

FUNDAÇÃO GETULIO VARGAS
ESCOLA DE ECONOMIA DE EMPRESAS DE SÃO PAULO

JOÃO MIGUEL SANCHES DE ANDRADE PISSARRA

**TREND FOLLOWING PERFORMANCE WITH SIZE AND LIQUIDITY:
EVIDENCE FROM US, BRAZIL AND PORTUGAL**

SÃO PAULO

2014

JOÃO MIGUEL SANCHES DE ANDRADE PISSARRA

TREND FOLLOWING PERFORMANCE WITH SIZE AND LIQUIDITY:
EVIDENCE FROM US, BRAZIL AND PORTUGAL

Thesis presented to Escola de
Economia de Empresas de São
Paulo of Fundação Getulio Vargas,
as a requirement to obtain the title of
Master in Finance.

Knowledge Field: International
Master in Finance.

Adviser: Prof. Dr. João Mergulhão
Prof. Dr. André Silva

SÃO PAULO

2014

Pissarra, João.

Trend Following Performance with Size and Liquidity: Evidence from the US, Brazil and Portugal / João Pissarra. - 2014.

60 f.

Orientador: João Mergulhão, André Silva

Dissertação (MPFE) - Escola de Economia de São Paulo.

1. Ações (Finanças). 2. Investimentos. 3. Bolsa de Valores. 4. Mercado de capitais. I. João Mergulhão, André Silva. II. Dissertação (MPFE) - Escola de Economia de São Paulo. III. Título.

CDU 336.76

JOÃO MIGUEL SANCHES DE ANDRADE PISSARRA

**TREND FOLLOWING PERFORMANCE WITH SIZE AND LIQUIDITY:
EVIDENCE FROM US, BRAZIL AND PORTUGAL**

Thesis presented to Escola de
Economia de Empresas de São
Paulo of Fundação Getulio Vargas,
as a requirement to obtain the title of
Master in Finance.

Knowledge Field: International
Master in Finance.

Approval Date

____/____/____

Committee members:

Prof. Dr. João Mergulhão

Prof. Dr. André Silva

Prof. Dr. Igor Cunha

ABSTRACT

In this work project, I analyze the effectiveness of applying trend following like strategies to three different country's equity markets, using a set of macro variables. Within each country, the strategy is tested against the large, small and main stock exchange indexes. I find that by combining the different strategy's signs is possible to achieve better risk-adjusted returns and reduce portfolio drawdowns levels. Overall, I emphasize the benefits of trend following investment style to a risk-averse type investor, achieving equity like returns with bond like volatility.

KEY WORDS: Trend following, index, large cap, small cap.

RESUMO

Neste trabalho, eu analiso a eficiência de se aplicar estratégias que identificam tendências em mercados de capitais, em três países diferentes, usando um conjunto de variáveis macroeconômicas. Em cada país, a estratégia é testada contra os índices de grande capitalização, pequena capitalização e o índice principal. Eu concluo que, ao combinar os sinais diários obtidos pela estratégia, é possível alcançar retornos ajustados ao risco superiores e reduzir as perdas possíveis do portfólio. No geral, enfatizo os benefícios de usar estratégias que exploram tendências para investidores avessos ao risco, obtendo retornos característicos de capitais próprios com a volatilidade característica de obrigações.

PALAVRAS CHAVE: Trend following, índice, grande capitalização, pequena capitalização.

TABLE OF CONTENTS

Index of Figures

Figure 1 - Standardized Prices for the main equity index of each country	10
Figure 2 - Long Only strategy across the three markets.....	18
Figure 3 - Pure Trend Following strategies across the three markets	22
Figure 4 - Pure Mean Reverting strategies across the three markets	24
Figure 5 - Calendar Anomalies (all together) strategies across the three markets	27
Figure 6 - CPI strategies across the three markets	31
Figure 7 - Interest rate strategies across the three markets.....	33
Figure 8 - S&P 500 spillover effect and VIX/VXO strategies across the three markets	37
Figure 9 - Final (Combining) strategy across the three markets	39

Index of Tables

Table 1: Pure Trend Following within each country indexes (2002-2013).....	47
Table 2: Pure Mean Reverting within each country indexes (2002-2013).....	48
Table 3: Calendar Anomalies strategy within each country indexes (2002-2013).....	49
Table 4: Consumer Price index strategy within each country indexes (2002-2013).....	50
Table 5: Short-term interest rate strategy within each country indexes (2002-2013)	51
Table 6: Volatility index and S&P 500 spillover effect strategy within each country indexes (2002-2013).....	52
Table 7: Combining strategy within each country indexes (2002-2013)	53
Table 8: Final (Combining) strategy across the three markets for the Sub Sample period	40
Table 9: Combining strategy within each country indexes with transaction costs (2002-2013)	54

Index

1. Introduction	9
2. Literature Review	11
3. Data and Methodology	15
4. Results	17
<i>4.1 Long Only</i>	17
<i>4.2 Trend Following</i>	19
<i>4.3 Mean Reversion</i>	23
<i>4.4 Calendar Market Anomalies</i>	25
<i>4.5 Consumer Price Index (CPI)</i>	28
<i>4.6 Interest Rates</i>	31
<i>4.7. S&P 500 spillover effect and Volatility index</i>	35
5. Combining Strategies	38
6. Sub-Sample test for the Combining Strategies.....	40
7. Conclusion.....	41
Bibliography	45
Appendix	47

1. Introduction

Nowadays, investors have at their disposal a wide variety of asset classes where they can invest their money. The technological revolution and the globalization of financial markets turned the investment process, domestically or abroad, simpler and more accessible to the daily day investor. Current investors focus on global diversification to achieve better risk-adjusted performance, being the traditional asset allocation of 40% in domestic bonds and 60% in domestic equities increasingly out of context.

There is a vast literature that highlights the benefits of investing across different markets and different asset classes, as well the advantages of applying trend following and momentum strategies in order to enhance risk-adjusted returns. The use of trend following and momentum strategies has one single objective: time the market. The use of entry and exit strategies based on past returns has the goal of predicting future financial market returns, leading investors to ride bullish markets and being out of the bearish ones. Furthermore, this signaling theory can be used with other important macroeconomic variables, whose behavior tends to influence the performance of a variety of asset classes like, e.g. equity. Notwithstanding the immense literature on the subject, usually it categorizes and aggregates different countries within a market type, leading to a more superficial analysis instead of a country based one. Consequently, the aim of this work project is to extend the previous studies in this area by applying trend following strategies and shaping equity returns at a country level.

The three equity markets chosen were US, Brazil and Portugal. Besides being widely studied along this master, their differences in terms of size and liquidity makes them the perfect fit for this analysis. Furthermore, instead of focusing solely in the main market

indexes, I will similarly test the behavior of large and small cap indexes and acknowledge how the different strategies behavior change according to market size. By focusing in three markets that differ in terms of liquidity, I expect to find more opportunities to explore market anomalies in less liquid indexes, since they tend to be less highlighted by actual literature, and where trading volume is considerably lower compared to the one of the US.

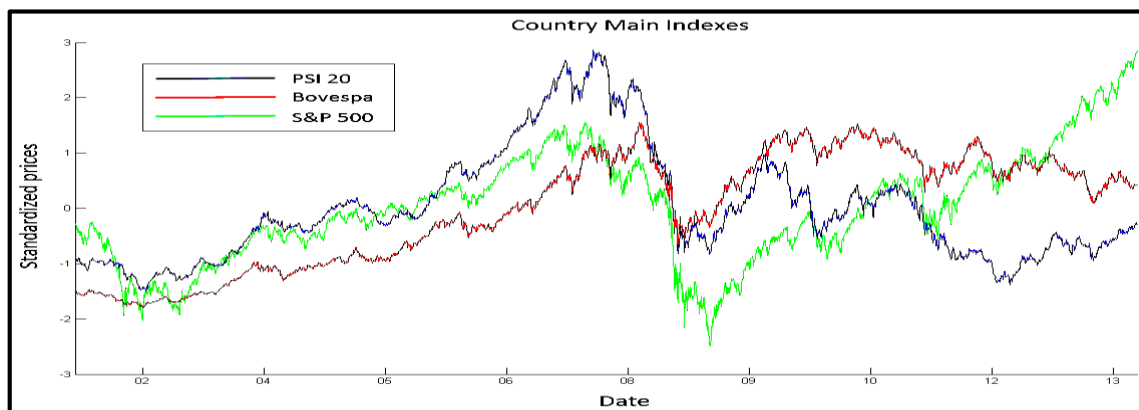


Figure 1 - Standardized Prices for the main equity index of each country

I find that portfolios that combine the different signs given by the trend following strategies outperform the respective indexes in Sharpe ratio terms, significantly reducing at the same time the drawdown levels. Furthermore, while for the Portuguese and Brazilian market the small cap was the one that displayed better risk-adjusted returns, for the US it was the large cap counterpart that performed better. Perhaps, the most important result was the massive reduction of volatility and the maximum drawdown levels. From a risk-averse investor perspective, the strategy succeed to present equity like returns with bond like volatility and drawdowns (Faber, 2013), being a good alternative for investors that look for long-term stable returns that do not compromise a large part of the investment value.

It is important to refer that these results should not be viewed as a finalized portfolio¹, but as an attempt to identify equity market properties across each country, to signal investors of the best way to approach each specific market.

The remaining of the report is organized as follow: in section 2, I present the literature review related with the topic studied; in section 3, I present the data and methodology used along the work project; In section 4, I display the main results for each strategy across the three markets; in Section 5, I present the Combining (Final) strategy for each index; in section 6, it's possible to find the strategy applied to a sub-sample period that confirms the good performance exhibited before; for last, section 7 concludes the report with the main results found.

2. Literature Review

Trend following and mean reverting strategies represent an important segment of financial literature. There is a growing evidence that using this type of strategies for a variety of asset classes exhibits better results from a risk-return perspective. As an investment style, trend following has been used for a relative long time. Back in the twenty century, Jesse Livermore, one of the icons of Wall Street, introduced this new investing approach. He explicitly stated, *“big money was not in the individual fluctuations but in the main movements, that is, not in reading the tape but in sizing up the entire market and its trend”* (Lefèvre, Edwin, 1923, p.54). Trend following relates to market momentum: when prices move in one certain direction in one period, it is likely to

¹ Along this work project, I focus completely in the equity market side, making no attempt to diversify at a country or asset class level.

continue on that direction in the next. Mean reverting will be the opposite: when the prices move far away from a certain historical mean, a correction is expected to happen in the next period, pushing those prices to more “reasonable” values.

Along the recent history, these type of strategies are getting more and more attention as investors try to contradict the market efficiency theory and obtain alpha returns above the market. In theory, abnormal returns or market anomalies are a chance result, an overreaction/underreaction of stock prices to information that tends to disappear in the long-term (Fama, 1997). According to the Efficient Markets Hypothesis (EMH), market mirrors all the information available to market participants at any given time (Fama, 1970). In other words, it is believed that stocks always trade at their fair value and is impossible to outperform the market through stock selection or market timing. Nevertheless, there is extensive evidence that contradicts and reject the EHM, and clarify how it is possible to predict future returns based on past returns (Jegadeesh and Titman, 1993). For instance, in the Portuguese market, the hypothesis of daily returns linearity is rejected, leading to the possibility of excess profit opportunities in the market (Afonso and Teixeira, 1998). Nevertheless, the introduction of the Euro as well the development and increased integration of financial markets, helped to increase efficiency in the Portuguese market. Similarly, institutional inefficiency seems to be present in Brazil. As Medeiros refers, *“the Brazilian market would be prone to be manipulated by informed traders. On the favorable events side, the informed traders would pull up stock prices attracting noisy traders. After some time, the informed traders would sell their positions to make profits and bring prices down, leaving “lemons” to the noisy traders [...] the Overreaction and the Underreaction Hypotheses rejects the canons of the Efficient*

Market Hypothesis. Besides, smaller markets should be more susceptible to this sort of irrational behavior” (Medeiros, 2005, p. 10).

Liquidity, when put in a context of market inefficiency, plays an important role in returns predictability. Indeed, prices are closer to a random walk benchmark during periods of higher liquidity. Return predictability diminishes during liquid periods as increased arbitrage activity during these periods enhances market efficiency (Chordia et al., 2007).

Trend following strategies succeed to improve risk-adjusted returns and achieve non risk-factor explainable returns independently of market’s characteristics. Furthermore, the use of trend following strategies is not exclusive to a certain asset class. When compared to equally weighted portfolios, trend following presents better risk-adjusted returns for commodities, equities or even bonds (Clare et al., 2012). Additionally, the benefits are not exclusively related with enhanced returns as shown by Clare et al.:

“[...] a pure trend following strategy, or one overlayed on a momentum strategy with volatility-adjusted weightings, reduces drawdown compared to buy and hold benchmark. We believe that such strategies would be ideal for risk averse investors [...]” (Clare et al., 2012, p.16).

Trend Following strategies act as signal filters, amplifying high frequency noise and inducing short-term positive autocorrelations (Farmer et al., 2001). The features of this type of strategies makes them suitable for any country stock market, being the results dependent on a set of characteristics like size, value or liquidity. For instance, it has been proved the existence of size effect across the stock market: small caps stocks tend to outperform their large cap counterparts in the long-run (Banz, 1980). This behavior is

likely to be present across trend following or momentum strategies as Jegadeesh and Titman documented:

“In fact, if the profits are not factor related, the strategies are likely to generate higher returns when they are implemented within the small-firm subsample that consists of less actively traded stocks and to generate lower returns when they are implemented within the large-firm subsample” (Jegadeesh and Titman, 1993, p.76).

Therefore, the small cap universe tends to generate higher momentum, though one possible explanation for these abnormal returns can be the impact of higher trading costs on price behavior, giving the illusion of trading opportunities when they do not exist (Lesmond et al., 2002). Despite the high transaction costs associated with illiquid assets, liquidity trading can be profitable and contradict the market efficiency theory. In the existent literature there is not a clearly and unanimous definition for liquidity or illiquidity. Liquidity can be seen as the order flow impact in price that results from adverse selections and inventory costs (Amihud, 2002). Strictly speaking, for the same set of expected cash flows, more liquid assets are expected to have higher prices (premium) while less liquid assets are expected to have lower prices (discount). Often investors also use stock turnover as proxy for liquidity (Datar et al., 1998), volume-to-earnings ratios (Chen et. Al., 2010) or even size, as small caps are believed to be more volatile and less liquid than the large cap ones. Furthermore, liquidity also varies at country level. Once we move from larger financial markets (e.g. US) to smaller ones, the liquidity effect tends to be stronger and more significant as mentioned before. Consequently, liquidity can also be an obstacle to investment. Institutional investors are often concerned with the relative riskiness of emerging markets. More particularly, their relative small size and illiquidity tend to limit information available and act as blocker to

foreign investment (Chuhan, 1994). Nevertheless, as less liquid stocks tend to outperform their more liquid counterparts across time, liquidity can be used as an investment style (Amihud and Mendelson, 1986). Taking advantage of liquidity market premium, by favoring less liquid stocks at the expense of more liquid ones turns out to be profitable, obtaining alpha/beta excess returns (Chen et. Al., 2010).

At the end, trend following strategies are a better alternative to the traditional 60% stocks and 40% bonds asset allocation. As Mohamed El-Erian, former manager of the Harvard endowment, stated, *“Diversification alone is no longer sufficient to temper risk. In the past year, we saw virtually every asset class hammered. You need something more to manage risk well”*². As different markets and non-correlated asset classes experience large declines simultaneously, and the normal benefits of diversification disappear, trend following can be a good solution. The strategy signals when an investor should exit a risky asset class in favor of risk-free investments, leading to equity like returns with bond like volatility and drawdowns (Faber, 2013).’

3. Data and Methodology

To explore the possible value in trend following approaches to equities, I considered three broad markets: USA, Brazil and Portugal. The purpose of this work project is to study strategy performance across different types of equity markets within each country, namely the small cap market, the large cap market and the main stock index. Therefore, the nine equity indexes used are: Brazil large cap index (Russell), Brazil small cap index

² <http://m.kiplinger.com/article/investing/T041-C000-S002-shaking-up-the-investment-mix.html>

(Russell), Bovespa index, Portugal large cap index (MSCI), Portugal small cap index (MSCI), PSI 20 index, Largest 100 stocks in market cap (S&P 100 index, USA), smallest 600 stocks in market cap (S&P 600 index, USA) and S&P 500 index. In addition to using these financial indexes, other macroeconomic variables were also considered: Consumer Price Index (USA, Portugal and Brazil), 3 month interest rate (USA), 6 month interest rate (Portugal), Selic rate (Brazil) and volatility indexes (VIX and VOX, USA). Regarding the interest rates, I used the ones with the shortest periodicity available, while for Brazil I used the Selic rate that is often considered a proxy to the Brazilian short-term interest rate. All the data used in this work project was collected and analyzed on a daily basis. The data sample covers the period between January 2002 and December 2013 for Brazil and US, while for Portugal it starts in January 2004³ and it goes as well until December 2013. I decided to use the method introduced by Faber (2006). Along the third section, the methodology used repeats itself with small changes dependent on the variable studied. The system is as follow (30-day moving average with volatility filter example):

$$\begin{aligned}
 &\textbf{If,} \quad P(t) > \text{Mean}(P(t : t-29)) + \text{Standard Deviation}(P(t : t-29)); \\
 &\quad \text{Strategy Signal} = 1 \\
 &\textbf{If,} \quad P(t) < \text{Mean}(P(t : t-29)) - \text{Standard Deviation}(P(t : t-29)); \\
 &\quad \text{Strategy Signal} = -1 \\
 &\textbf{Otherwise,} \\
 &\quad \text{Strategy Signal} = 0
 \end{aligned}$$

Some important observations regarding the system:

- 1) P = daily price and t = day;
- 2) $t \in [30 : \text{end}]$, we lose the first 30 observations;

³ The MSCI LC PT index daily prices were only available after JAN 2004.

