdellaoui *et al.* (2013) estimate this coefficient to be 1.31 for finance professionals, while it is 1.78 for the general public (*Amazon Mechanical Turk*) in the study by Toubia *et al.* (2013). The average value of 1.1503 indicates that a loss results in a decrease in satisfaction which is 1.1503 times more than the increase of satisfaction of an identical amount of gain. The degree of probability distortion (coefficient γ) estimated for this species is comparable to that regularly estimated among human

---

[69] Our results make it possible to identify a framing effect when lotteries are presented in an ordered way.
[70] The results are therefore not presented.

beings. In the order of 0.8-0.9, it reflects an over-estimation of the probabilities of rare events and an under-estimation of high probabilities.

In conclusion, the results obtained among children and several species of primates illustrate the close proximity with cognitive mistakes made by human beings (adults) when they make decisions in situations of risk. Our work has also made it possible to establish that these mistakes are detectable among young children, which tends to show that cognitive mistakes have biological origins. Our results also help to understand the results brought to light by studies in behavioural finance from a whole new angle, in particular those that highlight the importance of Cumulative Prospect Theory in explaining the disposition effect. More generally, these works question the ability of financial education policies to reduce behavioural biases.

Table 6: Results of estimating parameters for Cumulative Prospect Theory among non-human primates

Coeff.	All subjects n=31	Macaques n=5	Orang-utans n=6	Gorillas n=6	Chimpanzees n=8	Bonobos n=6
λ	1.1503 *** -0.1263	0 .8477 *** -0.1794	0.855 *** -0.0777	1.1357 *** -0.3338	1.4076 *** -0.3173	1.5889 *** -0.321
γ	0.9212 *** -0.0139	0.9629 *** -0.0504	0.8535 *** -0.1012	0.8931 *** -0.035	0.9026 *** -0.0203	0.9373 *** -0.0155
Log L	-7,866.87	-842.74	-798.14	-1,418.85	-2,372.48	-2,175.02
No. obs.	10,278	1,620	1,944	1,944	2,502	1,944

Note to the reader: This table presents the estimated coefficients for the parameters of Cumulative Prospect Theory among all subjects and for each of the five species of primates tested. The standard deviations (adjusted by the subjects' individual differences) are in brackets. *** indicates a significance level of 0.1%. Log L is the pseudo log-likelihood of the estimation.

Source: Romain et *al.*, 2015a.

Conclusion

This state of the art on individual investors' behaviour enables us to identify a certain number of levers on which the regulator can intervene. There are many implications of this work, and they aim to improve the well-being of individual investors.

The MiFID directive (2004/39/EC) adopted in April 2004 and which came into force in November 2007 aims, among other things, to guarantee investors uniform and increased protection. Within this framework, financial intermediaries are advised to give their clients a questionnaire, when subscribing to a financial product, to evaluate their level of knowledge and experience of financial products, as well as their sensitivity to risk. In a study prepared for the Autorité des Marchés Financiers (AMF), by Palma and Picard (2011) an initial assessment of this questionnaire was given. It is apparent that MiFID questionnaires are not uniform and that few of them really evaluate the attitudes of investors under risk. Consequently, based on the responses to the questionnaire, it is difficult for the financial intermediary to prove that it has complied with its duty to advise.

Furthermore, for the few firms that measure attitudes towards risk in their questionnaires, the data collected remains incomplete. Indeed, the works presented in the previous sections show that low participation in the stock market can result not only in risk-aversion of individual investors, but also in their ambiguity aversion[71]. Yet financial decisions generally take on the character of ambiguity rather than risk. Furthermore, mistakes in judgement do not occur in the same way depending on the context of the decision. Individuals demonstrating risk-aversion are

---

[71] For a reminder of the concepts of risk aversion versus ambiguity aversion, see note 28.

not necessarily those that show ambiguity aversion and vice versa (see, in particular Andersen *et al.*, 2009 and Attanasi *et al.,* 2014). On a biological level, ambiguity aversion has also been detected among macaques (Hayden *et al.*, 2010). Behavioural biases detected among humans could therefore result from natural selection processes that affect decision making in situations of ambiguity rather than situations of risk. Consequently, an initial recommendation would be to evaluate risk-aversion as well as ambiguity aversion in MiFID questionnaires. Using hypothetical choices in lotteries, as certain MiFID questionnaires do, makes it possible to evaluate both risk-aversion and ambiguity aversion. The evaluation of ambiguity aversion requires offering the possibility of "paying", by sacrificing part of the gains to receive missing information on the probabilities (Attanasi *et al.*, 2014).

Another approach in this domain would be to reduce the perceived ambiguity of financial products. In other words, this would mean using financial education, not only to reduce the perceived ambiguity of products, but also to improve the overall knowledge of investors and contribute to reducing their most costly biases. However, if a consensus now exists on the need to improve financial knowledge among the entire population, numerous questions remain. In particular, the age at which this effort to educate is conducted could be questioned. Our work shows that the cognitive abilities of children are too low at three years of age, but economic decisions are already biased at the age of five (Steelandt *et al.*, 2012, 2012a and Romain *et al.*, 2015a). In other words, the behavioural bases that we identify among investors later on in life are forged right in the heart of the family and by those around us. Financial education should therefore be offered before this age, and in a suitable, fun way. Undoubtedly, work being carried out in neuroeconomics, currently experiencing rapid growth, will be used to educate on these issues (Frydman *et al.*, 2014).

Equally, the MiFID questionnaire aims to measure the financial knowledge of investors. However, the results obtained are indirect and imperfect measures of real knowledge and financial aptitude. Indeed, academic works demonstrate that self-evaluation of financial knowledge differs greatly from true competences (Lusardi and Mitchell, 2014). Consequently, using responses to the MiFID questionnaire to prevent the sale of inappropriate products by advisers is very likely under-utilised at present. In particular, this questionnaire is not given to professionals whose knowledge and competences are assumed to be high. Therefore, we would encourage the implementation of the MiFID questionnaire among professional investors in order to calibrate the financial knowledge of individual investors in relation to this level of reference. Furthermore, this relative evaluation would help to reduce mistakes in individual investors' self-evaluation of their knowledge. Lastly, it would make the MiFID questionnaire more effective within the context of prudent commercial practices by financial advisers.

In a similar way, relying on hypothetical questions is insufficient for understanding actual behaviour. In particular, work carried out in the domain of Experienced Utility (Hertwig *et al.*, 2004) shows that choices differ when the consequences are experienced rather than hypothetical. In other words, questionnaires offering hypothetical choices do not make it possible to understand investors' attitudes under risk. Furthermore, choices depend on the context in which they are made, particularly in relation to the personal situation and wealth of the interviewee on the date the questionnaire is conducted. To remedy these objections, we propose that financial intermediaries carry out a careful review of the portfolios held and monitor the allocations, attitudes towards risk and the financial situation of their clients. Beyond conducting MiFID questionnaires with their clients on a regular basis, financial intermediaries could offer them more suitable advice taking into account their previous and current financial decisions and their projects.

Concerning the levers for financial participation, it is interesting to note the practical implications of two results highlighted in this article. Firstly, Agnew and Szykman (2005) have shown that the number of options offered in terms of allocations in a savings scheme has an impact on investment choices. In the same way, the default option is chosen in most cases. Company savings plans (*Plans d'Epargne Entreprise*) which come under this category of savings products could be structured in such a way as to limit the number of options freely chosen by the employee, on the one hand, and to accurately define the composition of the default option, on

the other. Additionally, to make the most of the favourable impact of social relationships on investment, automatic investment, like that which has been considered in the United States, for example, with investment by the State on behalf of employees of a portion of social security contributions, is an interesting approach.

Finally, while financial advice is an important tool for reducing individual's biases, it is not sufficient because it is not followed by the investors who need it most (Battacharya *et al.,* 2012). To encourage the beneficial effects of this advice, particularly by making people aware of the benefits of diversification, the consequences of loss aversion or even overconfidence, establishing and maintaining a relationship of trust is required between the advisor and advisee. In this respect, a diverse range of advisory services (financial advisers (CIFs), banking advisers) may support a compatible advisor/advisee relationship. However, when it comes to the beneficial effects of competition between advisory services for private investors, strategies using complex pricing structures could appear and reduce the well-being of advisees (Carlin, 2009).

