

Price Response to Factor Index Additions and Deletions

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Abstract

Abnormal price reaction around S&P 500 index changes has been considered as strong evidence that long term demand for stocks is downward sloping. This notion, however, has recently lost popularity due to the evidence that new additions are accompanied with a contemporaneous change in future earnings expectations. In this study we show that factor index rebalancing is a true information free event. The cumulative abnormal return from announcement to effective day is 1.07% for new additions and -0.91% for new deletions and around two-thirds of this effect is permanent. We find a direct relationship between the magnitude of abnormal returns and the abnormal volume coming from index funds. The documented effect results in a direct loss to index fund investors of 16.5 bps per annum.

JEL Classification: G11, G12, G14

Keywords: demand curves, factor premiums, low volatility, MSCI Minimum Volatility index, abnormal returns, abnormal volume, earnings change.

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I. Introduction

Flat demand curve for stocks is a key assumption in modern finance theories such as the Capital Asset Pricing Model of Sharpe (1964) and Lintner (1965) and the Arbitrage Pricing Theory of Ross (1976). These concepts are based on the idea that stocks have perfect substitutes and risk is the only determinant driving stock prices. If there is no change in the perceived riskiness of a stock investors can trade large quantities with no significant price impact. In this paper, we document significant abnormal price movements around factor index additions and deletions and provide evidence in favor of downward sloping demand curves.

As the lack of evidence for flat demand curves could cast doubts on these concepts a large body of literature is concentrated in this area. The general research framework is to identify stocks that exhibit supply shocks and examine their subsequent price reaction. A first stream of literature investigates price movements around large block sales and surprisingly document strong negative reactions (e.g. Scholes, 1972, Partch, 1985, Holthausen, Leftwich, and Mayers 1987). However, these events arguably suffer from information contamination. That is if the supply shock is caused by a flow of new information to the market then price movements are rational and reflect adjustments to their new fundamental values. Large block sales are often triggered by investors having new negative information about the stock. Later studies acknowledge this weakness and look for other ways to identify information-free events.

A large stream of literature on demand curves focuses on abnormal return patterns around S&P 500 index changes. It is motivated by the fact that, as Standard and Poor's claims, this index contains no relevant information about stocks, meaning that additions and deletions are purely mechanical. As such, if markets are efficient and demand curves for stocks are flat, new additions to the index are not supposed to exhibit abnormally high returns. Harris and Gurel (1986), Shleifer (1986), Beneish and Whaley (1996), Chen, Noronha, and Singal (2004) all document the opposite – new additions are associated with high abnormal returns. These studies, however, disagree on the reason for the price movement. Harris and Gurel (1986) show that the effect is temporary driven by compensation for providing immediate liquidity. The remaining studies find permanent price increase consistent with long-term downward sloping demand curves, which casts serious doubt on the efficient markets hypothesis.

More recent studies question the premise that S&P 500 additions are information-free events. Denis, McConnell, Ovtchinnikov, and Yu (2003) show that newly added stocks significantly improve both their forecasted and realized earnings, suggesting that despite thought to be information-free, index additions do contain new information for stocks. Therefore, the documented abnormal inclusion returns are not evidence for downward sloping demand curves but, similar to large block sales, they reflect the mechanism of prices adjusting to their fundamental values. Some of the reasons mentioned to explain the improved fundamentals after inclusion in the S&P 500 are better monitoring by investors, higher reputation risk for firm managers causing them to put more efforts, or higher analyst coverage leading to higher information quality which lowers the risk premium related to information uncertainty demanded by investors.

In this paper we identify a unique and novel information-free event in the face of factor index additions and deletions. These type of indices are relatively new investment vehicles based on the insights of Fama and French (1992, 1993) that some market segments, such as high book-to-price or small capitalization stocks systematically outperform the market portfolio in the long run. This trend, also known as factor investing, quickly gains popularity in the financial industry and opens new possibilities for practitioners as well as academics.

Factor indices are characterized by two unique features. First, all stocks included in the index are already part of a broader “parent” index. As such, the critique that there is an improvement in fundamentals after including stocks in a “parent”, e.g. S&P 500, is ungrounded since all stocks of a sub-index are already part of the broad index. That is there is no increased analyst coverage, management motivation, or better monitoring just because a stock is moved from one segment of S&P 500 to another. Second, the construction of factor indices is purely mechanical as it is simply based on ranking stocks on characteristics such as book-to-price, past volatility, or return-on-equity. This information is public and available to market participants so using it to put a ‘label’ on a stock should have no consequences for future stock return.