- 3) As referred along this report, some strategies will use the volatility filter while others don't (only use the mean moving average);
- 4) Given that, some variables have a contrarian effect in the indexes, the strategy signals in that case will be the opposite.

In the fourth section, the signals given by the different strategies are combined in order to reach the final output for each index.

The trend following filter will be a binary outcome in terms of equity allocation with either 100% investment in the respective index (Long, 1) or selling 100% the index (Short, -1). This variation⁴ to the method used by Faber (2006) and posteriorly by Clare et al. (2012), has the objective of approximating the strategy to the actual market conditions faced by investors. Additionally, transaction costs are also not considered.

4. Results

4.1 Long Only

I start by examining the main indexes behavior across the three countries and its respective small and large cap counterparts from a buy and hold strategy perspective. The Long only strategy descriptive statistics for the US (Panel A, B and C), Portuguese (Panel D, E and F) and Brazilian (Panel G, H and I) related indexes, can be found in every table presented along this report, identifiable by the ticker index.

⁴ In their work, in case of a negative sign, the authors invest in risk-less assets instead of short selling.

Compound annual returns range from approximately -3% to 20% with the MSCI LC PT and Russell SC BRL representing these extremes, respectively. The risk adjusted return winner was precisely the index that represents Brazilian small cap stocks with a Sharpe ratio⁵ of 0.92. Furthermore, in the overall picture, the Brazilian indexes exhibited the best results from a risk adjusted return perspective. Across the three countries, we observe that market behavior is coherent with actual literature that suggests the higher performance of small caps over large caps in the long term, although usually at the expense of higher volatility. The theory holds for the US and Portuguese market. However, in the Brazilian one, the small cap index presented both higher returns and less volatility (19.82% and 21.61%, respectively) when compared with the country main index Ibovespa (10.89% and 29.02%). Figure 2 demonstrates Bovespa's dependence on the country's biggest stocks.

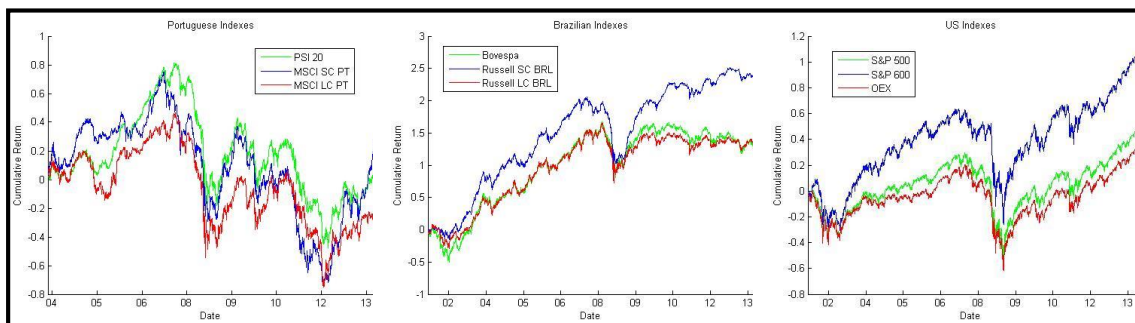


Figure 2 - Long Only strategy across the three markets

As one should expect, the three indexes revealed a homogeneous behavior. Nevertheless, while Russell LC BRL index returns were very similar with the Bovespa ones, the Russell SC BRL index clearly outperformed the latest in the sample period. In addition to the improved return and volatility, the latter also grants a lower maximum drawdown (approximately 34%) compared with the Bovespa one (approximately 54%).

⁵ The Sharpe ratio, introduced by William Sharpe in 1966, is a way to examine the performance of an investment by adjusting for its risk. Along this work, I use the index annualized return divided by the index annualized standard deviation version of this ratio.

4.2 Trend Following

In this section, I analyze the impact of implementing pure trend following strategies to the indexes mentioned before. I decided to use different moving averages (5, 30, 60, 90 and 250 days) in order to test strategy performance at a short, medium and long-term level. Looking at the main indexes for each country (Table 1), the Portuguese one stands out with enhanced annualized returns of approximately 1155% (using a moving average of 60 days) while maintaining volatility levels constant. The index presented a Sharpe ratio of 1.0851 while reducing the maximum drawdown by 50%. Furthermore, also Portuguese large and small cap indexes presented trend following characteristics being these ones stronger in the latter, where Sharpe ratios around 1 for 4 of the 5 signal lengths were obtained. Indeed, one should expect these results for more volatile markets like the Portuguese and Brazilian ones. Figure 1 (Section 1) illustrates the standardized prices for the main index in each country. First, is easily observed that the PSI 20 index presented a wilder behavior than the S&P 500 and Bovespa indexes, as it tended to “jump” more, therefore being a better candidate to bet on directional moves. Second, the auto regression levels can be used as proxy for the probability of having trend following or mean reverting properties. The daily autocorrelation for the PSI 20 (0.0643) supports the strategy’s performance success. The positive autocorrelation can be interpreted as the probability that a positive return is followed by a positive return in the next day and vice-versa. Additionally, the strategy maintained the Kurtosis value more or less constant, while for the skewness, is possible to observe a shift from a negative skewed distribution to a positive skewed one. A positive skewness implies that the mean of the sample is greater than the median. In other words, it is more volatile than average when making money and less volatile than average when losing money. These results are aligned with the ones for

the maximum drawdown: the strategy was able to reduce extreme results in negative terms while improving the positive ones. Despite presenting higher levels of volatility, the MSCI LC PT did not perform so well when compared with its small cap counterpart. The best Sharpe ratio (0.4249) was obtained using a moving average of 90 days, leading me to conclude that, from a risk-adjusted return perspective, pure trend following strategies are not the most suitable for the large cap market in Portugal. In the case of the MSCI SC PT, the strategy obtained the best results across all indexes studied in this section, as stated before. The mentioned index presented strong short and medium term trend following properties being these ones maximized when using a moving average of 5 days (Sharpe ratio equal to 1.24). The index daily and monthly autocorrelations (0.0636 and 0.2 respectively) were similar to the PSI 20 index one, foreseeing good results from a trend following perspective. The strategy managed to improve returns in approximately 1274% while reducing the maximum drawdown from 85% to 20%. I can conclude that the success of trend following strategies in the Portuguese main index is mostly driven by the small cap performance than its counterpart. These results are in accordance to the findings of Soares and Serra (2005), which proved how the Portuguese stock market shows momentum in the short/medium term, reverting to a certain mean after the 18th month.

Thus far, I focused in the Portuguese case. The next step is to assess the behavior of the strategy in the Brazilian market. The baseline strategy (Long only) clearly highlights Bovespa's greater returns (10.89%) when compared with PSI 20 and S&P 500. One would expect that these high returns would come at the expense of higher volatility values. In spite of that being true, the relation return/volatility is noticeably higher in the Brazilian case. Panel G, H and I (Table 1) reports the descriptive statistics for the pure

trend following strategy, comparing once again with the baseline long only strategy. From a Sharpe ratio perspective, the strategy showed higher performance when using a 30 and 60 days moving average, nevertheless the signaling strategy ended up adding low incremental value to the index performance. The annualized return varied between 11.38% and -1.70% while the annualized volatility stayed constant around 29%. Although, along the different signal lengths, the maximum drawdown increased to values that one may already find prohibitive. The negative autocorrelation (-0.01) may suggest mean reverting strategies as a better candidate to Bovespa index, nevertheless the value seems to be considerably close to zero to take significant conclusions. The Russell LC BRL presented more or less the same behavior as the Bovespa index, when tested for trend following properties. Once again, the strategy failed to present enhanced risk-adjusted returns, presenting on average lower Sharpe ratios than the long only strategy. The opposite happens in the Russell SC BRL case. Similar to the Portuguese example, the strategy seemed to perform extremely well, presenting Sharpe ratios between 1.09 and 1.42. If the returns of the small cap index were already impressive by themselves, the strategy was able to improve them, attaining incremental returns of approximately 10% (30 day moving average). The similarity between the two markets was once more emphasized by its Kurtosis and skewness levels. The Kurtosis value of 8 proves that the returns are far away from presenting normality properties since they present fat tails (relative high number of extreme results). It is also possible to see again a shift from negative skewed returns to positive skewed returns. Nevertheless, in this set of performance statistics, the maximum drawdown did not perform so well as in the Portuguese case. While in the long-term, the strategy presented lower maximum drawdowns values, in the short term those values stayed constant and even increased in

the 30-day moving average example. At the end, the trend following strategy (using a 30-day moving average) for the Russell Small Cap Brazil presented the best risk-adjusted returns but at the same time, the highest peak in portfolio's value lost.

Finally, the S&P 500 was the main index that presented the worst results. The returns always dropped despite the signal length, leading to very low and even negative Sharpe ratios. The poor performance of the strategy is highlighted by the maximum drawdown values. The maximum drawdown was always above the total value of the portfolio, making this strategy impossible to follow by any investor. Likewise, trend following applied to the OEX index and the S&P 600 showed a similar behavior. Both indexes failed to present enhanced returns in relation to the baselines portfolios, leading to, non-investable Sharpe ratios. Being the most efficient market among the three, this type of inefficiencies tend to disappear and be corrected faster. Furthermore, the negative daily autocorrelations lead me to believe in the success of contrarian strategies in this market instead of pure trend following strategies.

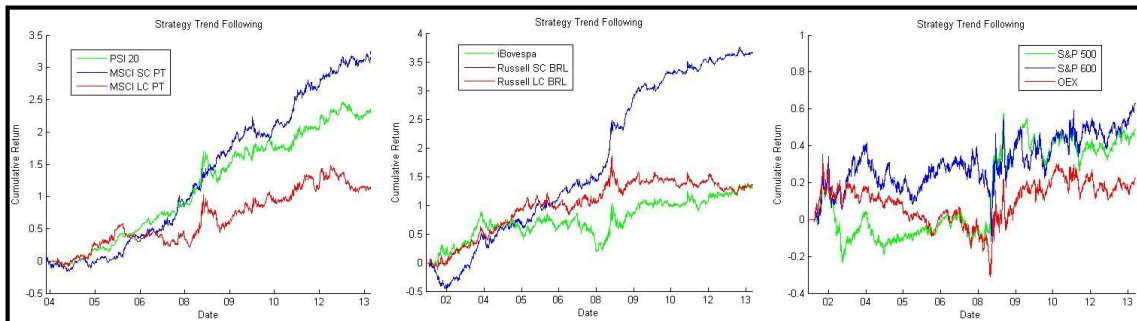


Figure 3 - Pure Trend Following strategies across the three markets

So far, I can take some conclusions regarding the pure trend following strategies. The three examples studied in this section, have shown that pure trend following is a risk-lover like strategy. All the benefits come from the returns side, whereas volatility stayed constant across the different signal lengths used. Furthermore, the Portuguese and Brazilian small cap indexes presented extremely good results when put in a trend

following context, however only the PSI 20 was able to similarly replicate the results performed by its small cap constituent. There is a particular literature that documents the influence of large caps in the Bovespa index and how they tend to shape the index behavior, however I will have the opportunity to study this hypothesis further ahead in this work project.

4.3 Mean Reversion

Having shown the performance of trend following strategies across the three different markets, the next logical step is to study mean reverting properties across the referred markets. Given the strong results obtained in the last section, it is expectable a poor performance of the PSI 20 index when given a mean reversion signal. Table 2 presents the Mean Reversion strategy descriptive statistics for the three main indexes and its respective small and large cap indexes.

For the Portuguese case, the strategy failed to present positive returns independently of the signal length given. This scenario complements the results obtained in the last section: the Portuguese market presents strong trend following characteristics in the short/medium term.

Regarding the Brazilian market, Chaudhuri and Wu (2004) documented the evidence of mean reversion in stock prices using emerging markets. Their results suggested the existence of mean reversion for several emerging countries as Brazil (1% significance), nevertheless, the speed of reversion supported (30 months) goes beyond the time lengths studied in this project. My results for the Brazilian market end up being similar to the ones found in the Portuguese market. Again, the strategy failed to present better risk-adjusted returns, and the previous scenario, where only negative returns were obtained,

repeated itself. I can conclude that Bovespa and the Brazilian Large cap market exhibited the most unpredictable returns across the three markets as both initial strategies failed to improve significantly the long only strategy Sharpe ratios. Given the characteristic high returns of this market, strategies that explore the volatility side instead of the returns one, may offer better value-added performance.

Contrarily, the US market displayed some interesting results, mainly in the short-term horizon. For the S&P 500 example, it was possible to increase returns by 198%, using a 5-day moving average, reducing at the same time the volatility values. At a 30/60-day basis was also possible to observe some mean reversion, nevertheless it was using the 5-day signal length that the best Sharpe ratio was obtained (0.8361). As mentioned before, the daily returns negative autocorrelation (-0.10) already forecasted this scenario. Besides offering better risk-adjusted returns, the strategy also reduced the maximum drawdown from 64% to 14%. This is one of the most important indicators for investors as, frequently, the liability of undertaking this type of strategies is the capacity to hold it in times of market distress. Once again, the strategy's extreme results, represented by the high kurtosis value (32.2), confirm the expected returns' non-normality⁶.

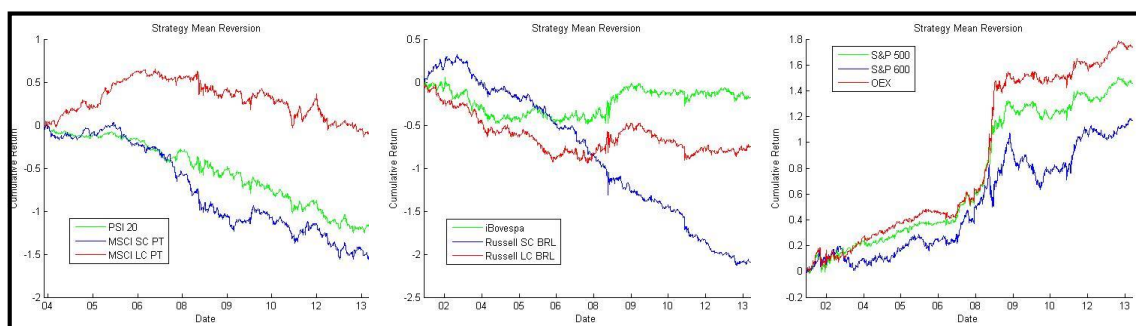


Figure 4 - Pure Mean Reverting strategies across the three markets

When applied to the OEX index (Large cap) the strategy performed even better, attaining a Sharpe ratio above one (using 5-day moving average). In this case, the high kurtosis

⁶ A Gauss/Normal distribution is expected to have a Kurtosis of 3 and a Skewness of 0.

was followed by a relatively high positive skewness, leading me to conclude that the strategy was more constant when losing money than making it. For the S&P 600 (Small cap), the results were identical but at a lower degree: poor performance in the medium/long-term while in the short-term the salient result was the volatility reduction.

4.4 Calendar Market Anomalies

There is a vast literature that tests and documents different types of market anomalies that tend to contradict the efficient market hypothesis. In this section, I will analyze three specific ones: the Monday effect, the January effect and the turn-of-the-month effect. The goal is to verify how the strategy that explores each calendar anomaly performs when we move from the most liquid market (US) to less liquid markets (Portugal). The weekend/Monday effect refers to the phenomenon in financial markets in which Monday returns tend to be lower compared with the previous Friday ones. There are multiple explanations for this market singularity as French (1980) and Richard Thaler (1987) acknowledged. This effect has been linked to high volatility in the weekends as well simply faded optimism by traders during this period. Across the three strategies, this was the one that presented less optimistic results. Nevertheless, it managed to exhibit positive sharpe ratios in 8 of the 9 indexes studied. The strategy descriptive statistics can be found in Table 3. The sharpe ratios obtained for the US market when tested against the weekend effect ranged between 0.13 and 0.19. I will highlight the S&P 500 since is the index that exhibited the best results. The Kurtosis value clearly stands out when compared with the long only strategy value for the S&P 500. It is important to remember that, the intervention in the market is more passive across the strategies studied in this section,

leading to a distribution with larger fat tails. Despite showing extreme results across the sample period, the maximum drawdown was only 20%, what represents a clearly improvement to the baseline portfolio. When applied to the Portuguese market, strategy's behavior was quite similar, though it should be noted the negative result displayed by the small cap index. Once again, the maximum drawdown values were reduced across the three indexes being in accordance with the high Kurtosis value: by considerably reducing the investment /trading days, we reduce our exposure to the market and the value at risk that comes with it. For last, the Brazilian market also displayed this type of anomaly, nevertheless at higher significance, having its peak in the small cap index (Sharpe ratio of 0.39). The next market anomaly studied was the January effect. The January effect refers to the buying rally during the first week of January, following the drop in price revealed in December. As Thaler (1987) and Gu (2002) documented, this pattern can be explained by year-end tax losses selling of stocks to offset capital gains and how investors tend to buy them back in January with the help of year-end bonuses. Notwithstanding, this phenomenon has been less noticeable in recent years, even for the small caps, as markets have adjusted to it across time. My results end up being contradictory, as both smallest and biggest Sharpe ratios were achieved by two different small cap indexes. Regarding the US market, it showed better performance when applied to S&P 500 and the large cap market, exhibiting enhanced Sharpe ratios of 0.57 and 0.48, respectively. I will focus on a return/volatility analysis, since it is useless to examine Kurtosis and Skewness when I am only trading January's first week each year. Similarly, PSI 20 and MSCI LC PT indexes were the winners for the Portuguese market, as the small cap index failed to present positive returns opposing common literature but in accordance with the findings of Silva (2010). For last, when applied to the Brazilian market, the strategy

displayed a constant behavior exhibiting enhanced risk adjusted returns for the three indexes. Contrarily to the examples shown before, the small cap index was the one with the best sharpe ratio (0.63) nevertheless still below the baseline index one. I decided to leave the turn-of-the month strategy to the end since it was the one with the best and most constant results across the three markets. The turn-of-the-month phenomenon refers to the positive pattern found in returns at the end of each month: stock prices rise during the last days and the first days of each month. Kunkel et al. (2003) document the persistence of this effect in several markets, while Nikkinen et al. (2006) acknowledged how the effect of macroeconomic news announcements at the end of each month help to explain this market anomaly. In this sample period, the effect was not only presented in the three markets, as also, surprisingly, exhibited better Sharpe ratios in relation to the baseline benchmark in each single index studied. Nonetheless, the best were evidenced by the Brazilian market with astonishing Sharpe ratios ranging between 1.14 and 1.59. It is important to mention how, contrarily to the US and Brazilian market, the Portuguese Large cap index performed relatively better than the small cap one (Sharpe ratios of 0.69 and 0.41 respectively). Furthermore, the maximum drawdowns were comparably lower than the baseline index ones, being in accordance with the success of the strategy.

