COMPARISON BETWEEN COMPUTERIZED AND TRADITIONAL TRADING

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TRABAJO FIN DE MASTER PARA LA OBTENCIÓN DEL TÍTULO DE MASTER EN INGENIERÍA DE LA ORGANIZACIÓN
Thank you to my tutor, who has supported and guided me in the elaboration of this master's thesis, and thank you to the Universidad Politécnica de Madrid, for giving me the opportunity to do it.
Summary

This master’s thesis was born because of the interests of the author in Big Data, Machine Learning and, especially, trading. Trading has evolved substantially in the last decades, mainly because of the influence of these new technologies.

The first part of this work, fields of domain, reflects this evolution. The purpose of this part is to give the reader an idea about the fields that are necessary to control if they want to understand the idea behind this research. These fields of domain, Big Data, Artificial Intelligence, Machine Learning and Trading, appear implicitly along the paper. As the reader will see in the chapter about algorithmic trading, machines have algorithms that give them the ability to invest, study the market, find trends...etc. This would not be possible without AI or Machine Learning, as they have to program machines to learn and so complicated processes.

Once the reader has understood how these sciences work and what things they are able to do, they will understand the content no matter the level of knowledge they had at the beginning.

The next part of the work is about the characteristics that traditional economics has attributed to humans in comparison to the characteristics that behavioral finance establishes now. The reader will understand how finance has seen traditionally human agents, finding that they have been treated as people with a complete rational mentality, independent, with unlimited knowledge and with the purpose of maximizing always their gains.

Behavioral economics tries to give a more realistic vision of humans: not always rational, they change their preferences; they are influenced by others...with the aim of adjusting the traditional economic models to these new assumptions about them. A science similar to behavioral economics is behavioral finance, explained in that part too. Behavioral finance explains how humans, with their lacks and abilities, influence financial markets causing a mispricing of securities.

This part about humans’ characteristics is mandatory to understand not only the results of the survey conducted with traders, but also the conclusions given at the end.

The following section is about the new trends in trading. Nowadays, people tend to invest in passive funds, which are funds that do not try to beat their benchmarks. Two examples of passive investing are index funds and usually ETFs (Exchange Traded Funds). Index funds mimic the behavior of an index, such as the S&P500 or the Ibex35. Copying the behavior of an index is not easy, as the index is not always the same, so a computer is in charge of buying the same stocks as the index and in the same proportion. ETFs are similar, but the difference is that they can be traded like a stock.

Another trend, that is also the most important according to the scope of the thesis, is the algorithmic fund. An algorithmic fund uses an algorithm to invest. A team of economists and engineers that use statistics and market behavior data designs this algorithm, building a model that decides in which stocks is more convenient to invest.
Presumably, this type of fund should be better, as it uses empirical data. The quantitative analysis conducted in the following part intends to compare this fund to a fund managed by a human.

The quantitative analysis consists in selecting a set of computer managed funds and find a similar set of funds managed by humans. This set contains funds that trade different securities in different markets, such as American Small Capitalization Stocks, Chinese Stocks, Commodities, etc. The comparison is made using the annual net return of each of the funds, performance with respect to the benchmark and average and cumulative returns.

This part is followed by a qualitative analysis.

With the qualitative analysis, the reader can see that what they learned in the part about behavioral economics and behavioral finance is real, as the answers the interviewed traders give show. Again, there is a comparison, but this time between the opinion of quantitative traders and the opinion of traditional traders.

The last part is a social responsibility study, that explores the contribution of this work and the subjects treated to the accomplishment of the Sustainable Development Goals, set by the United Nations.

Finally, the author gives the conclusion of the study. The conclusion connects all the sections, gives the result of the comparison between the traditional and algorithmic trading and answers to the following questions:

Are machines better than humans in the field of financial trading?

Will machines substitute traders?

**Key Words**

Algorithmic trading; artificial intelligence; behavioral economics; behavioral finance; Big Data; ETF; expense ratio; fund; HFT; investing; machine learning; mutual fund; quant fund; return; robo-advisor; security; stock exchange; sustainability; trader; trading.

**UNESCO Codes**

1206: Mathematics, Numerical Analysis
5304: Economic Sciences, Economic Activity
5307: Economic Sciences, Economic Theory
5399: Economic Sciences, Other Economic Specialties
6107: Psychology, General Psychology
Comparison Between Computerized and Traditional Trading

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INTRODUCTION

Introduction

- Reasons to choose the subject

Currently, two of the most important topics are Big Data and Machine Learning. They are mentioned almost every week in the news, and they are expected to create a big percentage of jobs in the following years. Along with these topics, finance is one of the most important matters in humans’ life.

In the recent years, both fields have joined their forces and each one has benefited from the other. This is the reason why the subject of this master thesis is *Difference between computers and humans in trading: Is an algorithm better than a human mind?*

The author has a big interest in markets and how the financial world works. Also, he is interested in these new technologies mentioned before, because he is conscious about the importance that they have nowadays. The master's degree he is completing has subjects that have helped him understand both fields, data and financial, but, more importantly, the master has augmented his interest in them.

Trading has always been a technical field of finance that has employed people who had to be constantly informed about the last news, who had to demonstrate an almost perfect understanding of the economic and business world and who had to be constantly in advance to the others, in order to achieve the best results. But right now, humans have to admit that there are advanced tools that can help them, even in such an unpredictable thing like markets.

One of the reasons that have helped to opt for this subject is the amount of news that appear in the most popular financial media (The Financial Times, Bloomberg…) about the increase in popularity of techniques such as high-frequency trading and algorithmic trading, and also the increase in the number of companies that are adopting these techniques.

As this type of trading is relatively new, the author thinks that there are possibilities to carry out a research work that leads to a conclusion about the quality of these techniques.

- Objective

The aim is to study the difference in performance of investing using “traditional” techniques (only human influence) or investing using “modern” techniques (human-machine, or even only-machine influence).

One of the parts of the study will involve interviewing people that work in algorithmic and in traditional trading and try to understand their point of view.
Introduction

• Structure

The thesis will be structured in seven parts:
1. Definition of the fields of domain that will be mentioned along the document, for example, machine learning, quantitative trading or traditional trading.
2. Presentation of the characteristics and key concepts of the “traditional” trading, especially the influence of behavioral economics in trading. In this part they will also be included the apparent limitations of humans in terms of financial skills.
3. Presentation of the characteristics and key concepts of the “modern” trading, dedication a long section to quantitative automated investing.
4. Quantitative analysis, comparing the historical performance of investment funds that use traditional techniques to the ones that use modern techniques.
5. Qualitative analysis, comparing the responses obtained with interviews to people that work in traditional trading and people that work in quantitative trading.
6. Social responsibility, an impact of the work in several fields, such as legal, environmental and social.
7. With the help of the previous analysis, conclusion of the thesis answering the following questions: Are machines better than humans in the field of financial trading? Will traders be substituted by machines?
Fields of Domain

Technical Fields

- Big Data

Big Data is, like its name indicates, a huge, large, big amount of information. Humans have always been using information, but it has not been until certain years ago that they are able to collect and store it, thanks to the technology they have developed in XX and XXI centuries.

Every event that happens in humans' lives produces data. For example, with a withdrawal of money from the cash machine, the bank receives the date of the withdrawal, the amount, the point where this cash machine is placed, who has made the operation…etc. According to IBM, around 2.3 trillion gigabytes are created each day¹.

Traditionally, big data has been defined with four V's²: Volume, Velocity, Variety and Veracity. Volume is the basis for an amount of information to be called big data. Velocity is very important, it has to be near to real-time velocity, as companies need to manage this information quickly in order to take actions based on it. For example, autonomous cars need to process all the information from its sensors to drive. Also, the information has to be diverse, that is what we call variety, because if we have different types of information, we can take a deeper image about the market or the consumer. Last, the information has to have veracity, because if not, all the analysis will not be true, and the potential actions taken will be incorrect. IBM says that poor data quality costs the US around $3.1 trillion a year¹.

Big data nowadays is the equivalent to gold throughout history: it is power. That is why all the companies right now are investing enormous quantities of money in this field. And it is the basic concept of this work. Without big data, machines could not process the information correctly in order to take the decisions to invest in one thing or another.

Big data has transformed trading too. As it will be seen later, the most advanced trading firms nowadays invest enormous quantity of money in this field, to have big data sets that help them to have the best possible analysis of the market. Also, trading firms have to manage a big quantity of information, and to handle it, big data techniques, such as database management or information analysis, need to be used.
Technical Fields

- Artificial Intelligence

Nils J. Nilson provided an interesting definition to this domain³:

“Artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment.”

The Encyclopedia Brittanica states a quite similar definition⁴:

“Ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.”

It can be seen that, essentially, AI intends to make “intelligent” machines, that can think, act for themselves, etc. According to Jake Frankenfield⁵, an expert in tech from Investopedia, the goal of Artificial Intelligence would be to learn, reason and perceive the environment. As the machine has to be able to mimic the human mind, it has to count with complex algorithms that can allow the machine to do every kind of task.

This science can be divided in two categories: weak and strong. The weak artificial intelligence refers to the systems designed to carry out just one particular task. For example, a videogame, the Amazon’s and Google’s voice assistants, etc. The strong artificial intelligence systems, on the other part, are the ones that are designed to do human-like tasks, such as self-driving cars or surgery. They must think, learn and do problem-solving.

Therefore, if these concepts are applied to investment banking and, more specifically, to trading, it can be concluded that the goal of AI in this field would be to make a machine that invests and takes decisions by itself. These trading machines could be considered either weak or strong artificial intelligence.
Difference between computers and humans in trading

- **Machine Learning**

  In one sentence, Machine Learning consists in teaching machines to learn. According to Oxford University\(^6\), “Machine Learning brings together statistics and computer science to enable computers to learn how to do a given task, without being programmed to do so”. A computer programmed to learn will seek statistical patterns among the things it is intending to learn, so that in the future it will be able to recognize these patterns and identify an object, for example.

  The more data we provide to the machine, the better, because it will have more references to rely on.

  Machine learning, and Artificial Intelligence as well, have experienced an increase in popularity these recent years thanks to four factors, according to a report released by Management Solutions\(^7\), a consulting firm, in 2018:

  - Big Data: The amount of information has increased in the last years.
  - Connectivity: Connectivity and access to data have improved.
  - Data treatment: Algorithms to treat data are more efficient.
  - Computing capacity: Processors are better and programming languages are more intuitive and powerful

  Applying this to finance, Machine Learning would consist in providing market behavior data over time to the computer, so it is able to recognize these patterns and take investment decisions\(^8\).

  eToro, the world’s leading social investment network, says that this technology is reshaping the industry of trading. In fact, this company is already using this science, and it has created a machine-learning-based tool that copies the trading strategies of the top 30 traders of its platform, generating returns of more than 22\(^%\).\(^8\)
Finance Fields

- Trading

Once the most technical concepts have been defined, the following sections will define the concepts regarding the financial part of this work.

Trading is “the action or activity of buying and selling goods and services”, according to the Oxford dictionary. Some examples would be buying a car in exchange of money, hiring a tourist guide to visit a city… However, this thesis refers exclusively to the financial markets’ definition of trading, that is the buying and selling of securities.

A security is any type of financial instrument that holds some type of monetary value. The more important ones are the stock, that represents a portion of a company; the bond, that gives the owner the right to perceive an amount of interest plus the initial amount in exchange of this initial amount; and a derivative, that represents any of the previous financial instruments.

- History of trading

The first stock exchange was founded in 1602 in Amsterdam. In the XVIIIth Century, stock exchanges appeared first in France and in England, being the most important the London Stock Exchange. At the end of this century, the New York Stock Exchange appeared, and today almost every country has its own. With the globalization and IT developments, there is no longer the necessity of a trading floor, almost every operation is done online.

- Exchange Trading

Until the development of modern communications methods, buyers and sellers needed to congregate in one place to be able to trade. The role of the exchange was to bring them together and provide an infrastructure of rules and regulations to ensure that trades were executed fairly and settled without delay.