References

Blanchard, O. et F. Giavazzi (2002), "Current account deficits in the Euro Area: the end of the Feldstein-Horioka puzzle?" *Brookings Papers on Economic Activity, 22,* p *147-209.*

Coakley, J., F. Kulasi et R. Smith (1998), "The Feldstein-Horioka puzzle and capital mobility: A review." *International Journal of Finance and Economics 3:* p *169-188.*

Feldstein, M. (2005), "Monetary policy in a changing international environment: the role of capital flows" *Working paper n° 11856, December.*

Abdellaoui, M., H. Bleichrodt et H. Kammoun (2013), *"*Do financial professionals behave according to prospect theory?*"* An experimental study, *Theory and Decision*, 74(3), p 411-429.

Ackert, F.L., B.K. Church et B. Englis (2002), *"*The asset allocation decision and investor heterogeneity: A puzzle?*"*, *Journal of Economic Behavior & Organization*, 47, p 423–433.

Agarwal, S., J.C. Driscoll, X. Gabaix et D. Laibson (2009), *"*The age of reason: Financial decisions over the life-cycle and implications for regulation*"*, *Brookings Papers on Economic Activity*, 40(2), p 51–117.

Agnew, J.R., H. Bateman et S. Thorp (2013), *"*Financial literacy and retirement planning in Australia*"*, *Numeracy,* 6 (2), Article 7.

Agnew, J.R. et L.R. Szykman (2005), *"*Asset allocation and information overload: The influence of information display, asset choice, and investor experience*"*, *The Journal of Behavioral Finance*, 6(2), p 57–70.

Alessie, R., M. Van Rooij et A. Lusardi (2011), *"*Financial literacy and retirement preparation in the Netherlands*"*, *Journal of Pension Economics and Finance,* 10 (4), p 527–545.

Almenberg, J. et J. Säve-Söderergh (2011), Financial literacy and retirement planning in Sweden, *Journal of Pension Economics and Finance,* 10 (4), p 585–598.

Amici, F., F. Aureli et J. Call (2008), Fission-fusion dynamics, behavioral flexibility and inhibitory control in primates, *Current Biology*, 18(18), 1415–1419.

Andersen, S., J. Fountain, G. Harrison et E. Rutstrom (2009), Estimating aversion to uncertainty, *Working paper*, University of Central Florida.

Andreu, L. et A. Puetz (2012), Are two business degrees better than one? Evidence from mutual fund managers' Education, *CFR working paper*, University of Cologne, Germany.

Arrondel, L., M. Debbich et F. Savignac (2013), Financial literacy and financial planning in France, *Numeracy,* 6 (2), Article 8.

Attanasi, G., C. Gollier, A. Montesano et N. Pace (2014), Eliciting ambiguity aversion in unknown and in compound lotteries: A KMM experimental approach, *Theory and Decision*, DOI 10.1007/s11238-013-9406-z.

Barber, B. et T. Odean (2000), Trading is hazardous to your wealth: The common stock investment performance of individual investors, *Journal of Finance*, 55, p 773-806.

Barber, B. et T. Odean (2001), Boys will be boys: Gender, overconfidence, and common stock investment, *Quarterly Journal of Economics*, 116, p 261-292.

Barber, B. et T. Odean (2002), Online investors: Do the slow die first?, *Review of Financial Studies,* 15, p 455-488.

Barberis, N., M. Huang et R.H. Thaler (2006), Individual, monetary gambles, stock market participation: A case for narrow framing, *American Economic Review,* 96, p 1069–1090.

Barberis, N. et M. Huang (2008), Stocks as lotteries: The implications of probability weighting for security prices, *American Economic Review*, 98, p 2066-2100.

Barberis, N., M. Huang et T. Santos (2001), Prospect theory and asset prices, *Quarterly Journal of Economics*, 116, p 1-53.

Barberis, N. et W. Xiong (2009), What drives the disposition effect? An analysis of a long-standing preference-based explanation, *Journal of Finance*, 64, p 751-784.

Barnea A., H. Cronqvist et S. Siegel (2010), Nature or nurture: What determines investor behavior?, *Journal of Financial Economics*, 98, p 583–604.

Barone-Adesi, G., L. Mancini et H.M. Shefrin (2013), A tale of two investors: Estimating risk aversion, optimism, and overconfidence, *Swiss Finance Institute Research Paper No. 12-21.*

Beckmann, E. (2013), Financial literacy and household savings in Romania, *Numeracy,* 6 (2), Article 9.

Bellofatto, A., R. De Winne et C. D'Hondt (2014), Beyond the disposition effect: Evidence from the 1999-2012 period, *Working paper*, Université catholique de Louvain, Louvain School of Management.

Benartzi, S. (2001), Excessive extrapolation and the allocation of 401(k) accounts to company stock? *Journal of Finance*, 56(5), p 1747–1764.

Benartzi, S. et R.H. Thaler (1995), Myopic loss-aversion and the equity premium puzzle, *Quarterly Journal of Economics***,** 110(1), p 73-92.

Benartzi, S. et R.H. Thaler (2001), Naive diversification strategies in retirement saving plans, *American Economic Review*, 91(1), p 79 –98.

Bergstresser, D., J. Chalmers et P. Tufano (2009), Assessing the costs and benefits of brokers: A preliminary analysis of the mutual fund industry, *Review of Financial Studies*, 22, p 4129-4156.

Bhattacharya, U., A. Hackethal, S. Kaesler, B. Loos et S. Meyer (2012), Is unbiased financial advice to retail investors sufficient? Answers from a large field study, *The Review of Financial Studies*, 25 (4), p 975-1032.

Black, F. (1986), Noise, *Journal of Finance,* 41, p 529–543.

Blume, M.E. et I. Friend (1975), The asset structure of individual portfolios and some implications for utility functions, *Rodney L. White Center for Financial Research Working Papers 10-74*, Wharton School Rodney L. White Center for Financial Research.

Bodnaruk, A. (2009), Proximity always matters: Local bias when the set of local companies changes, *Review of Finance,* 13 (4), p 629-656*.*

Boolell-Gunesh, S., M.H. Broihanne et M. Merli (2009), Disposition effect, investor sophistication and taxes: Some french specificities, *Finance*, 30 (1), p 51-78.

Boolell-Gunesh, S., M.H. Broihanne et M. Merli (2012), Sophistication of individual investors and disposition effect dynamics, *Finance*, 33(1), p 9-37.

Bordalo, P., N. Gennaioli et A. Shleifer (2012), Salience theory of choice under risk, *The Quarterly Journal of Economics*, 127(3), p 1243-1285.

Boyer, B.H. et K. Vorkink (2014), Stock options as lotteries, *The Journal of Finance*, 69 (4), p 1485-1527.

Brav, A., G.M. Constantinides et C.C. Geczy (2002), Asset participation with heterogenous consumers and limited participation: Empirical evidence, *Journal of Political Economy,* 110, p 793–824.

Broihanne, M.-H., M. Merli et P. Roger (2004), Finance comportementale, *Economica.*

Broihanne, M.-H., M. Merli et P. Roger (2014), Overconfidence, risk perception and the risk-taking behavior of finance professionals, *Finance Research Letters,* 2 (11), p 64-73.

Broihanne, M.H., M. Merli et P. Roger (2015), Diversification, gambling and market forces, *Review of Quantitative Finance and Accounting,* doi: 10.1007/s11156-015-0497-1.

Brown P., N. Chappel, R. Da Silva Rosa et T. Walter (2006), The reach of the disposition effect: large sample evidence across investor classes, *International Review of Finance*, 6(1-2), p 43-78.