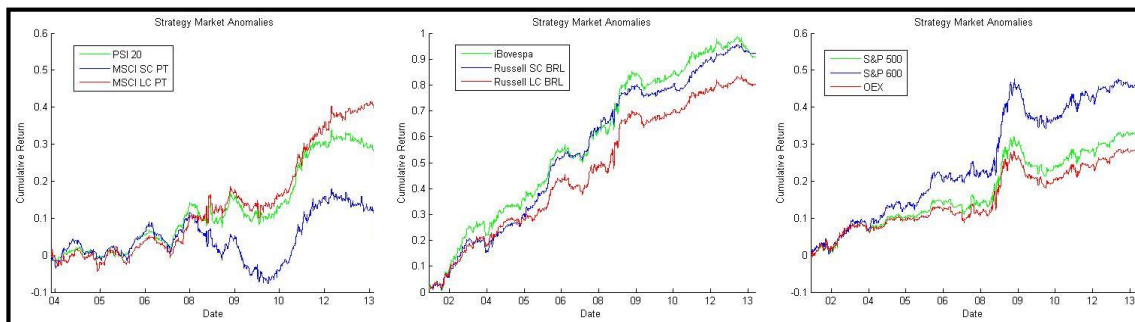


Figure 5 - Calendar Anomalies (all together) strategies across the three markets

Across the three strategies studied in this section, is possible to distinguish some relatively high/low skewness values. Nevertheless there is not an evidently correlation between Skewness signal and Sharpe ratio performance. Indeed, actual literature fails to give a

clear picture over investor Skewness preference. Exclusively in this section, I agree with the theory presented by Scott and Horvath (1980). Positively skewed returns will be preferred as they offer a limit downside while boosting at the same time the potential upside. By other words, the lottery effect will kick in the event of the appearance of market anomalies, leading investors to overweight the fat tail until the crowding out effect eliminates the inefficiency from the market. Despite the vast literature, it is possible to conclude that these market anomalies persist independently of the market characteristics.

4.5 Consumer Price Index (CPI)

Up to this point, I have considered pure strategy performance within each index and which are the advantages that one may take from it. Hereafter, I will concentrate on macroeconomic variable correlation with stock returns, and how its behavior can or not assist to predict the direction of the stock market. In this section, I will study how the CPI can help to shape equity returns. The CPI influence on US stock returns has been well established in the economic literature by, amongst others, Sharpe (2002) and Sirucek (2012). Sharpe (2002) documented how changes in expected inflation affected long-run return on stocks, while Sirucek (2012) examined the negative impact of inflation on share prices. Here I examine the indexes response to CPI from a trend following perspective with a volatility filter. The volatility filter will guarantee that I only go long or short if the macroeconomic variable exceeds a certain acceptable range. As CPI is a contradictory indicator, I go long when its values are below the moving average mean minus one standard deviation and vice-versa.

In the S&P 500 example, the strategy performed quite well, exhibiting improved Sharpe ratios in three of the four signal lengths studied. As one can notice in Table 4, there are no values for the 5-day moving average since it does not seem logical to test a monthly indicator against such short period⁷. The best scenario (S&P 500) was obtained when using the largest signal length possible, improving returns by 188% while maintaining volatility more or less constant. In addition to reveal better risk adjusted returns, the strategy also improved maximum drawdown and returns symmetry. The Kurtosis value, despite being high, was in accordance with the one exhibited by S&P 500. Therefore, these results were in agreement with actual literature, and given that the CPI is a lagging indicator it is reasonable to have the best results using the highest signal length. For the US large and small cap market the strategy behavior was similar, nevertheless the OEX index presented the best improvement in returns when compared with the long only strategy. Using a signal length of 250 days was possible to obtain a Sharpe ratio of approximately 0.52, 3.7 times higher than the long only one.

For the Portuguese scenario, the Consumer Price Index also helps improving index results. The benefit came once again at a long-term horizon (90 and 250 days length), where the PSI 20 displayed Sharpe ratios of 0.443 and 0.8341. Similarly to what was concluded in the previous section, the strategy does not improve volatility levels, nevertheless the enhanced returns are reasonably significant. Contrarily to the US scenario, the maximum drawdown increased from 64.3% to 75.7% (superior returns came at the expense of a higher value at risk). Furthermore, the strategy turn out being effective also for the Portuguese large and small cap market, although, in contrast to the US

⁷ CPI values are only revealed at the end of each month and a 5-day moving average would lead to extremely high kurtosis, as most of the time the daily and mean value would be the same leading us to stay out of the market.

example, the best results were evidenced by MSCI SC PT index. Regardless of the upgraded Sharpe ratio for the MSCI LC PT index (0.3669), it was the small cap index, that using a 250-day signal length, presented the best Sharpe ratio (0.9086). In accordance with PSI 20 index, the strategy achieved better returns. Even so, it failed to reduce the maximum drawdown. Notwithstanding the high maximum drawdown value (83%), it is important to refer that, by allowing short selling, I assume the possibility of taking advantage of severe declines in the market leading to results that are more volatile than if I wouldn't. Actual literature related with the subject failed to find statistical significance on the influence of Portuguese inflation in the national stock market.

For last, inflation in Brazil is one phenomenon that has been widely study given its irregular behavior. Inflation has been an “old enemy” of Brazilian economy for quite long, presenting several periods of hyperinflation across its history. Despite showing signs of improvement in the last years, inflation is still considerably high when compared with, per example, the US CPI values⁸. Therefore, as high inflation tends to create uncertainty and distrust in the market, I will observe how that traduces in strategy performance. When applied to Bovespa, the strategy exhibited improved performance using the three largest signal lengths, nevertheless the best risk-adjusted returns were obtained using a moving average of 90 days (Sharpe ratio of 0.5707). The strategy enhanced returns by 51% in relation to the baseline index, although those returns come at the expense of a higher maximum drawdown (60.35%). Despite the relatively high kurtosis and maximum drawdown values, they were in accordance with the ones presented by the index. The large and small cap markets response to the strategy was similar to the main index one,

⁸ In December of 2013, Brazil had an inflation of 5.91% while US had an inflation of 1.5%.

yet the Russell SC BRL exhibited once again the best Sharpe ratio across all the indexes studied (1.267 , 250 day moving average).

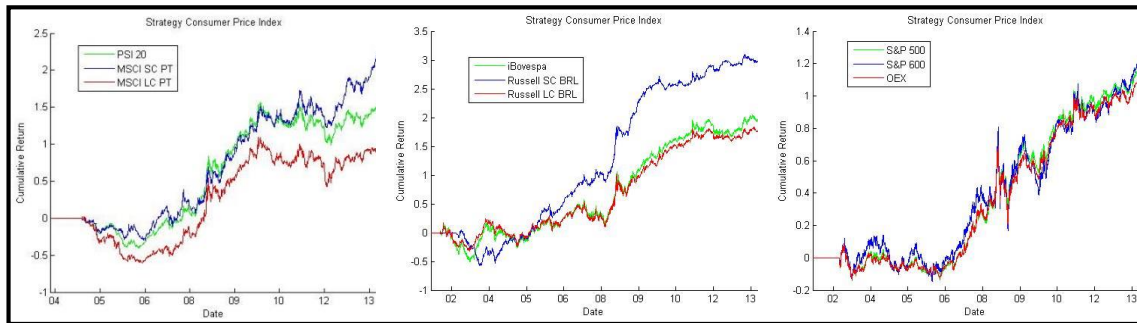


Figure 6 - CPI strategies across the three markets

Alike the pure trend following example, using the Consumer price index, the strategy was able to improve the already high returns of the Brazilian small cap index from 19.820% to 27% maintaining volatility constant at approximately 21%. Nevertheless, it is important to refer the move from negatively skewed returns to positively skewed returns and the considerably high increase in the maximum drawdown. Eid (2005) documented how the Bovespa index turned out being less efficient after the Plano Real⁹ and the stabilization of inflation, leading to a shift of excess returns in the stock from a normal distribution to a less well-behaved one.

4.6 Interest Rates

The second macroeconomic variable to test is the short-term interest rates. As mentioned in the data section, I will use the Brazil target rate SELIC as proxy for the Brazilian short-term interest rate, the 6-month government bond yield for Portugal and the 3-month government bond yield for US. Similarly, to CPI, interest rates are a contrarian and

⁹ The Plano Real (1994) was a set of measures taken to stabilize the Brazilian economy and mitigate country's high inflation.

lagging indicator: as external funding becomes more expensive, stock prices are expected to go down and vice-versa.

Sirucek (2012) documented this phenomenon proving the negative impact of US interest rates on Dow Jones index. However, when tested to S&P 500, the impact was positive, contradicting economic theory. In this case, the strategy exhibited a higher performance for the S&P 500 and the OEX than to the S&P 600, succeeding to achieve positive returns across four of the five signal lengths. Contrarily to the Selic rate, the 3-month bond is quoted in a daily basis, leading to better results in the medium-term than in the long term (250 moving average) as shown in table 5. The best result for the S&P 500 was obtained using a 30-day signal length leading to a Sharpe ratio of 0.6678, 3.56 times higher than the baseline index one. Once again, is important to refer the use of a volatility filter in order to obtain stronger results, anticipating a lower exposure to the stock market. The percentage of positive days and the maximum drawdown results confirm this idea. Given that the daily interest rate values were often between the out-of-the-market¹⁰ stipulated ranges, the strategy end up presenting a relatively low percentage of positive days (25.92%), although it also reduced the maximum drawdown from 64% to approximately 29%. Additionally, the volatility filter also affects the distribution of returns. The frequent neutrality against the market leads to several observations where the strategy's daily return is zero. Therefore, every time that I decide to go long or short, the returns (positive

¹⁰ Out-of-the market range refers to the values between the moving average mean plus one standard deviation and the moving average mean minus one standard deviation

or negative) will always be interpreted as extreme results, as the mean of the distribution will be close to zero.

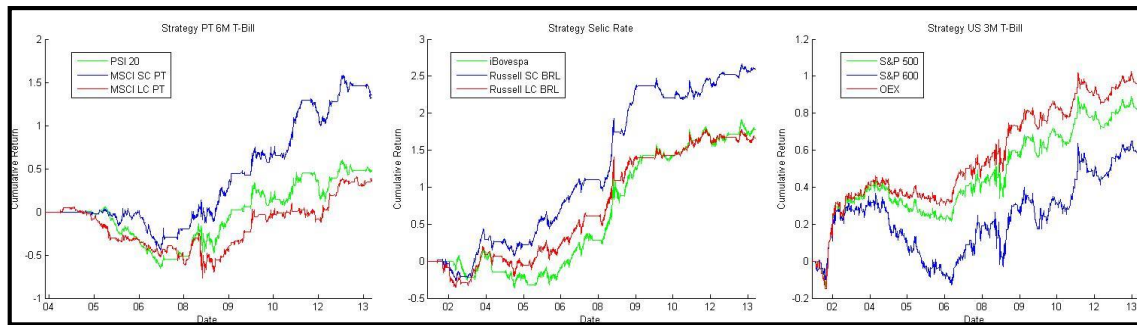


Figure 7 - Interest rate strategies across the three markets

For the OEX example, the strategy also exhibited better results when using a 5 and 30-day signal length, while for the small cap index, conditioned by the baseline index high Sharpe ratio, the strategy failed to present enhanced risk adjusted returns despite the signal length used.

The Portuguese and Brazilian markets were the ones where the strategy of using interest rates to predict market's direction performed better. I will now focus on the large and small cap indexes, as they were the ones with the most significant results. Looking at panel E (table 5) it is easy to identify two opposite results: while in the MSCI LC PT index the best Sharpe ratio was obtained using the lowest signal length, in its counterpart the best Sharpe ratio was obtained using the highest one. Despite the overall enhanced Sharpe ratios, the one for the large cap market is quite suspicious (0.7968). From a return perspective, it is possible to observe how the return of 14.94% is completely misaligned with the ones obtained using other signal lengths, leading consequently to relatively lower Sharpe ratios. One possible explanation could be the ineffectiveness of the 5-day moving average to avoid market noise¹¹. As these results are smoother for the PSI 20 and MSCI

¹¹ Market noise refers to the price data that distorts the picture of the underlying trend.

small cap Portugal index and interest rates tend to lag, I will focus this analysis in the higher signal length examples. Hereupon, the clear winner was the small cap index, where the strategy succeeded to increase annualized return from 2.340% to approximately 15% reducing at the same time the index volatility. Furthermore, using the highest signal length, was possible to approximate the Kurtosis value to the one presented by the baseline index, while exhibiting a clearly improved maximum drawdown. It is important to refer that, despite the relative inferior strategy performance for the PSI 20 and MSCI Large Cap Portugal index, the results showed better risk-adjusted returns than the baselines index ones.

For last, the Brazilian market exhibited Sharpe ratios that clearly outperformed the other two markets. As mentioned in the data section, the Selic rate is a monthly indicator, therefore it does not seem logical to test it for a moving average of 5 days. Panel G, H and I show how the strategy presented superior risk adjusted returns for the three indexes, often at the expense of a higher maximum drawdown. Once again, I will focus my attention in the small cap market, where were obtained Sharpe ratios above one for three of the four signal lengths tested. Despite the surprisingly high Sharpe ratios, these results are in accordance with actual literature on the subject. For instance, Hersen et al. (2013) documented this negative relationship, proving how a 1% increase in Selic rate leads to a 1,000 points drop in the Bovespa index. The strategy ended up being more “active” for the small cap index as the positive days percentage demonstrates, while return’s distribution fat tails got smoother with increases in the signal length. It is important to mention, how the extremely good performance of the Brazilian indexes across the sample period influenced the results, nevertheless the strategy managed to turn them even more attractive from an investor perspective.

4.7. S&P 500 spillover effect and Volatility index

Thus far, I studied the benefits of using macroeconomic variables to predict market direction. In this section, I will study the possible spillover effect of the US market in the Brazilian and Portuguese market, while for the US market I will study the behavior of the trend strategy when tested against volatility indexes. If in the first example is obvious why I only test two markets, in the second, the reason is the lack of available data (volatility indexes) for the Portuguese and Brazilian markets. Therefore, in order to avoid misleading results by using benchmark indexes, I decided to exclude both countries from the volatility index analysis.

It is logical to believe in the spillover effect of S&P 500 over different stock markets across the world: being one of the most followed indexes, its performance can shape investor sentiment, leading to a wave of optimism or pessimism across the other countries stock markets.

In the Portuguese and Brazilian markets, this idea ended up being true, nevertheless with more incidence in the Portuguese one. Table 6 confirms how the strategy exhibited improved Sharpe ratios despite the signal length used for the PSI 20 index. Indeed, when the S&P 500 is trading above its 90 days mean, it seems a good scenario to go long on the Portuguese main index and vice-versa. Furthermore, this strategy presented the best risk adjusted returns for the PSI 20 (Sharpe ratio of 0.8873), while exhibiting at the same time a relatively good performance for the large and small cap indexes. Despite the enhanced Sharpe ratios for the large cap index, the MSCI SC PT index showed once again the best performance, since was able to increase strategy returns by approximately 462% while reducing maximum drawdown to more acceptable values. Furthermore, the kurtosis

values were also more in accordance to the baseline index ones and there was a clearly negative skewness pattern over the three indexes.

