BACHELOR'S DEGREE IN FINANCE AND ACCOUNTING

FINAL DEGREE DISSERTATION

THE MERITS OF FACTORS AS POTENTIAL CORE ELEMENTS FOR PORTFOLIO CONSTRUCTION

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ABSTRACT

In the present work, the German DAX30 equity market is used, in the period 2017-2020 to try to demonstrate that a portfolio based on momentum factors, low volatility and a combination of both is capable of beating the benchmark index or passive strategies. Despite not being such a recent element, it has been gaining popularity in recent times, although in Europe it is still less present than in the United States. In addition, we analyse its performance in the recent crisis caused by Covid-19, what results it has had and if it confirms our hypothesis that, in the end, factors are winner strategies.

JEL CLASSIFICATION

Choice of portfolio G110; Investment decisions

Guideline: covers studies on issues related to financial investment decisions and decision criteria (derived from formal models, behavioural principles, or idiosyncratic heuristics). In addition, studies on financial risk management and measurement involving portfolio options, including value-at-risk analysis, are classified here.

Keywords: asset allocation, diversification, investment decisions, portfolio, portfolio choice, rate of return, risk analysis, risk return, value at risk, performance.

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1. INTRODUCTION

One of the most important decisions investors make is the asset allocation of a portfolio in order to maximise returns with the lowest possible risk. For this we have different trends of action: passive management and active management, but, in the last decades, the concept of Factor Investing has emerged in which we find characteristics of its predecessors.

The efficient market hypothesis tells us that, if all participants were fully informed and able to use this information, an active strategy would not add sufficient value to offset the cost of active management. On average and before management costs are included, the return per actively managed unit of money invested will be equal to that obtained through passive management. Indeed, extensive literature, such as DeMiguel, Garlappi, and Uppal (2009), suggests that the 1/N strategy beats any active strategy. Moreover, a 2017 S&P study reveals that more than 85% of European equities failed to outperform the market over the previous 10 years. Poor returns from active management caused many investors to switch to passive management. At the time, the widespread fall in all asset classes meant that investors were affected, and portfolios managed according to traditional diversification rules could not avoid losses. Correlations between asset classes increased exponentially and actively managed funds were at a disadvantage. As a result, strategies incorporating multi-factor and low volatility techniques have generated a great deal of commercial success in recent years as a solution to traditional asset allocation.

The literature has demonstrated the feasibility of investing using certain factors. The usefulness of factors as determinants of stock returns has been investigated globally, where we can find Kim et al. (2012) who showed that the five-factor model of Fama and French (1996) successfully explains stock returns in the Korean market. In Kim (2018b), low volatility portfolios were constructed that produced large excess returns. In the Chinese market Hu et al. (2019) and Liu et al. (2019) took into account the size and value factor, where although they found that the former existed, the latter was not statistically significant. The effect of the momentum factor was studied in Cheema et al. (2020) and a positive result was obtained. Israel, R, Moskowitz, T.B., Asness C.S. et al. (2013) both long and short term factors contribute to overall financial performance.

Based on this strand of literature that supports the success of factor-based strategies, we study whether factor-based portfolios can beat the market, and which factor is the best to follow. To this end, we focus on the German stock market, and use the Momentum and Low Volatility factors to analyse their better performance relative to the

DAX30 index, the Global X DAX Germany ETF, and the 1/N strategy. We corroborate the importance of factor investing as a strategy to improve performance, especially at time of economic recession, when markets turn downwards. Passive strategies may generate better results in periods of economic expansion, but in the long-term factor investing matters.

This research is organised as follows. Section 2 presents the subject of the current research. Section 3 focus on the ETF. Section 4 describes the dataset. Section 5 describes the methodology employed. Section 6 presents the empirical results. Section 7 develops a subsample analysis. Finally, section 8 concludes by summarizing the main results.

2. FACTOR INVESTING

2.1. DEFINITION AND ORIGINS OF FACTOR INVESTING

First of all, to understand exactly what we are talking about, we explain what an investment factor is. It is quality of an asset that allows to achieve a return adjusted to the risk greater than the obtained in the market. We can also define it as the streams that increase the profitability of bonds, stocks and other assets. So, a factor investing based strategy consist of choosing those assets correctly based on the characteristics that make them victorious.

> "Factors are the basis of investment, just as nutrients are the basis of the foods we eat." *Blackrock*

Therefore, factor investing can be described as a technique or investment model that consists on researching these drivers of performance and understand how they work to be able to take advantage of their benefits to supplement traditional models, with the objective of beating market indices.

The origin of factor investing dates back from the 1960s, when the Capital Asset Pricing Model (CAPM) was introduced by Treynor (1961,1962) Sharpe (1964), Lintner (1965a,b) and Mossin (1966). This model determines that asset performance is somewhat affected by market movement. It is when the first factor appears: beta, which measures asset's sensitivity to market movements. But in that moment, they did not interpret it as a factor itself, unlike the next ones do.

In the 1970s, investors discovered that assets have more characteristics than seen so far which reveal better risk-related outcomes. Numerous researchers studied the

different factors such as Banz (1981) focused on the size factor, Haugen and Baker (1991) on the low volatility factor, Carhart (1997) on the momentum factor, Piotroski (2000) on the value factor and Novy-Marx (2014) on the quality factor, among others who participated in the subject. One of the most significant studies that we comment below is the model of Fame and French.

Figure 1: The Evolution of Factor Investing. Source: An Overview of Factor Investing (2016)

But it was not until the late 2000s that it began to have relevance in the world of finance, thanks to the study of the behaviour of the Norwegian sovereign pension fund and its conclusions. In this study, they predicted a profitability that later turned out to be much worse than expected, so the efficiency of the model used was questioned, thus suggesting the existence of more influential factors in the return.

It can therefore be said that, because of the anomalies of the CAPM market model the concept of factor investing arose. The factor market itself was unable to fully explain returns, so others factors may be involved.

There is another reason for the "recent" popularity of the concept: technological advancement, specifically, current computational capacity. Thanks to this, management techniques are much more sophisticated and allow for more advanced methods at a lower cost.

According to Blackrock, the factor industry is estimated at $1.9 billion in 2017 and it is expected to grow to $3.4 billion by 2022, an increase of 79%. The increasing interest of factor investing can be appreciated in Figure 2, notice that Google searches related to this topic have increased considerably, with an historical maximum in 2020, specially in March, and following a growing trend so far.

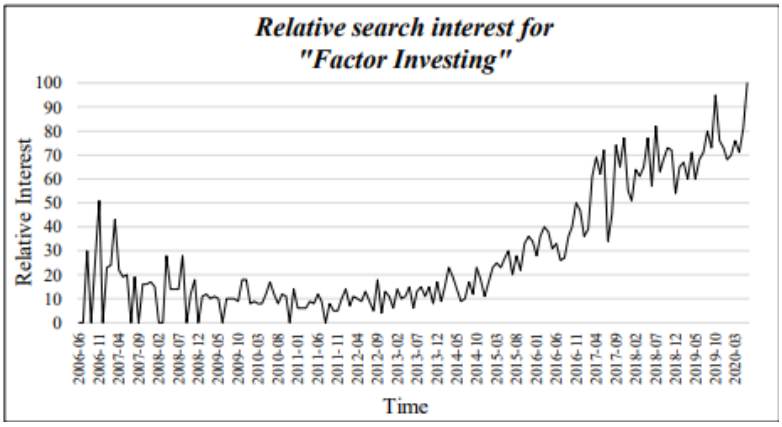

Figure 2: Relative search interest for Factor Investing. Source: Worldwide

2.2. TYPE OF FACTORS

There are factors linked to macroeconomics and factors linked to the characteristics of an asset (see Table 1).

