



ICADE BUSINESS SCHOOL  
MÁSTER UNIVERSITARIO EN FINANZAS

**BEHAVIOURAL FINANCE.  
FROM A THEORETICAL APPROACH TO  
EMPIRICAL APPLICATION**

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## **ABSTRACT**

Behavioural finance has arisen in last decades as a consequence of the gaps that have been found in the substantial assumptions of neoclassical finance theories. In this project the reader finds a complete exposition and analysis of the classical models, in which current financial knowledge and understanding is based, the transition that led to the development of the behavioural approach and finally the main theories and authors that have contributed to its creation.

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## INTRODUCTION

Behavioural finance appeared around the mid-20<sup>th</sup> century as a consequence of the introduction of psychology into economics. One of the facts that led to its creation were the new discoveries that were made about the cognitive processes <sup>1</sup> and the implementation of human choice <sup>2</sup> in other knowledge fields apart from economics. Behavioural approach differs with the neoclassical theory, which is widely applied in the financial markets, principally in the concept of rationality.

Statman, in his paper Behavioural Finance: Past Battles and Future Engagements (1999) mentioned that the battle of standard finance versus behavioural finance had market efficiency as a central point. The concept of market efficiency, which will be explained more in depth in following paragraphs, could have two meanings. The first one, that investors can not beat the market. The other one, that security prices are rational. These rational prices do only reflect utilitarian features, such as risk, but do not reflect value-indicative features, such as sentiment. Behavioural finance, however, demonstrates that value-indicative features have an importance in both investor choices and securities prices. As a conclusion, the author stated that finance fields should decline the idea of rationality in securities prices, and to concentrate in developing asset pricing patterns that combine utilitarian and value-expressing features, and accept the first meaning of the impossibility of investors to beat the market.

Before entering to develop neoclassical approach, I found it necessary to explain the concepts of expected value, risk aversion, certainty and rationality, in order the reader to understand the main notions on which this theory is based. Expected value is an anticipated value associated with a certain investment. In statistics the expected value is calculated by multiplying each of the plausible results by the likelihood of each one occurring, and adding all of them. Expected value is principally applied by investors to decide the scenario in which is most probable to obtain the target outcome (Investopedia, 2017). Risk aversion is defined as the preference for lower returns with known risks than higher returns with unknown risks, this is, among various investments with equal return and different levels of risk, the preference for lower interest (The Economic Times). Certainty is defined by the Cambridge Dictionary as the state of being completely confident or having no doubt about something. However, in the context of decision making the concept of uncertainty is more used, defined as a situation in which something is not known, or something that is not

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<sup>1</sup> Cognitive processes are defined as the performance of a cognitive activity or a processing and movement that affects the mental contents of a person, such as the process of thinking or the cognitive operation of remembering something (Reference)

<sup>2</sup> Choice is defined as the act of choosing or the act of picking or deciding between two or more possibilities (Merriam-Webster)

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known or certain (Cambridge Dictionary). Finally, rationality is the quality of being based on reason or logic (Merriam-Webster).

Neoclassical approach associates rationality with maximizing revenue, and assumes that economic agents, apart from being rational, have all the information available to make decisions. The theory of expected utility (Bernoulli, 1738), which is based on the concepts previously defined, is, as well, one of the pillars of neoclassical models. It is used mainly to define optimal decisions, and is widely accepted as the principle of rational conduct under uncertainty. The expected utility theory was later extended by Morgenstern and Von Neumann (1944), who showed that when a consumer or investor is presented a choice of outcomes with different levels of probability, the optimal decision would be the one that maximizes expected value. Investors are then expected to classify outcomes by preference, but expected value would be dependent on the probability of occurring. Neoclassical models also make the assumptions of preference for bigger quantities rather than smaller ones, cost minimization, highest return-investment choices and the superposition of self-interests above others' well-being.

The neoclassical theory, therefore, assumes a substantive rationality, defined as objective oriented rational action based on the results (Weber, 1921). This varies depending on the person or organization's preferences, agents that is assumed to have all the information available, and that will choose the alternative that provides the biggest expected utility.

The transition from neoclassical to behavioural finance started with authors like Maurice Allais, who in 1953 presented the Allais paradoxes, which are known in decision theory as the first separation from expected utility, and that will be explained in more depth in following sections. Gary Becker (1976) developed later the notion that economic analysis and decision making is applicable to any situation of choice, being the first that applied economic thinking to other social fields, such as racial discrimination. He proved that economic approach can serve as a global framework to understand all human behaviour, from social interactions to irrational behaviour.

Behavioural theory, on the contrary to the classical approach, is based on the concept of bounded rationality (Simon, 1955): people do not always behave rationally. This concept of bounded rationality emerged from the existence of two kinds of reasoning, one intuitive and unconscious, that is faster when making conclusions, and the other, rational and logical. The thinking process is formed by both of them. Sometimes intuitive thinking changes the conclusions of the rational one, so mistakes in reasoning could appear in some situations.

In Simon's opinion, two factors affect the possibility of stably and orderly develop a system of preferences, which is one of the pillars of the rationality that neoclassical approaches assume. The first one is the limited capacity to calculate; the second, the restricted amount of information that is possible to be held by the agent. According to

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Simon, the substantial rationality only happens when the agent confronts a choice that is simple and properly structured. If the selection is more complicated, agents would be satisfied with enough information, not all of it, would then simplify decisions and finally select a satisfactory, but not optimal solution.

This concept of bounded rationality was later developed by D. Kahneman and A. Tversky (1970), who are considered to be the founders of behavioural economics, by the conduction of various experiments oriented to support Simon's theoretical concepts on this matter. After reaching some conclusions on the alternative theory of decision making, they founded the prospect theory, which will be the theoretical starting point about behavioural finance in this project.

The main reason why these topics have been chosen to be developed in this project is the willingness to obtain a complete paper about the new approaches that have arisen in financial theories in last decades, especially regarding decision making. Behavioural finance is the result of new findings in the field, and I personally found it really interesting to understand this new approach, which could suppose a complete change in the way financial markets are understood and the way investing decisions are explained. This is the main reason why this topic has been chosen.

## OBJECTIVES

As explained in the introduction, there are two main currents of theory related to economic decision making under uncertainty, the neoclassical approach and the more recently developed behavioural theory, that differ principally in the way they assume the rationality of individuals or entities when making a decision. As decision making under uncertainty is one of the most habitual situations in financial fields, the theories and papers developed in this work have as a common framework decision making theories, and how each of the financial approaches explains the behaviour of financial agents in these uncertainty situations.

The majority of these theories and authors base their research in trying to answer questions as what do individuals expect when they invest, which level of risk are they prepared to assume, what do they fear, or how do they calculate what could they win/lose. These questions, translated to economic or financial fields, derive in the calculation of investors' expectations, risk or loss aversion and probability.

The main objective of this work is not to analyse which of the approaches is mistaken or right, or which of them is worth applying in reality, but to understand how each of them is applied in practice to financial fields and to deepen into the principal theories developed in behavioural finance, in order to understand how this theory was formed and to verify that this more recent approach can be empirically translated to financial markets.

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As behavioural finance is a relatively new approach, the theoretical information will help the reader acquire the basic knowledge about the subject, as well as the main ideas that the principal authors on behavioural finance have developed in their theories and papers. The other part of this work’s aim is to show the reader empirical examples of application of behavioural finance in markets, in order to understand the practical application that this subject could suppose in reality.

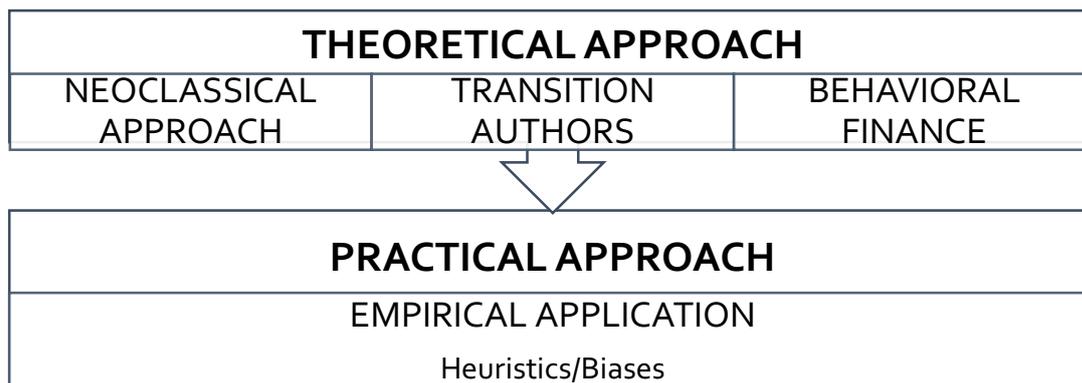
Before entering to develop behavioural main authors and theories, a review on neoclassical theories will be presented, as I found it necessary to understand the main concepts that this widely applied approach is based on, in order to later understand the questioning that some economists started to make about it, representing the transition from classical to behavioural theories.

As a result of reading this work, the reader will have a global view on how behavioural finance arose, which are the main differences with neoclassical economy, which are the main theories related to the subject and, finally, will be able to apply this knowledge to practical situations in the reality of financial markets.

**METHODOLOGY**

This work is divided in two main sections. The first one, the theoretical part, will introduce the principal concepts and set the general framework about behavioural finance, in order the reader to understand the second section, the empirical applications of this financial approach.

**Table 1:** Project Scheme



The methodology that will be applied in order to develop the previous points will be based on the academic papers and books that the authors have published, which suppose the basic source of information about the matter, and summarize them to make their understanding easier for the reader. Once the theory is exposed and explained, I will focus on three examples of heuristics and biases that, in my opinion, would be the most applicable and common in the reality of financial investing.

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The objective of this separation in sections is double. On the one hand, having the theoretical and practical sections well defined will help the reader get the general concepts about the subject in a first moment, and be able then to understand practical applications or representations of the theory having the theoretical background in mind. On the other hand, it will set a clear image about the development of behavioural finance in comparison to the neoclassical approach and through time, making a clear distinction between the different theories, authors and practical applications.

In conclusion, the methodology applied consists of collecting all the information available that the most relevant authors have disclosed. Once the theories are exposed, summarized and explained, I will expose three practical examples that will serve as explanation of the practical application of some concepts mentioned above in the reality of financial decision making. At the end of this work, the reader will have a complete knowledge about how behavioural finance arose, who are the main professionals that have developed this recent financial approach, and will be able to explain practically some situations that support this approach.

Regarding the separation of the different sections, the next table will serve as a summary of the organization of the project.

**Table 2:** Subsections Overview And Summary of Theories and Authors

<b>SECTION I: THEORETICAL FRAMEWORK</b>	
<b>Subsection</b>	<b>Theories and Authors</b>
Neoclassical Approach Applied To Financial Markets	Expected Utility Theory Financial Neoclassical Revolution
From Neoclassical Finance to Behavioral Finance: Transition Authors	Herbert Simon Maurice Allais Sanford J. Grossman – Joseph E. Stiglitz Robert J. Shiller
Behavioral Finance	Definition and Beginnings Prospect Theory Market Anomalies, Heuristics and Biases
<b>SECTION II: EMPIRICAL APPROACH</b>	
<b>Example</b>	<b>Bias/Heuristic</b>
Investor Behaviour And Decision-Making Style: A Malaysian Perspective	Representativeness Heuristic
Equity Portfolio Diversification	Over-Confidence Bias Inclination Towards Local Stocks Sensitiveness to Past Prices
The Disposition Effect: Selling Winners And Holding Losers	Disposition Effect

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In the first section I will develop the theories that, in my opinion, have played a fundamental role in the development of behavioural finance. As explained before, the main goal of this work is to set basic but also complete concepts about this approach, with the idea of generating a general knowledge about the matter. If the reader was interested in going in deep with this subject, a further research should be done.