The scenario repeated itself in the Brazilian market. Aside the benefits from a volatility perspective for the Bovespa and the Russell LC BRL indexes, the strategy exhibited also significantly enhanced returns in the medium/long term for the small cap index. The maximum drawdown was more or less constant across all signal lengths, but conditioned by the relative low value exhibited by the baseline index (34%). The Kurtosis value increase was quite significant leading to more extreme results than usual, being the negative returns the mainly foundation of this fatter tails (negative skewness). Actual literature on the subject confirms this tendency. Passos et al. (2014) documented the influence of several US stock indexes over the Brazilian stock market, findings that help to back up the theory of increasingly and interdependent financial markets.

The last variables to be analyzed are the volatility indexes, more precisely VIX (S&P 500 and S&P 600) and VXO (S&P 100). Regardless of VIX being the index directly related to the S&P 500, I will use it as a proxy for the S&P 600 since the only small cap volatility index for the US market is not available for the entire period covered in this work project. Chung et al. (2011) makes the case for the predictive informational content presented in VIX and S&P 500 index options, being its effectiveness higher when the market is over an extreme/volatile period. The strategy exhibited strong results for the S&P 500 and OEX indexes, while for the S&P 600, clearly conditioned by the assumption mentioned before, the strategy only exhibited enhanced Sharpe ratios in the very short-term. Similarly to the strategies before, the volatility filter used led to a low percentage of positive days, as the number of days out-of-the market were quite substantial (Table 6). However, the volatility filter assures outcomes more robust reducing at the same time

transaction costs borne by the investor. Often referred as the *fear index*, is important to clarify that VIX represents the market volatility expectations for the next 30 days.

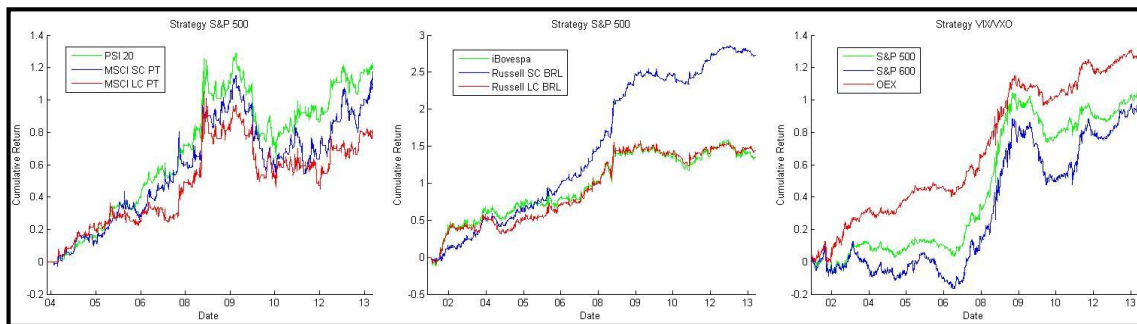


Figure 8 - S&P 500 spillover effect and VIX/VXO strategies across the three markets

Therefore, it is logical to assume that the strategy will perform better in the short term, as the index tends to get out of context as signal length increases. For both S&P 500 and S&P 100 indexes, the strategy presented the best Sharpe ratios using a signal length of 5 days (0.6514 and 0.8377, respectively). It is possible to observe how the index predictive effect tends to disappear as it moves to higher signal lengths, influenced mainly by decreasing annualized returns. Another identifiable pattern across the two indexes is the maximum drawdown and skewness values. The strategy aligned the best risk adjusted returns with the lowest maximum drawdown values, while the skewness tends to shift from high positive values (lower signal length) to negative values (higher signal length). From the interpretation of the relatively high skewness values, I can conclude that the strategy was reasonably stable when “making money” presenting occasionally some extreme negative returns. The reductions in the maximum drawdown were substantial, having its peak in the OEX example, where using a 5-day moving average was possible to cut the maximum drawdown value in approximately 80%.

To conclude, VIX and VXO successively reflected investor sentiment, determining consequently market direction on a short/medium term basis. Historically, the relationship between VIX and the behavior of the stock market has repeated itself across

many market cycles, nevertheless this relation seems to be more noteworthy during bull and bear cycles (exhibits its higher peak and lower trough during these periods).

5. Combining Strategies

Having shown that applying trend following rules to equities can improve the risk return characteristics of a certain portfolio, the next logical step is to create a final strategy that combines the signals given by the different sub strategies studied. The objective is to find better predictive signals and consequently improved risk adjusted returns. If for one certain day, two different strategies present the same signal, I interpret it as strong indicator to overweight/underweight the final strategy that specific day. Oppositely, if the two signals are contradictory (e.g. long and short), I stay out of the market. In order, to smooth over-fitting¹² biased returns, instead of using all the strategies signs for each index, I consider only the top 4/5 winners. Furthermore, the following section presents the sub-sample¹³ analysis that re-confirms the good performance of the combining strategy for a shorter period.

Table 7¹⁴ displays the descriptive statistics for the combining strategy performance across the nine indexes studied. Firstly, I recognize how the strategy managed to present Sharpe ratios above one for all the indexes except the MSCI LC PT. Notwithstanding, should be recalled that the Portuguese large cap index performance, from a long only perspective,

¹² Over-fitting occurs when a strategy or a function is too closely fit to a limited set of data. Attempting to make the model conform too closely to slightly inaccurate data can reduce its predictive power.

¹³ The sub-sample analysis refers to the same combining strategy but tested over the period between Jan 2010 and Dec 2013.

¹⁴ For more information on the constituents of the combining strategy, see the description of table 7.

was not only the worst among all indexes, as also exhibited a negative Sharpe ratio. Therefore, despite the non-convincing absolute output, in relative terms the benefits are substantial. From the return/volatility analysis, is possible to take some important conclusions. First, the volatility behavior is clearly more consistent across the three markets, with values varying between 6.3% and 10.78%, while the returns ranged between 8% and 18.76%. Taking into account that for the long only strategy the volatility values were all above 20%, the combining strategy succeed to present smoother returns. Second, the source of better Sharpe ratios was not exclusively the volatility or the returns, but a combination of both. Comparing with the long only strategy performance, is possible to find a pattern where the benefits for the indexes that had relatively high annualized returns (e.g. Russell LC BRL) came from the volatility side, while for the ones that had relatively low returns (e.g. MSCI LC PT), came from both sides. Indeed, the strategy for the Russell SC BRL index, that exhibited by far the best Sharpe ratio (2.10), failed to improve the returns of its long only counterpart. Nevertheless, it reduced the volatility levels in approximately 50%.

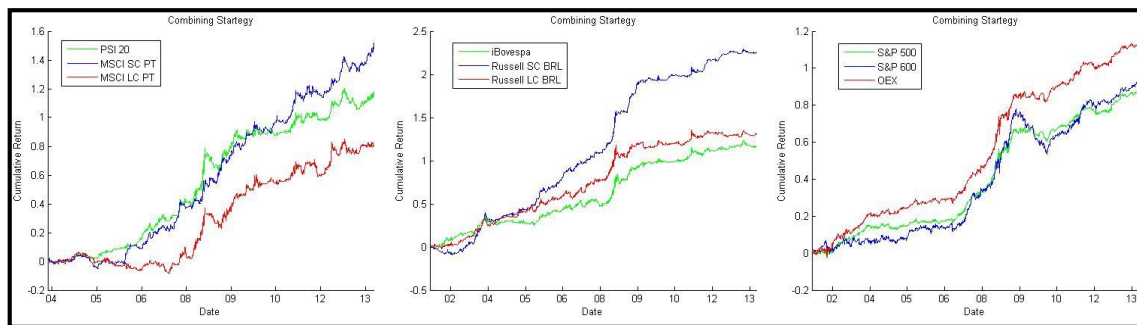


Figure 9 - Final (Combining) strategy across the three markets

The maximum drawdown, an indicator that gains further importance in long-term strategies¹⁵, was also significantly lower with values ranging between 5.57% and 13.94%. From a risk-averse perspective, the strategy brings huge benefits to investors when

¹⁵ Most of the times, investors have difficulties to stick to a certain strategy if drawdown values are substantially high and compromise a huge percentage of the portfolio value.

compared with relatively high drawdown values presented by the long only strategy. These results are a consequence of the good strategy performance across distress periods like the 2008 sub-prime crisis. For last, despite the high kurtosis exhibited by the final strategy, the values are in accordance with the long only strategy ones, since they are clearly conditioned by the January and end-of-the month strategies.

6. Sub-Sample test for the Combining Strategies

In this report, I choose to focus in investment strategies that, using long and short signs, indicate where an investor should move in the market. I will now examine the performance of the Combining (final) strategy for the period between January 2010 and December 2013. Table 8 displays the performance and respective descriptive statistics for the Combining strategy as well the long only strategy applied to the period mentioned before. The universe of indexes and macro variables is the same, as well the methodology used. The goal is to test how the strategy performed within a shorter period and

Panel A - Long Only Strategy - Sub Sample									
	Indexes								
	S&P 500	PSI 20	iBOV	MSCI SC PT	MSCI LC PT	S&P 600	OEX	RUSSELL SC BRL	RUSSELL LC BRL
Annualized Return (%)	12,42%	-8,01%	-7,80%	-0,30%	-5,91%	17,40%	11,77%	9,86%	-3,82%
Annualized Volatility (%)	17,10%	26,70%	21,87%	29,08%	27,04%	23,02%	16,55%	15,41%	18,89%
Sharpe Ratio	0,73	-0,30	-0,36	-0,01	-0,22	0,76	0,71	0,64	-0,20
Max. Daily Return (%)	4,63%	11,02%	4,98%	9,65%	11,75%	6,50%	4,32%	4,23%	4,42%
Min. Daily Return (%)	-6,90%	-7,12%	-8,43%	-9,25%	-7,12%	-8,86%	-6,44%	-7,06%	-8,21%
Maximum Drawdown (%)	18,18%	84,07%	46,36%	99,61%	75,42%	23,91%	17,01%	19,73%	35,09%
Positive Days (%)	54,54%	51,61%	47,80%	52,16%	50,19%	53,73%	55,72%	52,23%	49,81%
Kurtosis	7,52	5,91	5,11	5,48	6,53	6,65	7,19	8,40	6,12
Skew	-0,49	-0,15	-0,27	-0,34	0,02	-0,26	-0,46	-0,61	-0,41
Panel B - Combining Strategies - Sub Sample									
	Indexes								
	S&P 500	PSI 20	iBOV	MSCI SC PT	MSCI LC PT	S&P 600	OEX	RUSSELL SC BRL	RUSSELL LC BRL
Annualized Return (%)	5,54%	8,14%	3,96%	16,44%	8,88%	6,52%	7,14%	7,49%	3,62%
Annualized Volatility (%)	4,90%	9,99%	7,20%	11,27%	11,64%	6,90%	5,07%	6,36%	7,89%
Sharpe Ratio	1,23	0,81	0,55	1,46	0,76	0,94	1,41	1,18	0,46
Max. Daily Return (%)	1,87%	3,02%	5,06%	3,45%	4,11%	2,78%	2,13%	4,23%	6,15%
Min. Daily Return (%)	-1,66%	-4,41%	-2,41%	-4,83%	-7,05%	-2,59%	-1,82%	-2,54%	-2,61%
Maximum Drawdown (%)	5,06%	10,48%	8,14%	7,24%	9,34%	15,51%	5,61%	5,96%	8,11%
Positive Days (%)	38,54%	44,59%	36,29%	36,87%	44,37%	39,80%	37,91%	39,43%	37,21%
Kurtosis	11,84	8,82	22,10	10,99	15,28	9,70	10,56	26,27	30,26
Skew	0,77	-0,34	1,45	-0,51	-0,57	0,60	0,85	1,35	1,79

Table 8: Final (Combining) strategy across the three markets for the Sub Sample period

acknowledge the results without the influence of the 2008 sub-prime crisis, that due to its particular effect in the stock market tends to influence positively the results of the strategy.

Despite the Sharpe ratios of the combining strategy being relatively lower than the ones exhibited previously, it is important to refer that the behavior of the indexes for this period was also poorer, as the several negative annualized returns illustrate. The Portuguese market performance was clearly influenced by the country crisis which started in 2010, while for the Brazilian market the small caps continued its rally in opposition to the main and large indexes that displayed negative Sharpe ratios. The MSCI SC PT was the clear winner during this period moving from negative results to the highest one recorded among all indexes, plus a significant 92,73% reduction in the maximum drawdown level.

More important is to observe that the properties of the combining strategy mentioned in the previous section hold: enhanced risk adjusted returns for all strategies as well significantly drops in the drawdown levels. Once again, is possible to observe how this easy to implement strategy appeals for risk averse investors given the relatively low volatility levels.

7. Conclusion

I have studied the performance of signaling strategies across different equity indexes. I observed how trend following and mean reversion based in past prices improved significantly risk adjusted returns when compared with the index by itself. Furthermore, macroeconomic fluctuations also showed equity predictive properties along the three markets. Inflation, that plays an important role in Brazilian economy, and short-term

interest rates similarly managed to present better Sharpe ratios in relation to the long only strategy, nevertheless these results were constrained by the fact that some data periodicity¹⁶ was not matched. I would suggest testing the latter strategy using equity indexes on a monthly basis for even more improved and significant results.

Calendar market anomalies seem to persist despite the vast literature around them, having its peak in the end-of-the month/turn-of-the-month strategy. Despite the existence of valid explanations, this type of pattern in the market confirms the difficulty in achieving and maintaining the market efficiency hypothesis documented by Fama (1970).

The volatility indexes confirmed the strong predictive property of index options over index future behavior, while the spillover effect of S&P 500 over other countries markets was confirmed for Portugal and Brazil, with clear emphasis in the small cap market.

Besides the improvement in Sharpe ratio terms was possible to identify other type of patterns. The Bovespa index (Brazilian reference index) seems to be driven by its large cap components, confirming “*it’s perverse*” stock weighting as Oliver Leyland (Mirae Asset Global Investments, 2013) quoted. Bovespa heavily weights stocks according to liquidity and market capitalization¹⁷ leading to an increasingly two-tiered approach to the Brazilian market by investors. At the end, the combining strategy behavior for the Russell LC BRL and Bovespa index was very similar, while for other strategies like the CPI or the S&P 500 the returns were incredibly high-correlated (See figure 6 and 8). This leads me to conclude that the small cap market is clearly more attractive to investors than its larger counterpart is.

¹⁶ CPI and interest rates (Brazil) have a monthly periodicity while the rest of the data is on a daily basis.

¹⁷ As of 2013, OGX (market cap of R\$4.9B) had a weighting of 5.06%, while Ambev (market cap of R\$261,6B) had a weighting of 1.62%.

For Portugal, the small cap market was also the clear winner nevertheless the combining strategy applied to the PSI 20 also displayed significant improved risk-adjusted returns, while the opposite happened in the US market (relatively higher performance of the OEX index).

Finally, I examined the strategy performance against a shorter period sample (from 2010 and to 2013) that confirmed the success of the results presented before.

My results show that, combining simple trend following signals in one single strategy, leads to enhanced risk-adjusted returns despite the index used, though the main finding of this work is the source of the improved Sharpe ratios. For the indexes that presented relatively high returns (e.g. Russell LC BRL) the strategy even failed to improve index returns, nevertheless the reductions in the maximum drawdown and volatility were substantial leading to enhanced and smoother risk adjusted returns. Consequently, this type of strategy is a perfect match for very risk-averse investors that look for long-term strategy investments, having the opportunity to engage in higher returns with more acceptable drawdown levels, or in other words, equity like returns with bond like drawdowns and volatility (Faber, 2013).

The assumption of no transaction costs is quite strong¹⁸, mainly in Brazil where these values are considerably high, nonetheless Brazilian asset management companies started to offer these type of indexes to foreign investors¹⁹ and as markets get more integrated these values will move towards lower levels. Furthermore, I should remember the initial goal of this work project: identify equity indexes properties across each country to signal

¹⁸ Table 9 in the appendix presents the results for the combining strategies with transactions costs included

¹⁹ <http://www.ft.com/intl/cms/s/0/acf40c22-c90a-11e2-9d2a-00144feab7de.html#axzz38gdXYyQx>

investors the best way to approach each specific market and achieve higher risk adjusted returns in relation to the referred indexes.

The complexity of the methodology used along this work makes it easier to analyze the impact of this type of strategies along other equity markets. Therefore, it would be interesting to test signaling strategies across other countries equity indexes using other macroeconomic variables that may present higher returns predictive power.

Bibliography

Afonso, Antonio and Teixeira, João. 1999. "Non-Linear Tests of Weakly Efficient Markets: Evidence from Portugal." *Estudos de Economia*, 9(2): 169-187.

Amihud, Yavok, Mendelson, Haim and Pedersen, Lasse. 2005. "Liquidity and Asset Prices." *Foundations and Trends in Finance*, 1(4): 269-364.

Amihudm, Yavok. 2002. "Illiquidity and stock returns: cross-section and time-series effects." *The Journal of Financial Markets*, 5: 31-56.

Banz, Rolf. 1980. "The Relationship between Return and Market Value of Common Stocks." *Journal of Financial Economics*, 9: 3-18.

Bloomberg. 2014. *Bloomberg Professional*. Available at: Nova School of Business and Economics (Accessed: June 5, 2014)

Chaudhuri, Kausik and Wu, Yangru. 2004. "Mean Reversion in Stock Prices: Evidence from Emerging Markets." *Managerial Finance*, 29 (10): 22-37.

Chen, Zhiwu, Ibbotson, Roger, Hu, Wendy and Kim, Daniel. 2010. "Liquidity as an Investment style." *Financial Analysts Journal*, 69(3): 30-44.