On the one hand, we have 6 types of macroeconomic factors:

- **Economic growth.** Understood as exposure to the economic cycle. In other words, the income or the value of the products and services produced by an economy varies. The assumption of this risk for economic uncertainty can be rewarded with a premium.
- **The actual rates.** We define it as the risk that the interest rate will vary (the actual rate can be calculated as the difference between the nominal interest rate and the inflation rate). So, there is a premium for assuming this risk.
- **Inflation,** which is the widespread and continuous increase in the price of products and services, so it consists of exposure to this change. Assets may not adjust to rising prices and maintain their return.
- **Credit risk,** which we incorrectly associate with the risk of non-payment of obligations, but it goes further. It is really the risk that credit quality will deteriorate leading to a more likely increase of the default risk of companies.
- The fifth factor is **emerging markets,** understood as the reward for exposure to sovereign and political risks, when the country is less developed and unstable.
- And finally, **liquidity,** understood as the efficiency with which an asset can be converted into ready cash without affecting its market price.

On the other hand, factors are asset-related anomalies, which it means that performance does not just depend on beta. Table 1 provides a summary of these factors.

FACTOR	LITERATURE	DESCRIPTION
MARKET FACTOR	Treynor (1961; 1962); Sharpe (1964); Lintner (1965a, b); Mossin (1966); (Bawa y Lindenberg (1997)	Higher beta companies will offer higher performance.
SIZE FACTOR	Banz (1981); Fama and French (1993)	The difference between high and low-capitalization companies, in which the latter tend to have better returns.
VALUE FACTOR	Fama and French (1993); Piotroski (2000)	Undervalued companies (value) have better results than overvalued companies (growth).
MOMENTUM FACTOR	Levy (1967); Carhart (1997); Jegadeesh and Titman (1993)	Stocks that have done well in the near past will do well in the near future, so they will perform better. And vice versa.
LOW VOLATILITY FACTOR	Haugen and Baker (1991)	Assets with lower risk will have better risk-adjusted returns.

Table 1: Summary of different factors. Source: Own elaboration.

2.2.1. MARKET FACTOR

This effect refers to the beta (slope) of the asset in the CAPM model. Beta relates the performance variation of an asset when market performance varies.

The performance of the asset will depend on its sensitivity or beta with respect to the market risk premium, as only systematic risk is remunerated. The specific is not included because there is diversification and it can be eliminated through this process. It is said that the performance of the asset depends on its systematic risk because it depends fundamentally on its beta. The higher beta the higher the return.

It is therefore not treated as an anomaly, because beta allows us to explain the performance in the model, and when beta is not enough to explain returns, it is when the existence of anomalies appears that can explain this difference in valuation.

We can make a distinction between bullish and bearish moments and consider a beta for each of them (Bawa and Lindenberg (1997)): a) Low-capitalization assets are more sensitive to downs than ups, so their bearish beta is higher than the bullish beta: B^{-}_{i} >

B^+_i. b) The opposite will be the case with high-capitalization assets. They are more sensitive to uploads than downhill, so their bullish beta will be larger than their bearish beta: $B^-_i < B^+_i$.

2.2.2. SIZE FACTOR

It is a market anomaly that refers to the fact that returns on smaller or low-cap assets outperform larger or high-cap assets. One of the possible causes of this effect is due to failures in the CAPM model as it would not correctly calculate the risk and profitability of low-cap companies. Another reason would be because of the costs of this type of low-liquidity asset, so that investors demand a higher level of return, as a compensation for this low liquidity and for the higher costs. Finally, another cause that would explain this effect is the correlation between information and company size: the smaller the lower information availability, so there is less negotiation of these low-capitalization securities and lower expectations about their investment strategies.

This size factor has a lot to do with the January effect or year-change effect (found within behavioural finances). This anomaly shows the difference in returns from the end and beginning of the year, being on the last day less than the first 5 days of the year, since the stock exchange tends to go down and then the returns are abnormally higher. One of the causes is the tax issue, selling the securities at the end of the year to buy them in the following days. This effect mainly affects small and more volatile companies as their price is more variable compared to buy and sell orders. Thus, these two effects go hand in hand, the anomaly of the size effect occurs almost entirely in the first month, reducing its difference in the rest of the year.

2.2.3. VALUE FACTOR

At this point we will explain the anomaly of the relationship between book value and market value, thus giving the value and growth factor, anomalies also linked to the characteristics of the assets. When the book value is greater than the market value we are facing a value asset. This means that it is undervalued and in time it will return to its book value so there will be a benefit. These assets are characterized by being more stable, trading in more mature sectors, lower sales growth, and generally with barriers to entry. They are traditionally electrical sectors, concessions, highways or power. On the other hand, when the book value is less than the market value it is an active growth. This means that it is overvalued and over time the asset will converge to its book value so it will have been acquired at a higher price than it actually has. They are companies in the

expansion phase and are considered to be able to continue to grow, operate in changing markets, with a lot of competition and their product or service has great added value. Unlike value, its profits go to the business itself to continue to grow and not in the form of dividends. As a result, the value management style appears. It develops a valuation method that seeks to identify companies that are fundamentally undervalued.

With the emergence of these anomalies of asset behaviour, multifactorial models emerged. Eugene Fama and French (1992) found that stock returns could be explained by the portfolio's exposure to three factors: market, size and value. This model is an extension of the CAPM with over-performance as we add the size and value factors. It has been proved to be quite accurate and has been applied by many investors, and can be expressed as follows:

$$r_{i,t} = \alpha_i + \beta_{M,i} * r_{M,t} + \beta_{SMB,i} * r_{SMB,t} + \beta_{HML,i} * r_{HML,t} + \varepsilon_{i,t}$$

where

$\beta_{M,i}$= market factor

$\beta_{SMB,i}$= size factor

$r_{SMB,t}$= asset returns low capitalization - asset returns high capitalization

$\beta_{HML,i}$= value factor

$r_{HML,t}$= asset returns *high book-to-market* ratio – *low book-to-market* asset returns

SMB: size effect. Return on investing in low-capitalization (small) assets - Return on investing in big/large assets.

HML: value effect. Return on investing in assets with a high book-to-market ratio - Return on investing in assets with a low book-to-market ratio.

$$\text{book tonmarket Ratio} = \frac{Book\ value}{Market\ price}$$

+ ratio -> value assets -> low price

- Ratio -> growth assets -> high price

(The book-to-market ratio is the inverse of the price-to-book ratio).