The theoretical framework is, at the same time, divided in three main sections. The first one starts with a brief introduction about the neoclassical financial approach, which, as mentioned in the introduction, is the opposite concept to behavioural finance. Developing the main assumptions and theories in this approach, putting special attention to Bernoulli and Von Neumann and Morgenstern Expected Utility Theory, and then explaining Capital Asset Pricing Model or efficient markets theory, the reader will understand the previous background that led to the appearance of behavioural finance.

The second section inside the theoretical framework is focused on presenting the authors and papers that began questioning some assumptions and concepts of the neoclassical approach, starting a period of “transition” from neoclassical finance to the creation of behavioural approaches. In this part I will review the works of Herbert Simon and his concept of bounded rationality; Maurice Allais, and his famous Allais Paradox; as well as Sanford J. Grossman and Joseph E. Stiglitz work on the Impossibility of Informationally Efficient Markets, and finally R. J. Shiller’s contributions to the development of this approach.

The third and last section of the theoretical framework is destined to behavioural finance itself. In the first paragraphs the definition and beginnings of behavioural finance are displayed, presenting behavioural finance as a complementary approach for the gaps that were found in neoclassical theories, not as a completely contrary approach.

At this point, the main authors on the subject are developed. I will focus on the famous Prospect Theory of Daniel Kahneman and Amos Tversky (1974), who are considered to be, among others, the fathers of behavioural finance. The review made in previous sections about expected utility theory will be useful to understand the developments of these authors, as, until the publication of Prospect Theory, Bernoulli utility theory was the globally applied approach for decision making in uncertainty situations.

Kahneman and Tversky proved that expected utility theory did not take into account the behaviour of individuals, and developed a new model for decision making under risk. They later went further on the subject, and developed a second model which takes into account uncertainty as well as risk, Cumulative Prospect Theory, which is also explained.

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The behavioural finance theoretical section will follow with the works of Richard Thaler about the anomalies that he found in financial markets, and that are one of the main points that support the impossibility of market efficiency.

At this point, I will introduce the concepts of heuristics and biases, one of the central points of the behavioural theory, and that will serve as framework for the empirical examples that will be developed in the second part of this project.

The second section of this project has the objective of demonstrating the application, or in other words, the empirical support for behavioural finance theory. With the development of different empirical experiments carried out by professionals about some selected cognitive heuristic and biases, the reader will be able to make a practical idea of the application of this theory, in order to understand behavioural finance not only from a theoretical, but from a practical point of view as well.

## **SECTION I: THEORETICAL FRAMEWORK**

### NEOCLASSICAL APPROACH APPLIED TO FINANCIAL MARKETS

As explained in the methodology paragraph, this first theoretical section is focused on the neoclassical finance approach and the theories that support it.

Neoclassical economy assumes that a consumer's objective is to maximize utility or satisfaction, and this, translated to companies, would suppose maximizing revenue. In last instance, customers are the agents who direct market drivers as price or demand.

This approach, translated to financial fields, is supported by two developments: Bernoulli expected utility theory, later developed by Von Neumann and Morgenstern, and the financial revolutions that took place in the 60's decade.

### **EXPECTED UTILITY THEORY**

Although it has been mentioned superficially in previous sections, I found it necessary to make a brief review on expected utility theory, in order the reader to be able to get the main concepts about it, and to understand then the critique that Kahneman and Tversky made.

Expected utility principle was first proposed by Bernoulli in 1738, and it is a widely accepted theory on decision making under risk conditions. In this risky environment, each option of choice derives to a collection of possible outcomes, and the probability of each outcome is known. This theory affirms that individuals tend to maximize expected utility in their choices when deciding among risky alternatives, this is, they

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weight the utilities of individual outcomes by their probability and choose the option with the highest weighted sum (Levy, 1992).

Since expected utility was proposed, it is assumed that the value of money and other goods does not increment in proportion with material amount, but that exists a diminishing marginal utility for them. This marginal utility is interpreted in a concave utility function. On the other hand, it can also exist a growing or constant marginal utility for a specific good, which would be represented in a convex or linear utility function.

These different patterns of the utility function or marginal utility describe an individual's posture in relation to risk. The concavity of the utility function represents an individual's risk aversion, if the marginal utility is constant (linear function) the individual would be risk-neutral, and risk-acceptant if utility function is convex.

The application of this theory to decision making situations would be as follows: in a circumstance of selection between two options, the first one carrying a settled outcome of utility and the second one a lottery or gamble with the analogous utility, risk averse individuals would choose the settled outcome instead of the gamble, risk acceptant ones would prefer the gamble, and neutral position individuals would be indifferent.

As most people tend to be risk averse, they would prefer a certain outcome of less money to a fifty-fifty possibility of getting nothing or more money.

Expected utility theory was later developed by John von Neumann and Oskar Morgenstern in their book *Theory of Games and Economic Behavior* (1944). They translated Bernoulli's utility function, principally applied to wealth, to lotteries or gambles. The authors defined lotteries or gambles as a probability distribution over an established and limited collection of outcomes (sum of money, goods or events). The probability of each outcome occurring is also known. With the purpose of constructing an utility function applicable to lotteries or gambles, they established a set of assumptions regarding people's preferences, which are known as the preference axioms: completeness, transitivity, continuity, monotonicity and substitution<sup>3</sup>.

A utility function is assumed then to hold the expected utility property if for a gamble with a set of outcomes and probabilities of each one happening, the utility of the decision maker related with the gamble is calculated as the sum of each outcome's utility multiplied by its probability. An individual who selects one gamble for its higher expected utility is considered an expected utility maximizer. The principal disadvantage for this model, however, is that is proved that people do not meet the behavioral axioms cited previously.

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<sup>3</sup> For more information about Von Neumann and Morgenstern assumptions on people's preferences, read *Choice Under Uncertainty*, Jonathan Levin (October 2006)

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FINANCIAL NEOCLASSICAL REVOLUTION

Robert J. Shiller, in his paper *Tools for Financial Innovation: Neoclassical versus Behavioral Finance* (2006), talks about two different revolutions in financial fields.

**Table 3:** Financial Revolutions. Overview

Period	Financial Revolution	Facts
60's decade	Financial Neoclassical Revolution	CAPM Efficient Markets Theory Arbitrage-based option-pricing theory Intertemporal capital asset pricing models
80's decade	Behavioral Revolution	Questioning of sources of volatility Anomalies in financial markets Psychological theories in financial fields

The first one took place around the 60's decade, and it came with Capital Asset Pricing Model (CAPM), developed by William Sharpe (1964), concurrently with Treynor (1961) and Lintner (1965), who extended the Markowitz's portfolio theory, and the efficient markets theory. In this revolution the creation of arbitrage-based option-pricing theory and intertemporal capital asset pricing models also took part (Shiller, 2006).

He names the first events the financial neoclassical revolution, and in order to later understand the development of the behavioural approach, I will briefly explain the implications of these neoclassical theories in financial markets<sup>4</sup>.

The second financial revolution that the field experienced was the behavioural revolution, that started in 1980, and that will be developed in later paragraphs.

The Capital Asset Pricing Model (CAPM) explains the connection between risk and expected return. This theory affirms that the expected return of a portfolio is the risk-free rate plus a risk premium multiplied by the asset or the portfolio's systematic risk. Regarding the risk, it assumes that systematic risk is the only risk priced by rational investors, as it can not be removed diversifying.

On the other hand, a market is supposed to be efficient when prices fully reflect available information (E. F. Fama, 1969). This means that stocks are properly priced,

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in accordance to their characteristics. One implication that this hypothesis has is the fact that an investor is not able to get more return than another one with the same amount of invested funds, they would obtain the same profitability. Another consequence is that no investor can “beat the market”, as stock prices always reflect relevant information and always trade at their fair value, so investors can not take advantage of arbitrage opportunities, this is, buy undervalued stocks or take a short position on overpriced ones, expecting that prices will in the future correct toward fair value.

Efficient market theory is also linked to the “random walk” notion, by which information flows without obstruction and is instantaneously transmitted to stock prices, so future prices will only reflect future information and will not be related to today’s prices, with the consequence that changes in prices will be random and incalculable. As a result, an uninformed investor would get the same return than an expert one by investing in a diversified portfolio at market prices.

Apart from these assumptions and consequences of the efficient market theory, it is important to mention the assumption about rationality of this hypothesis, which affirms that the market globally is rational. It does not mean that all the investors in the market have to be rational, but that in general they have rational expectations and they are well informed, and that irrational investors’ performance will be corrected by rational traders.

Intertemporal capital asset pricing models were firstly developed by C. Merton, who expanded the previous model to forecast changes in the distribution of future returns. In this model, investors seek to maximize the utility of lifetime consumption and can trade continuously (R. C. Merton, 1973).

Although these pillars of the neoclassical financial approach have strong empirical support, some financial economists started to realize that stock prices were in part predictable, due to the psychological and behavioural elements of stock pricing.

## FROM NEOCLASSICAL FINANCE TO BEHAVIORAL FINANCE: TRANSITION AUTHORS

Around the mid-20<sup>th</sup> century, some authors started questioning the assumptions and application of neoclassical concepts in financial markets. This section is focused on the works of Herbert Simon, Maurice Allais, Grossman and Stiglitz and Shiller, who, with their papers, found some incoherencies in the application and the functioning in reality of the classical theories, such as market efficiency, which were the globally accepted and applied approaches in financial markets.

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**HERBERT SIMON**

Herbert Simon is known amongst economy fields for his theory of bounded rationality, concept mentioned previously as the base of the behavioral approach.

Bounded rationality theory has as a main point economic decision making, and differs substantially with the substantive rationality assumed by classical financial approaches. The author supported that individuals do not attempt to maximize the outcome of a certain action, because they are not able to understand and absorb all the information that would be necessary for that. First, exists an impossibility of accessing to all the information needed, and even if obtaining all the information was possible, people's intellect would not be able to digest it correctly. As Simon stated, "human mind is bounded by cognitive limits", referring to both knowledge and computational capacity limitations.

The concept of bounded rationality defines the rational decision that considers the cognitive limitations of the decision maker. Since behavioural approach is mainly focused on the influence of the decision process on the decision that is finally made, bounded rationality is one of its central concepts.

As mentioned before, expected utility theory assumes that decisions are made amongst a certain set of alternatives, with given probabilities for their outcomes and maximizing the expected value of the utility function. These assumptions are questioned by bounded rationality theory in situations of economic choice. Bounded rationality sets a process for generating alternatives instead of assuming a fixed set of alternatives; it does not assume given probabilities for outcomes, instead it applies estimation processes for them or proposes strategies for managing uncertainty without assuming the knowledge of probabilities; and finally instead of presuming the utility function maximization it contemplates a satisfactory decision.

Simon developed the concept of "satisficing", combining the words satisfy and suffice. He used this concept to define real behaviour, in which people make decisions that are satisfactory, good enough, not optimal, as assumed in classical approaches. He applied this notion to companies as well to individuals and events.

As a conclusion, we can state that Simon developed a new approach regarding decision making processes, behaviour modelling and cognitive psychology, and his theories led to a new conception of human behaviour and interactions in economic activities.