Chordia, Tarun, Roll, Richard and Subrahmanyam, Avanidhar. 2007. "Liquidity and market efficiency". *Journal of Financial Economics*, 87: 249-268.

Chuhan, Punam. 1994. "Are institutional investors an important source of portfolio investment in emerging markets?" Policy research working papers 1243

Clare, Andrew, Seaton, James and Smith, Peter N. and Thomas, Steve. 2012. "The Trend is Our Friend: Risk Parity, Momentum and Trend Following in Global Asset Allocation." Discussion papers in economics No.12/25.

Clare, Andrew, Seaton, James and Smith, Peter N. and Thomas, Steve. 2012. "Trend Following, Risk Parity and Momentum in Commodity Futures." Discussion papers in economics No.12/28.

Datar, Vinay, Naik, Narayan and Radcliffe, Robert. 1998. "Liquidity and stock returns: An alternative test." *The Journal of Financial Markets*, 1(2): 203-219.

EID, William. 2005. "Plano Real e a Bolsa de Valores de São Paulo." Msc. diss FGV-EASP/GV.

Faber, Mebane T. 2013. "A Quantitative Approach to Tactical Asset Allocation." *The Journal of Wealth Management*, 9(4): 69-79.

Fama, Eugene. 1970. "Efficient Capital Markets: A Review of Theory and Empirical Work." *The Journal of Finance*, 25(2): 383-417.

Fama, Eugene. 1998. "Market efficiency, long-term returns, and behavioral finance." *Journal of Financial Economics*, Vol.49, pp.283-306.

Farmer, J. and Joshi, Shareen. 2001. "The price dynamics of common trading strategies." *Journal of Economic Behavior & Organization*, 49: 149-171.

French, Kenneth. 1980. "Stock Returns and the Weekend Effect." *Journal of Financial Economics*, 8: 55-69.

Gu, Anthony. 2003. "The declining January effect: evidences from the U.S. equity markets." *The Quarterly Review of Economics and Finance*, 43: 395-404.

Hersen, Amarildo, Lima, Luciano and Lima, Jandir. 2013. "Evidências empíricas da influência da taxa média de juros sobre o mercado acionário brasileiro." *Gestão e Regionalidade*, 29(85): 77-92.

Jegadeesh, Narasimhan and Titman, Sheridan. 1993. "Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency." *The Journal of Finance*, 48(1): 65-91.

Kunkel, Robert, Compton, William and Beyer, Scott. 2003. "The turn-of-the-month effect still lives: the international evidence." *International Review of Financial Analysis*, 12: 207-221.

Lefèvre, Edwin. 1923. *Reminiscences of a Stock Operator*. New York: The Sun Dial Press.

Lesmond, David, Schill, Michael and Zhou, Chunsheng. 2002. "The illusory nature of momentum profits." *The Journal of Financial Economics*, 71: 349-380.

Medeiros, Otavio. 2005. "Reaction of the Brazilian Stock Market to Positive and Negative Shocks." *Progress in economics research*, 14: 231-247.

Nikkinen, Jussi, Sahlstrom, Petri and Äijö, Janne. 2006. "Turn-of-the-month and intramonth effects: Explanation from the important macroeconomic news announcements." *Journal of Futures markets*, 27(2): 105-126.

Passos, Bruno, Junior, Tabajara and Gaio, Luís. 2014. "The Influence of American Stock Markets on the Brazilian Stock Market." *Asian Journal of business and Management Sciences*, 3(5): 1-16.

Scott, Robert and Horvath, Philip. 1980. "On The Direction of Preference for Moments of Higher Order Than the Variance." *The Journal of Finance*, 35(4): 915-919.

Sharpe, Steven. 2002. "Reexamining stock valuation and inflation: The implication of analysts earnings forecast." *Review of economics and statistics*, 84: 632-648.

Silva, P. 2010. "Calendar "anomalies" in the Portuguese stock market." *Investment Analysis Journal*, 71: 37-50.

Sirucek, Martin. 2012. "Macroeconomic variables and stock market: US review." *International journal of computer science and management studies*, 12 (3): 2231-5268.

Soares, João and Serra, Ana. 2005. "Overreaction and Underreaction: Evidence for the Portuguese stock market." *Cadernos de Valores Mobiliários*, 22.

Thaler, Richard. 1987. "Anomalies: Seasonal Movements in Security Prices II: Weekend, Holiday, Turn of the Month and Intraday Effects." *The Journal of Economic Perspectives*, 1(2): 169-177.

Thaler, Richard. 1987. "The January Effect." *The Journal of Economic Perspectives*, 1(1): 197-201.

Appendix

Table 1: Pure Trend Following within each country indexes (2002-2013)

This table presents the descriptive statistics of portfolios formed on the basis of each country index trend following properties. The portfolio statistics were generated by applying trend following filters based on past prices using multiple moving averages length. Panel A, B and C represent the US indexes; Panel D, E and F represent the Portuguese indexes; Panel G, H and I represent the Brazilian indexes. For the Portuguese indexes, the testing period is from Jan 2004 to Dec 2013 due to the lack of available data. The performance statistics of all portfolios are based on a daily rebalancing.

Panel A - S&P 500							Panel B - OEX						
	Index	Trend Following(signal length, days)						Index	Trend Following(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	3,91%	-18,50%	0,20%	3,89%	4,00%	4,27%	Annualized Return (%)	2,80%	-18,57%	-22,00%	1,98%	0,53%	1,01%
Annualized Volatility (%)	20,89%	20,87%	20,92%	20,96%	20,95%	20,27%	Annualized Volatility (%)	20,63%	20,61%	20,60%	20,68%	20,65%	19,85%
Sharpe Ratio	0,1874	-0,887	0,010	0,186	0,196	0,211	Sharpe Ratio	0,1358	-0,901	-0,107	0,096	0,026	0,051
Maximum Drawdown (%)	64,00%	100,00%	100,00%	100,00%	100,00%	100,00%	Maximum Drawdown (%)	67,00%	100,00%	100,00%	100,00%	100,00%	100,00%
Positive Days (%)	54,00%	47,00%	49,00%	49,00%	50,00%	51,00%	Positive Days (%)	53,00%	48,42%	50,00%	51,00%	51,00%	51,00%
Kurtosis	12,15	12,03	12,16	12,19	12,30	13,95	Kurtosis	11,84	11,70	11,88	11,92	12,04	13,81
Skew	-0,21	-0,68	0,05	0,02	0,01	0,03	Skew	-0,14	-0,68	0,00	-0,05	-0,03	0,00
Panel C - S&P 600							Panel D - PSI 20						
	Index	Trend Following(signal length, days)						Index	Trend Following(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	8,96%	-14,44%	-5,72%	5,53%	5,14%	1,71%	Annualized Return (%)	2,01%	14,59%	22,42%	25,23%	24,68%	13,78%
Annualized Volatility (%)	24,98%	24,98%	25,00%	25,12%	25,19%	24,98%	Annualized Volatility (%)	23,17%	23,16%	23,19%	23,26%	23,33%	23,54%
Sharpe Ratio	0,3588	-0,578	-0,228	0,220	0,204	0,069	Sharpe Ratio	0,0869	0,630	0,967	1,085	1,058	0,585
Maximum Drawdown (%)	54,00%	100,00%	100,00%	100,00%	100,00%	100,00%	Maximum Drawdown (%)	64,27%	19,64%	28,01%	33,00%	32,00%	32,00%
Positive Days (%)	53,00%	49,00%	50,00%	51,00%	52,00%	52,00%	Positive Days (%)	52,00%	52,00%	52,00%	53,00%	53,00%	53,00%
Kurtosis	7,81	7,74	7,78	7,74	7,74	8,20	Kurtosis	10,19	10,21	10,22	10,20	10,16	10,31
Skew	-0,30	-0,32	0,14	0,17	0,08	0,07	Skew	-0,19	0,02	0,04	0,00	0,05	-0,11
Panel E - PSI 20 Large Cap							Panel F - PSI 20 Small cap						
	Index	Trend Following(signal length, days)						Index	Trend Following(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	-2,56%	-3,89%	1,70%	4,58%	11,41%	4,58%	Annualized Return (%)	2,34%	32,15%	29,64%	24,26%	28,77%	14,14%
Annualized Volatility (%)	26,83%	23,81%	26,81%	26,80%	26,86%	27,32%	Annualized Volatility (%)	25,99%	25,91%	25,91%	25,88%	25,93%	26,53%
Sharpe Ratio	-0,0954	-0,145	0,064	0,171	0,425	0,168	Sharpe Ratio	0,0902	1,241	1,144	0,937	1,109	0,533
Maximum Drawdown (%)	83,00%	96,60%	68,00%	66,00%	76,00%	72,00%	Maximum Drawdown (%)	85,00%	20,00%	14,77%	15,76%	20,00%	55,00%
Positive Days (%)	50,00%	48,61%	50,00%	50,00%	50,00%	50,00%	Positive Days (%)	51,00%	52,00%	53,00%	52,18%	52,71%	50,00%
Kurtosis	13,77	13,79	13,93	14,08	14,05	14,01	Kurtosis	7,57	7,60	7,70	7,76	7,78	7,60
Skew	0,38	-0,53	-0,50	-0,47	0,33	-0,51	Skew	-0,25	0,08	-0,09	0,06	-0,07	-0,37
Panel G - Ibovespa							Panel H - Bovespa Large Cap						
	Index	Trend Following(signal length, days)						Index	Trend Following(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	10,89%	-1,70%	11,38%	11,53%	6,36%	8,72%	Annualized Return (%)	11,15%	3,60%	11,38%	10,46%	10,57%	3,87%
Annualized Volatility (%)	29,02%	29,00%	29,00%	29,00%	29,00%	28,64%	Annualized Volatility (%)	26,15%	26,16%	26,20%	26,23%	26,32%	26,13%
Sharpe Ratio	0,3752	-0,059	0,392	0,397	0,219	0,305	Sharpe Ratio	0,4266	0,138	0,434	0,399	0,401	0,148
Maximum Drawdown (%)	53,97%	94,00%	70,00%	67,00%	66,00%	70,00%	Maximum Drawdown (%)	34,94%	53,00%	51,27%	41,43%	49,17%	47,49%
Positive Days (%)	53,00%	48,00%	49,44%	49,00%	49,00%	50,00%	Positive Days (%)	50,00%	48,00%	49,79%	49,43%	50,00%	49,63%
Kurtosis	7,88	7,85	7,90	7,95	7,98	8,50	Kurtosis	9,12	9,12	9,11	9,14	9,11	9,53
Skew	-0,10	-0,48	-0,05	-0,03	-0,09	-0,18	Skew	-0,10	-0,50	-0,08	-0,02	-0,08	-0,16
Panel I - Bovespa Small cap													
	Index	Trend Following(signal length, days)						Index	Trend Following(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	19,82%	23,57%	30,73%	26,46%	27,37%	26,02%							
Annualized Volatility (%)	21,61%	21,60%	21,59%	21,59%	21,61%	21,31%							
Sharpe Ratio	0,9172	1,091	1,423	1,225	1,266	1,221							
Maximum Drawdown (%)	34,00%	37,29%	45,00%	33,62%	23,77%	20,38%							
Positive Days (%)	53,00%	51,00%	52,00%	52,00%	52,00%	53,00%							
Kurtosis	8,38	8,29	8,26	8,34	8,38	9,04							
Skew	-0,49	0,02	0,22	0,17	0,12	-0,06							

Table 2: Pure Mean Reverting within each country indexes (2002-2013)

This table presents the descriptive statistics of portfolios formed on the basis of each country index mean reverting properties. The portfolio statistics were generated by applying mean reverting filters based on past prices using multiple moving averages length. Panel A, B and C represent the US indexes; Panel D, E and F represent the Portuguese indexes; Panel G, H and I represent the Brazilian indexes. For the Portuguese indexes, the testing period is from Jan 2004 to Dec 2013 due to the lack of available data. The performance statistics of all portfolios are based on a daily rebalancing.

Panel A - S&P 500							Panel B - OEX						
	Index	Mean Reversion (signal length, days)						Index	Mean Reversion (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	3,91%	11,67%	3,93%	1,86%	-0,78%	-4,46%	Annualized Return (%)	2,80%	15,02%	5,50%	1,94%	1,30%	-0,06%
Annualized Volatility (%)	20,89%	13,96%	15,98%	16,77%	17,28%	17,31%	Annualized Volatility (%)	20,63%	14,26%	15,96%	16,50%	17,21%	16,77%
Sharpe Ratio	0,1874	0,836	0,246	0,111	-0,045	-0,257	Sharpe Ratio	0,1358	1,053	0,344	0,118	0,075	-0,037
Maximum Drawdown (%)	64,00%	14,00%	21,00%	33,00%	37,00%	77,00%	Maximum Drawdown (%)	67,00%	13,32%	23,00%	29,00%	33,00%	50,00%
Positive Days (%)	54,00%	24,00%	28,00%	29,00%	29,00%	30,00%	Positive Days (%)	53,00%	24,00%	30,00%	30,00%	30,00%	30,00%
Kurtosis	12,15	32,20	24,97	23,39	23,23	23,85	Kurtosis	11,84	34,92	23,23	21,22	22,43	24,60
Skew	-0,21	-0,08	0,41	0,13	-0,09	-0,04	Skew	-0,14	1,83	0,55	0,45	0,03	0,07
Panel C - S&P 600							Panel D - PSI 20						
	Index	Mean Reversion (signal length, days)						Index	Mean Reversion (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	8,96%	10,00%	2,93%	1,83%	1,40%	-4,86%	Annualized Return (%)	2,01%	-13,68%	-20,35%	-19,35%	-2,22%	-15,12%
Annualized Volatility (%)	24,98%	16,94%	18,85%	19,29%	20,33%	20,31%	Annualized Volatility (%)	23,17%	16,47%	18,57%	19,38%	17,98%	19,47%
Sharpe Ratio	0,3588	0,595	0,155	0,095	0,069	-0,239	Sharpe Ratio	0,0869	-0,831	-1,096	-0,998	-0,123	-0,777
Maximum Drawdown (%)	54,00%	21,00%	33,00%	50,00%	38,00%	86,00%	Maximum Drawdown (%)	64,27%	100,00%	100,00%	100,00%	100,00%	100,00%
Positive Days (%)	53,00%	25,00%	29,00%	29,00%	30,00%	30,00%	Positive Days (%)	52,00%	23,00%	27,00%	29,00%	16,00%	27,00%
Kurtosis	7,81	19,41	14,77	13,84	14,75	14,88	Kurtosis	10,19	23,89	19,72	18,67	25,40	18,89
Skew	-0,30	0,57	-0,12	-0,05	-0,20	-0,05	Skew	-0,19	-0,27	-0,05	-0,08	0,09	0,12
Panel E - PSI 20 Large Cap							Panel F - PSI 20 Small cap						
	Index	Mean Reversion (signal length, days)						Index	Mean Reversion (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	-2,56%	-0,84%	-3,80%	-5,90%	-9,25%	-10,84%	Annualized Return (%)	2,34%	-15,28%	-25,52%	-30,67%	-23,97%	-16,74%
Annualized Volatility (%)	26,83%	18,42%	21,01%	21,13%	21,72%	23,13%	Annualized Volatility (%)	25,99%	18,37%	21,32%	21,65%	21,43%	21,64%
Sharpe Ratio	-0,0954	-0,046	-0,181	-0,279	-0,426	-0,469	Sharpe Ratio	0,0902	-0,832	-1,197	-1,417	-1,119	-0,774
Maximum Drawdown (%)	83,00%	47,00%	66,00%	87,00%	100,00%	100,00%	Maximum Drawdown (%)	85,00%	100,00%	100,00%	100,00%	100,00%	100,00%
Positive Days (%)	50,00%	24,00%	26,00%	28,00%	28,00%	31,00%	Positive Days (%)	51,00%	23,00%	27,00%	26,71%	26,00%	26,00%
Kurtosis	13,77	24,73	32,15	22,20	20,95	17,81	Kurtosis	7,57	16,54	13,87	13,67	13,57	12,62
Skew	0,38	-0,21	-0,14	0,13	0,17	0,22	Skew	-0,25	0,11	0,10	-0,02	0,09	0,34
Panel G - Ibovespa							Panel H - Bovespa Large Cap						
	Index	Mean Reversion (signal length, days)						Index	Mean Reversion (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	10,89%	0,27%	-2,35%	-10,40%	-11,42%	-8,31%	Annualized Return (%)	11,15%	-6,27%	-0,69%	-6,83%	-10,24%	-9,11%
Annualized Volatility (%)	29,02%	19,63%	22,68%	23,29%	23,60%	23,37%	Annualized Volatility (%)	26,15%	17,82%	20,41%	21,11%	21,78%	21,17%
Sharpe Ratio	0,3752	0,014	-0,104	-0,446	-0,484	-0,356	Sharpe Ratio	0,4266	-0,352	-0,339	-0,324	-0,470	-0,430
Maximum Drawdown (%)	53,97%	44,00%	60,00%	100,00%	100,00%	100,00%	Maximum Drawdown (%)	34,94%	94,00%	85,00%	100,00%	100,00%	100,00%
Positive Days (%)	53,00%	23,00%	29,00%	28,00%	28,00%	26,00%	Positive Days (%)	50,00%	22,00%	27,00%	28,00%	27,00%	25,00%
Kurtosis	7,88	22,06	15,60	15,79	15,80	16,75	Kurtosis	9,12	24,87	18,18	17,16	17,01	18,99
Skew	-0,10	1,11	0,27	0,11	0,07	0,19	Skew	-0,10	1,08	0,39	0,24	0,04	0,14
Panel I - Bovespa Small cap													
	Index	Mean Reversion (signal length, days)											
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	19,82%	-17,46%	-24,19%	-28,23%	-24,53%	-24,68%							
Annualized Volatility (%)	21,61%	15,41%	17,46%	17,84%	17,90%	17,79%							
Sharpe Ratio	0,9172	-1,133	-1,386	-1,583	-1,370	-1,387							
Maximum Drawdown (%)	34,00%	100,00%	100,00%	100,00%	100,00%	100,00%							
Positive Days (%)	53,00%	20,00%	27,00%	27,00%	27,00%	29,00%							
Kurtosis	8,38	20,04	14,59	15,11	14,95	15,49							
Skew	-0,49	-0,09	-0,38	-0,39	-0,32	-0,23							

Table 3: Calendar Anomalies strategy within each country indexes (2002-2013)

This table presents the descriptive statistics of portfolios formed on the basis of each country index calendar market anomalies. The portfolio statistics were generated by applying daily filters based on a certain calendar characteristic. In the Weekend/Monday effect, I short the index in the previous Friday. For the January effect, I go long in the first week of January every year. The end of the month strategy is obtained by going long from the 25th day of the month until the 1st day of the next month. Panel A, B and C represent the US indexes; Panel D, E and F represent the Portuguese indexes; Panel G, H and I represent the Brazilian indexes. For the Portuguese indexes, the testing period is from Jan 2004 to Dec 2013 due to the lack of available data. The performance statistics of all portfolios are based on a daily rebalancing.