2.2.4. MOMENTUM

The trend of assets that have done well in the recent past and will tend to do well in the recent future is known as momentum. Similarly, assets that have done wrong in the past will tend to misbehave in the future. According to Jegadeesh and Titman (1993), buying shares that have done well and selling the ones that have done the worst generates significant positive returns over periods of 3-12 months. But part of these anomaly returns dissipate in the next 2 years. Carhart (1997) extended the Fame and French model by adding a fourth factor: momentum. This is how the 4-factor model, attached below, emerges.

$$r_{i,t} = \alpha_i + \beta_{M,i} * r_{M,t} + \beta_{SMB,i} * r_{SMB,t} + \beta_{HML,i} * r_{HML,t} + \beta_{WML,i} * r_{WML,t} + \varepsilon_{i,t}$$

where WML (winners-loosers): return on "t" of investing in assets with higher performance in the past - return on "t" of investing in assets with lower performance in the past.

2.2.5. LOW VOLATILITY

Volatility is the way to measure financial risk of an asset. Statistically it can be calculated as the standard deviation (square root of the variance), defining itself as the dispersion or variability of a variable relative to its arithmetic mean. Therefore, if a share is far from the average as a whole, it means that it experiences large fluctuations and is more volatile than another share that does not vary so much from its average. So that, the low volatility factor refers to the variability of assets. This factor has shown striking long-term performance, as has the value or momentum factor. If you look at the risk-return combination we know that the theory says that the more risk an investor assumes, more expected return they will want, but the research shows that a low-risk-based portfolio does not necessarily have to reduce returns, hence it is considered an anomaly related to the characteristics of the asset.

In this strategy, stocks tend to reduce their loss of performance at bearish times, so it could be a good strategy to choose from, but similarly in bullish moments, it doesn't increase your performance as much.

This type of investment would not be suitable for the types of investors called aggressive, risk-loving types of investors, even though reasonableness would say that, for the same return, a rational investor would choose the one that would bear the lowest risk.

2.3. PROCESS TO BUILD A PORTFOLIO

To build a factor-based portfolio there are a number of steps to follow. The first step is to determine the objectives of the investment, what the investor wants to achieve when the horizon ends, what type of asset to invest in, and the risk aversion, that is, what risk he is willing to bear. An intermediate step is to know the available strategies to build a portfolio. If the investor decides to follow a factor investment strategy, then, the steps of this type of strategy begin. In the following figure we can see a picture of the process of building, monitoring and reviewing the portfolio made in depth.

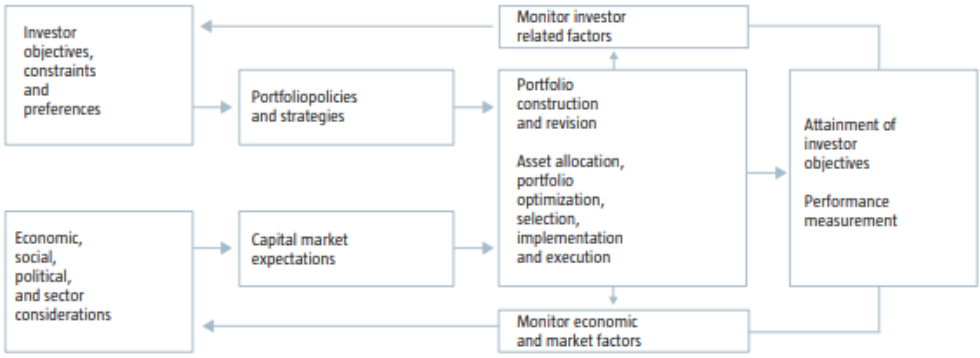

Figure 3: The Portfolio Construction, Monitoring and Revision Process. Source: Maggin et al. (2010).

First, the systematic analysis consists of analysing the evolution of the market and the different chosen factors to investigate (there are many factors, so you have to select the ones that interest the investor the most, and hence, analyse which one is best for you). After seeing their trend and results, we choose those that seem best, which will basically be the ones that outperform the market, although always taking into account the current socio-economic situation at the moment. After having chosen the factor(s) in which to base our strategy, we use the available data from the previous period to calculate the weights of the different types of assets to allocate in our portfolio, that is, based on the capital invested, the percentage that we allocate in each asset. And finally, the portfolio it is rebalanced at the end of the period, and the investment cycle begins again.

2.4. ADVANTAGES AND DISADVANTAGES

When making a decision, the pros and cons of this choice must be taken into account. Regarding investment by factors, we can say that one of the causes of its popularity is that it improves diversification. Portfolio diversification is the key issue in reducing portfolio risk. In recent years, however, the growing correlation between assets has made it difficult to achieve this diversification, since this means that a greater extension

of assets follows the same trend in the face of changes in the environment. Factor inversion is a concept in which anomalies do not follow the same trend, that is, they are not correlated. The reason why a portfolio rises or falls is not the same for each effect, so it is a challenge to achieve a better diversified portfolio and produce synergies between them.

Another of the fundamental causes is the reduction of costs, this is thanks to the fact that investing in factors consists of taking advantage of the factor premiums following rules to generate adjusted returns higher than those of the market as a whole. In general, this more profitable systematic approach has a lower cost than traditional active management, making it a mix between active and passive management. We continue with the generation of income due to the higher returns, sought by the low interest rates of fixed income. Finally, highlight the possibility of a sustainable investment through environmental, social and corporate governance aspects that have a positive social impact.

The absence of biases, which has led to more stable returns and better risk-adjusted returns (the objective of factor investing), in both fixed income assets and equity assets, has been demonstrated.

The following figure shows a summary of the benefits of applying a factor-based portfolio.

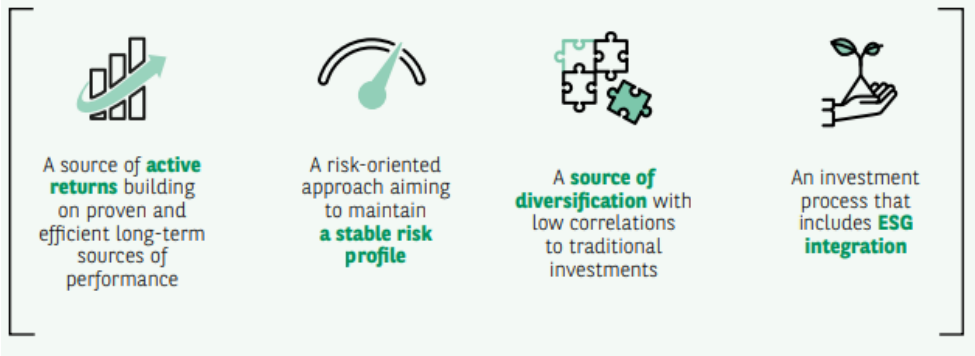

Figure 4: Summary of the benefits of applying a factor-based portfolio. Source: BNP Paribas Asset Management

As a drawback, we can say that the factors do not behave in the same way in bullish and bearish markets, in which being in the former it is very difficult to outperform the index, you just have to invest in it to obtain good returns, while in the Seconds tend to have better results (we will analyse this with our data set), so several writers argue against investment due to factors since it is not durable over time.

