ICADE

The application of Automated Valuation Models on value investing

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MADRID – Diciembre 2023

Abstract

This article is an examination of the benefits and advantages of using automated valuation models that predict the movements of the S&P 500 to enable long term investors to maximize value by lowering their average purchasing price. In the article the history of S&P 500 is examined as well as its historical returns. Additionally, the article explores the economic situation that Americans face mainly when they retire and proposes a feasible solution to make the financial situation of individuals by using value investing. Lastly, the article explains how a model has been developed to predict the movements of the S&P 500, allowing anyone to use it as a guide with the proposed strategy, which suggests a rational step by step set of instructions that leaves no doubt about how to take advantage of the model.

Keywords: finance, statistics, investing, ETFs, regression

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1. Introduction

Only 33% of generation Y, comprised by those born between 1980-2000, believed in 2016 that they were in a position to have a better life than their parents (Ipsos More, 2016) and it is said that "the average millennial has experienced slower economic growth since entering the workforce than an other generation in the US history", according to Andrew Van Dam in an article for the Washington Post named "The unluckiest generation in US history".

The truth is that the younger generations have faced quite a bumpy ride from an economic point of view, someone born in 1990 was 18 when the 2008 housing bubble crisis exploded and 30 when the Covid 19 pandemic breakout happened. Furthermore, in the USA many students leave university with huge amount of student loan debt which they struggle to pay for, while the housing prices increase and cost of living rises.

In this context the personal financial management is key, and within this topic I believe that investing can play a key role in helping households and individuals reach their financial goals and build wealth on the long term to provide stability. However, investing nowadays seems like a very technical thing to the general public or sometimes, and with certain assets (crypto coins), it can appear to be more similar to gambling. Social media platforms are filled with "gurus" who claim to have the exact right method to analyse the market and ensure that trading allows them to travel the world and work for just 3 hours a day from anywhere. Most of the time these are scams which are taught in courses that have to be paid for, and do not provide clients with the right set of skills to make a living of trading, in fact, in 2022 roughly 90% of individual non-professional investors lost money in the stock market (Chettiar, 2022)

As an alternative to this, I would like to introduce the concept of value investing. The fathers of value investment (David Dodd, Benjamin Graham, Warren Buffet, Peter Lynch) agree on the theory of maximizing value by choosing an asset with fundamental upside and trusting that markets will, on the long run, recognize its value. They defined the difference between an asset´s intrinsic value and true value as "security gap" which is meant to narrow with time and as markets begin to realise the value of that certain asset (Bestinver, 2023).

However, value investing is not always this straightforward as a lot can happen during the time it takes for the security gap to narrow. Markets, and there for individual assets, can be affected by numerous variables which might bring down or rise security prices. My choice of topic comes from the desire to track these variables to allow value investors to enter or exit investments at the best possible time to optimize returns.

My investigation objective is to create a regression model which allows to accurately predict the S&P 500's movements 30 days forward taking macroeconomic data as an input. As a result I expect to get an idea on what are the variables affecting this index most, and ideally develop a full model as a tool for investors to leverage to optimize their returns. If a full model is not developed I will try to at least make some advances where future researches can pick up from to carry on with the development of the topic.

As a secondary objective I intend to simulate a dollar cost averaging investment strategy following the insights provided by the model and compare the returns with the same strategy without the model.

The process I will follow along my investigation will be to firstly look into the history and returns of the S&P 500, to understand what it is and the value that it can offer investors. The I will dive into the dollar cost averaging strategy, which I will compare with the classic long/short method to highlight its advantages and disadvantages. Linked to this topic I will look into ETFs are they have made a huge impact on today´s financial markets and have changed the way people invest, opening a new very wide range of possibilities. After looking at that I will jump to have a look at the economic situation in which a lot of individuals in the US are currently in, and the big difference that investing can make on the long term for a lot of people.

After giving context to my investigation, I will move straight to AVMs, giving some context about what they are and the differences there are between applying them to real estate and to the stock market. Here I will give a general overview of the theory around regression modelling. Afterwards I will go into full detail about the variables I have chosen to run the model, giving a theoretical overview and some context to them. I will also look at the recent economic history to be able to put the numbers and their tendencies into context.

Once the variables are discussed, I will run the model and make the corresponding adjustments to optimize it. When I get comfortable with the model, I will take some of the observations out of it to run the resulting parameters and see how well the model does on predicting movements. Finally, I will sum up my conclusions and depending on the outcome of the model I will share my thoughts about what the best way to use the model is and the strategy I would personally recommend to follow.

2. Theoretical frame

2.1 History of the S&P

The S&P 500 Index was first compiled in March, 1957 and it is the most commonly-used benchmark for profitability in the equity financial markets, even more so for US stocks. The index of 500 stocks covers the vast majority of the largest 500 American companies by market value. 83% of all regularly traded stocks in New York, American and Nasdaq stock exchanges were comprised by the S&P. (Schwartz, 2004)

Originally, when the S&P 500 was created it was made up of 425 industrials, 25 railroad, and 50 utility firms, and it was not until 1976 that 40 financial stock were added, reducing industrials to 400, transportation to 20 and utilities to 40. In order to maintain diversification and to keep the index representative of all US trading stocks, the industries in 1988 Standard and Poors eliminated the fixation of industries. (Schwartz, 2004)

This index is constantly updated and on average 20 companies every year make the index after reaching Standard and Poor's requirements for profitability, valuation, earnings and overall financial health. On the other hand, an equal number vanish from the index due to elimination, mergers with other corporations or other corporate changes. Since the inception of the index over 1000 firms have been added and a similar number have been deleted.

2.2 S&P returns

It is well known that that over time, the S&P has beaten the returns of investors, mutual funds, and the majority of money managers. Despite the fluctuations, which are impossible to avid, over the last 25 years (1996-2022) the S&P has returned an average of 9% yearly. The index dropped in 2000, 2001 and 2002 to then drop by 37% in 2008 and by 22% in the first half of 2022.

Despite the worst value drops of that period being larger than the most positive performances (1997,2014,2019), the overall positive trends of the market drove the total market cap of the S&P 500 from $10 trillion in 2001 to $32 trillion by June 2022, showing the resiliency of the index and the benefits of the "creative destruction" process described by Schumpeter, in this case referring to the substitution of underperforming stocks by emerging companies in the index, which creates a dynamic of constant value creation. (Gupta, 2022)

2.3 Dollar cost averaging and ETFs

For an asset which seems to have a proven long term value creation record (even though past returns do not (Gary Smith, 2018)Dollar cost averaging consists of spreading the purchases of an asset over time (in this case a month). Applying this method to an asset which fundamentally has the ability to appreciate over time should make the investor purchase it at different prices. Making consistent purchases of an asset means that over time some purchases will be made at high prices and some will be made at low ones. When purchases are made at high prices it is very likely that the profitability is low over the medium term, however this negative effect on overall profitability is offset by purchases made when the prices are low.

Another important feature of this strategy is that the amount of the investment should remain constant, acquiring less shares when prices are high and more shares when the prices drop. Because the average cost is weighed by

the number of shares purchased at each price, the average price will always be higher than the average cost as seen on the table below

Assuming a constant investment of €900 over two periods on a stock worth €50 considering a scenario of a 50% increase and another with a 50% drop

50% Downside case			
	Price	Cost	NOSH
Period 1	50	900	18
Period 2	25	900	36
Average	37.5	33.3	

50% Upside case			
	Price	Cost	NOSH
Period 1	50	900	18
Period 2	75	900	12
Average	62.5	60.0	

Even though the average price of the share is constant on both scenarios, investors should not be misled by it as this does not mean that the portfolio is always profitable, in fact the downside case portfolio is 25% down while the upside case is 25% up. The strategy will only work if the average return of the asset is positive over time.

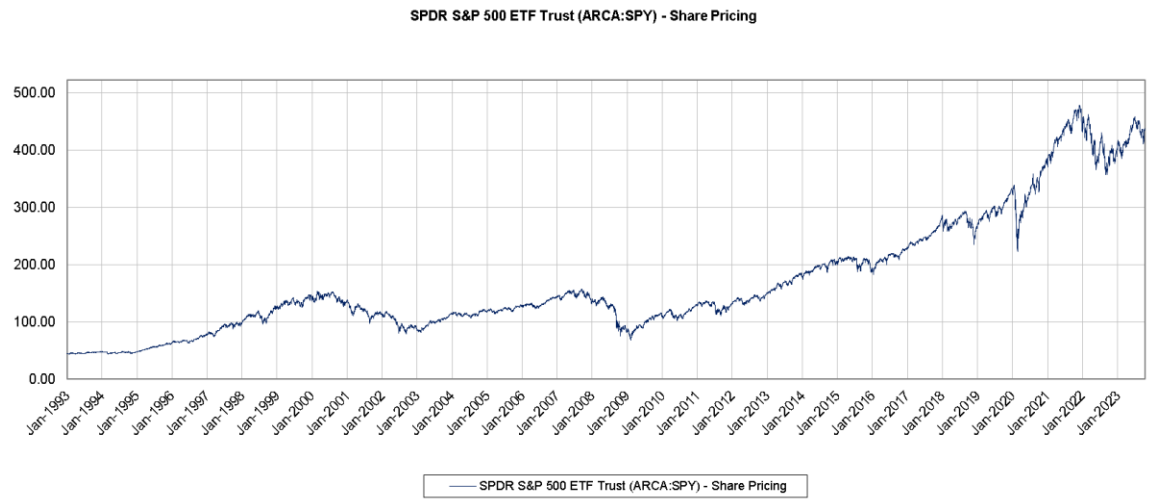
Also notice that a long short strategy, which consists on buying underpriced assets and selling underpriced ones, will always be more profitable as being on the stock market I always more profitable than being out (Gary Smith, 2018)

The long, short strategy however has some flaws to dollar cost averaging; the first one implies constant analysis of securities to find mispricing in the market, also this analysis can be wrong or new factors can appear during the investment period. For the average retail investor, the repetitive mechanism of dollar cost averaging and the (almost) certainty of profitability if there is conviction of a long-term upside makes it psychologically easier to access. Also, in a worst-case scenario of adverse conditions, the investor using dollar cost averaging can choose not to deploy capital during a certain period to carry on investing when the environment is friendlier. The strategy allows diversification of investment decisions over time, so despite not being optimal, it is an accessible way for smaller investors to create value in the stock market.