Panel A - S&P 500					Panel B - OEX				
	Index	Anomalies				Index	Anomalies		
		Weekend	January	End of the month			Weekend	January	End of the month
Annualized Return (%)	3,91%	1,95%	1,23%	6,01%	Annualized Return (%)	2,80%	1,38%	0,98%	4,89%
Annualized Volatility (%)	20,89%	10,11%	2,14%	10,49%	Annualized Volatility (%)	20,63%	10,47%	2,03%	10,44%
Sharpe Ratio	0,1874	0,19	0,57	0,57	Sharpe Ratio	0,1358	0,13	0,48	0,47
Maximum Drawdown (%)	64,00%	20,03%	3,98%	11,56%	Maximum Drawdown (%)	67,00%	22,53%	3,71%	16,82%
Positive Days (%)	54,00%	18,00%	2,00%	24,00%	Positive Days (%)	53,00%	19,00%	2,00%	23,00%
Kurtosis	12,15	85,55	349,45	58,49	Kurtosis	11,84	70,56	403,93	58,42
Skew	-0,21	0,36	12,20	-0,24	Skew	-0,14	0,56	13,71	-0,19
Panel C - S&P 600					Panel D - PSI 20				
	Index	Anomalies				Index	Anomalies		
		Weekend	January	End of the month			Weekend	January	End of the month
Annualized Return (%)	8,96%	2,08%	0,57%	9,07%	Annualized Return (%)	2,01%	2,04%	0,76%	6,56%
Annualized Volatility (%)	24,98%	12,36%	2,16%	12,63%	Annualized Volatility (%)	23,17%	11,37%	2,28%	10,90%
Sharpe Ratio	0,3588	0,17	0,26	0,72	Sharpe Ratio	0,0869	0,18	0,33	0,6
Maximum Drawdown (%)	54,00%	30,84%	6,54%	15,47%	Maximum Drawdown (%)	64,27%	30,11%	4,94%	17,17%
Positive Days (%)	53,00%	19,00%	2,00%	24,00%	Positive Days (%)	52,00%	19,00%	2,00%	24,00%
Kurtosis	7,81	45,93	284,75	32,05	Kurtosis	10,19	79,11	235,6	34,25
Skew	-0,30	1,36	1,62	-0,64	Skew	-0,19	0,41	3,61	1,21
Panel E - PSI 20 Large Cap					Panel F - PSI 20 Small cap				
	Index	Anomalies				Index	Anomalies		
		Weekend	January	End of the month			Weekend	January	End of the month
Annualized Return (%)	-2,56%	2,01%	1,27%	8,80%	Annualized Return (%)	2,34%	-2,87%	-0,77%	5,20%
Annualized Volatility (%)	26,83%	12,97%	2,65%	12,68%	Annualized Volatility (%)	25,99%	13,04%	4,33%	12,60%
Sharpe Ratio	-0,0954	0,16	0,48	0,69	Sharpe Ratio	0,0902	-0,22	-0,18	0,41
Maximum Drawdown (%)	83,00%	35,99%	3,52%	17,43%	Maximum Drawdown (%)	85,00%	58,90%	11,45%	19,73%
Positive Days (%)	50,00%	14,00%	5,00%	17,00%	Positive Days (%)	51,00%	13,00%	1,00%	17,00%
Kurtosis	13,77	75,89	297,56	50,12	Kurtosis	7,57	43,76	656,54	26,42
Skew	0,38	0,49	-7,65	2,46	Skew	-0,25	-0,96	-19,08	-0,65
Panel G - Ibovespa					Panel H - Bovespa Large Cap				
	Index	Anomalies				Index	Anomalies		
		Weekend	January	End of the month			Weekend	January	End of the month
Annualized Return (%)	10,89%	4,46%	1,90%	16,76%	Annualized Return (%)	11,15%	2,62%	1,67%	15,76%
Annualized Volatility (%)	29,02%	14,34%	3,91%	14,74%	Annualized Volatility (%)	26,15%	12,89%	3,66%	13,34%
Sharpe Ratio	0,3752	0,31	0,49	1,14	Sharpe Ratio	0,4266	0,2	0,46	1,18
Maximum Drawdown (%)	53,97%	21,41%	9,57%	10,32%	Maximum Drawdown (%)	34,94%	23,36%	10,11%	10,24%
Positive Days (%)	53,00%	19,00%	2,00%	25,00%	Positive Days (%)	50,00%	19,00%	2,00%	28,00%
Kurtosis	7,88	45,38	351,11	30,34	Kurtosis	9,12	54,17	400,95	32,02
Skew	-0,10	-0,12	11,33	0,78	Skew	-0,10	-0,04	11,90	0,82
Panel I - Bovespa Small cap									
	Index	Anomalies				Index	Anomalies		
		Weekend	January	End of the month			Weekend	January	End of the month
Annualized Return (%)	19,82%	4,21%	1,73%	17,18%					
Annualized Volatility (%)	21,61%	10,82%	2,73%	10,80%					
Sharpe Ratio	0,9172	0,39	0,63	1,59					
Maximum Drawdown (%)	34,00%	22,05%	5,41%	10,31%					
Positive Days (%)	53,00%	20,00%	3,00%	29,00%					
Kurtosis	8,38	52,71	318,49	25,81					
Skew	-0,49	1,42	12,59	-0,28					

Table 4: Consumer Price index strategy within each country indexes (2002-2013)

This table presents the descriptive statistics of portfolios formed on the basis of each country index CPI properties. The portfolio statistics were generated by applying CPI filters based on past prices using multiple moving averages length. The contrarian effect of CPI in the stock market leads me to go long when the CPI is relatively low and short when the CPI is relatively high. Panel A, B and C represent the US indexes; Panel D, E and F represent the Portuguese indexes; Panel G, H and I represent the Brazilian indexes. For the Portuguese indexes, the testing period is from Jan 2004 to Dec 2013 due to the lack of available data. The performance statistics of all portfolios are based on a daily rebalancing.

Panel A - S&P 500							Panel B - OEX						
	Index	CPI (signal length, days)					Index	CPI (signal length, days)					
		5	30	60	90	250		5	30	60	90	250	
Annualized Return (%)	3,91%	-	2,83%	5,03%	5,05%	11,28%	Annualized Return (%)	2,80%	-	2,60%	6,17%	5,08%	10,32%
Annualized Volatility (%)	20,89%	-	20,84%	20,96%	20,95%	20,26%	Annualized Volatility (%)	20,63%	-	20,57%	20,66%	20,65%	19,84%
Sharpe Ratio	0,1874	-	0,136	0,240	0,241	0,557	Sharpe Ratio	0,1358	-	0,127	0,299	0,246	0,520
Maximum Drawdown (%)	64,00%	-	56,69%	38,00%	42,42%	40,00%	Maximum Drawdown (%)	67,00%	-	56,09%	34,28%	41,82%	38,11%
Positive Days (%)	54,00%	-	49,60%	49,73%	49,50%	49,72%	Positive Days (%)	53,00%	-	50,74%	51,66%	50,92%	51,37%
Kurtosis	12,15	-	12,35	12,19	12,29	13,99	Kurtosis	11,84	-	12,06	11,95	12,04	13,85
Skew	-0,21	-	-0,17	-0,09	-0,09	-0,08	Skew	-0,14	-	-0,14	0,18	0,24	-0,11
Panel C - S&P 600							Panel D - PSI 20						
	Index	CPI (signal length, days)					Index	CPI (signal length, days)					
		5	30	60	90	250		5	30	60	90	250	
Annualized Return (%)	8,96%	-	5,34%	7,17%	7,07%	11,37%	Annualized Return (%)	2,01%	-	3,54%	-1,48%	10,35%	19,62%
Annualized Volatility (%)	24,98%	-	24,96%	25,09%	25,19%	24,97%	Annualized Volatility (%)	23,17%	-	23,23%	23,31%	23,37%	23,52%
Sharpe Ratio	0,3588	-	0,214	0,286	0,281	0,456	Sharpe Ratio	0,0869	-	0,153	-0,063	0,443	0,834
Maximum Drawdown (%)	54,00%	-	52,77%	38,60%	44,89%	35,36%	Maximum Drawdown (%)	64,27%	-	44,55%	61,18%	71,23%	75,70%
Positive Days (%)	53,00%	-	50,87%	50,78%	50,38%	50,83%	Positive Days (%)	52,00%	-	50,33%	49,87%	51,51%	52,66%
Kurtosis	7,81	-	7,89	7,79	7,75	8,21	Kurtosis	10,19	-	10,17	10,14	10,16	10,31
Skew	-0,30	-	-0,28	-0,20	-0,12	-0,04	Skew	-0,19	-	0,00	-0,12	0,09	0,02
Panel E - PSI 20 Large Cap							Panel F - PSI 20 Small cap						
	Index	CPI (signal length, days)					Index	CPI (signal length, days)					
		5	30	60	90	250		5	30	60	90	250	
Annualized Return (%)	-2,56%	-	-5,18%	-3,08%	3,93%	10,02%	Annualized Return (%)	2,34%	-	-3,37%	1,28%	12,40%	24,08%
Annualized Volatility (%)	26,83%	-	26,80%	26,80%	26,87%	27,32%	Annualized Volatility (%)	25,99%	-	25,98%	25,92%	25,98%	26,50%
Sharpe Ratio	-0,0954	-	-0,193	-0,115	0,146	0,367	Sharpe Ratio	0,0902	-	-0,130	0,050	0,477	0,909
Maximum Drawdown (%)	83,00%	-	71,89%	71,04%	75,79%	77,50%	Maximum Drawdown (%)	85,00%	-	74,51%	57,03%	75,57%	82,59%
Positive Days (%)	50,00%	-	49,39%	49,73%	50,00%	52,00%	Positive Days (%)	51,00%	-	49,54%	49,92%	51,49%	52,00%
Kurtosis	13,77	-	13,90	14,03	14,08	14,05	Kurtosis	7,57	-	7,62	7,72	7,75	7,63
Skew	0,38	-	-0,17	-0,89	-0,28	-0,56	Skew	-0,25	-	-0,12	-0,29	-0,25	-0,26
Panel G - Ibovespa							Panel H - Bovespa Large Cap						
	Index	CPI (signal length, days)					Index	CPI (signal length, days)					
		5	30	60	90	250		5	30	60	90	250	
Annualized Return (%)	10,89%	-	6,49%	13,82%	16,59%	14,99%	Annualized Return (%)	11,15%	-	8,54%	12,13%	15,16%	13,90%
Annualized Volatility (%)	29,02%	-	29,05%	29,05%	29,07%	28,63%	Annualized Volatility (%)	26,15%	-	26,20%	26,23%	26,31%	26,12%
Sharpe Ratio	0,3752	-	0,223	0,476	0,571	0,524	Sharpe Ratio	0,4266	-	0,326	0,463	0,576	0,532
Maximum Drawdown (%)	53,97%	-	76,07%	68,21%	60,35%	56,33%	Maximum Drawdown (%)	34,94%	-	48,38%	52,85%	41,04%	40,23%
Positive Days (%)	53,00%	-	47,89%	48,84%	48,92%	48,40%	Positive Days (%)	50,00%	-	48,59%	49,20%	49,55%	49,46%
Kurtosis	7,88	-	7,91	7,95	7,99	8,51	Kurtosis	9,12	-	9,11	9,13	9,11	9,54
Skew	-0,10	-	-0,11	0,03	-0,05	-0,05	Skew	-0,10	-	-0,06	0,10	0,02	0,02
Panel I - Bovespa Small cap													
	Index	CPI (signal length, days)						Index	CPI (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	19,82%	-	11,39%	15,38%	22,47%	27,00%							
Annualized Volatility (%)	21,61%	-	21,65%	21,63%	21,63%	21,31%							
Sharpe Ratio	0,9172	-	0,526	0,711	1,039	1,267							
Maximum Drawdown (%)	34,00%	-	56,05%	57,54%	53,44%	59,04%							
Positive Days (%)	53,00%	-	49,27%	49,10%	49,95%	51,34%							
Kurtosis	8,38	-	8,27	8,36	8,36	8,97							
Skew	-0,49	-	0,07	-0,02	0,18	0,17							

Table 5: Short-term interest rate strategy within each country indexes (2002-2013)

This table presents the descriptive statistics of portfolios formed on the basis of each country index interest rate properties. The portfolio statistics were generated by applying short-term interest rate filters based on past prices using multiple moving averages length. The contrarian effect of interest rates in the stock market leads me to go long when the short-term interest rate is relatively low and short when the short-term interest rate is relatively high. Panel A, B and C represent the US indexes; Panel D, E and F represent the Portuguese indexes; Panel G, H and I represent the Brazilian indexes. For the Portuguese indexes, the testing period is from Jan 2004 to Dec 2013 due to the lack of available data. The performance statistics of all portfolios are based on a daily rebalancing.

