



MARKET TRENDS, MOMENTUM EFFECT AND EFFICIENT MARKET HYPOTHESIS

AUTOR: JOSU EGUIGUREN BALERDI

DIRECTOR: FRANCISCO GUIJARRO MARTÍNEZ

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ABSTRACT

The main purpose of this research project has been to analyse if any profitable intra-day strategy can be designed in the German DAX index, taking into account the previous day's trend. Regarding the pattern followed by this index, five different strategies have been ranked, including the trend strategy and mean reversion strategy. The first one takes advantage of the momentum effect, so consists on taking long position when prices are rising and short positions when the market is oversold. The mean reversion property is just the opposite.

Once knowing that the DAX follows some kind of pattern, the market efficiency has been tested to know how can an investor make profits from it. On the other side, the impact of Stop-Loss and Stop-Profit trading mechanisms in the investments performance has been analysed as well in terms of risk and return.

The main conclusions are that the German stock market is not completely efficient because the mean reversion strategy performs better than the other ones in almost all the sample period. Moreover, the use of Stop-Losses is extremely advisable, while the Stop-Profits depends on the investors risk profile.

Keywords: Momentum effect; Trend; Stops; Market efficiency.

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1. PURPOSE OF THE PAPER

Operating according to the market trends gives to the investors the possibility to make profits. The strategies based on these trends makes the most of the momentum effect. This effect consists on:

“The momentum effect is a quite usual market phenomenon by which asset prices follow a trend for a rather long time. This can mirror economic evolutions, but in some cases, it brings a growing discrepancy between prices and “fundamental” values (see effect, overreaction, trend, bandwagon...) ... until reality strikes back.” (Behavioral-Finance group, 2015)

In this paper, the possibility of creating profitable strategies in the German stock market will be analysed, taking into account the index previous performance, that is, if it is preferable to invest looking at the previous day's evolution, or not. The German stock market is one of the most relevant in Europe, considered the biggest benchmark after London City and it is really easy to obtain the price of its most important assets. The index which measures the performance of the 30 major trading companies in this market is the DAX Index. Furthermore, different mechanisms such as Stop-Loss and Stop-Profit will be applied to observe how they affect to the value of the investments, in terms of risk and return. These tools are supposed to be very useful to reduce the volatility of different financial assets.

When establishing some patterns to operate in any financial market, two strategies can be considered, which can be complementary. On the one hand, assuming that the investor will take a long position (buying an asset) a positive threshold can be established to ensure a profit when prices are rising. If the investor considers that the rise is big enough, he will close the position. Thus, he avoids the possibility to lose the profit if the price go down again. This maximum threshold is called Stop-Profit or Take-Profit. On the other hand, if the value of an investment is decreasing, a negative threshold can be established and close the position to avoid having big losses. This mechanism is called Stop-Loss. It can be considered as the maximum acceptable loss.

Therefore, the effectiveness (or the lack of it) of these mechanisms will be analysed in this paper. In case they are effective to reduce risks and/or increase the returns, it will be interesting to know which one is the optimal value of the Stops. In terms of getting this optimal threshold, different scenarios will be considered and different Stop combinations tested.

2. INTRODUCTION

The main reason to choose the DAX index is that it is a very relevant market in Europe, characterised by its high liquidity. According to the information obtained from the *www.investing.com* website, the average monthly trading volume in 2016 was 2,06 billion.

The investors have the possibility to buy and sell the index using CFD, a derivative asset characterised by allowing a high leverage with low transaction costs. Most brokers include in their contracting platforms the possibility to buy and sell this kind of assets in real time. In the same way, it is possible to operate through ETF. The return of this asset is determined by the evolution of an index.

The DAX (Deutscher Aktienindex) is the index composed by the 30 major German companies of the Frankfurt Stock Exchange and was founded in July of 1988. It is calculated by the weighted average of the capitalization and the order book volume of each company. The members with the biggest weight in the index are Bayer (9.27%), Siemens (8.73%), SAP (8.16%), BASF (8.02%) and Allianz (7.74%).

The German Stock Market operates under the XETRA electronic trading venue. The sessions open at 9:00 and close at 17:30: However, in case of trading through CFD on DAX future contracts it is usual to operate from 8:00 to 22:00.

3. HYPOTHESIS SPECIFICATION

After determining the main purposes of the paper and before starting to develop the analysis of the German market's evolution, the following hypothesis have to be specified. The objective is to be able to prove if these hypotheses are true or not after the tests.

3.1. Hypothesis 1: The momentum effect does not exist.

In case of demonstrating that the performance of a stock is not influenced by its previous day's performance, it will be possible to assure that the momentum effect does not exist. In this case, the evolution of the prices will be completely unpredictable and the random walk theory will be fulfilled.

Consequently, the technical analysis and the different mechanisms used in this kind of analysis will be completely ineffective and useless because the forecasts made from technical analysts are based on the historical performance of stocks. As a result, it will be demonstrated that the investors always operate

in a rational way, and the over-reactions caused by euphoria or depression are inexistent in this particular market.

Precisely, one of the core ideas in which the market efficiency theory is based is the unpredictability of the stock prices.

All these ideas imply that the actual price of the stocks mirrors the fundamental (or intrinsic) value, that is, the prices include all the available information in the market. When some new information is revealed related to a particular stock, the investors will operate with the objective of maximizing their profits and these transactions will change the price until being equal to the new fundamental value. In this way, the new price will reflect all the available information again. Therefore, all the financial assets are perfectly valued in every moment. The most important exponent of this theory is Eugene Fama (1970)

Thus, there will be very few opportunities of getting a higher return than the market: To have privileged information, to take advantage acting before the rest of the investors when new information is revealed or assuming higher risks than the market. Moreover, people who do not believe in this theory will make some transactions and create inefficiencies. These inefficiencies can be used to make profits by other investors.

Hence, working with unpredictable prices makes impossible to have a higher average return than the market in a long run. It is possible to have better short term results in a random way but there is not any strategy which guarantee a continuous profit in a long run. In other words, the momentum effect does not exist and it is impossible to take advantage of it, being ineffective all the strategies analysed in this paper.

However, the existence of the momentum effect would demonstrate that the market is inefficient and when an upward trend is observed two alternatives could be considered: to take a long position (expecting that the trend will continue) or to take a short position (expecting that the trend will change and the price must go down because the fundamental value of the stock is lower than its price. This idea is based on the mean-reversion property)

To be able to demonstrate that the momentum effect actually does not exist, the results of the tests should be neutral. In case of having a pattern (positive or negative) it will be possible to assure that some strategies are better than other ones, that the described phenomena exist and therefore it will be possible to determine some mechanisms in order to make profits in the market.

3.2. Hypothesis 2: It is better to take a short position when the market experiments a downward trend.

As mentioned in the first hypothesis, when the market experiments a downward trend, two alternatives are considered: to take a short position (selling stocks) or a long position (buying stocks). Both strategies are reasonable because some investors can feel that the price will continue decreasing (in case of being false the first hypothesis) and that is why it is a better option to sell. Other ones can think that the price is now lower than the fundamental value of the stock and it will rise again. In this case, would be a better idea to buy the stock, following the mean-reversion property.

“Mean reversion is the theory that interest rates, security prices, or various economic indicators will, over time, return to their long-term averages after a significant short-term move.” (InvestingAnswers, Inc., n.d.)

Applying uniform criteria in order to test both strategies, the results must show which alternative is better. That is the reason why the tests will be done in the following way: Depending on the previous session performance, a long or short position will be taken. The tests will be carried out in all possible scenarios, including a random strategy (50% probability of taking a long position and 50% of taking a short position). The results will be analysed to verify if there is any strategy better than the rest or all of them report similar performance.

3.3. Hypothesis 3: Use of Stop loss and Stop profit in order to decrease the volatility of the investments.

After understanding how these mechanisms work, it seems that they could be really useful in order to reduce the risk of having huge losses. This can happen because the Stop Loss allows to make impossible to loss more than a previously determined threshold and the Stop Profit ensures a profit if the performance of the investments is good enough. Hence the Stop Profit could be useful to prevent financial agents from changes of trend when they are in the profitable status.

However, in the same way in which the session profits can be lost because of market fluctuations, it is possible to have a turnaround in the loss status. If an investor applies Stop Loss, he can have his position closed and he will not get any benefit from this turnaround. So, are these mechanisms useful to reduce losses and guarantee a return or they are just limits applied to give some control feeling to the investors? And in case they are useful, which is the optimal point to determine a Stop in order to maximize returns and limit the risk?

3.4. Hypothesis 4: The mix between the best Stop combination and the best strategy will report great results.

In case of discovering an optimal investment strategy in the 2nd hypothesis and an optimal stop combination in the 3rd hypothesis, how it will perform if both are combined? Are the results better than in any other case? Can this strategy report similar performance in the future?

4. SAMPLE FOR THE ANNUAL RETURNS ANALYSIS

To check if the first two hypotheses are true is not necessary to apply Stops because the position taken at the beginning of the session will not be closed until the final of it. Therefore, it is enough having an opening and closing value of the Index every day. That is why the sample period can be much larger, it is possible to analyse the market evolution with very few values. In this case, the sample is composed of the daily DAX Index data between November 26, 1990 and November 15, 2011. For the analysis of the Stop Loss and Stop profit mechanisms every session has been divided in 15 minutes' intervals, so is not feasible to work with such a big amount of data and the sample period will be shorter.

The tests will be made using the Index values, so the conclusions may be extrapolated to every financial asset which replicates DAX performance, like an Index replicating stocks portfolio or the Exchange Traded Funds (ETF). The ETF are assets whose performance is determined by the investments managed by a fund which replicates an Index. Nevertheless, the ETF and stocks can be traded in a similar way.

On the other hand, the investors who want to invest using Contracts for difference (CFD), can take into account the conclusions obtained in this paper because the capital gains or losses from these financial assets are determined by the rise or decrease of the value of the corresponding stock index. One of the differences from the futures is that the CFDs require lower leverage, so they are less risky. The CFD are non-regulated contracts between investors and brokers, so the different terms as the multiplier are negotiated. On the other side, the futures are regulated and the multiplier of the DAX index is 25 at this moment, which means that a variation of one point of the index will vary in 25€ the value of the bet.

Regarding the transaction fees, these are the current costs of some important brokers while operating with stocks or CFD of the DAX:

*“Core Spreads – 0.8 point spreads
ETX Capital – 1 point spreads
Investors Intelligence Spread Betting – 1 point spreads
Spreadex – 2 point spreads
IG – 1 point spreads
Plus 500 – 0.88 point spreads”* (Spread Betting Brokers, n.d.)

Investors trading through ETX Capital, Investors Intelligence Spread Betting or IG, the last day of the sample would have a transaction fee of 0.017%. On the other side, in the case of futures, some contracts can be purchased with a minimum transaction fee of 0.75€ (DeGiro broker) but it is usual to trade with costs around 7€ per contract.

However, each broker offers different services, so that is why the costs are so different from each one. Therefore, due to the wide range of different brokers and services offered by them, in this paper the transaction costs will not be included in order to analyze the performance of the investments.

5. DESCRIPTION OF THE TESTS CORRESPONDING TO THE DAILY RETURNS SAMPLE

5.1. Random strategy.

At the beginning of each session a long or short position will be taken in a random way and closed at the final of the day. This test will be useful to know how will perform a completely inexperienced investor who do not use any investment analysis tool. It will be the most important benchmark in order to compare the results of the rest of the tests. To check if the other strategies are good or not it is essential to know if they are at least better than the random strategy.

5.2. Same position in all the sessions.

In case of taking a long position every day, the stocks will be purchased at the beginning of each session and sold at the final of it. On the contrary, regarding to the short position, the stocks will be sold at the beginning of the session and purchased at the final of it. Using this method, at the final of the sample period it has to be evident which one performed better, that is, if the sessions had an upward or downward trend.

5.3. Trend strategy.

Following the momentum effect theory, expecting that the trend will continue as in the previous day, a short position will be taken if the previous session was bearish. Hence the stocks will be sold at the beginning of the day and bought again at the final of it. On the contrary if the previous session was bullish, the investors may expect another similar performance, so they will buy stocks at the beginning of the day and sell everything at the closing price.

If the results of this test are much better than the random strategy ones, the existence of the momentum effect can be considered, although needing more tests to reinforce this thesis.

5.4. Mean reversion strategy.

This strategy is the opposite of the trend strategy, thus when the previous session is bullish a short position will be taken at the beginning of the day. Logically in case of experiencing a bearish session, the investors will expect a rise in prices and they will take a long position at the next open of the market.

The process of drawing conclusions will be similar to the previous strategies. However, the results will be compared with the trend strategy to know which one performs better in the German stock market and if the probability of experiencing a continued trend is higher or lower than the probability of experiencing a turnaround.

5.5. Performance of the different strategies using Stop Loss and Stop Profit mechanisms.

It is interesting to analyse the intra-day evolution of the DAX Index too. For that purpose, new tests will be carried out introducing the Stop Loss and the Stop Profit mechanisms to know how they improve the performance of the investments or they are ineffective. Different levels of Stops will be set and combined in the strategies explained above. With this it will be possible to know whether the Stops have a similar impact in all the strategies.

The main purpose of this test is to discover the optimal Stop combination for the best investing strategy.

6. TESTS APPLICATION

6.1. Random strategy.

Using the daily returns to carry out the tests, the sample is composed by 5301 sessions, from 26/11/1990 to 15/11/2011. Taking a long or short position

in a random way at the opening of each session, in 2660 times a long position was taken and a short position in 2641.

The average of simple daily returns was 0.0032990% with a standard deviation or volatility of 1.2747595%. In case of investing 1,000€ in the opening of 26/11/1990 and repeat the transactions until the day close in 15/11/2011, the portfolio final value would be 763.31€. The maximum value of this portfolio was 1,180.89€ and was registered in 15/11/1995, while the minimum value was 340.16, in 11/09/2001 triggered by the terrorist attacks suffered by the United States.

Illustration 1: Evolution of 1,000€ portfolio. Random strategy (Source: Author)

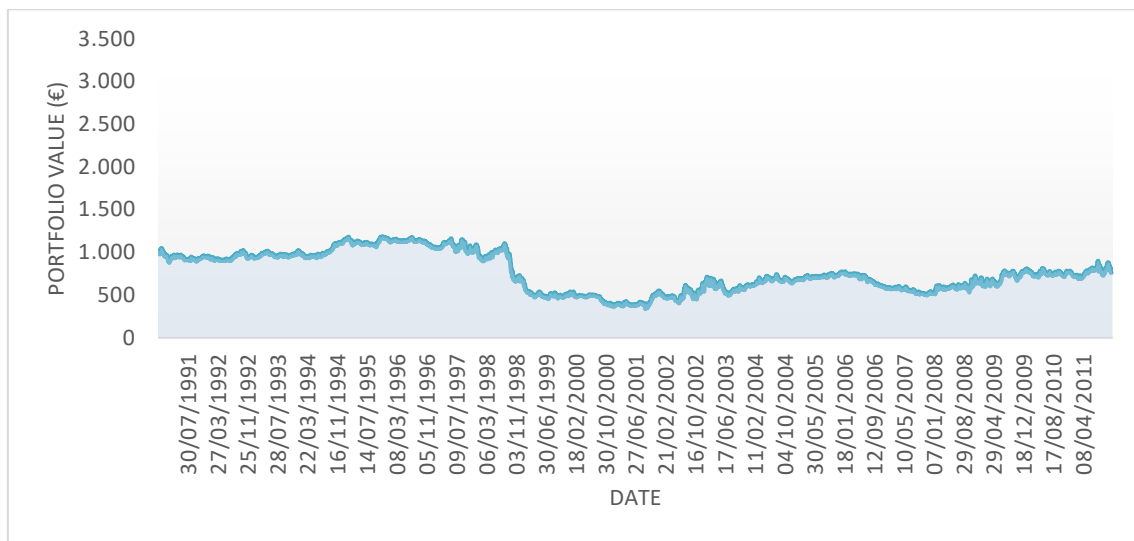


Table 1: Daily return results. Random strategy (Source: Author)

Number of days			Average daily return	Std. deviation (σ)	Max. daily return (28/10/2008)	Min. daily return (11/09/2001)	Revaluation (all the period)
Negative return	Positive return	0% return					
2,647	2,551	103	0.033%	1.2748%	11.786%	-8.701%	-23.67%

The maximum return was caused by an incident with Volkswagen stocks in October 2008. After the outbreak of the financial crisis the short sellers were predominating the European stock markets because the expectations were extremely pessimistic. The situation was quite similar for Volkswagen. The owner of the 40% of the stocks of the German car manufacturer was Porsche and to fight against the continuous depreciation of its stocks caused by short sellers, they announced that they were going to purchase 30% more of Volkswagen stocks.

This announcement increased instantly the value of the stocks, the funds started to close their short positions with the purpose of minimizing the losses. Volkswagen stocks revaluated more than 81% in a very short period of time. In

the session of October 28, 2008 in some moments the value of each stock was higher than 1,000€. Even if important companies value like Deutsche Post, Commerzbank, Deutsche Bank or Continental decreased by more than 10%, the DAX Index rose 11.786%.

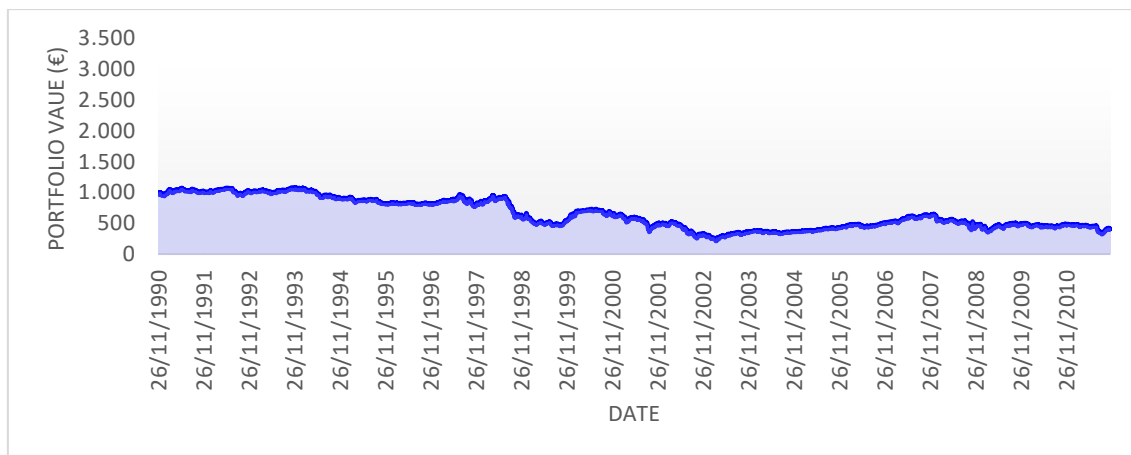
“Volkswagen briefly became the world's biggest company by market value on Tuesday, as short sellers caught betting on a price drop with borrowed stock scrambled to find shares after a buying spree by Porsche.” (Marsh, 2008)

On the other side, the heaviest drop observed in all the period, dates to September 11, 2001, when the World Trade Center and the Pentagon were attacked by the terrorist group Al Qaeda in the United States.

6.2. Same position in all the sessions.

In case of taking a long position in all of the 5,301 openings and closing it at the final of each session, this would be the outcome: The average simple daily return is -0.0087%, while investing 1,000 at the opening in 26/11/1990 and keep doing the same transactions every day, the final portfolio value would be 409.18€, having a depreciation of more than 59%. Nevertheless, this value is not the lower in all the period because the minimum value dates to March 12, 2003 with a portfolio value of 216.55€.

Illustration 2: Evolution of 1,000€ portfolio. Long strategy (Source: Author)



In that period, characterised by global political instability generated by the imminent US invasion in Iraq, the recent 9/11 attacks and the outbreak of the Dot Com companies bubble, the DAX index was experiencing a really negative trend, registering the lowest values since November 1995.

Table 2: Daily return results. Long strategy (Source: Author)

Number of days			Average daily return	Std. deviation (σ)	Max. daily return (28/10/2008)	Min. daily return (11/09/2001)	Revaluation (all the period)
Negative return	Positive return	0% return					
2,499	2,699	103	-0.0087%	1.2747%	11.786%	-8.701%	-59.08%

On the other side, the short strategy consists on taking a short position without regarding the previous day's performance. With this policy, the outcome is just the inverse of the long position: The average daily simple return is 0.0087% and the portfolio final value 1,032.15€. However, the maximum value of the portfolio is 2,868.08€ in March 12, 2003, while the minimum value is 839.75 in December 28, 2007, a few days or weeks before than the crash of the stock markets in January 2008, consequence of the financial crisis.