From a personal financial management perspective, dollar cost averaging also seems to be a better option for investors, as they can make the choice of what part of their income they want to allocate to investments and stick to it on a consistent basis without having to make decisions other that what asset they want to apply this strategy to, or even choose a few different ones if they want to diversify.

An ETF is an investment vehicle that aims to track a certain index, the first one (SPDR) was the first US Listed ETF and aimed to replicate the performance of the S&P (Lettau, 2018)

The original SPDR ETF has appreciated since its inception and even through the 2008 and 2020 crisis it has shown resiliency to appreciate (Capital IQ, s.f.)



However, as the ETF product developed, new ETFs can be found on commodities, industries, or regions (Emerging markets, semiconductors…). More recently and with the popularization of responsible investing, ETFs have been created on companies that meet specific ESG criteria (women leadership, racial inclusivity, environmental responsibility)

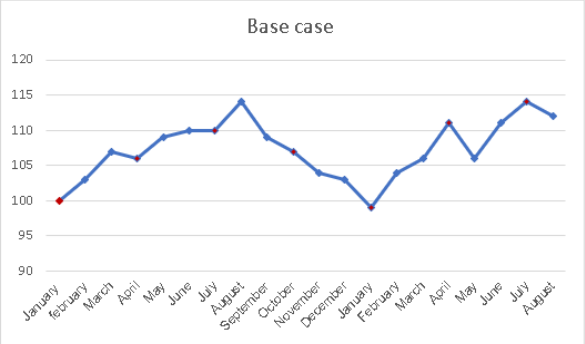
Investing on ETFs is also known as passive investing, as the portfolio management is limited to the automated tracking of an index, this also means that ETF investments hav4 much lower fees than mutual funds as the need to monitor the investment is minimal.

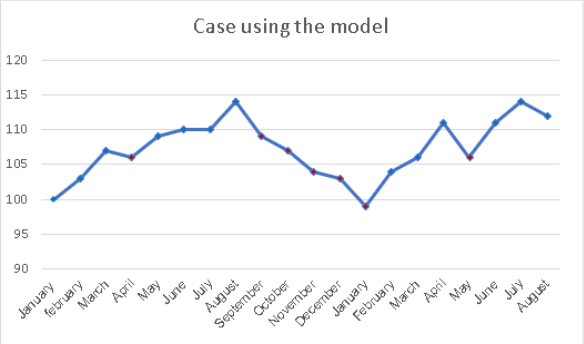
Retail investors are now in a very favourable environment to get involved in the stock market, as there are a wide range of products available to facilitate investment decisions. ETFs (Exchange Traded Funds) allows investors to get into any industry/asset class/market without having to go through the stock picking process, which has been left for professionals.

The investment timing can make a big difference in the overall profitability of this strategy, even though we are talking about intrinsically valuable assets which should appreciate over time, the ramp up period may be cyclical and buying at the peaks or at the lows of those cycles will have a considerable impact on profitability of the investment.

This is the aspect of this strategy that the model I am making pretends to address. The model should be able to tell the investor if the price of the S&P 500 is expected to increase or decrease in the following 30 days. In case of the price increasing, the investor can save his capital and deploy it on the following month if the model predicts a price drop See the graphs below.

Base case assumes investment is made every three months, and the model case assumes investments are only made if a depreciation prediction is made by the model. Red markers indicate investment





The return of the security over the period was 12% and the base case saw a 5.2% return, while the return of the model case was 7.1%, which is 37% higher than the base case. Of course, assuming 100% effectivity of the model is not realistic, but this explains how much value can be crystalized if the investment timing is optimized. If 60% effectivity is assumed, we would expect a 22% upside vs the base case which is still worth it.

2.4 The financial management problem

51% of Americans earning over $100,000 live pay check to pay check and more than half Americans feel like they feel like they are not saving enough for retirement (Armstrong, 2023). If those earning $100k per year invested a monthly amount into the stock market (S&P 500) through an ETF along the duration of their professional careers, the compound interest effect would multiply savings and bring financial safety to this people.

The American law gives benefits to investors which make this strategy an even better choice.

- Roth IRA (Individual retirement account): this retirement account model allows investors to make contributions until age 70 and a half and to make tax free withdrawals from age 59 and a half assuming the account vintage is over 5 years. The maximum contribution to these accounts is of $6,500 per year, which would equal to $500 per month and the eligibility to open this accounts depends on income, not allowing high earners to open one (IRS, 2023)
- 401k plans: this retirement account plan for active employees allows them to choose what portion of their salary they are willing to save, and in which way they want to do so (ETFs being an option). The best part is that in many cases the Company will make an additional contribution to the retirement plan of up to 100% of the employee's contribution. (Bank, 2016)

These benefits should be a significant incentive for individuals to consider investing in the stock market. Even in the case of non-American investors, the compound interest effect on a monthly investment of $300 can make a significant impact on the financial stability of the average household considering this data on the median net worth in America in 2022 published by the Motley Fool, a financial advisory firm from Virginia, USA. (Federal Reserve, 2023)

- For the age group 55-64 the median net worth was $364,270
- For the 65-74 bracket it was $410,000

- People over 75 years old have a mean net worth of $334,700

Notice how after 75 the net worth figure decreases due to most individuals having retired already and are spending more than they earn.

Having those figures in mind let's have a look at this sensitivity table which analyses the balance of a 40 year monthly investment in the stock market. As already mentioned the original S&P500 ETF has had an average return of over 8% since inception, in this table I have looked at four different possible scenarios. First we have the 7% pessimistic scenario, which still provides a balance higher than the average net worth for 55-64 year old Americans. The base case scenario would be between 8-9% and crosses the half a million-dollar milestone balance with monthly additions of $200-300 dollars. Just to point it out again, contributions do not always have to come entirely from the investor in the US, many company benefits include 401k regimes.

Annually compounded, a $100 monthly invested has been considered as a $1,200 annual investment which is compounded at the correspondent yield on an annual basis. No principal considered

		Average annual yield			
		7%	8%	9%	10%
Monthly investment	$ 100	$ 134,039	$ 189,951	$ 268,473	$ 378,463
	$ 200	$ 268,077	$ 379,903	$ 536,947	$ 756,925
	$ 300	$ 402,116	$ 569,854	$ 805,420	$ 1,135,388
	$ 400	$ 536,154	$ 759,806	$ 1,073,894	$ 1,513,850
	$ 500	$ 670,193	$ 949,757	$ 1,342,367	$ 1,892,313

2.5 Application of automated valuation models

Going back to the main topic of this investigation, now I will explain how an automated valuation model can be used to maximize the value creation potential of the dollar cost averaging strategy to allow investors to crystallize more value from their investments. But first let's look more into automated valuation models.

An automated valuation model is defined as a mix of mathematical and statistical modelling to calculate asset values, comparing the current value to other assets at the same point of time. The capabilities provided by big data evolution have scaled the spread of this techniques due to the efficiency they bring to the valuation tasks as they provide more speed, bring cost savings, allow for scalability, and assure consistent results. (Royal Institution of Chartered Surveyors, 2022).

These models have spread quickly across the real estate industry as due to the nature of its assets, the asset type comparability degree is higher and pricing is mostly set from a comparables perspective. However this is very different in the stock market as to begin with, valuation gaps to target prices are a lot larger than those in the real estate market. Furthermore, properties are a lot more comparable than companies. Properties of the same characteristics and location will be priced equally most of the time, however companies from the same industry and sector which sell the same product may be regarded very differently by investors because there are many more considerations and complexities to take into account.

If still in doubt about my last statement have a look at the table below. The table shows 25 listed companies from different industries with high market cap and enough average daily trading volume to generate a healthy level of liquidity for the shareholder that trade at very different levels if discount to the target price provided by equity research analysts consensus (Bloomberg). It is very hard to find assets in the real estate market priced at a 40% discount to their intrinsic value. (table located on the next page)

The table below contains data from Bloomberg as of 16th of November 2023

Name	Sector	Mkt Cap (€m)	% 52W High	Disc./(prem.) to target price (%)	YTD performance
ArcelorMittal	Industrials	18,318	70.4%	40%	(13%)
Cellnex	TMT	23,229	84.4%	36%	6%
IAG	Airlines	8,973	90.4%	32%	31%
Bankinter	Financials	5,560	89.2%	31%	(1%)
Acciona	Infra	7,244	69.1%	31%	(23%)
CaixaBank	Financials	30,294	96.2%	31%	10%
Banco Santander	Financials	59,719	95.3%	31%	32%
Nexi	Financials	9,081	77.8%	29%	(6%)
Allfunds	Financials	3,670	61.7%	29%	(11%)
Banco de Sabadell	Financials	7,132	95.0%	28%	44%
ACCIONA Energia	Utilities	9,140	70.1%	19%	(23%)
Merlin Properties	Real Estate	4,085	92.1%	16%	(1%)
Endesa	Utilities	20,254	88.9%	16%	8%
Amadeus	Tech	27,724	87.6%	15%	27%
BBVA	Financials	48,726	98.4%	15%	45%
Azimut	Financials	3,093	90.6%	15%	3%
Telefonica	TMT	21,392	89.7%	14%	10%
Mapfre	Financials	6,221	98.2%	13%	12%
Iberdrola	Infra	69,885	89.9%	11%	1%
Red Eléctrica	Utilities	8,181	84.5%	11%	(7%)
Inditex	Retail	109,426	97.4%	11%	43%
Ferrovial	Infra	21,828	97.2%	10%	22%
Aena	Infra	22,740	97.3%	10%	29%
Fluidra	Industrials	3,610	86.1%	7%	29%
Enagas	Utilities	4,202	86.5%	6%	3%
ACS	Construction	9,892	99.9%	(3%)	33%
Naturgy	Utilities	25,986	92.8%	(7%)	10%

In this case we will be looking at the valuation of an index. In fact, for the investment strategy which we have been discussing, knowing if the value of the index will be up or down in a month should be enough to make an investment decision, the actual target price would be a lot harder to estimate correctly, and given the long term approach to the investment it is not as relevant. It must remain clear that the objective to maximize value is to lower the average purchasing price

Also, an index is more linked to more tangible economic variables than a single company, as it is quite likely that there are qualitative variables such as strategic decision or specific supplier issues which are harder to model.

