A Work Project, presented as part of the requirements for the Award of a Masters Degree in Finance from the Faculdade de Economia da Universidade Nova de Lisboa.

TRADING THE CHANGES OF STOCK MARKET INDEX COMPOSITION: EVIDENCE FROM EUROPEAN MARKETS

João Maria Lencastre Marinho da Cunha nº 932

A Project carried out on the Finance course, with the supervision of

Professor Afonso Eça

January 8th, 2016

Trading the changes of stock market index composition: evidence from European markets

ABSTRACT

This paper studies the changes in European stock market indexes composition from 1995 to 2015. It was found that there are mixed price effects producing abnormal returns around the effective replacement of added and deleted stocks. The price pressure hypothesis seems to hold for added stocks in some indexes but not for deleted stocks as there is not a clear inversion of behaviour after the replacement. Finally, the building and back testing of a trading strategy aiming to capture some of those abnormal returns shows it yields a *Sharpe Ratio* of 1.4 and generates an annualised *alpha* of 11%.

Keywords: Stock index revision, additions, deletions, event study, abnormal returns, European markets, trading strategy

1. Introduction

The behaviour of joiners and leavers of major world stock market indexes is already a studied topic. Stock index replacements tend to produce price effects and abnormal returns around those events. However, most papers focus on the theoretical hypotheses which may explain the abnormal returns. This paper not only aims to confirm their existence but also tries to put that knowledge into practice by proposing a trading strategy to capture those abnormal returns that could be used by hedge funds.

Stock indexes aggregate stocks which share something in common such as belonging to a certain trading exchange, geography or business area. The most popular stock market indexes aggregate the biggest stocks in trading exchanges measured by the free-float market capitalization and volume of trading such as the American *S&P 500*, the British *FTSE-100*, the German *DAX-30* or the Japanese *Nikkei-225*.

Besides the extra awareness any stock gets from being a member of a major stock market index, its demand and traded volume may increase automatically due to another reason whose explanation follows. Stock market indexes represent the behaviour of the market as a whole and therefore they are usually benchmarks for asset managers with which they compare their returns. Consequently, to manage risk or to get exposure to the benchmark, those agents may want to trade the index directly using futures or a basket of stocks. Furthermore, the explosion of passive investment vehicles such as Exchange Traded Funds (ETF's) and Index Funds created another demand source for the members of the main stock market indexes. For the security to mimic the behaviour of the index with the smallest tracking error possible, it must contain a proportional basket of stocks, i.e. all members of the index.

This paper focuses on the biggest European stock indexes namely the *FTSE-100*, the *EURO STOXX-50*, *IBEX-35*, *CAC-40* and *DAX-30*. All those stock indexes are revised periodically to adjust its members to its rules. The rules are specific of each stock index and may differ from each other but the main objective of all of them is to aggregate the most important and biggest companies in its respective market. Only the *EURO STOXX-50* differs in the range of stocks, as the objective is the same but all Euro Zone stocks are eligible.

If, as literature suggests, the hypothesis of abnormal returns is verified, then it may be possible to trade them in order to profit from these market inefficiencies.

This study is organized as follows. In Section 2 a literature review is performed and several hypotheses are raised to explain possible abnormal returns around the stock market indexes replacements. The data used in this study is the subject of Section 3 while Section 4 explains the methodology used to assess abnormal returns and how to proceed with the structuring of the trading strategy. The results of the performed tests are presented in Section 5 and Section 6 draws the main conclusions of the paper.

2. Literature Review

2.1 Existing Hypothesis

The Efficient Market Hypothesis (*EMH*) states that all prices fully reflect and incorporate all the relevant available information so it is not possible to capture abnormal returns in such market. However, and according to previous studies on this topic, there may be timeframes around additions and deletions where the *EMH* does not apply meaning that opportunities may arise for arbitrageurs to profit from those inefficiencies. There are several hypotheses which could explain price effects around the events of changes in index members. The most popular are summarised by Duque and Madeira (2004) and

Bildik e Gülay (2001) and try to provide answers to the simple question of why should a change in a list lead to price effects in stocks.

Price pressure hypothesis: There is extra demand before the effective replacement due to index fund managers trying to adjust their portfolio to minimise tracking error. However, shortly after the replacement this effect should disappear as a new equilibrium is achieved. Blume and Edelen (2004) argue that "to obtain the small tracking errors that are actually observed, an indexer must follow very closely an exact replication strategy" which consequently creates extra demand for added stocks and decreases the demand for deleted stocks.

Imperfect substitutes hypothesis: Equilibrium prices will move in order to accommodate shifts in the demand curve caused by index funds quasi-compulsory ownership of stocks and the consequent decrease of the number of free-float stocks. Under this hypothesis these effects are permanent.

Information hypothesis (also attention hypothesis): Stocks added to the index will increase in price as its trading cost decreases in result of the easier effort to search for company news and research. Under this hypothesis the effect is also permanent.

Liquidity hypothesis: One assumption of this hypothesis is that volume of trading increases after additions which is mostly corroborated by empirical findings (as in Harris and Gurel (1986) and Hegde and McDermott (2003)). After the addition and the increase in volume traded, investors stop requiring a liquidity premium for holding the added stocks because liquidity increases due the narrowing of bid-ask spreads.

Selection Criteria Hypothesis: The simple fact of the inclusion (exclusion) is itself a positive (negative) signal for investors. Inclusions and exclusion are consequence of stocks meeting selection criteria and that event causes investors to be more (less) confident about the future prospects of the company.