**MAURICE ALLAIS**

Maurice Allais is widely known for his Allais Paradoxes, considered the first empirical interrogation of the neoclassical rationality assumptions and expected utility.

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Allais developed the Theory of Choice Under Uncertainty And The Criteria For Rational Economic Decisions, which arose with the author's motivation to expand the theories of economic equilibrium and maximum efficiency to uncertainty situations, and it basically questions Von Neumann and Morgenstern theory of games and the applied foundation for rational decision making until the moment.

In order to extend economic equilibrium and efficiency to risk situations, Allais presented a paper in 1952 in which he displayed the possibility of considering uncertainty in the future and choices under uncertainty. Von Neumann and Morgenstern had assumed that rationality was given by the maximization of utility.

Allais rejected this assumption, as it did not take into account fundamental psychological values, which are the centre of the theory of risk. He demonstrated his idea by exposing some examples, the most famous of them the Allais paradox, which in words of the author "is paradoxical in appearance only, and it merely corresponds to a very profound psychological reality, the preference for security in the neighbourhood of certainty". The Allais paradox consists in the following situations, where the subject must choose between situations A and B:

**Tabla 4:** Allais Paradox Experiment

*Situation A: Certainty of receiving 100 million.*

*Situation B: 10% chance of 500 million; 89% chance of 100 million; 1% chance of nothing.*

Then, they must choose between the following:

*Situation A': 11% chance of 100 million; 89% chance of nothing.*

*Situation B': 10% chance of 500 million; 90% chance of nothing.*

Situations A and B have a common consequence of receiving 100 million with probability 89%. In situations A' and B' this common consequence is eliminated.

Expected utility theory would assume that, if A is chosen against B, A' would be chosen against B'.

However, the results obtained by Allais showed that individuals did not follow a utility function that could be maximized in order to understand their behaviour.

Moreover, he showed that it does exist a cardinal utility, or psychological value, whose function is unalterable from one person to another, and that could explain questions such as the psychological impact of wealth change from the richest to the poorest, or the subjective impact of tax burdens.

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Definitely, Allais was the first economist that challenged the rationality assumption with his paradox for decision making under risk, and proved that individuals do not meet expected utility assumptions, which were accepted as a model for understanding choice under uncertainty.

Allais paradox was later developed by authors who demonstrated that more assumptions of rationality were not supported empirically, as in Daniel Kahneman and Amos Tversky prospect theory (1974), which will be explained in depth in following sections.

SANFORD J. GROSSMAN & JOSEPH E. STIGLITZ

Although Grossman and Stiglitz have published several papers and theories, in this work I will focus on their academic paper On the Impossibility of Informationally Efficient Markets, which contradicts the efficient markets theory, thus being one of the most important works on behavioural finance approaches.

The paper starts: “If competitive equilibrium is defined as a situation in which prices are such that all arbitrage profits are eliminated, it is not clear whether it is possible that a competitive economy will always be in equilibrium. Clearly not, for then those who arbitrage make no return from their costly activity. Hence the assumptions that all markets, including that for information, are always in equilibrium and always perfectly arbitrated are inconsistent when arbitrage is costly” (S. J. Grossman, J. E. Stiglitz; 1980).

The authors developed which is known as the Grossman-Stiglitz paradox, that, in short, exposes the notion that, as information has a cost, available information cannot be fully reflected on prices, because if it happened, people that spent resources in order to obtain information would not be compensated, idea that concludes with the impossibility of an informationally efficient market.

In the above-mentioned paper, Grossman and Stiglitz propose a model “in which there is an equilibrium degree of disequilibrium” (S. J. Grossman, J. E. Stiglitz, 1980). In the model, the information of informed people is reflected in prices but partly, in order that individuals that consume resources to get information are compensated.

The model is developed for capturing that, when informed agents notice (are informed about) future high returns of a security, they bid prices up, and the contrary when they are informed about low return. In this way, prices make available the information of informed people to the not informed.

In the model Grossman and Stiglitz develop, people in financial markets can choose between two kind of asset: a secure asset, or a risky one. The return of the risky asset is represented by the sum of the part of information that is perceptible and that has a

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cost, and an unobservable variable. Individuals are assumed to be equal, but with the option to spend resources in information or not. The part of individuals who decide to acquire information is linked to the price of the asset, that is represented in a function of the information perceptible and costly and the supply of the risky asset.

The equilibrium would be set when the utility of the informed people is equal to that of the uninformed ones. The point of the authors is that, as all the variables (costly information, the section that chooses to acquire information and price) change, the point of equilibrium moves.

The conclusion they reach is that the price of the asset is not informationally complete, but that becomes more efficient as the part of individuals who acquire information grows.

One disadvantage for Grossman and Stiglitz' model is the number of assumptions that they make for the model to work, fact that has made it less reliable and easier to criticise by other professionals. Despite this fact, the model provides strong evidence to confirm that market efficiency can not always apply, due to the limited compensation that individuals get from purchasing information, especially when that information supposes a cost.

### ROBERT J. SHILLER

Robert J. Shiller is considered one of the precursors of the behavioural approach applied to economics. One of his most famous works is the book *Irrational Exuberance*, where the author warns that signals of irrational exuberance amongst investors had increased exponentially since the global financial crisis.

In this work I will focus principally on Shiller's paper Tools for Financial Innovation: Neoclassical Versus Behavioral Finance, which has been mentioned in previous paragraphs, and where the author exposes the suitability of the application of behavioural finance in order to complete the gaps that neoclassical theories present.

In author's words, the second financial revolution that the field experienced in the last half of 20<sup>th</sup> century was the behavioural revolution in finance, that started in 1980 with the questioning of the sources of volatility and the detection of various anomalies in financial markets and with the efforts to introduce some psychological theories into financial theories.

Behavioral revolution and neoclassical revolution, mentioned in paragraphs above, happened in separate periods and surged from very diverse authors, reason why the normal assumption is to brand them as incompatible (Shiller, 2006). The author, however, states that both revolutions have always been interrelated, and that several important applications of each one will need the utilisation of both approaches.

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Shiller introduces then Paul A. Samuelson's 1937 paper A Note on the Measurement of Utility, and presents this author as one of the creators of one of the principal models in neoclassical finance, the intertemporal model, and concurrently as the precursor of some notions on behavioural finance. In this paper, Samuelson exposes a model that presents people as maximizers of utility dependent on a budget constraint (Samuelson, 1937).

**Equation 1:** Samuelson Utility Maximization Model Dependent On Budget Constraint

$$\begin{aligned} & \max \\ & J = \int_0^b U(x)e^{-\pi t} dt \\ & \text{subject to :} \\ & S = \int_0^b x(t)e^{-rt} dt. \end{aligned}$$

In this model,  $J$  is the present value of utility  $U$  of the individual's consumption  $x$  discounted at a rate  $\pi$ .  $S$  is the individual's wealth at time 0,  $r$  is the market interest rate and  $b$  is the forecasted date of death. These equations are present in almost all theoretical finance. Samuelson, however, criticised his own model stating "In conclusion, any connection between utility as discussed here and any welfare concept is disavowed. The idea that the results of such a statistical investigation could have any influence upon ethical judgments of policy is one which deserves the impatience of modern economists".

The motives of this critic foresaw some basic notions in behavioural finance. The author remarked that the model was of behaviour in consistence with time: if individuals at any time between today and their date of death thought about the maximisation issue from that day forward, they would not alter their plans. In reality, however, individuals are not time consistent, and tend to live for the present day as the most important in life (Shiller, 2006).

Samuelson exposed as a confirmation the fact that individuals usually try to control themselves by restraining their future choices. The inconstancy of individuals in self controlling has arisen many times when considering personal savings rate, which changes considerably through time for no specific reason.

Some tendencies in behavioural finance look for improving Samuelson's model to include the time inconsistency of preferences. For example, Lowenstein and Prelec (1992) presented some variations to the model, and Laibson (1998) proposed to substitute the previous utility function with the following equation.

**Equation 2:** Laibson Utility Function

$$J_t(x_0, x_1, \dots, x_b) = E_t \left[ U(x_t) + \beta \sum_{\tau=1}^{b-t} U(x_{t+\tau}) e^{-\pi\tau} \right]$$

The differences between neoclassical and behavioural finance may then have been magnified. Behavioral approach is not so distinct to the neoclassical one. Shiller states that “the best way to describe the difference is that behavioral finance is more eclectic, more willing to learn from other social sciences and less concerned about elegance of models and more with the evidence that they describe actual human behaviour”.

In the third part of his paper, Shiller presents one example of the application of the two different approaches with the introduction of private accounts for Social Security, as a way to demonstrate that both approaches can, and in some cases must, be applied together.

The core idea in his example is the creation of private accounts to replace traditional delimited-benefit old age insurance for social security. This concept has already been applied in some countries, although it has not been created in the United States, country in which Shiller’s example is centred. The author states that “there is considerable momentum toward private accounts” and that some US presidents have already proposed that people could invest some of their Social Security participation in private accounts.

One of the benefits of these proposals would be the notion of “ownership society” (Shiller, 2006). The concept would be that individuals manage their own lives, and are better citizens too, if they own financial assets as well as a home. These benefits to ownership society have been studied many times during history. Michael Sherraden is one of the principal promoters of this notion, who exposed that the best form to enrich the existence of the less lucky in our society is to educate them to be capitalists (Sherraden, 1991).

Sherraden developed an asset-based welfare, which has had some effects in the United Kingdom. In this country, Tony Blair’s government began granting new-born babies with £250. The progenitors can decide to invest the fund deciding among a set of investment options, and can contribute to the fund as well. The aim of the program is to connect parents with investing and with contemporary economy.

This ownership society is a perception for future with good promise. Shiller states that society needs to know behavioural finance so as to place ownership society in the correct perspective. Behavioral finance would also be one motive to support government engagement in people’s investing decisions. Another central issue of behavioural finance is the incapability of lots of individuals to save for the future. Some neoclassical scholars, applying Samuelson’s model, have signalled that the

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traditional and currently applied Social Security system would suppose a disincentive to saving.

United States government proposal for individual accounts had as a central notion the life-cycle accounts supervised by the Federal government. The life-cycle fund would be one of the choices that employees could choose to invest their personal accounts, and would balance the portfolio allocation in stocks and bonds depending on the age of the worker. This life cycle fund would be the best option to invest in, becoming the default fund, which most investors would choose. The proposal also included that employees would directly be transferred to the life-cycle fund when they reach the age of 47.

This central default option, what happens when people do nothing, would be another important notion of behavioural finance. It would also represent a self-control mechanism. The life cycle fund may have its basis in the neoclassical question what would an intertemporal optimizer do to manage his or her portfolio over the lifetime? (Shiller, 2006). Samuelson began stating that an individual that wanted to maximise the value of the intertemporal utility function by allocating the portfolio amongst a risky high returned asset and less risky assets would not alter the allocation. If the utility function does not get altered through time, the same happens with the allocation of the portfolio.

Nevertheless, finance theorists have proposed to introduce young people's present value of labour income in the portfolio, idea that has lead to a set of papers that present how to apply calibrated models to concretely advice on optimal allocation of these type of portfolio. These works exhibit unpredictability on how the optimal life-cycle portfolio should be. The global notion is that the traditional 100-years old rule<sup>5</sup> could be altered in life-cycle portfolios.

Neoclassical authors do not seem to be near an agreement on the optimal life-cycle portfolio, and a significant examination of the issues of this portfolio seems to be present. Neoclassical approach looks as greatly important for this discussion, since it provides the proper theoretical structure to find what individuals should do with their portfolios, although not what they do in reality.