Illustration 3: Evolution of 1,000€ portfolio. Short strategy (Source: Author)

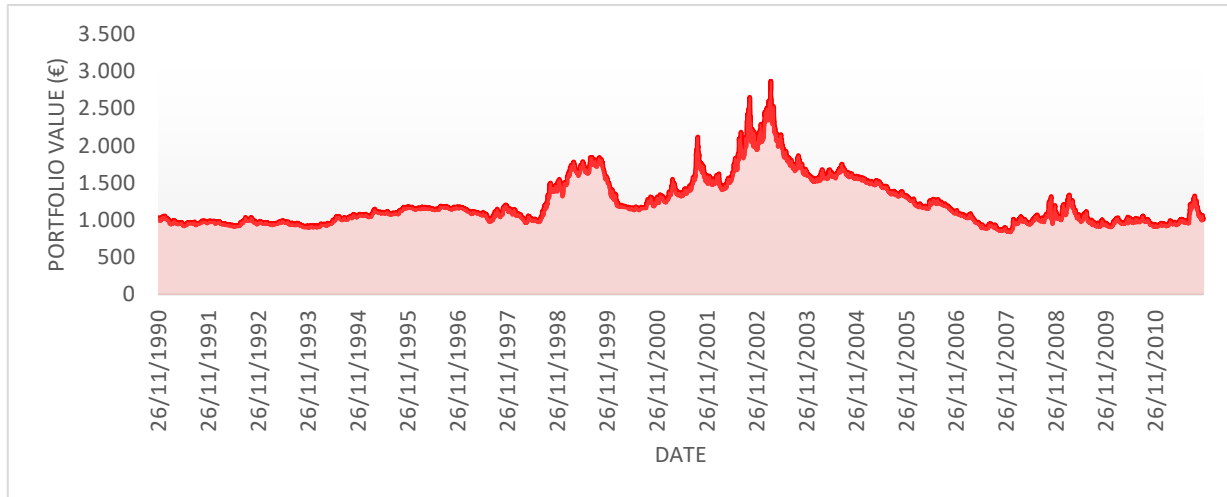


Table 3: Daily return results. Short strategy (Source: Author)

Number of days			Average daily return	Std. deviation (σ)	Max. daily return (28/10/2008)	Min. daily return (11/09/2001)	Revaluation (all the period)
Negative return	Positive return	0% return					
2,699	2,499	103	0.0087%	1.2747%	8.701%	-11.786%	3.22%

Still having more negative days, the results are much better short selling everyday than taking a long position, because the final portfolio value is higher in almost all the period. The results are much better than in the random strategy too so even if not having enough arguments to assure that the DAX index is not efficient, it looks like it does not follow a random walk pattern.

6.3. Trend strategy.

Following the trend strategy, the investments will be done assuming that in the market the trends of commodity prices will continue in time. Therefore, if the previous day's opening price was lower than the closing price, that is, it was a bullish session, the probability of having another similar day is higher than experiencing a bearish session. In the same way, it is usual to have a succession of bearish sessions.

Thus, it is possible to make profits through the momentum effect. In this test, 5300 day's return has been obtained due to the first observation is just used to see if it is bearish or bullish and determine the position of the next session.

So, the average daily simple return obtained after the tests is -0.0229%, the worst value of all the strategies. Furthermore, the final value of the 1,000€ portfolio, in case of repeating the transactions during the sample period by this strategy, is 193.10€. This means that the investment has a depreciation of 80,69%, without taking into account the transaction costs.

The day with the highest loss in all the period was November 24, 2008. The previous session was bearish, so a short position was taken in the following one. In this day, the US Federal Reserve announced his contribution in the Citigroup bank financial rescue. All the stock markets worldwide received the news with upward trends, so the investors who bet against the market suffered big losses.

“The U.S. government has agreed to guarantee over \$300 billion of Citigroup's troubled assets -- loans and securities backed by residential and commercial real estate and other such assets” (Quillia, 2008)

Illustration 4: Evolution of 1,000€ portfolio. Trend strategy (Source: Author)

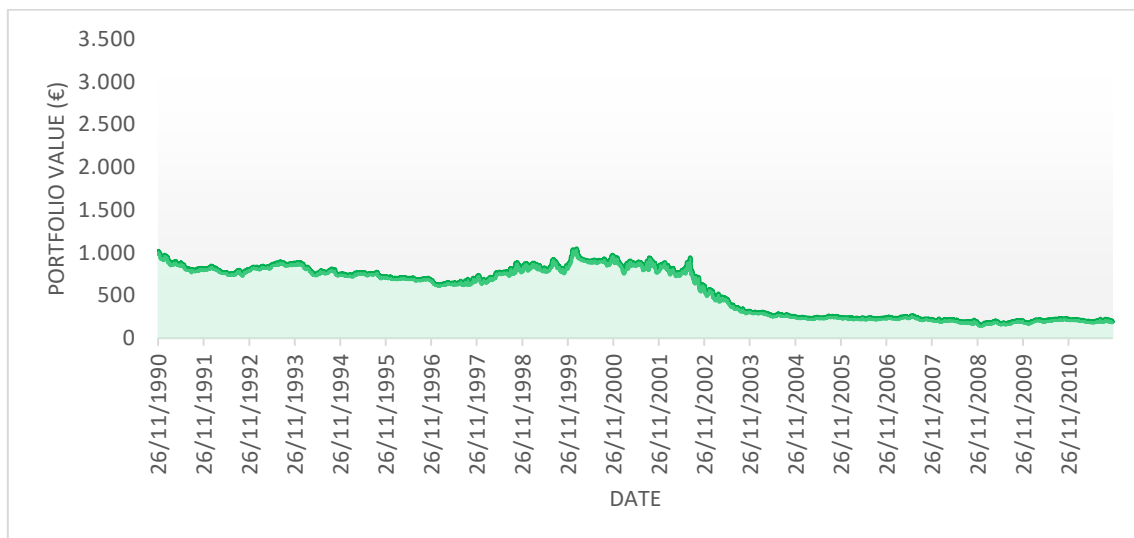


Table 4: Daily return results. Trend strategy (Source: Author)

Number of days			Average daily return	Std. deviation (σ)	Max. daily return (11/09/2001)	Min. daily return (24/11/2008)	Revaluation (all the period)
Negative return	Positive return	0% return					
2,677	2,520	103	-0.0229%	1.2744%	11.786%	-9.277%	-80.69%

Looking at the graphical representation of the portfolio value of the short strategy, it is undoubtedly much worse than the previously analysed ones. It is the strategy with the worst average return, the one with most negative return days, the portfolio is losing value from the beginning of the sample period and a big loss in 2003 is observed due to the economical context of that period.

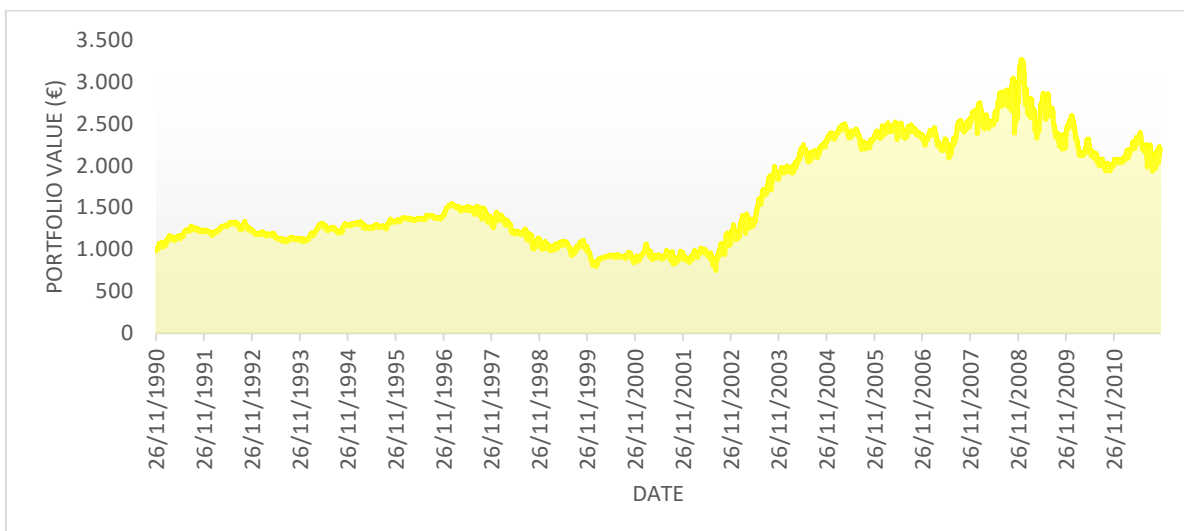
Therefore, even if it is possible to talk about the existence of some trends, following the strategy which allows to take advantage of the momentum effect is not appropriate, because having a determined performance in the previous session does not mean it will be reproduced again in the future. With this situation, it is really important to compare this results with the ones that are going to be obtained in the next test, analysing the mean reversion strategy, the opposite of the trend strategy.

6.4. Mean reversion strategy.

As mentioned in the previous sections, this strategy is based on the theory which states that once exceeded a determined threshold, the commodities prices have to return until their usual range. So if the price of a stock increased in the past, it should decrease until its average value and vice versa. Consequently, when the price rises, it is a good opportunity to short sell and make profit and when the price goes down the investors should be taking long positions.

After carrying out the test, taking a long or short position in the 5300 sessions depending on the previous day's performance, these are the results:

Illustration 5: Evolution of 1,000€ portfolio. Mean reversion strategy (Source: Author)



As shown in the graph above, the portfolio value increased significantly in the two big economic crisis of the 2000s decade. It is striking to see that at the day close of January 2, 2003 the value of the portfolio was 1,121.67€ while in December 30, 2003 the registered value was 1,953.14€. The maximum value in

the sample is 3,266.83€, in December 19, 2008, when the Real Estate bubble burst and the global economy went into a depression. Nevertheless, after that period the portfolio value began to decrease gradually with some interruptions until the final of the sample.

Furthermore, the minimum value of the portfolio dates to August 5, 2002, in a very special economical context. The Euro currency come into force in January 1999 but it showed to be very weak against the dollar until 2002. In addition, after applying tough austerity measures (Hartz Plan), in May 2002 Germany announced to have been overcome the economic recession caused by the stock market crash of the dot com and telecom companies. Meanwhile, in the United States, George W. Bush was trying to reactivate the economy after the big crisis caused by the dot com companies bubble burst and the World Trade Center attack. He was applying expansive policies for that. In general, the governments of developed countries were trying to boost their economies after a bad period. The minimum value of the portfolio was 747.75€.

The final value of the portfolio in 15/11/2011 registered 2,187.61€, which means an appreciation of 118.76%.

The next table shows a brief summary of the results:

Table 5: Daily return results. Mean reversion strategy (Source: Author)

Number of days			Average daily return	Std. deviation (σ)	Max. daily return (24/11/2008)	Min. daily return (11/09/2001)	Revaluation (all the period)
Negative return	Positive return	0% return					
2,520	2,677	103	0.0229%	1.2744%	9.277%	-11.786%	118.76%

Therefore, this is the strategy which shows the best results.

However it is really shocking to see how a strategy based on betting against the market (short selling) has good results when the opening DAX points were 1,466.3 in November 26, 1990 and the session of November 15, 2011 closed with 5,884.94 points.

These values show that during the sessions, the stock market has experienced more bearish days and the drops were sharper than the rises in bullish days, while the index value has multiplied its value by four. The explanation of this phenomena is that between the closing prices of the sessions and the opening prices of the next ones there had been huge increases. Indeed, the intra-day variations sum is -3,923.56 while the total increase during the gaps is 8,342.2.

Consequently, it is interesting to analyse the impact of the variations during the gaps depending on each strategy. Thus, an extra section will be added to the mentioned ones to carry out the same tests but including this

characteristic. The main difference between the previous tests and the next ones will be that in the previous ones the return was obtained using the opening and closing value of the same session, while in the next ones the difference between two closing values will be taken into account to calculate the returns. In such a way, the variations experienced during the gaps will be included in calculating the returns.

6.5. Distribution of intra-day returns.

In the graph below it is represented the distribution of the daily returns of each strategy.

Illustration 6: Distribution of daily simple returns. All the strategies (Source: Author)



All the lines which represent the different investment strategies, seems to be very similar and it is difficult to distinguish between each other. To make the interpretation easier and analyse the graph more accurately, the next graph shows the same data but with a much narrower range, focused on the most frequent returns.

Illustration 7: Detailed distribution of daily simple returns. All the strategies (Source: Author)



Because of the similarity between the different lines, a T test will be carried out to discover if there are significant differences in terms of average return of the strategies, taking into account the standard deviation too. These two components are represented in the distribution graphs above. Knowing that the results generated through the different strategies defined in this paper are obtained using the same values of the sample, the test will be carried out under the related groups assumption.

A null hypothesis and an alternative hypothesis are stated.

- Null hypothesis (H₀): Two strategies have the same average return.
- Alternative hypothesis (H₁): Two strategies have a different average return.

To obtain the T value of related groups the following formula is used:

$$t = \frac{\bar{X}_d}{\frac{S_d}{\sqrt{n}}}$$

In the table above the respective T values are shown:

Table 6: Student T results (Source: Author)

	Long	Short	Trend	Mean reversion	Random
Long		-0,48	0,56	-1,33	-0,47
Short	0,48		1,33	-0,56	0,22
Trend	-0,56	-1,33		-1,31	-1,07
Mean reversion	1,33	0,56	1,31		0,79
Random	0,47	-0,22	1,07	-0,79	

With a confidence level of 95% and a sample size of 5,300 observations, the critical value for two tails tests is 1.96. If any value in the table had been higher than the critical value in absolute terms, it would be possible to claim that the average return of two strategies are different statistically. However, as shows the table, all the T values are lower than the critical value in absolute values. The meaning of this values is that still having different average returns, there is a great dispersion, which makes possible to have higher and lower returns than the average of each other. Therefore, due to the high standard deviation there is no significant statistical difference between all the average returns.

7. CONCLUSIONS AFTER THE INTRA-DAY RETURNS ANALYSIS:

Once discovered the reason why the short strategy beats the long strategy, even if the index has multiplied its value by four, it is obvious that there is a very relevant omitted variable if only the intra-day returns are taken into account: the variations during the gaps between the day close and opening of the following sessions, which are bigger than the ones observed in them.

Thus, a downward trend is observed during the session, while the opening prices are significantly higher than the previous closing prices. This means that taking a long position in every session cannot be profitable at all. Those are the main indicators of the performance of each strategy.

Table 7: Indicators of the analysis of daily simple returns. All the strategies (Source: Author)

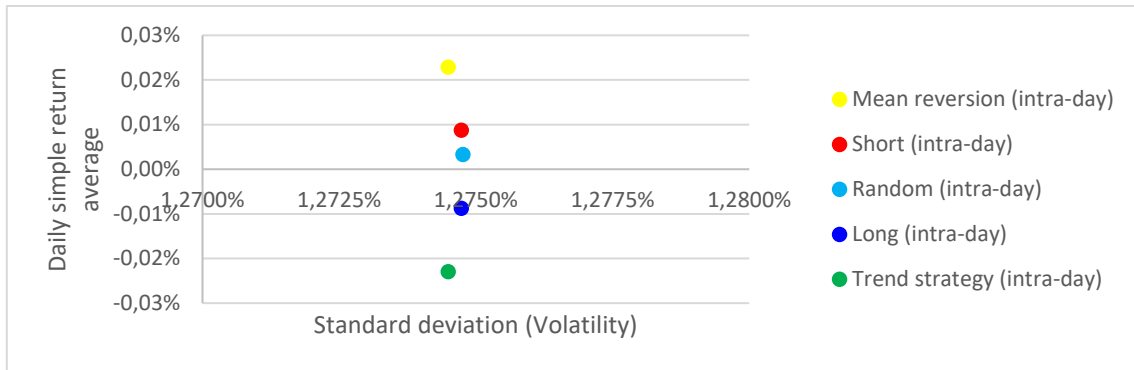
	Average return	Standard deviation	Portfolio value (1,000€)
Random	0,003299%	1,274759%	763,31€
Long	-0,008738%	1,274734%	409,18€
Short	0,008738%	1,274734%	1.032,15€
Trend strategy	-0,022904%	1,274494%	193,10€
Mean reversion	0,022904%	1,274494%	2.187,61€

The table shows very clearly that the best investment strategy for this sample is the mean reversion strategy, due to it obtains the higher average daily return by far with the lowest volatility. Nevertheless, the standard deviations of all the alternatives are very similar. So, investing 1,000€ at the beginning of the sample period and managing it in the proposed way, the profit would be higher than 118% without taking into account the transaction costs.

Logically, the worst alternative is the inverse strategy, that is, the one based on believing that the previous day's trend will continue in a similar way. It has the lowest return and the same risk than the mean reversion strategy. The same portfolio of 1,000€ would have a final value of 193.10€ if the trend strategy is followed (without including the transaction costs).

In order to represent the risk and return parameters in a more visual way, the performance graph is shown below:

Illustration 8: Risk and return comparative without stops and gaps. All the strategies (Source: Author)

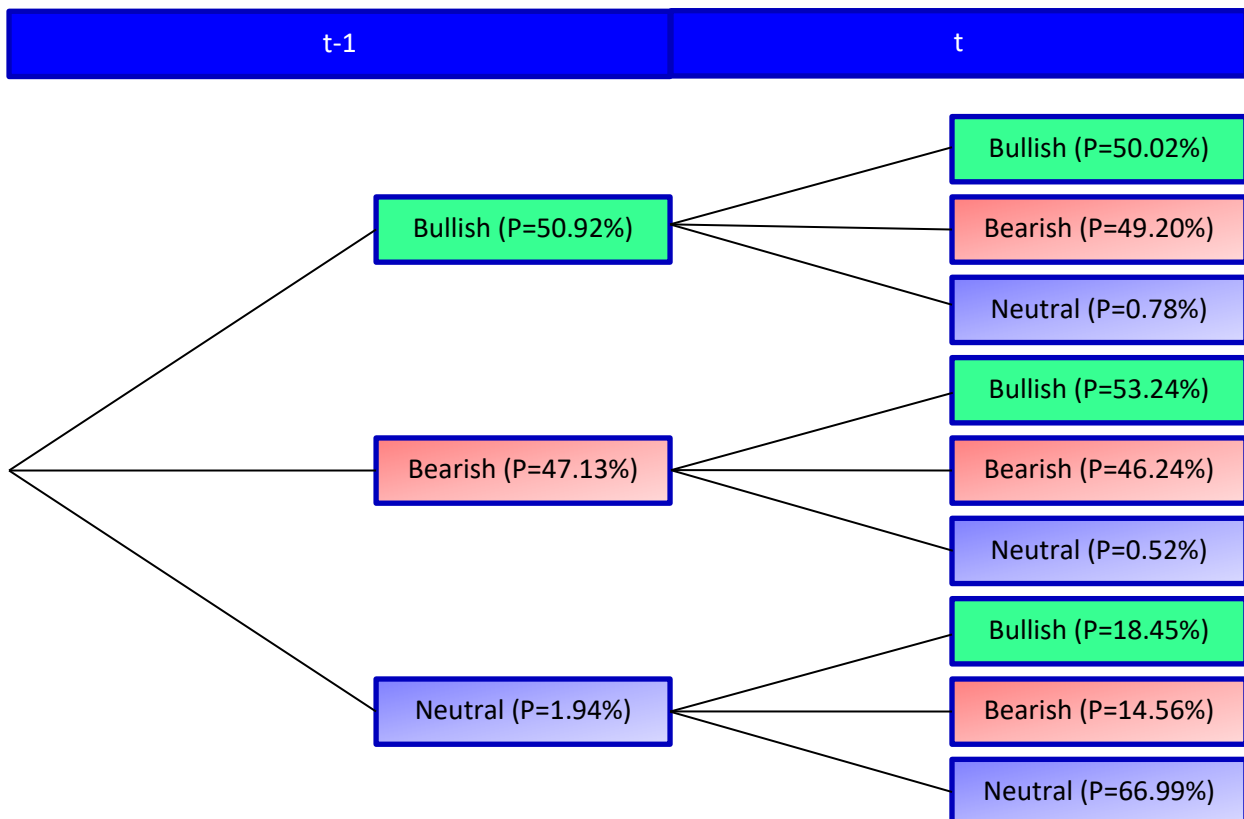


In this illustration, it does not appreciate any new fact, it is just to strengthen the previous conclusions, explained in the paragraphs above.