2.5. INVESTMENT INDUSTRY

In this section we have a look at the investment industry that applies factor-investing based strategies.

Maarten Polfliet is responsible for the management team of Conservative Equities of Robeco, a Dutch fixed income and equity asset management company, which was born after the crack of 29 and currently manages assets for 176 billion euros. It has funds for both low-risk strategies and other factors, as well as a multifactor model of 4 premium factors. Polfliet explains that factor investment is suitable for deviating from the market and therefore offering diversification. Within their strategy, they use low-risk stocks, i.e. with low beta and volatility and, as a result of that, have a better risk-adjusted performance profile than the market.

Andrew Ang is BlackRock's global factor strategy manager and also talks the topic. In 2018 he compared factor investment with mobile phones, which has always been separately the various functions they offer, but are now condensed into the same device. He believes that the same happens with factor investing: "It is the ability to find trends in thousands of listed companies and do so in a low-cost way, both in fixed income and in equities". In that year, they were overweight the momentum factor given in economic growth and underweight the value factor, and he believes that this type of investment creates added value.

We also found Amundi, a French asset management company, which currently manages funds with 1.729 billion euros, being the largest asset management company in Europe. The manager establishes Value, Timing, Quality, High Dividend, Low Volatility and Size as the 5 most significant assets and offers solutions for active and passive management.

It is also worth mentioning the company Welzia, which has opted for new funds in which propose as more significant factors Value, Quality and Momentum.

Moreover, factor investing is a strategy followed not only by large companies and institutions, but by several small investors.

3. ETF

3.1. WHAT IS, HOW IT WORKS AND ORIGINS OF THE ETF

ETFs are the English acronym for Exchange Traded Fund, and it is named as it is publicly traded. It consists of a type of value that tracks an index, sector or commodity such as

commodities or bonds that can be sold on a stock exchange, the same as a regular stock, making it a hybrid instrument between an investment fund and a stock.

ETFs that replicate an index (benchmark), acquire a basket of securities composed of the shares of this index. This makes it an instrument for diversification, being one of the advantages of its use. The first publicly traded fund dates back to 1993 in the USA, specifically in New York, replicating the S&P 500, which is still in force today, although in 1990 the Toronto Index Participation Unit (TIPS) was the first to have the characteristics of an ETF.

In Europe the first appeared 7 years later than in the USA with “iShares STOXX Europe 50” with the 50 largest European companies and “iShares EURO STOXX 50” with the 50 largest companies in the euro zone, and in Spain for only 15 years with "Stock ETF Ibex 35" of BBVA. In 1997 there were only 2 publicly traded funds in the world, in 2002 it already exceeded a hundred and in 2009, more than a thousand. In 2014, ETFs represented 5.5% of European fund investments, compared to 12% of investments in the USA, and 1% in Spain.

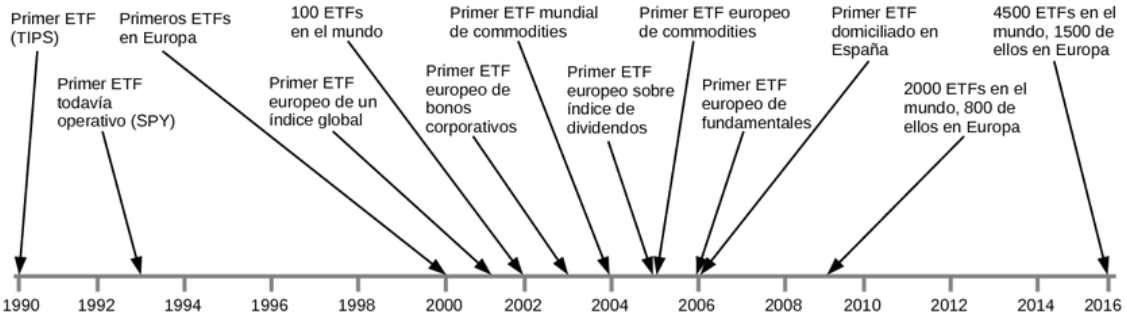

Figure 5: Time axis of the ETF 1990-2016. Source: Los Revisionistas

3.2. ADVANTAGES AND DISADVANTAGES

As in all cases, there are certain advantages and disadvantages attached to ETFs.

On the positive side, we find 6 key points:

1. **Accessibility**: they do not have minimum investment or it is a small amount so a large amount of capital is not needed, but they must be whole numbers, not fractional.
2. **Diversification:** it is one of the main advantages. When investing in a publicly traded fund, a basket of securities is acquired that replicates an index, so by definition it is an instantly diversified portfolio, allowing to reduce its risk.

3. **Liquidity:** thanks to the instantaneous trading process they offer great liquidity to the investment, always in the trading hours of trading. And even though it can be done in a day, it doesn't translate into higher volatility. In addition, they have specialists who are required to provide liquidity.
4. **Immediacy and transparency:** throughout the hours the value of the investment, the volume, the composition...
5. **Dividends:** There are types of ETFs that offer dividends from the companies that make up the fund, in addition to the return of the fund. It occurs mostly in equity funds**.**
6. **Cost efficiency and reduced expense ratio:** the case of no subscription or disbursement fees causes costs to be reduced. But this does not mean that it has no kind, it has commissions related to the sale, as in the case of stocks.
   In addition, it can be made in a single transaction, since different values are acquired in a single, deferring from the traditional market.

Looking at the negative part and risks of ETFs we find 5 important points to keep in mind:

1. **Market Risk**: refers to the correlation between the index and the ETF. This can be measured with the Tracking error: if this index is high, it means that it follows in a less faithful way to the index.
2. **Liquidity Risk**: Although liquidity is one of the advantages of investing in a stock-traded fund, those where liquidity is low can lead to a higher transaction cost or make it difficult to buy and sell
3. **Tax Risk**: If an international fund is acquired, it may have high taxes to be taken into account that affect return, such as in government bond ETFs, which are subject to federal income tax.
4. **Credit Risk**: actually the risk of default. Refers to the issuer being able to cope with payments or being delayed.
5. **Exchange rate/currency risk**: The ETF is in the currency of the country in which it is managed, so it can be caused by the difference in currency between the index and the ETF, adding also the risk of the stock index itself.

4. DESCRIPTION OF THE DATA SET USED IN THE STUDY

For our research, the German stock market DAX 30, also known as DAX or DAX Xetra (German: Deutscher Aktienindex) has been analysed[1]. It is composed by 30 blue chip companies, that is, well-established companies that have a good level of liquidity and income. These companies are best listed on the Frankfurt Stock Exchange, the largest German companies in terms of volume and market capitalization. Table 2 details the companies that make it up, highlighting the famous companies ADIDAS, BAYER, SIEMENES or VOLWSWAGEN. As we see, there are a wide range of companies from various sectors that make up the index, making it diversified.