2.2 Empirical findings

This topic has been studied for a long time and several authors advocate the existence of abnormal returns. Using Portuguese stocks traded in the Lisbon Stock Exchange, Duque and Madeira (2004) found different price effects for additions and deletions as did Chen, Noronha and Singal (2004) using S&P 500 stocks. According to Duque and Madeira (2004), added stocks experience an upward trend until the effective replacement takes place, after which the behaviour is inverted. These are precisely the same conclusions of Bildik e Gülay (2001), Blume and Edelen (2004) and Chakrabarti, et al. (2005). Regarding deletions, most papers cannot provide evidence with the same strengh that brand additions after the replacement day. Chen, Noronha and Singal (2004) claim that this assymetry between the behaviour of added and deleted stocks from the S&P 500 index has to do with assymetric changes in investor awareness providing evidence of the *Information Hypothesis*. The common conclusion is that stocks deleted from indexes react negatively from the announcement until the effective replacement but no effect is clear after the deletion.

3. Data Description

Data on 982 events comprising 20 years of additions and deletions of the main European stock market indexes was collected from *Reuters* terminal. The list retrieved contains an identification of the event (addition or deletion), a stock identifier and the effective date of the event.

Between all the European stock markets, it was chosen to perform the research on the biggest and more popular indexes namely the *CAC-40* (France), *DAX-30* (Germany), *FTSE-100* (United Kingdom), *IBEX-35* (Spain) and *EURO STOXX-50* (Euro Zone). All the rules for additions and deletions are not specified in this paper as they are irrelevant for the purpose of the study. The constituency of the indexes and the respective addition of the first stocks was chosen not to be included in the study as these additions have a different nature and are not consequence of a replacement. The breakdown of those events by stock market is important to be mentioned as there are indexes with a significant higher number of events due to the higher frequency of the rebalancing. All those 982 are summarised in Table 1 both by stock market and by the event's year.

Table 1- Description of the number of events used in the study

Number of events (Additions; Deletions)

	CAC-40	DAX-30	FTSE-100	IBEX-35	EURO STOXX-50		CAC-40	DAX-30	FTSE-100	IBEX-35	EURO STOXX-50
1995	5 ;4	1 ;1	11 ;8	4 ;4	0 ;0	**2007**	2 ;2	1 ;1	20 ;19	5 ;5	6 ;6
1996	0 ;1	3 ;3	10 ;9	0 ;1	0 ;0	**2008**	1 ;1	3 ;3	17 ;18	5 ;6	2 ;2
1997	5 ;5	0 ;	14 ;14	5 ;4	0 ;0	**2009**	1 ;1	4 ;5	17 ;17	1 ;2	2 ;2
1998	3 ;1	2 ;2	14 ;15	5 ;4	1 ;1	**2010**	2 ;3	1 ;1	13 ;13	2 ;0	2 ;2
1999	8 ;7	1 ;1	16 ;16	3 ;2	10 ;10	**2011**	2 ;4	2 ;2	11 ;10	4 ;4	4 ;5
2000	4 ;4	2 ;2	32 ;32	6 ;6	5 ;5	**2012**	2 ;2	3 ;3	7 ;8	2 ;3	3 ;3
2001	2 ;2	4 ;4	18 ;16	4 ;4	3 ;3	**2013**	1 ;2	0 ;1	10 ;10	5 ;5	2 ;3
2002	2 ;2	2 ;2	13 ;13	2 ;3	1 ;1	**2014**	1 ;1	0 ;	11 ;10	2 ;2	1 ;1
2003	2 ;3	1 ;1	11 ;8	4 ;5	2 ;2	**2015**	2 ;2	1 ;1	4 ;5	3 ;3	0 ;0
2004	1 ;1	0 ;	7 ;12	2 ;2	2 ;2						
2005	3 ;3	1 ;1	11 ;11	4 ;4	2 ;3	**% of Total**	**11%**	**7%**	**57%**	**15%**	**10%**
2006	3 ;3	1 ;1	14 ;15	6 ;6	0 ;0						

It is important to stress at this point that for the list gathered for each stock market replacements, some events were also not considered due to the lack of reliable stock identifiers. Those events, account for a little more than 6% of the 982 total events mainly between 1995 and 2003 and are distributed reasonably in a proportional manner between the stock market indexes and between joiners and leavers. As such, it was believed that this missing data would not significantly alter the main conclusions of paper and the study proceeded with the events for which there was reliable data. The date of the effective replacement is defined from this point onwards as ED and it will be the reference to define the trading days. For each of the events, daily prices between ED-50 and ED+20 were retrieved whenever they existed. It may happen that prices do not exist for the whole period because in the case of leavers, due to company events such as bankruptcy or M&A events for example, the stock may stop being traded after ED. The same procedure was conducted for each event's respective stock market with daily data on the index price being retrieved between ED-50 and ED+20.

The dataset of this study comprises series of stock prices and index prices from which series of daily returns for each event were calculated for stocks and indexes.

4. Methodology

4.1 Event Study

The first stage of this study is to confirm the empirical findings mentioned in the section above. To do so, the first step is to define a model for the normal returns so that excess returns are considered abnormal returns. For simplicity and because the ultimate goal of the study is to propose an easy to implement trading strategy, the market adjusted returns model was chosen to define abnormal returns as follows:

$$AR_{i,t} = R_{i,t} - R_{mt} \tag{1}$$

with $AR_{i,t}$ being the abnormal return of stock i on day t, $R_{i,t}$ the arithmetic return of stock i at day t and R_{mt} the index arithmetic return on day t.