Therefore, it is logical to think that in this period, when the DAX index experiences an upward trend, the probability of the next session to be bearish is higher, so the recommendation would be to close the long positions or short sell. On the contrary, when a downward trend is observed, the best choice would be to close the short positions or to invest taking long positions. To make sure that this statement is correct, the probability of having changes of trends or chaining days with the same trend will be analysed.

The diagram below shows the probabilities of all the possibilities.

Illustration 9: Probabilities of chaining positive/negative sessions or having changes of trends (Source: Author)



From this illustration it is possible to obtain the different probabilities which are interesting for this analysis. On the one hand, it is shocking to see that taking a random session of the sample, there is a higher probability of having a bullish session but the short position investment strategy reports better results. This means necessarily that the bearish sessions are less quantitatively but the drops are much more relevant than the rises and the average daily simple returns certifies this.

On the contrary, in the previous sections it was demonstrated that the mean reversion strategy beats the rest very clearly, which make interesting to know the probability of chaining two sessions with different trends. Looking at the illustration above the following calculations can be done:

$$P(\text{Continue the trend}) = 0.5092 \times 0.5002 + 0.4713 \times 0.4624 = 0.4726 = 47.26\%$$

$$P(\text{Change of trend}) = 0.5092 \times 0.4920 + 0.4713 \times 0.5324 = 0.5014 = 50.14\%$$

In the calculations, the sessions with the same opening and closing prices are not included because a fictitious scenario is raised in this paper, where there is not any transaction cost. Consequently, in these days regardless of the chosen strategy, the returns, portfolio value and other parameters keep constant.

Those percentages are a key factor to understand the results, because they show very clearly that there is a higher probability of experiencing trend changes than chaining two days with the same trend or price. This explains why the mean reversion strategy adapts to the DAX market better than any other. Moreover, having a sample of 5300 observations, these probabilities cannot be obtained by chance.

In the next graphs the evolution of the different 1,000€ portfolio's evolution is shown, managed with different strategies. Note that the illustration number 11 is drawn with a logarithmic scale.

Illustration 10: Evolution of 1,000€ portfolio. All the strategies (Source: Author)



Illustration 11: Evolution of 1,000€ portfolio with logarithmic scale. All the strategies (Source: Author)



Both illustrations show that the short position strategy was the most profitable between the years 2000 and 2003, due to the depression of the German stock market, consequence of the burst of the dot com companies bubble and the panic after 9/11 attacks. Incidentally, this period was the best for the trend strategy. Nevertheless, when the confidence in the stock markets was recovered with the economic growth, the profits of the mean reversion strategy improved drastically, as same as the value of the portfolio managed by the long strategy.

Very relevant companies such as Lehman Brothers and many others specialised in mortgage lending went bankrupt in 2008 because of the global financial crisis. This situation had consequences in the evolution of the different portfolios. The effectiveness of the mean reversion strategy decreased slightly, while the one based on short selling halt the decline and a little rebound can be appreciated in its line. Logically, the long strategies performance is much worse in this period because the index was experiencing a downward trend. However, the impact of the second crisis of the 2000s was much lower than the first one because lower variations can be observed in the graph.

Probably, the strategy which represents the reality in a better way is the random strategy. In the dot com crisis period the portfolio losses its value, while in the following years a big improvement is observed until 2007. In this year starts to fall again motivated by the first signs of the financial crisis.

With this information and without testing the stop loss and stop profit mechanisms it is possible to provide the initial approaches to accept or reject the first two stated hypotheses.

1-. The market is efficient, so the momentum effect does not exist:

As explained before, if the momentum effect does not exist, no title's return will be affected by its previous performance. After carrying out these tests it is demonstrated that when an upward or downward trend is observed, the probability of experiencing a change the next day is higher. Moreover, after discovering that taking the same position every day the results are not too good, it is not correct to claim that the good results of the mean reversion are caused by a higher number of bearish or bullish sessions. Hence the results of the random strategy are much better than in the case of trend strategy, but worse than mean reversion ones. Therefore, and pending more tests, it seems that the actual performance of the DAX index is affected by the trend observed in the previous session.

In this sample the returns does not follow a random walk pattern, which means that the DAX index is not completely unpredictable. This circumstance can be considered as an inefficiency and gives to the investors the possibility to make profit applying an appropriate strategy, apart from having privileged information or assuming higher risk than the market.

As a consequence, the market is not completely efficient in principle, because the past evolution affects slightly to the present performance, the DAX index returns are not totally random.

2-. When a downward trend is observed in the market the prices are expected to continue decreasing, so a short position is recommended and vice versa:

The previous tests demonstrate very clearly that a strategy based on betting in favour of the continuity of the trends is bad, experiencing big losses in the portfolio value. Hence, this hypothesis need to be rejected necessarily. The best way of getting high returns is to manage the investments with the inverse idea, that is the mean reversion strategy which obtains in addition, the lowest volatility. When a downward trend is observed, there is a higher possibility of experiencing an increment of prices in the next session, so a long position is highly recommended. The opposite transaction should be done if the observed trend is bullish.

8. GAPS INCLUDING TESTS APPLICATION

To measure the probable impact of the gaps in the risk and return of each strategy, the same tests will be carried out but including the variations experienced in them.

8.1. Random strategy.

The methodology of this test will be almost the same of the intra-day returns test, taking the positions randomly. The difference is that in this case the gaps will be included in the analysis. For that, the returns will be calculated with the difference between two closures, while in the previous tests the calculations were made with the difference between the openings and closures of the same day.

To be able to compare and enhance the consistency of the results, the same positions will be taken in each session of the sample. The sample is composed by 5,300 sessions because the closing value of the DAX in the first day will be taken as the starting point.

In this case, the average daily simple return obtained is 0.0406% while the final value of the 1,000€ portfolio shows the relevance of the variations during the gaps, registering 4,842.7€. Assuming that the final value of the portfolio with the intra-day returns was 763,31€, there is no doubt about the big differences between the day closes and the following openings, since the portfolio's final value is 6 times higher.

The illustration above shows the differences between the daily returns of the two random strategies.

Illustration 12: Distributions comparative between intra-day and inter day strategies. Random strategy (Source: Author)

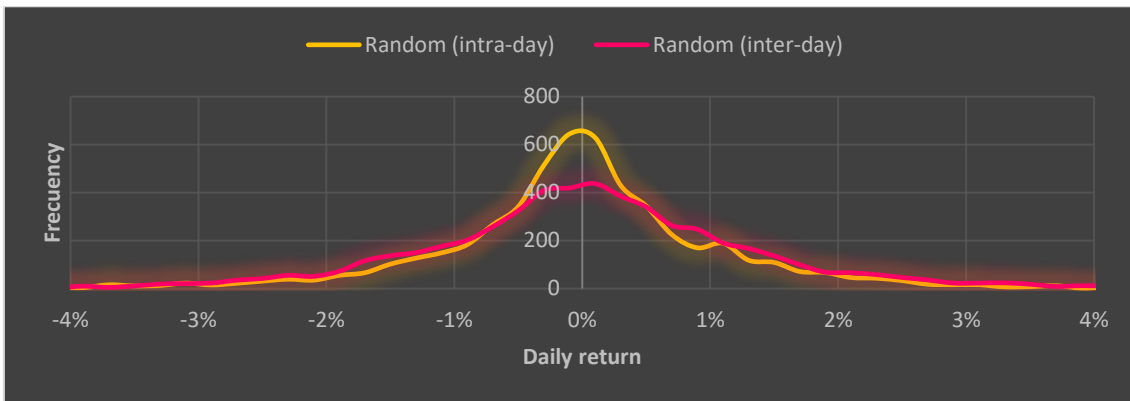


Table 8: Risk and return of intra-day and inter-day investments. Random strategy (Source: Author)

	Random (intra-day)	Random (inter-day)
Average return	0.003299%	0.040644%
Standard deviation	1.274759%	1.476028%

The most evident point of the graph is that the days having a return close to 0% are fewer including the gaps in the analysis. In the same way, extreme values are more frequent as can be seen in both sides of the bell. On the other side the shape of the inter-day line is wider and this means that the gaps make the strategy more profitable but riskier at the same time. It is possible to have very positive or negative days more frequently. The values of the average daily simple return and the standard deviation strengthen these statements.

To discover if both averages are statistically different, a T test will be carried out. The closing and opening prices are the same in both cases, the difference is that in the inter-day average the gaps were included, so the samples are related. Using the same formula of the previous T Student test, the T value is -1.41. This T value is lower in absolute terms, than the critical value of 1.96, which is the recommended figure for a confidence level of 95%. Therefore, the high dispersion of the daily returns make the T value too low to assure that there is a significant difference between both averages.

8.2. Same position in all the sessions.

Following the hypothesis explained in the point 5.2., the tests will be carried out taking a long or short position at the closure of each session but every day the same. This is equivalent to buying or short selling a financial asset at the beginning of the sample and keeping the investment until the final of it. It has no sense to close and open the same position at every closing. Thus, the biggest advantage of this strategy and including the gaps is that there is a possibility of saving big amounts of money in transaction costs and consequently obtain a higher return.

Regarding to the long strategy, the average daily simple return is 0.03742% and the portfolio's final value is 4,077.70€. If only intra-day returns are included the average return is negative and the 1,000€ portfolio is devaluated by more than 59%. Hence, the gaps have a big impact in a profitability of the investments, because a portfolio with a devaluation of more than 59% can be appreciated in more than 400% if the gaps are included.

Illustration 13: Distributions comparative between intra-day and inter day strategies. Long strategy (Source: Author)

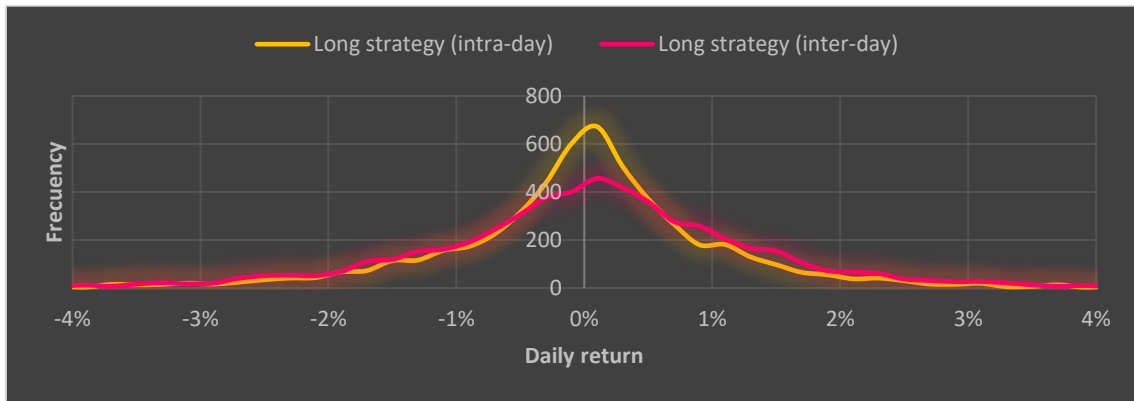


Table 9: Risk and return of intra-day and inter-day investments. Long strategy (Source: Author)

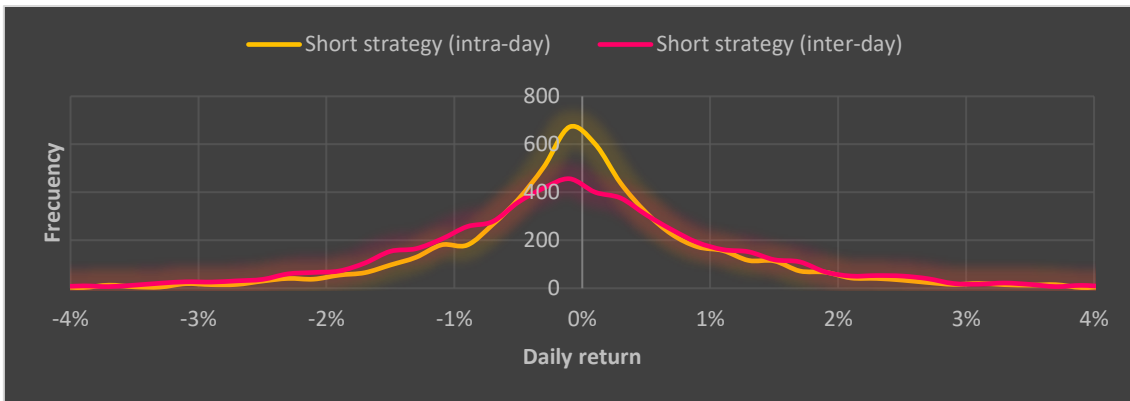
	Long strategy (intra-day)	Long strategy (inter-day)
Average return	-0,008738%	0,037417%
Standard deviation	1,274734%	1,476113%

As happens with the random strategy, the gaps make the investment much more volatile, having extreme returns more frequently. However, this is not the key to understand how a strategy with negative returns can become positive. The biggest difference, as explained in previous sections, is that the drops are very sharp during the sessions while the rises during the gaps are more relevant than these decreases.

The T value between both alternatives is -5.22 which is in absolute value much higher than the critical value of 1.96. In this case the null hypothesis has to be rejected which means that it is not possible to confirm that there is not any statistical difference between the averages.

On the other hand, the final value of the 1,000€ portfolio in case of managing it short selling the index is 77.16€, still the Index losses points during the sessions. Nevertheless, this is another example of the relevance of the gaps, which make the drops observed during the sessions insignificant.

Illustration 14: Distributions comparative between intra-day and inter day strategies. Short strategy (Source: Author)



Looking at the distributions of the illustration above, the conclusion is the same as in the previous cases; including the variations between closing and openings increases the volatility of the investment, as well as the probability of having higher or lower returns.

Table 10: Risk and return of intra-day and inter-day investments. Short strategy (Source: Author)

	Short strategy (intra-day)	Short strategy (inter-day)
Average return	0.008738%	-0.037417%
Standard deviation	1.274734%	1.476113%

Finally, the T test is carried out to verify if the averages are statistically different when including the gaps. The T value for the short strategy is 5.22, which is much higher than the critical value of 1.96 and means that the hypothesis which states that the averages are different is true considering the dispersion of the daily simple returns.

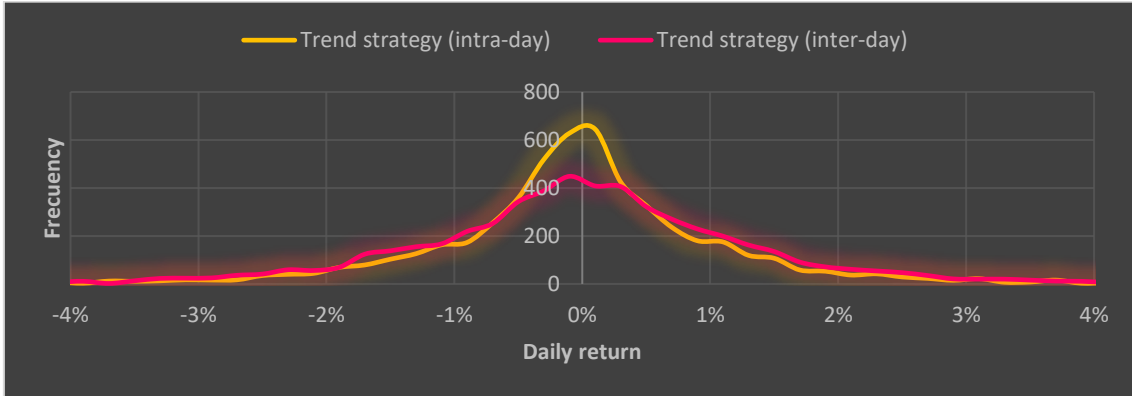
8.3. Trend strategy.

In case of following this strategy and obtain very positive results, the conclusion would be clear: the momentum effect exists in the German stock market and having a bullish session increases the probability of the next day to be bullish too (and vice versa). To include the differences between the openings and day closes the decisions are made in every day close. Thus, knowing that in the first day of the sample the closing is lower than the opening, a short position is taken in the moment the session ends. This position will be kept until the next day close and in this moment, if the day's trend is negative again, nothing will be done. On the contrary if the trend changes, the position will change too and a long position will be taken.

Following this pattern, the final value of the 1,000€ portfolio is 738.10€ which is much higher than the value obtained in case of intra-day trading (193.10€). The average return is 0,005182%, lower than the ones obtained with the inter-day random and long position trading.

In the graph below the distribution of daily returns of intra-day and inter-day investments is shown in case of the trend strategy.

Illustration 15: Distributions comparative between intra-day and inter day strategies. Trend strategy (Source: Author)



The conclusions are the same in the previous cases: Including the gaps in the analysis contributes to a higher volatility of the daily returns.

Regarding the T test, a -3.19 value is obtained, again higher in absolute terms than the critical value of 1.96. Hence, it is not correct to say that there is not any statistically significant difference between both averages.

Table 11: Risk and return of intra-day and inter-day investments. Trend strategy (Source: Author)

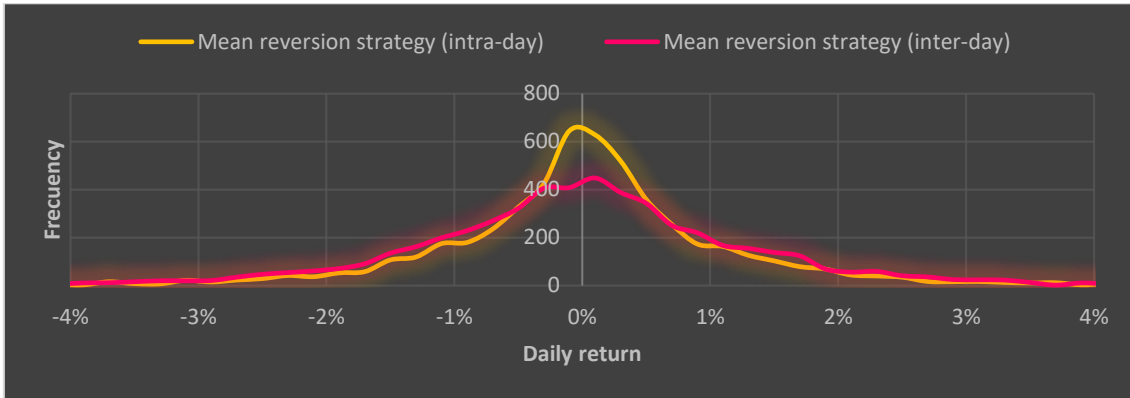
	Trend strategy (intra-day)	Trend strategy (inter-day)
Average return	-0.022904%	0.005182%
Standard deviation	1.274494%	1.476579%

8.4. Mean reversion strategy.

The remaining strategy is the mean reversion. In this analysis, the assumptions made in the section 5.4. will be followed and under this circumstances the final value of the 1,000€ is 426.27€. Comparing it with the intra-day trading portfolio, which has a value of 2,187.61€ and with the previous section information, it is demonstrated that there is a higher probability of continuing the trend experienced during the session, after the closing.

The average return is -0.00518%, much lower than the one obtained with intra-day trading in case of the mean reversion strategy, which was 0.022904%

Illustration 16: Distributions comparative between intra-day and inter day strategies. Mean reversion strategy (Source: Author)



The graph above gives the same information than the previous ones and it is that the standard deviation of returns increases when the variations of the gaps are included.

Table 12: Risk and return of intra-day and inter-day investments. Mean reversion strategy (Source: Author)

	Mean reversion strategy (intra-day)	Mean reversion strategy (inter-day)
Average return	0.022904%	-0.005182%
Standard deviation	1.274494%	1.476579%

Finally, the same circumstance of the all previous strategies, except in case of the random strategy, is given again, due to including the gaps makes the simple returns average different from the intra-day trading. To make this statement a T value of 3.19 is obtained, which is higher than the critical value determined in previous sections.