In this study we have used the daily prices of the DAX30 and all the assets that make up the index, as well as the Global X DAX Germany ETF, obtained from investing.com, with a time horizon of November 2016 to December 2020, with a sample composed of 996 observations.[2]

COMPANY	**DESCRIPTION**
Adidas	Textile and footwear company
Allianz	Insurance carrier
BASF	Chemical industry
Bayer	Chemical and pharmaceutical industry
Beiersdorf	Consumer goods
BMW	Automotive industry
Continental	Tires
Covestro	Chemical industry
Daimler	Automotive industry
Delivery Hero	Food delivery service
Deutsche Bank	Banking

[1] We focus our research in the German market since Germany is the largest economy in the Eurozone. We have studied only the DAX30 index, but this analysis can be also extended to other indices.

[2] In carrying out this work, there have been some inconveniences such as obtaining the data, which have been downloaded for free from the investing.com website, for which they have been chosen according to the offer of the link. In addition, a limitation of the search has been the time horizon for all assets, in which 2 of them did not fit the same period, DELIVERY HERO AND LINDE PLC. which became part of the DAX in 2017, so we cannot perform an analysis without all the assets not containing the same number of data. For this reason, 2 types of analysis have been performed. The first eliminating these companies only in 2017, so they were not represented in 2018 (since we relied on the previous year to calculate the data of the current year) and the second eliminating them completely from the analysis and having 28 assets. Main results hold regardless for both analyses.

Deutsche Börse	Finance
Deutsche Post	Postal company
Deutsche Telekom	Telecommunications
Deutsche Wohnen AG	Estate
E.ON	Public services
Fresenius	Healthcare
Fresenius Medical Care	Healthcare
HeidelbergCement	Construction materials
Henkel	Consumer goods
Infineon	Semiconductor manufacturer
Linde	Industrial gas manufacturer
Merck	Chemical and pharmaceutical industry
MTU Aero Engines	Airlines
Munich RE	Reinsurer
RWE	Public services
SAP	Software
Siemens	Technology
Volkswagen Group	Automotive industry
Vonovia	Estate

Table 2: Summary of the DAX 30 assets

5. METHODOLOGY

In this section, several calculations are made that are interesting to observe the evolution and results that concerns us: the average annual return, the average standard deviation, and the Sharpe ratio [3]from the values taken daily of the Global X DAX Germany ETF, DAX30 index, 1/N strategy and factor investing strategies.

[3] The Sharpe ratio is a measure of performance that considers the relationship between risk and profitability, so the higher the ratio, the better, as it means that the better the fund's profitability relative to risk

Starting from the prices, we obtain the continuously compounded returns on a daily frequency by taking the logarithm and subtracting the previous value, so that, returns at the day t, for t=1,2, . . ., T are calculated as follows:

$$Rt = 100 * \ln(\frac{P_t}{P_{t-1}})$$

Then, for each year and each asset, we calculate the mean, the standard deviation and the Sharpe ratio on an annual basis (computed as the excess returns over the risk-free asset divided by their standard deviation). Finally, we annualize data for each year and compute the mean of annualized returns, standard deviation and Sharpe ratio for the whole period studied that we use to implement the different strategies.

Regarding the **equally weighted** strategy, also known as the 1/N strategy, given a set of N assets, we invest the same percentage, that is, 1/N for each of them. So, for our data set, a portfolio has been made with the risk and return values of the years 2018-2020. Thus, an equal weight has been performed for the 30 assets, with this being the weight of 3.33%. We explain next the methodology employed to implement the factor investing strategies.

As far as the Momentum factor is concerned, we implement two strategies: Momentum Only Assets and Momentum All. The **Momentum Only Assets** strategy consists of investing in those assets that had positive returns in the immediately previous year. In this strategy we have 3 years to carry out the portfolio since by taking as a reference the previous year, we can only use this strategy in the years 2018, 2019 and 2020. With this, we went on to analyse the year 2017, in which the assets that had negative returns are not included in the strategy. The remaining assets with positive returns and are the ones used in our portfolio for next year 2018 which are weighted in proportion to the return offered this previous year, regardless of whether in the year in question they obtain positive or negative returns.

Regarding to the **Momentum All** strategy we discard the asset with the worst performance data during the last year, so its weighting is 0%. Thus, the remaining 29 stocks participate in next year's portfolio according to its performance, so that, those stocks that offer higher return have higher weight in our portfolio.

The objective of **Volatility Only Assets** is to obtain a portfolio with the lowest risk. This strategy is implemented with a "solver" analysis, a tool provided by Excel, which combines a myriad of weights and obtains a series of weights from each asset so that the portfolio has the minimum risk. To run solver, a number of constraints are determined

to get the result of the variables. One of them is that the sum of all weights has to be equal to unity, since we invest the full amount, and in addition, we add the constrain that all these weights have to be >0, that is, weights cannot be negative. As in the other strategies, the weights calculated in the previous year are used for the portfolio of the current year.

On a **Volatility All** strategy the same procedure is followed to obtain the weights, but we remove the restriction that all weights must be positive. This means that the investor sells short positions, this means that he sells assets that he does not have yet. The idea of this is to buy them again when they have reached the expected price. Weights calculated in the previous year are then used for the portfolio of the current year.

In our last strategy, we combine **Volatility + Momentum**, so that we consider returns adjusted to the risk associated with them, to this end, we use the Sharpe ratio. We include in our portfolio those stocks with positive Sharpe ratio and propose more weight in the portfolio to those assets that have the best ratio.

6. EMPIRICAL RESULTS

Table 3 shows the performance of the DAX30 index, the DAX ETF and the equally weighted strategy during the period studied (passive strategies). We see how the benchmark (DAX30 index) has performed better than the 2 passive strategies, having a positive return of 2.22%, not very high, but surpassing the -0.49% of the DAX ETF. In addition, it is observed that it has a better annualized risk, so its Sharpe ratio has almost the same value but with the opposite sign. It can be also appreciated that the equally weighted strategy is the one with the highest risk (30.42%).

	Average annual return	Annualized standard deviation	Annualized Sharpe Ratio
Dax30 (benchmark)	**2,22%**	**21,25%**	**15,93%**
Global X DAX GERMANY ETF	-0,49%	24,16%	-13,18%
Equally weighted	1,24%	30,42%	3,69%

Table 3: Global results of DAX30 and DAX ETF 2018-2020

Table 4 displays the performance for the different factor investing strategies implemented (active strategies). Notice that according to the average annual return

criteria, the best strategy to follow between this period is the Momentum All[4], followed by Momentum Only Assets[5], having both the 17.07% and 7.28% returns respectively, as well as the highest risk-adjusted returns compared to the other strategies, 77.28% and 30.84% respectively. A shocking fact is that the 2 volatility strategies[6] have opposite results, since one shows a positive return of 3.25% and the other negative one of 5.29%.