As a conclusion for his Financial Review, Shiller comments that behavioural finance is starting to be significantly present in public policy, as in the social security reform, and that it includes great understanding of diverse social sciences that provide actual

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<sup>5</sup> The most extended advice is that individuals should be heavily present in the stock market when they are young, and that they should gradually reduce their exposure to the stock market as they age. The conventional rule has been that one should have one hundred minus one's age as the percentage of one's portfolio in stocks (Shiller, 2006)

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alternatives. What behavioural finance offers, in words of the author, could be presented as the safeguard for neoclassical finance. By providing neoclassical models a right perspective, it would be plausible to apply these models more rightly. In words of Shiller “those who adhere too religiously to one model run the risk of making themselves irrelevant by losing sight of when it is that their model is appropriately applied and when not”.

The author ends stating that we have to use both neoclassical finance and behavioural finance in order the financial transformation that is coming with the technology era leads to improved lives for society, and take financial institutions to a greater level.

Robert J. Shiller, being an author educated in the classical current, has written several papers and books highlighting the importance of application of behavioural finance in order to reach a higher level of understanding of financial markets and investors behaviour, and bringing to light the gaps of neoclassical theories. He is considered one of the precursors of the approach, and was one of the first that began questioning the development of classical approaches to introduce real behaviour.

For a further study on Shiller’s works, the reader should read some of his studies, named *From Efficient Markets Theory to Behavioral Finance* (Robert J. Shiller, 2003) or *Irrational Exuberance* (Robert J. Shiller, 2000).

## BEHAVIOURAL FINANCE

As previously explained, the most extended research on finance is based on the assumption of investors’ rationality, and the maximization of utility making use of all the information available in the market, in order to create portfolios that are risk-return balanced.

However, when psychological elements started to apply to economics, some authors, as the presented in the previous section, reached the conclusion that in reality investors are not entirely rational, and that they act sometimes driven by feelings, they sometimes confuse market noise with relevant information or act under behavioural biases.

The neoclassical approach may offer unrealistic assumptions about human behaviour, as economic agents may not treat information in a correct way or may not make correct decisions (Baltussen, 2009). Moreover, markets are assumed to be frictionless, so securities must be priced at their fair value.

This new financial paradigm supposed the starting point of behavioural finance theories.

### DEFINITION AND BEGINNINGS

## BEHAVIOURAL FINANCE. FROM A THEORETICAL APPROACH TO EMPIRICAL APPLICATION

Between the multiple definitions that can be found about behavioural finance, the Martin Sewell's one seems to be one of the most concise: "Behavioural finance is the study of the influence of psychology on the behaviour of financial practitioners and the subsequent effect on markets" (Sewell, 2007).

Behavioural revolution started around the 80's decade with the questions that arose about the causes of the volatility in markets, with the detection of various anomalies and with the attempt to introduce psychological theories into financial markets. The first paper on behavioural finance was published in 1972 by Paul Slovic, although it was two decades later when a collection of papers on the subject was presented with the name of *Advances in Behavioural Finance*. Since then, a considerable volume of research has been carried through, from Kahneman and Tversky's Prospect Theory to current developments.

Coming back to the beginnings of this approach, R. J. Shiller (2006) states in his paper *Tools for Financial Innovation: Neoclassical versus Behavioural Finance* that "neoclassical and behavioural revolutions came at different times and largely from different people, so it may naturally be assumed that the two approaches are incompatible. Those who are most impressed with the neoclassical finance sometimes seem to regard behavioural finance as an uprising of the heathens. In fact, however, the two revolutions in finance have always been intertwined, and some of the most important applications of their insights will require the use of both approaches". This statement seems to mean that both approaches are not substitutive; in fact, behavioural finance appears as the solution to many points of the neoclassical approach that can not be proved.

In the next sections, I will make a review of some of the most famous papers and theories on behavioural finance, from D. Kahneman and A. Tversky's Prospect Theory, and the works of Richard Thaler on market's anomalies, to the theory on Heuristics and Biases that is one of the most important concepts on behavioural finance.

### PROSPECT THEORY (DANIEL KAHNEMAN & AMOS TVERSKY)

Daniel Kahneman and Amos Tversky presented in 1979 their prospect theory, one of the soundest papers to appear in an economic academic journal. They are considered to be, among others, the fathers of behavioural economics, in part for the release of the prospect theory and for the subsequent improvement of the model.

In the abstract of their paper *Prospect Theory: An Analysis of Decision Under Risk*, they state: "This paper presents a critique of expected utility theory as a descriptive model of decision making under risk, and develops an alternative model, called prospect theory. Choices among risky prospects exhibit several pervasive effects, which are inconsistent with the basic tenets of utility theory" (Kahneman, Tversky, 1979).

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The prospect theory, therefore, appears as a critique of the expected utility theory, which had, until that moment, controlled the research and analysis of decision making under risk. The authors presented in the previously mentioned paper a series of choice problems which transgresses the premises of the utility theory, reaching the conclusion that this latter “is not an adequate descriptive model” (Kahneman, Tversky, 1979) and proposed an alternative model for decision making under risk.

***Prospect Theory: An Analysis of Decision under Risk (1979)***

Empirical anomalies were found in utility theory, which in some occasions appeared not to match with real behaviour of individuals. These inconsistencies led Daniel Kahneman and Amos Tversky to create an alternative theory for decision under risk conditions.

Prospect theory differentiates two stages in the decision procedure.

**Table 5:** Stages in Decision Procedure developed in Prospect Theory

Phase	Actions
Editing or Framing Phase	Preliminary analysis of the decision Identification of options, outcomes, probabilities and values
Evaluation Phase	Evaluation of edited possibilities Selection of the best alternative

The first phase, called the editing phase or framing phase, which involves the preliminary analysis of the decision issue. It contains the identification of the options available, the attainable outcome or consequence of each one, and the values and probabilities related to each of the outcomes. It also includes the organization and reformulation of the options in order to “simplify subsequent evaluation and choice” (Levy, 1992; Kahneman & Tversky, 1979).

The second stage is the evaluation phase, in which the edited possibilities are evaluated and the selection is made. I have to mention that this second phase is which has received more attention, and in which the Kahneman and Tversky’ model is based.

In the editing phase the individual simplifies the decision issue by reconstructing the outcomes and probabilities. He identifies a reference point and translate outcomes into deviations from it, in the form of losses or gains, which can alter orientation

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toward risk. Then, probabilities are rounded off, eliminating very improbable outcomes by rounding their probability to zero. Dominated choices are eliminated and equal outcomes' probabilities are combined, and the elements of a prospect are separated according to their level of risk. Usually, components that all prospects have are eliminated too, as well as irrelevant options, fact that could suppose changes in preference and violations of invariance.

Due to the difficulty of predicting the edition of decision problems in certain cases, the authors focused on the evaluation phase of alternatives rather than in the edition of them, and the behaviour observed is set in this second phase.

At this point, the individual evaluates the previously edited alternatives and chooses the one with the greatest weighted value. This weighted value is the result of multiplying the value of an outcome by a decision weight.

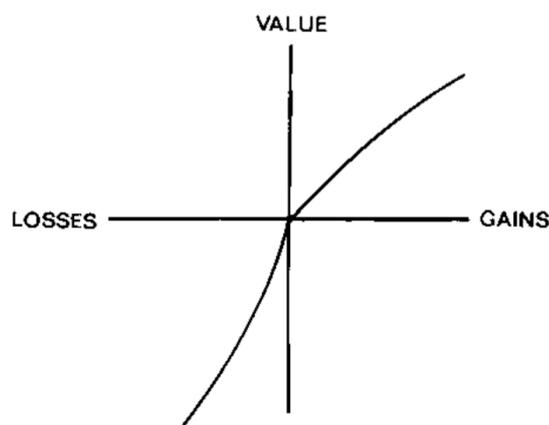
#### **Equation 3:** Weighted Value Equation

$$V = \sum w(p_i) * v(x_i)$$

Where  $V$  is the weighted value of a prospect,  $p$  is the probability of outcome  $x$ ,  $w(p)$  is the probability weighting function and  $v(x)$  is the value function.

This latter element, the value function, has three main properties: it is defined on deviations from a reference point, is generally concave for gains and convex for losses and is steeper for losses than for gains (Kahneman & Tversky, 1979). These conditions capture the concept of loss aversion and indicate that the marginal utility of gains diminishes more quickly than the marginal disutility of losses. (Levy, 1992)

#### **Illustration 1:** Value Function that Satisfies the Three Conditions

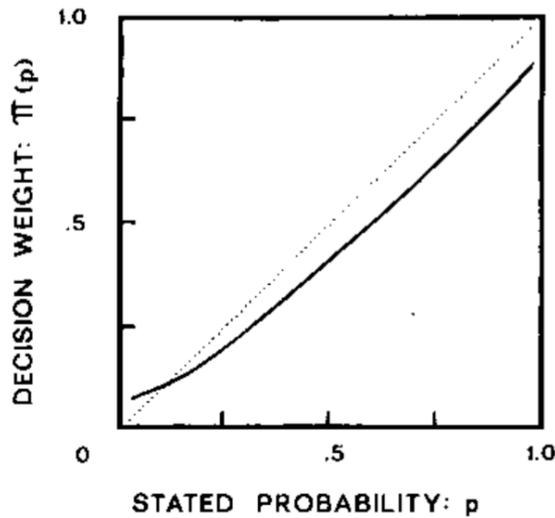


Kahneman and Tversky state also in prospect theory that, due to the introduction of the decision weights, their approach is more complex than in utility theory.

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The weighting function, for its part, quantifies the impact of events, formulated in terms of their probability, on the desirability of the prospects. Decision weights are expressed as a function of probability, although in reality they are also influenced by other factors.

**Illustration 2:** Hypothetical Weighting Function



This function has also various properties.

**Table 6:** Summary of the Properties of the Weighting Function

Property	Explanation
1	Weighting function not well-behaved near its end points
2	Increment in the weighting function in the region from 0 to 1
3	The slope of the weighting function is smaller than 1 in the whole range
4	Small probabilities are over weighted Big probabilities are under weighted
5	Decision weights do not sum 1. Subcertainty.

First, weighting function is not well-behaved near its end-points. This fact shows the impossibility of predicting the behaviour in situations of really small or very large probabilities. This is, the variance of the function is not uniform and is really high in the area proximal to 0 or 1. The authors admit this unpredictability, and explain that

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“because people are limited in their ability to comprehend and evaluate extreme probabilities, highly unlikely events are either ignored or over weighted, and the difference between high probability and certainty is either neglected or exaggerated” (Kahneman, Tversky, 1979).

The second characteristic of the weighting function is that exists a hard increment in the weighting function in the region between 0 and 1. This means that changes in probabilities proximal to 0 or 1 have largest effects when evaluating the prospects.

The third one is that the slope is smaller than 1 in the whole range, with the exception of the region proximal to the end-points of the function. Taking into account that the slope defines the sensitivity of the decision weights (this is, of preferences to changes in probabilities), the meaning of this fact is that preferences are usually less sensitive to variations in probability than the expectation principle suggests. One consequence is that the total of decision weights related to complementary events is generally less than the weight assigned to the concrete event, capturing an essential element of people’s attitude to uncertain events.

Fourth, small probabilities are overweighted whereas bigger probabilities are underweighted. Although it is not sure in what point they pass from overweighting to underweighting, it is certain that probabilities are underweighted in the biggest part of the range.

The last property of the weighting function is that decision weights do not sum 1 for choices between two options, which Kahneman and Tversky define as subcertainty.