After computing series for abnormal returns, everything is set to perform tests in order to assess the significance of those returns. It is clear that the null hypothesis of these tests is the absence of abnormal returns, i.e. null abnormal returns. However, before performing hypothesis tests one needs to have a first glance at the results so that alternative hypothesis can be formulated. As such, the average abnormal return is computed for each day by index and by type of event (additions and deletions) in order to have a sense of the behaviour that should be tested in the first place. With those daily average abnormal returns one can compute a cumulative series rebased at 100% on ED to simplify any comparison. Depending on the evidence from the first approach and from the empirical findings presented in Section 2, the procedure tests if the null hypothesis of non-existent abnormal returns is true for different periods of time. The dataset is also divided by index so that it is possible to identify different behaviours in different indexes.

Event studies usually face a problem which is the non-stationarity of returns series when the event alters the variance as well as the mean of returns because it creates problems with the conventional hypothesis tests to the mean. As such, the series is only tested after being standardized using the Boehmer, Masumeci and Poulsen (1991) standardized cross-sectional test (*BMP*) as they provide evidence of the vulnerability of standard hypothesis tests to the mean of a series in a period of abnormal volatility. Furthermore, they prove that the standardization of returns decreases the probability of a Type I error, rejecting the null hypothesis when it is indeed true. In practice, standardization under the *BMP* imply “that more volatile (i.e., noisier) observations get less weight in the averaging than the less volatile and hence more reliable observations” (Kolari and Pynnönen 2010). This procedure transforms the series in a stationary process thus conventional hypothesis tests can be applied. Kolari and Pynnönen (2010) argue that the *BMP* is not optimal as it does not account for cross-sectional correlation. These problems arise particularly when the event for all stocks is the same day. In this case however, those warnings about cross-sectional correlation were ignored because the dataset relates to different periods of time as the effective date of replacement is not the same for all stocks.

The *BMP* transforms abnormal returns (*AR*) into standardized abnormal returns (*SAR*) in the following way:

$$SAR_{i,t} = \frac{AR_{i,t}}{\sigma_i} \tag{2}$$

where σ_i is the standard deviation from the estimation period which was chosen to be the range between ED-40 and ED-11.

$$\sigma_i = \sqrt{\frac{1}{(T-1)} \sum_{t=1}^{T} (AR_{i,t} - \overline{AR}_{i,t})} \qquad (3)$$

Making use of equation (2) and (3) and by adding a term to adjust the forecast error, $SAR_{i,t}$ can thus be defined as:

$$SAR_{i,t} = \frac{AR_{i,t}}{(\sigma_i)\sqrt{1 + \frac{1}{T_i} + \frac{(R_{mt} - \bar{R}_m)^2}{\sum_{e=1}^{T} (R_{me} - \bar{R}_m)^2}}} \qquad (4)$$

where: R_{me} is the market return for day e of the estimation period (for each stock event market return is consider the respective stock market where the event happened); $\bar{R}_m$ is the average market return during the estimation period; R_{mt} is the market return in day t; R_{me} is the market return in day t and T_i is the number of days in the estimation period.

With the series of $SAR_{i,t}$ one can perform a one-tailed test to the mean to check the following hypothesis:

H0: $SAR_{i,t} = 0$

H1: $SAR_{i,t} < 0$ or H1: $SAR_{i,t} > 0$ depending on what the first approach suggests.

T-Statistic is defined as follows:

$$t = \frac{\frac{1}{T} \sum_{i=1}^{N} SAR_{i,t}}{\sqrt{\sigma^2_{(SAR_{i,t})}/N}} \qquad (5)$$

Both the periods before and after the event are tested. It is also tested the full sample and only the 2nd half to make sure results are consistent throughout the whole sample. A critical analysis to the results of these tests is performed in order to proceed to the structuring of the trading strategy. This critical analysis is of great importance as it draws the first conclusions regarding what happens around the additions and deletions of stocks.

4.2 Trading Strategy

Building up on the results of the previous stage, a trading strategy is structured and back tested. Following the same simplicity mind-set described above and more importantly, to avoid the phenomenon of *over fitting* there are some key guidelines for the structuring.

a) Because all the study of returns is performed using daily data, there is not any sort of intraday orders to trade;

b) Following the same rationale related to the nature of the study performed, all the positions taken are in spreads between the stock and the market where the event takes place. Any long position in any stock has a short position in the broad index and vice-versa for short positions in stocks. In practice, this imposition should offset any market effect as it constitutes a market risk hedging with a market beta = 1;

c) Unless the previous study provides strong evidence of different behaviours among different indexes, the same strategy is to be pursued in all indexes;

d) In practice, there is an announcement date (AD) from which onwards it is publicly known the changes in indexes' membership. That announcement happens typically about 2 months before the effective replacement but that time difference may vary due to special circumstances i.e. M&A events or bankruptcy or by different index specific rules. Due to the fact that the data collected lacks that AD, and after research about the rules of the used indexes, a conservative approach was taken considering reasonable to assume that at the day ED-10 it was already publicly known the event to occur 10 days later. To make sure that no forward looking information is being used when building the strategy, it is imposed that only after ED-10 *inclusive* it is possible to start trading regarding that event.

e) The last guideline has to do with leverage and trading costs. Trading costs do exist in the real world and they cannot be disregarded so the back test tries to mimic exactly what would happen in the real trading of the strategy. A trading cost of 7 b.p. is accounted for every time a new position is opened or closed in any stock or stock market index (via futures market). Therefore, if a position is opened in 2 spreads within the same stock market, on the day of the opening it is subtracted to the daily return 3 * 7 b.p. in result of the trading of 2 stocks and 1 stock market future. By default, in the back test a position of 20% of the whole portfolio is set in all spreads regardless of the number of spreads being traded in any day. This means that there may exist days with only 20% of portfolio exposure if only 1 event is being traded or 200% of exposure if 10 events are being traded at the same time. This was considered a better solution rather than having always a 100% exposure. Imposing a constant exposure would mean that all events would not have the same weight because the number of events happening at the same time is obviously not constant. Trading costs often ruin trading strategies as they offset all the profits. One way to go around this problem is to increase leverage, i.e. the exposure of the strategy, and this instrument may be used if a strategy has everything to be successful but trading costs are offsetting all returns.