The contributions of this paper can be summarized as follows. First, by using MSCI Minimum Volatility indices we show that factor index rebalancing is a true-information free event. Additions and deletions are not associated with significant increase in future earnings expectations. Second, we document positive (negative) and significant abnormal price reaction for newly added (deleted)

stocks. The cumulative abnormal return from announcement to effective day is 1.07% (-0.91%) and around two-thirds of this effect is permanent. This evidence suggests that after a stock is added to a factor index there is a new supply-demand equilibrium achieved from a rightward shift of a downward sloping demand curve. Third, we find a direct relationship between the magnitude of abnormal returns and the abnormal volume coming from index funds. Finally, we estimate the cost of transparency for public factor indices to be 16.5 bps per annum which has important implication for the pricing of investment vehicles aiming to provide access to academically documented factor premiums.

The rest of the paper is organized as follows. Section II makes a detailed overview of the related literature and explanation hypotheses. Section III describes our data, index choice, and methodology. Section IV summarizes our main empirical findings. Section V presents a discussion and alternative explanation of the results. Section VI explains the practical implication of our study and Section VII concludes.

II. Related literature and competing hypotheses

1. Related literature

The idea that S&P 500 index changes contain no information about the earnings of companies triggered a wave of academic research using it as a tool to examine the assumptions of CAPM and modern finance theory. In his influential study, Shleifer (1986) questions the market efficiency hypothesis by showing that a new stock inclusion to the S&P 500 index results in a 3% permanent price increase. The main hypotheses which explain this pattern are the imperfect substitutes hypothesis and the price pressure hypothesis. Shleifer attributes his results to downward sloping demand curves triggered by increased index fund trading which is in line with the former hypothesis.

In a simultaneous study Harris and Gurel (1986) also test abnormal return and volume reactions around S&P 500 index changes. Unlike, Shleifer (1986), Harris and Gurel (1986) document that the abnormal price increase almost fully reverses within two weeks. The temporary nature of the effect provides evidence for the price pressure hypothesis which suggests that long term demand

curves for stocks might still be flat as proposed by the efficient markets hypothesis. As such, the abnormally high return immediately following announcement of index changes serves as a compensation for passive stock holders who offer immediate liquidity to index funds, while the subsequent price reversal allows them to buy back their stock at a profit.

Beneish and Whaley (1996) analyze the effect of a methodological change in the S&P 500 composition – the decision to announce future index changes five days before they are actually implemented. Using intraday data the authors show that this change affects index tracking significantly. The previously documented 3% immediate price increase in Shleifer (1986) appears to be an unfeasible trading strategy as this is a close-to-open return reflecting market microstructure mechanisms. However, the five day pre-announcement period attracts risk arbitrageurs who buy future additions in advance with the idea to sell them at a higher price later on. This arbitrage activity is estimated to increase prices with around 2.2% before the effective day.

Chen et al. (2006) dig deeper into the negative effect of risk arbitrageurs to index investors. First, they justify five days pre-announcing window as it allows investors to prepare better for the future trades. However, as index trackers are forced to keep a low tracking error, they tend to buy the new additions at the effective day, allowing arbitrageurs to perfectly anticipate the future trades. The loss of S&P 500 index investors is reported to be as large as 4 bps amounting to almost 4 billion US dollars per annum.

Chen et al. (2004) study in further detail both the additions and deletions to the S&P 500 index. They confirm the findings of Shleifer (1986) that prices of newly added stocks exhibit a permanent increase. However, they contribute to the literature by showing that there is an asymmetric effect in price responses, caused by the lack of permanent price decline for index deletions. The effect is explained with change in investor's awareness as the number of shareholders in a given stock is largely increased after it is added to the index but it is not decreased after the stock is delisted. In contrast, in an earlier study Goetzmann and Garry (1986) show a continuous price drop following an exclusion from the S&P 500 index, motivated with expectations for worsened quality of the future financial information, stemming from reduced analyst coverage or poorer control on accounting statements.

Denis et al. (2003) recognize the importance of this stream of literature and dig deeper into their main assumption – no underlying information change after an S&P 500 addition. They do so by analyzing the expected and realized earnings prior to and following an addition to the index. Surprisingly, the study finds that analyst earnings forecasts of newly added stocks are higher than the forecast of the benchmark companies. Furthermore, the realized earnings of new additions beat those of peer firms, indicating that operating performance improves after stocks are added to S&P 500. The authors do not elaborate on the causal relationship of whether stocks experience improved performance because they are added to the index or they are added to the index because of their improved performance (despite S&P rejecting the later). In both cases the fact that announcement for an index change is associated with positive earnings information for the newly added firms means that S&P 500 index additions are not information-free events.