My approach to create a model for this case will be a regression model analysis is a way to statistically segregate which variables have a larger impact on a certain outcome. But furthermore, it helps to understand in what way each factor affects and the relationship between them. (Gallo, 2015). In this case our dependant variable is the SPDR S&P 500 ETF price 30 days after the date in which we observe the independent variables.

The result of a regression model is a formula which gives the values of the independent variables a parameter (beta) and adds a residual error term (U), which represents the part of the dependant variable which is not explained by the independent variables.

$$Y = x1 * \beta x1 + x2 * \beta x2 + x3 * \beta x3 + \cdots xn * \beta xn + U$$

The method used for estimating the parameters is called ordinary least squares and it is used to obtain the parameters which apply to each of the independent variables. The goal in this method is to minimize the sum of the differences between the independent variable values and the predictions the model would have made with the available data. Equations are solved to get to the minimal value of the coefficients that lead to the optimal fitting line. Once the parameters are found, this are fit into the model to make new predictions with different data. (Amaral, 2021). In this case I will use GRETL as the software to help me with my calculations.

There are other types of models, for example, when the dependant variable is binary, or categorical, meaning that it takes one out of two possible values, categorical values can always be summarized into 1s and 0s. These regressions are modelled as a logit of p, being p the probability of the dependant variable taking value of 1. (Penman, 2022)

2.6 Variables

In order to feed the model I have used a set of 5,000 pieces of cross sectional data dating back to 2003. The variables I have chosen are mainly quantitative as most of the variables affecting the economy are. I understand that market sentiment, defined as the belief about future cashflows and investment risks which is not justified by factual arguments, (Baker, 2007), is an important fact to take into consideration for equities market valuation. However, for this case and given we are looking at an index containing the 500 largest companies in the US, I am going to assume that general market sentiment about the stock market will very likely be a product derived from the general confidence on the economy and on the economic decision makers to provide a safe environment for businesses to develop and for demand to grow, and all of this is directly linked to the variables I have chosen.

The data set I have put together from multiple sources dates back to 2003, I chose to look so much into the past because since the world entered the 2000s the financial markets and the economy in general have gone through a lot of contraction and expansion, and I believe that watching all the iterations between variables and how they have affected the growth of the S&P was going to be beneficial for the model.

Before looking into what variables I have considered for the model I think we should look at what has happened over the last 20 years and the effects it has had on the financial markets. Here are some of the major recent-economic-history periods:

The financial crisis (2007-2008)

(Duignan, 2014) The collapse of the U.S. housing market caused the failure of major banks and mortgage lenders among other financial industry companies. This was the result of a continued lowering of interest rates by the Federal reserve, which enabled banks to extend consumer credit a low prime rate, leading to consumers increasing house purchasing. This situation steadily led to an increase in prices exceeding the intrinsic value of the assets, also known as a bubble. Meanwhile, consumers kept borrowing money from banks, frequently using the houses as a collateral. Furthermore, banks used the increasing amounts of mortgages to create securities (mortgage-backed securities) which were sold to investors in the capital markets as a way to increase their liquidity and reduce risky loan exposure.

The problem appeared when the Federal reserve began to increase interest rates, leading to default of those borrowers of adjustable-rate mortgages. As panic began to spread, the demand in the housing market decreased, which lowered the prices and disabled many borrowers to rescue themselves from default, as their houses were worth less than their debt. The S&P 500 fell by c.50% from its peak in 2007 to March 2009 (Dwyer, 2009) and the aftermath was a worldwide financial crisis and economic contraction.

Post financial crisis recovery

(Strain, 2021) The recovery from the Great recession was the longest lasting period of economic growth in the US economic history, characterized by a positive job creation trend and output growth. Even though the growth streak went on for a whole decade, the recovery was slower than it had been after previous financial crisis, for example, the three previous recessions only saw six years pass by before unemployment levels were back down to healthy levels, but for The Great Recession 9 years had to pass.

The general response from countries to the crisis was to do as much as possible to bring back economic activity, try to preserve main financial institutions to prevent further damage and to provide businesses with a shield that allowed them to carry on with their activity, avoiding job cuts. The OECD countries introduced stimulus packages to incentivise the economy and push demand in the short term, allowing to preserve existing jobs. Furthermore, those sectors which where considered to be key economic drivers, such as the construction or automobile sector where also stimulated by most of the governments. (OECD, 2009)

Other measures implemented aimed at supporting households with, for example, tax cuts, support for low earners or cuts in healthcare costs, but also to aim at long term growth through innovation.

Eurozone Crisis (2010-2014)

(Ray, 2023) Also known as the debt crisis, this was a direct consequence of the 2008 housing bubble crisis which is explained above. In Europe, the first country to be affected by the financial crisis was Iceland, which had a massive financial sector which exceed over 1,000% of its GDP due to the heavy reliance of its banking system on foreign investment. On the other hand, during this period the country´s debt levels were over 500% of its GDP, a lot higher than the European Union standard of 3% per budget year. A funds exit in 2008 caused the system to collapse and when Iceland's government stated that it would rescue domestic investors but not foreign ones, the financial systems of the Netherland and the United Kingdom were also teared down, with around 350,000 depositors losing $5 billion.

The debt levels of many countries were above the European imposed 3% of the annual budget, and their inability to deal with their liabilities began to threat the existence of the Euro, however, the German Chancellor at the moment, Angela Merkel along with the French President, Nicolas Sarkozy and the European Central Bank, led the efforts to create a European Funded Bailout Plan, which allowed seriously indebted nations such as Spain or Greece to repay their debt with loans from the EU and the IMF under the willingness of those favoured by the program to implement economic measures to avoid repeating the same event.

Covid 19 Pandemic

The Covid 19 crisis was the end to a period of economic expansion, in the beginning of 2020 the media started to fill with news about a highly contagious virus originated in Wuhan, China. After only a few weeks, all countries were imposing lockdowns, travel restrictions and testing protocols while cases of Covid surged at unbelievable rates. The lockdown length was variable across countries but most of them had them last at least two months. The slowdown of the economy was not only due to lockdowns, as when this were lifted a whole new set of restrictions such as social distancing, indoor dining prohibitions, strict travelling regulations and others held back the economy from returning to normality.

The stock market was heavily impacted by these events and Wall Street delivered its worst figures since the 2008 Great recession, with the S&P 500 index falling by 19% and tech stocks even lower to 24% (US Bank, 2023).

Even though this are the major events which had a larger global impact, there are other key events such as the Russia-Ukraine war which has brought a lot of instability to Europe as the reliance on Russian Oil and Gas has increased the prices of commodities and raised the question about energetical sovereignty in Europe.

Even though it is hard to summarise every detail of what has happened during the last 20 years, it surely has been enough to be sure that the data set that is going to feed the model shows a fair image about how the market moves and how those movements relate with other indicators.

Below is the set of variables I have included in my sample data set. Along with them I have included some basic statistics to allow better understanding.

- Average: the sum of all the values of a group of observations divided by the number of observations
- Median: the middle number of a group of observations or data set

- Standard Deviation: (National Library of Medicine) it is a measure of how dispersed data is in relation to the mean, therefore a large or small result will indicate a high degree of variability in the dataset, while the closer it gets to zero the tighter around the mean data will be.
- Lowest: the smallest observed number
- Highest: the largest observed number

Dependent variable:

My dependant variable of choice is the price of the SPDR ETF thirty days forward. To get this variable I sourced on Bloomberg to get the daily price on every market trading day since 01/12/2003. The reason for this date to be the starting point is that some data bases for the other variables did not date further back. I took the price data and matched it with the thirty day before date, so that when observing the variable on the, for example, 1st of June 2010, the data figure would be the price of the SPDR ETF on the 31st of June 2010. The variable is measured in dollars.

Independent /explanatory variables:

Price of the SPDR ETF as of the observation date

This was the open price of the ETF provided by Bloomberg in dollars. The reason to include this variable was that there it is definitely explanatory to the price in 30 days, the way I think o it is that the model will kind of use it as a starting point, so I expect a very low beta coefficient for this and a high p-value as the significance of the price at date should be very high when defining short term future prices. The variable observations were extracted from Capital IQ, a market information bank created by Standard & Poor's. The main statistics for this variable are the following:

- Average: 210.7
- Median: 176.1
- Standard Deviation: 105.8
- Lowest: 67.9
- Highest: 479.2

An observation that can be made is the difference between the lowest and the highest value. The lowest value was achieved in 2009 while the highest value was reached in 2022, so in the case of having invested in 2009, the result would be a c.7.1x Money on Money, and an IRR of 16.1%, which for a lot of portfolio managers would be a more than satisfying result.

The graph of the share price performance can be seen on page 3, we can see two very clear periods, one until 2012, and another from 2012 onwards. The first one shows a steady upward tendency with some bear market periods which are slowly recovered. The second period shows a steeper curve, with nearly vertical recovery after it hit a bottom peak during the Covid 19 crisis, but entering another valley 24 months later. Also, the post Covid period has seen a lot more volatility than the historical tendencies.