Provided that the strategy follows these guidelines, its results are analysed to assess if the evidence from the event study proves itself to have been successful in the past years. After building the first strategy the results are criticised and improvements suggested so that an optimal result is achieved. The back test uses the whole sample but the years since 2010 (1995-2009) so that the same strategy can be applied with the last 5 years (2010-2015) in order to test the strategy out-of-sample. Throughout the analysis of the tests' results several metrics are observed:

a) The magnitude of the returns measured by *Sharpe Ratio* (*SR*) without subtracting the risk-free return as our strategy does not consume capital (it is always a long-short portfolio);

$$SR = \frac{\overline{R_t}}{\sigma_{R_t}} \quad (6)$$

b) The generation of positive *alpha* according to the *Fama-French 3 Factors Model with Momentum Factor* or, the *Carhart 4 Factors Model (C4F)*. It is an extension of the popular *CAPM* and aims to explain portfolio returns based on 4 different risk-factors: market (*MKT-RF*), size (*SMB*), value (*HML*) and momentum (*WML*) factors. European risk-factors data were retrieved from Kenneth R. French's website which contains a monthly database. Monthly returns of the strategy were computed and regressed as follows:

$$R_{i,t} = \alpha_i + \beta_{1,i} * (R_{m,t} - rf_t) + \beta_{2,i} * SMB_t + \beta_{3,i} * HML_t + \beta_{4,i} * WML_t \quad (7)$$

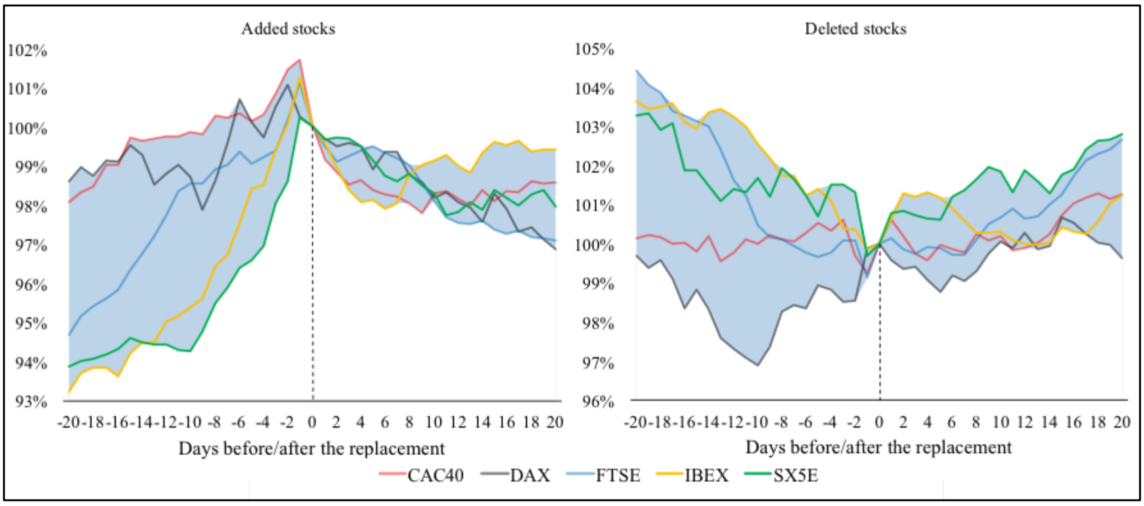
c) Other issues that concern hedge fund managers such as the maximum drawdown (the highest possible loss over the analysis period) and whether the strategy's returns are continuous over time and are not clustered in a specific period of time.

5. Results

5.1 Event Study

Following the methodology presented in Section 4, the existence of abnormal returns measured in excess of the market was assessed previously with a simple mean behaviour analysis using the whole sample. The results for additions and deletions are present in Figure 1:

Figure 1 – Mean behavior rebased at 100 on ED of added stocks (left) and deleted stocks (right)



Concerning additions to the indexes, it appears that there is a price effect around ED with positive abnormal returns before ED and an inversion slightly before ED. Before the replacement, the first quick conclusion is that this positive price effect is more noticeable in *IBEX-35* and *EURO STOXX-50* which tend to invert 1 day before ED. After the inversion, despite the fact that *IBEX-35* has again one of the most evident negative behaviours, the *CAC-40* also stands out.

The same procedure was conducted for deletions. While there was a clear indication of the behaviour around additions, in this case the conclusion is not straightforward. Some indexes such as the *IBEX-35*, the *FTSE-100* and the *EURO STOXX-50* seem to have a negative behaviour before ED inverting also 1 day before the event. For the other indexes it is hard to draw a first conclusion because neither before nor after the event there is a clear trend.

With these first quick results, one can proceed to the hypothesis tests with the explained *BMP* standardization procedure. 40 different tests were performed (2 periods for the 5 indexes with full sample and only 2nd half) divided between additions and deletions. For additions, two different periods which seem to be those with more pronounced behaviour were tested:

a) Before ED: from ED-10 to ED-1 the alternative hypothesis of positive abnormal returns was tested;

b) After ED: from ED to ED+6 the alternative hypothesis of negative abnormal returns was tested;

Since in the case of deletions there is not a clear behaviour the same tests were performed in the following symmetrical windows:

a) Before ED: from ED-10 to ED-1 the alternative hypothesis of negative abnormal returns was tested;

b) After ED: from ED to ED+10 the alternative hypothesis of positive abnormal returns was tested.