Boyer (2011) first initiates factor or style indices as academically interesting phenomena. He focuses on S&P/Barra Value and Growth indices as they are already part of the broader S&P 500 index and convey no additional information about stocks. Boyer shows that a simple relabeling of a stock from ‘value’ to ‘growth’ increases its co-movement with the index to which it is added irrespective of the change in characteristics of this stock. He attributes this movements to active style investors who want to mitigate the deviation from the relevant style benchmark.

The information content of S&P 500 index additions has opened a gap in the literature which still persists. We fill this gap by analyzing abnormal price reaction around factor index additions and deletions as proxies for information free events.

2. Competing hypotheses

Imperfect substitutes hypothesis

Classic asset pricing theories such as CAPM and APT assume that demand curves for stocks are perfectly elastic or flat. In a CAPM framework risk is the only determinant of stocks expected return and investors can buy unlimited quantities of any stock. That is if supply of a stock is scarce they will buy another stock with similar risk return characteristics. APT assumes that investors can replicate any stock with a combination of other stocks so supply shocks have no effect on its expected return. Introducing real-life frictions in such a model might change the perception of

perfect substitutes. For example, if a new stock is included in an index, there is a higher demand from index trackers, motivated by maintaining lower tracking error rather than its risk return characteristics. That is, if stock A is included in an index and stock B has exactly the same expected return, index fund investors will still prefer stock A. However, the unchanged risk return profile gives no incentive to investors holding the stock to sell it. As such, they will require a higher return premium in order to sell the stock to passive investors which will move the equilibrium price up. This framework has been used to interpret permanent price increase around demand shocks as evidence for long-term downward sloping demand curves.

Price pressure hypothesis

The price pressure hypothesis gives an explanation of abnormal returns around index rebalancing which is in line with efficient markets hypothesis. It assumes that if prices reflect all available information demand is perfectly elastic in the long run. However, it does not mean that short term frictions are not possible. In this case there is no new equilibrium price caused by index trackers. Price goes up due market microstructure mechanisms. In the face of high unbalanced supply and demand orders market makers face costs related to deviating from optimal inventory and finding counterparty for the trade. To offset these costs the market maker will adequately adjust the bid-ask spread which will be reflected in the observed price. However, when the price deviates too much from its fundamental value, informed investors will trade in the opposite direction which will bring it back to the existing equilibrium level. This would mean that demand curves slope down only in the short term while remaining flat in the long term.

III. Data and methodology

1. Data

We download Morgan Stanley Capital International (MSCI) constituent data for Global markets, United States, Europe, and Emerging markets from FactSet. For each region we download MSCI Minimum Volatility holdings as well as the relevant parent index holdings. Detailed data description can be seen in Table 1.

[INSERT TABLE 1 ABOUT HERE]

MSCI Minimum volatility indices are rebalanced twice a year, last working day of May and November at close prices and the change becomes visible on the next working day. The first rebalancing with available data on FactSet is November 2010 (May 2011 for Europe) which is when we start our analysis. This differs from the actual launching date of the index which is in 2008 for Global markets and U.S and 2009 for Europe and Emerging markets but is a reasonable assumption since major index trackers such as iShares started tracking the index in 2011. Our final sample is November 2010 – December 2015 consisting of 11 rebalancing moments. On average MSCI Minimum Volatility indices have 183 stocks with 20 new additions and 14 new deletions per rebalancing. The actual number of additions and deletions ranges between 12 and 25 for the additions and 10 and 19 for the deletions. The annual single counted turnover is 20% which matches the announced turnover by MSCI.

Our return and shares outstanding data are downloaded from Interactive Data Exshare. If not available we use MSCI returns series, and where this is also not available - S&P/IFC. Daily returns include dividends, stock splits and other capital adjustments and are denominated in US dollars. Free float adjusted market capitalization data are obtained from FTSE and S&P/IFC and. U.S. dollar denominated price and trading volume per share data are gathered from FactSet. Volume is measured in U.S. dollar per share traded per day at all exchanges where the stock is listed with available data on FactSet. We then multiply it by number of shares outstanding to calculate our total trading volume variable. Analyst earnings forecast data are gathered from Institutional Brokers' Estimate System (IBES). We use median forecast for end of fiscal year one (FY1) and fiscal year 2 (FY2).