Inclination toward risk is determined then by the combination of the value function and the probability weighting function, and not only by the utility function. At this point in their theory, Kahneman and Tversky examine the conditions under which risk aversion or risk pursuing are predicted to happen. The conclusion they get is that risk aversion will be encouraged in the area of gains where probabilities are underweighted and the value function is concave, so there is an undervaluation of the gamble outcome relative to the certain one; and risk seeking will occur in the area of losses where weights applied to risky negative prospects are reduced by underweighting, making them more attractive.

Summarizing the key elements of prospect theory, we have: 1) a value function that is concave for gains, convex for losses, and steeper for losses than for gains, and 2) a nonlinear transformation of the probability scale, which overweights small probabilities and underweights moderate and high probabilities (Kahneman & Tversky, 1992)

### ***Advances in Prospect Theory: Cumulative Representation of Uncertainty (1992)***

One decade after the presentation of *Prospect Theory: An Analysis of Decision under Risk*, Daniel Kahneman and Amos Tversky released their posterior developments of the prospect theory explained above. By the time these advances were published, expected utility theory had been seriously questioned, and there was a general agreement that the theory did not adequately explain individual decision.

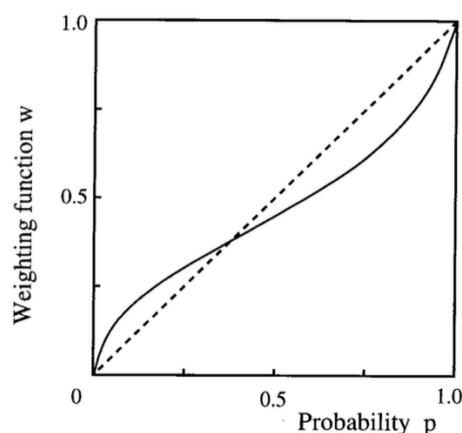
Later developments on prospect theory derived in a new description called cumulative functional, which transformed cumulative probabilities instead of individual ones. Based on this cumulative functional, the authors extended the theory to uncertain as well as to risky prospects with any number of outcomes (Kahneman & Tversky, 1992). The result was the cumulative prospect theory, which origins diverse evaluations of gains and losses and joins the processing of risk and uncertainty.

Cumulative prospect theory extends the previous version in several aspects. First, it can be applied to any finite prospect and extended to continuous distributions. Second, it applies to both probabilistic and uncertain prospects and third permits diverse decision weights for gains and losses.

Both prospect theory and cumulative prospect theory observe that individuals fix a reference point to evaluate possible outcomes, instead of think about them related to the last status. In addition, they show diverse positions towards gains or losses, and concern more about potential losses than potential gains, phenomenon called loss aversion. The main difference between both theories is related to the tendency of overweighting or underweighting events.

Original prospect theory assumed that individuals overweight all improbable events, independent of their outcome; cumulative prospect theory, instead, considers that overweighting occurs for extreme but improbable events, and underweight "average" events. This occurs because of cumulative probabilities are transformed, not probabilities itself.

#### **Ilustración 3:** Cumulative Prospect Theory Weighting Function



## ***Conclusions***

Kahneman and Tversky developed a model that explains how individuals make decisions under risk or uncertainty, obtaining a more accurate theory from the psychological point of view and compared to expected utility theory. The conclusions on theory are that, on the one hand, the probability of getting a gain is commonly seen as bigger, and on the other hand, that losses cause a deeper emotional impact, reason why individuals would choose options that offer perceived gains to losses, although in reality both had the same result.

It can not be forgotten the importance of the reference point previously explained, which is set in order to evaluate the possible results, and the deviations from it define the value function, resulting in concave for gains (risk aversion), convex for losses (risk seeking) and steeper for losses than for gains (loss aversion).

The main differences between prospect theory, in which value is calculated, and utility theory are that utility must be linear in probabilities, and value is not, and that utility is dependent on final wealth, while value is defined in terms of gains and losses, this is, deviations from present wealth.

Prospect theory is, if not the principal, one of the central basis in which behavioral finance is based, and the starting point that this approach found as basis. After the publication of prospect theory, economists and scholars started deepening into behavioural finance theories. Kahneman and Tversky did also found the behavioural heuristics, and Richard Thaler found some famous market anomalies, concepts that jointly became one of the main currents against markets efficiency.

These concepts will be the subject of the following section of the work, in which these anomalies and behaviour biases are defined.

## **MARKET ANOMALIES, HEURISTICS AND BIASES**

After the release of prospect theory, Kahneman and Tversky published their work on cognitive heuristics, where they exposed representativeness heuristics, availability heuristics and adjustment and anchoring heuristics, which will be developed in the first place.

After this publication, Richard Thaler started developing some experimental studies among his students where he investigated some behavior to analyze if classical economy did in reality have solid basis. He found that people do not behave as rational as thought, and this experimental study converted in what he called market anomalies.

Heuristics and market anomalies have been related since then, as both studies interrelated to start questioning the assumptions of neoclassical theory.

**Table 7:** Overview of the Market Anomalies and Heuristics and Biases Developed

Concept	Definition	Types
Heuristics and Biases	<p>Heuristics: mental 'rules of thumb' that people employ for all kinds of judgements.<sup>6</sup></p> <p>Biases: An inclination or preference that influences judgment from being balanced or even-handed.<sup>7</sup></p>	<p>Representativeness</p> <p>Heuristics</p> <p>Availability Heuristics</p> <p>Adjustment and Anchoring Heuristics</p>
Market Anomalies	<p>Anomalies: empirical results that seem to be inconsistent with maintained theories of asset-pricing behaviour. They indicate either market inefficiency (profit opportunities) or inadequacies in the underlying asset-pricing model.<sup>8</sup></p>	<p>January effect</p> <p>Weekend effect</p> <p>Holidays effect</p> <p>Turn of the month effect</p> <p>Intraday effect</p> <p>Endowment effect</p> <p>Loss aversion</p> <p>Status Quo Bias</p>

## HEURISTICS AND BIASES

Around the early 70's decade, psychologists started investigating mistakes in human judgement, since the main belief was that these mistakes were caused by the use of heuristics<sup>9</sup>. Academic research on human reasoning was then transformed by the works of Amos Tversky and Daniel Kahneman, based on their heuristics and biases program, and that are collected in their book *Judgement Under Uncertainty: Heuristics and Biases* (1982).

<sup>6</sup> Judgement, Heuristics and Biases (Liam Delaney, 2013).

<http://economicspsychologypolicy.blogspot.co.uk/2013/10/lecture-summary-judgement-heuristics.html>

<sup>7</sup> Business Dictionary. <http://www.businessdictionary.com/definition/bias.html>

<sup>8</sup> Anomalies and Market Efficiency (G. William Schwert, 2002)

<sup>9</sup> In psychology, heuristics are simple, efficient, but not always rational rules which people often use to form judgments and make decisions. They are mental shortcuts that usually involve focusing on one aspect of a complex problem and ignoring others (Internet Science: Third International Conference, INSCI 2016, Franco Bagnoli Anna Satsiou Ioannis Stavrakakis Paolo Nesi Giovanna Pacini Yanina Welp Thanassis Tiropanis Dominic DiFranzo)

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The heuristics and biases program was focused on investigating how people make judgements under uncertainty and on verifying to what extent this process coincided with the rational theory on decision making, previously explained.

The main notion of the program – judgement under uncertainty depends on a set of heuristics and not on algorithmic procedures (Gilovich, Griffin, 2002) – has had an enormous influence in theory making and research in a huge range of disciplines, especially in economics, and has led to the development of economic behavioural approach.

In the following paragraphs I will develop the main approaches to heuristics and biases, from Kahneman and Tversky classical study to more recent updates to this work.

### CLASSICAL STUDY – DANIEL KAHNEMAN & AMOS TVERSKY

Daniel Kahneman and Amos Tversky developed their point of view about the concept of bounded rationality, which is mentioned in previous sections. They were sure that intuitive judgement processes were completely different than the assumed by rational model approach of decision making.

The authors (1974), with a base assumption that the subjective evaluation of the majority of real quantities depends on partial data of insufficient validity, proposed that the human brain needs to turn to heuristics, or general indications, that provide valid substitutes in most of the cases. In their paper *Judgement Under Uncertainty: Heuristics and Biases*, the authors state “How do people assess the probability of an uncertain event or the value of an uncertain quantity? This article shows that people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors” (Tversky, Kahneman, 1974).

Kahneman and Tversky defined three overall-purpose heuristics: availability, representativeness, and anchoring and adjustment. These heuristics hold many intuitive judgments under uncertainty, and were simple and efficient because they involve fundamental computations that the human brain has adjusted to develop.

In the first experiments that were carried out by the authors in this work, each heuristic was related to a series of biases, which are defined as deviations from the rational approach that worked as signals or evidences that the related heuristics appeared. In the following paragraphs each heuristic and its associated bias are defined.

### Representativeness Heuristic

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Representativeness heuristic appears when people face a situation in which they have to answer to a probabilistic question of the type (i) what is the probability that the object A belongs to class B? (ii) What is the probability that event A originates from process B? Or (iii) what is the probability that process R will generate event A? (Kahneman, Tversky, 1974). Representativeness heuristic makes probabilities be valued by the level to which A is characteristic of B, in other words, by the extent in which A is similar to B. The more similar A to B is, the probability of A originating from B is regarded to be high, and vice versa. Basically, representativeness heuristic is related to estimate the probability of an event, which usually is made based on available data, which may not be representative of the real probability.

This manner of valuation of probability causes mistakes, since similarity or representativeness is not affected by some factors that should affect judgements of probability.

### Availability Heuristic

Availability is applied when judging the frequency of a class or the probability of an event, since cases of huge classes are often remembered better and faster than cases of less frequent classes. However, as availability is related to other factors than frequency and probability, the trust on availability conducts to biases, which will be explained below. In other words, availability is the tendency to evaluate the probability of an event based on how easily cases of such events can be brought to mind.

### Adjustment and Anchoring Heuristic

Anchoring is the event by which people set a starting point for making estimates adjusted to reach the final answer. This initial value could be proposed by the formulation of the problem, or be a result of an incomplete calculation. In both cases adjustment is usually deficient. In other words, different initial values conduct to different estimates, which are influenced by the starting values. Adjustment from an anchor happens not only when the starting point is given, but also when people make estimates taking into account some unfinished computation.

In words of the authors “these heuristics are highly economical and usually effective, but they lead to systematic and predictable errors. A better understanding of these heuristics and of the biases to which they lead could improve judgments and decisions in situations of uncertainty” (Kahneman, Tversky; 1974)

Kahneman and Tversky research had an enormous effect on the investigation about cognitive and social psychology. These heuristics still are studied and keep being investigated, mostly in decision making studies, and they are regarded as the basis for the modern assumptions on these fields.

## CRITIQUE TO THE CLASSICAL STUDY – GERD GIGERENZER

## BEHAVIOURAL FINANCE. FROM A THEORETICAL APPROACH TO EMPIRICAL APPLICATION

Although Kahneman and Tversky work on heuristics had an immense acceptance in the economic field, it also had to stand with some criticism and scepticism. I found it interesting to explain briefly the main points in which the critic is based.