It was performed a simple one-tailed T-test to $SAR_{i,t}$ with a significance level of 5% and 10%. The level of 10% was chosen because these tests' goal is to reject only those events that clearly should not be included in the trading strategy due to the inexistence of abnormal returns. By increasing the significance level, one is indirectly reducing the probability of committing a Type II error, rejecting the null hypothesis incorrectly. The results (t-statistics) of the hypothesis tests ran for the full sample by type of event (addition or deletion) and by stock index are presented in Table 2:

Table 2 – T-statistics for hypothesis tests using full and only 2nd half of sample (* indicates significance at the 10% level, ** indicates significance at the 5% level)

Panel - Additions: Full Sample ; 2nd Half of Sample

	CAC-40	**DAX-30**	**FTSE-100**	**IBEX-30**	**EURO STOXX-50**
ED-10 to ED-1	2.51**; 1.31*	0,59; -0,17	6.14**; 4.81**	5.50**; 2.47**	6.22**; 4.80**
ED to ED+6	-4.40**; -3.11**	-1.55*; -1.58**	-6.46**; -3.81**	-4.16**; -2.57**	-2.06**; -1.58*

Panel - Deletions: Full Sample ; 2nd Half of Sample

	CAC-40	**DAX-30**	**FTSE-100**	**IBEX-30**	**EURO STOXX-50**
ED-10 to ED-1	-1.35*; 0,65	1,08; 1.70**	-5.29**; -2.48**	-2.82**; -1.50*	-2.32**; -2.26**
ED to ED+6	0,97; -0,65	-0,68; -0,69	2.37**; -1.48*	-0,42; -0,16	1.52*; -0,51

Different results regarding additions and deletions were reached. Deletions are the first subject of analysis. In the case of the *DAX-30*, one cannot reject the null hypothesis of zero abnormal returns not only before but also after ED. As far as other indexes are concerned, in the period before ED all the tests indicated negative abnormal returns while after ED, none of the indexes suggested a clear inversion of behaviour. The analysis on the 2nd half of the sample is even opposing results found using the whole sample.

In terms of additions the results were much more constant across indexes, which gives extra robustness to the results of this analysis when compared to deletions. It is observed a clear rejection of the null hypothesis for both periods before ED and after ED with the exception of events before ED taking place in the *DAX-30*. These tests suggested that the behaviour of the *DAX-30* is clearly different from all other stock indexes so the stocks added to the *DAX-30* were excluded from the trading strategy. Clearly, the *price pressure hypothesis* presented in the literature review seems to hold for added stocks. These results also corroborate what other studies have concluded.

It is important to keep in mind at this point that despite the fact that some tests reject the null hypothesis with higher "confidence" due to lower *p-value*, and hence lower probability of committing a Type I error, it does not mean directly that the magnitude of those abnormal returns are higher. In other words, these tests only reject the null hypothesis of zero abnormal returns and do not aim to rank indexes based on the magnitude of abnormal returns. That magnitude of returns is tangible in the results of the trading strategy and is assessed in the following sections.

The study proceeds to the next stage with the structuring and back test of a trading strategy, with the following takeaways:

a) *DAX-30* was excluded from both the additions and deletions sample;

b) The behaviour in the periods around additions is clear for all other indexes thus all of them are to be back tested;

c) The behaviour in the periods before deletions is also clear and negative for all indexes but the *DAX-30* so they should also be back tested in the following stage;

d) The behaviour in the periods after deletions is not clear as the null hypothesis is almost rejected. As such, the period after deletions was excluded in the building of the trading strategy.

5.2 Trading Strategy Structuring

The back test of investment strategies is very useful as it illustrates the results of that strategy if it was implemented in the past. One can always argue that past performance does not guarantee future returns but it is one of the few ways to test if any strategy works of if it does not. Furthermore, until now only the existence of abnormal returns was tested which by itself is not a sufficient condition to justify the existence of an investable strategy. The magnitude of those returns may not be enough to beat a benchmark or to compensate the investor for taking risk, i.e. volatility of his portfolio. The back test aims to assess exactly these issues that an investor bears in mind.

In this study several back tests were performed in order to assess which strategy performed better in the past and to recommend a trading strategy for the future. It was used as a benchmark the stock market index *EURO STOXX-50* so that one can compare the cumulative performance of the strategy and the main metrics computed.

It was chosen to start by including all the events not discarded in previous tests in the back test investing in the spread between stocks and the stock market where the event takes place as explained in Section 4. As such, the strategy trades both additions and deletions in the *CAC-40, IBEX-35, FTSE-100* and *EURO STOXX-50* in the periods before and after ED in the case of additions and only before ED in the case of deletions (Strategy 1). Figure 2 illustrates Strategy 1 and its results are summarised in Table 3:

Figure 2 – Timeline of trading in Strategy 1

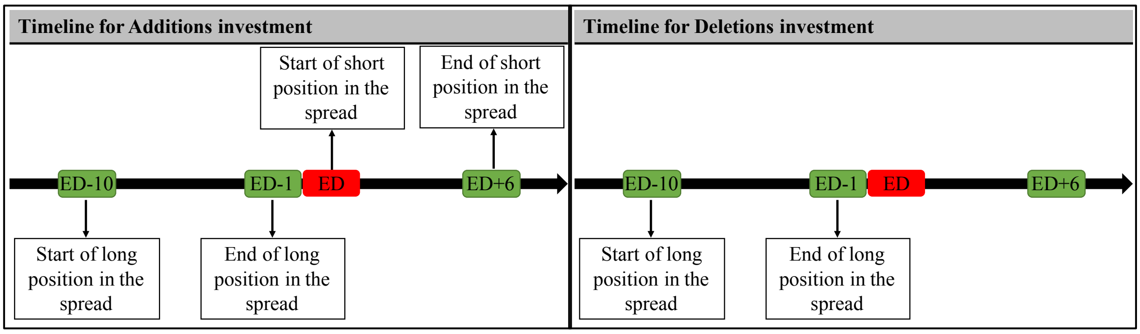


Table 3 - Strategy 1's metrics for the 1995-2009 period (* indicates significance at the 5% level)

STRATEGY 1 (1995-2009)	Strategy	Benchmark	Risk-Factors Regression (monthly returns)					
Average Annual Return	28,3%	7,8%		Alpha	MKT-RF	SMB	HML	WML
Annual Volatility	18,8%	23,0%	**Coefficient**	2,31%	-0,01	-0,47	-0,14	0,28
Sharpe Ratio	1,50	0,34	**S.E.**	0,48%	0,09	0,18	0,18	0,10
Maximum Drawdown	-40,4%	-66,9%	**T-statistic**	4,84*	-0,14	-2,58*	-0,79	2,78*

As expected due to the previous statistical tests, this strategy generates positive returns with an *SR* of 1.50 and a significant (5% significance level) positive *alpha* of 28% annualised. In fact, returns are abnormally high with an average annual return above 28%. However, this spectacular performance comes at the expense of a very high maximum drawdown above 40% which is clearly too high. Reducing leverage to a 10% exposure per event (default exposure is 20%) does not seem to improve the output as it decreases

SR to 0.95 and only reduces the maximum drawdown to 22%. This value is still considered to be higher than desired thus 3 options were considered:

1. Exclude the period before ED in deletions as their behaviour was not significant for events in the *CAC-40* and because evidence from the statistical tests was not as strong as was evidence from additions (Strategy 2);

2. Exclude *FTSE-100* events as it is an index with much more additions and deletions which may lead to a higher number of arbitrageurs trying to profit from these same behaviours and because it increases the expenses in trading costs (Strategy 3);

3. Join both 2 and 3 excluding deletions and events in the *FTSE-100* (Strategy 4).

The results for Strategies 2, 3 and 4 are summarised in Table 4:

Table 4 - Strategy 2, 3 and 4 metrics for the 1995-2009 period (* indicates significance at the 5% level)

STRATEGY 2 (1995-2009)								
	Strategy	**Benchmark**		**Risk-Factors Regression**				
Average Annual Return	21.3%	7.8%		Alpha	MKT-RF	SMB	HML	WML
Annual Volatility	13.3%	23.0%	**Coefficient**	1.90%	0.08	-0.23	-0.31	0.13
Sharpe Ratio	1.60	0.34	**S.E.**	0.36%	0.07	0.14	0.13	0.08
Maximum Drawdown	-25.2%	-66.9%	**T-statistic**	5,34*	1.09	-1.65	-2,33*	1.75
STRATEGY 3 (1995-2009)								
Average Annual Return	13.1%	7.8%		Alpha	MKT-RF	SMB	HML	WML
Annual Volatility	8.5%	23.0%	**Coefficient**	1.13%	0.13	-0.12	-0.25	0.10
Sharpe Ratio	1.53	0.34	**S.E.**	0.24%	0.05	0.09	0.09	0.05
Maximum Drawdown	-12.0%	-66.9%	**T-statistic**	4,65*	2,76*	-1.32	-2,71*	1.95
STRATEGY 4 (1995-2009)								
Average Annual Return	11.8%	7.8%		Alpha	MKT-RF	SMB	HML	WML
Annual Volatility	7.1%	23.0%	**Coefficient**	1.06%	0.11	-0.13	-0.28	0.10
Sharpe Ratio	1.67	0.34	**S.E.**	0.24%	0.05	0.09	0.09	0.05
Maximum Drawdown	-11.9%	-66.9%	**T-statistic**	4,45*	2,41*	-1.39	-3,20*	2,04*

All strategies improve the results when it comes to decreasing the maximum drawdown and increasing *SR* and despite the fact that they generate lower *alphas*, they are still significant and positive for all strategies. However, excluding deletions and events in the *FTSE-100* is the best option.

It was performed the back test for Strategy 4 out-of-sample in the period 2010-2015 to check whether these positive results remained. The positive trend remained but in a lower magnitude. In fact, a simple one-tailed T-test at 5% significance level to the series of strategy's returns could not reject the hypothesis of zero returns. Consequently, it was performed the same strategy without trading costs to check whether the bad performance is due to trading costs and this hypothesis was confirmed. Without trading costs, during the period 2010-2015 Strategy 4 still generated significant *alpha* with an *SR* of 1.17. As explained in Section 4, leverage can be increased so that trading costs do not offset all returns. As such, leverage was increased to a level of 50% weight in every trade and the results show that it has still been possible to trade successfully this strategy since 2010 and to beat the market according to the *C4F* Model. Possible reasons to explain the lower success of the strategy in the past years are suggested in Section 6. Results for the out-of-sample back test follow:

Table 5 - Strategy 4's metrics with and without trading costs for the 2010-2015 period (* indicates significance at the 5% level)