Brown, J.R., Z. Ivkovic´, P.A. Smith et S. Weisbenner (2008), Neighbors matter: causal community effects and stock market participation, *The Journal of Finance*, 63, p 1509–1532.

Brown, M. et R. Graf (2013), Financial literacy and retirement planning in Switzerland, *Numeracy* 6 (2), Article 6.

Brunnermeier, M.K. et J.A. Parker (2005), Optimal expectations, *American Economic Review*, 95, p 1092-1118.

Brunnermeier, M.K., C. Gollier et J.A. Parker (2007), Optimal beliefs, asset prices and the preference for skewed returns. *American Economic Review*, 97, p 159-165.

Bucher-Koenen, T. et J. Koenen (2010), Do smarters consumers get better advice? An analytical framework and evidence from German private pensions, *CDSE Discussion Paper No. 105.*

Bucher-Koenen, T. et A. Lusardi (2011), Financial literacy and retirement planning in Germany, *Journal of Pension Economics and Finance,* 10(4), p 565–584.

Bucks, B.K., A.B. Kennickell et K.B. Moore (2009), Recent changes in U.S. family finances from 2004 to 2007: Evidence from the survey of consumer finances, *Federal Reserve Bulletin*, 95, A1–A56.

Calcagno, R. et C. Monticone (2015), Financial literacy and the demand for financial advice, *Journal of Banking and Finance,* 50, p 363-380.

Calvet, L.E., J.Y. Campbell et P. Sodini (2007), Down or out: Assessing the welfare costs of household investment mistakes, *Journal of Political Economy*, 115, p 707-747.

Calvet, L.E., J.Y. Campbell et P. Sodini (2009), Measuring the financial sophistication of households, *American Economic Review*, 99 (2), p 393-398.

Campbell, J. (2006), Household finance, *Journal of Finance*, 61(4), p 1553-1604.

Carlin, B.I. (2009), Strategic price complexity in retail financial markets, *Journal of Financial Economics*, 91, p 278–287.

Charles, K.K. et E. Hurst (2003), The correlation of wealth across generations, *Journal of Political Economy,* 111, p 1155–1182.

Chen, G.M., K.A. Kim, J.R. Nofsinger et O.M. Rui (2004), Behavior and performance of emerging market investors: Evidence from China, *Working paper*.

Chen, G.M., K.A. Kim, J.R. Nofsinger et O.M. Rui (2007), Trading performance, disposition effect, overconfidence, representativeness bias and experience of emerging market investors, *The Journal of Behavioral Decision Making*, 20, p 425-421.

Chen M., V. Lakshminarayanan et L. Santos (2006), How basic are behavioral biases? Evidence from capuchin monkey trading behavior, *Journal of Political Economy*, 114(3), p 517-537.

Cheng, T., C. Lee et C. Lin (2013), An examination of the relationship between the disposition effect and gender, age, the traded security, and bull bear market conditions, *Journal of Empirical Finance*, 21, p 195–213.

Chevalier, J. et G. Ellison (1999), Are some mutual fund managers better than others? Cross-sectional patterns in behavior and performance, *Journal of Finance,* 54, p 875-899.

Choi J.J., B.C. Madrian et D. Laibson (2004), Plan design and 401(k) savings outcomes, *National Tax Journal*, 57(2), p 275–298.

Cohen, L., A. Frazzini et C. Malloy (2008), The small world of investing: Board connections and mutual fund returns, *Journal of Political Economy*, 2008, 116(5), p 951-979.

Cole, S., A. Paulson et G.K. Shastry (2014), Smart money? The effect of education on financial outcomes, *Review of Financial Studies*, doi:10.1093/rfs/hhu012.

Cooper, R., C.Woo et W. Dunkelberg (1988), Entrepreneur's perceived chances of success, *Journal of Business Venturing*, 3, p 97-108.

Coval, J.D. et T.J. Moskowitz (1999), Home bias at home: Local equity preference in domestic portfolios, *Journal of Finance*, 54, p 2045–2073.

Coval, J.D. et T.J. Moskowitz (2001), The geography of investment: Informed trading and asset prices, *Journal of Political Economy*, 109, p 811-841.

Crossan, D., D. Feslier et R. Hurnard (2011), Financial literacy and retirement planning in New Zealand, *Journal of Pension Economics and Finance,* 10(4), p 619–635.

Deaves, R., E. Lüders et M. Schröder (2010), The dynamics of overconfidence: Evidence from stock market forecasters, *Journal of Economic Behavior and Organizition*, 75(3), p 402-412.

DeBondt, W.F. et R.H. Thaler (1985), Does the stock market overreact?, *Journal of Finance*, 40, p 793-805.

DeLong, J.B., A. Shleifer, L.H. Summers et R.J. Waldmann (1990), Noise trader risk in financial markets, *Journal of Political Economy* 98, p 703–738.

De Palma, A. et N. Picard (2011), Évaluation des questionnaires MIF en France, Étude pour l'Autorité des Marchés Financiers, février.

Dhar, R. et N. Zhu (2006), Up close and personal: Investor sophistication and the disposition effect, *Management Science*, 52(5), p 726-740.

Dimmock, S.G. et R.W. Kouwenberg (2010), Loss-aversion and household portfolio choice, *Journal of Empirical Finance*, 17(3), p 441-459.

Dufour, V., M. Pelé, E.H.M. Sterck et B. Thierry (2007), Chimpanzee anticipation of food return: Coping with waiting time in an exchange task, *Journal of Comparative Psychology*, *121*(2), p 145-155.

Ellsberg, D. (1961), Risk, ambiguity, and the Savage axioms, *The Quarterly Journal of Economics*, 75, p 643-669.

Fama, E. (1970), Efficient capital markets: A review of theory and empirical work, *Journal of Finance*, 25(2), p 383-417.

Feng, L. et M. Seasholes (2005), Do investor sophistication and trading experience eliminate behavioral biases in financial markets? *Review of Finance*, 9, p 305-351.

Fernandes, D., J.G. Lynch et R.G. Netemeyer (2014), Financial literacy, financial education, and downstream financial behaviors, *Management Science*, 60(8), p 1861–1883.

Fornero, E. et C. Monticone (2011), Financial literacy and pension plan participation in Italy, *Journal of Pension Economics and Finance,* 10 (4), p 547–564.

Foucault, T., D. Sraer et D.J. Thesmar (2011), Individual investors and volatility, *Journal of Finance,* 66(4), p 1369-1406.

Frydman, C., N. Barberis, C. Camerer, P. Bossaerts et A. Rangel (2014), Using neural data to test a theory of investor behavior: An application to realization utility, *Journal of Finance*, 69 (2), p 907–946.

Gamble, K.J., P.A. Boyle, L. Yu et D.A. Bennett (2014), Aging and financial decision making, *Management Science* Published online in Articles in Advance 29 Oct 2014.

Georgarakos, D. et R. Inderst (2011), Financial advice and stock market participation, *ECB Working paper series, No 1296.*

Giannetti, M. et Y. Koskinen (2005), Investor protection and demand for equity, *Working Paper*, Stockholm School of Economics.

Glaser, M. et M. Weber (2007), Overconfidence and trading volume, *Geneva Risk Insurance Review*, 32(1), p 1-36.

Glaser, M. et M. Weber (2010), Overconfidence, in Baker, H. K., and J. Nofsinger (eds.) Behavioral Finance: Investors, Corporations, and Markets, Hoboken, NJ: John Wiley & Sons, Inc., p 241-258.

Goetzmann, W.N. et A. Kumar (2008), Equity portfolio diversification, *Review of Finance*, 12, p 433-463.

Gottesman, A. et M. Morey (2006), Manager education and mutual fund performance, *Journal of Empirical Finance*, 13, p 145-182.

Grinblatt, M. et M. Keloharju (2000), The investment behavior and performance of various investor types: A study of Finland's unique data set, *Journal of Financial Economics,* 55, p 43–67.

Grinblatt, M. et M. Keloharju (2001), What makes investors trade? *Journal of Finance*, 56(2), p 589-616.