According to Morningstar, the returns for the SPDR ETF are the following:

- YTD: 18.02%
- 3Y: 12.40%
- 5Y: 13.50%
- 10Y: 13.77%

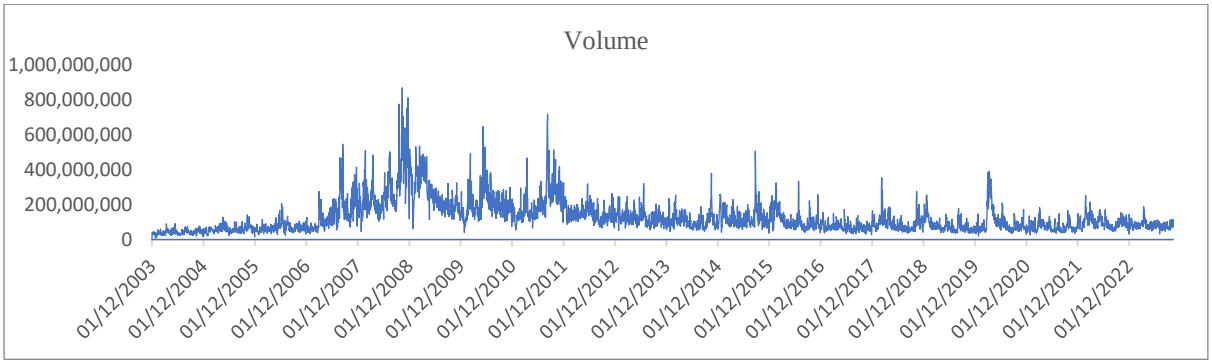
Volume

This is the volume of the asset which was traded (or changed hands) on the stock market on a certain day. This variable is interesting to observe because it has an implicit explanation for market sentiment and investment appetite, therefore it is widely used by traders to identify patterns and have a general overview on what strength there is behind market moves. It is also considered by investors because it gives an idea of the liquidity of an asset, investors usually prefer liquid stocks if they can choose because it gives them more flexibility on buying and selling, even more if they are trading large amounts of capital. The value of this variable is calculated as number of shares traded in the market times their price and is measured in the same currency as the asset, so dollars for this occasion. Below is a summary of the main statistics of the observations

- Average: 124,964,203.2
- Median: 94,933,700.0
- Standard deviation: 92,254,149.8
- Lowest: 8,055,800.0
- Highest: 871,026,300.0

Even though it may seem like the highest and lowest figures are very different, it must be taken into account again that these are monetary volumes, and not share volumes, that is why unsurprisingly, the dates of highest and lowest volumes and prices are very close to each other.

The graph below shows the volume across time, and it can be seen that there is a period of more activity in the trading of the security. During the 2006-2007 period there was a considerably higher volume of trades, however the share price was lower so we can assume that it was the volume of shares which was higher than it is today.



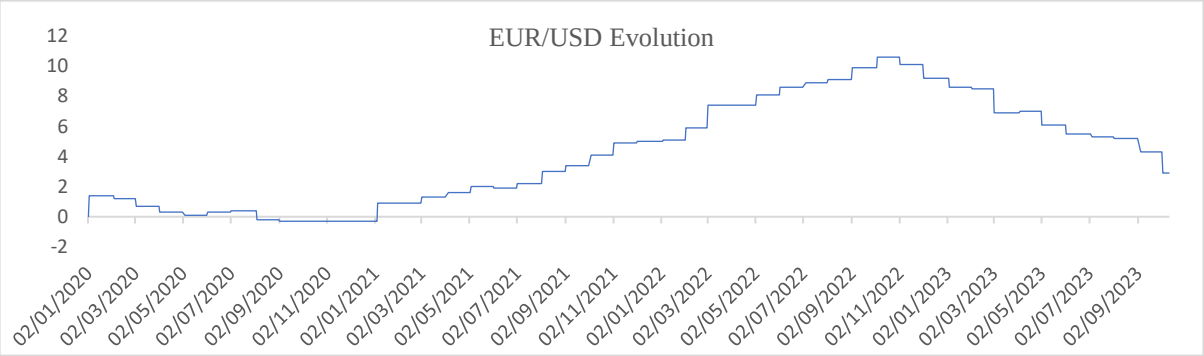
Eurozone inflation

Even though the S&P 500 is an American index, many of those companies have a global reach and are very internationalized, and therefore are affected by what happens elsewhere.

Inflation measures the price increase in goods and services over a certain period, in this case I have collected monthly data in order to track as accurately as possible the iterations with the dependant variable. The way it is calculated is as a percentual increase on CPI, consumer price index, which is a representative average of the prices in a country and is kept constant over time to avoid consistency issues.

The unit of measure of this variable is %, being a positive figure an increase in prices and therefore inflation and a negative figure a decrease in prices also known as deflation. (Oner) Most governments aim to keep inflation at a 2% yearly because it allows economic agents to make decisions about spending, borrowing, and investing with certainty about what prices will be looking like (Board OF Governors of the federal Reserve System, 2020). Even though it could seem sensible at first to aim at below 0 levels of inflation (deflation) due to the attractiveness of lower prices, this is not a good idea if it is given a second thought, as consumption would slow down if prices are expected to decrease, which could be incredibly harmful to the economy. (Oner)

- Average: 2.11%
- Median: 1.80%
- Standard deviation: 2.00%
- Lowest: -0.60%
- Highest: 10.6%



A positive comment about this variable is that apparently, on average, regulators in Europe have been able to keep inflation within their objective figures. The highest inflation reached in the Eurozone was in November 2022. These was the year when the Ukraine-Russian armed conflict started, creating a lot of uncertainty around fuel and energy due to the high dependence of Europe on Russia on this matter. Furthermore, other industry driving raw materials such as semiconductors were experiencing (and are today) a shortage, while the weight of China and Taiwan on the production of these and the tension between the regions creates more uncertainty.

Breakeven inflation rate 10yr - US

This inflation rate is calculated by comparing an inflation linked bond with a nominal bond of the same maturity and aims to predict the effect of inflation on certain investments (Colestock, 2023). The result tells investors the needed inflation to make no profit or loss (breakeven) when buying a bond. The reason to include this variable is

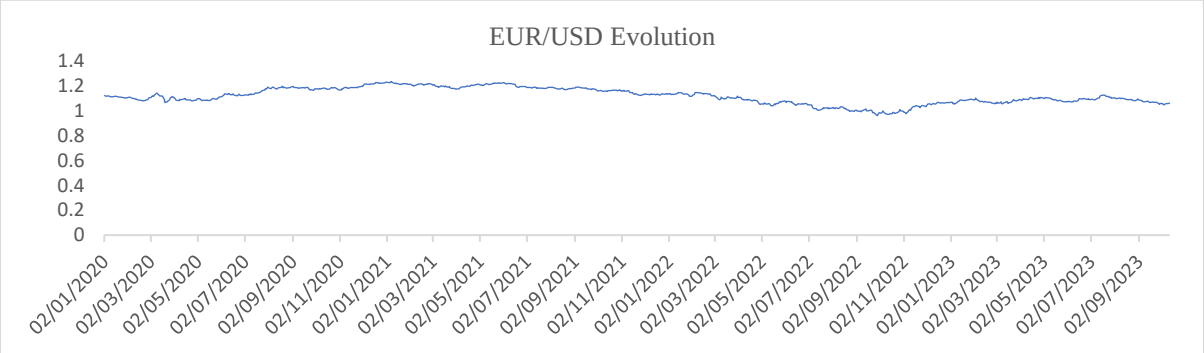
to see inflation from another perspective which is domestic to the S&P500. In this case I have used daily data as it was the highest frequency, and as before, I think that the more frequent the data the easier it will be to see the interaction and effects on the dependant variable

- Average: 2.09%
- Median: 2.19%
- Standard deviation: 0.4%
- Lowest: 0.04%
- Highest: 3.02%

EUR/USD

Currency is a good indicator of how the economy of a country is doing as it allows comparison among different countries. In this case, I want to include the exchange rate evolution between the Euro and the U.S. Dollar. In this case we are looking at how many Dollars can be purchased with a Euro, so theoretically, if the dollar gains strength against the Euro, the figure should decrease, as buying dollars will be more expensive, therefore less dollars will be purchased with a Euro. Despite the Euro being historically more expensive than de Dollar, the two currencies traded at par for the first time since 2002 in July 2022, meaning they had a 1:1 exchange rate. This was due to the loss of demand for euros given the macroeconomic context that was going on in the euro zone in 2022 with the already mentioned war and energy crisis, however this was a great opportunity for American consumption in Spain, as their money was worth around 15% more. See below the statistical summary of the observations. The unit of measure is €/$ and the data was collected daily

- Average: 1.24
- Median: 1.23
- Standard deviation: 0.13
- Lowest: 0.96
- Highest: 1.60



The highest exchange rate was during the 2008 crisis, when a euro was able to buy 1.6 dollars, and of course the figure hit a low peak during 2022, in September specifically.

USD/CNY

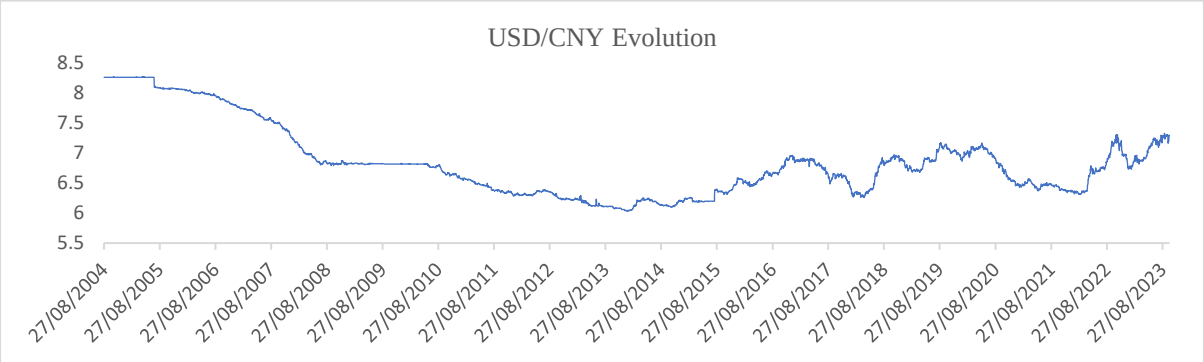
Following the rationale of the EUR/USD variable, I have introduced the exchange rate between the Dollar and the Chinese Yen. Beyond showing the strength of the Dollar against other powerful economies, this variable shows how much the growth of China, and the strengthening of its currency affects the American economy. China is the runner up to the world´s largest economic power and challenges the hegemony of the United States, and therefor the trust of investors in its industry, or at least their preferences. Due to these reasons I believe that this variable holds some of the qualitative information regarding what the market thinks about the US growth and its degree of competitiveness against emerging economic powers.