2. MSCI Factor Indices.

MSCI has introduced a new family of indices aiming to provide exposure to academically documented factor premiums. The two most popular and long standing indices are MSCI Value Weighted Index and MSCI Minimum Volatility index. The former uses an approach of weighting all constituent stocks in the parent index according to valuation variables such as book-to-price. This makes it unsuitable to investigate price reaction around new additions as they overlap with

the additions to the parent index. On the other hand, MSCI Minimum Volatility index family is one that aims to provide access to the low volatility factor (Black, 1972, Ang et.al, 2006, Blitz and Van Vliet, 2007) by investing in a subset of stocks with lower risk profile within its parent index. This ensures that new additions do not coincide with new additions to the parent index but are rather relabeling of existing stocks.

MSCI Minimum Volatility index uses the Barra Open Optimizer to create a minimum variance portfolio conditional on a predefined set of constraints (MSCI Minimum Volatility Indices Methodology, 2012). The resulting portfolio is a subset of the relevant parent index e.g. MSCI World index. The index is rebalanced semi-annually coinciding with the parent index rebalancing. Changes in the index are effective as of the close of the last working day in May and November which makes them visible the first working day of the next month. According to MSCI, changes are announced nine trading days before they actually take place. Turnover is limited to 20% per year single counted as it is split between new inclusions and reweighting existing stocks in the index.

3. Methodology

The first step in our approach is to identify new additions and new deletions. A stock is considered newly added (deleted) the first day when it is in (out of) the portfolio. This day we identify as the effective day (ED). Since MSCI adds stocks at close prices a stock is effectively in the portfolio at market open at ED, meaning that if index trackers want to have the stock at ED they need to buy it at ED-1. Announcement day (AD) is nine business days before stocks are added (deleted) so $AD = ED-9$.

We follow these steps for MSCI Minimum Volatility indices as well as their relevant parent indices. We exclude stocks which are simultaneously added to the factor index and the parent index. This step has two important consequences. First, we control for the “S&P 500” inclusion effect. Previous literature has shown strong and significant price reaction around S&P 500 additions as Chakrabarti et al. (2005) show that the effect holds for other benchmark indices such as MSCI World or MSCI USA index . Since MSCI Minimum Volatility indices are rebalanced at the same times as their parent indices some stocks enter both indices simultaneously. As such, it might be that the observed price reaction for the overlapping stocks is not due to addition to the

factor index but due to addition to the parent index which is an already documented effect. Removing these stocks from our sample allows us to investigate the pure effect of factor index additions and deletions. This is a conservative choice and biases our results downwards. Second, we exclude index changes due to corporate actions. If a stock is added (excluded) to a factor index due to corporate event such as spin off or acquisition it will (not) be seen also in the parent index at the same time. Excluding parent index changes will remove corporate action motivated index changes from our sample.

Our main analysis follows a standard event study methodology. The abnormal return of a stock i at day t (AR_{it}) is calculated as the return of stock i in excess of the return of the factor index it is added to (excluded from). We use the factor index as the appropriate benchmark to control for the low beta characteristics of the low risk stocks targeted by minimum volatility indices. This is also the relevant benchmark for investors in factor indices. Cumulative abnormal return (CAR) of stock i from day $t-n$ to day t is calculated as the sum the abnormal returns of stock i from day $t-n$ to day t ($CAR_{i,t-n:t} = \sum_{t-n}^t AR_i$). Average abnormal return at day t (AAR_t) is the average of the abnormal returns of all new additions (deletions) at day t ($AAR_t = \frac{1}{N} \sum_i AR_{it}$, where N is the number of additions or deletions). As a robustness check we also calculate abnormal returns using a market model. We only include trading days removing weekends and public holidays. Public holidays we define as days with no trades in any stocks of the parent index. In our global markets analysis we exclude U.S. public holidays as in these days trading volume is abnormally low and distorts the market volume ratios.

In our main sample we include additions and deletions from the four regional MSCI Minimum Volatility indices – United States, Global markets, Europe, and Emerging markets. The abnormal return of every stock is calculated relative to the index it is added to (deleted from). So if at day t we have two additions – stock A and stock B. Stock A is added to MSCI USA Minimum Volatility index and stock B is added to MSCI World Minimum Volatility index the average abnormal return (AAR) of our sample at month t would be the average of the excess return of stock A over MSCI USA Minimum Volatility index and the excess return of stock B over MSCI World Minimum Volatility index.