9. SUMMARY OF INTER-DAY RETURNS ANALYSIS

In the previous sections, it is mentioned that the explanation of the bad performance of the intra-day long strategy, still increasing the index value, is the great relevance of the gaps. In consequence, to demonstrate the impact of the gaps, new test has been carried out making the decisions about taking long or short positions at the closure of each session and keeping it until the next day close. The results of these new tests are quite different as shows the next table:

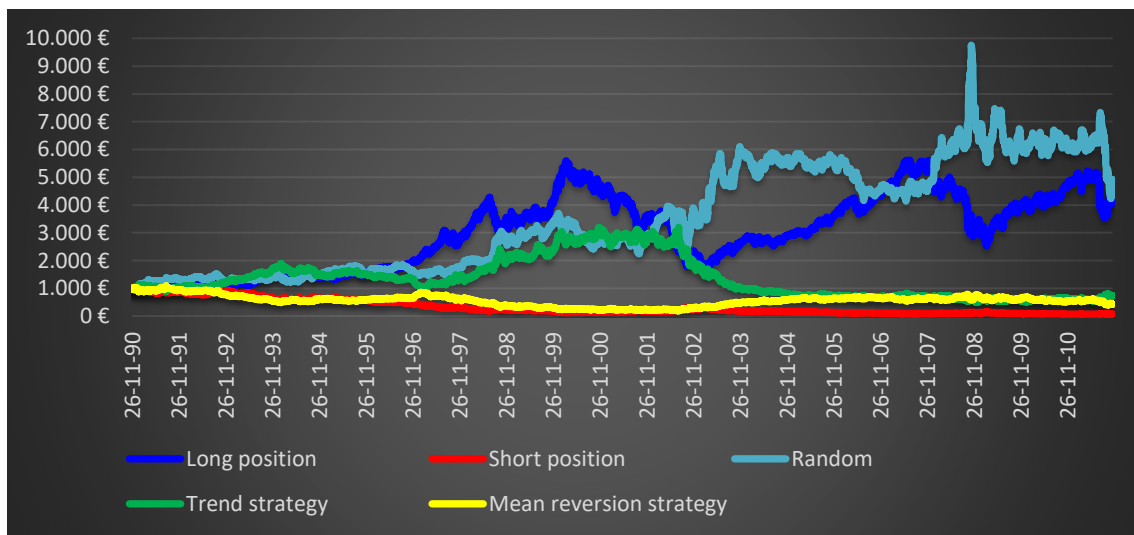
Table 13: Inter day simple return analysis results (Source: Author)

	Average return	Standard deviation	Portfolio final value (1000€)
Random	0.040644%	1.476028%	4,842.66€
Long position	0.037417%	1.476113%	4,077.70€
Short position	-0.037417%	1.476113%	77.16€
Trend	0.005182%	1.476579%	738.10€
Mean reversion	-0.005182%	1.476579%	426.27€

In this case, the strategy which gets the best results is the random strategy, due to the average daily return is the highest of all the strategies combined with the lowest volatility and therefore, the portfolio with the highest value is managed taking positions in a random way. Hence, it is not possible to demonstrate the inefficiency of the market testing inter-day annual returns. However, neither it is correct to claim certainly that the market is efficient, due to can exist some strategies which beat the index in a continuous way. To be able to assure that the market is completely efficient, there cannot exist any strategy which beat the market systematically, so it is very tricky to do it.

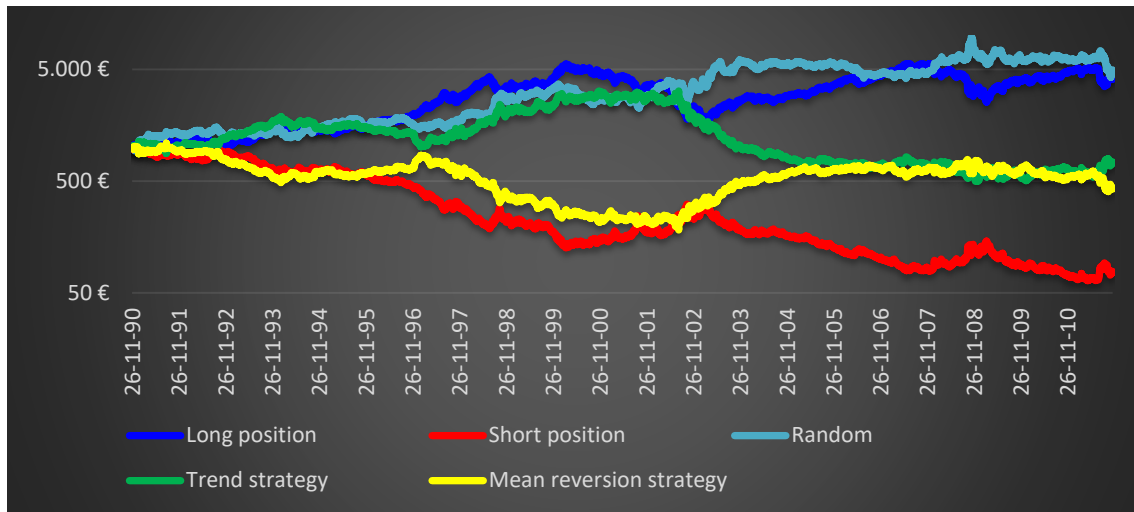
On the other side, the evolution of the 1,000€ portfolio managed by different strategies is shown in the graph below, representing the final values at the right side.

Illustration 17: Evolution of the value of 1,000€ portfolio including the gaps. All the strategies (Source: Author)



To observe much more clearly the variations in relative terms, the same graph is shown but represented through a logarithmic scale.

Illustration 18: Evolution of the value of 1,000€ portfolio including the gaps with logarithmic scale. All the strategies (Source: Author)



In both graphs, it can be verified that the random strategy is the best way to obtain good results, beating the rest of the strategies almost all over the period after 2001.

However, the long position strategy is the next one with the highest average return, still experiencing significant drops during the sessions. This situation demonstrates that the price variations in the gaps are so remarkable that makes the investment value multiply by four, still having a really bad intra-day performance. Moreover, the previous graphs show that short-selling in a long term without closing positions at any moment is inappropriate, losing almost all the value of the investment. From the 5,300 analysed gaps, in 2,881 times the opening value is higher than the closing value, which makes a percentage of 54.36%. The average increase of each gap has been 17.43 points. On the other side, in 2,386 times, 45.02% the opposite happens, that is, the opening value is lower than the closing price, with an average decrease of 17.54 points. Finally, in the rest of 33 times, 0.62%, the closing and opening price of the next session are the same.

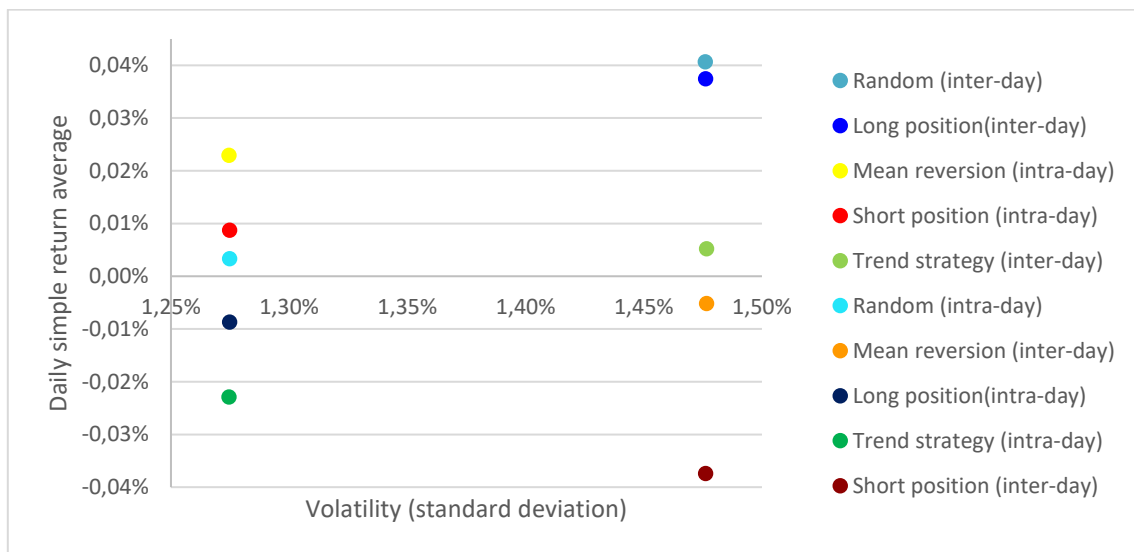
In consequence, to take advantage of the variations experienced in the gaps having higher returns, there are two essential points to take into account: The first one is that when a trend is observed in any session, it is more probable to have an inverse trend in the next session. Secondly, in the biggest part of the gaps, the closing value is lower than the opening of the next day.

More precisely, if a bullish session is observed there is a probability of 56.32% to experience a positive gap after the closing with an average increase of 16.22 points. The probability of having a negative gap is 43.46% while the average fall is 14.74 points. The remaining 0.22% corresponds to the neutral gaps, that is, when the closing value of a session and the opening value of the next session is the same.

On the other side, after the bearish days, the probability of having positive gaps is 53.04% and 46.76% of having negative gaps with average variations of 16.96 points and -17.9 points respectively. Still having bigger drops during the gaps, quantitatively are less frequent, so in general terms it has a positive balance. Therefore, in all cases the investors with long positions will make profits through the gaps.

As in the previous case, to draw conclusions more easily, the graphical representation of the results is shown, including the intra-day and inter-day strategies.

Illustration 19: Risk/return comparative without Stops (intra-day and inter-day trading). All the strategies (Source: Author)



In this paper, when a risk and return comparative graph is showed the dominance analysis will be carried out in all cases. According to the illustration above, some strategies should not be applied by any investor because there are other alternatives which have the same return with lower volatility or the same volatility with higher return. In this context, the inter-day random strategy will never be dominated because it has the higher average daily simple return from all the strategies. Moreover, it is the one with the lowest volatility from the inter-day trading alternatives. Therefore, all the inter-day strategies will be dominated by the method based on taking positions randomly. However, the risk of all the inter-day investment strategies is much lower.

In this last group, the strategy with the highest average daily simple return is the mean reversion strategy. In this case, there is a similarity with the inter-day results, due to the alternative with the highest return is the one with the lowest volatility. The trend strategy has exactly the same volatility because just the inverse positions are taken. However, the return is much lower in this case. In consequence, the mean reversion alternative dominates the rest.

Considering the results all of the tests together, including the intra-day and inter-day trading, the first conclusion drawn is that keeping the investments active during the gaps allows to obtain much higher returns, but at the same time the risk increases very significantly. Therefore, the decision of closing the positions at the final of every session depends on the risk profile of each investor.

In the next table the obtained returns are listed in an aggregate form, ranked from the most to least profitable.

Table 14: Average of daily simple returns. All the strategies (Source: Author)

	Average return
Random (intra-day)	0.040644%
Long position(intra-day)	0.037417%
Mean reversion (inter-day)	0.022904%
Short position (inter-day)	0.008738%
Trend strategy (intra-day)	0.005182%
Random (inter-day)	0.003299%
Mean reversion (intra-day)	-0.005182%
Long position(inter-day)	-0.008738%
Trend strategy (inter-day)	-0.022904%
Short position (intra-day)	-0.037417%

The table shows that if the main objective of an investor is to obtain high returns, the inter-day trading strategies should be considered. If the chosen strategy is the correct, very relevant profits may be made compared to intra-day trading alternatives. Nevertheless, in case of applying a bad strategy, the losses can be very significant. Therefore, the risk is a critical factor to take into account and in the following table the standard deviations of the returns are listed, ranked in the order of less risky to riskier.

Table 15: Volatility of daily simple returns. All the strategies (Source: Author)

	Standard deviation
Mean reversion (inter-day)	1.274494%
Trend strategy (inter-day)	1.274494%
Short position (inter-day)	1.274734%
Long position (inter-day)	1.274734%
Random (inter-day)	1.274759%
Random (intra-day)	1.476028%
Long position (intra-day)	1.476113%
Short position (intra-day)	1.476113%
Trend strategy (intra-day)	1.476579%
Mean reversion (intra-day)	1.476579%

The main conclusion is very clear because all the inter-day strategies daily volatility is approximately higher in 15%. Thus, as seen in previous sections, closing the positions when the sessions finish makes the yield curve much smoother. On the other side, it is striking, on a smaller scale, that when the gaps are not included, the strategies based on taking positions depending on the previous day's performance (trend and mean reversion) are less volatiles, while if the gaps are included these strategies become the riskiest strategies. However, the volatility of the intra-day strategies is extremely similar, thus, the difference between the highest and lowest standard deviation is 0.000265% per session. The situation is very similar with inter-day trending alternatives, being this difference of 0.000551%. Therefore, the volatilities of the two types of strategies can be clearly identified.

In consequence, the decision of keeping the investments active, and in this way making profits during the gaps, depends on the investors risk profile. This decision will condition the pattern which have to be followed to obtain a good performance.

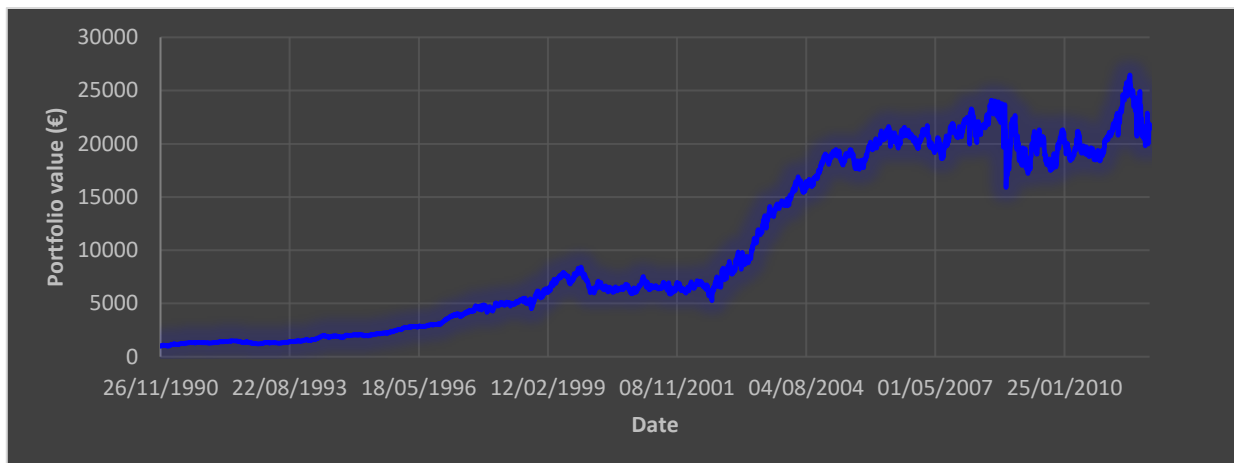
In the previous paragraphs, the different situations observed in the sample period have been analysed, trying to forecast the most probable future scenarios looking at the trends experienced in the German stock market and the past and present variations. On the basis of these conclusions, an investor can decide to combine different strategies during the sessions and during the gaps. The following could be an example:

Knowing that the mean reversion strategy is the best alternative during the sessions and the probability of experiencing positive gaps is higher than any other possibility, both strategies can be combined. In this way, an intra-day mean reversion strategy will be followed during the day but when the session closes if a short position is taken, the investor must change his position. But if the long position is taken in the session it will not be necessary to make any transaction and this gives a possibility to save in transaction costs. When the session opens again the position to take by the investor will be determined by the previous day's performance, as states the contrarian trading theory.

After carrying out the necessary calculations to evaluate this combined strategy, the results show a portfolio final value of 21,457.57€, which means that the initial portfolio is multiplied in more than 21 times. The daily average return is 0.06832% and the standard deviation 1.44442%. Apart from the highest return by far, it has the lowest volatility of the inter-day strategies.

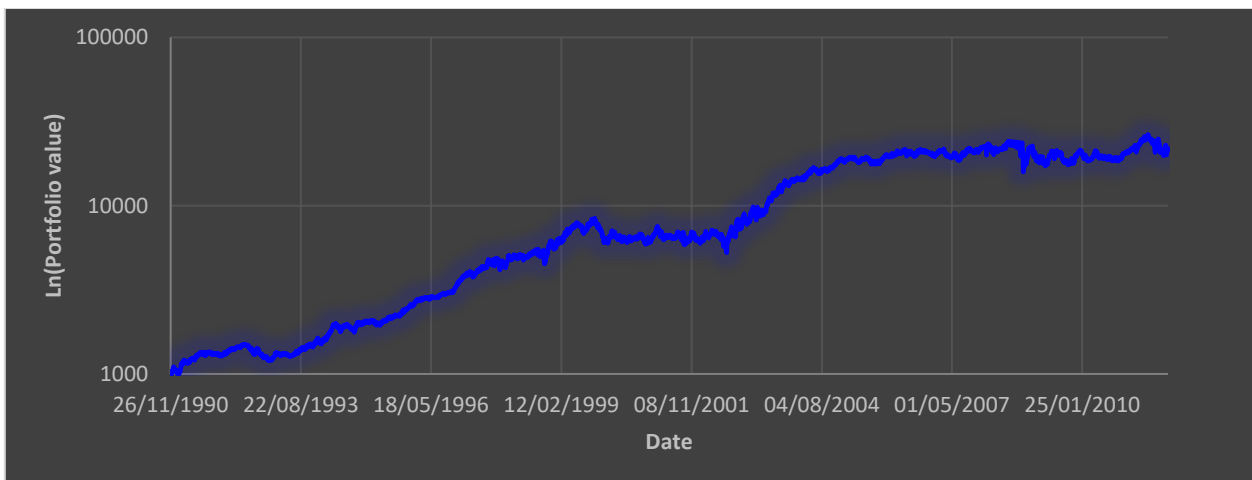
The graph above shows the evolution of 1,000€ portfolio is the new combination is followed.

Illustration 20: 1,000€ portfolio value evolution. Combined strategy (Source: Author)



The illustration shows the increase of the portfolio value in absolute terms. It is clearly represented that the best moment for this strategy was the economic expansion period between the two big crisis of 2000s. The investment value was multiplied by three in this period. However, it is not the best graph to know if this increase has been constant or not and for that it would be better to look at the logarithmic scaled graph, as the following:

Illustration 21: 1,000€ portfolio value evolution with logarithmic scale. Combined strategy (Source: Author)



Looking at this graph it is easier to appreciate that the increase has been constant all over the sample period. Except for the two economic crisis in which the portfolio value remains constant, this value increases continuously which means that this new strategy fits very good to the evolution pattern followed by the German stock market between 1990 and 2011.

However, the most important matter when reaching this point is the next: It is possible to guarantee that the market will continue behaving following the same pattern observed in the sample? Obviously, if the answer of this question is yes, the results must be very similar to the ones obtained with the tests.

But it is really difficult to give a precise answer to this question, due to assuming that if there is a strategy which performed in such a good way in such a long period suggests the continuation of this theory in the next years. The good or bad performance of the strategies cannot be the consequence of a certain economic cycle or just luck. However, it is impossible to offer any guarantee that the trend will continue in the same way in the future. That is why the application (or not application) of the investment guidelines given in this paper depends on the readers or investors critical sense.

On the other side, in this paper it is not possible to analyse the performance derived of all the possible strategical combinations can be made in the future, because there are hundreds or thousands different alternatives. An investor can design his own strategy by taking certain positions depending on the economic cycle, use a different alternative in the gaps, change it again temporally to adapt to market circumstances, etcetera. so, it is virtually impossible to analyse all the possibilities.

10. PERFORMANCE OF THE DIFFERENT STRATEGIES USING THE STOP LOSS AND STOP PROFIT MECHANISMS

As stated in the section 5.5. when the different tests are described, new tests have been carried out applying the Stops. In this case, it is necessary to get the DAX index values with a 15 minutes' timeframe. In consequence, to be able to work efficiently and manage properly the big amount of data, the sample period is shorter than in previous cases. Thus, the first day included in the sample is November 2, 2000 and the last one, December 2, 2011, which makes 2,822 days in total. Having the index values of each 15 minutes in 2,822 days makes a sample of 108,773 observations.

Regarding the Stops, the applied limits, both positive (Stop Profit) and negative (Stop Loss) have been the following: No Stop, 2%, 1% and 0.5%. Thus, all the possible combinations have been analysed, in total 16, as the table shows.