The growth of China´s economic power since the implementation of economic 5 year plans in 1979 made the country's GDP increase at a 10% compounded annual growth rate until 2017 ((Morrison, 2019), meaning it has doubled its economy roughly every seven years. The growth in the region was mainly due to a productivity increase derived from a steep technological development, which has left the American stakeholders worried about the Chinese state increasing its efforts on technological development by applying further interventionist economic measures. A more positive view on the matter is that the United States have to figure out the way to get China into understanding its importance in the Role of international trade and the need for cooperation rather than getting into trade wars that cap China´s economy growth and modernization.

The variable is measured in USD/CNY, notice how it is measured inversely if compared to the prior variable, so if the variable equals, for example 7, this will mean that a Dollar can buy 7 Yens. The observations were made daily to improve accuracy. See below the key statistics summary for the observations.

- Average: 6.90
- Median: 6.81
- Standard deviation: 0.64
- Lowest: 5.86
- Highest: 8.28

The graph shows a downward trend until 2013 followed by a period of more volatility which again led to a drop during Covid. After the pandemic the dollar spiked its power over the Yen



Nasdaq Index

This variable show the price of the Nasdaq at the time of the observation. The name stands for National Association of Securities Dealers Automated Quotations, and it is the second largest market in the USA after the New York Stock Exchange. It began in 1972 and lists more than 3,000 securities (Britannica Encyclopedia)

The index focuses on technology stocks, which are more volatile than other industries securities. It has a market cap of c.$30bn.

The reason for using this other security as a variable is the weight of technology in the S&P 500. The United States are home to some of the most successful technology companies, and it is a massive hub for the industry. In fact, the SPDR ETF top holdings are the following:

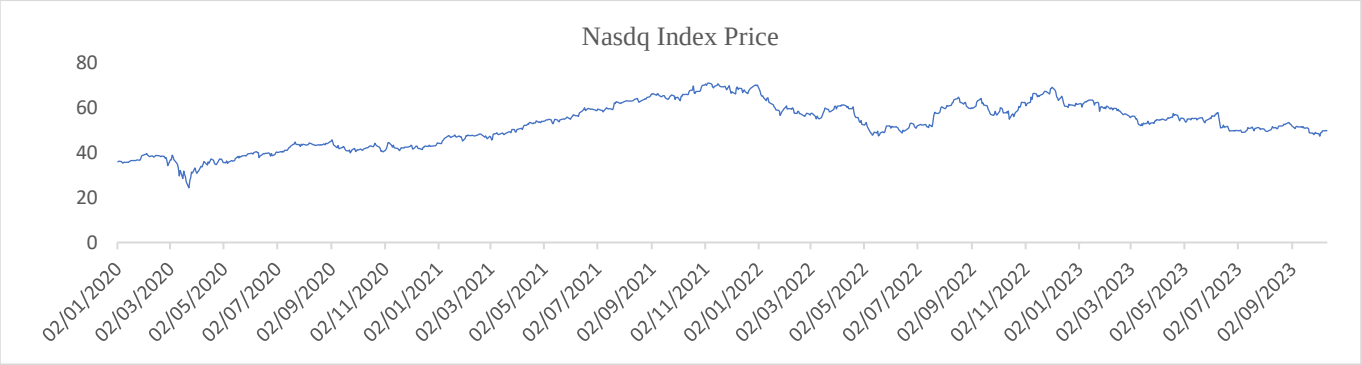
- Microsoft
- Apple
- Amazon
- Nvidia
- Alphabet Class A (Google)
- Meta (formerly known as Facebook)
- Alphabet Class C (Google)
- Berkshire Hathway (Warrren Buffet´s investment firm)
- Tesla
- The United Health Group.

All these stocks make c.32% of the total SPDR ETF assets, and only Berkshire Hathaway and United Health Group do not belong to the technology sector. Even though Tesla is a car manufacturer, I think that considering it an outsider to the tech industry is misleading due to the high weight of technological advances that the firm has pioneered. The same happens with Amazon, which despite not being directly fully involved in technology, the Amazon Web Services division is a leader in cloud computing and software engineering, also, the firm has taken the involvement of technology on its retail business to the next level by pioneering delivery by in house developed drones or the inclusion of robots on daily tasks.

The measure of this variable is in dollars and the observations have been collected on a daily basis, the figures below show a key statistical summary of the observations in the data set.

- Average: 21.2
- Median: 13.3
- Standard deviation: 17.5
- Lowest: 1.8

- Highest: 70.9



The evolution of Nasdaq can be relatable to the technology consumption trades, with a rather flattish evolution until 2012 and an upwards ride which only took a hit with Covid to then spike up. The pandemic was a detonator for a huge expansion of technological developments, first of all the surge of telework and the home office sector, which boosted the sale of devices, and also, the development of other technologies such as blockchain, artificial intelligence or virtual reality. One thing to notice about this index is the massive growth it has experienced over the last 20 years, an investment at its lowest point (1.8) would have provided a maximum return of over 38 times if exited at the highest point, and an implied internal rate of return (IRR) of 23.7%.

American GDP growth

(Dynan, 2018) GDP is one of the most reliable measures of growth in the economy, its defined as the sum of the value of the products sold within the borders of a country or region over a certain period of time. It is only the sum of the value of the final products, so it does not take into account raw materials .

The classic formula for GDP is the following

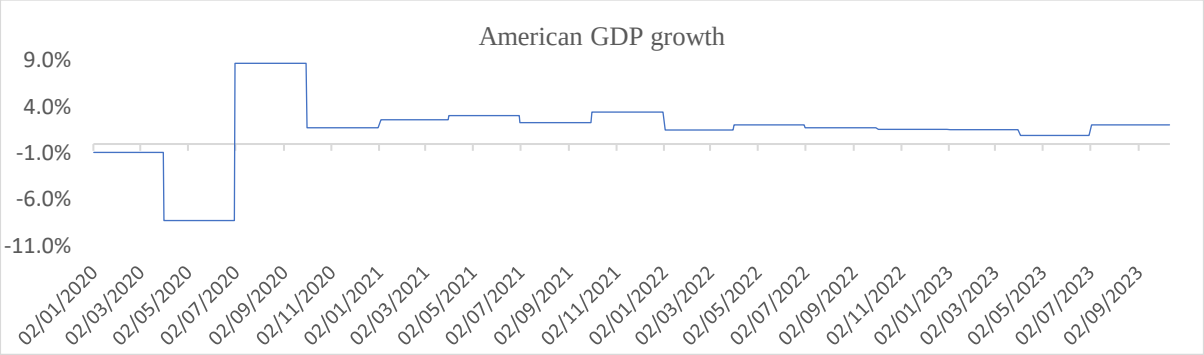
$$GDP = C + I + G + (X - M)$$

Where C is consumer spending, I is business investment, G is government expenditure and (X-M) represents the difference between exports and imports, which is also known as net exports. Even though it has some limitations, like only taking into account new build real estate transactions, not reflecting underground economy or not showing other important features of a well-developed country such as environmental health or overall satisfaction with quality of life, GDP is still the go to measure of economic growth for most economists.

In order to understand this figure, it is usually represented as a % as it is an easier to deal with figure than the gross amount of euros that the formula returns, also, in order to avoid the data being misleading, the figures shown do not take inflation into account. If this was not the case the different components of the formula would be altered as the figures would grow due to price increases rather than because of a true increase in production. For this case the data was collected quarterly, and it represents the GDP growth year on year, so if for a certain date the figure is 1%, this means that during that period GDP was 1% higher than it was during the same period in the previous year. Below are the main statistics of the observations.

- Average: 1.10%

- Median: 1.22%
- Standard deviation: 1.58%
- Lowest: -8.26%
- Highest: 8.71%



As seen on the graph, the USA has seen very few quarter in which it has had negative growth, meaning that its production levels have decreased. One curious area to look into is the 2020/2021, which corresponds to the largest and the smallest figures in the data set, in this case, and during the worst part of the pandemic, GDP decreased by 8.26%, however, the following quarter, it was able to grow back from where it was and delivered an 8.71% growth rate, meaning that it did not only recover the levels of production that it had before the pandemic, but also gained additional 0.45% growth. Even though the graph can suggest that during that period the economy grew by c.16% (from c. -8% to 8%), it must be remembered that this is not the case and that the 8% lost was recovered from what had been lost.

2.7 Correlation

To give a final overview of the variables I would like to have a look at the correlation coefficient they have with the dependant variable. The correlation coefficient measures how close or associated two variables are and how strong the relationship between them is. The coefficient takes values between 1 and -1, being the first one perfect correlation and the latter one perfect linear negative correlation. A correlation coefficient of 0, however, means that the two variables have very little relationship between them, so increasing or decreasing the value of either of them will not alter the other.

The correlation coefficient formula is the following

$$r = \frac{\mathrm{Cov}(X,Y)}{\sqrt{(Sx^2 * Sy^2)}}$$

The numerator of the equation is the covariance of the two variables, which explains to what extent variables can change together, and also how these changes happen. A positive covariance means that for X, larger values tend to be observed when large values are observed in Y and vice versa, while negative covariance would mean that values observed for X tend to take larger numbers when Y takes smaller ones. (McDonough, 2023)

The denominator includes the square roots of the variance of the observations made for variables X and Y The variance is just a measure of dispersion which is calculated by adding the squared difference between each of the

observations and the mean of the sample and dividing it by the number of observations. In fewer words, it is very similar to saying that it is the average difference to the variable in absolute terms, due to the numbers being squared.

$$\sum(\text{xi-}\mu)\text{^}2/\text{n}$$

It is important to make clear that correlation does not mean causality, this means that even if two variables have a very high correlation this does not mean that one is a direct driver of the other. Fo example, a Harvard student of the Criminology Faculty, carried out a study which showed high correlation between the number of films in which Nicholas Cage appeared and the number of deaths by drowning in a year. Another example of two variables which despite being correlated do not have any causality are the number of pirates and the ice cream consumption. If we were to take correlation as an indicator for causality, we could affirm that ice cream consumption increase was a key driver for the nearly disappearing of piracy. Which is clearly not.