The trading of securities it is usually referred to as stock market. Depending on its functioning, we can distinguish two types of stock markets: order-driven markets and quote-driven markets.

- Order-Driven Markets

It is also known as an auction market. Traditionally, the market participants had to congregate in one place where they could agree the prices at which they were willing to pay for the securities. Nowadays, these auctions take place using electronic methods. The computer system matches and sells orders and executes them immediately. The London Stock Exchange would be an example of an order-driven market.
Difference between computers and humans in trading

- Quote-Driven Markets

Firms will buy and sell securities in response to demand from investors. The firm that makes the market, the market maker or dealer, has to quote a price to sell (ask price) and a price to buy (bid price). Market makers have to be prepared to deal at that price for all trades up to a certain amount of stock. The profit is made by the difference between the stock sold and the stock bought. There will also usually be more than one market maker in any one stock, in order to ensure that competitive prices are quoted. The NASDAQ would be an example of a quote-driven market.

There exist other types of trading, such as Over The Counter (OTC), internalization and Electronic Communication Networks (ECNs), but the scope of this paper is not the different types, but the influence of Big Data and Machine Learning in trading in general, so we will not continue with those types.

- Mechanics of Trading

The investor that wants to sell or buy a stock, will usually place his order through a broker, who will execute the trade by seeking another trader interested in that stock. As there will be more than one trader, the broker will choose the one from whom he can take the bigger profit.

In an order-driven market, the client’s order will enter in a book with other orders. When two orders match, the operation is closed. In a quote-driven market, the broker will contact the market makers that hold or want the shares in which the client is interested in, and he will choose the one that has the most competitive price. If the client wants to buy shares, for example, the broker will search the lowest ask price.

In the market, it can be distinguished two types of orders: passive and aggressive\textsuperscript{11}.

Passive orders would be the orders that are make above or below the best price (buy cheaper than the lowest price offered and sell more expensive than the highest price offered), so they have to wait before someone accepts that price. For example, if the best price offered for the Y company share is $100.5, a passive order would be one to buy that company share at $100, as it will not be filled yet.

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This type of orders shows a price/time priority. This means that the orders that are filled first are the ones that have the best price (the lowest price for a sell order and the highest price for a buy order), and among the ones that have the same price, the ones that have arrived first.

An aggressive order is a type of order that specifies the quantity but not the price. The order would be “buy 200 shares of the Y company”, and the shares would be bought at the best possible price (the cheapest one).

- Computerized Trading

Computerized trading, as one can deduce by looking at its name, encompasses a wide range of concepts. The most basic one has been seen in the preceding point, and it refers to the system that matches one order with another. A more advanced version of this would be a system that matches orders that were programmed to be closed under certain conditions (for example, when the market reaches a certain price).

Computerized Trading has been put as a different section from Trading because it has completely changed the way trading has been working historically, and it is even changing the way markets behave. This is why it should be treated as a different concept.

This type of trading has introduced computers as a new type of players in the market. In fact, computers are starting to manage funds. According to the Tabb Group (a consulting and research firm specialized in capital markets), 36% of the institutional trading volume (trading between institutional investors, in other words, companies that dedicate themselves to financial securities) is done by quant funds, that will be described in the next paragraph.

There exist three types of computer managed funds: index funds, that are a portfolio of stocks or bonds designed to mimic the composition and performance of a financial market index, ETFs (Exchange-Traded Funds), that is a security that involves a
collection of securities, and quant funds, that select securities using the capabilities of advanced quantitative analysis.

To understand the size and impact of this new technique, in 2014 the estimates ranged from 60 percent to 80 percent of daily market transactions volume or more. Since then, this percentage has increased. In 2019, Deutsche-Bank has said that 90% of equity-futures trades and 80% of cash-equity trades are executed by algorithms without any human input.

It is so big the impact that algorithmic trading has in today’s markets, that in 2010 a “Flash Crash” occurred. Dow Jones plunged around 1000 points (9%) in a few minutes, and then it recovered in just a few minutes too. It is believed that algorithmic trading (the type of trading that quant funds do) is behind this type of crashes, and it will have more impact in the future, as machines act immediately after news are published¹³.
Finance Fields
“TRADITIONAL” TRADING

Behavioral Economics

Based on the article “Behavioral Economics”\textsuperscript{4} of the Current Biology magazine, written by Colin F. Camerer, Behavioral Economics uses psychology and other social sciences to create an alternative theory to traditional economics theories that explains the behavior of economic agents. Traditional economics has assumed that these agents took perfectly rational decisions in order to maximize their revenues or the benefit they could obtain from a good or a service. It has also assumed that they did not interact between each other. Additionally, these theories have simplified human behavior.

As one can logically think, humans do not take perfectly rational decisions. Is it rational to play lottery instead of investing the same amount in a company's stock? It is not. It would be safer, using probability, to invest the same amount in the market, as it has more probability to generate a positive return. But the fact is that people play lottery. Moreover, another fact is that they tell their friends that they have played lottery that year, so maybe some of them will end up playing too.

Therefore, people do not always take rational decisions and they interact with other agents. Behavioral economics try to make the traditional economic models more rigorous and realistic. Prices, income, perceived risk…they all affect human behavior.

The mentioned article says that the most important decisions people make, such as education of their children, career or professional steps, are very complex and it would be difficult for humans to find the most optimal path.

According to another book, “Behavioral Economics for Dummies”\textsuperscript{5}, from the author Morris Altman, in behavioral economics, realistic assumptions are critical in building economic models that help the agents analyze the world. These assumptions allow them to better understand how people make their decisions, such as which factors contribute to make a good or bad decision.

In conventional economics, the economic models try that the predictions that one can obtain through these models respect the classical assumption, whereas in behavioral economics there is more care that the models are connected with the reality. For example, as the Nobel award winner Milton Friedman says, traditional economics assumes the perfection of the individual agents. He puts an example with the expert billiard players. If it assumed that they have calculated perfectly, using mathematics models, the best trajectory of the ball, and the best shot, one would be able to predict the perfect shot, or in other words, one could determine how the round is going to unfold. This is far from reality as we can think.

However, if the problem is regarded through the eyes of behavioral economics, one can study the most successful billiard players and he or she would be able to explain better the events, such as when a player is going to make a difficult shot, what characteristics should the player have…In summary, behavioral economics, apart from predicting possible events, helps also to explain these events.
Behavioral Economics

- Conventional Economics Assumptions\textsuperscript{15}

As it was said before, traditional economics simplifies the reality and makes assumptions about human behavior, to explain the economy and build the economic models. Traditional economics has several assumptions:

- People's preferences are stable and consistent: They usually change their preferences as they grow.
- People are solitary decision makers: Their friends, historical and economical background or social norms influence in each of their decisions.
- The facts that lead people to have certain preferences do not matter: Understanding how people's preferences have evolved to be what they are helps economists to understand what determines those preferences (and changes in preferences).
- People have the same preferences: Even inside households and firms people have different preferences.
- Agents always tend to maximize: People and firms do not always choose the path that allows them to obtain the maximal profit. Sometimes they have to take a decision that helps other people, for example.
- People have perfect knowledge: As it was seen in the billiard example, it would be impossible that someone takes all his or her decisions with all the information. Also, our computational capacity is limited, so people cannot simulate each scenario to choose the best one.
- People have willpower: Not all the things that they do reflect their true preferences. For example, many people smoke without wanting to.

In conclusion, people do not always choose the best decision. They make mistakes, they share things, etc. This shows that the human behavior needs to be studied better before assuming things, and before building an economic model.

- Neuroeconomics: The influence of the brain in decision-making\textsuperscript{15}

Neuroeconomics involves the study of the brain and how the brain impacts the understanding of economic behavior. It uses brain-imaging technology to measure people's psychological responses to economic stimuli.

The brain is structured in different parts, and each of them is responsible for one or more capacities. For example, the frontal lobes are responsible for responding to environmental stimuli and executing judgements, which means that they are responsible for decision-making. Another part that plays an important role in decision making is the amygdala, responsible for the emotional feelings. It has been proven that emotive and intuitive factors are part of the complex decision-making process.

Antonio Damasio, a Portuguese neuroscientific, has done research about the importance of this emotional part of the brain in decision-making. According to Damasio, emotions help people to make quicker and smarter decisions. He puts the example of when people cross the road and a car approaches, and he says that, obviously, people do not stare at the car thinking about the many actions that they can take. Instead, our feelings push us to jump aside. Without the influence of emotions, it would take a longtime to make decisions.
Behavioral economist’s findings show that the average human brain is consistent with some behaviors, such as:

- **People prefer the present to the future**
- **Aversion to loss affects decision-making:** Research has found that even a loss that does not affect our net financial position, such as gaining and losing a dollar (Net position = 0), affects people negatively.
- **People care about keeping up with the rest:** Conventional economics says that individual agents tend to maximize their wealth regardless to the other agents. Thanks to brain-imaging studies, it has been found that humans care about their position relative to others. In fact, these findings have shown that they even prefer to gain less if the other gains nothing, than winning both a bigger quantity than the initial one.
- **People like to trust and be trusted:** People feel good when they interact with others and when they generate relations based in trust.

BBVA conducted a research in 2018 with more than 14,000 employees, to show that human brain is not as rational as we think. This research shows that humans have behaviors that are not perfectly rational, which is in line with the facts presented above.

BBVA made two groups (A and B) for some questions and in others they answer the same question.

The survey proves four types of effects that are common:

- **Anchoring effect**

Each group receives an image with a ball in a roulette’s box, being the numbers that appear in the box different, one higher than the other. The question was how many African countries are in the United Nations.

Group A, which was seeing the number 34, answered that in the UN there are 44 African countries. Group B, which had a 5, answered that 11.

This shows that humans’ brain uses information as a reference for future decisions, even if it has nothing in common with the decision they have to take. This explains why Group A chose a higher number of countries than group B.

- **Allocation effect**

Both groups had the same question, that was if they would exchange your lottery ticket with a friend if he offers you 1€. 75% of the participants answered that they would not exchange the ticket.

If one thinks about it, the right thing would be to exchange the ticket, because both numbers have exactly the same probability of winning, and if none of them wins, you would have won 1€.

The decision of not trading with the ticket is because humans tend to give more value to things just because they own them.
- Certainty and probability effect

The question was what contingency plan he or she would activate under emergency conditions for a town with a population of 600. This time the rest of the question was different for each group. Group A was given two options, option 1, 200 people are certain to survive; option B, 2/3 chances that everybody dies. Group B had 400 people are certain to survive as option 1, and 1/3 of probability that everybody survives as option 2.

In group A, 68% chose option 1, while 75% of people in group B chose option 2.

This shows that people prefer options that are set in a positive tone.

- Nostalgia effect

Group A was asked to remember when and where they learned to ride a bicycle, and group B was asked about their passport number. After that, the same question was asked to both of them: How much money are you willing to donate to help children in hospitals?

As group A was asked to think about a happier memory than group B, they said a higher quantity than group B.

This is what we know as nostalgia effect, that is produced when past and happy memories, instead of neutral ones, influence our decisions.
Behavioral Finance

According to the paper written by Nicholas Barberis and Richard Thaler, named *A Survey of Behavioral Finance*¹⁷, Behavioral Finance is defined as a science that helps to understand some financial phenomena, using models in which agents are not fully rational. More precisely, this science studies the impact of human behavior in the stock markets.

As was seen in the previous sections, human agents are characterized as “perfectly rational”, which means that they fully process all the information, and they take the most optimal decisions, based on this information.

If the agents that trade in the markets were fully rational, the stock prices would reflect its fundamental value (the value obtained by dividing the equity value of the company (obtained through the discounted cash flows method) by the number of shares). This scenario would be the consequence of the Efficient Market Hypothesis, that states that all the agents have the characteristics mentioned in the conventional economics theories. As it is known, this is not true. Behavioral economics says that the deviation of the price from its fundamental value is caused by the irrationality of the agents.