The most important and heavier critic about the heuristics is Gerd Gigerenzer, psychologist, who once stated “The heuristics in the heuristics-and-biases program are too vague to count as explanations. They are labels with the virtue of Rorschach inkblots: A researcher can read into them what he or she wishes. The reluctance to specify precise and falsifiable process models, to clarify the antecedent conditions that elicit various heuristics, and to work out the relationship between heuristics have been repeatedly pointed out. (Gigerenzer, 1996)

In brief, what Gigerenzer thought was that, for instance, representativeness, failed to establish testable constraints on the decision process. The justification for this criticism was based on the explanation that the authors provided for the heuristics, that may not be well founded, in the sense that the explications are not unique and every time valid for explaining some behaviours, as anchoring.

### **MARKET ANOMALIES**

Richard H. Thaler studies behavioural economics and finance, together with the psychology of decision making. He has investigated the consequences of making less rigid the classical economic assumption that all individuals are rational, and introduce the possibility that some agents behave as humans. He is the director of the Centre for Decision Research, and is the co-director, jointly with Robert Shiller of the Behavioral Economics Project at the National Bureau of Economic Research.

In this work I will expose the series of papers that Thaler wrote about market anomalies, that are one of his most famous works, and that suppose the main empirical critic to the market efficiency theory.

#### SEASONAL MOVEMENTS IN SECURITIES PRICES I. ANOMALIES: THE JANUARY EFFECT (1987)

In this first paper of the first series on anomalies, Richard Thaler presented what he defined as the January effect, one of the most extended anomalies in financial markets.

The author states in the paper that “stock markets are a good place to look for anomalies for several reasons”. The first one, in this type of market data is abundant. The second, security markets are considered the most efficient of all markets.

Anomalies are hard to be consequence of transaction costs or other market mistakes. The third one, theories on securities pricing, as the Capital Asset Pricing Model

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(CAPM), structure them. This first article is centred on seasonal patterns, one kind of anomalies.

Efficient market hypothesis assumes that prices are set by a random walk, this is, it is not possible to estimate them taking into account past prices. Investigators, however, tested this hypothesis and the results showed that seasonal patterns in an identical-weighted index of New York Stock Exchange prices on the period 1904 - 1974. The average monthly return in January was 3.5%, in contrast with other months in which the average was around 0.5%. One third of the results happened in January. This result was not showed in large companies composed indexes, as the Dow Jones Industrial Average. Because an equal-weighted index is a basic average of the prices of the companies listed on the NYSE, it provides smaller companies a bigger weight than their share of market value. Discovering a January effect only in an equal-weighted index may insinuate that it is a small firm event.

Authors as Marc Reinganum (1983) had studied this January effect encouraged by a possible reason for it given by tax-loss selling. The reasoning is that the prices of companies that have in the past decreased will decrease more in the last months of the year, as owners sell the stocks to get capital losses. After the new year, prices will increase without the selling pressure. This argument is not based on rational behaviour by all agents.

Others have studied the January effect in diverse countries, and they have discovered that January results were particularly high in fifteen of sixteen. In some of them, the January return surpassed the average return of the whole year. These investigations also showed that, although taxes are in certain extent relevant for the January effect, they do not provide the whole answer. For example, the January effect is present in Japan, where no capital gain tax or loss compensation exists. The same happens in countries with different fiscal years, or in countries where capital gains tax was not present in the period under study.

Moreover, De Bondt and Thaler (1985) discovered that the companies which had been the greater winners or losers over a five-year period present afterwards excessive returns in the opposite direction. In other words, the winners present negative results, and losers positive returns, which are concentrated in January.

Apart from that, Tinic and West (1984) found that the return to riskier shares is present only in January, in the rest of months riskier shares do not provide bigger returns. Thaler then says that “the CAPM is exclusively a January phenomenon”.

As a conclusion, we can state that stock prices increase in January, in particular small firms' prices and firms whose stock has declined in past years. Risk premium is also present almost only in January for risky stocks.

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SEASONAL MOVEMENTS IN SECURITIES PRICES II. ANOMALIES: WEEKEND, HOLIDAY, TURN OF THE MONTH AND INTRADAY EFFECTS (1987)

In the second paper of the series, Thaler presents another set of seasonal anomalies present in stock markets, as a way to conclude his work on this type of anomaly, the behaviour of prices over weekends, before holidays, at the turn of each month and within the day (Thaler, 1987).

**The Weekend Effect**

Thaler defines the daily return for a particular day of the week as “the return from the close of the previous trading day to the close of trading on that day”. Taking into account this definition, how could Monday returns be compared to the returns of the rest of days? The logical manner would be that prices might increase more in Mondays than on the rest of days, as the period between the closing on Friday and the closing on Monday is bigger than the normal period of one day. In fact, the Monday returns should be three times bigger than in other days. An alternative view is the “trading time hypothesis”, that says that returns are produced in active trading and, for that reason, returns would be equal for every trading day. Thaler states that this view is not reasonable, and that none of the alternatives are compatible with the data.

One of the first works on weekend effects was presented by M. J. Fields. This author studied the unwillingness of traders to maintain their owned assets through the uncertain weekend, which would have as a consequence that long positions are liquidated and prices on Saturday should therefore decrease. His results, however, showed that prices have the trend to increase on Saturdays. In more than the 50% of the cases, the price on Saturday was \$10 bigger than the week average, and lower only a 30% of the cases.

Another study shows that Standard and Poors index of 500 stocks increased a 62% of the Fridays in the period analysed, day in which the average return was a 12%, and barely a 39.5% of Mondays, when the average return was 18%.

Both studies defined Monday returns as the difference between the closing price on Friday and the closing price on Monday. The question then is if prices decrease on the day of Monday or during the weekend. In other study Richard Rogalski found that prices increase on Mondays from the opening to the close, and the negative returns were present between the closing on Friday and the opening on Monday. Therefore, this Monday effect transformed into the weekend effect. The findings showed also that the weekend effect was different in January. In this month, weekend and Monday returns are positive.

**Holidays Effect**

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Kenneth French (1980) studied prices after holidays while investigating the weekend effects, and did not discover anything special. However, Fields (1934) discovered that the DJIA presented a high balance of increases the day before holidays.

Another study carried out by Robert Ariel (1985) showed that the average return in an equal-weighted index on the pre holidays was 52.9%, in comparison to the average 56% on the rest of days. In a value-weighted index the pre holiday return averaged 36.5%, and a 26% on the rest of days.

This contrast, in Thaler's words, is both statistically and economically significant (Thaler, 1987). Moreover, over the last 90 years, the 51% of the capital gains in the DJIA have taken place on ten preholiday days per year.

### Turn of The Month Effects

Ariel (1987) has studied the trend of results within months. He divided months in two parts: the first part started with the last day of the previous month. He made a comparison between the cumulative returns for both periods using equal-weighted and value-weighted indexes. The results showed that the returns of the last half of the month are negative. All the returns in the period take place in the first part of the month. Another later study showed that, apart from the four days around the turn of every month, the DJIA fell.

### Intraday Effects

The latest work on seasonal price variations is based on the Francis Emory Fitch tape, which offers a record of stock transactions ordered by time, made with the NYSE between December 1, 1981 and January 31, 1983.

Lawrence Harris (1986) utilised this tape to study intraday price changes. He obtained rates of return of every fifteen minutes' periods in which the market was open. He discovered that the weekend effect drops during the first forty-five minutes of market on Monday, with prices declining in this time. On the rest of the days, prices increase exponentially during these first forty-five minutes. Moreover, returns are greater when the end of the trading day is close, principally on the last day of trade. The end of the day prices variations are bigger when the last transaction happens in the last five minutes of trading. Harris studied and declined the likelihood that this result could be related to mistakes in the data or manipulation of the prices. One rejecting reason is that opening price variations are usually positive, and if the price was bigger at the end of the day, the assumption would be that the next opening variations were negative.

The conclusions are that exists a pattern for the findings in both *January Effect* and *Weekend, Holiday, Turn of the Month and Intraday Effects* papers. Irregular price variations happen "around the turn of the year, the turn of the month, the turn of the

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week, the turn of the day and before holidays. “Why? Most of the reasonable, or even not so reasonable, explanations have been tested and rejected. Certainly it is safe to say that no one would have predicted any of these results in 1975, when the efficient market hypothesis was thought by most financial economists to be a well-established fact” (Thaler, 1987).

Investors who are willing to enter the market could vary their timing of investment to benefit of the predictable price variations. Thaler enumerates then a series of factors that “seem worth investigating”. For example, the fact that price variations may be explained by trends that affect the flow of funds present in the market. Individuals sell in December and buy in January. Apart from this, institutional investors might make changes in their portfolios conditioned by the season because of the practice defined as “window dressing”. Another explanation for seasonal price variations is that they could be related to the systematic timing of the arrival of good and bad news. This would be the most probable for the weekend effect.

These alternatives could be the explanation for why patterns of buying and selling exist that coincide with calendar time. They are not consistent with market hypothesis, as this latter assumes that exists a elastic supply of arbitragers and traders ready to buy or sell when prices vary from their intrinsic values.

The final conclusions that Thaler presents for these two papers on seasonal price movements are that this is a challenge for theorists. "What then do the anomalies mean? They mean that the theories of capital asset pricing (at least as they pertain to equity markets) have been toppled. They mean that the most interesting insights into the pricing behaviour of stocks are being discovered by tedious and painstakingly thorough examination of data. They mean that, in the constant ebb and flow between theory and empirics, empirics currently holds the upper hand." (Marc Reinganum, 1984). Richard Thaler does not agree with this statement. He says that the challenge is empirical. The answers would be present in experimental investigations. The challenge, then, is of every economist to understand why these seasonal movements happen.

THE ENDOWMENT EFFECT, LOSS AVERSION, AND STATUS QUO BIAS (1991)

In the latter paper *The Endowment Effect, Loss Aversion, and Status Quo Bias* (1991), jointly with Daniel Kahneman and Jack L. Knetsch, Richard Thaler states that “economics is different from other disciplines in the conviction that all behaviour can be explained by assuming that agents have stable preferences and make rational decisions in markets that clear”. If an empirical finding can not be rationalized or if

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improbable assumptions are requisite to explicate it inside the standard, it is defined as an anomaly<sup>10</sup>, and Richard Thaler presented three anomalies in the paper mentioned in order to prove that complete rationality does not happen as often as it was thought before.

To introduce these anomalies, they presented the example of an individual who loves wine, and that had bought some wine bottles in the past at low prices. The wines had highly appreciated since then, passing from cost \$10 at the moment of the purchase to \$200 in the present. This person drinks some of this wine in punctual occasions, but he would not be disposed to sell it for \$200, and would not buy more bottles at this price.

Thaler (1980) named the fact that individuals usually ask for much more to quit an object that they would want to pay to acquire the *endowment effect*. This example also shows the *status quo bias*, developed by Samuelson and Zeckhauser (1988), that is defined as the preference for the present state that biases the individual in opposition to buy and sell the wine. These anomalies are an indication of an asymmetry of value that Kahneman and Tversky called *loss aversion*, the harm of giving an object is bigger than the value related to purchasing it. The central point of the paper is to give evidence of support to endowment effects and status quo bias, and related them to loss aversion.

In the following paragraphs I will make a review of the principal anomalies that these authors found in financial markets, and that suppose the basic critic to the efficient market theory.

### Endowment Effect

Endowment effect is one of the basic principles of Kahneman and Tversky prospect theory. In short, is the definition given to the fact that individuals give a higher value to objects they own. The empirical support for endowment effect has been proved in a set of experiments during past decades. For example, Cornell University investigators provided university students with a coffee cup or a chocolate bar, both with the same market value. The first results were that half students chose the coffee, and the other half the chocolate. The goods were randomly distributed, without taking into account the preferences, and researchers told the students to exchange: students that preferred coffee but were given chocolate, or the contrary, were able to interchange.