The correlation between the dependant variable and the explanatory ones is the following:

- Price today: 0.99. It was quite obvious that the current price was going to be extremely correlated with the future price, as it is a beginning point, and most securities only fall to a certain extent during short periods of time, usually.
- Volume: even though I expected a high value for this one, the correlation with the dependant variable is -0.36. This means that on months of high volume we can expect future lower prices. If this is thought about the other way round, the idea of a month of low volume anticipating higher trading activity and therefore more demand which pushes prices up does not seem illogical.
- Eurozone inflation: 0.40, growth in the S&P seems to increase when inflation does, this makes sense if we consider that companies are able to push price increases into the final client and maintain their profitability margins, which would increase company cashflows and therefore push valuations up. On the other hand, periods of inflation usually create uncertainty about the future of the economy, which generates less appetite for investment. Of the two arguments, the first one seems to be more reflected by the result of the correlation coefficient.
- The breakeven inflation rate in the US had a correlation coefficient of 0.02 with the 30 days forward price of the SPDR ETF, even though I included this measure to look at inflation from another perspective and to see if the indicator had an effect o investing activity which affected price, it seems to have no kind of interaction and we can expect that the model will find it irrelevant.
- EUR/USD exchange rate: this variable had a -0.66 correlation coefficient. It was expected that the value will be negative, as the higher it is the lower the dollar is as a currency against the euro and the tighter its purchasing power. However, a nearly 0.70 is quite a high score, which makes sense, as if companies grow in the USA it means that they are being invested in, and this requires dollars, pushing demand and growth. Also, when companies sell their products abroad, many times they ill agree to be paid on their domestic currency, again pushing its demand.
- USD/CNY: -0.27, I expected this to be positive, as it would mean an strengthening of the dollar against the Chinese yen, however, if the yen depreciates against the dollar, it would be more expensive to acquire American products, and would decrease demand for them. China is a very large market and it makes

sense that a decreased demand from their side affects the results of US companies with significant activity there.

- Nasdaq: 0,97, this was not a surprise because as seen previously, the SPDR ETF holds a significant amount of technology assets, explaining the high degree of correlation between both.
- GDP growth: 0.27, despite being positive, the correlation is not as high as it could have ben thought to be. My explanation behind this is that increased production is not the only sign of a healthy economy and has already seen, there are many important factors which this metric does not take into account. Also, we have entered an era in which most investors take into account the qualitative characteristics of investments in terms of ESG. Sustainable investments are on the rise and this is a pretty good sign of it. I would even suggest that if this investigation had been carried out 10 years ago the correlation would probably have been a lot higher.

After having looked into the variables and the rationale behind their inclusion in the model I will now use Gretl, econometrics modelling software, to run the variables and see the output. I will make changes to optimize the result and explain the process. But first I want to look into the key theoretical concepts which I will be using to refer to the model.

The following are measures which help to understand how reliable and accurate

- R^2: known as the coefficient of determination, it points out what percentage of the output is defined by the independent variables (University of New Castle). It is a value between 0 and 1, 1 meaning that the whole dependant variable is explained by the independent variable
- Adjusted R^2: this is always equal or less to ordinary R^2 because it considers the number of variables. The more variables are added into the model, the larger R^2 will be, as more of the output of the model will be explained (because there are more variables). This metric adjusts the ordinary R^2 to the significance of the variables, so it will only increase if the number of variables is increased with meaningful ones or decreased by non-meaningful ones.
- P-value: it allows to assess whether the observed effects happen by chance or if there is actual statistical significance. It represents the probability of obtaining results, assuming the null hypothesis is true. The way to interpret this is to decide whether the null hypothesis is rejected (low p-value and low probability of results being a product of random) or to fail to reject the null hypothesis. (LaMonte, 2021)

2.8 Model outputs:

I will now begin to run the model while making different changes and documenting the process before I arrive to the final version:

Model nº1:

For this model I am going to use the whole data set and all the variables.

```
Model 2: OLS, using observations 1-5000
Dependent variable: Price30daysforward

                      coefficient   std. error   t-ratio    p-value
  ---------------------------------------------------------------------
  const                18.9387       4.46596       4.241   2.27e-05  ***
  Pricetoday            0.891290     0.0106631    83.59    0.0000    ***
  Volume               -6.11804e-09  2.81499e-09  -2.173   0.0298    **
  EurozoneInflation    -1.60819      0.151599     -10.61    5.16e-026 ***
  Breakeveninflati~     0.379305     0.719372       0.5273  0.5980
  EURUSD               -8.34126      2.33597      -3.571   0.0004    ***
  USDCNY                0.480100     0.371769       1.291   0.1966
  NasdaqPrice           0.664988     0.0605376    10.98    9.39e-028 ***
  GDPgrowthquarter~     0.0707936    0.0175330      4.038   5.48e-05  ***

Mean dependent var   212.6433   S.D. dependent var   106.9327
Sum squared resid    775977.0   S.E. of regression   12.46897
R-squared            0.986425   Adjusted R-squared   0.986403
F(8, 4991)           45333.28   P-value(F)           0.000000
Log-likelihood      -19706.41   Akaike criterion     39430.81
Schwarz criterion    39489.46   Hannan-Quinn         39451.37

Excluding the constant, p-value was highest for variable 6 (Breakeveninflationrateus)
```

In this first case we see that all variables are very significant (all of them but two have extremely low P values) which is important because in this case it is unwanted to take the risk of predictions being right by random and not because of actual statistical relationships between the data. We can see that the price at the date of the observation of the ETF and the Nasdaq both have really high parameters, according to the model, the price of the SPDR ETF 30 days forward will be c.89% of what it is at the date of the observation. Furthermore, the exchange rate between the euro and the American dollar has a negative impact on the model output, which due to the reasons seen while correlation was explained it is not that surprising.

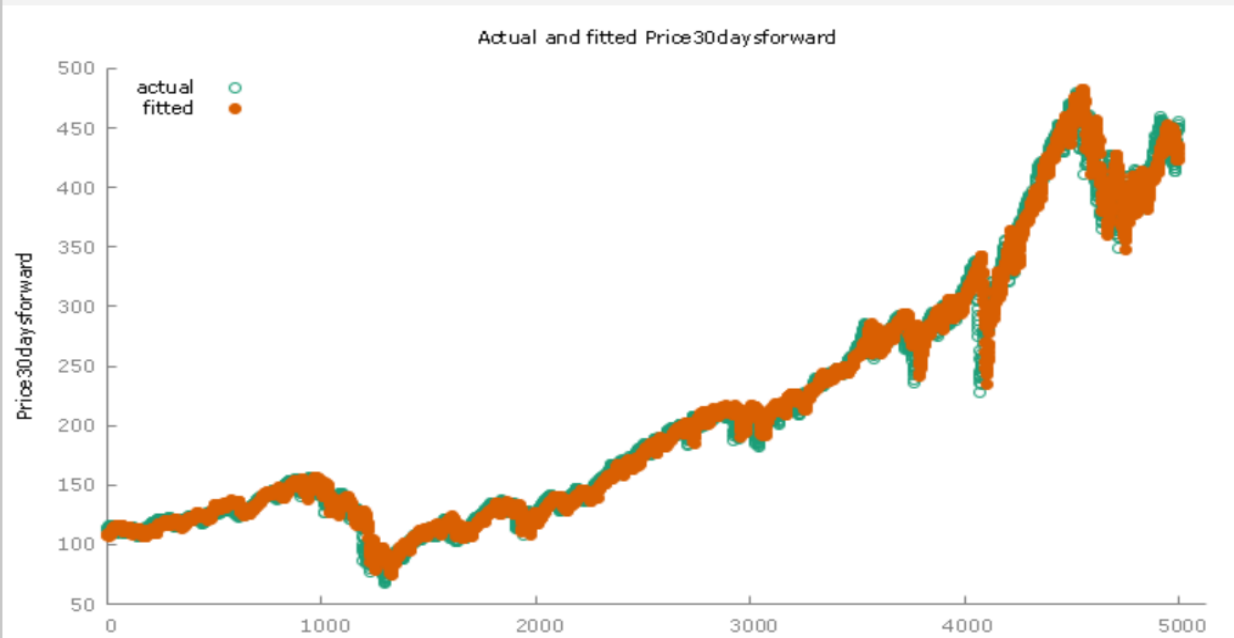
Some variables which have turned out to highly significant are the GDP growth, which had low positive correlation, however, as discussed in the previous section, the impact of GDP growth on price is only of 7cents per percentual increase, which helps to confirm the theory of other factors mattering beyond pure economic output.

The least significant variables were the breakeven inflation rate and the exchange rate between the dollar and the Chinese yen. Despite the will to look at inflation differently, the breakeven inflation variable has a coefficient of nearly 0, impacting minimally on the output. When saying that the parameter is nearly 0, it is considered that the units of measure of the variable are percentual points, in the case of volume, the parameter associated with the variable is extremely low, but the units of measure are millions of euros, so the impact in price is tangible despite the low value of the parameter.

The result in terms of the degree of explanation of the dependant variable is a pretty high R^2 and the same for the adjusted variation of the metric. This metrics, with minimal difference between them due to the, in general, high significance of all variables, indicate that in the model, nearly 99% of the future price is explained by the chosen

variables. This is the reason for the graph below to show such a similarity for the estimated output and the actual data.

This graph the actual observed data vs the fitted results from applying the resulting parameters to the values of the data base.