An objection to the behavioral finance theory argues that the deviations produced by irrational agents are corrected by other agents that have a more rational mentality. To give an example of this, imagine a share whose price goes down from 30 to 20$ because of the pessimistic thoughts of a group of irrational agents. The rational agents would buy this mispriced security and, due to the increase of demand, the price would go up again and the rational traders would have obtained a profit. This is known as arbitrage.

Behavioral finance’s idea is that the solutions to correct the deviation in prices are risky, so the mispricing continues its existence.

The risks that affect the arbitrage possibilities given by a mispricing are:

- **Fundamental risk**: This risk is caused by the appearance of unexpected (bad) news about the company whose shares are being traded. Rational investors can expect this to happen, so they hedge their movements with other security that acts as a substitute. The problem is that this substitutive share is not always perfect.

- **Noise trader risk**: This is the risk due to an increase in the pessimistic thoughts of traders, that would make the price to go even lower. This can cause that the rational traders sell their securities in advance, in order to prevent future losses.

Apart from these risks, there are some evidences that show that the arbitrage is limited, because there are some mispricing situations that remain along the time. One clear evidence is the inclusion of a stock in an index. According to the publication *Price and Volume Effects Associated with Changes in the S&P 500: New Evidence for the Existence of Price Pressure*¹⁸, from the authors Harris, L. and E. Gurel, when a stock is added to the index, there is an average increase in price of around 3.5 percent. This change is produced just by the inclusion in the index, not by the change of the fundamental value of the stock.

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What Information Is Important for Traders? What Are Their Procedures to Invest?

If one reviews the descriptions of the Markets and Trading positions in Goldman Sachs, Bank of America and other investments banks, he or she can see that there are three main departments: Sales, Trading and Research.

Briefly, Sales functions involve being in contact with the investors, communicating them information about securities, etc. On the other way, they are in contact with the trading team to tell them information about news, financial reports and other relevant events.

The other two teams, Trading and Research, are more important regarding the scope of this dissertation.

Traders basically do the things that were described in the introduction, in the section “Trading”. They have to buy and sell securities and look for investment opportunities. When they detect an investment opportunity, they have to tell it to the Sales team, so they can communicate it to the clients. They have to read the available information that the Research team has obtained about world events, reports, news, regulations...So the three teams have to be constantly in contact.

The Research team are the ones that have to explore and do analysis in order to build a good database that allows the Sales and the Trading teams to do properly their work. It is very important to have a great Research team because the better this team is, the more accurate will be the predictions of the trader about the investments opportunities, and the better will the results of the company be.

According to the London Stock Exchange, the factors that influence the most in a stock price are the performance of the company and the environment.

Public companies publish their financial reports twice a year. Also, they have to publish information about any event that influences their stock price, such a possible takeover or information about a new product, through a regulatory channel.

The environment means the economic conditions. If these conditions are good, the share prices will tend to increase (if their situation is good too).

It can be seen once the previous chapters are read that there is a third thing that has an important impact in the markets, the investors behavior.

In the part about economic conditions and environment, there was a reference to the world events that happen every day. Even if the event is not related to the industry an investor wants to invest in, if it is important enough, such as a war announcement, a new government, etc., it will surely impact the price.

Philip Becker, co-head of the EMEA FX and interest rate trading group at BNP Paribas London, tells his day at work to illustrate a trader day.
He receives a call warning him about a bond auction in Tel-Aviv, so he has to make a bid for a certain amount of these bonds. He finally takes a 200$ million position. He receives another call about a bond auction in Hungary.

He also tells that one of the traders of his team, based in Budapest, has been asked by Bloomberg about his thoughts about how the market will go. Later that day, an event occurs: An exchange of fire between Israel and Lebanon. He says that this event will not have an influence in prices if it does not continue escalating. Finally, he ends his day pricing a swap between dollars and Turkish lira.

Trading is a job in which you have constant interaction with many countries, and you have to pay attention to every movement in the market to be the one that takes the deal.

Usually, traders are specialized in one industry, and inside that industry, they are specialized in just one type of security. Philip Becker was specialized in foreign currency, that are the operations that involve exchanging one currency for another. Another trader can be specialized in the internet industry, in the Spanish market…
What Information Is Important for Traders? What Are Their Procedures to Invest?
“Modern” Trading

In the introduction was seen that computers have entered in trading as a new type of players. They have a great capacity of analysis; they can gather almost all the historical information available and they can take quick decisions.

In this chapter will be discussed the three types of funds that were mentioned in the introduction: index, ETFs and quant funds.

Index Funds

According to Investopedia, the popular financial content media, an index fund is a type of portfolio that tracks the stocks of a market index, such as the S&P 500 or the Ibex 3521. It holds the same stocks and in the same proportion as the index, and it never sells or trade with them, so it is a form of passive investment, as it does not try to beat the market or index.

It does not necessarily match an established index such as Nasdaq or S&P, but it can track “alternative” index, made up by the fund itself. For example, an index made by the 300 biggest Oil & Gas companies, another that tracks Australian and Japan shares, etc.

In a paper published by Pablo Fernández, an IESE professor, about the return of mutual funds in Spain from 2001 to 201622, it is said that the average return of mutual funds in Spain during that period was 2.32%, while the return of the IBEX 35 was 5.24%. He says that only 15 funds in Spain, from the 632 analyzed, had a higher return than the market.

It shows that beating the market is very difficult and requires a lot of effort, therefore it is supposedly a good idea to invest in an index fund, follow the market, and avoid all the effort that is needed to beat it.

Warren Buffet, one of the most successful investors in the world, said in an interview with the CNBC channel23 that he invested his first amount in 1942 in an index that tracked the American market and that he never looked at it or worried about it. In 2018 this amount has grown to millions of dollars.

To decide in which index you have to invest, Buffet continues, you must invest in one that you think it will grow and grow during several years. He follows a long-term strategy.

These references do not mean that investing in an index will automatically generate positive cash flows. The index in which one invests must be carefully studied.

One of the main disadvantages of index funds is that market indexes change with time. The stocks and the volume that represent within the index are not always the same. For example, if a company starts to obtain bad results, it will exit from the top 100 companies with the biggest capitalization (the typical index). If that happens, it would mean that the index will no longer contain that company, and therefore the index fund would have to change.

Jose Valdés Sacristán
Index Funds

A problem that follows the mentioned disadvantage is that, when the index fund is managed by a computer, the computer is the one responsible of adjusting the proportion of the stocks. As it was mentioned in the introduction when the concept of algorithmic trading was explained, the actions of computers have an influence in the market.

In the part “Quantitative Analysis” we will see how indexes normally perform better than the average actively managed funds.
Exchange Traded Funds (ETFs)

According to the American Stock Exchange\textsuperscript{24}, an ETF is an index-based product. It is a portfolio of securities, listed in stock markets and based in an index. Apart from being influenced by the index, its Net Asset Value (NAV) is the result of supply and demand in the market.

\[
NAV = \frac{Value\ of\ funds'\ portfolio - Funds'\ expenses}{Number\ of\ shares\ outstanding}
\]

Bolsa de Madrid defines ETFs as follows\textsuperscript{25}: “ETFs are hybrids between stocks and funds. They offer the diversification of a mutual fund and the flexibility of a stock, as you can buy it or sell it with a single operation”.

As they are listed in stock exchanges, there must be a market maker, that has the function of assuring an enough quantity of shares outstanding, as well as being compromised to sell at the ask price, and to buy at the bid price.

In mutual funds, investors can purchase or sell their shares, but in ETFs, investors buy and sell it as if it was a stock. Another main difference is that ETFs are traded with its market price, established at any moment during the day, while the mutual funds’ price is the NAV, established only at the end of the day.

Regarding the differences between an index fund and an ETF, the main one is that the index fund is a form of passive investing, while ETFs can be active or passive. Passive investing means that you just purchase a share of the index fund, for example, and that index fund does nothing else but following the underlying index. Conversely, active investing would be a fund that tries to beat the market. It is an option of investing that allows you to speculate and make a profit.

Greenwich Associates, the leading provider of market intelligence and advisory in the financial industry, has published its fifth annual edition of the European ETFs Study\textsuperscript{26}. It has interviewed 127 institutional investors, including institutional funds, asset managers or insurance companies.

The study shows that ETFs investments grew in 2018 in answer to the high volatility of that year, caused by the China-US trade war, Brexit, interest rates changes and the economic slowdown in Europe. 2018 was one of the worst years for equity markets. The investment in ETFs is expected to increase in 2019.

This research states that the investors participating in the study have around one-quarter of total assets allocated to index strategies, preferring among them the ETFs. The Head of Investment Risk of a company interviewed says that “ETFs are cheap, liquid and track the indices of the markets with low tracking error”.

Jose Valdés Sacristán
Exchange Traded Funds (ETFs)

European investors are using ETFs as long-term and strategic investments. A strategic investment means a form of passive investment, while tactical investment is used to describe active investment. As it is known, tracking an index is a typical way of passive investment. ETFs can be used to make active investment, as they are traded like stocks. However, the study finds that a change is being produced, and investors are using them as a passive investment.

In the previous chart is shown that there has been an increase in the number of investors holding ETFs for a period of one year or longer, the threshold to be considered as a strategic investment.

There is an alternative for the typical ETF that tracks an index called Smart Beta ETF\(^{27}\). This type of ETF combines passive and active investment strategies, searching a diversified portfolio that increases return and reduces risk. The study says that investors are increasing allocations to smart beta ETFs.

The top ETF provider in Europe is iShares/Blackrock\(^{26}\) (iShares is Blackrock’s passive investment platform). In the chart of the following page, the top providers in Europe for this type of product are displayed:

![](chart.png)

*Source: Greenwich Associates 2018 European Exchange-Traded Funds Study*
**TOP ETF PROVIDERS**

<table>
<thead>
<tr>
<th>Provider</th>
<th>2018</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>iShares/BlackRock</td>
<td>94%</td>
<td>91%</td>
</tr>
<tr>
<td>Xtrackers/DBX</td>
<td>56%</td>
<td>43%</td>
</tr>
<tr>
<td>Lyxor</td>
<td>47%</td>
<td>52%</td>
</tr>
<tr>
<td>SPDRs/State Street</td>
<td>46%</td>
<td>40%</td>
</tr>
<tr>
<td>Amundi</td>
<td>39%</td>
<td>26%</td>
</tr>
<tr>
<td>UBS</td>
<td>31%</td>
<td>22%</td>
</tr>
<tr>
<td>Vanguard</td>
<td>31%</td>
<td>35%</td>
</tr>
<tr>
<td>PowerShares</td>
<td>22%</td>
<td>19%</td>
</tr>
<tr>
<td>Wisdom Tree</td>
<td>15%</td>
<td>6%</td>
</tr>
<tr>
<td>PIMCO</td>
<td>11%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Note: Based on 89 respondents in 2018 and 77 in 2017.
Source: Greenwich Associates 2018 European Exchange-Traded Funds Study

*Chart 2 - Top ETF providers in Europe*
Innovation and personalization have arrived at finance. This is why new trading instruments have arrived, such as robo-advisors, in the case of personalization, and the use of algorithms and computers, in the case of innovation.

The book FinTech Innovation defines robo-advisors as “fully automated machines which make investment decisions without any human interaction and can fully replace professionals to provide advice that eliminates any conflict of interests to benefit final investors”.

The majority of robo-advisors are held by FinTechs. They are experiencing a high growth because these types of companies have gained credibility and acceptance these recent years, and also because more and more investors are familiar with medium advanced technology, compared with the investors of twenty years ago. Another reason is that nowadays everybody has a smartphone and is connected to the internet, what makes the use of robo-advisors possible.

Another reason why robo-advisors popularity is soaring is because of the change from active investing to passive management. This has been seen in the section about ETFs and index funds. It is very difficult to beat the market, or, in other words, to have an alpha (the excess in return of one or several assets with respect to their benchmark), so investors are opting for passive investing. The fact that robo-advisors avoid human intervention, makes possible to eliminate the drawbacks of human behavior, seen in the chapter about behavioral finance.