	Average annual return	Annualized standard deviation	Annualized Sharpe Ratio
Momentum Only Assets	7,28%	30,41%	30,84%
Momentum All	**17,07%**	28,18%	**77,28%**
Volatility Only Assets	3,25%	28,72%	16,64%
Volatility All	-5,29%	**26,98%**	-16,74%
Low Volatility + Momentum	5,42%	29,84%	24,28%

Table 4: Global results of the different strategies 2018-2020

At this point we want to make a comparison between the active and passive strategies that have been discussed throughout the work. For a better understanding, results in Table 3 and Table 4 are depicted in Figures 6. Note that, all factor-based strategies exceed the benchmark (DAX30 index), the ETF associated with the DAX 30 and also the equally weighted strategy (see the annualized Sharpe ratio), with the exception of the volatility all strategy with the worst performance (Sharpe ratio equal to -16,74%). The best positioned among strategies is the momentum all strategy, beating by far the

[4] Focusing on the Momentum All strategy, the asset that had the worst performance was FRESENIUS SE, so it had a null participation in the 2018 portfolio and then calculating the difference in the return of each asset with that of FRESENIUS SE to obtain the rest of weights.

[5] Regarding the Momentum Only Assets strategy, when taking the values of the previous year to calculate those of the current year, we comment that, in 2017, SIEMENS, BMW, HENKEL VZO MERCK DEUTSCHE TELEKOM and FRESENIUS SE were not included in the distribution of the weight of 2018 for having negative returns. We highlight MTU AERO with almost 8% of the portfolio, and at the other end DAIMELER with only a 0.03% stake.

[6] In the case of Volatility Only Assets, we highlight MTU AERO as in the first strategy analysed, with almost 79% of the weight of the portfolio. As in the other strategies, for Volatility All 2 data stand out. The first ADIDAS with a negative weight of more than one third and on the other end we have MTU AERO, being its weight in the portfolio of more than 3/4. These along with the other weights are those that offer a portfolio variance less than another combination.

benchmark. The momentum only assets strategy also exceeds the benchmark by more than three times the return rate and twice as much in Sharpe's ratio. In summary, looking at the Sharpe ratios obtained in the total period, we corroborate the importance of factor investing as a strategy to improve performance.

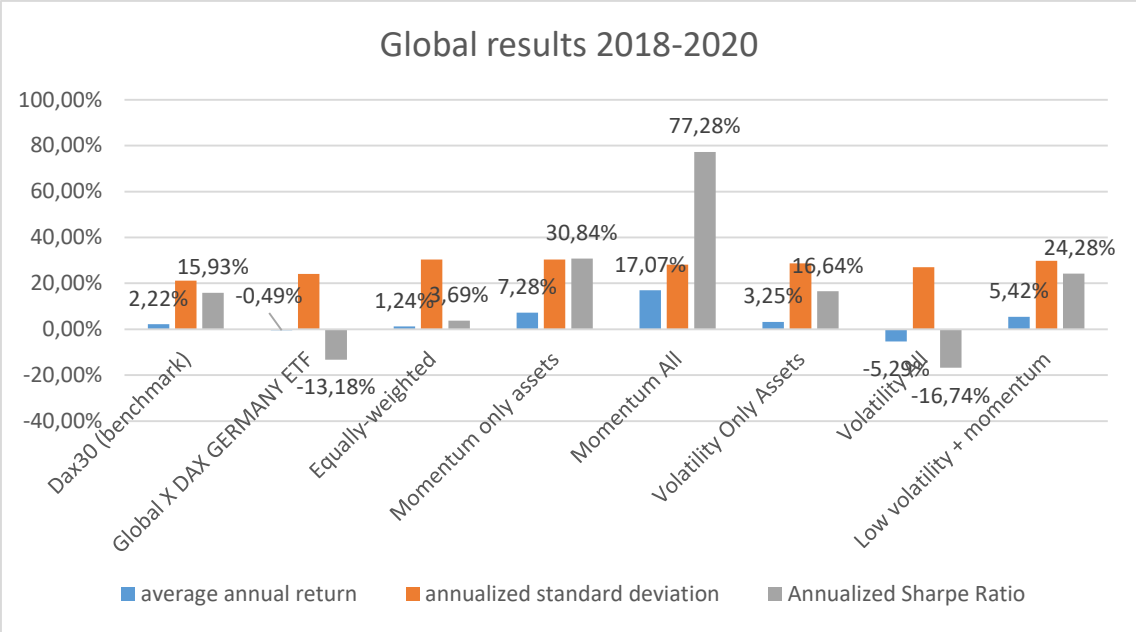

Figure 6: Global results of Active and Passive strategies

7. SUBSAMPLE RESULTS

In this section, we are interested in knowing the performance of factor investing strategies in each of the years included in the sample (2018, 2019 and 2020) relative to passive strategies. Since financials markets have evolved in different ways during this period, considering bull and bear markets, it is important to further investigate how active and passive strategies behave in different scenarios.

Table 5, 6 and 7 show the performance for 2018, 2019 and 2020 respectively. Without a doubt, 2018 (Table 5) was a very bad year for world stock markets that declined due to a number of events: low interest and the intention of central banks to raise them soon also made investors afraid, the uncertainty of Brexit, the trade war between the US and China, and the Deutsche Bank financial restructuring plan among others. All this caused global stock market data to fall sharply, as we can see from the data in this analysis, which affected the index, the ETF and the stocks (see Table 5 and Table 8). However, those investors that had followed a momentum all and volatility only assets strategy would have got a good performance, since they would have obtained a return of 20,34%

and 0,84%, with a risk of 18.55% and 26,95%, and a Sharpe ratio of 109,69% and 3,24% respectively. Focusing on the Sharpe ratio per year, we clearly see in Figure 7 how the one with the best Sharpe ratio was the Momentum All strategy (109,69%), followed by the rest of factor investing strategies that managed to beat the index, the 1/N strategy and the ETF, positioning the latter as the worst data. So, in terms of Sharpe ratio, the performance of all factor investing strategies was better than the performance of either the DAX30 index or the passive strategies (see Figure 7).

	2018		
	Average annual return	Annualized standard deviation	Annualized Sharpe Ratio
Dax30 (benchmark)	-20,91%	**16,00%**	-133,27%
Global X DAX GERMANY ETF	-30,55%	18,15%	-170,62%
Equally Weighted	-21,71%	25,24%	-86,01%
Momentum Only Assets	-17,21%	25,48%	-67,56%
Momentum All	**20,34%**	18,55%	**109,69%**
Volatility Only Assets	0,84%	26,95%	3,14%
Volatility All	-16,05%	26,30%	-61,03%
Low Volatility + Momentum	-16,80%	24,53%	-68,46%

Table 5: Results of strategies in 2018

In 2019 markets evolved in a very different way. It was a very good year for investment, and here the one that did the best (considering the average annual return) was also a Momentum strategy, but this time, Momentum Only Assets strategy, with approximately 31%, followed by the low volatility strategy with 28.20%. Although, notice that the DAX30 and the ETF are the ones with lower risk. Looking at the Sharpe ratio, we can appreciate that the DAX30 index had the best performance followed by the Momentum only assets strategy (see Figure 8).