In order to increase the R^2 adjusted I am going to make a second model excluding the least meaningful variables of Model 1. The R^2 adjusted metric takes into account the number of variables so it should be higher than in model one if the ones with the highest p values are withdrawn. What is meant by higher is higher in comparison to the non adjusted R^2, this number will always grow if there are more variables

Model nº2

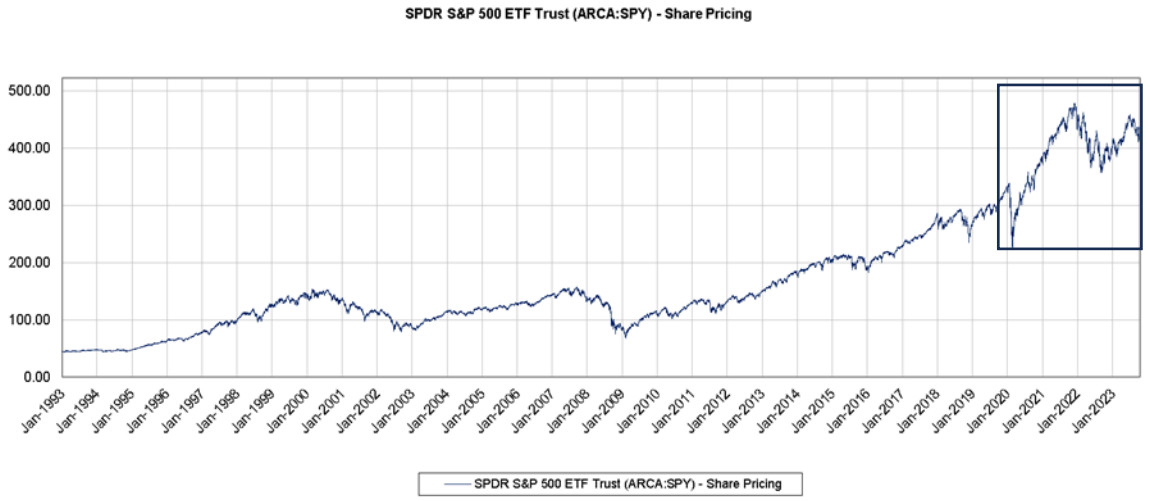
```
Model 3: OLS, using observations 1-5000
Dependent variable: Price30daysforward

                      coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------------------
  const                23.3010      2.73310       8.525   1.99e-017 ***
  Pricetoday            0.891261    0.00975060   91.41    0.0000    ***
  Volume               -7.90517e-09 2.35182e-09  -3.361   0.0008    ***
  EurozoneInflation    -1.54401     0.119499    -12.92    1.37e-037 ***
  EURUSD               -8.17726     1.92739      -4.243   2.25e-05  ***
  NasdaqPrice           0.663610    0.0556210    11.93    2.24e-032 ***
  GDPgrowthquarter~     0.0601055   0.0159603     3.766   0.0002    ***

Mean dependent var   212.6433   S.D. dependent var   106.9327
Sum squared resid    776314.2   S.E. of regression   12.46918
R-squared            0.986419   Adjusted R-squared   0.986403
F(6, 4993)           60441.97   P-value(F)           0.000000
Log-likelihood      -19707.49   Akaike criterion     39428.98
Schwarz criterion    39474.60   Hannan-Quinn         39444.97
```

As expected, the R squared metric has fallen, even though it has done so by a very unsignificant amount, however, the adjusted R squared has remained intact. Interestingly, the removal of these two variables has decreased the p value of volume, making it an even better fit for the model. Another observation to be made if compared with model nº1 is that the constant has increased. As mentioned, the constant collects all the information that is left outside of the model but that still impacts the dependant variable.

Given that at this point the model looks quite well on paper, I am going to withdraw part of the data in order to make a new model to then estimate the non included observations. My choice of period to do this will be from the beginning of 2020 until now, I will leave that time outside of the model.



The area inside of the square is the one which I am going to leave outside from the new data set. Before watching the result, it can be observed that the period has more volatility than the historical trend. If the model is trained with data which behaves differently than the conditions where it is tested do the result could be not as accurate.

Model nº3

The new data set has roughly 4000 observations, and the significance of the variable has been different so to test I am going to test then full model with all the variables first to see if there are any differences on the significance of the variables.

```
Model 1: OLS, using observations 2003-12-01:2019-12-31 (T = 4049)
Dependent variable: Price30daysforward

                       coefficient   std. error   t-ratio    p-value
  ---------------------------------------------------------------------
  const                 17.7191       3.57436       4.957   7.44e-07  ***
  Pricetoday             0.958885     0.00871324  110.0     0.0000    ***
  Volume                -1.10632e-09  1.83259e-09   -0.6037  0.5461
  EurozoneInflation     -1.82463      0.163672     -11.15    1.89e-028 ***
  Breakeveninflati~      2.17371      0.499760       4.349   1.40e-05  ***
  EURUSD               -10.1136       1.55026       -6.524   7.70e-011 ***
  USDCNY                -0.220679     0.293709      -0.7514  0.4525
  NasdaqPrice            0.227771     0.0553813      4.113   3.99e-05  ***
  GDPgrowthquarter~      0.0229487    0.0153821      1.492   0.1358

Mean dependent var   169.5717   S.D. dependent var   61.24542
Sum squared resid    219339.5   S.E. of regression   7.368307
R-squared            0.985555   Adjusted R-squared   0.985526
F(8, 4040)           34454.26   P-value(F)           0.000000
Log-likelihood      -13827.39   Akaike criterion     27672.78
Schwarz criterion    27729.54   Hannan-Quinn         27692.89
rho                  0.951806   Durbin-Watson        0.096981

Excluding the constant, p-value was highest for variable 3 (Volume)
```

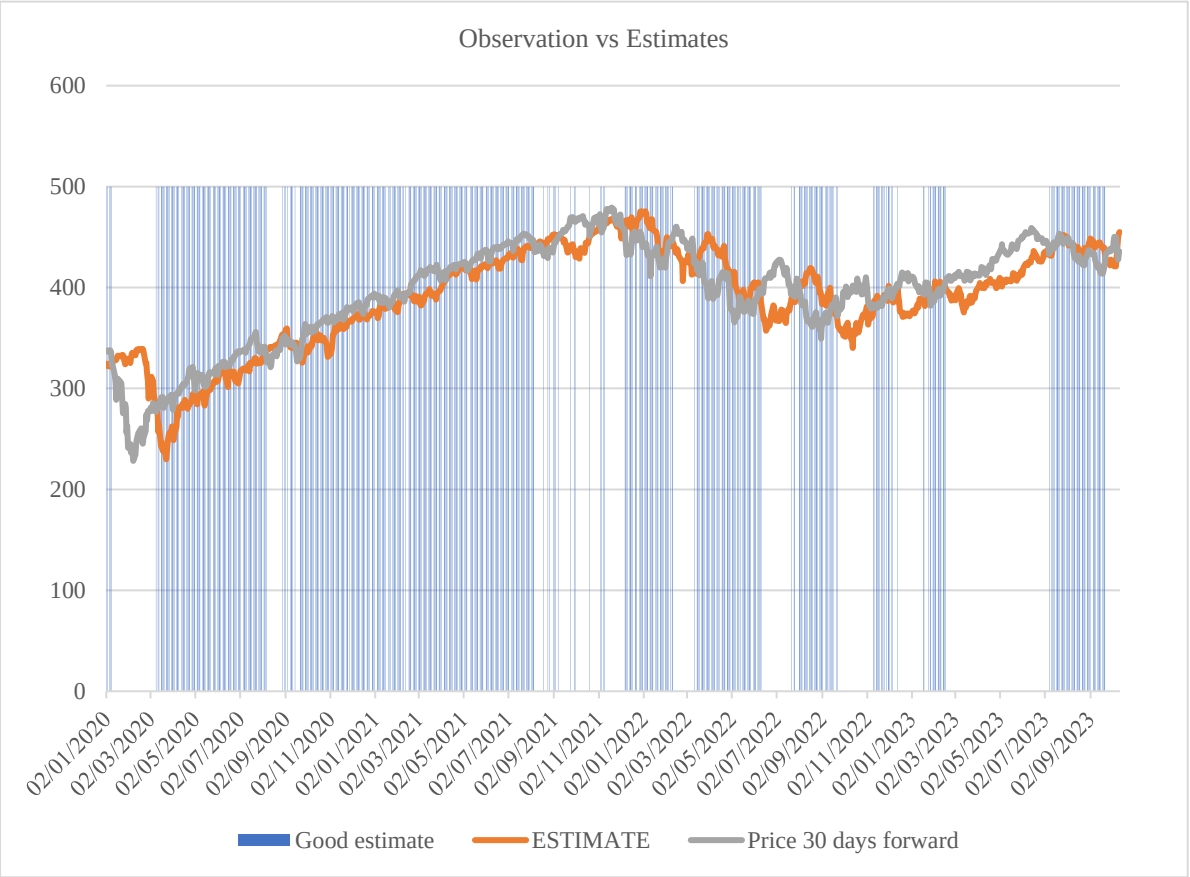
The new test gives surprising results, as volume and GDP are no longer significant while breakeven inflation seems to have increased its relevance. However, the r squared and adjusted R squared are still similar high, at around 0.99, there fore I want to try to run the left data through the model to see how good it is from an predictive point of view.

The formula for this model was the following

$$\text{Price in 30 days} = 17.72 + 0.96 * \text{price} - 0.0 * \text{volume} - 1.82 * \text{eurozone inflation} + 2.17 * \text{breakeven inflation} - 10.11 * \text{EUR/USD} - 0.22 * \text{USD/CNY} + 0.23 * \text{Nasdaq} + 0.02 * \text{GDP}$$

The following graph represents the estimations vs the actual price across time and the blue shadowed background represents the times when the model was right about its guesses. I have considered then model to be right when it matched the estimations and the observations matched on being higher or lower than the price as of the date of observation. The model was considered to be wrong whenever an estimate was a decrease or an increase of price

and the actual observation showed the opposite.