Robo-advisors manage around $1 trillion according to various analysts. The biggest robo-advisor’s companies by assets under management (AUM) are:

<table>
<thead>
<tr>
<th>Robo-Advisor</th>
<th>AUM in Millions (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vanguard Personal Advisory Service</td>
</tr>
<tr>
<td>2</td>
<td>Schwab Intelligent Portfolios</td>
</tr>
<tr>
<td>3</td>
<td>Wealthfront</td>
</tr>
<tr>
<td>4</td>
<td>TD Ameritrade Essential &amp; Selective Portfolios</td>
</tr>
<tr>
<td>5</td>
<td>Betterment</td>
</tr>
<tr>
<td>6</td>
<td>Personal Capital</td>
</tr>
<tr>
<td>7</td>
<td>ETrade Core Portfolios</td>
</tr>
<tr>
<td>8</td>
<td>WealthSimple</td>
</tr>
<tr>
<td>9</td>
<td>FutureAdvisor</td>
</tr>
<tr>
<td>10</td>
<td>M1 Finance</td>
</tr>
<tr>
<td>11</td>
<td>Interactive Advisors</td>
</tr>
</tbody>
</table>

*Table 1 - Biggest robo-advisors by AUM*
To continue talking about investing without humans, the next topic are the quant funds. Quantitative investing is an investment process in which securities are chosen based on defined rules, Morningstar says. Traditionally, traders and mutual funds have used technical and fundamental analysis, market momentum and markets situation to analyze their investments, but there has always been the presence of humans, as the ones who have taken at least the final decision.

Fundamental analysis means analyzing the “fundamentals”, that are the past, and present financial statements, as well as a forecast. These allows to calculate the theoretical stock price. On the other side, technical analysis involves looking at charts about the stock’s historical price with respect to the market and try to obtain a pattern.

Quant funds have a human team that designs the algorithms and creates the model, and it is the model that chooses later the stocks, instead of being the humans. The managers of the quant fund seek some data that they will use as a criterion for building the model. For example, stocks from a certain type of company.

Morningstar puts the example of picking stocks with low P/E ratio. They see how these stocks have performed in the market in the last years. Then they test them in a market with different conditions. Finally, if the test has been positive, they add the criterion to the model. This contributes to the creation of the algorithm, that will be adopted by the computer. That is why it is also called algorithmic trading.

Some data that quant funds managers typically use are:

- Fundamental analysis data: Net income and financial ratios such as P/E ratio.
- Macro and micro forecasts: Predictions about the GDP growth or the earnings of the company for the next quarter.
- Others: Consumer trends, consumer needs, disruptive competitors in the industry…

Quant funds and quantitative strategies are often referred as “black-box investing” or “black-box strategies”, because the algorithms they use are extremely secret, as they are the difference between two similar quant funds.
Quant Funds

- High Frequency Trading (HFT)

HFT forms part of algorithm trading. It uses algorithms similar to the ones explained before, but that imply instructions to trade (buy and sell) in milliseconds.

While traditional programmed trading is more related with the analysis of trends, HFT is related to scalpers-techniques such as buying and selling a huge quantity of assets in order to influence prices.

According to David M. Halsey, author of the book “Trading the measured move: a path to trading success in a world of algos and high frequency trading”12, HFT platforms use extremely fast computers to place extremely quick trades based on profit opportunities discovered by their algorithms.

This trading technique remarks the difference in trading capability between humans and computers. A human scalper may have multiple screens with different charts and information, that he can read in a little amount of time and then take a decision to try to make profit. On the other hand, a computer has access to all the information available on the internet and a super analysis capacity, which will allow it to have a much greater impact than the human.

According to The Economist, High-Frequency Traders, acting as middlemen, are involved in half of the daily trading volumes13.

The book “Inside the black box: a simple guide to quantitative and high frequency trading” from the author Rishi K. Narang, explains the necessity of being the first one in closing an order, in other words, the fastest one to buy and sell.

In a passive order, a type of trading order explained in the introduction, the prioritization is in terms of price and time. If you offer the best price to buy a quantity of a certain stock (the highest price), then you would be put the first in queue in the order book. If the order is filled, then your operation has been successful.

In a situation in which your order is not the first one, the best price to sell (ask or offer price) may end up being equal to the price at which you are bidding, so, once you get the amount of shares you have just bought, you are only able to sell at the same price you have bought. As HFT operate with a very short-term strategy, this is one of the reasons why HFT need to be the first ones.
HFT use several techniques to avoid latency (the delay of operations in a network) and being the first ones in order books:

- Placing physically near the exchange’s matching engine (the software that manages the order book): This reduces the amount of time data takes to be transmitted to the servers of the trading firm. Stock exchanges have data warehouses to store these matching engines, and they rent space to trading firms that want to be the first ones in receiving the information.

- Seeking physical solutions to reduce latency: Apart from being physically near to the matching engine, trading firms have to gather the data in one place to manage it and take the decision (made by the algorithm). Information has to travel necessarily. Right now, the fastest method is a fiber optic network. The book mentioned previously says that the latency between New York and Chicago is around seven milliseconds one way.

- Frequency of orders: The frequency at which orders from stock exchanges arrive to trading firm is not linear, there is no stationarity in the number of messages received during the day.

<table>
<thead>
<tr>
<th></th>
<th>50th Percentile</th>
<th>99th Percentile</th>
<th>99,9th Percentile</th>
<th>99,99th Percentile</th>
<th>99,999th Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 second</td>
<td>13</td>
<td>259</td>
<td>546</td>
<td>1,755</td>
<td>4,179</td>
</tr>
<tr>
<td>100 milliseconds</td>
<td>0</td>
<td>13</td>
<td>84</td>
<td>863</td>
<td>1,306</td>
</tr>
<tr>
<td>10 milliseconds</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>269</td>
<td>557</td>
</tr>
<tr>
<td>1 millisecond</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>56</td>
<td>106</td>
</tr>
</tbody>
</table>

*Table 2 - EBAY orders per second in 2012*

It can be seen in this table that in the busiest second of the day, 4,179 messages arrived, and one could expect to see 418 messages in the busiest 100 milliseconds, as 100 milliseconds are 10% of a second. But instead there are 1,306 messages. We confirm the nonlinearity of orders.

These are just a few of the many problems that HFT face, and they are all in terms of milliseconds. That shows the importance of having the best algorithm, designed by the most intelligent people and to spend the maximal amount possible in improving it.
What Are the Needs in Modern Trading?

XTX markets, "a leading quantitative-driven electronic market-maker partnering with counterparties, exchanges and e-trading venues globally to provide liquidity across asset classes"\(^{30}\), bases its business in algorithms developed by engineers. It has no human traders and just one salesperson, an article in Bloomberg says\(^{31}\). It was founded in 2015 and in 2016 overtook Deutsche Bank as the world’s biggest spot currency trader.

A firm with just 124 employees but running $150bn in assets, seems to be the future in trading. In just a few years, with a complete quant culture, it has become one of the biggest players in market-making. The majority of its employees come from computer and math fields, as it can be seen in the following chart.

![Chart 3 - Background of XTX Markets’ employees](image)

JP Morgan has a budget of $11 billion for technology in 2019 and it counts with more than 50 thousand people working in the field. They want to be leaders in trading automation, not by substituting humans for computers but by allowing humans to work in tandem with technology. In a paper released in 2019\(^{32}\), they claim to have automatized the minute decisions in trading with algorithms, so humans can concentrate in communicating with the clients. JP Morgan has been ranked as first in trading by market share.

In a recent article published in Bloomberg\(^{33}\), where it is also mentioned the expenditure of three big investment banks, in which JP is also included, says that Citi group has been “automating news, analytics, pricing and trade ideas for salespeople” in the trading unit. The article also mentions that now 1,600 front-office staff trained in Python programming language.
Stuart Riley, global head of operations and technology for the bank’s Institutional Clients Group, has said that “the delineation between traders and technologists in markets is disappearing”.

The two possibilities of quantitative strategies have been shown: no-human or human-computer. It will be the industry itself the one that will determinate the winner.
What Are the Needs in Modern Trading?
Quantitative Analysis

Introduction to the analysis of funds

The following points explain different aspects about mutual funds that one must know before analyzing a fund. These aspects are important because two mutual funds can be similar in terms of assets, but they may differ in terms of commissions, distribution of dividends or returns or the type of market in which they invest.

The quantitative analysis contains eight pairs of funds (quant funds and human-managed funds). First, the quantitative funds have been selected. As it is difficult to fund this type of funds, the pairs were selected to be similar to the quantitative funds.

• Class

There are three different types of classes in mutual funds: A, B and C. These classes determinate the different fees and structures. This type of expense is known as load.

- Class A (front-end load): A percentage of the initial investment in the mutual fund is taken out as a commission. This type of class is more expensive at the beginning but is better if the position is held over the long term.
- Class B (back-end load): The total amount paid by the client is invested in shares, however, a commission is taken out when the client receives the gains resulting from the selling of shares. Class B shares can be converted to class A shares.
- Class C (level-load shares): The total amount paid by the client to the mutual fund is invested in shares, instead of dedicating a part of this quantity to pay an initial commission. The commissions are paid through annual fees.

There is another type of expense, the expense ratio. Expense ratio, measured in percentage, is calculated dividing the fund’s assets value by the fund’s fees that the investor has to pay. It is the fee that the investor pays annually to the mutual fund. The fee is charged on the investor’s assets under management, instead of being charged on profits. It is not a payment made separately. It is made with the amount that you have invested in the fund. Class B and C pay a higher expense ratio than class A shares.

For example, if someone has $1,000 investment in a mutual fund, the fund’s return is 10% and the expense ratio is 1%, he or she would receive $90.

There exists another type of class, called the R class, charged usually in retirement plans. This type of class does not have loads, but it charges a specific fee, the 12-b1 fee, that ranges from 0.25% to 0.5%.

Finally, if the investor does not want any financial advice, there are no-loads funds available. Those types of funds are less expensive, as they do not have the loads, but they do not receive financial advice or planning. The types D or P shares would be a type of no-load fund.
Introduction to the analysis of funds

Institutional investors have the I, X and Y classes. Those types of classes require a minimum investment of $250,000 or more, so they are not available for everyone. They have lower expense ratios than the other classes.

- Distribution type

Accumulation: The fund invests again the profit gained
Distribution: The fund distributes the profit to each of the fund holders

An accumulation distribution type favors compound interest, that is the effect of reinvest your gains and produces better returns.

- Currency

Sometimes, a European fund invests in the US or vice versa. In the USA, operations are made in dollars and in Europe, in euros. Therefore, the mutual fund would have to use a forex hedge, to prevent the risks of a bad exchange rate.

For example, if the European mutual fund buys US equity, it would have to hedge to dollars, because if the euro gets stronger than the dollar, then the mutual fund would lose money when it wants to retire the gains. The mutual fund can get hedge against currency exchange rate with an option, that gives it the right to exchange the currency at a certain rate. The negative aspect is that if it does not execute the option, you lose the price of the option times the number of options it had.

Mutual funds must calculate carefully the currency risk, because the currency may not move in the direction they have calculated and therefore the currency hedging would be useless. In a research conducted by the Financial Times, it was proven that, many times, the mutual funds that did not hedge against currency moves, obtained a better result than the ones that did.

- Historical

“Past returns do not mean future returns”. All the funds that have been studied warn this. Investors cannot invest in a fund just because it has performed well in the past.

To compare the return of different funds, there exist different possibilities:
- Compound Annual Growth Rate, in addition with standard deviation (volatility), to see not only how the fund has performed but also the fund’s risk.
- The Net Return in a Year, that shows how much would have gained the investor if they had invested in the fund a year before
- Average Annual Total Return calculated with the arithmetic mean of the Total Return of each year of the fund along the period.
• Type of security

Mutual funds can be divided into five categories according to the type of security in which they invest:

- Money Market: Invest in short-term high rated debt.
- Fixed Income: Government and corporate bonds.
- Equity: Stocks.
- Balanced: Combine both stocks and bonds.
- Other: Invest in other type of security like currency, commodities, derivatives, real state...