Grinblatt, M. et M. Keloharju (2009), Sensation seeking, overconfidence, and trading activity, *Journal of Finance*, 64, p 549–578.

Grinblatt, M., M. Keloharju et J.T. Linnainmaa (2012), IQ, trading behavior and performance, *Journal of Financial Economics,* 104, p 339–362.

Guiso, L., Haliassos M. et T. Jappelli (2001), *Household portfolios.* Cambridge, MA: MIT Press.

Guiso, L., P. Sapienza et L. Zingales (2008), Trusting the stock market, *Journal of Finance*, 63, p 2557-2600.

Hackethal, A., M. Haliassos et T. Jappelli (2012), Financial advisors: A case of babysitters? *Journal of Banking and Finance,* 36, p 509-524.

Haliassos, M. et C.C. Bertaut (1995), Why do so few hold stocks? *Economic Journal*, 105, p 1110–1129.

Hayden, B.Y., S.R. Heilbronner et M.L. Platt (2010), Ambiguity aversion in rhesus macaques, *Frontiers in Neuroscience,* 4, p 1–7.

Heaton, J. et D. Lucas (1999), Stock prices and fundamentals, *NBER Macroeconomics Annual,* 14, p 213–242.

Heilbronner, S.R., A.G. Rosati, J.R. Stevens, B. Hare et M.D. Hauser (2008), A fruit in the hand or two in the bush? Divergent risk preferences in chimpanzees and bonobos, *Biology Letters,* 4, p 246–249.

Heimer, R. Z. (2014), Friends do let friends buy stocks actively, *Journal of Economic Behavior and Organization*, 107 (B), p 527-540.

Hertwig, R., G.B. Elke, U. Weber et I. Erev (2004), Decisions from experience and the effect of rare events in risky choice, *Psychological Science,* 15, p 534–539.

Hong, H., Kubik, J.D. et J.C. Stein (2004), Social interaction and stock-market participation, *Journal of Finance* 59, p 137–163.

Huberman, G. (2001), Familiarity breeds investment, *Review of Financial Studies*, 14, p 659-680.

Huston, S. (2010), Measuring financial literacy, *The Journal of Consumer Affairs*, 44(2°, p 296-316.

Ivkovic, Z. et S. Weisbenner (2005), Local does as local is: Information content of the geography of individual investors' common stock investments, *Journal of Finance*, 60, p 267-306.

Iyengar, S., W. Jiang et G. Huberman (2003), How much choice is too much? Contributions to 401(k) retirement plans, *Working paper 2003–10*, The Wharton School, Pension Research Council.

Jacobsen, B., J.B. Leeb, W. Marqueringc et C.Y. Zhang (2014), Gender differences in optimism and asset allocation, *Journal of Economic Behavior and Organization*, 107 (B), p 630-651.

Jianakoplos, N.A. et A. Bernasek (1998), Are women more risk averse? *Economic Inquiry*, 36, p 620–630.

Jin, L. et A. D. Scherbina (2011), Inheriting losers, *Review of Financial Studies,* 24(3), p 786-820.

Kahneman, D., P. Slovic et A. Tversky (1982), Intuitive prediction: Biases and corrective procedures, in *Judgment Under Uncertainty: Heuristics and Biases*, CUP, London.

Kahneman, D. et A. Tversky (1979), Prospect theory: An analysis of decision under risk, *Econometrica*, *47*(2), p 263-291.

Kaniel, R., G. Saar et S. Titman (2008), Individual investor trading and stock returns, *Journal of Finance,* 63, p 273–310.

Kaustia, M., E. Alho et V. Puttonen (2008), How much does expertise reduce behavioral biases? The case of anchoring effects in stock return estimates, *Financial Management*, 37(3), p 391-411.

Kaustia, M. et S. Knüpfer (2012), Peer performance and stock market entry, *Journal of Financial Economics*, 104, p 321–338.

Kelley, E. K. et P.C. Tetlock (2013), How wise are crowds? Insights from retail orders and stock returns, *Journal of Finance,* 68(3), p 1229–1265.

Kelly, M. (1995), All their eggs in one basket: Portfolio diversification of U.S households, *Journal of Economic Behavior and Organization*, 27(1), p 87-96.

Kilka, M., et M. Weber, 2000, Home bias in international stock return expectations, *Journal of Psychology and Financial Markets*, 1 (3-4), p 176-192.

Kimball, M., et T. Shumway, 2006, Investor sophistication and the participation, home bias, diversification, and employer stock puzzles, Working paper.

Klapper, L.F., et G.A. Panos, 2011, Financial literacy and retirement planning: The Russian case, *Journal of Pension Economics and Finance,* 10 (4), p 599–618.

Knight, F., 1921, Risk, uncertainty, and profit, Hougthon Mifflin, Boston.

Korniotis, G.M., et A. Kumar, 2011, Do older investors make better investment decisions? *Review of Economic and Statistics*, 93(1), p 244–265.

Kumar, A., 2007, Do the diversification choices of individual investors influence stock returns? *Journal of Financial Markets*, 10, p 362-390.

La lettre de l'observatoire de l'épargne de l'AMF, 2014, numéro 7, mars.

La lettre de l'observatoire de l'épargne de l'AMF, 2014, numéro 9, juin.

Leal, C., Armada M., et J. Duque, 2006, New evidences on the disposition effect of individual investors, *Faculade de Economia da Universidade do Porto Working Paper*, p 1–30.

Lease, R.C., Lewellen, W.G., et G.G. Schlarbaum, 1974, The individual investor: attributes and attitudes, *Journal of Business*, 29, p 413-433.

Linnainmaa, J. T., 2010, Do limit orders alter inferences about investor performance and behavior? *Journal of Finance,* 65, p 1473–1506.

Linnainmaa, J. T., 2011, Why Do (Some) Households Trade So Much? *Review of Financial Studies,* 24(5), p 1630-1666.

Liu, H., 2014, Solvency constraint, underdiversification, and idiosyncratic risks, *Journal of Financial and Quantitative Analysis*, 49(2), p 409-430.

Love, D.A., 2010, The effect of marital status and children on savings and portfolio choice, *Review of Financial Studies*, 23, p 385–432.

Luce, R. D., et H. Raiffa, 1957, Games and decisions, *New York:Wiley*.

Lusardi, A., 2011, Americans' financial capability, *National Bureau of Economic Research Working Paper 17103*.

Lusardi, A., et O.S. Mitchell, 2007, Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth, *Journal of Monetary Economics,* 54, p 205-224.

Lusardi, A., et O.S. Mitchell, 2008, Planning and financial literacy: How do women fare?, *American Economic Review*, 98 (2), p 413-417.

Lusardi, A., et O.S. Mitchell, 2009, How ordinary consumers make complex economic decisions: Financial literacy and retirement readiness, NBER Working Paper No. 15350.

Lusardi, A., et O.S. Mitchell, 2011a, The outlook for financial literacy, in *Financial literacy: Implications for retirement security and the financial marketplace*, edited by O.S. Mitchell et A. Lusardi, p 1–15. Oxford and New York: Oxford University Press.

Lusardi, A., et O.S. Mitchell, 2011b, Financial literacy and planning: Implications for retirement well-being, in *Financial literacy: implications for retirement security and the financial marketplace*, edited by O.S. Mitchell and A. Lusardi, p 17–39. Oxford and New York: Oxford University Press.

Lusardi, A., et O.S. Mitchell, 2014, The economic importance of financial literacy: Theory and evidence, *Journal of Economic Literature,* 52(1), p 5–44.

Lusardi, A., Schneider D., et P. Tufano, 2011, Financially fragile households: Evidence and implications, *Brookings Papers on Economic Activity*, p 83-134.

Malmendier, U., et S. Nagel, 2011, Depression babies: Do macroeconomic experiences affect risk-taking? *The Quarterly Journal of Economics*, 126, p 373-416.

Mankiw, N.G., et S.P. Zeldes, 1991, The consumption of stockholders and nonstockholders, *Journal of Financial Economics*, 29, p 97–112.