Panel A - S&P 500							Panel B - OEX						
	Index	3 month bond (signal length, days)						Index	3 month bond (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	3,91%	3,89%	9,85%	5,09%	3,43%	-4,95%	Annualized Return (%)	2,80%	4,49%	8,31%	4,99%	3,85%	-3,46%
Annualized Volatility (%)	20,89%	13,67%	14,76%	15,74%	16,18%	17,46%	Annualized Volatility (%)	20,63%	13,44%	14,74%	15,47%	16,00%	17,31%
Sharpe Ratio	0,1874	0,285	0,668	0,323	0,212	-0,283	Sharpe Ratio	0,1358	0,334	0,563	0,323	0,241	-0,200
Maximum Drawdown (%)	64,00%	23,31%	28,62%	28,98%	26,66%	70,06%	Maximum Drawdown (%)	67,00%	20,37%	25,62%	24,34%	25,14%	58,00%
Positive Days (%)	54,00%	21,46%	25,92%	27,15%	27,62%	31,64%	Positive Days (%)	53,00%	21,92%	26,42%	28,14%	28,70%	33,10%
Kurtosis	12,15	29,92	24,87	26,48	28,00	23,07	Kurtosis	11,84	30,03	25,19	25,84	27,23	22,33
Skew	-0,21	1,52	0,88	-0,33	-0,07	-0,40	Skew	-0,14	1,65	0,53	-0,29	0,28	-0,23
Panel C - S&P 600							Panel D - PSI 20						
	Index	3 month bond (signal length, days)						Index	6 month bond (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	8,96%	5,15%	5,03%	3,34%	3,21%	-3,90%	Annualized Return (%)	2,01%	1,74%	1,10%	4,43%	-0,50%	5,23%
Annualized Volatility (%)	24,98%	16,21%	17,86%	18,38%	18,88%	21,08%	Annualized Volatility (%)	23,17%	15,84%	19,03%	19,26%	19,33%	21,33%
Sharpe Ratio	0,3588	0,318	0,282	0,182	0,170	-0,185	Sharpe Ratio	0,0869	0,110	0,058	0,230	-0,026	0,245
Maximum Drawdown (%)	54,00%	27,59%	36,29%	38,17%	41,64%	75,61%	Maximum Drawdown (%)	64,27%	56,24%	70,23%	73,09%	88,44%	66,99%
Positive Days (%)	53,00%	21,86%	25,89%	27,36%	28,57%	32,78%	Positive Days (%)	52,00%	22,02%	27,15%	29,35%	28,62%	33,13%
Kurtosis	7,81	14,67	17,87	17,73	17,07	13,79	Kurtosis	10,19	22,10	21,71	21,54	20,90	12,93
Skew	-0,30	0,68	0,00	-0,61	-0,46	-0,51	Skew	-0,19	-0,16	-0,11	-0,12	-0,29	0,23
Panel E - PSI 20 Large Cap							Panel F - PSI 20 Small cap						
	Index	6 month bond (signal length, days)						Index	6 month bond (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	-2,56%	14,94%	2,47%	3,91%	2,41%	2,70%	Annualized Return (%)	2,34%	7,72%	3,95%	6,08%	8,61%	14,82%
Annualized Volatility (%)	26,83%	18,75%	20,72%	20,99%	21,21%	23,96%	Annualized Volatility (%)	25,99%	18,03%	19,92%	20,62%	20,94%	21,82%
Sharpe Ratio	-0,0954	0,797	0,119	0,186	0,114	0,113	Sharpe Ratio	0,0902	0,428	0,198	0,295	0,411	0,679
Maximum Drawdown (%)	83,00%	19,02%	86,87%	77,82%	80,86%	67,15%	Maximum Drawdown (%)	85,00%	41,90%	65,26%	63,30%	47,11%	55,68%
Positive Days (%)	50,00%	22,03%	28,15%	29,40%	29,31%	33,97%	Positive Days (%)	51,00%	21,33%	27,63%	29,15%	28,98%	34,18%
Kurtosis	13,77	40,38	24,20	23,43	22,25	19,80	Kurtosis	7,57	20,74	15,59	14,68	14,88	11,38
Skew	0,38	1,95	-0,28	-0,21	-0,32	-0,17	Skew	-0,25	0,38	0,10	0,18	0,41	0,68
Panel G - Ibovespa							Panel H - Bovespa Large Cap						
	Index	Selic (signal length, days)						Index	Selic (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	10,89%	-	8,63%	13,59%	15,89%	16,98%	Annualized Return (%)	11,15%	-	7,33%	10,95%	14,32%	15,58%
Annualized Volatility (%)	29,02%	-	16,57%	22,56%	24,83%	25,91%	Annualized Volatility (%)	26,15%	-	14,93%	20,50%	22,65%	23,54%
Sharpe Ratio	0,3752	-	0,521	0,602	0,640	0,655	Sharpe Ratio	0,4266	-	0,491	0,534	0,632	0,662
Maximum Drawdown (%)	53,97%	-	55,75%	65,40%	67,65%	67,75%	Maximum Drawdown (%)	34,94%	-	42,03%	38,11%	36,32%	41,32%
Positive Days (%)	53,00%	-	17,52%	31,67%	35,82%	37,75%	Positive Days (%)	50,00%	-	17,75%	31,93%	36,60%	38,89%
Kurtosis	7,88	-	17,99	12,85	12,16	11,73	Kurtosis	9,12	-	20,84	15,27	13,71	13,14
Skew	-0,10	-	0,28	-0,01	-0,07	-0,05	Skew	-0,10	-	0,37	0,03	-0,02	0,03
Panel I - Bovespa Small cap													
	Index	Selic (signal length, days)						Index	Selic (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	19,82%	-	11,05%	18,68%	22,28%	20,76%							
Annualized Volatility (%)	21,61%	-	12,32%	17,44%	18,88%	19,43%							
Sharpe Ratio	0,9172	-	0,897	1,071	1,180	1,068							
Maximum Drawdown (%)	34,00%	-	32,73%	31,08%	37,93%	39,23%							
Positive Days (%)	53,00%	-	17,95%	33,01%	37,66%	39,76%							
Kurtosis	8,38	-	23,73	14,33	12,78	11,96							
Skew	-0,49	-	0,54	0,03	0,09	0,16							

Table 6: Volatility index and S&P 500 spillover effect strategy within each country indexes (2002-2013)

This table presents the descriptive statistics of portfolios formed on the basis of Portuguese and Brazilian indexes S&P 500 market spillover properties, and the US indexes VIX properties. The portfolio statistics were generated by applying trend following filters based on S&P 500 and the volatility indexes past prices using multiple moving averages length. Panel A, B and C represent the US indexes and respective test against the volatility indexes; Panel D, E and F represent the Portuguese indexes tested against the S&P 500 price behavior; Panel G, H and I represent the Brazilian indexes also tested against the S&P 500 price behavior. For the Portuguese indexes, the testing period is from Jan 2004 to Dec 2013 due to the lack of available data. The performance statistics of all portfolios are based on a daily rebalancing.

Panel A - S&P 500							Panel B - OEX						
	Index	VIX (signal length, days)						Index	VIXO (signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	3,91%	8,97%	7,27%	5,61%	-0,40%	0,38%	Annualized Return (%)	2,80%	10,87%	10,29%	6,85%	2,85%	-0,50%
Annualized Volatility (%)	20,89%	13,76%	15,66%	15,87%	16,12%	15,66%	Annualized Volatility (%)	20,63%	12,98%	15,14%	15,67%	16,01%	15,31%
Sharpe Ratio	0,1874	0,651	0,465	0,353	-0,025	0,002	Sharpe Ratio	0,1358	0,838	0,680	0,437	0,178	-0,033
Maximum Drawdown (%)	64,00%	15,42%	23,95%	25,79%	42,36%	45,00%	Maximum Drawdown (%)	67,00%	13,07%	18,35%	24,09%	28,66%	44,69%
Positive Days (%)	54,00%	23,35%	25,08%	24,12%	23,24%	21,05%	Positive Days (%)	53,00%	22,82%	24,98%	24,36%	24,16%	22,06%
Kurtosis	12,15	28,33	29,27	27,51	27,12	33,62	Kurtosis	11,84	30,42	26,17	26,82	25,50	33,22
Skew	-0,21	0,83	0,42	0,06	0,01	-0,38	Skew	-0,14	0,94	0,59	0,23	0,14	-0,35
Panel C - S&P 600							Panel D - PSI 20						
	Index	VIX (signal length, days)						Index	S&P 500(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	8,96%	8,37%	5,26%	3,92%	-4,25%	-3,71%	Annualized Return (%)	2,01%	0,19%	11,12%	12,95%	16,70%	9,88%
Annualized Volatility (%)	24,98%	16,57%	18,06%	18,31%	18,52%	18,43%	Annualized Volatility (%)	23,17%	16,11%	18,14%	18,40%	18,82%	19,94%
Sharpe Ratio	0,3588	0,505	0,291	0,214	-0,230	-0,201	Sharpe Ratio	0,0869	0,012	0,613	0,704	0,887	0,496
Maximum Drawdown (%)	54,00%	25,91%	34,70%	23,89%	74,71%	80,47%	Maximum Drawdown (%)	64,27%	43,91%	23,70%	24,38%	25,76%	41,16%
Positive Days (%)	53,00%	23,05%	24,72%	23,89%	23,11%	21,01%	Positive Days (%)	52,00%	25,10%	32,19%	32,98%	33,88%	36,45%
Kurtosis	7,81	17,53	18,23	16,11	16,12	20,53	Kurtosis	10,19	24,26	20,83	18,35	17,65	15,93
Skew	-0,30	0,28	0,19	-0,21	-0,35	-0,61	Skew	-0,19	-1,45	-0,28	-0,08	-0,01	-0,22
Panel E - PSI 20 Large Cap							Panel F - PSI 20 Small cap						
	Index	S&P 500(signal length, days)						Index	S&P 500(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	-2,56%	-3,95%	2,77%	3,88%	8,32%	5,09%	Annualized Return (%)	2,34%	5,29%	13,17%	10,76%	13,27%	5,94%
Annualized Volatility (%)	26,83%	18,92%	20,89%	20,59%	20,89%	22,93%	Annualized Volatility (%)	25,99%	18,06%	20,16%	20,63%	20,89%	21,92%
Sharpe Ratio	-0,0954	-0,209	0,133	0,188	0,398	0,222	Sharpe Ratio	0,0902	0,293	0,653	0,522	0,635	0,271
Maximum Drawdown (%)	83,00%	67,43%	67,69%	71,43%	72,31%	73,95%	Maximum Drawdown (%)	85,00%	42,37%	40,12%	40,12%	40,12%	60,66%
Positive Days (%)	50,00%	24,03%	30,41%	31,23%	32,19%	35,24%	Positive Days (%)	51,00%	24,37%	31,45%	31,27%	32,23%	34,99%
Kurtosis	13,77	38,92	22,45	21,45	20,73	23,94	Kurtosis	7,57	19,79	15,15	13,37	13,28	11,82
Skew	0,38	-2,68	-0,14	-0,12	-0,05	0,49	Skew	-0,25	-0,70	-0,43	-0,12	-0,19	-0,54
Panel G - Ibovespa							Panel H - Bovespa Large Cap						
	Index	S&P 500(signal length, days)						Index	S&P 500(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	10,89%	5,48%	11,79%	7,71%	9,42%	7,98%	Annualized Return (%)	11,15%	9,05%	12,12%	7,77%	9,95%	8,15%
Annualized Volatility (%)	29,02%	19,54%	22,59%	23,37%	23,74%	24,03%	Annualized Volatility (%)	26,15%	17,65%	20,25%	21,09%	21,70%	21,91%
Sharpe Ratio	0,3752	0,280	0,522	0,330	0,397	0,332	Sharpe Ratio	0,4266	0,512	0,599	0,369	0,458	0,372
Maximum Drawdown (%)	53,97%	25,94%	39,22%	36,24%	42,34%	46,59%	Maximum Drawdown (%)	34,94%	19,84%	20,81%	25,71%	32,48%	37,95%
Positive Days (%)	53,00%	22,67%	29,64%	30,14%	30,98%	33,31%	Positive Days (%)	50,00%	23,23%	29,96%	30,26%	31,58%	33,55%
Kurtosis	7,88	19,54	16,23	15,64	15,21	14,93	Kurtosis	9,12	22,96	18,68	17,78	16,73	16,89
Skew	-0,10	-0,17	0,03	-0,02	-0,04	-0,20	Skew	-0,10	-0,13	0,05	-0,05	-0,06	-0,14
Panel I - Bovespa Small cap													
	Index	S&P 500(signal length, days)						Index	S&P 500(signal length, days)				
		5	30	60	90	250			5	30	60	90	250
Annualized Return (%)	19,82%	11,63%	23,01%	21,68%	23,44%	20,98%							
Annualized Volatility (%)	21,61%	14,55%	17,15%	80,00%	17,78%	17,25%							
Sharpe Ratio	0,9172	0,799	1,342	1,228	1,318	1,217							
Maximum Drawdown (%)	34,00%	28,15%	38,82%	36,91%	38,79%	37,99%							
Positive Days (%)	53,00%	23,10%	30,94%	31,27%	32,80%	35,19%							
Kurtosis	8,38	18,12	16,12	16,07	15,52	16,25							
Skew	-0,49	0,49	0,67	0,57	0,54	0,27							

Table 7: Combining strategy within each country indexes (2002-2013)

This table presents the descriptive statistics for the portfolios created by combining the signs of the different strategies for each index. The S&P 500 combining strategy was obtained using the signs from the MR, VIX, 3M T-Bill, January and EOM strategies. The S&P 600 combining strategy was obtained using the signs from the MR, VIX, CPI, January and EOM strategies. The OEX combining strategy was obtained using the signs from the MR, VIX, 3m T-Bill, CPI and EOM strategies. The PSI 20 combining strategy was obtained using the signs from the TF, S&P500, CPI, January and EOM strategies. The MSCI SC PT combining strategy was obtained using the signs from the TF, CPI, January and EOM strategies. The MSCI LC PT combining strategy was obtained using the signs from the TF, CPI, S&P500, 6m T-Bill and EOM strategies. The Bovespa combining strategy was obtained using the signs from the TF, Selic, Weekend, January and EOM strategies. The Russell SC BRL combining strategy was obtained using the signs from the TF, Selic, S&P500, January and EOM strategies. The Russell LC BRL combining strategy was obtained using the signs from the TF, Selic, weekend and EOM strategies. For the Portuguese indexes, the testing period is from Jan 2004 to Dec 2013 due to the lack of available data. The performance statistics of all portfolios are based on a daily rebalancing.

Panel A - Combining Strategies									
	Indexes								
	S&P 500	PSI 20	iBOV	MSCI SC PT	MSCI LC PT	S&P 600	OEX	RUSSELL SC BRL	RUSSELL LC BRL
Annualized Return (%)	8,14%	13,26%	10,01%	14,58%	8,13%	8,00%	9,70%	18,76%	10,89%
Annualized Volatility (%)	6,13%	9,90%	9,91%	10,04%	10,78%	7,60%	7,11%	8,92%	10,68%
Sharpe Ratio	1,33	1,34	1,01	1,45	0,75	1,05	1,37	2,10	1,02
Max. Daily Return (%)	4,46%	7,41%	5,06%	4,40%	5,48%	4,54%	5,06%	5,19%	6,15%
Min. Daily Return (%)	-4,63%	-6,03%	-8,21%	-6,08%	-7,05%	-3,94%	-5,30%	-6,21%	-9,88%
Maximum Drawdown (%)	5,57%	7,71%	8,04%	9,15%	13,74%	13,94%	5,71%	9,35%	7,53%
Positive Days (%)	39,84%	45,29%	40,23%	37,74%	42,46%	40,74%	39,91%	44,83%	39,47%
Kurtosis	33,37	20,87	27,45	14,78	14,79	15,21	33,51	22,71	34,60
Skew	1,20	0,41	-0,40	-0,36	-0,07	0,73	1,29	0,61	-0,39

Table 9: Combining strategy within each country indexes with transaction costs (2002-2013)

This table presents the descriptive statistics for the portfolios created by combining the signs of the different strategies for each index and deducting transaction costs. The S&P 500 combining strategy was obtained using the signs from the MR, VIX, 3M T-Bill, January and EOM strategies. The S&P 600 combining strategy was obtained using the signs from the MR, VIX, CPI, January and EOM strategies. The OEX combining strategy was obtained using the signs from the MR, VIX, 3m T-Bill, CPI and EOM strategies. The PSI 20 combining strategy was obtained using the signs from the TF, S&P500, CPI, January and EOM strategies. The MSCI SC PT combining strategy was obtained using the signs from the TF, CPI, January and EOM strategies. The MSCI LC PT combining strategy was obtained using the signs from the TF, CPI, S&P500, 6m T-Bill and EOM strategies. The Bovespa combining strategy was obtained using the signs from the TF, Selic, Weekend, January and EOM strategies. The Russell SC BRL combining strategy was obtained using the signs from the TF, Selic, S&P500, January and EOM strategies. The Russell LC BRL combining strategy was obtained using the signs from the TF, Selic, weekend and EOM strategies. For the Portuguese indexes, the testing period is from Jan 2004 to Dec 2013 due to the lack of available data. The performance statistics of all portfolios are based on a daily rebalancing. The daily transactions costs used were the following: 15 basis points for the US indexes, 20 basis points for the Portuguese indexes and 40 basis points for the Brazilian indexes.

	Indexes								
	S&P 500	PSI 20	iBOV	MSCI SC PT	MSCI LC PT	S&P 600	OEX	RUSSELL SC BRL	RUSSELL LC BRL
Annualized Return (%)	0,59%	10,37%	-0,86%	7,25%	4,27%	1,46%	0,73%	10,17%	-3,49%
Annualized Volatility (%)	6,13%	9,91%	9,96%	10,07%	10,79%	7,61%	7,11%	8,96%	10,72%
Sharpe Ratio	0,10	1,05	-0,09	0,72	0,40	-0,19	0,10	1,13	-0,33
Max. Daily Return (%)	4,41%	7,41%	4,98%	4,40%	5,48%	4,51%	4,97%	5,19%	6,05%
Min. Daily Return (%)	4,68%	-6,03%	-8,29%	-6,08%	7,05%	-4,00%	-5,36%	-6,21%	-9,98%
Maximum Drawdown (%)	20,52%	9,33%	32,95%	21,85%	24,62%	36,91%	18,94%	18,83%	53,73%
Positive Days (%)	34,78%	44,14%	37,32%	36,49%	41,09%	36,97%	35,31%	41,94%	34,85%
Kurtosis	33,34	20,80	27,33	14,65	14,72	15,10	33,31	22,46	34,42
Skew	1,18	0,43	-0,43	-0,34	-0,05	0,68	1,24	0,64	-0,44

Figure 10 - US indexes monthly maximum drawdown (index and combining strategy)