It is important to have a diversified portfolio in order to reduce risk. Equities are the riskiest assets, but also the ones that provide the highest return. On the other side, corporate bonds are the one that have the lowest risk and provide the lowest returns.

Another factor of risk is liquidity. A stock that does not have liquidity, such as a small-cap company, is riskier than a blue-chip company.

Investopedia suggests start having a risk portfolio, with a majority of equity, and as long as our retirement approaches, move towards safer assets such as bonds. To build the optimal portfolio, this site says that one could base its calculation on a normal distribution.

The normal distribution built has to be based on the mean of the return of the stock and on the standard deviation.

- Mean: The average of daily changes of the stock price. The higher the better. It gives an idea of how much return can we expect.
- Standard deviation: The amount each of the values deviate from the mean. The lower the better. The higher the riskier.

A strategy that helps to choose the right asset allocation is the factor strategy, that will be explained later.

• Geographical area

Securities from emerging markets (Brazil, India, China) are riskier than securities from developed countries such as the US or Europe. The risk is due to liquidity and the country risk.
Introduction to the analysis of funds

- Funds' investment strategies

The most popular investment strategies are\(^3\):\(^9\):

- Growth: Investing in companies that are growing rapidly and that have strong and increasing earnings.
- Value: Investing in companies that seem to be undervalued.
- Momentum: This strategy consists in investing in companies that are experimenting an increase in their share price.
- Contrarian: Investing in companies that are not experiencing momentum or growth. It is a strategy that goes against the current.
- Income: This strategy focuses on dividend payments. They invest in companies that are known to pay dividends, such as mature companies that are not growing as rapidly as new companies.
- Factor\(^{40}\): It consists in identify drivers of return across different asset classes. There exist macroeconomic factors, that explain returns across different asset classes, and style factors, that explain the returns within one of those asset classes. They help investors to have defined goals and enhance returns and diversification. It is important to know the factors that drive the returns of a portfolio to choose the optimal asset allocation and the shares of the companies that correspond with those factors. This strategy harnesses all the previous ones.

Image 4 - Types of factors
Funds’ Comparison

Mutual funds managed by computers or that follow a quant strategy (a strategy based on defined rules and algorithms) will be compared against mutual funds actively managed by humans, that are, funds that have a human management team that decides in which stocks will the fund invest.

The funds compared will be funds that have the same share class, the same or similar asset allocation and the same or similar geography. The return of the fund itself will be compared to the return of the fund to which is being compared. Apart from that, the return of the fund with respect to its benchmark (alpha) will be provided in the cases in which that information is available.

The graphs shown below have been built based on the daily NAV variation of each fund. This variation of each day has been obtained dividing the NAV of that day by the NAV of the precedent day. The Napierian logarithm has been applied to each of these variations, and finally the cumulative return has been calculated.

Some companies provide information about their funds in terms of growth of a given quantity, normally $10,000, but the return can be calculated using the formula of the net return.

When two funds have different periods available, due to different inception dates, the period chosen will be the shortest. The standard period that will be chosen will be since 2015, that is, 5 years.

- First pair of funds: Global shares small capitalization
  - Quant fund: Abante Quant Value Small Caps

Summary

This fund invests more than 75% of its assets in equities, mainly in small cap international values, although it can invest also in medium/large capitalization assets. The principal geographical zones are Europe, USA and Asia, and the rest are Australia and Canada.

The selection of equities rests on a quantitative method that selects undervalued and financially strong companies with a good momentum.

Fund information

- ISIN: ES0162950002
- Class: Not provided
- Commissions and fees: 1.35% management, 9% results and 0.1% deposit.
- Benchmark: MSCI World Small Cap Net Total Return EUR Index
Funds’ Comparison

Return

The data start at the beginning of November 2017, in 2017 (from November until December 31st) the return was 1.65%, in 2018 it was -17.06% and in 2019 it has been 20%. The fund announces that in 2018 “important changes were made”, which may explain the difference in return between 2018 and 2019.

The average annual return since November 2017 until December 31st, 2019 is 1.53% and the cumulative return is 1.16%.

- Human fund: Goldman Sachs Global Small Cap Core EUR

Summary

This fund invests in equity from small capitalization companies around the world, considering a small capitalization company a capitalization lower to the capitalization of the bigger company in the S&P index.

The main geography is the USA, followed by the Euro Zone and Japan. The rest of the geographies are the Europe non-Euro Zone and Canada.

Fund information

- **ISIN:** LU1599216113
- **Class:** Not provided
- **Commissions and fees:** 1.5% management and 5.5% front-end load.
- **Benchmark:** S&P Developed Small NR USD
In 2017, during the same period as the Abante Quant Small Caps fund, the return was 0.58%, in 2018 it was -9.7% and in 2019 it has been 28.05%.

The average annual return since November 2017 until December 31st, 2019 is 6.31% and the cumulative return is 19.18%.

- Comparison
Funds’ Comparison

The Abante fund benchmark, MSCI World Small Cap Net Total Return EUR Index, had a performance of -9.12% in 2018 and 29.12% in 2019\(^4\). The average annual return of this index is 10%.

The benchmark of the Goldman Sachs fund was not fund, so its return will be compared with Abante’s benchmark. As it can be seen, Goldman Sachs Global Small Cap had a better performance if it is compared to the performance of Abante Quant Value Small Caps, but both performed worse than the Global Index MSCI World Small Cap.

The Goldman Sachs also did better in terms of average annual and cumulative returns. Therefore, the Goldman Sachs Global Small Cap fund has performed better for the same period than the Abante Quant Value Small Caps.

- Second pair of funds: Commodities
  - Quant fund: *Esfera Seasonal Quant Multistrategy*\(^4\)

Summary

This mutual fund invests mainly in derivatives based in commodities. The rest of the fund’s assets are invested in equity and fixed income.

Its main positions are KC HRW Wheat, NY HARBOR RBOB Gasoline and SPDR GOLD TRUST.

Fund information

- **ISIN**: ES0131462097
- **Class**: R
- **Commissions and fees**: 0.1% deposit and 1.35% management calculated based on fund’s assets; 9% results.
- **Benchmark**: Bloomberg Commodity Index (BCOM Index)

Return

![Chart 7 - Esfera Seasonal Quant Multistrategy return](image)
The inception date is October 2017. In 2017 (from November 1st until the end of the year) its return was 0.41%, in 2018 the return was 4.18% and in 2019 it has been 5.1%

The average annual return has been 3.2% and the cumulative return since November 1st, 2019 until December 31st, 2019 has been 9.96%.

- **Human fund:** *GS Commodity Strategy Fund*

**Summary**

The fund maintains exposure to the commodities’ market with commodity-linked derivatives. The main positions are the energy industry, agriculture and industrial metals.

**Fund information**

- **Symbol:** GCCRX
- **Class:** R
- **Commissions and fees:** 1.2% management.
- **Benchmark:** S&P GSCI Commodity Index

**Return**

The fund’s return for the same period as the Esfera Seasonal Quant fund in 2017 was 9%, in 2018 the return was -15.4% and in 2019 it has been around 8.7% (data not updated yet).

The average annual return has been 0.77% and the cumulative return since November 1st, 2019 until November 31st, 2019 (data not updated yet) has been -3.08%.
The Bloomberg Commodity Index return\(^47\) (the benchmark for the Esfera Seasonal Quant fund) in 2017 (from October to December) was 5.32%, in 2018 it was -13.22% and in 2019 it has been 5.06%. The average annual return has been -0.95% and the cumulative return -6.52%.

The Esfera Seasonal Quant Multistrategy fund outperformed the benchmark in 2018 and in 2019. It has also had a higher average and cumulative return.

The S&P GSCI Commodity Index\(^48\) return was, in 2017 (from October 1\(^{st}\) to December 31th), 11.37%, in 2018 -13.8% and in 2019 16.5%. The cumulative return since 2017 is 7.16% and the average annual return has been 4.7%.

The GS Commodity Strategy fund has not outperformed its index at any moment.

Comparing both funds, it can be seen that in 2017 the GS fund was better, in 2018 the Esfera fund had a higher return and in 2019 the GS is better again.

The conclusion is that the Esfera Seasonal Quant fund has performed better, because it has had a higher average year return, a largely better cumulative return and it has also beaten its benchmark.
Difference between computers and humans in trading

- Third pair of funds: European equity
  - Quant fund: *Candriam Quant Equities Europe*

**Summary**

Invests in companies whose registered office is in Europe. The geographies that have more presence are the United Kingdom, Suisse, France and Germany. The industries that have more presence are the financial industry, healthcare, industry and necessity goods.

**Fund information**

- **ISIN:** LU0149700378
- **Class:** C
- **Commissions and fees:** 1.94% management and 3.5% entry.
- **Benchmark:** MSCI Europe NR EUR Index

**Return**

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>11.7%</td>
<td>0.5%</td>
<td>11%</td>
<td>-12.2%</td>
<td>22.24%</td>
</tr>
</tbody>
</table>

Although the fund’s inception was in 2003, the fund’s return will be analyzed since 2015. It is a period larger than the two previous pair of funds, but it is because there is more data available.

Since 2015, the average annual return has been 6.65%. The cumulative return since 2015 has been 33.5%.
Funds’ Comparison

- Human fund: *JPM Euroland Equity*

**Summary**

Invests in companies that are part of the Eurozone. The geographies with more weight are France, Germany, Netherlands and Spain. The industries with more presence are capital goods, financial and utilities.

**Fund information**

- **ISIN:** LU0129440391
- **Class:** C
- **Commissions and fees:** 0.71% management
- **Benchmark:** MSCI EMU Index

**Return**

The fund was constituted in 1988, but the period that will be studied will be since 2015.

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>14.63%</td>
<td>3.35%</td>
<td>16.64%</td>
<td>-13.57%</td>
<td>25.17%</td>
</tr>
</tbody>
</table>

The average annual return since 2015 is 9.24%, and the cumulative return since 2015 has been 49.49%.
Difference between computers and humans in trading

- Comparison

The benchmark for the Candriam Quant Equities Europe is the MSCI Europe Index, whose performance has been:

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>8.22%</td>
<td>2.58%</td>
<td>10.24%</td>
<td>-10.57%</td>
<td>26.05%</td>
</tr>
</tbody>
</table>

The average annual return since 2015 is 7.3% and the cumulative return is 37.96%. The fund has outperformed the benchmark in 2015 and in 2017. It has had lower average annual and cumulative returns.

The benchmark for the JPM Euroland Equity is the MSCI EMU Index, whose performance has been:

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>9.81%</td>
<td>4.37%</td>
<td>12.49%</td>
<td>-12.71%</td>
<td>25.47%</td>
</tr>
</tbody>
</table>

The average annual return since 2015 is 7.89% and the cumulative return is 41.21%. It has outperformed the index in 2015 and in 2017. The fund has had a higher average annual return and a slightly higher cumulated return.

If both funds are compared, the JP Morgan fund has only performed worse in 2018, and this fund has done better than its index in terms of average annual and cumulative returns. Taking all that into account, JP Morgan Euroland Equity fund has performed better than the Candriam Quant Equities Europe.
Funds’ Comparison

- Fourth pair of funds: USA equity
  - Quant fund: *UBS Equity USA Quantitative*

Summary

Invests in USA equity with a quantitative method. The industries in which has more assets are technology, financial services, healthcare and telecommunications.