STRATEGY 4 (2010-2015) with trading costs								
	Strategy	**Benchmark**		**Risk-Factors Regression**				
Average Annual Return	2.7%	4.0%		Alpha	MKT-RF	SMB	HML	WML
Annual Volatility	3.9%	21.7%	**Coefficient**	0.28%	-0.02	-0.03	0.06	-0.01
Sharpe Ratio	0.69	0.18	**S.E.**	0.17%	0.04	0.09	0.08	0.06
Maximum Drawdown	-6.2%	-35.0%	**T-statistic**	1.67	-0.60	-0.32	0.71	-0.12
STRATEGY 4 (2010-2015) without trading costs								
Average Annual Return	4.6%	4.0%		Alpha	MKT-RF	SMB	HML	WML
Annual Volatility	3.9%	21.7%	**Coefficient**	0.47%	-0.03	-0.04	0.06	-0.02
Sharpe Ratio	1.17	0.18	**S.E.**	0.18%	0.04	0.09	0.09	0.06
Maximum Drawdown	-5.2%	-35.0%	**T-statistic**	2,54*	-0.65	-0.40	0.67	-0.29

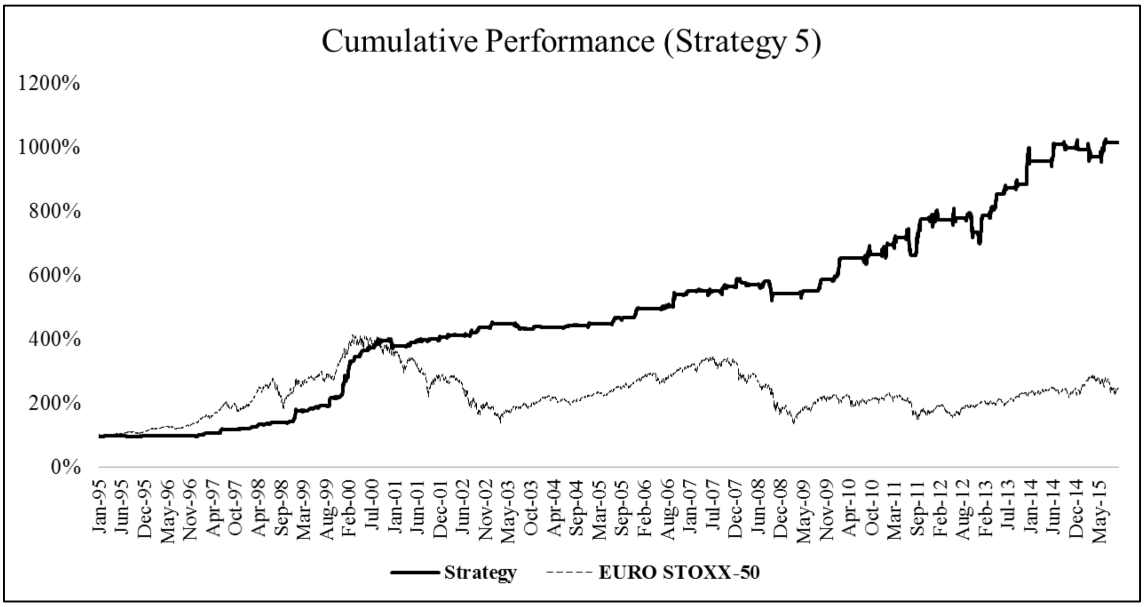
Table 6 - Strategy 4's metric with trading costs and with increased leverage for the 2009-2015 period (* indicates significance at the 5% level)

STRATEGY 4 (2010-2015) with trading costs and increased								
				Risk-Factors Regression				
Average Annual Return	9.5%	4.0%		Alpha	MKT-RF	SMB	HML	WML
Annual Volatility	9.7%	21.7%	**Coefficient**	1.00%	-0.06	-0.09	0.15	-0.04
Sharpe Ratio	0.98	0.18	**S.E.**	0.44%	0.10	0.23	0.22	0.16
Maximum Drawdown	-13.6%	-35.0%	**T-statistic**	2,24*	-0.67	-0.39	0.69	-0.24

5.3 Proposed Strategy's Analysis

The strategy which increased the weight of every trade to 50% from 2010 onwards is referred as from now on as Strategy 5. Cumulative performance of Strategy 5 using the whole sample is illustrated in Figure 3:

Figure 3 - Strategy 5 cumulative performance vs EURO STOXX-50 over the 1995-2015 period rebased at 100%



Looking at the chart, one can highlight another two positive points of the strategy. Firstly, the fact that returns are not affected during periods of strong losses in the *EURO STOXX-50* such as the 2000-2002 and 2007-2009 periods. In those periods, the cumulative performance remained quite stable which is very appealing to hedge fund managers seeking to protect capital during crisis. Another important aspect has to do with the clustering of returns in a specific period of time which did not happen: returns were constant over time which is also another goal hedge fund managers seek. Using the whole sample, the results of Strategy 5 are presented in the Table 7:

Table 7 - Strategy 5's metrics for the 1995-2015 period (* indicates significance at 5% level)

STRATEGY 5 (1995-2015)								
	Strategy	**Benchmark**	**Risk-Factors Regression (monthly returns)**					
Average Annual Return	11,1%	6,7%		Alpha	MKT-RF	SMB	HML	WML
Annual Volatility	7,9%	22,6%	**Coefficient**	0,93%	0,09	-0,11	-0,20	0,08
Sharpe Ratio	1,41	0,30	**S.E.**	0,20%	0,04	0,09	0,08	0,05
Maximum Drawdown	-13,6%	-66,9%	**T-statistic**	4,55*	2,18*	-1,25	-2,52*	1,63

As expected after a closer look at the comparison between the cumulative performance of the strategy and the cumulative performance of the benchmark, and despite being significantly positive (t-statistic is 2.18), the market coefficient from the C4F regression is very small. According to the regression, a portfolio following this strategy is exposed to only 9% of the market swings which is especially important during crisis. At a 5% significance level, *SMB* and *WMB* factors are not significantly different from 0 while the value factor *HML* is negative and significant with a value of -20% meaning the portfolio is capturing negatively the returns provided from a value portfolio. Lastly, it is important to stress the fact that the strategy not only had a higher *SR* but also a lower maximum drawdown when compared to the benchmark, the *EURO STOXX-50*.