The estimations obtained by the model seem to be lagged during time, looking at the dip suffered by the asset during the pandemic breakout it is very easy to appreciate how the model predicts a very similar pattern, but does it later on. For unexpected phenomena like this one it is understandable that the model does not react as easily, if we included as a variable the price of pharma companies, or the volume of hospital bed occupation we could end up with a pandemic proof model which reacted well to these events, however it was not the case. What is interesting to see is that the model does react, probably as indicators begin to change, it must be taken into account that the market sentiment in these events has very little to do with the economic indicators. It does not matter if inflation is healthy, and the dollar is powerful if individuals think that the world is coming to an end and that their lives are going to change drastically. However, as indicators begin to reflect the reality of the global scenario, the model reacts showing an incredibly similar dip pattern. The predictions through the rest of 2020 and the first two quarters was quite good, however from November of that year a period alternating periods of more consistency and windows of no right estimations, creating those tunnels which appear because of the estimate and the observation going in opposite directions. What is quite surprising is that the last period of no right estimates, which lasts, about 5 months, the pattern is very similar to the one between October of 2020 and august 2021, which the model did a pretty good job with.

Out of the 948 tests, the model made a correct prediction on 584 occasions and failed to replicate the movement of the asset's price on 364. This means that the model is accurate 62% of the time and fails 38% of times.

In order to try to optimize the success of the estimate I am going to recreate the model using only the most significant variables to see if the result is any better.

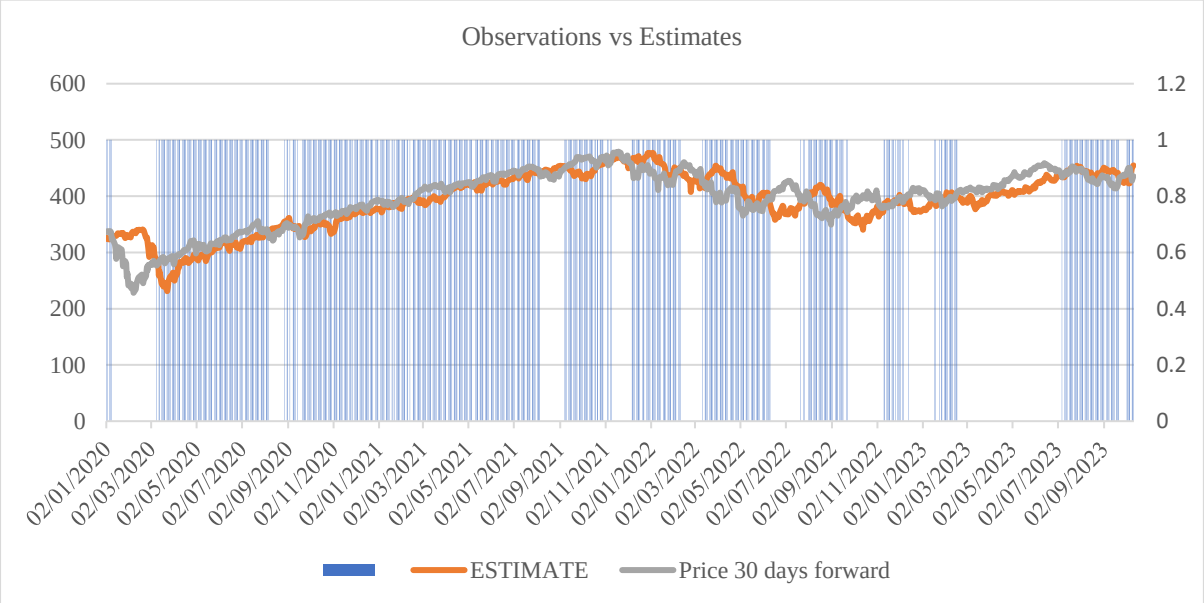
Model n°4

```
Model 2: OLS, using observations 2003-12-01:2019-12-31 (T = 4049)
Dependent variable: Price30daysforward

                      coefficient   std. error   t-ratio    p-value
  ---------------------------------------------------------------------
  const                14.8451      1.89692       7.826   6.39e-015 ***
  Pricetoday            0.969297    0.00746139  129.9     0.0000    ***
  EurozoneInflation    -1.88432     0.154646    -12.18    1.44e-033 ***
  Breakeveninflati~     1.90292     0.402076      4.733   2.29e-06  ***
  EURUSD               -9.22277     1.28141      -7.197   7.28e-013 ***
  NasdaqPrice           0.197506    0.0523508     3.773   0.0002    ***

Mean dependent var    169.5717   S.D. dependent var    61.24542
Sum squared resid     219671.2   S.E. of regression    7.371141
R-squared             0.985533   Adjusted R-squared    0.985515
F(5, 4043)            55083.23   P-value(F)            0.000000
Log-likelihood       -13830.45   Akaike criterion      27672.90
Schwarz criterion     27710.74   Hannan-Quinn          27686.31
rho                   0.952002   Durbin-Watson         0.096582
```

This model is made with the same umber of observations as the previous one but excludes the variables which turned out to be less significant. The R squared figure is still around the 0.95 even though it has decreased by a very small amount, while the adjusted r squared figure has remained the same. In this case, regarding the parameters, the constant has decreased by about three units and the EUR/USD variable has increased by three units. The rest of the parameters have remained pretty much the same.



Again, the pattern is very similar in terms of the model taking time to adapt to unexpected scenarios but doing a good job replicating them posteriorly. However, in this case, the model improved its accuracy and had 615 right estimates vs 333 wrong ones, meaning that the model was right 65% of the time, this is an improvement of 4.84% in relative terms if compared to the previous model and a gross improvement of 3%.

This is therefore, my final Automated Valuation Model for the SPDR ETF of the S&P 500 index.

Price in 30 days = 14.84 + 0.97 * price -1.88 * eurozone inflation + 1.9* breakeven inflation - 9.22 * EUR/USD + 0.20 * Nasdaq

3. Conclusions

The model nº4 was accurate 65% of the time, however if the data which was excluded is included and retested when enough time has passed to have a considerable amount of data, I should think that the iterations that happened during Covid and since the pandemic breakout should make the model more accurate under times of uncertainty, when the investor sentiment is more irrational.

Going back to the topic which I would like this model to be applied, which is value investing, I think there are some very interesting findings and that if the model is used correctly and updated periodically, the results achieved can surely help to add value to investors and optimize their returns.

The S&P 500 has historically returned between 8 and 9% every year, this means that it does not really matter when the investment is made, as sooner or later the 8-9% return will probably materialize. I understand that past returns do not guarantee future returns, but I also think that considering the track record of the asset and the time it has been around for, it is probably not totally inaccurate to speak as if in this case, past returns did somehow show what future returns can be like. But going back on track, the fact that on the long term, and from a value investing perspective, the return will come at some point, it does not really matter if the model makes a mistake, because it will have no cost on the long run (or at least the return will be the same). However, if 65% of time and thanks to trusting the model, investments are made at a lower price, the extra 0.3% (for example) will compound too, increasing returns. To make it more understandable, lets figure out an investment of €10, after 40 years the value of it will be €314 if a rate of 9% if considered, however, if due to having bought at lower prices the average rate of return is 9.3%, the value of the investment rises to €350, which is 12% higher than in the 9% scenario.

Having extra 12% of savings is something that everyone would say yes to mostly in cases when the majority of people is close to quitting work and that in some cases can be enough to pay for healthcare expenses, college education or maybe just to reach a level of savings which allows to live with les financial worries.

I would also like to highlight my recommendations on how to use this model to increase earning potential using the dollar cost averaging which was discussed at the beginning. This method is based on the assumption that being on the market is always more profitable than being off it and assumes a monthly investment rate, however, differently to the dollar cost averaging strategy it does not always keep the investment amount constant. The investment method is meant to make investing easier and the decision making more straight forward for those who despite having no experience at all want to get into it. The problem many times with new investors is that they do not understand market cycles and are driven by fear of missing out, finding it hard to keep a discipline approach to investing.

Proposed investment method

The steps to follow to use this model are the following:

1. At the date of the investment, search the most recent data for the variables (most recent data should be previous day closing), and run the model.
2. Depending on the output there are two possible net steps

   a. If the model suggests a higher price 30 days forward, invest the monthly amount.
   b. If the model suggests that the price 30 days forward invest 35% of the amount (35% is the probability of the model to guess wrong).
3. Depending on if the model was right or wrong do one of the following
   a. If the model´s prediction was wrong invest the monthly amount and the remaining 65% of the previous month if it was the 2b case.
   b. If the model´s prediction was right, keep doing the same thing. Run the new data through the model and invest all available funds if there is a price increase prediction and only 35% of the available funds.

The reason behind investing 35% of the amount if the model says there will be a price drop is to take some risk coverage and to still make some returns, also the motivation behind investing all the available fund is because in a worst case scenario, and given that there is no reason to expect a massive dip in the market, it will always be better to be in the market and outside of it.

The proposed strategy aims to optimize the returns of the investor by lowering average acquisition prices.

As next steps, I think that the model along with the strategy should be tested more realistically with the full model and compare the returns of a dollar cost averaging strategy vs the proposed strategy with the aid of the model. I believe that that task could be handed over to the Investment Club of the Universidad Pontifica Comillas or to the Economics Research development.

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Por la presente, yo, Lucas Klingenberg Martínez estudiante de Administración de Empresas (E2) Bilingüe de la Universidad Pontificia Comillas al presentar mi Trabajo Fin de Grado titulado The application of Automated Valuation Models on value investing ", declaro que he utilizado la herramienta de Inteligencia Artificial Generativa ChatGPT u otras similares de IAG de código sólo en el contexto de las actividades descritas a continuación [el alumno debe mantener solo aquellas en las que se ha usado ChatGPT o similares y borrar el resto. Si no se ha usado ninguna, borrar todas y escribir “no he usado ninguna”]:

1. **Brainstorming de ideas de investigación:** Utilizado para idear y esbozar posibles áreas de investigación.

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