Fund information

- **ISIN:** LU0246276595
- **Class:** P
- **Commissions and fees:** 0.72% management and 3% entry.
- **Benchmark:** MSCI USA NR USD

Return

![Chart 13 - UBS USA Quant Equity](chart)

Its yearly returns are:

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>10.85%</td>
<td>11.51%</td>
<td>5.52%</td>
<td>-4.58%</td>
<td>24.99%</td>
</tr>
</tbody>
</table>

*Table 7 - UBS USA Equity Quantitative return*

The average annual return has been 9.66% and the cumulative return since Jan 1st, 2015 has been 55.55%.
Difference between computers and humans in trading

Human fund: **UBS US Total Yield**

**Summary**

The fund invests in selected US companies that are expected to outperform the market. The portfolio is diversified, avoiding an excessive quantity of a single stock. The industries in which the fund is present are financial services, consumer goods, industry and healthcare.

**Fund information**

- **ISIN:** LU0868494617
- **Class:** P
- **Commissions and fees:** 1.2% management.
- **Benchmark:** MSCI USA NR USD

**Return**

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>7.23%</td>
<td>12.14%</td>
<td>3.87%</td>
<td>-1.35%</td>
<td>23.65%</td>
</tr>
</tbody>
</table>

The average annual return has been 9.1% and the cumulative return since Jan 1st, 2015 has been 52.35%.
Funds’ Comparison

- Comparison

The benchmark for both is the MSCI USA NR USD, whose return has been:

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>0.69%</td>
<td>10.89%</td>
<td>21.19%</td>
<td>-5.04%</td>
<td>30.88%</td>
</tr>
</tbody>
</table>

The average annual return since 2015 is 11.72% and the cumulative return is 68.16%. The quant fund has outperformed the benchmark in 2015, 2016 and in 2018. It has had lower average annual and cumulative returns.

The human fund has outperformed the benchmark in 2015, 2016 and in 2018. It has lower average annual and cumulative returns as well.

If both funds are compared, the quant fund has performed better in 2015, 2017 and in 2019. The average annual and cumulative returns have been better for the quant fund. It can be concluded that both funds are almost identical, but the quantitative fund is slightly better.
Difference between computers and humans in trading

- Fifth pair of funds: Chinese equity
  - Quant fund: *Robeco QI Chinese A-Share Active Equities*[^57]

**Summary**

The fund invests in stocks that are listed as A-Shares in China. The model selects the stocks with value, quality and momentum strategies. It also integrates positive reviews from analysts.

The composition of the sectors is: Financial services, consumer goods, industry, basic materials and technology

**Fund information**

- **ISIN:** LU1675172263
- **Class:** I
- **Commissions and fees:** 1.33% expense ratio
- **Benchmark:** MSCI China-A International Index (Net returns, USD)

**Return**

![Chart 16 - Robeco QI Chinese Equity return](chart.png)

The fund was created at the end of 2017, so the returns will be for the years 2018 and 2019. In 2018, the return was -28.07% and in 2019 it has been around 19% (data not updated yet).

The average annual return is -4.5% and the cumulative return is -3%, according to their webpage data.

Jose Valdés Sacristán

[^57]: [Source](https://example.com)
Funds’ Comparison

- Human fund: Robeco Chinese A-Share Equities

Summary

The portfolio is made by Chinese A-Shares, selected with fundamental analysis. The portfolio is concentrated in just 30-50 stocks.

Fund information

- ISIN: LU1529950328
- Class: I
- Commissions and fees: 1.07% expense ratio
- Benchmark: MSCI China-A International Index (Net returns, USD)

Return

As it can be seen, the fund is almost as recent as the quant fund. The 2018 return was -26.36% and the 2019 return has been 51.7%

The average annual return has been 12.67% and the cumulative return is 17.3%.
Difference between computers and humans in trading

- Comparison

In the upper graph can be seen that both funds have performed quiet similarly until May 2019, in which the human fund starts to perform better than the quantitative fund.

Furthermore, in each of the funds’ graphs can be seen its performance relative to their benchmarks. Both funds have the same indeed. The human fund has always performed better than the MSCI China-A International Index and the quantitative fund has almost never outperformed it.

The returns of this index in 2018 and 2019 are -30.38% and 35.23% respectively. Both funds performed better than the index in 2018 and just the Robeco human fund has outperformed the benchmark in 2019.

Taking all the above into account, it can be concluded that the Robeco Chinese A-Shares is performing and has performed better than the Robeco QI Chines A-Share Active Equities.
Funds’ Comparison

- Sixth pair of funds: USA Small Cap equity
  - Quant fund: Advantage Small Cap Growth Fund

Summary

The fund bases its strategy in growth companies and seeks long-term growth. It has 80% of its assets in small-capitalization US companies, defined as companies with a size similar to the average size of the Russell 2000 companies.

Fund information

- Symbol: PSGIX
- Class: A
- Commissions and fees: 0.5% expense ratio
- Benchmark: Russell 2000 Growth Index

Return

![BlackRock Advantage Small Cap return chart]

The return in the last five years, since December 2014, has been:

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>-3.86%</td>
<td>13.06%</td>
<td>14.63%</td>
<td>-5.29%</td>
<td>33.45%</td>
</tr>
</tbody>
</table>

Since December 2014 the average annual return has been 10.4% and the cumulative return is 57.48%.
Difference between computers and humans in trading

- Human fund: *JPM US Small Cap Growth Fund*\(^6^0\)

Summary

Invests using a growth strategy in US small capitalization companies

Fund information

- **ISIN:** LU0053671581
- **Class:** A
- **Commissions and fees:** 5% initial charge, 1.8% management, 0.5% exit
- **Benchmark:** Russell 2000 Growth Index

Return

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>-4.13%</td>
<td>5.67%</td>
<td>40.07%</td>
<td>-7.72%</td>
<td>36.1%</td>
</tr>
</tbody>
</table>

The average annual return has been 14% and the cumulative return is 78.21%.
The two funds cannot be put in the same graph because one has a symbol identifier and the other one has an ISIN identifier (US and EU policies respectively).

Russell 2000 returns since 2015 are:

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>-1.58%</td>
<td>11.04%</td>
<td>21.9%</td>
<td>-9.49%</td>
<td>28.2%</td>
</tr>
</tbody>
</table>

The average annual growth is 10.01% and the cumulative return is 54.58%.


The average annual and cumulative returns of the human fund have been superior to the ones of the quantitative fund.

It can be seen that BlackRock’s fund has had higher returns more years in the same period than the JP Morgan’s fund, although this last fund has performed remarkably better than its benchmark. That is why it can be said, although both have performed similarly, that the JP Morgan US Small Cap Growth Fund has performed better since 2015 than the Advantage Small Cap Growth Fund.
Difference between computers and humans in trading

- Seventh pair of funds: Emerging markets equity
  - Quant fund: *Robeco QI Emerging Markets Active Equity*[^61]

**Summary**

This fund invests in stocks of emerging markets. The factors in which the fund bases its strategies are value, quality and momentum.

**Fund information**

- **ISIN**: LU0329355670
- **Class**: D
- **Commissions and fees**: 1.51% expense ratio
- **Benchmark**: MSCI Emerging Markets Index (Net Return, EUR)

**Return**

![Robeco QI Emerging Markets return](chart.png)

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>-12.5%</td>
<td>20.23%</td>
<td>22.52%</td>
<td>-13.33%</td>
<td>20.59%</td>
</tr>
</tbody>
</table>

*Table 10 - Robeco QI Emerging Markets return*

The average annual return has been 7.5% and the cumulative return is 36.4%.

[^61]: Reference to a specific fund or investment product.
Funds’ Comparison

- Human fund: *Emerging Markets Diversified Equity Fund*\(^\text{62}\)

Summary

This fund invests in stocks of emerging markets. The factors in which the fund bases its strategies are value, quality and momentum.

Fund information

- **ISIN**: LU0535954134
- **Class**: C (similar to class D)
- **Commissions and fees**: 0.96% expense ratio
- **Benchmark**: MSCI Emerging Markets Index (Net Return, USD)

Return

![JPM Emerging Markets](chart23)

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>-4.28%</td>
<td>14.78%</td>
<td>24.28%</td>
<td>-14.86%</td>
<td>22.72%</td>
</tr>
</tbody>
</table>

*Table 11 - JPM Emerging Markets Diversified return*

The average annual return is 8.53% and the cumulative return is 42.67%.
Difference between computers and humans in trading

- Comparison

![Comparison Robeco QI JPM Emerging Markets](image)

Both funds have performed almost equal the last five years. Below can be seen a comparison against their index.

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>-5.23%</td>
<td>14.51%</td>
<td>20.59%</td>
<td>-10.27%</td>
<td>20.61%</td>
</tr>
</tbody>
</table>

*Table 12 - MSCI Emerging Markets Index (Net Return, EUR)*

The average annual return has been 8.04% and the cumulative return is 41.64%.

Although both funds have had almost the same behavior, as it can be seen in the graph, the JP Morgan fund has outperformed Robeco’s fund in 2015, 2017 and 2019. Furthermore, JP Morgan Emerging Markets fund has always outperformed the MSCI Emerging Markets Index, except in 2018.

The average annual and cumulative returns are better for the fund of JP Morgan, also if there are compared with the benchmark.

Definitely, the JP Morgan Emerging Markets Diversified Equity Fund has performed better than the Robeco QI Emerging Markets Active Equities since 2015.
Funds’ Comparison

- Eighth pair of funds: World Equity
  - Quantitative fund: *Candriam Quant Equities World*

Summary

This fund invests in stocks of companies whose legal address is any part of the world or that develop their activity in any part of the world. The sectors that have more weight are technology, financial services and healthcare. The majority of the stocks are US companies.

Fund information

- **ISIN**: LU0235267860
- **Class**: C
- **Commissions and fees**: 3.5% entry, 1.47% expense ratio
- **Benchmark**: MSCI World (Net Return, USD)

Return

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>8.42%</td>
<td>11.54%</td>
<td>7.16%</td>
<td>-9.5%</td>
<td>22.37%</td>
</tr>
</tbody>
</table>

Table 13 - *Candriam Quant Equities World return*

The average annual return has been 8% and the cumulative return is 43.33%.
Difference between computers and humans in trading

- Human fund: *JP Morgan Global Equity Fund*[^64]

**Summary**

This fund invests in a portfolio of global companies. The sectors that have more weight in this portfolio are technology, financial services and healthcare. The majority of the stocks are US companies.

**Fund information**

- **ISIN:** LU0243499265
- **Class:** C
- **Commissions and fees:** 0.71% expense ratio
- **Benchmark:** MSCI World (Net Return, USD)

**Return**

![JPM Global Equity Chart](chart26.png)

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>9.12%</td>
<td>8.06%</td>
<td>9.1%</td>
<td>-7.17%</td>
<td>22.46%</td>
</tr>
</tbody>
</table>

*Table 14: JPM Global Equity Fund return*

The average annual return is 8.31% and the cumulative return since 2015 is 46.24%.
Funds’ Comparison

- Comparison

The return of the MSCI World Index is:

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>10.42%</td>
<td>10.73%</td>
<td>7.51%</td>
<td>-4.11%</td>
<td>30.02%</td>
</tr>
</tbody>
</table>

Table 15 - MSCI World Index return

The average annual return has been 10.91% and the cumulative return is 63.89%.

In 2015, 2017, 2018 and 2019, the JP Morgan fund has had a higher return. Also, the average annual and cumulative returns have been better for this fund.

In comparison with the index, both have performed equally wrong, because they have outperformed it just in 2016, in the case of the quantitative fund, and in 2017, in the case of the human fund.