Table 16: Possible stop combinations (Source: Author)

		STOP LOSS			
		No Stop	2%	1%	0.5%
STOP PROFIT	No Stop	No Stop	2%	1%	0.5%
	2%	No Stop	2%	1%	0.5%
	1%	No Stop	2%	1%	0.5%
	0.5%	No Stop	2%	1%	0.5%

10.1. Random strategy.

When designing this strategy, the positions to take at the openings have been determined randomly, with the same probability to take a long or short position. In this way, a short position has been taken in 1,458 session while in 1,364 a long position is taken.

The positions can close because of two reasons: the first one is that the index have exceeded the previously determined thresholds and secondly because the session has come to the end. Logically, the more adjusted the stop, the less frequently the investment will be active at closures. The next table shows the number of activated stops with the different combinations.

Table 17: Number of activated stops. Random strategy (Source: Author)

		Stop Loss															
		No Stop Loss				2%				1%				0.5%			
Stop Profit	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	
Stop Loss	0	0	0	0	369	354	308	239	954	935	841	691	1,650	1,625	1,513	1,275	
Stop Profit	0	374	997	1,665	0	359	972	1,635	0	313	885	1,528	0	252	716	1,271	
End session	2,822	2,448	1,825	1,157	2,453	2,109	1,542	948	1,868	1,574	1,096	603	1,172	945	593	276	

These figures demonstrate that when the Stop Loss is very adjusted, the probability of activating it and therefore, having losses is much higher, still they are much less important. In parallel, if the Stop Profit is very adjusted, it will be activated in more times, which means experiencing more positive returns, but a lower profit in each one. Hence, closing the position very soon, an investor will be ensuring a minimum loss or profit, depending on the activated Stop.

The next table shows the sessions with positive and negative returns, generated by the applied Stop combinations:

Table 18: Number of positive and negative sessions. Random strategy (Source: Author)

		Stop Loss							
		No Stop		2%		1%		0.5%	
		Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
Stop Profit	No Stop	1,432	1,390	1,403	1,419	1,267	1,555	976	1,846
	2%	1,460	1,362	1,429	1,393	1,293	1,529	1,002	1,820
	1%	1,592	1,230	1,560	1,262	1,432	1,390	1,131	1,691
	0.5%	1,871	951	1,839	983	1,720	1,102	1,417	1,405

As expected, the combination with the most positive returns is the one with the lowest Stop Profit, that is 0.5%.

Regarding the index, the summation of all the daily increases and decreases are represented in the table below:

Table 19: Accumulated increase of the DAX index. Random strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	-876.21	3,030.32	5,741.51	6,462.72
	2%	-988.82	1,981.39	4,505.42	5,509.96
	1%	-3,509.53	-1,432.34	1,716.08	2,535.09
	0.5%	-6,465.78	-4,026.34	-1,395.84	174.48

Taking into account that in the case of CFD and futures the profits or losses are calculated by the difference of index points regarding the opening of each session, this table is really important for the ones who trade with these financial assets. In consequence, if an investor trades a future contract of the DAX index, on the condition that he will get 25€ if the index rise by one point and if it decrease he will pay the same amount of money, and a combination consisting of not applying any Stop Profit and a Stop Loss of 0.5% have been chosen, at the end of the sample period he would have made a profit of 161,568€ minus the respective transaction costs.

On the other side, in case of investing 1,000€ in the first opening of the sample and replicating the same transactions in each session as detailed before, these are the portfolio values it would be obtained after the last day close.

Table 20: Final values of the 1,000€ portfolio. Random strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	571.92	1,502.93	2,921.97	4,367.43
	2%	611.84	1,262.50	2,245.56	3,461.94
	1%	420.24	693.81	1,384.79	1,903.26
	0.5%	216.23	366.20	652.62	1,009.07

It is important to emphasize at all time that in this paper it have been working with simple returns, which makes possible to have a combination with a higher average daily return but lower final portfolio value than another. Taking as benchmark the strategy with no Stops, it is clear that the random strategy has a bad performance in this sample because it experiences a devaluation of 42.81%. If no stops are determined, the methodology of this test is identical to

the previously carried out ones, so just changing the sample and the taken positions, the performance can differ significantly.

A clear pattern is observed in this table: The combinations with adjusted Stop Loss obtain a much higher return, while the opposite happens with the Stop Profits, because in general when the Stop Profits are adjusted the final portfolio values are lower. Therefore, in terms of return, the most profitable strategy is obtained by combining the lowest Stop Loss (0.5%) without any Stop Profit, while the worst combination is composed by the lowest Stop Profit and the no application of any Stop Loss.

One of the most shocking factors in the table 20 is the big difference of the results depending on the selected combination. The portfolio value can vary from 216.23€, which means a devaluation of 78%, to 4,367.43€, an appreciation of 336%. This fact demonstrates that an appropriate application of Stops in a bad strategy as the random, can have very good results.

Knowing that the sample period is composed by 133 months, it is possible to transfer this results and obtain the annual returns as listed in the table below:

Table 21: Annual returns. Random strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	-4.92%	3.74%	10.16%	14.23%
	2%	-4.34%	2.13%	7.57%	11.86%
	1%	-7.52%	-3.24%	2.98%	5.98%
	0.5%	-12.91%	-8.67%	-3.78%	0.08%

Therefore, undoubtedly the Stop Loss and Stop Profit mechanisms can have a huge impact in the returns obtained by the random strategy and they make possible to get very good performances, even if the chosen trading alternative is bad without using any Stop. In consequence, it would be very interesting to analyse if this impact is equivalent in the rest of the strategies, or if the effectiveness of these mechanisms depends on the circumstances of the random strategy.

Nevertheless, when interpreting this results it is necessary to understand why a strategy based on closing positions as soon as possible in losing status reports so good results, when the biggest part of the days ends with losses. Trying to explain this fact, it is critical to discover the intensity of the drops and rises and for that, the next table is drawn showing the average daily simple returns differentiated by positive and negative sessions.

Table 22: Average of the daily simple returns in positive and negative sessions. Random strategy (Source: Author)

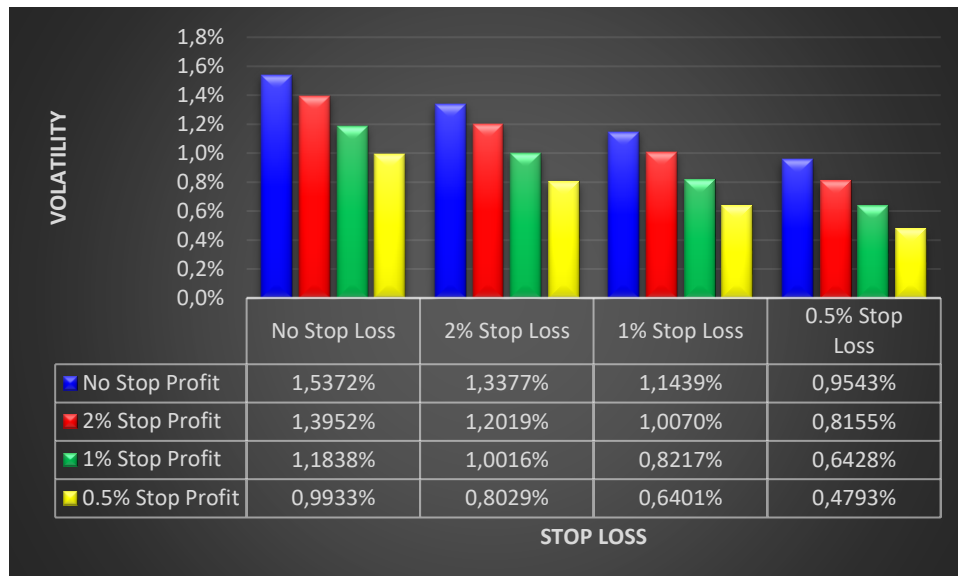
		Stop Loss							
		No Stop Loss		2%		1%		0.5%	
		Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
Stop Profit	No Stop	1.0256%	-1.0727%	1.0201%	-0.9623%	1.0078%	-0.7405%	1.0394%	-0.4628%
	2%	0.9666%	-1.0518%	0.9603%	-0.9538%	0.9475%	-0.7390%	0.9734%	-0.4625%
	1%	0.7472%	-1.0212%	0.7451%	-0.9387%	0.7434%	-0.7356%	0.7539%	-0.4627%
	0.5%	0.4639%	-1.0587%	0.4637%	-0.9604%	0.4638%	-0.7574%	0.4669%	-0.4680%

The table shows that the less adjusted the Stop Profit, the higher average return will be obtained in positive sessions. In the same way, the less adjusted the Stop Loss, the bigger losses will be registered in negative sessions. That is why still registering the worst positive/negative days' ratio, the most adjusted Stop Loss and no Stop Profit combination has the best portfolio final value.

Moreover, pending more tests to the rest of strategies, the outcome shows that the application of Stop Profits makes the performance of the investment worse in terms of return, and the more Stop Profits are activated, the worse will be the obtained results.

Regarding to the risk, the daily standard deviations of the different Stop combinations are shown in the next table and its graphical representation

Illustration 22: Daily volatility. Random strategy (Source: Author)

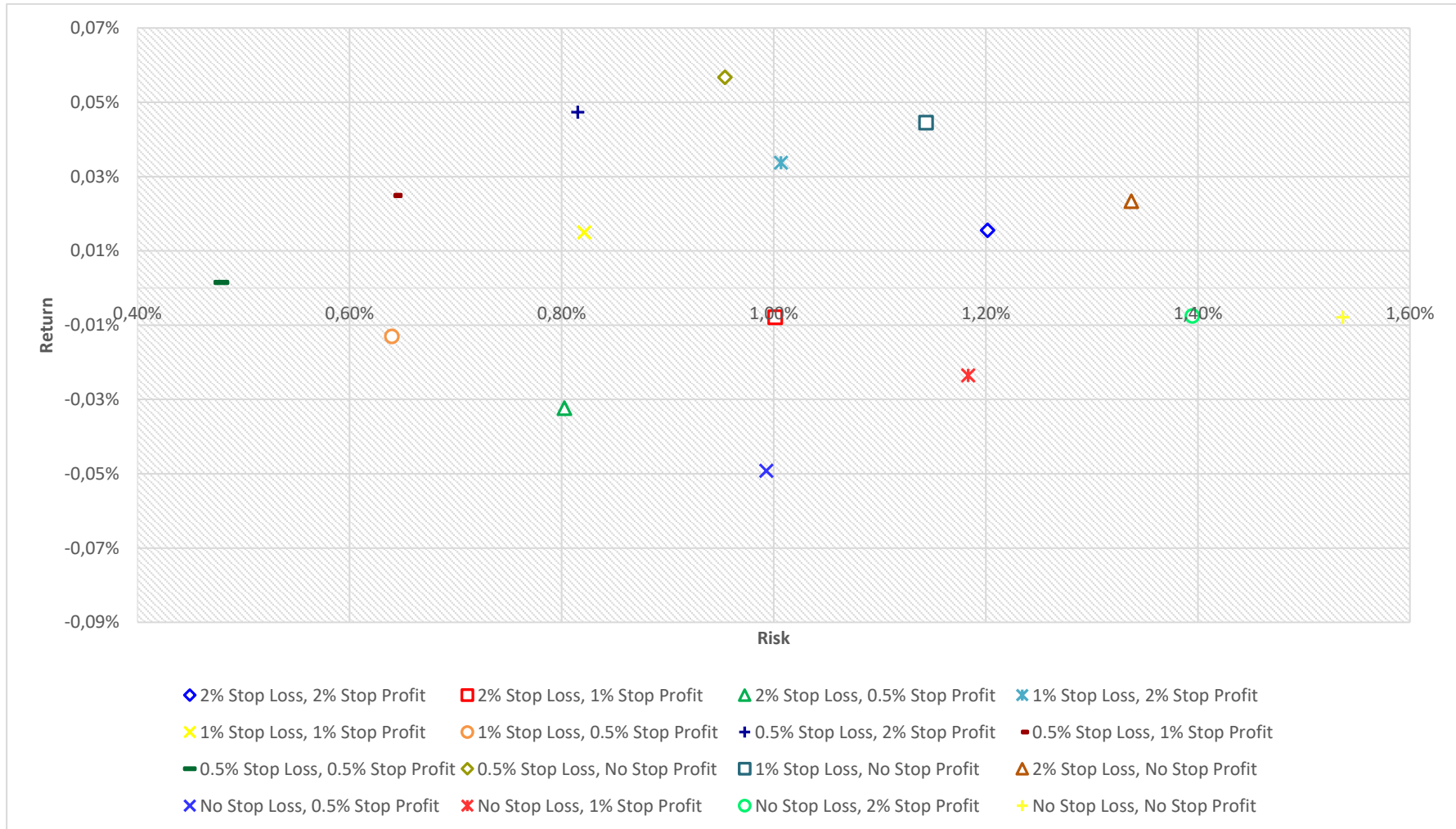


Logically, the application of adjusted stops reduces the risk of the investment significantly. Thus, applying a 0.5% Stop Loss and a 0.5% Stop Profit makes the standard deviation of the returns 68.81% lower than in case of

not using any Stop. So, the effectiveness of the Stops to reduce the risk is enormous.

Therefore, once knowing the average of daily returns and the volatility of each combination, they will be represented in a graph for one last analysis.

Illustration 23: Risk/return of different Stop combinations. Random strategy (Source: Author)



The main conclusion drawn from the previous illustration is that the combinations which are not dominated are the following:

- 0.5% Stop Loss, no Stop Profit (highest return)
- 0.5% Stop Loss, 2% Stop Profit
- 0.5% Stop Loss, 1% Stop Profit
- 0.5% Stop Loss, 0.5% Stop Profit (lowest risk)

Therefore, it is evident the importance of applying an adjusted Stop Loss, due to it allows to reduce the losses and the volatility of the investments. However, a high Stop Profit increases the returns as well as the risk, so choosing a high or low Stop Profit will depend on the investor's risk profile.

10.2. Same position in all the sessions.

First, the strategy which consist in taking long positions in the openings and closing them when the limits are exceeded or when the session ends will be analysed. Consequently, the activated Stops or the sessions finished without activating any of them are shown in the next table:

Table 23: Number of activated stops. Long position strategy (Source: Author)

Stop Profit	Stop Loss															
	No Stop Loss				2%				1%				0.5%			
	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%
Stop Loss	0	0	0	0	426	415	363	289	1,029	1,011	918	743	1,664	1,643	1,531	1,282
Stop Profit	0	317	922	1,651	0	298	897	1,618	0	257	808	1,512	0	201	662	1,264
End session	2,822	2,505	1,900	1,171	2,396	2,109	1,562	915	1,793	1,554	1,096	567	1,158	978	629	276

On the other side, in the next table the number of sessions with positive and negative returns are listed:

Table 24: Number of positive and negative sessions. Long position strategy (Source: Author)

Stop Profit	Stop Loss							
	No Stop Loss		2%		1%		0.5%	
	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
No Stop	1,470	1,352	1,430	1,392	1,288	1,534	1,017	1,805
2%	1,487	1,335	1,445	1,377	1,309	1,513	1,038	1,784
1%	1,613	1,209	1,577	1,245	1,439	1,383	1,160	1,662
0.5%	1,912	910	1,876	946	1,750	1,071	1,453	1,368

The number of positive sessions is higher than in the random strategy with all the combinations. However, it is not enough to claim which one is better because this information needs to be complemented by the average return and the portfolio value. As in the previous case, the combinations with the best positive/negative returns are the ones with the most adjusted Stop Profit and the highest or non-existent Stop Loss.

Regarding the evolution of the DAX index when applying the long position strategy, the next table shows the accumulated profit in all the sessions that compose the sample by each Stop combination:

Table 25: Accumulated increase of the DAX index. Long position strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	-2,789.13	-2,251.09	1,836.22	6,119.68
	2%	-6,270.23	-6,108.13	-1,342.59	2,926.97
	1%	-7,414.82	-7,156.06	-2,489.47	1,555.24
	0.5%	-6,808.82	-6,505.74	-2,249.55	477.05

These figures suggest that the long position strategy is not very successful, due to in almost all the cases the index has accumulated losses, including the combination without Stops.

Moreover, to be able to compare the results, the final portfolio values in case of investing 1,000€ at the opening of November 2, 2000 and following the long position strategy with different Stop combinations until the day close in December 2, 2011, are shown in the table below.

Table 26: Final values of the 1,000€ portfolio. Long position strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	607.67	615.39	1,501.82	4,188.29
	2%	260.76	239.13	722.35	2,004.92
	1%	220.17	226.40	636.48	1,595.66
	0.5%	211.29	213.89	562.26	1,097.18

The same pattern is repeated with the long position strategy, i.e., to obtain high returns an adjusted Stop Loss should be applied, while it is not advisable to apply any limit when the returns have a positive trend, because the investor would be limiting his profits. The table of portfolio values shows that just applying a Stop Loss of 0.5% no investor will lose money regardless of the chosen Stop Profit.

On the other side, the effectiveness of the Stops in the returns is remarkable in this case as well, because in the best case the portfolio is

appreciated in 319% approximately, while with the worst combination the devaluation is 78.87%.

In the next table the annual returns obtained through the long strategy are shown:

Table 27: Annual returns. Long position strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	-4.39%	-4.29%	3.74%	13.80%
	2%	-11.42%	-12.11%	-2.89%	6.48%
	1%	-12.76%	-12.54%	-3.99%	4.31%
	0.5%	-13.09%	-12.99%	-5.06%	0.84%

Finally, to complement the information of number of positive and negative sessions in order to explain the returns, the average daily simple returns of these days are shown in the next table:

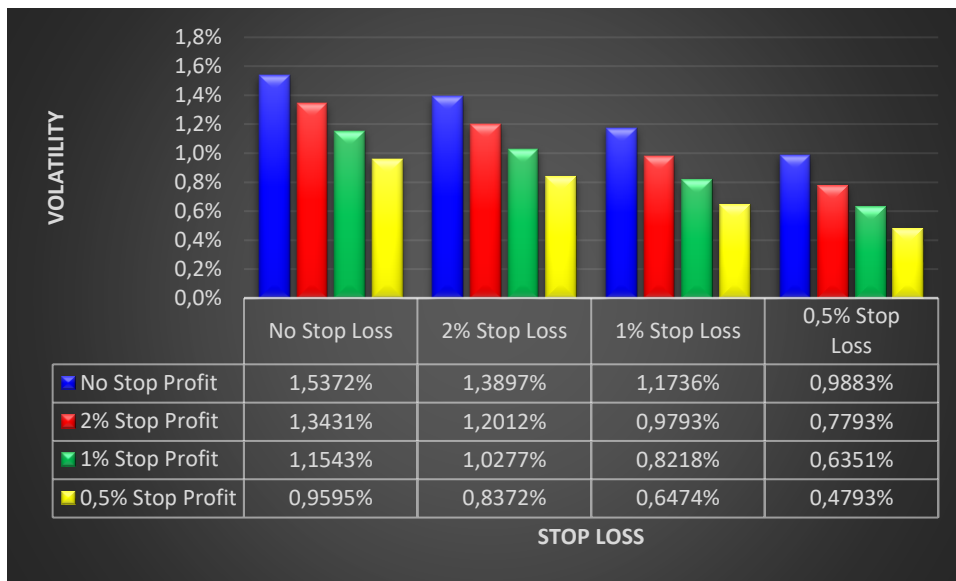
Table 28: Average of the daily simple returns in positive and negative sessions. Long position strategy (Source: Author)

		Stop Loss							
		No Stop Loss		2%		1%		0.5%	
		Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
Stop Profit	No Stop	1.0011%	-1.1007%	0.9889%	-1.0314%	0.9660%	-0.7721%	0.9919%	-0.4721%
	2%	0.9018%	-1.0859%	0.8921%	-1.0252%	0.8754%	-0.7700%	0.8860%	-0.4717%
	1%	0.7170%	-1.0660%	0.7155%	-1.0135%	0.7128%	-0.7675%	0.7205%	-0.4713%
	0.5%	0.4551%	-1.1126%	0.4550%	-1.0548%	0.4557%	-0.7932%	0.4579%	-0.4776%

An adjusted Stop Loss ensure not losing much money in days in which the return is negative, while to ensure a high positive return it is better to not apply any Stop Profit or at least not an adjusted one. Therefore, to find an optimal strategy in case of long position strategy, a balance will have to be found between the positive/negative days' ratio and the intensity of the decreases and increases in each stop combination.

After analysed the return of the different combinations, the risk or the volatility of the investments will be studied. In the following graph the standard deviations of daily simple returns are shown.