Markowitz, H., 1952, Portfolio selection, *Journal of Finance*, 7(1), p 77-91.

Markowitz, H., 1959, *Portfolio selection: Efficient diversification of investments*, John Wiley, New York.

Massa, M., et A. Simonov, 2006, Hedging, familiarity and portfolio choice, *Review of Financial Studies*, 19, p 633-686.

Menkhoff, L., Schmidt U., et T. Brozynski, 2006, The impact of experience on risk taking, overconfidence and herding of funds managers: Complementary survey evidence, *European Economic Review*, 50, p 1753-1766.

Mitton, T., et K. Vorkink, 2007, Equilibrium underdiversification and the preference for skewness, *Review of Financial Studies*, 20, p 1255-1288.

Moore, D.A., et P.J. Healy, 2008, The trouble with overconfidence, *Psychological Review*, 115(2), p 502-517.

Nicolosi, G., Peng L., et N. Zhu, 2009, Do individual investors learn from their trading experience?, *Journal of Financial Markets*, 12, p 317–336.

Odean, T., 1998, Are investors reluctant to realize their losses?, *Journal of Finance,* 53(5), p 1775-1798.

Odean, T., 1999, Do investors trade too much?, *American Economic Review,* 89, p 1279-1298.

Osili, U.O., et A.L. Paulson, 2008, Institutions and financial development: Evidence from international migrants in the United States, *Review of Economics and Statistics*, 90, p 498–517.

Pelé M., Broihanne M.-H., Thierry B, Call J. et V. Dufour, 2014, To bet or not to bet? Decision-making under risk in non-human primates*, Journal of Risk and Uncertainty*, doi: 10.1007/s11166-014-9202-3.

Poterba, J.M., et A.A., Samwick, 1995, Stock ownership patterns, stock market fluctuations, and consumption, *Brookings Papers on Economic Activity,* 2, p 295–372.

Puetz, A., et S. Ruenzi, 2011, Overconfidence among professional investors: Evidence from mutual fund managers, *Journal of Business Finance and Accounting*, 38 (5-6), p 684-712.

Quiggin, J., 1982, A theory of anticipated utility, *Journal of Economic Behavior and Organization*, 3 (4), p 323-343.

Remund, D., 2010, Financial literacy explicated: The case for a clearer definition in an increasingly complex economy, *The Journal of Consumer Affairs*, 44(2), p 276-295.

Roger, P., 2014, The 99% market sentiment index, *Finance*, 35(3), p 53-96.

Roger, P. et M.-H. Broihanne, 2006, Les joueurs de loto français choisissent-ils leurs numéros au hasard ?, *Revue de Statistique Appliquée*, 54(3), p 83-98.

Roger, P. et M.-H. Broihanne, 2007, Efficiency of betting markets and rationality of players: Evidence from the French 6/49 lotto, *Journal of Applied Statistics,* 34(6), p 645-662.

Romain A., Broihanne M.-H., Call J., Thierry B., Wascher C.A.F., De Marco A., et V. Dufour, 2015, Do monkeys and great apes like risk? The attraction of gains drives gambling behaviour, *mimeo*, Strasbourg University. *En révision dans Plos One.*

Romain A., Broihanne M.-H., et V. Dufour, 2015a, Framing effect in decision-making under in children, *mimeo*, Strasbourg University.

Sekita, S., 2011, Financial literacy and retirement planning in Japan, *Journal of Pension Economics and Finance,* 10 (4), p 637–56.

Shapira, Z., et I. Venezia, 2001, Patterns of behavior of professionally managed and independent investors, *Journal of Banking and Finance*, 25(8), p 1573-1587.

Shefrin, H., et M. Statman, 1985, The disposition to sell winners too early and ride losers too long: theory and evidence, *Journal of Finance*, 40 (3), p 777-790.

Shu P.G., Yeh Y.H., Chiu S.B., et H.C. Chen, 2005, Are Taiwanese individual investors reluctant to realize their losses? *Pacific Basin Finance Journal*, 25(2), p 201-223.

Slovic, P., 1972, Psychological study of human judgment: Implications for investment decision-making, *Journal of Finance*, 27 (4), p 779-799.

Statman, M., Thorley, S., et K. Vorkink, 2006, Investor overconfidence and trading volume, *Review of Financial Studies*, 19, p 1531–1565

Steelandt S., Dufour V., Broihanne M.-H. et B. Thierry, 2011, Monkeys make investment based on calculated pay-off, *PloS One*, 6(3): e17801.

Steelandt, S., Dufour, V., Broihanne, M-H. et B. Thierry, 2012, Children make investment based on calculated pay-off, *PLoS One*, 7: e33239.

Steelandt S., Thierry B., Broihanne M.-H. et V. Dufour, 2012a, The ability of children to delay gratification in an exchange task, *Cognition*, *122, p 416–425.*

Steelandt, S., Broihanne, M.-H., Romain, A., Thierry, B. et V. Dufour, 2013, Decision-making under risk of loss in children, *PLoS One*, 8: e52316.

Talpsepp, T., 2011, Reverse disposition effect of foreign investors, *Journal of Behavioral Finance*, 12(4), p 183–200.

Taylor, S., et J. Brown, 1988, Illusion and well-being: A social psychological perspective on mental health, *Psychological Bulletin,* 103, p 193-210.

Thaler, R., et S. Benartzi, 2004, Save more tomorrow: Using behavioral economics to increase employee savings, *Journal of Political Economy,* 112, p S164-S187.

Törngren, G., et H. Montgomery, 2004, Worse than chance? Performance and confidence among professionals and laypeople in the stock market, *Journal of Behavioral Finance*, 5, p 148-153.

Toubia, O., Johnson E., Evgeniou T., et P. Delquié, 2013, Dynamic experiments for estimating preferences: An adaptive method of eliciting time and risk parameters, *Management Science*, 59(3), p 613-640.

Tversky. A., et D. Kahneman, 1986, Rational choice and the framing of decisions, *Journal of Business,* 59, p 251-278.

Tversky, A., et D. Kahneman, 1992, Advances in prospect theory: Cumulative representation of uncertainty, *Journal of Risk and Uncertainty*, *5*(4), p 297-323.

Van Rooij, M., Lusardi, A., et R. Alessie, 2011, Financial literacy and stock market participation, *Journal of Financial Economics*, 101 (2), p 449–72.

Vissing-Jørgensen, A., 2002, Limited asset market participation and the elasticity of intertemporal substitution, *Journal of Political Economy*, 110, p 825-853.

Vissing-Jørgensen, A., 2003, Perspectives on behavioral finance: Does "irrationality" disappear with wealth? Evidence from expectations and actions, *NBER Macroeconomics Annual*.

von Neumann, J., et O. Morgensten, 1944, *Theory of Games and Economic Behavior*, Princeton: Princeton University Press.

Weber M., et F. Welfens, 2006, An individual level analysis of the disposition effect: Empirical and experimental evidence, *Working Paper*, University of Mannheim.

Westergaard, G.C., Liv C., Chavanne T.J., et S.J. Suomi, 1998, Token mediated tool-use by a tufted capuchin monkey (*Cebus apella*), *Animal Cognition,* 1(2), p 101–106.

Westergaard, G.C., Liv C., Rocca A., Cleveland A., et S.J. Suomi, 2004, Tufted capuchins (*Cebus apella*) attribute value to foods and tools during voluntary exchanges with humans, *Animal Cognition,* 7(1), p 19–24.

Wilson. T.D., Houston C.E., Eitling K.M., et N. Brekke, 1996, A new look at anchoring effects: Basic anchoring and Its antecedents, *Journal of Experimental Psychology: General,* 125, p 387-402.

Yamada, H., Tymula, A., Louie, K., et P.W. Glimcher, 2013, Thirst-dependent risk preferences in monkeys identify a primitive form of wealth, *Procedings of the National Academy of Sciences,* 110, p 15788–15793.

Yaari, R. E., 1987, The dual theory of choice under risk, *Econometrica*, 55, p 95-105.