	2019		
	average annual return	annualized standard deviation	Annualized Sharpe Ratio
Dax30 (benchmark)	24,03%	**14,37%**	**168,93%**

Global X DAX GERMANY ETF	17,28%	18,05%	97,08%
Equally Weighted	20,35%	23,94%	85,00%
Momentum Only Assets	**31,02%**	21,89%	141,75%
Momentum All	23,92%	22,53%	106,18%
Volatility Only Assets	13,03%	22,47%	58,01%
Volatility All	5,39%	20,63%	26,11%
Low Volatility + Momentum	28,20%	21,68%	130,06%

Table 6: Results of strategies in 2019

In the year 2020, regarding the average annual return, the factor investing strategy that stands out again is the Momentum Only Assets strategy, with a return of 8.04%, and this time, there are 2 strategies that show a negative result, both being volatility based strategies (see column 1 in Table 7). However, notice that this year the winner is the ETF whether we consider annual returns or the Sharpe ratio with a return of 11,81% and a Sharpe ratio of approximately 34%.

	2020		
	average annual return	annualized standard deviation	Annualized Sharpe Ratio
Dax30 (benchmark)	3,53%	**33,38%**	12,12%
Global X DAX GERMANY ETF	**11,81%**	36,28%	**33,99%**
Equally Weighted	5,08%	42,08%	12,08%
Momentum Only Assets	8,04%	43,85%	18,32%
Momentum All	6,94%	43,46%	15,97%
Volatility Only Assets	-4,12%	36,75%	-11,22%
Volatility All	-5,20%	34,02%	-15,29%
Low Volatility + Momentum	4,87%	43,32%	11,25%

Table 7: Results of strategies in 2020

In Table 8, we can appreciate how different stocks behaved, and a result of this, how this affected the DAX30 index in the period analysed.

2018	2019	2020

	Average annual return	annualized standard deviation	Annualized Sharpe Ratio	Average annual return	annualized standard deviation	Annualized Sharpe Ratio	Average annual return	annualized standard deviation	Annualized Sharpe Ratio
DAX30	-0,08%	1,01%	-8,23%	0,10%	0,91%	10,53%	0,01%	2,10%	0,67%
Global X DAX GERMANY ETF	-0,12%	1,14%	-10,60%	0,07%	1,14%	6,03%	0,05%	2,29%	2,05%
ADIDAS	0,04%	1,78%	2,01%	0,19%	1,62%	11,98%	0,01%	2,64%	0,42%
ALLIANZ	-0,04%	1,24%	-2,97%	0,09%	0,97%	9,61%	-0,03%	2,75%	-1,24%
BASF	-0,17%	1,29%	-13,31%	0,05%	1,50%	3,05%	-0,02%	2,73%	-0,59%
BAYER	-0,22%	1,85%	-11,70%	0,08%	1,95%	3,97%	-0,17%	2,69%	-6,17%
BEIERSDORF AG	-0,03%	1,07%	-2,73%	0,07%	1,19%	5,52%	-0,05%	1,75%	-2,79%
BMW ST	-0,08%	1,31%	-6,46%	0,01%	1,34%	1,06%	-0,01%	2,88%	-0,17%
CONTENENTAL AG	-0,26%	1,92%	-13,32%	-0,02%	1,89%	-1,04%	0,02%	3,39%	0,60%
COVESTRO	-0,28%	2,21%	-12,86%	-0,02%	2,05%	-0,84%	0,08%	2,71%	2,92%
DAIMLER	-0,18%	1,47%	-12,15%	0,03%	1,80%	1,69%	0,06%	3,74%	1,69%
DELIVERY HERO	-0,01%	2,23%	-0,28%	0,33%	2,46%	13,24%	0,24%	2,96%	7,98%
DEUTSCHE BANK AG	-0,34%	2,10%	-16,13%	0,00%	2,30%	-0,13%	0,10%	3,63%	2,85%
DEUTSCHE BOERSE	0,03%	1,27%	2,63%	0,12%	1,17%	10,37%	0,00%	2,26%	-0,11%
DEUTSCHE POST	-0,21%	1,45%	-14,45%	0,15%	1,19%	12,40%	0,07%	2,46%	2,85%
DEUTSCHE TELEKOM	0,00%	1,09%	0,06%	-0,01%	0,84%	-0,86%	0,01%	1,92%	0,54%
DEUTSCHE WOHNEN AG	0,04%	1,17%	3,27%	-0,04%	1,55%	-2,53%	0,07%	1,85%	3,95%
E.ON SE	-0,02%	1,35%	-1,50%	0,04%	1,09%	3,82%	-0,02%	1,91%	-1,04%
FRESENIUS SE	-0,18%	2,28%	-7,74%	0,07%	1,69%	4,20%	-0,11%	2,53%	-4,49%
FRESENIUS ST	-0,18%	2,04%	-8,82%	0,06%	1,57%	4,07%	0,01%	1,76%	0,76%
HEIDELBERGCEMENT	-0,22%	1,44%	-14,97%	0,08%	1,48%	5,59%	-0,02%	3,06%	-0,78%
HENKEL VZO	-0,06%	1,16%	-5,14%	-0,01%	1,48%	-0,97%	0,00%	1,77%	0,02%
INFINEON	-0,11%	2,09%	-5,39%	0,07%	2,22%	2,96%	0,17%	3,42%	5,11%

LINDE PLC	0,03%	1,85%	1,64%	0,13%	1,30%	10,34%	0,04%	2,28%	1,94%
MERCK	0,00%	1,45%	0,07%	0,07%	1,14%	5,81%	0,12%	2,00%	5,75%
MTU AERO	0,02%	1,73%	1,39%	0,20%	1,40%	14,25%	-0,07%	4,33%	-1,64%
MUNICH RE	0,02%	1,17%	1,86%	0,14%	0,90%	15,06%	-0,03%	3,02%	-1,06%
RWE AG ST	0,05%	1,80%	2,50%	0,15%	1,47%	10,44%	0,09%	2,49%	3,79%
SAP	-0,03%	1,42%	-2,09%	0,14%	1,63%	8,38%	-0,05%	2,63%	-1,76%
SIEMENS AG	-0,12%	1,41%	-8,18%	0,08%	1,34%	5,65%	0,05%	2,59%	1,74%
VOLSKWAGEN	-0,07%	1,81%	-4,10%	0,10%	1,46%	6,85%	-0,06%	3,39%	-1,72%
VONOVIA SE	-0,02%	1,23%	-1,48%	0,08%	1,25%	6,46%	0,09%	1,99%	4,42%