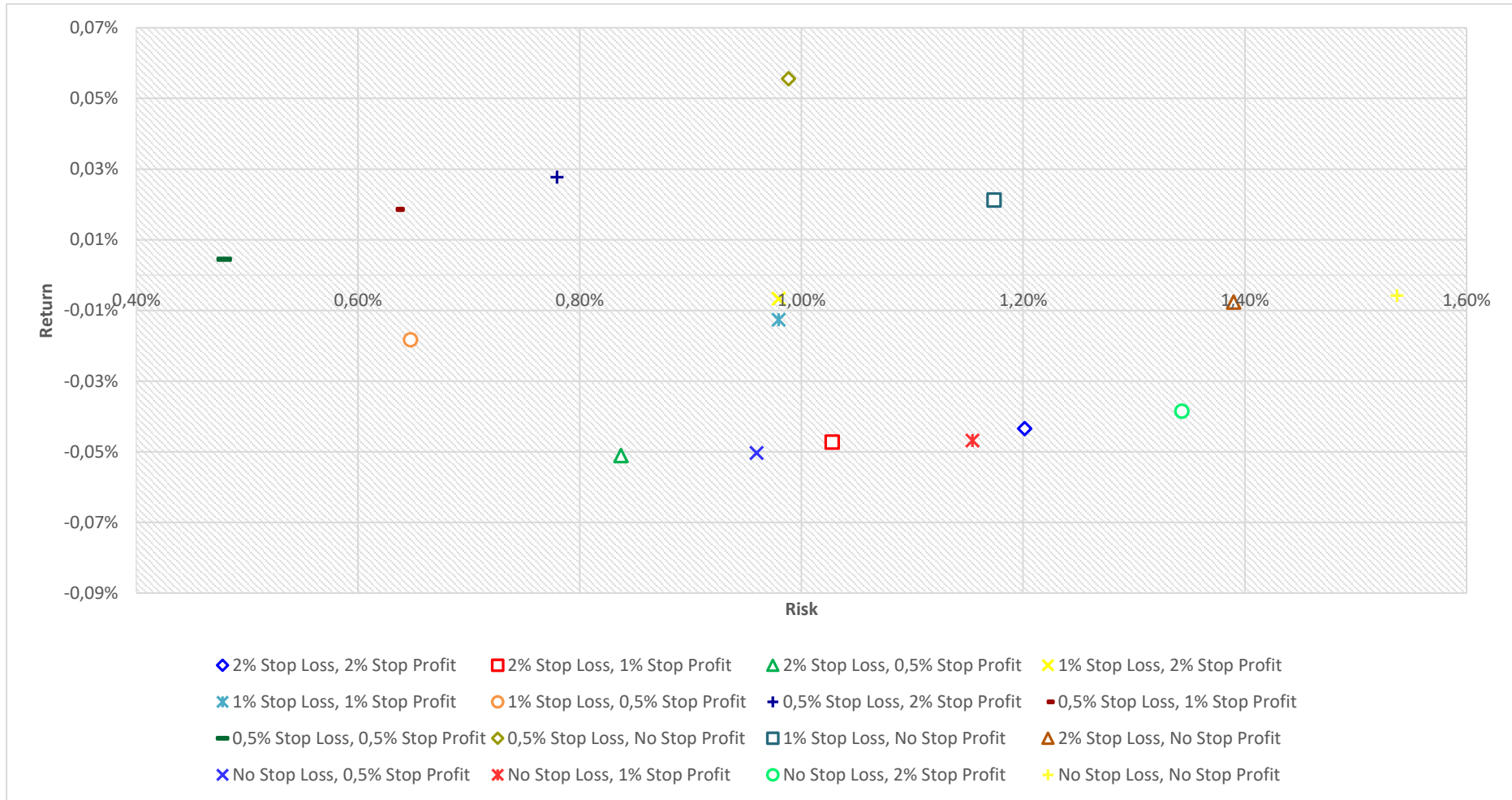
Illustration 24: Daily volatility. Long position strategy (Source: Author)



As seen before, the application of Stops reduces the volatility very significantly. Compared to the random strategy, there is not a clear pattern to say which one is riskier because with some combinations the random strategy is riskier, while in the others the opposite happens. Therefore, the main conclusion drawn from this graph is that the Stops are extremely effective mechanisms for the investors who want to reduce the risk of their investments.

To finish with the long position strategy, the graphical representation linking the risk and return is shown to find the possible dominances.

Illustration 25: Risk/return of different Stop combinations. Long position strategy (Source: Author)



The strategies represented in the left-top part of the graph are the ones which are not dominated by any other alternative. These combinations are the following:

- 0.5% Stop Loss, no Stop Profit (highest return)
- 0.5% Stop Loss, 2% Stop Profit
- 0.5% Stop Loss, 1% Stop Profit
- 0.5% Stop Loss, 0.5% Stop Profit (lowest risk)

As happens in the previous case, the graph is a clear example of the relevance of applying the lowest Stop Loss possible, due to it permits to reduce the drops in negative days, as well as the risk of the investments. On the other side, in the down-right part of the graph are represented the strategies which consist on taking the profits as soon as possible, with a very low return or the ones including combinations without Stops with very high volatility.

Regarding the short position strategy, the positions taken by the investors are just the inverse of the long position strategy. In this way, during bullish sessions the Stop Loss have been activated and, conversely, Stop Profits during bearish days. In the next table are listed the exact amount of days in which the Stops are activated depending on each combination.

Table 29: Number of activated stops. Short position strategy (Source: Author)

		Stop Loss															
		Sin Stop Loss				2%				1%				0.5%			
Stop Profit	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	
Stop Loss	0	0	0	0	317	298	258	202	922	897	809	666	1,651	1,618	1,513	1,278	
Stop Profit	0	426	1,029	1,664	0	415	1,010	1,642	0	363	917	1,527	0	289	742	1,268	
End session	2,822	2,396	1,793	1,158	2,505	2,109	1,554	978	1,900	1,562	1,096	629	1,171	915	567	276	

As a result of this Stops configuration, the following number of positive and negative sessions have been experienced:

Table 30: Number of positive and negative sessions. Short position strategy (Source: Author)

		Stop Loss							
		No Stop Loss		2%		1%		0.5%	
		Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
Stop Profit	No Stop	1,352	1,470	1,335	1,487	1,209	1,613	910	1,912
	2%	1,392	1,430	1,377	1,445	1,245	1,577	946	1,876
	1%	1,534	1,288	1,512	1,310	1,382	1,440	1,070	1,752
	0.5%	1,805	1,017	1,783	1,039	1,658	1,164	1,354	1,468

Regardless of the Stops combination, there are more negative sessions than in the long position strategy. However as stated previously, a higher percentage of positive days does not necessarily mean a better performance in terms of return.

The next table have been drawn to show the accumulated profit of the DAX index (in basis points) through the different combinations after the last day close.

Table 31: Accumulated increase of the DAX index. Short position strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	2,789.13	6,270.23	7,414.82	6,808.82
	2%	2,251.09	6,108.13	7,156.06	6,505.74
	1%	-1,836.22	1,218.29	2,406.61	2,187.40
	0.5%	-6,119.68	-3,030.55	-1,805.34	-1,029.66

In this case, the combinations with the highest performance are the ones with a Stop Loss of 1%, having better results than the ones with the most adjusted Stop Loss. However, this circumstance does not have to repeat necessarily in the case of the 1,000€ portfolio, due to the method to measure the increases is different. Regarding the methodology of calculating the increases of the Index in basis points, the session opens with the market opening value, while the position closes with the Stops or when the stock market session ends. In this way, the difference between the opening value and the value in which the position is closed contributes to the accumulated increase. The next day the same operation will be replicated, taking the opening value according to the Index value on this day.

However, in the case of the 1,000€ portfolio, the session opens with the same portfolio value of the closure on the previous day, it does not matter if there has been any variation between the moment in which the position was closed and the next opening, so the daily return in both cases is the same but it is applied in a different scale. Therefore, depending on the financial asset the investor is managing, one table will be more important or the other. In case of trading with CDF or futures, the benchmark will be the accumulated increase of the DAX table, while if the traded assets are ETF or an index replicating portfolio the investor should be regarding to the 1,000€ portfolio value.

These final values of the 1,000€ initial portfolio, managed by the different combinations analysed in this paper, are the following.

Table 32: Final values of the 1,000€ portfolio. Short position strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	844.39	2,303.94	3,116.41	3,647.30
	2%	942.01	2,781.83	3,276.66	3,833.62
	1%	451.25	1,024.79	1,272.83	1,556.60
	0.5%	181.04	409.68	526.59	742.64

In this case, there are some similarities and differences compared to the pattern observed in the previous tests. In general, as in the previous cases, it is a mistake to apply an adjusted Stop Profit when the returns are looking for high returns. Furthermore, the Stop Losses should be adjusted as much as possible. On the other side, the first difference is that the combinations which performed better according to the table 31, the accumulated increase of the index, are not the best in this case, because the combinations with 0.5% Stop Loss threshold register better results than the Stop Loss of 1%. Secondly, the application of a Stop Profit is advantageous for the first time in this paper, due to it is better to take the profits when the index has exceeded the 2% threshold. Therefore, it is not correct to claim that the Stop Profits are counterproductive in terms of increasing the returns in all the cases. Depending on the characteristics of the sample it can be advisable to use Stop Profits in certain times, still not being very often.

Having the final values of the portfolio it is simple to get the annual returns of the investments which are listed in the next table:

Table 33: Annual returns. Short position strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	-1.51%	7.82%	10.80%	12.38%
	2%	-0.54%	9.67%	11.30%	12.89%
	1%	-6.93%	0.22%	2.20%	4.07%
	0.5%	-14.29%	-7.74%	-5.62%	-2.65%

One of the most relevant characteristic of the short strategy is that the best portfolio has a lower return than the ones obtained with the random and long strategy with the same Stop combination. Exactly the same happens with the worst portfolio, due to is worse than the comparable alternatives. However, the same cannot be said with all the combinations, because there are some combinations in which the short strategy is better than the analogous ones. Therefore, depending on the Stops combination the investor want to apply, it would be better to use one or another strategy.

To complement the information of the positive/negative ratio and understand better the results of the portfolio and the index increase in basis points, the average return in positive and negative sessions have been calculated.

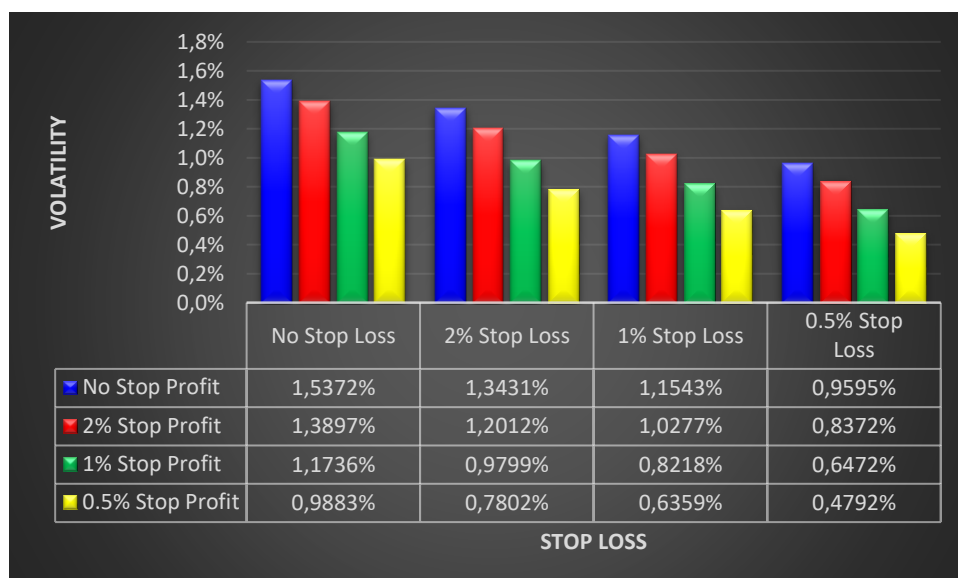
Table 34: Average of the daily simple returns in positive and negative sessions. Short position strategy (Source: Author)

		Stop Loss							
		No Stop Loss		2%		1%		0.5%	
		Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
Stop Profit	No Stop	1.1007%	-1.0011%	1.0859%	-0.9018%	1.0660%	-0.7170%	1.1126%	-0.4551%
	2%	1.0314%	-0.9889%	1.0252%	-0.8921%	1.0135%	-0.7155%	1.0548%	-0.4550%
	1%	0.7721%	-0.9660%	0.7698%	-0.8763%	0.7673%	-0.7130%	0.7930%	-0.4557%
	0.5%	0.4721%	-0.9919%	0.4717%	-0.8870%	0.4713%	-0.7214%	0.4773%	-0.4583%

These returns are the key factor to explain that no necessarily a bad positive/negative returns ratio means that the Stop combination is inadequate, due to the difference between the returns in positive and negative days is extremely important to determine the final value of the portfolio or the accumulated increase of the index in basis points. Therefore, as stated in the previous sections, the most advisable would be to find a well-balanced combination which allows to optimize the returns taking into account both factors, the positive/negative days' ratio and the increases/decreases in these days.

On the other side, the risk has to be analysed too to be able to evaluate the performance of the strategies. The standard deviation of the daily simple returns is used for that. The following table lists these standard deviations which are drawn in the illustration:

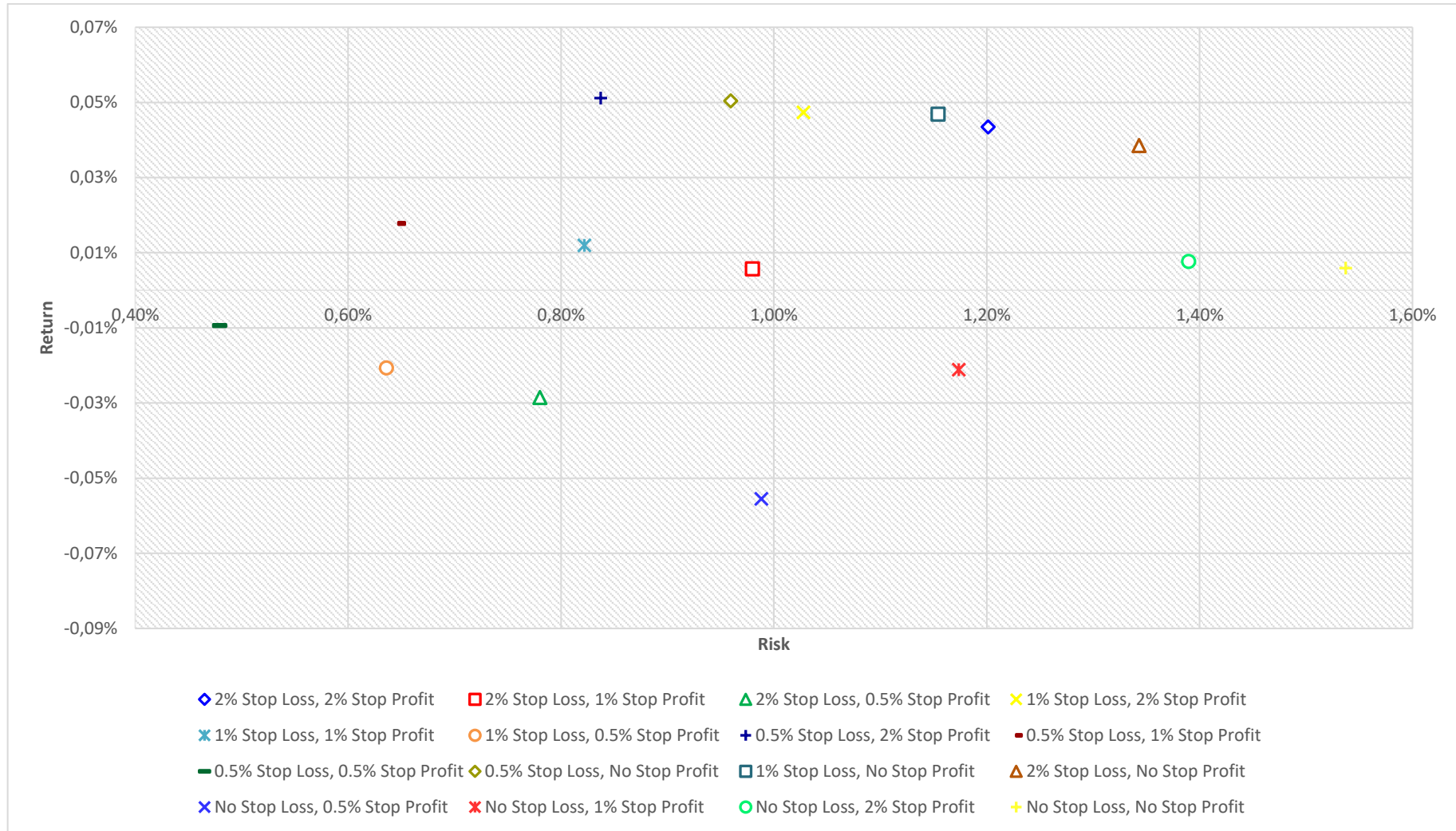
Illustration 26: Daily volatility. Short position strategy (Source: Author)



The same logical pattern is observed in this graph as in the previous cases: The Stops are an extremely effective resource to reduce the risk of the investments. The total volatility of the investment can be reduced by two thirds if a very adjusted Stop combination is used. Therefore, any investor who want to protect himself from the big variations of the stock markets should think about the application of the Stops.

After calculating the returns and the standard deviations of the short position strategy of all the sessions through the 16 combinations, the results have been represented graphically to verify which ones are the dominating combinations.

Illustration 27: Risk/return of different Stop combinations. Short position strategy (Source: Author)



As happens with the random and long position strategy, the line which links all the combinations including the most adjusted Stop Loss dominates the rest, because it makes possible to limit the losses in negative sessions and the risk of the investment as well.

However, there is a slight difference, due to it is preferable to apply a 2% Stop Profit to obtain the highest return. The combination which in the previous cases has the highest return, i.e., 0.5% Stop Loss and no Stop Profit, has a very slightly lower average return with higher volatility, so it is dominated.

10.3. Trend strategy.

When designing the trend strategy with Stops, it has been assumed that the trends in the stock markets exist, so the expected return of a session is conditioned by the performance of the previous session. With this idea, the strategy has been configured in the following way: if the previous session has experienced an upward trend, it is expected to continue in the same way, so it is more probable to have an upward trend during the next day as well. In consequence, when an increase in the DAX index value has been detected, a long position will be taken in the next day. On the contrary, if the opening value of the previous day was higher than its closing value, a short position will be taken.

Furthermore, the same stops combination of the previous tests has been used to be able to compare the results. Thus, when the return of a session has exceeded the determined limits, the position has been closed instantly.

It should be taken into account that when working with this strategy, the first session is just to see the performance of the stock market and know how to invest on the second day, buying financial assets or short-selling. In consequence, from 2,821 sessions, in 1,469 a long position has been taken and a short position on the remaining 1,352 days.

With this information, the activated stops in the sample period are listed in the following table:

Table 35: Number of activated stops. Trend strategy (Source: Author)

Stop Profit	Stop Loss															
	Sin Stop Loss				2%				1%				0,5%			
	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%
Stop Loss	0	0	0	0	370	358	313	255	997	977	890	746	1,709	1,682	1,581	1,342
Stop Profit	0	373	953	1,605	0	355	929	1,577	0	308	835	1,459	0	236	660	1,203
End session	2,821	2,448	1,868	1,216	2,451	2,108	1,579	989	1,824	1,536	1,096	616	1,112	903	580	276

Applying this stops to the DAX index, the observed positive and negative days are shown in the table below:

Table 36: Number of positive and negative sessions. Trend strategy (Source: Author)

	Stop Loss							
	No Stop Loss		2%		1%		0.5%	
Stop Profit	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
No Stop	1,381	1,440	1,355	1,466	1,225	1,596	927	1,894
2%	1,412	1,409	1,384	1,437	1,253	1,568	955	1,866
1%	1,550	1,271	1,520	1,301	1,383	1,438	1,074	1,747
0.5%	1,822	999	1,792	1,029	1,663	1,158	1,359	1,462

The positive days with the trend strategy are fewer than in the case of the long strategy but more frequent than with the short strategy. Therefore, more information is needed to evaluate the performance of this alternative, as the accumulated increase of the DAX index, the portfolio final values or the intensity of the drops and rises experienced in positive and negative days.