Taking all the above, it is clear that the JP Morgan Global Equity Fund has done better since 2015 than the Candriam Quant Equities World.
Results Obtained

The results from the quantitative analysis are the following, according to the factors that appear below:
Factor 1: Best performance in the period overall
Factor 2: Outperform the index the majority of the period
Factor 3: Lower commissions
Factor 4: Fund with the higher average annual return
Factor 5: Fund with the higher cumulative return
Factor 6: Higher return in 2018
Factor 7: Higher average annual return than the index
Factor 8: Higher cumulative return than the index

H stands for “Human fund” and Q for “Quantitative fund”. The fund that appears in each cell is the cell that has had

<table>
<thead>
<tr>
<th>Pair</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
<th>Factor 6</th>
<th>Factor 7</th>
<th>Factor 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
<td>-</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Q</td>
<td>Q</td>
<td>H</td>
<td>Q</td>
<td>Q</td>
<td>Q</td>
<td>Q</td>
<td>Q</td>
</tr>
<tr>
<td>3</td>
<td>H</td>
<td>-</td>
<td>H</td>
<td>H</td>
<td>Q</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>4</td>
<td>Q</td>
<td>Q/H</td>
<td>H</td>
<td>Q</td>
<td>Q</td>
<td>H</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>6</td>
<td>H</td>
<td>Q/H</td>
<td>Q</td>
<td>H</td>
<td>Q</td>
<td>Q/H</td>
<td>Q/H</td>
<td>Q/H</td>
</tr>
<tr>
<td>7</td>
<td>H</td>
<td>Q/H</td>
<td>H</td>
<td>H</td>
<td>Q</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>8</td>
<td>H</td>
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Result: H, Q/H

Table 16 - Quantitative Analysis results

- In six cases, human funds have performed better in the period studied compared to quantitative funds. The two cases in which quantitative funds performed better than humans were Commodities and USA Equity.
- Human and algorithmic funds have outperformed their benchmark the same number of times. The difference is that humans outperform the benchmark with a bigger difference than quantitative funds.
- Traditional funds have lower commissions.
- In six cases, human funds have had a higher average annual and cumulative return. The two cases in which quantitative funds have had higher returns have also been the same ones as the cases that performed better in the period overall.
- Human and algorithmic funds have had a similar performance in 2018, which was the most complicated year for the markets of the last five years. In a bear market, machines have learned to stop losses as well as human funds do. One must also remark that quantitative funds have had higher returns in 2018 in cases in which the best performing fund, overall, was a human fund.
- In the majority of the pairs, the human fund has outperformed its benchmark in terms of average annual and cumulative performance.
Results Obtained
Qualitative Analysis

Methodology

In the line with the comparison between quantitative and human trading, a qualitative approach will be done. Several interviews with both algorithmic and traditional traders will take place, in an interview style, to see how they respond to the questions that reflect the difference between the two modus operandi.

For the algorithmic trading, the interviewee will be asked about the necessary things to create an algorithmic, the data that this algorithm needs, the human intervention and the advantages and disadvantages of algorithmic trading.

Traditional traders will be asked questions related with the behavioral economics characteristics and neuroeconomics findings. They will also be asked about the information that they need to know or look at every day and the advantages and disadvantages of human trading.

Finally, both types of traders will be asked to give their opinion about the influence of the new trading technologies (algorithmic and HFT).
Interviews

Interviews

- Algorithmic trading interviews


Javier started his career implementing algorithms with machine learning in a couple of consulting firms, but he soon started at Banco Santander in the Electronic Trading Platform, where he does algorithmic trading.

- What is necessary to build an algorithm?

First of all, it is mandatory to know how to program. Then it is necessary to know some things about the way markets work and also how to analyze data. The next step would be to “backtest” your information with a historical database and the last step is to test your model in conditions.

- Does the computer need data constantly?

Of course, as well as you have entered historical data to build the model, it is necessary to feed the computer with real time data constantly, because if not the algorithm does not work.

- Is there human intervention?

It depends on the algorithm, but in most of the cases there is no human intervention, unless there is something to fix or they need to close the order because they are losing money.

- Has a quantitative fund any specific advantages?

The first advantage is that your results are based in mathematics and specific actions. You can track the movements that have made you obtain a good result. Apart from that, with the automatization of tasks, you are able to do other things. Last, a robot can pay attention and follow hundreds of stocks, while a human being can only study one or two in detail.

- Has a quantitative fund any specific disadvantages?

The main disadvantages are due to errors in programming or errors in the backtest, that can lead to have losses.

- Do you think that human traders will disappear?

Not at all, humans will still be necessary to build the algorithm, even economics profiles, because they will have to advise programmers in the construction, and there will be necessary to have people that monitor the algorithm. Also, humans will be necessary to communicate with the client.
Difference between computers and humans in trading

- Do you think that markets are controlled or influenced by machines?

Machines provide liquidity, they are always disposed to buy and sell. The popular Flash Crash in 2010 is even thought to have been caused by a mistake, not by the action of a machine itself.

- Do you think that HFT is positive or negative?

I see it as a positive thing. It is true that some orders are favoring specific firms that are very fast. However, I oppose completely to manipulation techniques such as spoofing (put many buy orders and then retire them, so the price increases but the firm ends up selling).

2. Paloma Marín: Algorithmic trading quant at BBVA

Paloma is an algorithmic quant trader at BBVA since 2018. She pays attention in real time to the strategies of the algorithm and she analyzes the algorithm strategies in order to find weak points and improve them.

- What is necessary to build an algorithm?

Step by step it would be: Define the strategy, define the way to evaluate the performance, understand the datasets that we have, design and test the strategy, train the algorithm (if it's a machine learning algorithm), start to introduce the algorithm into the real markets and monitor the performance.

- What type of data does the computer need?

Depending on the type of the algorithm, the two possibilities would be historical or real time data.

- Is there human intervention?

Depends on the algorithm and what we understand by algorithm

- Has a quantitative fund any specific advantages?

The speed at which the algorithm sends orders to the market and reacts to the market conditions is considerably higher than the speed of the human. Plus, many more information sources can be studied, scalability, it reduces human errors...

- Has a quantitative fund any specific disadvantages?

The main risks are the magnification of the market instabilities and algorithms that do not behave as expected.
Interviews

- Do you think that human traders will disappear?

I do not think that human employment may be destroyed but transformed. Traders will stop executing manually and his or her function will be managed or monitor the algorithms.

- Do you think that markets are controlled or influenced by machines?

Flash Crashes may occur due to the mentioned magnifications of the instabilities, but little by little algorithms are getting better.

- Do you think that HFT is positive or negative?

Neither positive nor negative, but, in my opinion, it is risky to invest in the technology necessary to do HFT because, as technology advances so fast, the investment made will soon remain obsolete.

3. Raúl Gallardo: Technology and Algorithmic Trading

Raúl has studied computer management and economics at Universidad Rey Juan Carlos and Universidad Autónoma de Madrid, respectively. Then, he started studying quantitative algorithms at Universidad Politécnica de Madrid, he has also the CFA certificate. He started his professional career at Everis consulting, but he soon changed to trading. Right now, he is a trader at Esfera Capital.

- What is necessary to build an algorithm?

The first thing is to find an economic driver, that is a fact that causes the appearance of certain events. For example, for wheat commodities, there will be less wheat if there are less precipitations. Another example: Zara sells more coats if the weather is colder.

- What type of data does the computer need?

You can put as many as you want. The typical ones are data and volume.

- Is there human intervention?

It depends on the algorithm. Normally you have some type of protocol that indicates when a human can take part. One can also disconnect the algorithm when there is a big economic event that was not programmed, such as a Brexit election.

- Has a quantitative fund any specific advantages?

The main one is that you can measure your actions. When humans invest, they are influenced by their feelings, so sometimes cannot measure their actions.
Difference between computers and humans in trading

- Has a quantitative fund any specific disadvantages?

Complexity. And also, that back testing is very complex. Sometimes the algorithms are very complex, and they are “overoptimized", so they have many economic drivers and we cannot obtain the best performance.

- Do you think that human traders will disappear?

I do not think so. I think that their decisions will have less influence.

- Do you think that markets are controlled or influenced by machines?

There are a lot of machines, but machines act because humans have designed their algorithms and they are monitoring them. There are a series of managers that are responsible for the movements.

- Do you think that HFT is positive or negative?

I see it as something very positive, they provide a lot of liquidity, you have always someone that is ready to buy or sell. If someone wants to enter in the HFT business, that someone has to be in agreement with the competitive race for the maximal speed, but for the rest of traders, is something positive.
Javier studied business administration at Universidad Autónoma de Madrid, and he began to work at a little trading firm. Since 2017, he works as trader at Magallanes Value Investors, a firm specialized in investing using a momentum strategy.

- Do you always use the same investment strategy?

The investment strategy is always the same, in the case of Magallanes Value Investor, we follow a value investment strategy, that means analyzing the fundamentals of the companies we follow. We have to pay attention to the cause of the undervalued situation of the company, if it is because a negative earnings expectation, a declining market…

- Do you sometimes trust your gut, or do you always follow the same strategy and you base your operations only in data?

I always follow my strategy and I always do a previous study in which my strategy can be based on.

- If, at some point, your strategy implies to have a big loss, would you continue with it or would you change it even if you thought it is correct?

I would check again the calculations that made me arrive to this decision. Then I would have to make a decision between changing my initial decision or maintain it, even though it implies a big loss.

- Do you have a short or a long-term strategy?

Long-term, because our funds are designed to follow that strategy. Never lower 5-7 years.

- To which information do you have to pay attention every day?

News, not only the specific news of a company but also macroeconomic news such as politic decisions, regulations…Of course I have to pay attention to the release of the companies’ results and their quote prices.

- Do you see the new trading technologies as a threat to your work?

No, I see them just as different strategies.
Difference between computers and humans in trading

- Do you see any specific advantage or disadvantage about the fact that the one that takes the decisions is a human and not a machine?

It depends on the strategy. In our case, I think a deep analysis of fundamentals cannot be carried out by a machine. Machines can do intra-day trading (buy and sell in the same day) but they are not able to do a long-term strategy.

2. Jose Ángel Zabalegui: Economist and Social Trader

Mr Zabalegui started his professional career working as a broker and then as a derivatives trader at Crédit Agricole. Afterwards, he has worked in different companies and since 2017 he is a qualified investor at the CFD trading platform eToro.

- Do you always use the same investment strategy?

Yes, I follow the JM Hurst cyclic theory, which analyzes the habitual fluctuations in many financial markets. I analyze the moment in which a price is high or low.

- Do you sometimes trust your gut, or do you always follow the same strategy and you base your operations only in data?

I follow my instinct, but I try to follow a certain strategy as well. I think that is absolutely necessary to have methodology and discipline, in addition with your own sense.

- If, at some point, your strategy implies to have a big loss, would you continue with it or would you change it even if you thought it is correct?

It is mandatory to work using stop-loss (a certain level at which you sell to stop losing money) and with the idea of Value at Risk.

- Do you have a short or a long-term strategy?

I buy a sell with a 5-weeks difference

- To which information do you have to pay attention every day?

To the changes in the cyclic analysis I perform due to the new quote prices

- Do you see the new trading technologies as a threat to your work?

Algorithmic trading was born with the goal of eliminate human’s emotions. In my opinion, HFT has diverted to a wrong understanding of technology, bots try to trick the other bots…I think it should be forbidden, everyone has to play with the same latency.
Interviews

- Do you see any specific advantage or disadvantage about the fact that the one that takes the decisions is a human and not a machine?

I think that not even quantum intelligence would be able to mimic common sense, intuition or resilience. Humans and machines should work along.

Nevertheless, human traders should avoid let feelings influence their decisions. Trading is a “real time business”, you see in real time how much you are earning or losing, which can produce feelings such as euphory, anger…

3. Mar: Trading expert

Mar has been trading all her life, she has a certification of “Trading Expert” and right now she is an asset advisory.

- Do you always use the same investment strategy?

I have several strategies; I choose one based on the market conditions.

- Do you sometimes trust your gut, or do you always follow the same strategy and you base your operations only in data?

I never trust my gut. In trading one must be very disciplined. I follow the same strategy, I am very unbiased, I never let feelings disturb me.

- If, at some point, your strategy implies to have a big loss, would you continue with it or would you change it even if you thought it is correct?

If the strategy that I am following involves that loss, I continue with it. As I said before, I never let the feelings divert me from my goal.

- Do you have a short or a long-term strategy?

It depends on the strategy, sometimes I close orders within seconds, other orders are intra-day trading, other are from one week to another…

- To which information do you have to pay attention every day?