The abnormal volume estimation methodology follows the one used in Harris and Gurel (1986). We calculate the ratio of trading volume of a stock divided by its normal trading volume, corrected

by the trading volume of the market divided by the market's normal trading volume. The average abnormal volume (AAV) for all additions deletions is

$$AAV_t = \frac{1}{N} \sum_i \left(\frac{V_{it}}{V_{mt}} \cdot \frac{V_m}{V_i} \right) \quad (1)$$

Where V_{it} is the dollar traded amount of stock i at day t , V_{mt} is the dollar traded amount of all stocks in the parent index at day t , V_i is the 40 day average trading volume of stock i from AD-50 to AD-10 where AD is the announcement day. AD-10 (ten days before the announcement day) is the first day of our event window, V_m is the average trading volume of all stocks in the parent index from AD-50 to AD-10. Our final sample formation follows the same steps as the sample for abnormal returns.

We calculate the earnings expectation changes in the spirit of Dennis et al. (2003). Use the median analyst forecast denominated in U.S dollars. The change in forecast of stock i (ΔF_{it}) is calculated as the difference between the median analyst forecast 10 days after the effective day and the median analyst forecast 10 days before the effective day (one day before the announcement day). The average change in earnings forecast for all additions (deletions)

$$AF_t = \frac{1}{N} \sum_i (F_{it} - F_{it-20}) \quad (2)$$

We also calculate the average change in forecast scaled by price in order to correct for structural differences between earnings levels across countries using the following formula

$$AFP_t = \frac{1}{N} \sum_i \left(\frac{F_{it} - F_{it-20}}{P_{it}} \right) \quad (3)$$

We then calculate the change of earnings forecast for all stocks in the relevant factor index as the average change of earnings forecast of all constituent stocks. We use median earnings forecast for the current fiscal year end in the May rebalancing and median forecast for the end of the following fiscal year end in the November rebalancing. The reason for using fiscal year two forecast is that 10 days after the November additions is 12 days before the end of the current fiscal year end when the realized earnings are known with high certainty so expectations are less relevant.

After we have calculated the ratios we test for a difference in means between the earnings forecast change of new additions (deletions) and the market earnings forecast change.

$$t = \frac{AF_t - AFM_t}{\sqrt{\frac{s_{AF_t}^2}{N_{AF_t}} + \frac{s_{AFM_t}^2}{N_{AFM_t}}}}$$

Which has distribution $T(m)$ with

$$m = \frac{\left(\frac{s_{AF_t}^2}{N_{AF_t}} + \frac{s_{AFM_t}^2}{N_{AFM_t}}\right)^2}{\frac{\left(\frac{s_{AF_t}^2}{N_{AF_t}}\right)^2}{N_{AF_{t-1}}} + \frac{\left(\frac{s_{AFM_t}^2}{N_{AFM_t}}\right)^2}{N_{AFM_{t-1}}}} \quad (4)$$

Where $s_{AF_t}^2$ is the variance of earnings forecast changes of all additions (deletions), $s_{AFM_t}^2$ is the variance of earnings forecast changes of all additions (deletions). N_{AF_t} and N_{AFM_t} are the number of observations in the additions (deletions) sample and all stocks in the factor index.

Finally we run a regression of abnormal return on abnormal volume

$$AR_{i,ED-1} = a + b \cdot AV_{i,ED-1,t} + \varepsilon_{i,ED-1} \quad (5)$$

Where $AR_{i,ED-1}$ and $AV_{i,ED-1,t}$ are the abnormal return and abnormal volume of stock i the last day before the effective day.

IV. Empirical results

In Table 2 we show the main results of an event study surrounding additions in MSCI Minimum Volatility indices (the index). We examine both short- and long-term price reaction by using alternative event windows. The period of focus is the nine day period between the announcement day and the effective day (AD : ED) as this is where we expect the prices to move abnormally.

Panel A shows results for newly added firms in the index. The cumulative abnormal return from AD to ED is 1.07% which is positive and highly significant (t-stat of 7.16). For 62% of the additions CAR has been positive during this period. 0.63% out of the 1.07% is gained only in the day preceding the effective day (ED-1) showing that the effect is largely driven by the shift in demand caused by index funds. 0.31% of the cumulative abnormal return is offset in the five days following the effective day (ED : ED+5) but the price seems to stabilize at this level as it remains

intact in the following 10 days ($CAR_{ED:ED+15} = -0.34\%$ which is almost equal to the -0.31% from ED to ED+5). We do not extend the post addition event windows further as results might be contaminated with stock specific information.