To observe the impact of the Stop combinations and the resulting positive/negative days' ratio in the DAX index, the increases and decreases are shown in the next table. As in the previous cases, the accumulated profit is the sum of the differences between the opening value and the one registered when the position is closed. In consequence, the results are obtained in basis points.

Table 37: Accumulated increase of the DAX index. Trend strategy (Source: Author)

		Stop Loss			
		Sin Stop	2%	1%	0,50%
Stop Profit	Sin Stop	-3.618,13	-886,69	2.165,96	3.030,40
	2%	-4.905,83	-2.210,63	925,62	1.454,61
	1%	-7.134,82	-5.061,88	-2.454,60	-1.442,34
	0,50%	-9.912,50	-8.096,09	-5.326,33	-2.694,02

The table shows that it is very advisable to apply Stop Loss which permits to close a position when the evolution of a session is very negative and stop accumulating losses. Moreover, the most adjusted the stop the better would be the results in terms of return. On the other side, just the opposite happens with the Stop Profits, due to if they are very adjusted, the profits will be limited, still ensuring more positive return days. However, it must be verified if this pattern is repeated when 1,000€ are invested in an index replicating stock portfolio, following the methodology explained above. These values are listed in the next table:

Table 38: Final values of the 1,000€ portfolio. Trend strategy (Source: Author)

		Stop Loss			
		Sin Stop	2%	1%	0,50%
Stop Profit	Sin Stop	258,45€	525,20€	1.118,69€	1.793,26€
	2%	217,00€	426,99€	862,33€	1.307,04€
	1%	161,65€	263,77€	467,92€	750,06€
	0,50%	89,13€	136,66€	257,47€	514,40€

The main conclusion drawn from this data is that, as demonstrated in the first part of this paper, the trend strategy is not appropriate if high returns are desired. The results obtained with all combinations are the worst in this research and still being possible to observe positive returns, almost all the portfolios have lost value. It is shocking to see that there is a combination in which the portfolio has been devaluated by 91%, caused by a bad strategy and combination choice. Taking into account the transaction costs, probably the investor who has followed this alternative would have lost the 100% of his investment.

Anyway, if there is any investor who believe in the trend following strategy and wants to apply it, a very adjusted Stop Losses should be applied to limit the losses in negative sessions.

From these values, the annual returns can be obtained for all the Stop combinations:

Table 39: Annual returns. Trend strategy (Source: Author)

		Stop Loss			
		Sin Stop	2%	1%	0,50%
Stop Profit	Sin Stop	-11,49%	-5,64%	1,02%	5,41%
	2%	-12,88%	-7,39%	-1,33%	2,45%
	1%	-15,16%	-11,33%	-6,62%	-2,56%
	0,50%	-19,60%	-16,44%	-11,52%	-5,82%

This table just reaffirm the comments made in the previous paragraph, revealing much lower returns than in the rest of the strategies.

To finish the analysis of the returns of the trend strategy, the average daily simple return in positive and negative days is shown in the next table:

MARKET TRENDS, MOMENTUM EFFECT AND EFFICIENT MARKET HYPOTHESIS

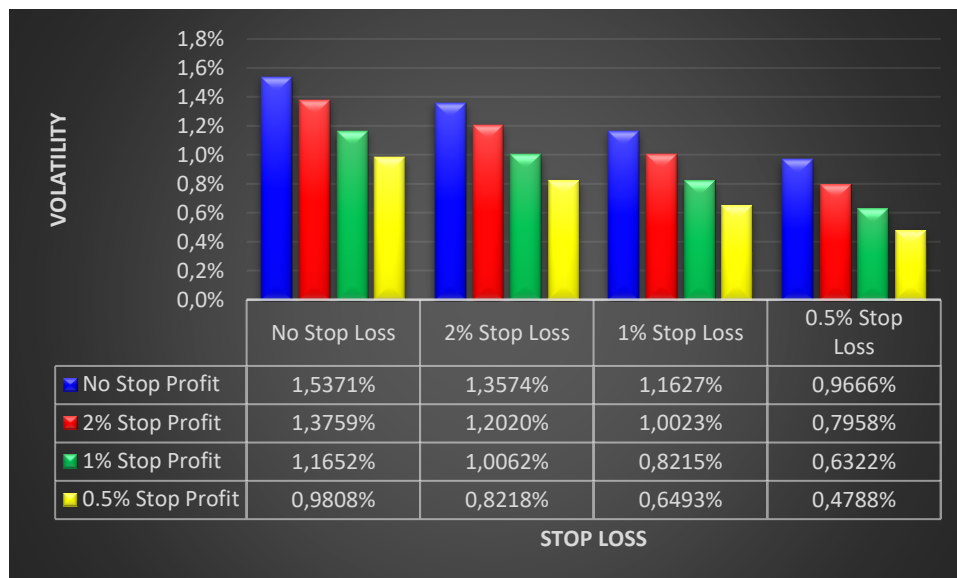
Table 40: Average of the daily simple returns in positive and negative sessions. Trend strategy (Source: Author)

		Stop Loss							
		Sin Stop Loss		2%		1%		0,50%	
		Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
Stop Profit	Sin Stop	1,0346%	-1,0630%	1,0177%	-0,9670%	1,0022%	-0,7505%	1,0306%	-0,4668%
	2%	0,9622%	-1,0536%	0,9523%	-0,9622%	0,9370%	-0,7492%	0,9489%	-0,4665%
	1%	0,7369%	-1,0267%	0,7346%	-0,9496%	0,7302%	-0,7485%	0,7392%	-0,4677%
	0,50%	0,4598%	-1,0666%	0,4596%	-0,9844%	0,4586%	-0,7706%	0,4619%	-0,4726%

In general, the intensity of the drops is higher of the rises, which added to a not very good positive/negative days' ratio, makes non-advisable to invest through this strategy. Furthermore, it is important to remember the conclusions drawn in the analysis of daily returns without stops, in which it has been demonstrated that the probability of changing trends is higher than chaining bearish or bullish days.

The other essential component in order to analyse the performance of an investment is the risk and that is why the standard deviations of the daily simple returns have been calculated. These values are represented in the next illustration:

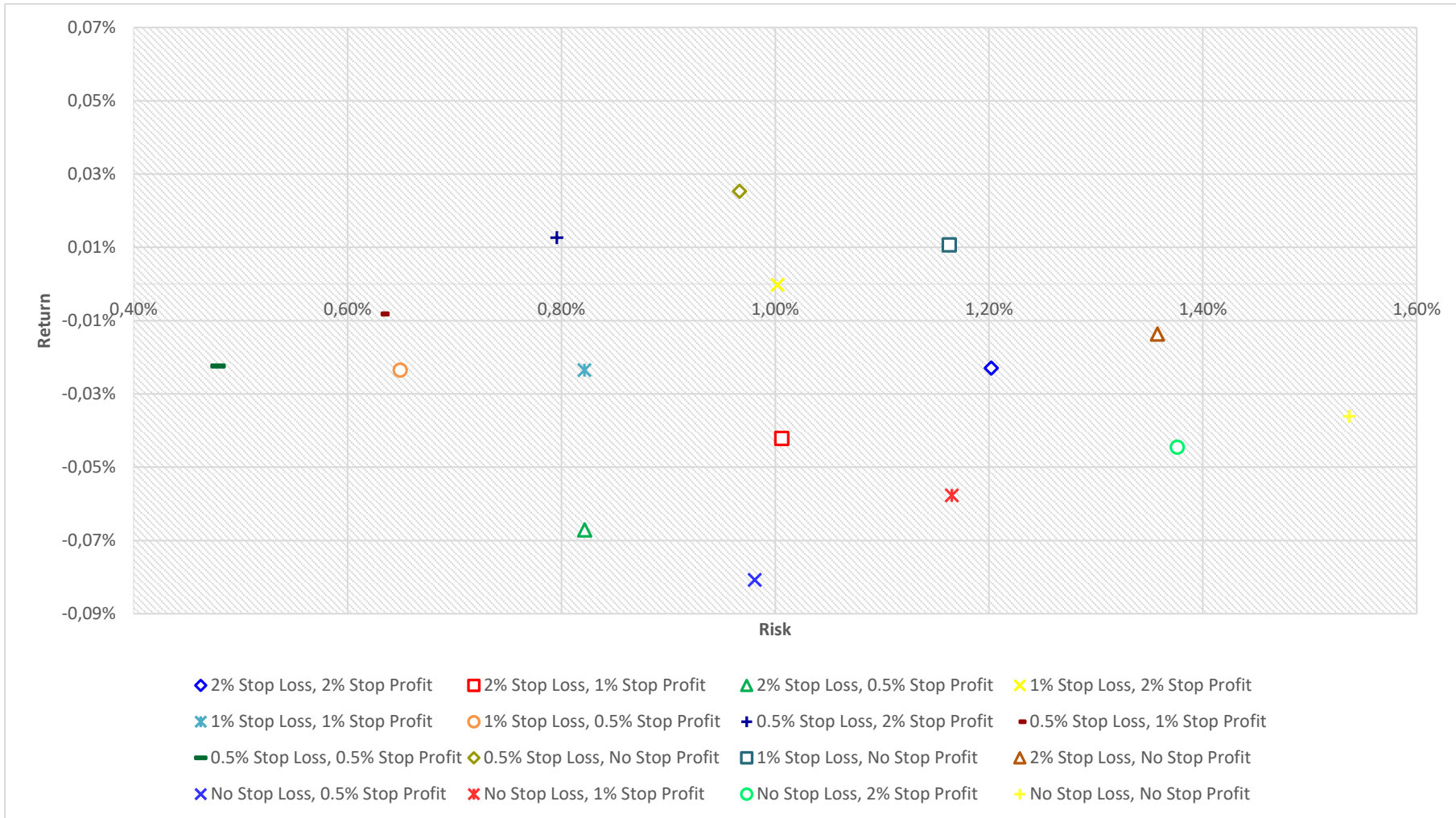
Illustration 28: Daily volatility. Trend strategy (Source: Author)



Regardless of the chosen strategy, all the volatility tables show very similar values following the same pattern, the more adjusted the Stops the less risky will be the combination in all cases. In case of the trend strategy, the risk of the No Stop Profit-No Stop Loss combination is three times higher than the risk of the most adjusted Stops combination.

Therefore, to be able to observe much more clearly, in the same graph, the two components analysed in the previous paragraphs, the risk/return graph of the trend strategy has been drawn including all the combinations.

Illustration 29: Risk/return of different Stop combinations. Trend strategy (Source: Author)



The patterns observed with the previous strategies are repeated in this case as well, being very advisable the application of very adjusted Stop Losses in order to reduce the risk of the investment, protecting it from the big variations of the stock markets. The only combinations which are not dominated are the following:

- 0.5% Stop Loss, no Stop Profit (highest return)
- 0.5% Stop Loss, 2% Stop Profit
- 0.5% Stop Loss, 1% Stop Profit
- 0.5% Stop Loss, 0.5% Stop Profit (lowest volatility)

10.4. Mean reversion strategy.

The procedure followed in this point is exactly the same as in the point 10.3. but with the exception that the position taken at the beginning of each session is just the opposite: If an upward trend has been experienced in the previous session, a short position has been taken, while if the previous session was bearish, a long position. Moreover, it has been commented that in 1,469 sessions a long position was taken and a short position in 1,352. In this case, as the opposite strategy is applied, a short position has been taken in 1,469 times and a long position in the remaining 1,352 sessions.

In the previous sections, in which the daily returns have been calculated without using any Stop, it has been demonstrated that the strategy with highest returns is the mean reversion strategy. Therefore, this test has to demonstrate if this statement is true or not using the Stop Loss and Stop Profit mechanisms.

For that, the days in which the position was closed by the activation of Stops or just because the session closed are listed in the table below:

Table 41: Number of activated stops. Mean reversion strategy (Source: Author)

	Stop Loss															
	No Stop Loss				2%				1%				0.5%			
Stop Profit	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%	No Stop	2%	1%	0.5%
Stop Loss	0	0	0	0	373	355	308	236	953	930	836	662	1,605	1,578	1,462	1,217
Stop Profit	0	370	997	1,709	0	358	977	1,682	0	312	889	1,579	0	254	743	1,328
End session	2,821	2,451	1,824	1,112	2,448	2,108	1,536	903	1,868	1,579	1,096	580	1,216	989	616	276

The number of days with positive and negative returns generated by this Stop configurations are shown in the following table:

Table 42: Number of positive and negative sessions. Mean reversion strategy (Source: Author)

		Stop Loss							
		Sin Stop		2%		1%		0,50%	
		Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
Stop Profit	Sin Stop	1,440	1,381	1,409	1,412	1,271	1,550	999	1,822
	2%	1,466	1,355	1,437	1,384	1,300	1,521	1,028	1,793
	1%	1,596	1,225	1,568	1,253	1,437	1,384	1,155	1,666
	0,50%	1,894	927	1,866	955	1,745	1,076	1,448	1,373

The number of positive days is higher than in the rest of strategies, except in the case of the long position strategy. Therefore, if the average of the positive returns is high and the negative ones not very low, good results may be obtained through this strategy.

The next table shows the sum of all the variations of the index during the sample period, applying different stops it has been working on this paper. These figures are especially relevant for the investors who are trading with CFD or futures.

Table 43: Accumulated increase of the DAX index. Mean reversion strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	3,618.13	4,905.83	7,134.82	9,912.50
	2%	886.69	2,210.63	4,937.58	7,992.50
	1%	-2,165.96	-925.62	2,371.73	5,149.64
	0.5%	-3,030.40	-1,454.61	1,306.77	2,141.40

The application of this strategy permits to see the highest index increase of all the analysed combinations, due to it has not been possible to reach any other increase of 9,912.5 basis points. To have a clear vision about the magnitude of this figure and have some data to compare, two examples will be given: For example, the session of November 2, 2000 opened in 7,067.7 basis points, while in December 2, 2011 this value was 6,117.73 basis points. It is shocking to see that the increase in basis points is higher than the total value of the index. However, there are some combinations which give higher values with the short strategy than the ones listed in this table.

In consequence, it has to be verified how this increases are transferred to the portfolio which has an initial capital of 1,000€.

Table 44: Final values of the 1,000€ portfolio: Mean reversion strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	1,985.31	2,699.61	4,213.49	8,536.04
	2%	1,131.98	1,557.90	2,764.31	5,892.64
	1%	610.36	873.50	1,731.53	3,295.18
	0.5%	428.28	639.90	1,155.80	1,584.03

Excluding the values obtained with a 2% Stop Profit, in which the short position strategy registers an especially good performance (even higher than not applying any Stop Profit), in the remaining combinations the mean reversion strategy seems to be the best alternative. Moreover, the patterns observed in almost all the previous cases are encountered again, due to the Stop Profits make the returns worse, while the adjusted Stop Losses prevent the investors from big drops. In consequence, when trading through the mean reversion strategy, the best combination of the analysed ones in terms of return is 0.5% Stop Loss and no Stop Profit.

In a hypothetical case in which an investor has carried out the same operations in the same period, his portfolio could be revaluated by 753.6% in the best case, while if the worst stop combination the devaluation would be more than 57%. These figures highlight again the relevance of choosing appropriate Stops because it can have an extreme impact in the returns. The next table shows the annual returns obtained by using the portfolio's final values and the length of the sample period:

Table 45: Annual returns. Mean reversion strategy (Source: Author)

		Stop Loss			
		No Stop	2%	1%	0.5%
Stop Profit	No Stop	6.38%	9.37%	13.86%	21.35%
	2%	1.12%	4.08%	9.61%	17.36%
	1%	-4.36%	-1.21%	5.08%	11.36%
	0.5%	-7.37%	-3.95%	1.31%	4.24%

Having an annual return of 21.35% over 11 years makes this investment very successful undoubtedly. However, in this paper the transaction costs or the tax treatment of the profits have not been taken into account. Therefore, the results in a real world would be lower than the ones listed in the table, because a fictitious scenario have been raised.

The same happens with ETF or CFD, due to when trading with this kind of financial assets is necessary to incur additional costs as management fees, especially when opening and closing positions at every session. Therefore, all this different costs may reduce significantly the returns.

Finally, in order to explain the good performance of the mean reversion strategy, still not having an extremely good positive/negative days' ratio, the table which lists the returns differentiated by positive or negative sessions is added.

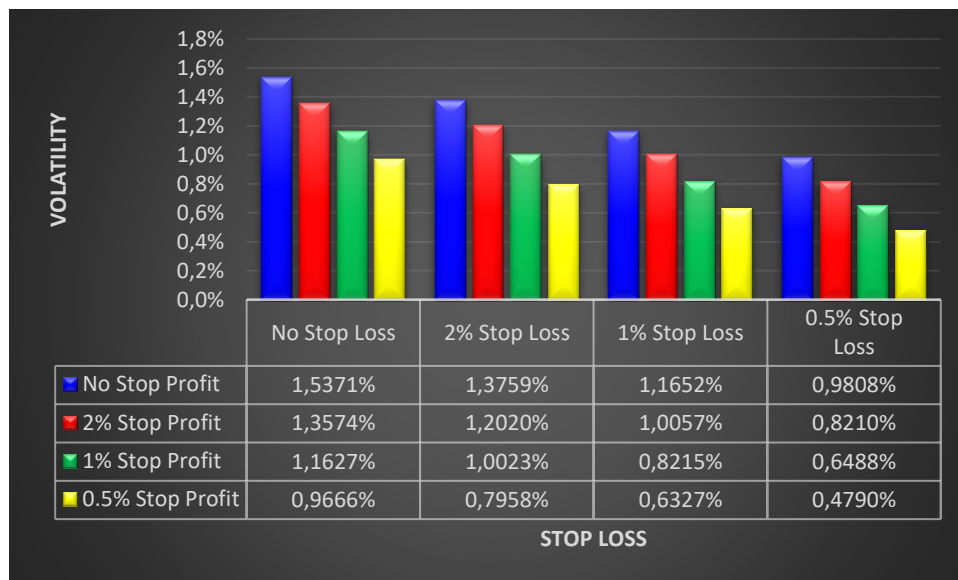
Table 46: Average of the daily simple returns in positive and negative sessions. Mean reversion strategy (Source: Author)

		Stop Loss							
		No Stop		2%		1%		0.5%	
		Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions	Positive sessions	Negative sessions
Stop Profit	No Stop	1.0630%	-1.0346%	1.0536%	-0.9622%	1.0267%	-0.7369%	1.0666%	-0.4598%
	2%	0.9670%	-1.0177%	0.9622%	-0.9523%	0.9488%	-0.7347%	0.9834%	-0.4596%
	1%	0.7505%	-1.0022%	0.7492%	-0.9370%	0.7483%	-0.7304%	0.7700%	-0.4587%
	0.5%	0.4668%	-1.0306%	0.4665%	-0.9489%	0.4676%	-0.7397%	0.4723%	-0.4623%

In this case, the returns in both, positive and negative days are worse than in the short position strategy. However, the final value of the portfolio is higher. This circumstance happens because as stated before, simple returns have been used.