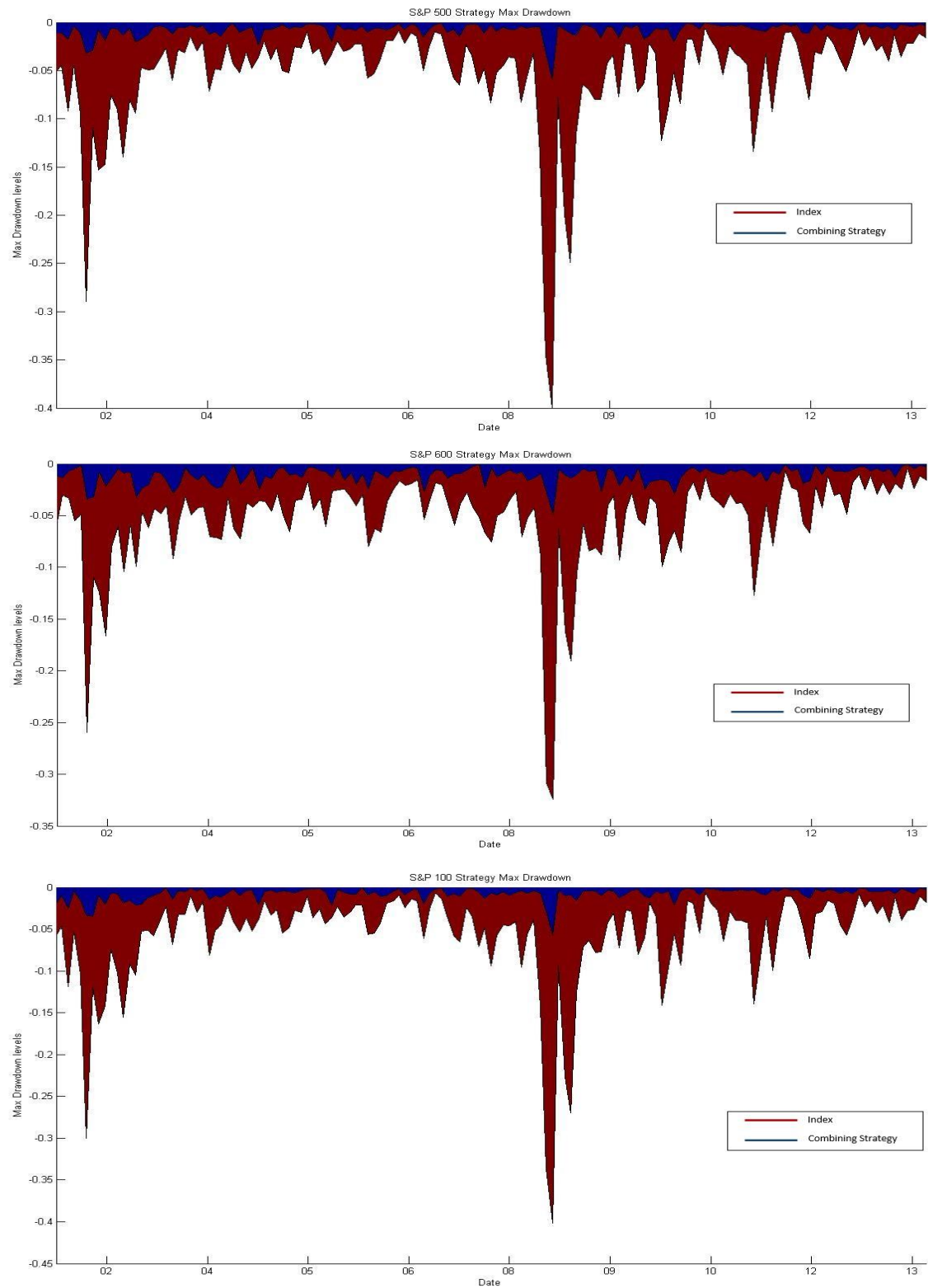


Figure 11 - Portuguese indexes monthly maximum drawdown (index and combining strategy)

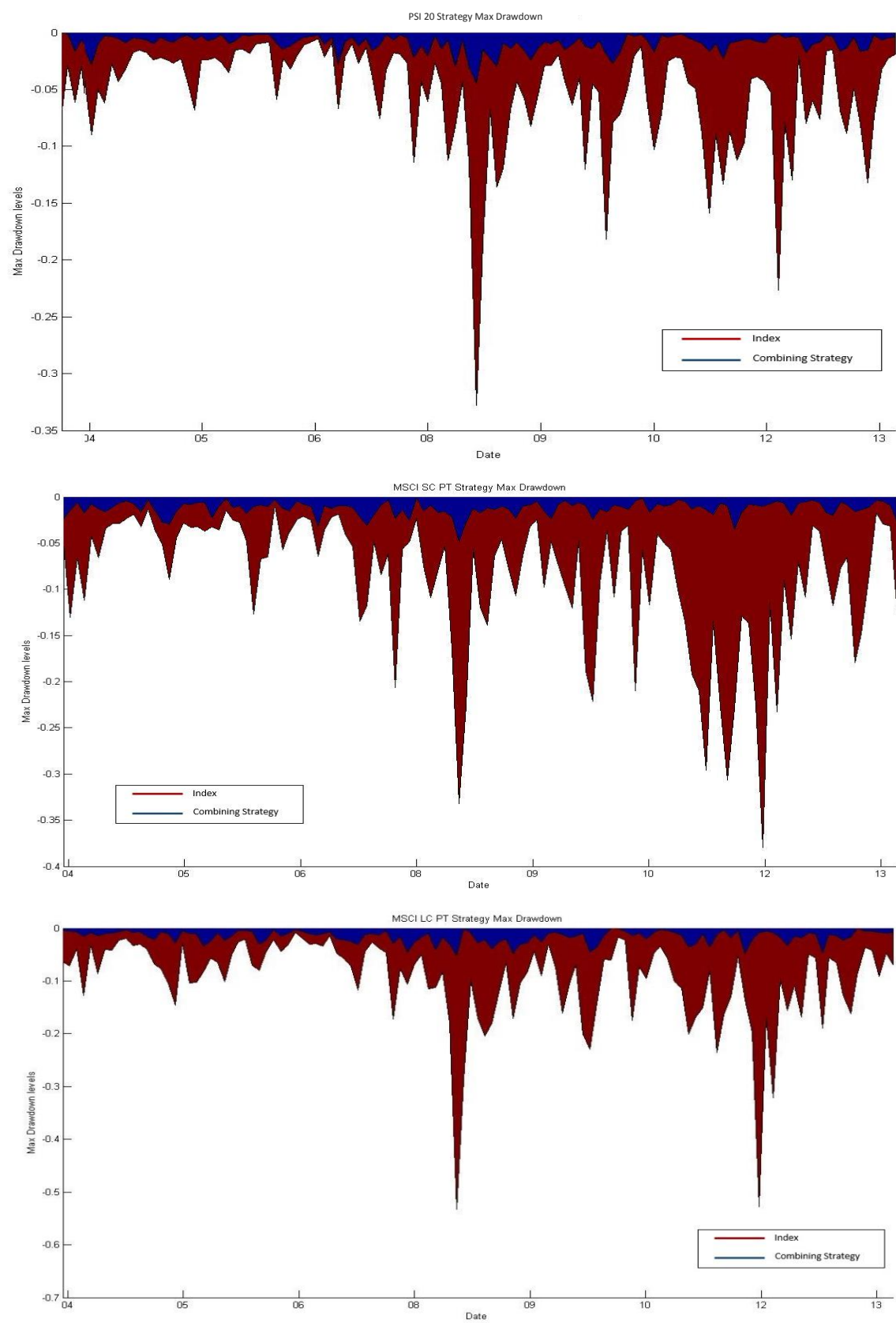


Figure 12 - Brazilian indexes monthly maximum drawdown (index and combining strategy)

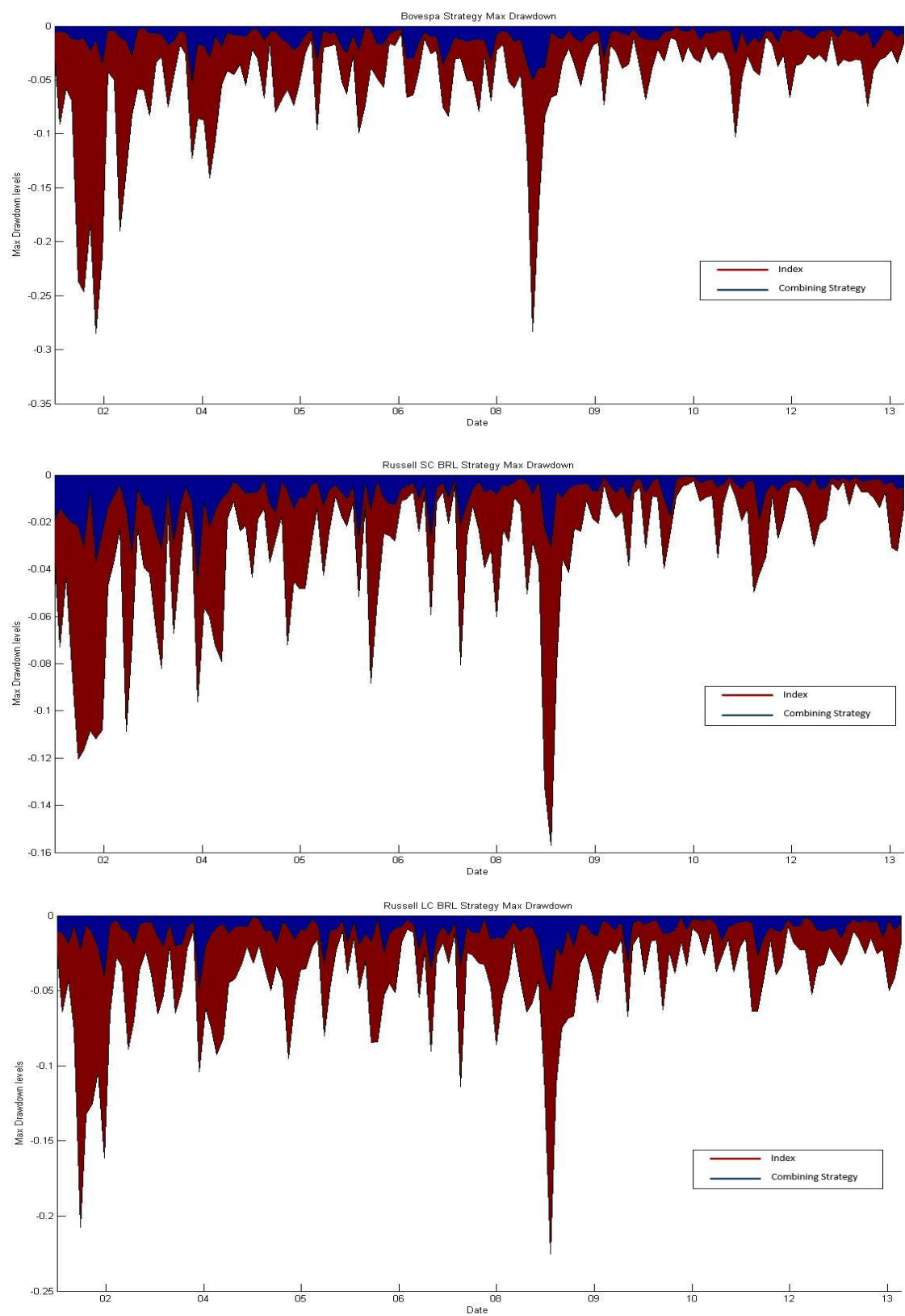


Figure 13 - Return/volatility performance for the US indexes

This figure presents the risk-adjusted returns (Sharpe ratio) for all strategies tested across the US equity market. Relatively larger dots as well as underlined tickers identify the main indexes and respective combining (Final) strategies. Each dot in the graph represents the best result obtained for the different signal lengths tested.

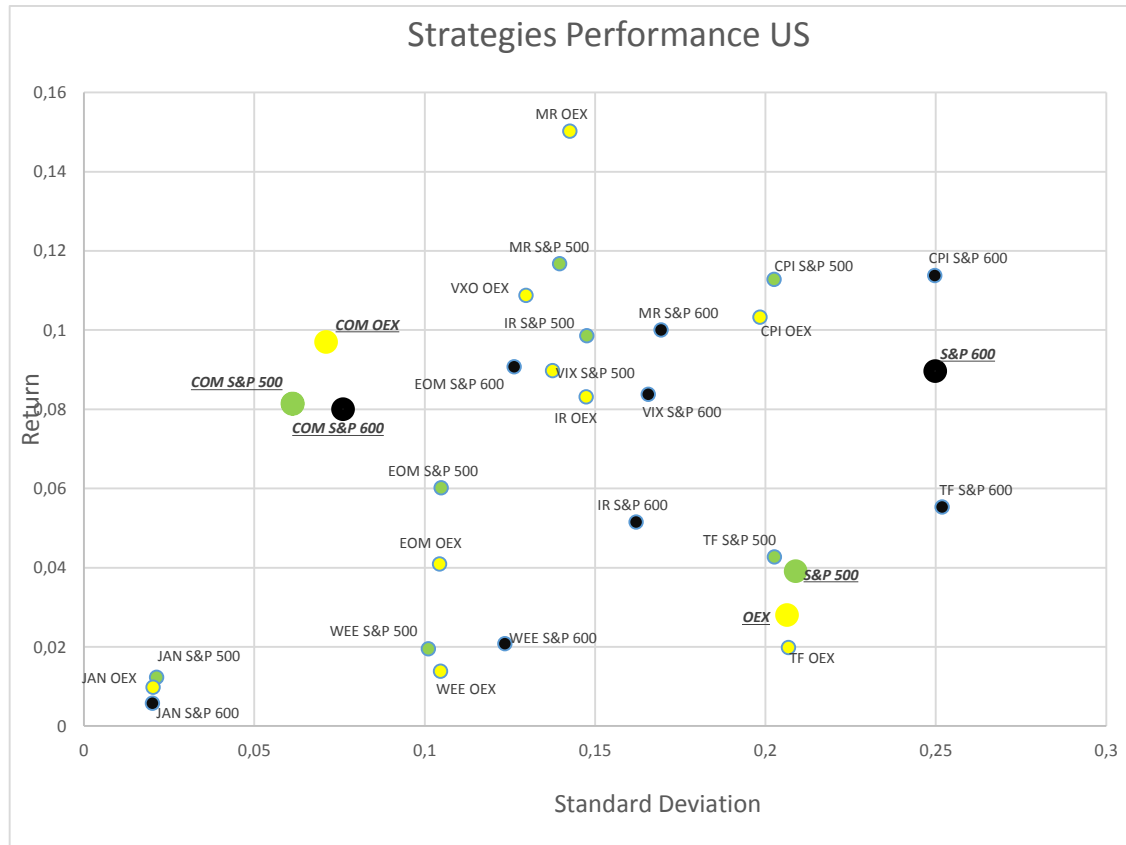


Figure 14 - Return/volatility performance for the Portuguese indexes

This figure presents the risk-adjusted returns (Sharpe ratio) for all strategies tested across the Portuguese equity market. Relatively larger dots as well underlined tickers identify the main indexes and respective combining (Final) strategies. Each dot in the graph represents the best result obtained for the different signal lengths tested.

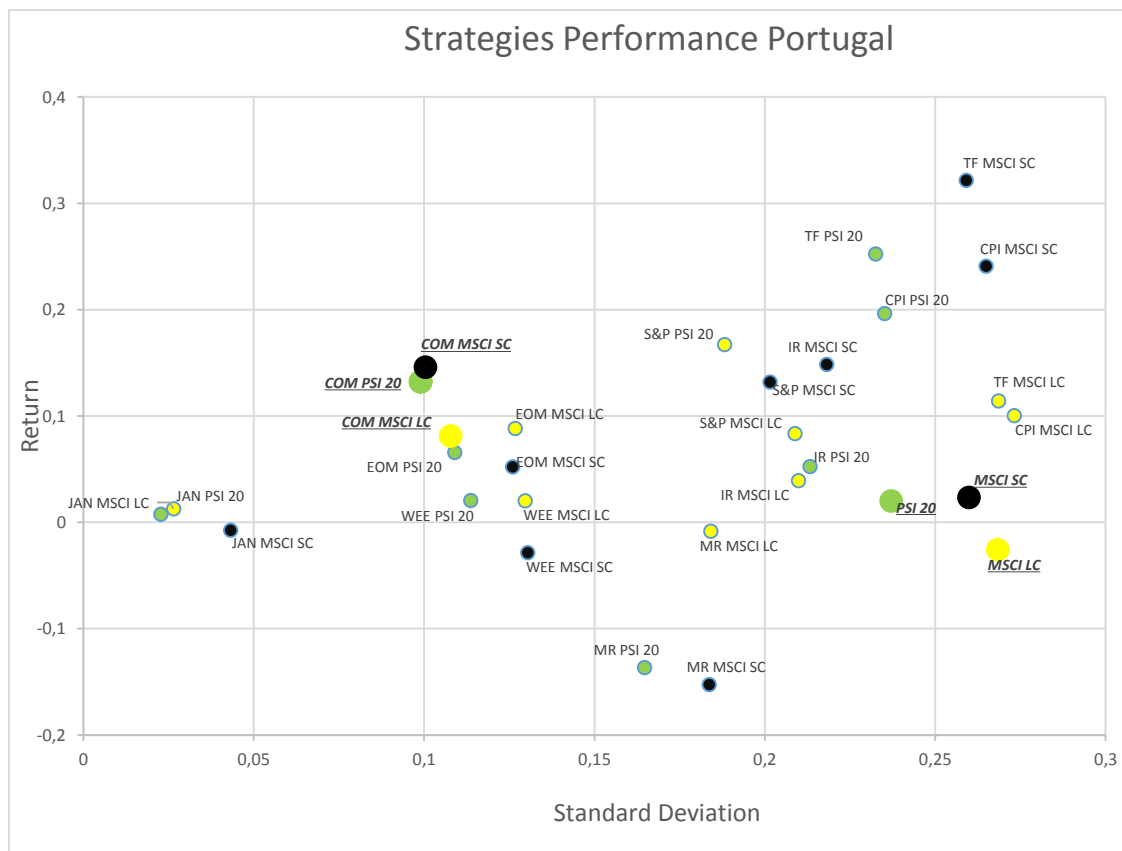


Figure 15 - Return/volatility performance for the Brazilian indexes

This figure presents the risk-adjusted returns (Sharpe ratio) for all strategies tested across the Brazilian equity market. Relatively larger dots as well as underlined tickers identify the main indexes and respective combining (Final) strategies. Each dot in the graph represents the best result obtained for the different signal lengths tested.