Only a 10% of the students decided to trade, when the expected result would be that the 50% had exchanged, fact that proves the endowment effect. Once they owned the objects, even with the little value that they presented, ownership had altered the

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<sup>10</sup> G. William Schwert defines anomalies as empirical results that seem to be inconsistent with maintained theories of asset-pricing behavior (Anomalies And Market Efficiency, 2003)

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students' preferences. Other experiments have showed equal results, and as a result a critic of neoclassical theories has arisen. If endowment effect is solid, individuals' economic choices are completely distinct to what economists have until the moment assumed. The consequences of this would be deep, for example the assumption of classical economy that individuals need only few traders for prices in markets to be efficient, the amount of trade with endowment effect would be smaller than it would without it.

Another example of existence of endowment effect is economist John List's experiment to test it. He put in real market various traders with diverse experience, and the result was that the less trading experience the person had, the less probable he was to trade, although a good deal could be made. Traders with more experience were less inclined to endowment effect, and traded in more consistency with neoclassical theory.

### Status Quo Bias

The status quo bias defines the fact that individuals tend to be biased in relation with doing nothing or maintaining their past or present decisions.

Samuelson and Zeckhauser proved this effect and name it the status quo bias, as a consequence of loss aversion, by which individuals prefer to stay in the current state, since the drawbacks of changing it are bigger than the benefits.

## SECTION II: EMPIRICAL APPROACH

In this second section of the project the main objective is to present real situations in which investors show some biases at the time of deciding how to manage their investments.

As shown in the theoretical framework, authors as Richard Thaler or Daniel Kahneman and Amos Tversky presented some anomalies in financial markets as well as in investors' behaviour. These findings have become the principal basis of the critic against efficient markets theory and models as the CAPM. Investors may not be completely rational, as neoclassical theories assume, and this is the reason why the empirical prove of the anomalies and biases in markets or individuals' behaviour could suppose the final justification against substantive rationality in investors' behaviour.

In this section I will present some examples of biases in individuals' behaviour at the time of investing or managing investments.

Initially, the empirical examples of the existence of biases in the behaviour of investors were to be proved by carrying out surveys or questionnaires to known people.

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The first approximation was to ask teachers, colleagues or relatives about how they decide in what products to invest or, more simply, how they manage their money. If people showed loss aversion, for example, this could suppose one prove in favour of the behavioural papers about market anomalies and investors' biases.

This idea was rejected because of the lack of objectivity that the experiment could have supposed. If some relatives were asked, probably they would have answered in a non-natural manner, and the experiment would have been biased by the relation of the author with the individuals asked.

As there was no possibility to contact enough professional or semi-professional investors with no relationship with this project, the first approximation about conducting some surveys was discarded.

Finally, instead of conducting an experiment that could have not been decisive, the empirical examples presented in this project are extracted from academic papers and real experiments carried out by professional authors.

Decisions of investment are assumed to be made in a rational way. In order to make rational decisions, based on real facts, emotional interferences or individual feelings have to be avoided (Harrison, 1975). Rational behaviour is understood in the context of investing as buying at a lower price and selling at a higher price. However, bounded rationality seems more accurate to describe the real behaviour of investors: rationality is restricted by individuals' limited knowledge and perception capacity.

On the one hand, initial judgements of a decision, such as getting the information and analysing it, that are made depending on the individual's perceptions, can affect decisions and lead to lower results than the optimal, as emotions reduce the person's control and change his behaviour (Rizzi, 2008). Some mental mistakes appear when judging alternatives, fact that causes erroneous expectations and a bad evaluation of the stock, which leads in irrational decision making (Fuller, 2000). On the other hand, each person's abilities also play a role in the decision process. An investor who has a great analysing ability would behave more rationally when making an investment decision.

Summarizing, we can distinguish between two types of biases that affect investors' decision making: cognitive biases or emotional biases, because of our limited cognitive abilities or by emotional tendencies (Lazaroff, 2016). Cognitive biases are more related with processing or memory mistakes, whereas emotional biases are psychological predispositions that lead investors to behave irrationally, these latter more difficult to correct than cognitive ones.

In the following paragraphs, I will resume three empirical studies of, on the one hand, representativeness heuristic among Malaysian investors, and on the other hand, two

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different biases: the first one, the overconfidence that makes investors under-diversify their portfolios; the second, the disposition effect explained by Barber and Odean (2013).

These cognitive biases are two examples of the most common behaviour among investors, reason why they are explained in depth in the empirical approach. Regarding representativeness heuristic, it is one of the principal characteristics of investor behaviour, main reason for explaining it empirically.

### INVESTOR BEHAVIOUR AND DECISION-MAKING STYLE: A MALAYSIAN PERSPECTIVE (Wong Wee Chun & Lai Ming Ming, 2009)

This first example is a summary of the paper Investor Behaviour and Decision-Making Style: A Malaysian Perspective, written by Wong Wee Chun and Lai Ming Ming (2009), where the authors investigate investor behaviour in the Malaysian stock market. In this work, I will focus on their findings about representativeness heuristic.

The overall result of this study showed that behavioural biases had an influence in stock market investors' behaviour, and principally that representativeness and anchoring heuristics play an important role in decision making. Over confidence also was found to be an influencing factor in decision making, although investors that were studied did not know enough about financial markets.

The authors' objective was to study empirically investors' behaviour, and to investigate which are the factors that affect investment decisions.

After making a brief review on past literature about the principal concepts on behavioural finance and the factors that affect investment decisions, the authors present the experiment methodology and conclusions.

### METHODOLOGY

Chun and Ming created questionnaires and provided individual domestic stock market (Bursa Malaysia) investors with them. The questionnaire was divided in four different parts, each one designed to capture some data about the investor (whether the person invested in stock market, their investment characteristics, their experiences in order to describe their behaviour and their demographic features). In total they obtained 290 questionnaires for the study.

Regarding the data they obtained, the majority of the investors were males, who appeared to be more aggressive when investing in the stock market and more likely to take more risk. In terms of risk tolerance, in general they did not accept a loss of

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more than 15%. In general, the answerers do not spend enough time to study investment decisions, fact that makes investment risky.

Finally, when behaviour was analysed, the results showed that stock market investors were, in general over-confident although only one third of them regarded themselves as experienced investors. The majority of them also stated that they were more worried about having a big loss than about not obtaining a profit.

### REPRESENTATIVENESS HEURISTIC

Focusing on the representativeness heuristic, the authors found that the majority of the respondents presented this behaviour. “82.1% of the investors stated that they avoided investing in companies with a history of poor earnings while 87.3% believed that good stocks were firms with past consistent earnings growth. About 58.7% of the respondents relied on past performance to buy stocks because they believed that good performance would continue” (Chung, Ming, 2009). This shows that investors do think that the expectations are that, unless the future performance of a company was uncertain, the company will keep performing.

As a conclusion for the heuristic, the authors state that recent or past prices performance is regarded as an anchor to invest, as investors usually base their decisions on the difference between the stock last 52-week prices movements and the current market price.

### CONCLUSIONS

The authors prove that, on the one hand, the rationality among investors does not exist, and on the other hand, regarding behavioural biases, they reveal that they are present on the majority of individuals at the time of investment decision making.

Some of the investors surveyed presented overconfidence about their knowledge or capability to invest in stocks. They usually traded because of their willingness to obtain easy gains as a consequence of price anchoring and representativeness heuristics instead of real forecasts about the company's future. Moreover, investors showed to be risk and loss averse, but assuming more risk due to these behavioural biases.

Chung and Ming finish their study with “future research should be undertaken to investigate when or under what circumstances investors are most likely to make these behavioural responses”.

EQUITY PORTFOLIO DIVERSIFICATION (William N. Goetzmann & Alok Kumar, 2001)

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The first study on the existence of biases in the way investors make decisions that will be exposed is Equity Portfolio Diversification, written by William N. Goetzmann and Alok Kumar.

In the paper, the authors prove that “U.S. individual investors hold under-diversified portfolios, where the level of under-diversification is greater among younger, low-income, less-educated, and less sophisticated investors. The level of under-diversification is also correlated with investment choices that are consistent with over-confidence, trend-following behavior, and local bias.” (Goetzmann & Kumar, 2001)

### INTRODUCTION

In the U.S. equity risk is mainly composed by idiosyncratic variables, which could be greatly diminished by diversifying the portfolios. It is widely assumed by rational models that investors keep diversified portfolios to diminish non-compensated risk, and asset pricing models assert that securities are valued by a diversified investor who asks for no recompense for keeping idiosyncratic risk. The authors formulate the interrogation about these assumptions being true or not, and about which behavioural characteristics are related to under-diversification, characteristic that would suppose one prove against the substantive rationality that classical approaches assume.

### METHODOLOGY

Goetzmann and Kumar analysed the decisions of diversification in the portfolios of around 40.000 equity individual investors during the period from 1991 to 1996.

**Tabla 8:** Phases of the Investigation on Portfolio Diversification

<b>First Step</b>	Estimate to which extent under-diversification happen Check if diversification improves through time
<b>Second Step</b>	Calculate the correlation between diversification choices and personal features Evaluate if under-diversification is due to transaction costs, information, preferences or behavioural biases
<b>Third Step</b>	Relation between diversification and performance Effects of under-diversification on welfare

Their work was based on three main steps. The first one, they made some estimates on the scope to which under-diversification appeared in portfolios and analyse if diversification increased year after year. Then, they reported how the diversification decisions made were correlated with investors' personal features and their trading and

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investment criterion. Using the correlations obtained, they valued if the evidence on under-diversification could be explained by trading costs, information, individual preferences or behavioural biases. Finally, in order to measure the consequences of under-diversification on welfare, they studied the connection between the portfolio diversification and performance.

In this work I will focus on the second step that the authors carried out, without entering to explain the other parts of the investigation. This second step presents the correlation between diversification choices and personal features, and in a second instance the explanation for under-diversification is presented.

The principal point that I will develop is the correlation found between the investment decision and personal preferences or behavioural biases, which is the subject with which this work is concerned.<sup>11</sup>

### RESULTS OBTAINED

The results showed that a big quantity of investors is under-diversified. Focusing on the results obtained in the second step previously mentioned, we can extract two key conclusions on the role that behaviour plays at the time of deciding in which to invest (in this case, stocks).

Investors' position towards risk is an influencing variable when deciding about diversification. The more risk averse an investor is, the more diversified his portfolio would be, and vice versa. Suggestions are that tolerance towards risk decreases with age, reason why portfolio diversification would increment with age.

The most important fact discovered in the investigation, however, is related to behavioural variables. In words of the authors "at least three psychological biases could be associated with investors' diversification choices" (Goetzmann & Kumar, 2001).

First, under-diversification could be caused by a sensation of over-confidence about their investment capabilities by the investors. It has been noticed that when, in decision making situations, difficulty or familiarity are applied, individuals tend to think that they can manage the result of the situation. This, applied to investment situations, investors could present an illusory sense of control (Langer, 1975) as they make their own decision, getting involved in the investment process.

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<sup>11</sup> For more information about William N. Goetzmann and Alok Kumar findings, please visit the link to access the complete paper.

[ftp://economia.unica.it/mattana/Modelli\\_Mercati\\_Finanziari/Slides/Lecture\\_2/CRAA.pdf](ftp://economia.unica.it/mattana/Modelli_Mercati_Finanziari/Slides/Lecture_2/CRAA.pdf)

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In order to prove the correlation between over-confidence and diversification, the authors set an over-confidence approximation and studied if it was correlated with diversification.