Zeisberger, S., Vrecko, D., et T. Langer, 2012, Measuring the time stability of prospect theory preferences, *Theory and Decision*, 72, p 359–386.

■ High Frequency Arbitrage: Is there Cause for Concern?

Thierry Foucault, HEC Paris

"To make a parrot into a learned financial economist,
he only needs to learn the single word "arbitrage""
(Stephen Ross, American Economic Review, 1987).

Abstract

High Frequency Arbitrage: Is there Cause for Concern?

High frequency traders often exploit very short lived arbitrage opportunities. In this article, I argue that high frequency arbitrageurs can harm liquidity when they exploit arbitrage opportunities due to delays in the adjustment of asset prices to information. I discuss evidence of this effect and implications for market design.

Résumé

Les traders haute-fréquence exploitent fréquemment des opportunités d'arbitrage de durées très courtes. Lorsque ces opportunités sont dues à des retards dans l'ajustement des cotations boursières à l'arrivée d'information, l'activité des arbitragistes peut conduire à une baisse de liquidité de ces actifs. Je discute des résultats empiriques récents mettant en évidence cet effet et les implications pour l'architecture des marchés.

Introduction

Information technologies have revolutionized trading in financial markets. Intermediaries (brokers and dealers) use them to process vast amount of financial information that they then exploit in their trading decisions. High frequency trading is one manifestation of this evolution. It is defined by the Securities and Exchange Commission (SEC) as "*The use of extraordinarily high-speed and sophisticated computer programs for generating, routing, and executing orders […]*" (See SEC (2010), p. 45). Thus, high frequency traders are characterized by their speed: they receive information, process it, and trade on it faster than other investors. To be faster, they make very significant investments, e.g., they pay fees to "co-locate" (place their servers in close proximity to exchanges' servers) or get fast access to data feed from data vendors. They also invest in computers and hire skilled coders to accelerate the speed at which they can process information.

There is yet little agreement on the effects of this evolution on market quality (e.g., volatility and liquidity) and long term investors (see Biais and Foucault (2014) for a survey of the literature on high frequency trading). One reason is that high frequency traders' strategies are heterogeneous For instance, Baron et al. (2012) find that high frequency traders in the E.mini futures on the S&P500 specialize either in "liquidity making" (using primarily limit orders for their trades) or "liquidity taking" (using primarily market orders).[72] Hagströmer and Norden (2014) also observe that HFTs on Nasdaq OMX specialize in providing or consuming liquidity. In light of these findings, SEC (2014) writes:

"*Perhaps the most noteworthy finding of the HFT dataset papers is that HFT is not a monolithic phenomenon but rather encompasses a diverse range of strategies. In particular, HFT is not solely, or even primarily, characterized by passive market making strategies that employ liquidity providing orders [...] Moreover, the level and nature of HFT activity can vary greatly across different types of stocks.*" (SEC, 2014, p.9)

Two different types of strategies rely intensively on market orders: (i) directional strategies and (ii) cross-market arbitrage strategies. Directional traders use various signals (e.g., news, asset prices, trade data etc.) to anticipate future price movements. Cross-market arbitrageurs exploit deviations of prices from no arbitrage relationships. For instance, the price of an Exchange Traded Fund (ETF) must in theory be equal to the price of its underlying basket of assets. When the ETF price is higher (lower), arbitrageurs can sell (buy) the ETF and buy (sell) the underlying basket of assets to obtain an instantaneous profit.

Given the heterogeneity in HFTs' strategies, the lack of agreement on their effects is not surprising. For instance, high frequency market makers are providing liquidity to market participants. If fast trading enables them to lower their costs, then fast market making should be associated with more liquid markets. In contrast, directional traders raise other market participants' exposure to adverse selection, and thereby can impair market liquidity (see Biais, Foucault, and Moinas (2014)).

The effect of high frequency arbitrage on market quality is less clear-cut, and, as the SEC points out in a recent survey of empirical findings on high frequency traders: "*the literature does not reveal a great deal about the extent of the HFT arbitrage strategies*" (see SEC (2014)). Yet, high frequency arbitrageurs' profits are significant. For instance, for 2009 alone, these profits in U.S. markets were estimated at $21 billion by the Tabb Group. Moreover, U.S. researchers (Budish, Cramton, and Shim (2013)) recently proposed to replace continuous limit order markets to batch auctions markets, on the ground that (i) continuous limit order markets were creating technical arbitrage opportunities due to latencies in market responses to new information and (ii) these arbitrage opportunities are socially wasteful and harm liquidity. For instance, they write:

"*market correlations completely break down at high-frequency time horizons, which creates technical arbitrage opportunities available to whomever is fastest, inducing an arms race for speed. We then show that the arms race has two kinds of negative effects: it is socially*

wasteful, and it harms liquidity. The arms race and these negative effects are thus a consequence of flawed market design. As an alternative, we recommend frequent batch auctions – uniform price sealed-bid double auctions conducted at frequent but discrete time intervals, such as once per second (or even once per 100ms)." (Budish, Cramton, and Shim, in Response to "CFTC Concept Release – Risk Controls and System Safeguards for Automated Trading Environments RIN 3038-AD52"

Why can high frequency arbitrageurs be socially wasteful? Is there evidence of harmful effects of high frequency arbitrageurs on liquidity? I discuss these questions in the rest of this article, in light of empirical findings reported in Foucault, Kozhan, and Tham (2013).

1. Toxic arbitrage opportunities

Arbitrage is a cornerstone of financial economics. By swiftly taking advantage of arbitrage opportunities, arbitrageurs correct price inefficiencies. This however does not mean that arbitrage makes markets more efficient in all dimensions. In fact, the effect of arbitrageurs exploiting short lived arbitrage opportunities on market liquidity is theoretically ambiguous (see Foucault, Kozhan, and Tham (2013) for an economic analysis).

To see this, consider a stock that trades on two trading platforms E and C (say Euronext and BATS Chi-X in Europe). Its fair value is 100. The bid and ask prices for this stock are 99.5 and 100.5 on trading platform E and 99 and 101 on trading platform C. Now suppose that good news arrive regarding the stock, calling for a revision of its fair value at 102. Liquidity suppliers' reaction to such news cannot be instantaneous. Suppose that, for this particular news, liquidity suppliers on platform C are faster than those on platform E. They cancel their quotes and post new bid and ask prices for the stock at 101.5 and 102.5, respectively. As long as liquidity suppliers on platform E do not revise their quotes, there is an arbitrage opportunity: one can buy shares at 100.5 on trading platform E and sell them immediately at 101.5 on platform C. If an arbitrageur is fast enough to exploit this opportunity, he will earn a riskless profit of one euro per share. This profit is obtained at the expense of slow liquidity suppliers on platform E who sell the asset to the arbitrageur at 100.5 and therefore lose 100.5-102= -1.5 per share. This loss exceeds the arbitrageur's profit because the latter implicitly pays a trading cost of fifty cents when selling the asset to liquidity suppliers on platform C at 101.5 while its fair value is 102.

This type of arbitrage opportunity, due to asynchronous price adjustments to news in a pair of assets related by a non-arbitrage relationship, is "toxic."[73] Indeed, it does not create gains from trade since the trading loss of slow liquidity suppliers is equal to the gain of arbitrageurs and liquidity suppliers who, by chance, were fast enough to update their quotes. Worse, in anticipation of this risk, liquidity suppliers should quote larger bid-ask spreads to cover losses incurred when their stale quotes are picked off by fast arbitrageurs, as in the previous example.

Not all arbitrage opportunities are due to asynchronous price adjustments to news, however. A second reason for which arbitrage opportunities arise are "price pressures" in one asset due to a strong transient demand or supply for this asset. Consider again the previous example and suppose now that one investor has an urgent need to buy the stock (e.g., to hedge a position in another asset). The investor chooses to place a marketable buy order on trading platform C at 101.5 for a size that exceeds the number of shares supplied up to this price. Hence, the investor's buy order executes only partially and the unfilled part of his order is transformed in a buy limit order at 101.5 on platform C. The new bid price on platform C becomes 101.5 as in the previous example. Arbitrageurs will again exploit the arbitrage opportunity by selling shares at 101.5 to the investor and buying shares at 100.5 on platform E. However, in this case, all parties in the transaction make a gain. The investor obtains the liquidity he was seeking, the arbitrageur earns a profit on his arbitrage position, and liquidity providers on platform E earns the spread on their trade with the arbitrageur since the fair value of the asset is unchanged.