5.4 Sensitivity Analysis

Not only it is important to check how the proposed strategy performed but also to see how results change if inputs are slightly changed. This sensitivity analysis checks how do *SR* and the significance of *alphas* (measured by the t-statistic) react to different periods of trading. Start day of the long position in the spread for additions ranges from ED-11 until ED-8 and the end of the short position ranges from ED+5 until ED+8. Table 8 summarises results:

Table 8 - Sensitivity analysis to SR and significance of alpha when changing the start and end of the trading periods

	Sharpe Ratio				Alpha's significance (t-statistic)			
	End of short position (day)				End of short position (day)			
Start of long position (day)	5	6	7	8	5	6	7	8
-11	1.30	1.35	1.36	1.31	4.17	4.31	4.43	4.29
-10	1.37	1.41	1.42	1.36	4.41	4.55	4.67	4.51
-9	1.36	1.40	1.41	1.35	4.40	4.53	4.66	4.51
-8	1.35	1.39	1.39	1.33	4.50	4.62	4.75	4.58

As it is observable, the main results are very stable when small changes happen with the periods of trading. *SR* stays persistently above 1.3 while *alpha* generation is also always clear significantly positive. One can consequently conclude that the proposed strategy is not an isolated sweet spot with results that vanish when small input changes happen.

6. Summary and Conclusions

Companies change over time. Some experience an incredible increase in its market value while others become irrelevant or even disappear. Therefore, stock market indexes' composition is changed over time to ensure a proper reflection of the broad market. This study aimed to check whether these events produced abnormal returns in added and deleted stocks as suggested by literature. Furthermore, it tried to structure an attractive trading strategy for a hedge fund to apply.

This study analysed the return of stocks in excess of the market of both added and deleted stock around the effective replacement date. Events ranging from 1995 until 2015 within the most popular European indexes (*CAC-40*, *DAX-30*, *FTSE-100*, *IBEX-35* and *EURO STOXX-50*) were subject of the analysis.

The study found that changes in index composition indirectly affect stock excess returns as suggested in the literature.

There is evidence of the theory of price pressure suggested in the literature for added stocks with the exception of events in the *DAX-30*. Stocks added to other indexes have statistically significant positive excess returns until a day before ED. After ED, events in all analysed indexes generate negative and statistically significant excess returns. Regarding deletions, results are mixed. In the period before ED only the *FTSE-100*, *IBEX-35* and the *EURO STOXX-50* show negative excess returns. After ED it is not possible to draw any significant conclusion.

It was also observed a decrease in the significance of results when testing only the 2nd half of the sample which may indicate that these abnormal returns are being already traded by arbitrageurs. However, it was still possible to successfully trade and generate *alpha* since 2010 by increasing the weight of the trades.

The proposed trading strategy was back tested with trading costs and includes only additions in the *CAC-40*, *IBEX-35* and *EURO STOXX-50* as including *FTSE-100* and deletions generated a large drawdown which cannot be recommended. It trades the spreads between the stocks and the stock market index where the event takes place with a long position in the spread from ED-10 to ED-1 and a short position from ED to ED+6. Back tested for the whole sample, the strategy yields a Sharpe Ratio of 1.41 and generates an annualised *alpha* of 11%. For the period from 2010 onwards, Sharpe Ratio decreases to 0.98 while *alpha* slightly increases to 12% proving the attractiveness of the strategy also in the past years. These positive results are not changed with small changes of the inputs (start and end day of the trading strategy). Moreover, the strategy's results are stable when small changes in the start and end day of the strategy occur. Finally, it seems to react positively during crisis and to generate continuous returns over time.

References

Bildik, Recep, and Güzhan Gülay. 2001. "Effects of Changes in Index Composition on Stock Market: Evidence from Istanbul Stock Exchange."

Blume, Marshall E., and Roger M. Edelen. 2004. "S&P 500 Indexers, Tracking Errors, and Liquidity." *The Journal of Portfolio Management*, 37-46.

Boehmer, Ekkehart, Jim Masumeci, and Annette B. Poulsen. 1991. "Event-study methodology under conditions of event-induced variance." *Journal of Financial Economics*, December: 253-272.

Chakrabarti, Rajesh, Wei Huang, Narayanan Jayaraman, and Jinsoo Lee. 2005. "Price and volume effects of changes in MSCI indices – nature and causes." *Journal of Banking & Finance*, May: 1237-1264.

Duque, João, and Gustavo Madeira. 2004. "Effects associated with index composition changes: evidence from the Euronext Lisbon Stock Exchange."

Harris, Lawrence, and Eitan Gurel. 1986. "Price and Volume Effects Associated with Changes in the S&P 500 List: New Evidence for the Existence of Price Pressures." *The Journal of Finance*, September: 815-829.

Hegde, Shantaram P., and B. John McDermott. 2003. "The liquidity effects of revisions to the S&P 500 index: an empirical analysis." *Journal of Financial Markets*, May: 413-459.

Kolari, James, and Seppo Pynnönen. 2010. "Event-Study Methodology: Correction for Cross-Sectional Correlation in Standardized Abnormal Return Tests." *Journal of Financial Research.*