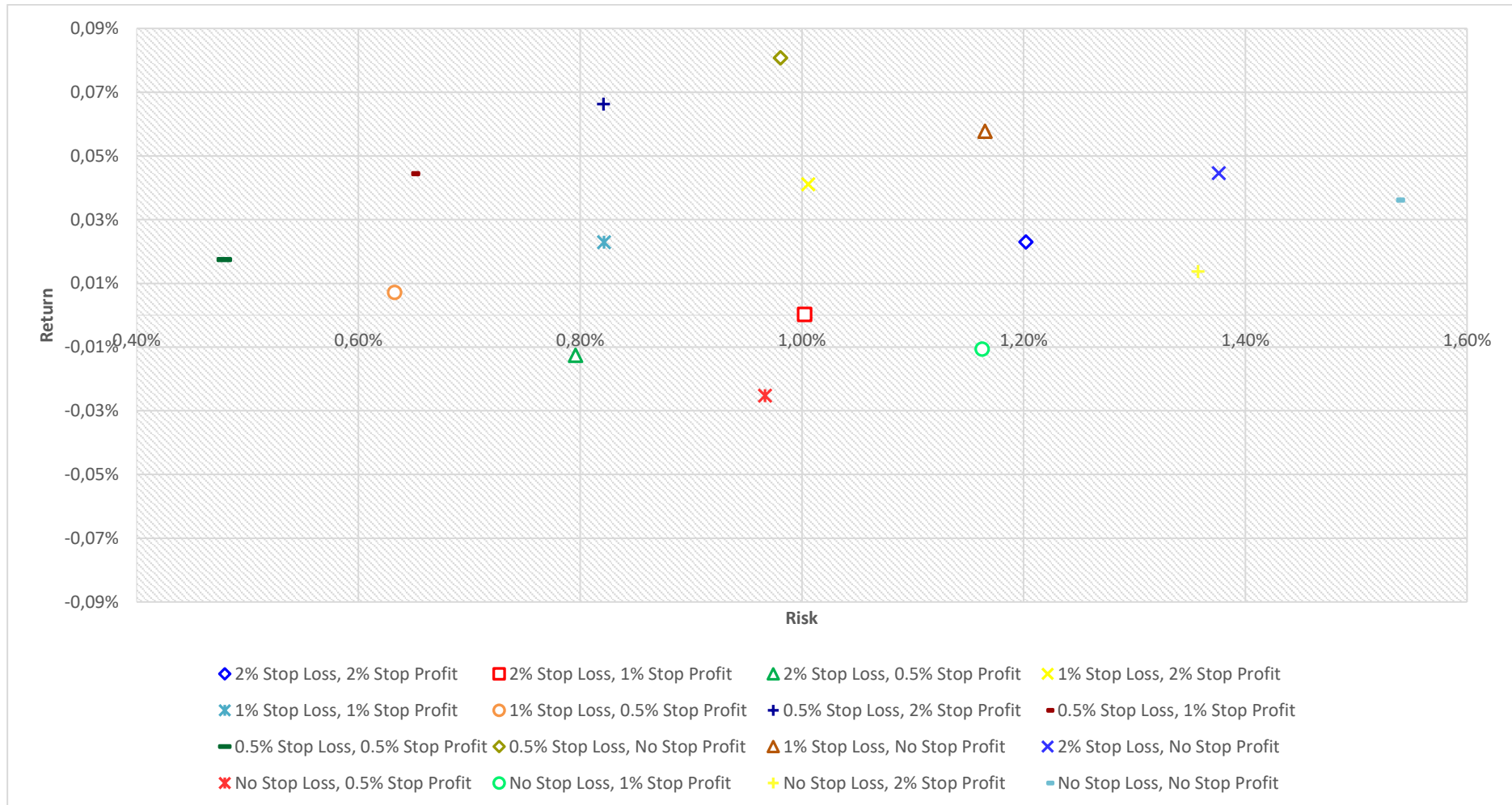
On the other side, regarding the risk of each combination, a table and a graph with standard deviations has been drawn, as in the previous cases.

Illustration 30: Daily volatility. Mean reversion strategy (Source: Author)



The conclusions are quite the same as in the previous strategies, that is, the Stops are extremely effective when reducing the risk of the investments in the equity markets, because the more adjusted the Stops, the lower the volatility observed throughout all the period. Finally, a graph representing the risk and the return of the different combinations is shown above:

Illustration 31: Risk/return of different Stop combinations. Mean reversion strategy (Source: Author)



As stated in the previous paragraphs, the return obtained through this strategy is higher than in the other cases. Regarding the stops, the lowest Stop Loss continues being the most advisable and the Stop Profit reduces both, the risk and the return of the investments.

Finally, the combinations which are not dominated are the following:

- 0.5% Stop Loss, no Stop Profit (highest return)
- 0.5% Stop Loss, 2% Stop Profit
- 0.5% Stop Loss, 1% Stop Profit
- 0.5% Stop Loss, 0.5% Stop Profit (lowest risk)

As in most cases, the line which links the combinations including the lowest Stop Loss dominates the remaining ones. This demonstrates again the relevance of applying very adjusted Stop Losses while the Stop Profit must be chosen depending on the investor's risk profile.

11. SUMMARY OF THE RESULTS

To make easier the process of drawing the appropriate conclusions, the results of the previous tests are shown in this section in aggregated form.

11.1. Accumulated profits or losses of the DAX index.

Table 47: Accumulated increase of the DAX index. All the strategies (Source: Author)

Stop Loss										
Sin Stop Loss						2%				
	Random	Long	Short	Trend	Reversion	Random	Long	Short	Trend	Reversion
Sin Stop	-876,21	-2.789,13	2.789,13	-3.618,13	3.618,13	3.030,32	-2.251,09	6.270,23	-886,69	4.905,83
2%	-988,82	-6.270,23	2.251,09	-4.905,83	886,69	1.981,39	-6.108,13	6.108,13	-2.210,63	2.210,63
1%	-3.509,53	-7.414,82	-1.836,22	-7.134,82	-2.165,96	-1.432,34	-7.156,06	1.218,29	-5.061,88	-925,62
0,50%	-6.465,78	-6.808,82	-6.119,68	-9.912,50	-3.030,40	-4.026,34	-6.505,74	-3.030,55	-8.096,09	-1.454,61

Stop Loss										
1%						0,50%				
	Random	Long	Short	Trend	Reversion	Random	Long	Short	Trend	Reversion
Sin Stop	5.741,51	1.836,22	7.414,82	2.165,96	7.134,82	6.462,72	6.119,68	6.808,82	3.030,40	9.912,50
2%	4.505,42	-1.342,59	7.156,06	925,62	4.937,58	5.509,96	2.926,97	6.505,74	1.454,61	7.992,50
1%	1.716,08	-2.489,47	2.406,61	-2.454,60	2.371,73	2.535,09	1.555,24	2.187,40	-1.442,34	5.149,64
0,50%	-1.395,84	-2.249,55	-1.805,34	-5.326,33	1.306,77	174,48	477,05	-1.029,66	-2.694,02	2.141,40

11.2. Final values of the initial 1,000€ portfolio.

Table 48: Final values of the 1,000€ portfolio: All the strategies (Source: Author)

		Stop Loss									
		No Stop Loss					2%				
		Random	Long	Short	Trend	Reversion	Random	Long	Short	Trend	Reversion
Stop Profit	No Stop	571.92€	607.67€	844.39€	258.45€	1,985.31€	1,502.93€	615.39€	2,303.94€	525.20€	2,699.61€
	2%	611.84€	260.76€	942.01€	217.00€	1,131.98€	1,262.50€	239.13€	2,781.83€	426.99€	1,557.90€
	1%	420.24€	220.17€	451.25€	161.65€	610.36€	693.81€	226.40€	1,024.79€	263.77€	873.50€
	0.5%	216.23€	211.29€	181.04€	89.13€	428.28€	366.20€	213.89€	409.68€	136.66€	639.90€

		Stop Loss									
		1%					0.5%				
		Random	Long	Short	Trend	Reversion	Random	Long	Short	Trend	Reversion
Stop Profit	No Stop	2,921.97€	1,501.82€	3,116.41€	1,118.69€	4,213.49€	4,367.43€	4,188.29€	3,647.30€	1,793.26€	8,536.04€
	2%	2,245.56€	722.35€	3,276.66€	862.33€	2,764.31€	3,461.94€	2,004.92€	3,833.62€	1,307.04€	5,892.64€
	1%	1,384.79€	636.48€	1,272.83€	467.92€	1,731.53€	1,903.26€	1,595.66€	1,556.60€	750.06€	3,295.18€
	0,50%	652.62€	562.26€	526.59€	257.47€	1,155.80€	1,009.07€	1,097.18€	742.64€	514.40€	1,584.03€

11.3. Annual returns obtained with each strategy.

Table 49: Annual returns. All the strategies (Source: Author)

		Stop Loss									
		No Stop Loss					2%				
		Random	Long	Short	Trend	Reversion	Random	Long	Short	Trend	Reversion
Stop Profit	No Stop	-4.92%	-4.39%	-1.51%	-11.49%	6.38%	3.74%	-4.29%	7.82%	-5.64%	9.37%
	2%	-4.34%	-11.42%	-0.54%	-12.88%	1.12%	2.13%	-12.11%	9.67%	-7.39%	4.08%
	1%	-7.52%	-12.76%	-6.93%	-15.16%	-4.36%	-3.24%	-12.54%	0.22%	-11.33%	-1.21%
	0.5%	-12.91%	-13.09%	-14.29%	-19.60%	-7.37%	-8.67%	-12.99%	-7.74%	-16.44%	-3.95%

		Stop Loss									
		1%					0.5%				
		Random	Long	Short	Trend	Reversion	Random	Long	Short	Trend	Reversion
Stop Profit	No Stop	10.16%	3.74%	10.80%	1.02%	13.86%	14.23%	13.80%	12.38%	5.41%	21.35%
	2%	7.57%	-2.89%	11.30%	-1.33%	9.61%	11.86%	6.48%	12.89%	2.45%	17.36%
	1%	2.98%	-3.99%	2.20%	-6.62%	5.08%	5.98%	4.31%	4.07%	-2.56%	11.36%
	0.5%	-3.78%	-5.06%	-5.62%	-11.52%	1.31%	0.08%	0.84%	-2.65%	-5.82%	4.24%

11.4. Risk of all the strategies and Stop combinations.

Table 50: Standard deviations of returns. All the strategies (Source: Author)

		Stop Loss									
		No Stop Loss					2%				
		Random	Long	Short	Trend	Reversion	Random	Long	Short	Trend	Reversion
Stop Profit	No Stop	1.5372%	1.5372%	1.5372%	1.5371%	1.5371%	1.3377%	1.3897%	1.3431%	1.3574%	1.3759%
	2%	1.3952%	1.3431%	1.3897%	1.3759%	1.3574%	1.2019%	1.2012%	1.2012%	1.2020%	1.2020%
	1%	1.1838%	1.1543%	1.1736%	1.1652%	1.1627%	1.0016%	1.0277%	0.9799%	1.0062%	1.0023%
	0.5%	0.9933%	0.9595%	0.9883%	0.9808%	0.9666%	0.8029%	0.8372%	0.7802%	0.8218%	0.7958%

		Stop Loss									
		1%					0.5%				
		Random	Long	Short	Trend	Reversion	Random	Long	Short	Trend	Reversion
Stop Profit	No Stop	1.1439%	1.1736%	1.1543%	1.1627%	1.1652%	0.9543%	0.9883%	0.9595%	0.9666%	0.9808%
	2%	1.0070%	0.9793%	1.0277%	1.0023%	1.0057%	0.8155%	0.7793%	0.8372%	0.7958%	0.8210%
	1%	0.8217%	0.8218%	0.8218%	0.8215%	0.8215%	0.6428%	0.6351%	0.6472%	0.6322%	0.6488%
	0.5%	0.6401%	0.6474%	0.6359%	0.6493%	0.6327%	0.4793%	0.4793%	0.4792%	0.4788%	0.4790%

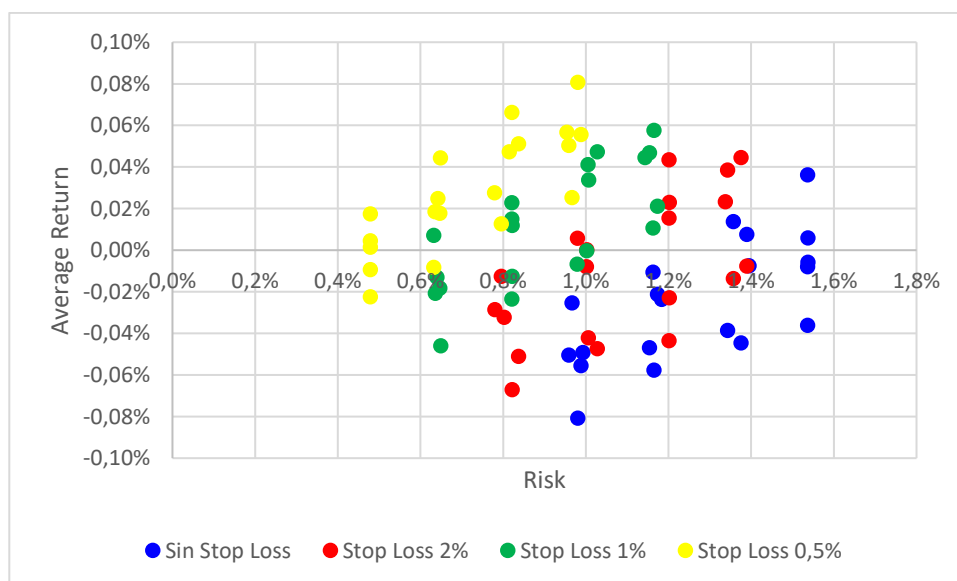
12. CONCLUSIONS

Before starting to comment the multiple conclusions drawn from the different tests carried out in this paper, it is necessary to mention that these conclusions are just applicable to the sample used for that. To be able to make valid statements about other indexes or financial assets, similar tests have to be carried out for them and analyse their performance. In consequence, the application of the guidelines given in this paper will depend on the reader, assuming that the circumstances which affected to this particular sample will never be exactly the same to the ones could affect to other indexes or sample periods.

After observed the obtained results, the first conclusion is that the Stops are extremely efficient mechanisms in order to modify the returns or risk of investments, positively or negatively. Therefore, whatever the chosen strategy the application of appropriate Stops is crucial to have an expected outcome. The hypothesis number three challenges the capability of these mechanisms, so there is no doubt about their impact in the volatility and return of the investments.

However, which one is the best Stop combination? To be able to answer this question, it is necessary to look at the pattern followed by the risk and return in the graphs of the different strategies, as explained in the previous sections. Thus, all the points derived from the risk/return graphs are represented in the same illustration. In order to know which one is the optimal Stop Loss level, the different points are sorted by the levels used in this paper, that is, 0.5%, 1%, 2% and no application of it.

Illustration 32: Stop Loss analysis (Source: Author)

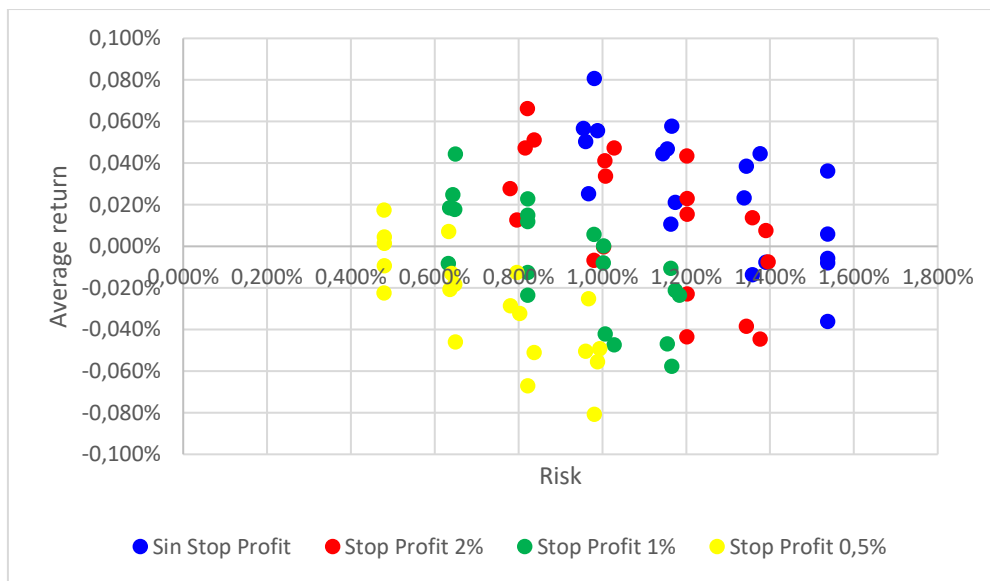


The graph shows very clearly that the most adjusted Stop Loss, the higher return and lower return will get the investor. Therefore, it is correct to claim certainly that the Stop Loss must be adjusted as much as possible because it limits the volatility of the returns and the drops in negative days are much lighter. The negative sessions are much more frequent than the positive ones, but it is not a problem if these drops are irrelevant.

However, this rule is not always met because there are some exceptions as happens with certain Stop Losses in the case of the long position strategy. In this particular case, with a 2% Stop Profit and 2% Stop Loss the performance is better than not applying any Stop Loss. Therefore, not in all the situations the applications of adjusted Stop Losses will improve the performance of the investments. However, this circumstance is very strange because only happens in one particular time during all the tests.

On the other side, the same graph is shown as in the previous case but grouping by Stop Profits instead of Stop Losses.

Illustration 33: Stop Profit analysis (Source: Author)



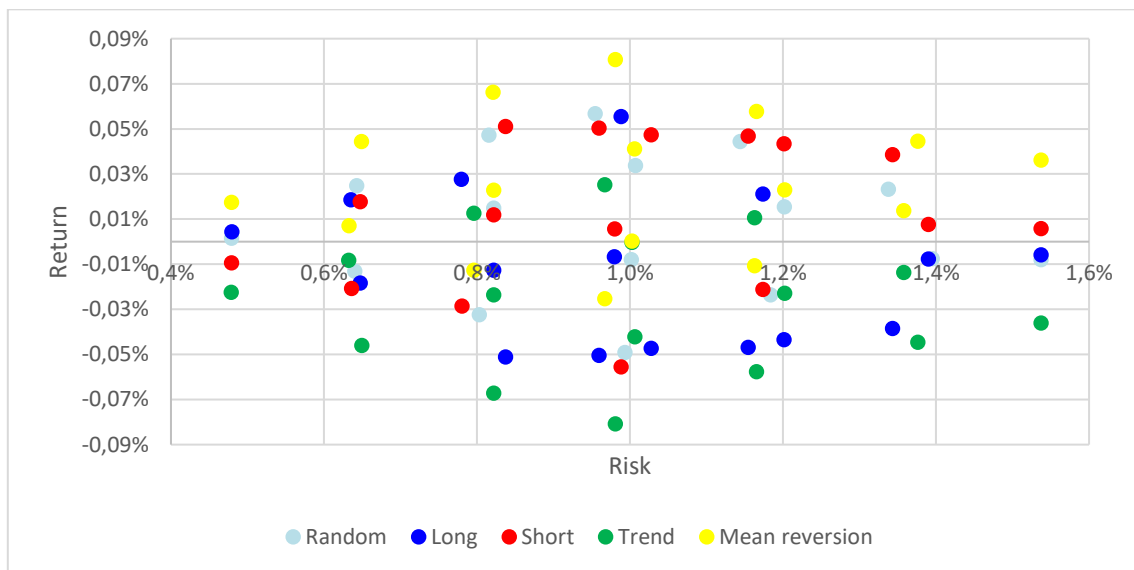
From the previous illustration, the Stop Profits reduce the returns. Moreover, the earlier the profits are taken, the more profits will be losing the investors. Therefore, if the stock market agents are looking for high returns it is not advisable to use Stop Profits because the application of this mechanism makes possible to have more positive days but the average increase in each of these days will be much lower.

However, apart from the returns, it is effective to reduce the risk of the investments as well, so it is quite appropriate for investors who are very risk averse. Therefore, the choice of the level of the Stop Profits will depend on each risk investor's profile: the risky investors will not apply any Stop Profit,

while the ones who are trying to avoid big variations in their portfolio will use very adjusted thresholds.

On the other side, in the first part of this paper, the sections in which the intra-day returns without Stops are analysed, it has been demonstrated that the best alternative to invest during the sessions is the mean reversion strategy. To verify if this fact is repeated again in the new sample, which is shorter but more exhaustive, the graph including all the points obtained by the combination of Stops and strategies is shown, but grouped in this case by the 5 different strategies tested in this paper.

Illustration 34: Risk/return of all the strategies (Source: Author)



Looking at the tables from section 11 it is possible to verify that even changing the sample period and without applying any Stop, the mean reversion strategy continues being the best alternative. Therefore, it is clear that this one is the strategy which suits best to the DAX index in the recent past

In the same way, the application of the Stops does not change this conclusion, because the graph shows that having a similar volatility, it gets the highest return in most cases. On the other side, logically, the worst strategy is the inverse one, that is, the trend strategy. All this shows that the combination of a good strategy, with a good stop combination makes possible to have a very good performance as stated in the hypothesis number four.

Finally, all these guidelines can be taken into account to design different strategies when investing in the future, as long as the readers trust in the repetition of the patterns observed in the sample used in this paper. By this way, this research can help to decide which position to be taken at the opening or at day close, which stop to apply, to keep the investment active during the gaps or not, etc. to develop profitable investment strategies by taking advantage of market trends.

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