Thus, whether high speed arbitrageurs are harmful for market quality should depend on (i) the *composition* of arbitrage opportunities in a given pair of assets and (ii) arbitrageurs' *relative speed* of reaction to toxic arbitrage opportunities. More specifically:

1. Illiquidity in a given asset pair should be higher on days in which the fraction of arbitrage opportunities that are toxic is higher.
2. Illiquidity in a given asset pair should be higher on days in which the fraction of toxic arbitrage opportunities that terminate with an arbitrageur's trade (rather than a quote update) is higher, i.e., in days in which arbitrageurs have been relatively faster than liquidity suppliers in reacting to arbitrage opportunities.

Testing these two implications can shed light on whether one should slow down high frequency arbitrageurs or not. To see this, consider again the Budish/Cramton/Shim's proposal to replace continuous limit order book markets with batch auctions. Budish et al. (2013) argues that this change in market structure will make the market more liquid by largely suppressing liquidity suppliers' exposure to the risk of being picked off by arbitrageurs. This is similar to decreasing the fraction of arbitrage opportunities that are toxic. However, by how much would this improve liquidity?

This question is key since a significant improvement in liquidity is required to justify the costs of significantly changing the current structure of financial markets. Answering it requires (a) documenting the extent to which toxic arbitrage opportunities are toxic (if few opportunities are toxic, one should not be too much concerned) and (b) measuring the sensitivity of illiquidity to the fraction of arbitrage opportunities that are toxic (i.e., measuring the extent to which illiquidity is higher when toxic arbitrage opportunities are more frequent). If this sensitivity is small then eliminating toxic arbitrage opportunities with batch auctions is unlikely to be useful.

Now consider proposals to slow down the speed of trading by adding a small random delay to the execution time of incoming market orders. These proposals would not affect the composition of arbitrage opportunities in the market (toxic vs. non-toxic) but they might (if adequately designed) reduce the odds that arbitrageurs are able to react to a toxic arbitrage opportunity before liquidity suppliers update their quotes. Again the question is by how much would this improve liquidity? By how much for instance a, say, 1% decrease in the likelihood that a high frequency arbitrageur can hit stale quotes will affect liquidity? If the answer is "by not much" then changes in market design that reduce high frequency arbitrageurs' speed are unlikely to matter.

2. Evidence

So far academic research does not provide much guidance on these questions. One reason is that high frequency cross market arbitrage opportunities are difficult to observe. Indeed, these opportunities are very short lived (of the order of a few milliseconds and most of the time less than one second) and will therefore not be detected in datasets that report prices, at, say, fixed time intervals (e.g., every second or minute). Moreover, asset pairs related by a non-arbitrage relationship often trade in different trading platforms (e.g., derivatives on the CAC40 index trade on Liffe Connect while constituent stocks trade on NYSE Euronext). If price reporting by these platforms is not perfectly synchronized then one might erroneously conclude that arbitrage opportunities exist when in fact these are simply artifact of reporting lags.

In Foucault, Kozhan, and Tham (2013), we circumvent these problems by using data on prices and trades in the market for three currency pairs: dollar/euro, dollar/pounds, and euro/pounds. For instance, consider a U.S. based arbitrageur. At each instant, he can (i) invest dollars in euros, (ii) use the euros to buy pounds and (iii) use these pounds to buy dollars. If the final amount obtained in dollar is higher than the initial investment then there is a triangular arbitrage opportunity.

Our data come from one of the two main trading platforms used by foreign exchange dealers (Reuters D-3000). This platform is a limit order book market where traders can place market and limit orders in each currency pair traded on Reuters D-3000. Our data comprise all orders and trades submitted from January 2003 to December 2004 on Reuters D-3000 with a time stamp accuracy of 1/100 seconds. As all trades take place on the same trading platform, observations for quotes in different currencies are perfectly synchronized. We can therefore accurately measure when a triangular arbitrage opportunity occurs, when it terminates, and how it terminates (by an update of limit orders books for currencies in our sample or an arbitrageur's trade). As we observe all quotes posted in the market at any point in time, we can also measure whether triangular arbitrage opportunities are indeed profitable after accounting for arbitrageurs' trading costs (bid-ask spreads). Conservatively, we restrict our attention to triangular arbitrage opportunities that deliver a profit of, at least, one basis points per unit of the base currency (the minimum trade size is 1 million of base currency in Reuters D-3000).

Overall, we observe 37,689 triangular arbitrage opportunities in our sample, that is, about 40 per day.[74] These opportunities are very similar to those exploited by high frequency arbitrageurs: they are very short (they last less than one second on average), deliver a small profit (of about 1.5 bps on average), and are virtually riskless. Speed is critical to exploit these opportunities because they are very short and the first trader to react to the opportunity has an incentive to fully exploit it, leaving no room for further profits.

We classify all arbitrage opportunities in two groups: those due to asynchronous reactions of exchange rates to news and those due to transient price pressures. To this end, we use the same methodology as Shive and Stulz (2010). In a nutshell, if quotes revert to their original level after an arbitrage opportunity terminates then the arbitrage opportunity is likely to be due to a transient demand or supply shock. It is therefore classified as non-toxic. If instead quotes do not revert after an arbitrage opportunity terminates then the arbitrage opportunity is likely to be due to a permanent shift in fundamentals. The arbitrage opportunity is then classified as toxic. Figure 1 shows the daily total number of triangular arbitrage opportunities (light grey line) and the daily number of toxic triangular arbitrage opportunities (dark line) in our sample.

Figure 1: Daily Number of Triangular Arbitrage Opportunities (grey solid line) **and Toxic Arbitrage Opportunities** (black solid line) **in dollar/euro, euro/pound, and dollar/pound from January 2003 to December 2004**
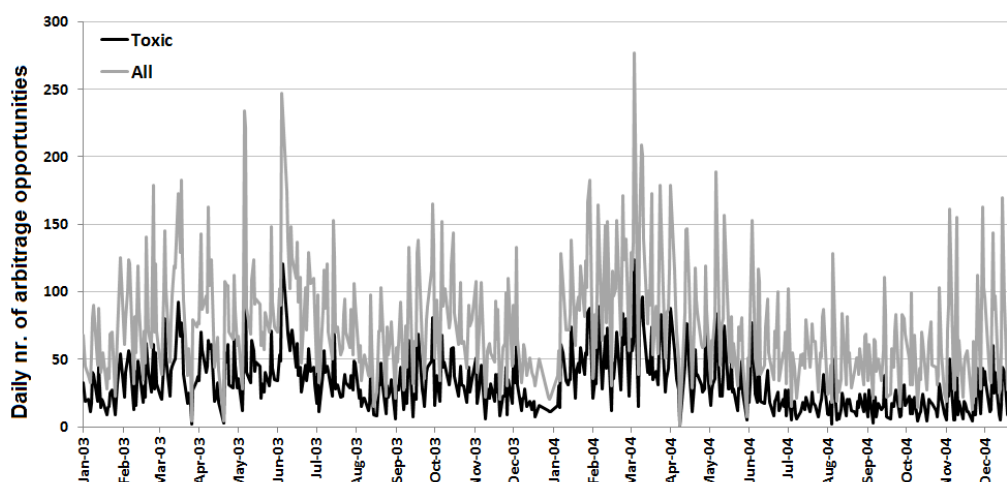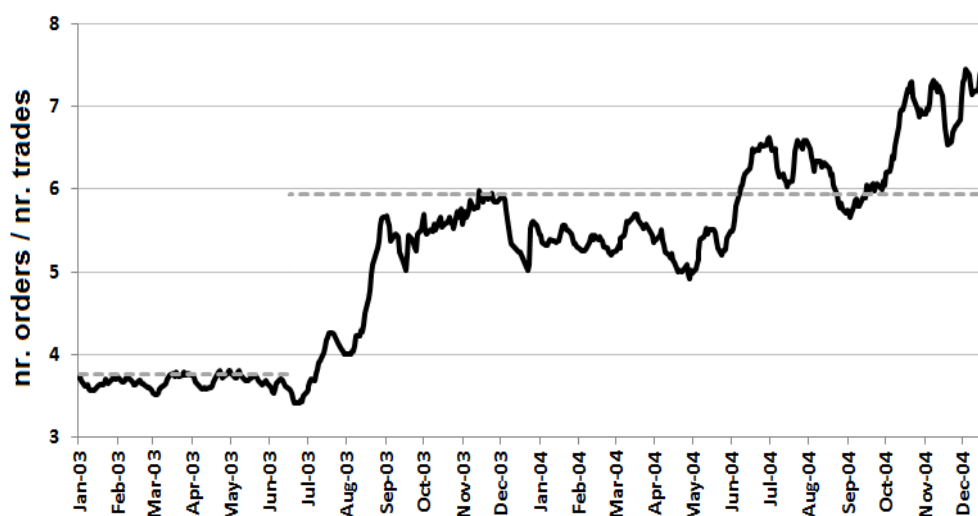