It depends on the strategy, normally data about the companies and market conditions.

- Do you see the new trading technologies as a threat to your work?

I do not see them as a threat. If I ever have the opportunity to have things done by a computer, I would be delighted!
Difference between computers and humans in trading

- Do you see any specific advantage or disadvantage about the fact that the one that takes the decisions is a human and not a machine?

Advantage: From my own experience, human mind is beyond any machine in terms of creativity and algorithm design, although it is true that speed and logic typical of an algorithm are impossible for a human being.

Disadvantage: Humans get tired. Trading demands a lot of attention, objectivity, discipline and patience. A lack of patience and discipline is the worst thing if you work in trading. Also, it is bad to let emotions influence your decisions, such as anger or ego, because ego makes you see what you want to see, instead of seeing what it is.
Results obtained

The results from this qualitative analysis are the following:

- Algorithmic traders

The three traders have said that to build an algorithm one must have knowledge about markets, find an economic driver to design the strategy and back test it. Once the algorithm seems to work, the trader has to put it in the real market and monitor it. Algorithms need a big volume of real and historical data, and usually they do not need human intervention.

The advantages that they have mentioned about machines are that the results are based in mathematics and statistics, hence the procedures are tangible, and they can use them to improve the algorithm. Apart from these advantages, machines allow humans to concentrate in other things and they can follow more companies.

The disadvantages of machines are mainly programming errors and the scalability of a mistake, as they are usually involved in operations with a large volume.

All traders think that human traders will not disappear, as there will be a collaboration between them and the machines. Nevertheless, human traders will have to know how to program and it is probable that they will have less influence.

The three respondents said that they do not see markets controlled by machines. Machines provide liquidity and their algorithms are improving. Raúl, trader at Esfera Capital, thinks that machines do not think by themselves, but that humans are responsible for machines’ decisions, as they have designed them.

Last, HFT is not seen as a bad think, they consider it as a different strategy, but they have mentioned that one must be careful before investing in that technology, as it evolves very quickly.

- Traditional traders

Human traders have said that they always follow the same strategy, although Jose Ángel Zabalegui also follows their instinct. In the question about keep following the strategy despite there is the risk of a big loss, one has said that he would check again the calculations and other one, Mar, said that she would continue with the operation. The three of them follow short and long-term strategies and they check almost the same type of information, with the exception of Jose Ángel, that also checks the changes in cycles.

In general, interviewees do not see the new technologies such as algorithmic trading or HFT as a threat. They see these technologies as an opportunity to increase their productivity or they seem them as a different strategy. Only Jose Ángel thinks that HFT is not fair, as everyone should operate with the same latency.
The main advantage of a human fund versus a quantitative one is, according to two of them, that a human’s intuition cannot be mimicked by a machine. Javier Magallanes mentioned that machines are not able to do a deep analysis of the fundamentals of a company. Jose Ángel and Mar both think that a positive thing about machines is that they do not get tired and that they are not disturbed by feelings such as anger or euphoria. According to Mar, many of her friends lose a lot of money due to the influence of their feelings.

To summarize, algorithmic and human traders have a positive attitude towards the presence of machines in trading, as they both think that humans and machines can collaborate. In addition, the two types of traders have recognized the superiority of machines in terms of speed, but they have agreed about the impossibility of a machine to mimic human’s creativity.
Results obtained
Social Responsibility

Social and Professional Responsibility Study

This study will be based on the Sustainable Development Goals. The Goals selected will be the ones that are affected by the scope of this work.

The Goals that this thesis contributes to reach, as well as the explanation, are described below.

- Goal 8: Decent work and economic growth

The objective of this Goal is to “promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”.

This master’s thesis contributes to this goal because it aims to clarify concepts about trading and investment. Once the reader ends the thesis, he or she has to have improved the comprehension of the trading industry and how it works.

By improving the comprehension, the reader can invest with more knowledge, and therefore obtain more return with his or her investment. If one invests with care and responsibility, the risk in which one incurs reduces.

Another important fact is that the money that is invested ends up in the companies that are part of a mutual fund, or in the owners of the security that is bought. That contributes to the wealth distribution as well as to the economic growth, because companies will have more money to carry out their business.

- Goal 9: Industry, innovation and infrastructure

The aim of this goal is to “build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”.

This work contributes to the last point: foster innovation. The new technologies that play a key role in today’s world (machine learning, artificial intelligence and big data) have been explained, so the reader can understand the power of those sciences and investigate them and apply them to his or her trading strategy.

As it has been seen, human and quantitative funds perform similarly, but quantitative funds can avoid the rationality that is characteristic of humans and perform better under stress situations.

With innovation, algorithms will arrive to a point in which they always maximize the return of their trading strategy, and more people will leverage that new advantage.
CONCLUSION

Conclusion

Within the behavioral economics and finance areas, the study showed the apparent lack of ability that humans had to control their feelings and emotions. One can arrive to the conclusion that humans are not qualified to invest due to three things:

- Aversion to loss: This characteristic can drive to a conservative investing style, that prevents humans from increasing their earnings.
- Unstable preferences: This characteristic can make that a human change its strategy depending on other factors that do not contribute to increase the return.
- Allocation effect: The fact that humans give more value to the things they own indicates that they may not make the correct decision of when to purchase or sell a stock.

All the previous facts are the source of the mispricing present in financial markets, according to what it was seen in the behavioral finance part. This is what originated the first hypothesis:

Can something help, or even overtake, humans?

If that “something” is a machine trained with artificial intelligence and machine learning, that has all the possible historical and present data synthesized and analyzed using Big Data techniques, and programmed to invest using an algorithm, then the hypothesis changes to:

*Can a machine perform better than a human?*

The mentioned machine is not a utopia, but a reality, as it has been proven in the modern trading section, concretely in the part about quantitative funds. To answer this hypothesis, a quantitative analysis was made.

The most important conclusion obtained from this analysis is that human funds perform slightly better than algorithmic funds.

The main explanation is that algorithms are designed by humans, and if humans are the ones who establish the criteria that the machine uses to invest, then the machine will have the same defects related to missed opportunities and failed investments.

Another explanation to this difference in performance is that, as it will be shown in the conclusions about the qualitative analysis, humans try to “act like machines”. They try to follow always the same rules, in order to avoid the influence of their emotions, so in the majority of the cases they eliminate that defect.

If machines are faster than humans are and they can analyze more data, and they do not have any feelings, so they are completely unbiased, why the results have shown that human funds control the trading performance? The response to that question seems to be also the main difference between machines and humans: human intuition.
In the end, one has to have clear that finance reflects the economic behavior of humans. The consequence of this is a difficulty for machines to understand humans, and it explains why humans can understand or even “predict” what other humans will do, as they belong to the same species.

With the study of the behavioral economics and finance science, another hypothesis was formulated:

*Are human characteristics the defect that causes the mispricing in financial markets?*

To answer this hypothesis, a qualitative analysis was made. The conclusions about that analysis are the following:

It has been proven that people’s preferences are neither stable nor homogenous and that they have aversion to loss. The traditional traders answered that they usually follow the same strategy, but each of them has their own, and that they sometimes change it due to intuition or due to a risk of losing a big quantity of money. The three of them said that, to succeed in trading, one must be very disciplined and “act as a machine”, therefore, this characteristic may be one example of a cause of the mispricing in markets.

In addition, the allocation effect was proven. Algorithmic traders tend to give more value to their algorithm, they think that is better than humans and they are not considering changing it, and traditional traders give more value to human creativity and human presence, rather than algorithms, although both types think that a collaboration would be a good thing.

The result is that humans, at the moment of creating the algorithm, transmit their flaws to machines. Algorithms may not be influenced by anger or euphoria, but they still have stop losses that may prevent them from achieving a higher return, or they have received the order of not selling a certain type of stock just because the team that programmed the algorithm believes that owning that stock is important.

Answering to the question formulated in the hypothesis, and according to the opinion of the author, the human characteristics are the cause of the mispricing in financial markets. The Efficient Market Hypothesis stated that agents had the characteristics that traditional economics assumes: complete rationality and independence.

As it has been seen, this is not true, human characteristics are more similar to the statements of Behavioral Economics: Influence of feelings, interaction, and change of preferences, so financial markets reflect these behaviors.

Even machines reflect these behaviors, as humans create them, although it is true that machines do not have feelings and that a successful trader has to resemble a machine in that aspect.

To sum up, both quantitative and qualitative analysis have shown that humans will always be superior to machines because they have creativity and instinct and because machines are created by humans. However, machines and humans can obtain better results if they collaborate and machines cover the flaws of humans.
FUTURE LINES OF INVESTIGATION

The quantitative analysis was made comparing quantitative funds with funds managed by humans. As it has been seen previously, quantitative funds follow algorithms designed by humans, and these algorithms have some of the inherent characteristics of humans, which makes difficult to evaluate accurately the true potential of a machine.

A future line of investigation would be creating a machine that explores financial data, historical and current, and that creates the algorithm once it has explored all the data, with no human intervention. That would show the real performance of a machine in trading with respect to a human.

This machine would have to be created using Artificial Intelligence and Machine Learning, because it has to learn to identify financial patterns and economic drivers, and it also has to learn how to program, in order to program its own algorithm.

There are multiple courses in the internet that explain, once controlling the two mentioned technical fields, how to build an algorithm capable of investing.

The difficult part of this future line of investigation is that the human just builds the machine, and it will be the machine the one that designs the algorithm.

In opinion of the author, it would be really interesting to make this test, because it will really show the potential of humans and machines.
Conclusion
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Temporal Planning and Budget

Temporal Planning

- Project’s Breakdown Structure

As it can be seen in the index, the project is divided in seven parts (without taking into account the introduction), that are the fields of domain, traditional trading, modern trading, quantitative analysis and qualitative analysis, social responsibility and conclusion.

A project breakdown structure consists in dividing the project into the different parts that are necessary to accomplish it. In this case, the necessary parts to accomplish the mentioned project are indeed the seven parts mentioned at the beginning of this section.

Below is the project breakdown structure, with each part explained:

- Fields of domain: This part requires to study each of the fields of domain that one has to comprehend before reading the thesis. These fields are Big Data, Artificial Intelligence, Machine Learning and Trading.
- Traditional trading: This part contains the explanation of behavioral economics, the response to conventional economics, that explains what the characteristics of the human being are in terms of behavior. It also contains the explanation of behavioral finance, that is a science that aims to explain how the human behavior has an impact in the financial markets. Last, it contains facts about the normal day in a trader’s life.
- Modern trading: In this part, it can be found the new trends that are present in trading, index funds, ETFs and the most important one, quantitative or algorithmic trading. At the end there are the needs that a company that wants to implement algorithmic trading has.
- Quantitative analysis: Comparison of the performance between quantitative funds (funds that base the selection of stocks in models designed by algorithms) and human funds (funds in which a human team decides in which stocks to invest).
- Qualitative analysis: Interviews and opinions from experts that work in the trading industry, both algorithmic and traditional trading.
- Social responsibility: Impact of the work in environmental, social, ethical and legal terms.
- Conclusion: Presentation of the conclusion to which the author of the master’s thesis has arrived, once the work has been completed.
Budget

- Gantt’s Diagram

This paper was started in July, when the proposal from the author was made to the thesis professor, and the scope of it was established. It ends in January, as it is the limit date to deliver the thesis to the University.

The Gantt’s diagram shows the time distribution for each of the parts.

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Image 5 - Gantt's Diagram

Budget

The easy way to do the budget is to calculate the number of hours the author has spent doing the work. The number of hours can be obtained from the number of ECTS this master’s thesis has assigned.

In the master’s program one can see that the master’s thesis subject has 12 ECTS. It is known that 1 ECTS is equivalent to 25 to 30 hours of work. If 12 is multiplied by that range, the number of hours necessary to accomplish this paper must be between 300 and 360 hours. The wage paid per hour may be multiplied by 300 and 360 to obtain the budget range.
Difference between computers and humans in trading