The findings were that this “illusion of control” develops an erroneous sense of over-confidence. The consequence of over-confidence is that investors decide not to diversify their portfolio, since they think they will increase their performance by actively trading (Groetzmann, Kumar, 2001).

The second bias that the authors found is the inclination that investors show towards local stocks, fact that is also correlated with under-diversification. This preference for local stocks increases the “illusion of control”, which derives in not being conscious that knowledge about a stock does not imply controlling the results of the portfolio. Moreover, the preference for local stocks makes investors think that these attain less risk, reason for under-diversifying the portfolio.

The last bias found was that individuals that are more sensitive to past prices diversify less.

Groetzmann and Kumar did also study the effects of investment behaviour of groups on asset prices. For this, they divided investors depending on their diversification level (low or high) applying the average correlation between the stocks in the portfolio.

The levels they obtained classified investors as diversified, undiversified or unclassified. They found that the behaviour of under-diversified investors has a bigger correlation with market returns.

## CONCLUSIONS

The authors conclude that a great proportion of individual investors are under-diversified. In general, investors appear to be conscious about the profits of holding diversified portfolios, but they do not really take into account the correlations between their portfolio stocks.

This under-diversification, apart from the erroneous stock choice, is caused by an illusory sensation of control that derives to an over-confidence status.

Regarding the behaviour of investor groups, the authors found that under-diversified investors have a bigger impact in market returns.

This under-diversification, which is not consistent with rationality, has consequences on asset pricing. Due to the sensation of control, investors tend to think that their portfolio is less risky than it really is, changing the overall perception regarding market risk. Investors would then ask for diverse amounts to compensate risk, fact

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that makes asset pricing models need a calibration to compensate the level of under diversification and risk perception.

## THE DISPOSITION EFFECT: SELLING WINNERS AND HOLDING LOSERS (Brad M. Barber & Terrance Odean, 2013)

The second empirical example that will be exposed is about the existence of the disposition effect amongst investors, section that will be based on the investigations that Brad M. Barber and Terrance Odean in their paper *The Behaviour of Individual Investors* (2013).

In this work, Barber and Odean studied, among other features of investors behaviour, the disposition effect, concept defined by Shefrin and Statman (1985) as “the preference of individual investors for selling stocks that have increased in value since bought (winners) relative to stocks that have decreased in value since bought (losers)” (Barber, Odean 2013).

Basing their research on works carried out by other authors in the past, Barber and Odean present the disposition effect with a simple model, then revise the main past theories and works on the topic and expose some feasible explications for disposition effect.

### DISPOSITION EFFECT

The disposition effect is a consistent event. Barber and Odean present a simple model in order to demonstrate it. The model takes this form:

$$h(t, x(t)) = h_0(t) \exp(\beta_1 x_1 + \dots + \beta_p x_p)$$

In this,  $h(t, x(t))$  is the hazard rate at time  $t$  conditional on a sample of  $p$  observed predictors as of period  $t$  (denoted  $x(t)$ ). The base hazard rate,  $h_0(t)$ , express the hazard rate when all predictors have a value of zero. The  $\beta$  coefficients are estimated from the data in which the authors base. The hazard rate is the probability density function of the hazard event at time  $t$  conditional on survival to time  $t$ .

In this concrete investigation, the hazard situation is the trading of a stock, and  $t$  is expressed in days following the initial trade. The hazard rate is then conditioned by the covariates for the stock for which the rate is calculated and the investor to which the stock is exchanged at a time posterior to the trade.

The authors then make estimations on the hazard rate for each  $k$ th covariate, calculated with a one-unit increment in the covariate:

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$$\exp(\beta k) = h_0(t) \exp(\beta_1 x_1 + \dots + \beta_k (x_k - 1) + \dots + \beta_p x_p) h_0(t) \exp(\beta_1 x_1 + \dots + \beta_k x_k + \dots + \beta_p x_p)$$

The hazard ratio, expressed by  $\exp(\beta k)$ , represents the ratio of hazard rates for two stocks with the same covariates, with the exception that  $x_k$  is one unit bigger for the stock whose hazard rate is set in the numerator.

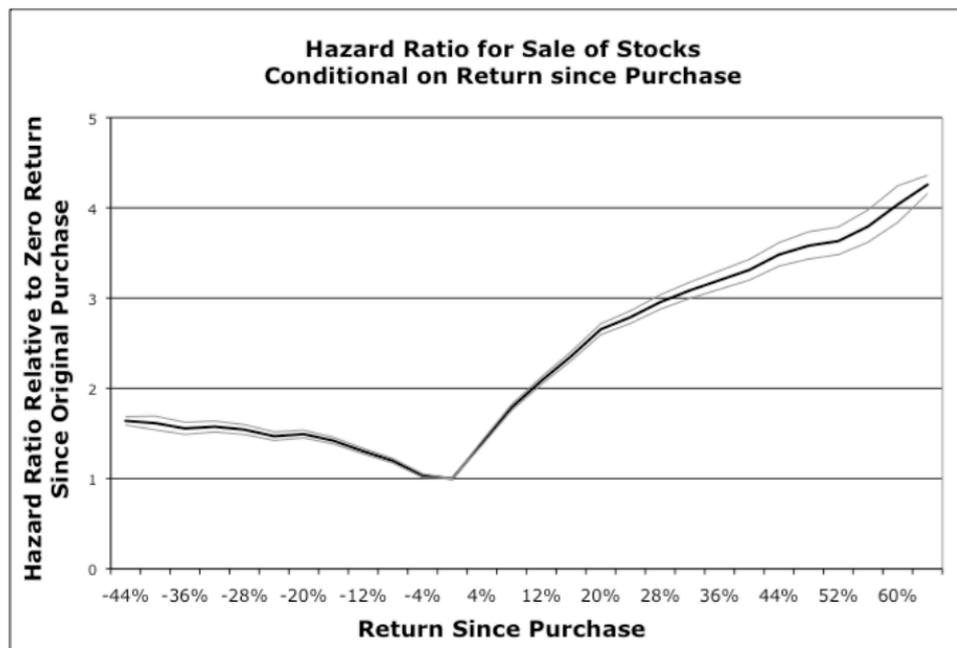
This model attains no assumptions about in which manner the base hazard rate varies through time and makes no estimations about this base rate. In fact, the assumption is that the hazard ratios do not vary through time.

Then, to study in which way the return of the stock since acquired has consequences on the hazard rate, the authors formulate dummy variables for return groups of 4%. The groups were:

$$r < -42\%, -42\% < r < -38\%, \dots, -2\% < r < 2\%, \dots, 58\% < r < 62\%, 62\% < r$$

The authors show their findings in the next graph.

**Ilustración 4:** The Disposition Effect



This graph shows the hazard ratio obtained when selling (y) with diverse returns since the stock was bought (x) for the period 1991-1996.

If we take the graph, we can obtain some conclusions. The default hazard rate would be the non-showed group from -2% to 2%. The trend of selling stocks increments exponentially as returns do so. Negative returns from the moment of acquiring the

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stock do also increment the hazard rate of selling, but not so exponentially as in the previous case.

EMPIRICAL AND EXPERIMENTAL STUDIES

The next part of the investigation presents the works of a variety of authors that have studied this phenomenon and confirmed its existence.

Barber and Odean mention, for instance, Weber and Camerer experiment (1998) in which results showed that the individuals that took part in it sold winners at a 50% higher rate than losers when presented with price changes of six different stocks. Moreover, the 60% of the selling were winners, and only the 40% were losers.

An interesting finding was made by Grinblatt and Keloharju (2001) when they investigated the disposition effect based on the trading records of almost every Finnish investor in 1995 and 1996. They demonstrated that investors tend to hold losers. "Relative to a stock with a capital gain, a stock with a capital loss of up to 30% is 21% less likely to be sold; a stock with a capital loss in excess of 30% is 32% less likely to be sold". (Barber, Odean, 2013).<sup>12</sup>

The disposition effect has been confirmed for individual investors in diverse nations, for professional investor groups and for various assets. Even there is some evidential studies on the disposition effect for institutional investors. However, the disposition effect has been proved to be more strong amongst individual investors than corporate investors or groups.

Disposition effect is also found to be more exaggerate for investors with poor financial knowledge. Also it was found that the more trades an investor makes on a daily basis, the smaller the tendency to present the disposition effect.

Apart from the evidence supporting the existence of disposition effect, there are some studies al well about the capacity of investors to discover how to elude disposition effect through time. This phenomenon might decrease with the more experience got in trading measure in times traded, not so when experience is measured in years.

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<sup>12</sup> For further reading on studies on disposition effect, visit the link to The Behaviour of Individual Investors (2013).

<https://poseidon01.ssrn.com/delivery.php?ID=219001114087079079092011090026100120037055014079020004006016099081084104109103012120048037019016019029045025022019088086098024010085044017083102026120105065090059047103070103088072104012101102120005121003064114065067093015094070125127004121087&EXT=pdf>

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**EXPLANATIONS FOR DISPOSITION EFFECT**

In order to understand why do investors behave this way, Barber and Odean suggest some feasible explanations for disposition effect.

They mention that, first, taxes can not be the reason for the disposition effect. For tax purposes, they state, investors might defer gains by keeping their profitable stocks. They would be able to obtain tax losses if they sold non-profitable investments.

One explanation could be a mixing of prospect theory, regret aversion, mental accounting and control problems (Shefrin and Statman, 1985). However, it is not yet clear how prospect theory could be applied to stock investments. Some authors have translated the theory to trading behaviour, and found that prospect theory might not certainly suppose a trend of obtaining gains more promptly than losses. Yao and Li (2011) investigated the situation of interaction between investors applying prospect theory and constant relative risk averse investors. They found that this mixing usually leads to a negative trading tendency, fact that favours disposition effect and contrarian behaviour.

Other authors have studied the paper that emotions play in the disposition effect. The findings were that investors do not present the disposition effect in situations in which they actively decide the stocks in which to invest. This proves that feelings as regret or on the contrary pride, affect the disposition effect.

Disposition effect might then be related to the feeling of regret when an individual repurchases at a higher price than he sold the stock previously, and priding when vice versa. Consistent with this explanation, it has been proved that individuals show this type of emotions only when they are responsible of the initial sale, which could mean that investors do not repurchase stocks at a higher price than they presold them to avoid regret.

**CONCLUSIONS**

After developing a complete and deep analysis on behavioural finance, some conclusions can be obtained.

First of all, we can assure that the classical assumptions on, at least rationality, do not sustain in the reality of financial markets, fact that has been demonstrated with some examples. The widely extended approach by which financial decision making is understood in the present seems to be based on assumptions that are not true in the reality of financial behaviour.

On the other hand, it needs to be understood that behavioural finance is not a contrary approach to the classical one, but it does fill the gaps that the latter does not

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cover, the majority regarding investors behaviour. Empirical investigation and studies present some real facts that suppose the basic critic against neoclassical assumptions, which have been developed in the second section.

It is clear that the behavioural theories need to keep being studied and developed, as they also present some gaps or assumptions that need to be reviewed. It is also clear that this recent approach explains better and more deeply the real behaviour of investors, fact that could suppose an improvement on the way individuals make decisions of investment or the way financial markets are understood.

If behavioural approach keeps being developed, it could change the general opinion and empirical proves about the way financial decision making is explained.

With the theories that have been exposed here, and the empirical studies that diverse authors have released, the objective of presenting a complete paper on the behavioural finance approach is reached.

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