Source: Foucault, Kozhan, and Tham (2013).

Using econometric techniques, we analyze how various daily measures of liquidity (the quoted bid-ask spread, the effective bid-ask spread, and the slope of the limit order book) for the currency pairs in our sample vary with (i) the fraction of triangular arbitrage opportunities that are toxic (i.e., the ratio of the number of toxic arbitrage opportunities on a given day divided by the total number of opportunities on this day) and (ii) the frequency with which a toxic arbitrage opportunity terminates with a trade from an arbitrageur (i.e., the number of toxic arbitrage opportunities that terminate with an arbitrageur's trade divided by the total number of toxic arbitrage opportunities). The first variable characterizes the *composition* of arbitrage opportunities in a given day while the second characterizes arbitrageurs' *relative speed* in exploiting toxic arbitrage opportunities.

We find a strong positive association between illiquidity and the fraction of arbitrage opportunities that are toxic, at the daily frequency. For instance, a one standard deviation increase in this fraction (a 10% increase in our data) in a given day is associated with a 3% increase in the size of effective bid-ask spreads in this day. This is consistent with the conjecture that the composition of arbitrage opportunities matters for liquidity.

To measure the effect of arbitrageurs' relative speed on illiquidity, we exploit a technological change that took place during our sample period. In July 2003, Reuters introduced a new functionality called "Autoquote API" (API stands for Application Programming Interface). This functionality enables traders to automate order submission to the Reuters D-3000 trading platforms. Its introduction effectively marked the outset of algorithmic trading on this platform and triggered a large increase in message traffic on Reuters for the currency pairs in our sample (see Figure 2).

Figure 2: Evolution in the Order-to-Trade ratio on Reuters D-3000 from January 2003 to December 2004 in dollar/euro, euro/pound, and dollar/pound from January 2003 to December 2004

Source: Foucault, Kozhan, and Tham (2013).

Anecdotal evidence suggest that algorithmic trading in currency markets was initially developed to take advantage of arbitrage opportunities (see Chaboud et al. (2014) for a discussion). Thus, the introduction of Autoquote API should enable arbitrageurs to increase the speed at which they react to the occurrence of triangular arbitrage opportunities relative to dealers. Consistent with this conjecture, we find that the introduction of Autoquote API on Reuters coincides with an increase of about 4% in the frequency with which toxic arbitrage opportunities terminate with an arbitrageur's trade. It also coincides with an increase in illiquidity, consistent with the conjecture that an increase in arbitrageurs' relative speed of reaction to toxic arbitrage opportunities should increase illiquidity. Specifically, our estimates suggest that a 1% increase in the frequency with which an arbitrage opportunity terminates with an arbitrageur's trade is associated with a 4% increase in the size of effective bid-ask spreads for the currency pairs in our sample.

3. Conclusion

Should high frequency arbitrageurs be a cause of concern? The answer is a careful yes, because high frequency arbitrageurs can harm liquidity in some cases. When they exploit arbitrage opportunities due to stale quotes, i.e., lagged adjustment of prices to new information, arbitrageurs' adversely select liquidity suppliers with stale quotes. As a result they make the market less liquid, which in turn might impair the realization of gains from trade. In contrast when arbitrageurs exploit arbitrage opportunities due to transient price pressures, they enhance market liquidity.

How to alleviate harmful effects of high frequency arbitrageurs without losing its benefits? One solution is to delay the execution of *marketable* orders by a small *random* delay (of the order of a few milliseconds).[75] This approach has several advantages. First, liquidity suppliers retain the option of not changing their quotes and trade with arbitrageurs if they find it beneficial (as in the case of arbitrage opportunities due to transient demand shocks). Second, it does not slow down those posting non-marketable limit orders. Hence, it tilts the odds of winning the arbitrage race in favor of liquidity suppliers. Third, the average delay with which market orders get execution can be adjusted to asset characteristics, in particular to the composition of arbitrage opportunities in each asset. In assets in which arbitrage opportunities are unfrequently due to news arrival, this delay should be small while in assets where arbitrage opportunities are mainly

due to news arrival, this delay should be longer. Fourth, it should decrease traders' incentive to make massive investments to just gain a few milliseconds in reacting to toxic arbitrage opportunities. Last, but not least, it is relatively easy to implement as it does not require a complete overhaul of current trading mechanisms in electronic markets (as a move to batch auctions would require).

Randomizing execution times of market orders might increase by a few milliseconds the time required to correct an arbitrage opportunity but it should reduce liquidity suppliers' exposure to toxic arbitrage trades. The loss for pricing efficiency should be very small but the liquidity gain could be significant.

References

Baron, M., J. Brogaard and A. Kirilenko (2012), « The Trading Profits of High Frequency Traders », *Working Paper*, University of Washington.

Biais, B., T. Foucault and S. Moinas (2013), « Equilibrium Fast Trading », *forthcoming in Journal of Financial Economics*, voir http://dx.doi.org/10.2139/ssrn.2024360.

Biais, B. and T. Foucault (2014), « HFT and Market Quality », *Bankers, markets, and Investors*, 128, 5-19.

Brogaard, J., T. Hendershott and R. Riordan (2014), « High Frequency Trading and Price Discovery », *Review of Financial Studies*, 27, 2267–2306.

Budish, E., P. Cramton and J. Shim (2013), « The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response », *Working paper*, University of Chicago.

Chaboud, A., B. Chiquoine, E. Hjalmarsson and C. Vega (2014), « Rise of the Machine: Algorithmic trading in the foreign exchange market », *Journal of Finance*, 69, 2045–2084.

Foucault T., M. Pagano and A. Röell (2013), « *Market liquidity: theory, evidence, and policy* », Oxford University Press.

Foucault T, R. Kozhan and W.W Tham (2003), « Toxic Arbitrage », voir : http://dx.doi.org/10.2139/ssrn.2409054.

Hagströmer B. and L. Norden (2013), « The Diversity of High-Frequency Traders », *Journal of Financial Markets*, 16, 741-770.

SEC, (2010), « Concept Release on Equity Market Structure », Release No. 34-61358; File No. S7-02-10.

SEC, (2014), Equity market structure literature review, Part II: High Frequency Trading, Staff of the Division of Trading and Markets, 1-37.

Shive, Sophie and Paul Schultz (2010), « Mispricings of dual class shares: Profit opportunities, arbitrage, and trading », *Journal of Financial Economics*, 98, 524-549.

Ross, Stephen A. (1987), « The Interrelations of Finance and Economics: Theoretical Perspectives », *American Economic Review*. May, 77, pp. 29 –34