Table 8: Results of DAX30 stocks

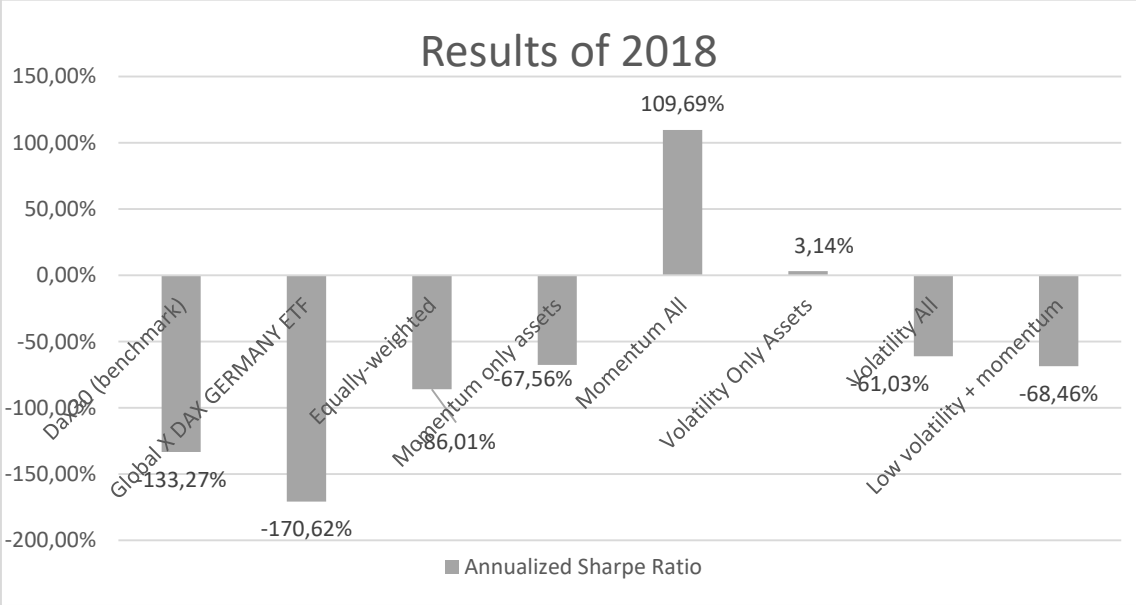

Figure 7: Sharpe ratio (2018) of Active and Passive strategies

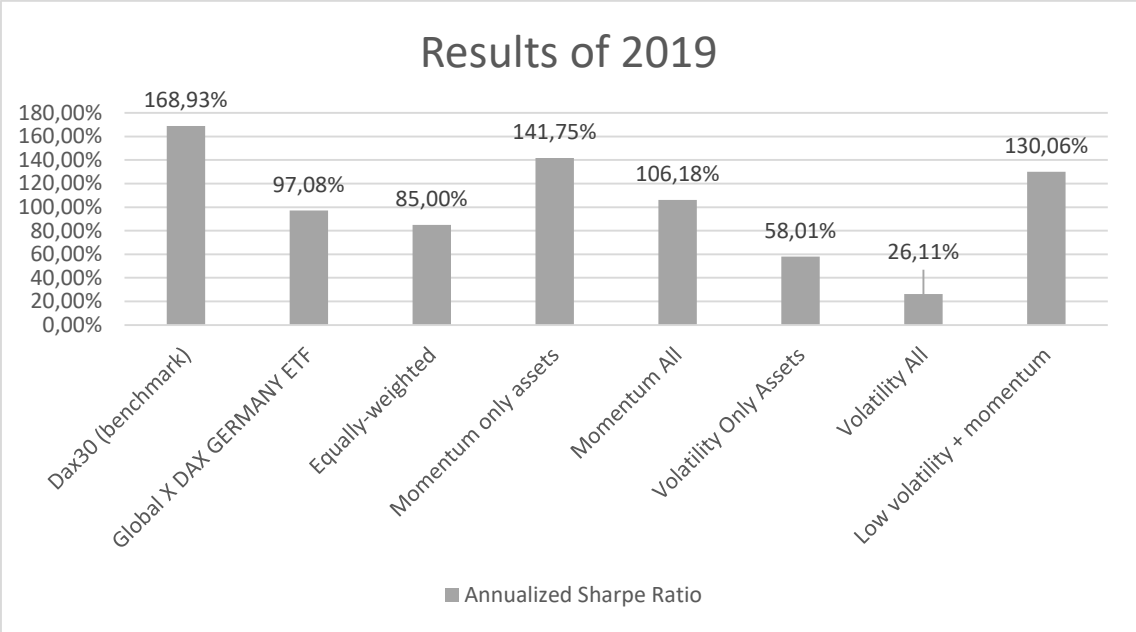

Figure 8: Sharpe ratio (2019) of Active and Passive strategies

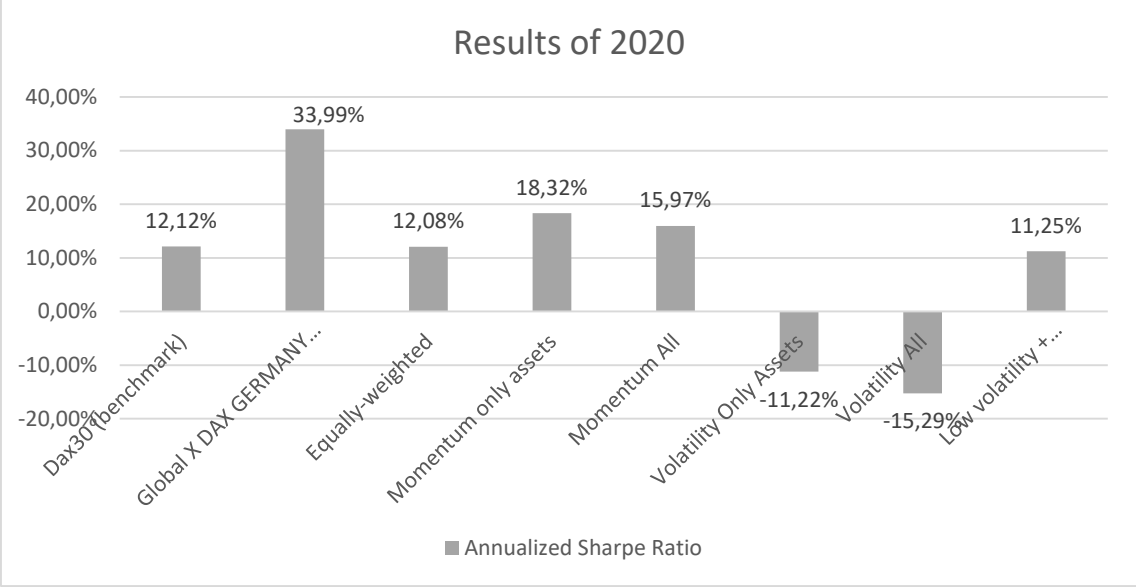

Figure 9: Sharpe ratio (2020) of Active and Passive strategies.

This subsample analysis reveals two interesting results: a) the advantage of factor investing strategies and the short- comings of passive investment in bear markets (year 2018), and b) that passive strategies take full advantage in bull markets (year 2019) generating better results.

In summary, what stands out of this analysis is that factor investing plays a crucial role to improve performance, especially when markets turn downwards. Passive strategies

may generate better result in periods of economic expansion, but in the long-term factor investing matters.

8. CONCLUSIONS

This document examines the ability of factor-based portfolios during the 2018-2020 period to outperform the benchmark portfolio, and passive strategies such as the ETF and the 1 / N strategy. Empirically, we find strong evidence that factor-based portfolios manage to outperform the benchmark and any passive strategy. Concretely, the momentum factor is the winner since it has been the furthest away from the benchmark. We can also see how in bearish markets the performance of factor investing strategies is clearly better. Only in periods of economic expansion passive strategies generate better results. This can be summarized in the fact that Factor Investing may have a worse behaviour in the short term, when markets rises, but that they succeed in the long term.

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