[INSERT TABLE 2 ABOUT HERE]

These results suggest that 32% (0.34% out of 1.07%) of the abnormal price reaction is temporary and 68% is permanent. The high permanent increase in price is consistent with the long-term downward sloping demand curve documented by Shleifer (1986). The temporary increase can be attributed to a liquidity premium charged by stock owners for rebalancing their portfolio or arbitrage activity. A distinctive feature of factor indices is that they are fully transparent. To construct them a publically known algorithm is used meaning that informed investors can perfectly anticipate the new additions (by replicating the index) even before the announcement day. Our results, however, show that this is not done as CAR in the 10 days before the announcement day is only 0.12% and is not statistically different from zero (t-stat of 0.69).

We continue the analysis with abnormal volume estimation. Our approach corrects for both stock and market normal volume levels so the expected value in a ‘normal’ day is 1. Panel B shows that the average trading volume of new additions between the announcement and the effective day is 30% higher than normal which is statistically significant (t-stat = 3.81). Consistent with the abnormal return analysis the highest volume is observed in the day prior to ED as it is 74% higher than expected. The trading volume then slowly normalized to an average of 1.15 during the three weeks after the addition. The fact that trading volume remains abnormally high relative to pre-addition levels is consistent with the permanent price increase caused by a structural shift in demand. The small difference in number of observations is attributable to return or volume data availability.

Figure 1 shows the cumulative abnormal return and abnormal volume patterns on a continuous basis. The trading volume starts to increase shortly after the announcement day, then lowers again, and reaches its maximum at ED-1. This pattern can be explained by arbitrageurs taking their positions right after announcement and index trackers needing to wait until the last moment to maintain low tracking error. Arbitrageurs then unwind their positions in the days after the addition takes place which justifies the sharp price drop right after the effective day. Afterwards the price seems to stabilize.

[INSERT FIGURE 2A ABOUT HERE]

In table 3 we show that the opposite conclusions hold for index deletions. CAR from AD to ED-1 is -0.91% as 57 percentage point are lost in the final day before deletion. 64% of all deletions have negative return in the day prior to the effective day. Approximately half of price loss (0.49% out of 0.91%) is gained back within three weeks after deletion. Compared to additions here we see a stronger price reversal after the effective day which is partly consistent with the asymmetric S&P 500 effect documented by Chen et. al (2004). Trading volume shows similar patterns as the ones for additions. It is equal to exactly 1.00 during the ten days prior announcement and then increases, peaking at the day prior deletion at a level 46% higher than normal. It then normalizes back to 1.01 on average in the three weeks after the deletion.

[INSERT TABLE 3 ABOUT HERE]

Figure 2 shows virtually the opposite return and volume patterns to the ones of index additions. Due to short sales constraints we do not see a very high trading volume after the announcement day. However, prices continuously drop in anticipation of the forthcoming excess supply coming from index trackers. Trading volume peaks at ED-1 and within the next two days stabilizes back to normal levels.

[INSERT FIGURE 2B ABOUT HERE]

V. Result interpretation

In this section we conduct further tests to differentiate better between competing explanations of the observed effect.

1. Information content in factor index changes

First we address the information contamination hypothesis which is the main criticism of the literature focusing on S&P 500 additions.

In the spirit of Denis et. al (2003) we use a number of alternative methodologies to show the change in expectations for the future earnings of additions and deletions to the index. Panel A of Table 4 presents the frequency of earnings forecast changes. In this analysis we should not only focus on the number of positive or negative forecast changes of additions and deletions but we should compare them to the frequency of changes in the relevant benchmark which, as in our event study

analysis, is all constituent stocks in the factor index. During our sample period 47.1% of the forecasts are revised downwards, 36.6% upwards and 16.3% exhibit no change. This is consistent with previous studies showing the analysts are more likely to revise their estimates downwards with the approach of fiscal year end. New additions have earnings forecast frequencies almost exactly equal to those in the benchmark (47.2%, 37.3%, and 15.5% respectively) meaning that the higher abnormal returns cannot be attributed to a higher likelihood of earnings forecast increase. Deletions do have slightly higher probability of a downward revision (52.3% compared to 47.1% in the benchmark)

[INSERT TABLE 4 ABOUT HERE]

The equal probability of earnings forecast change in newly added firms and the benchmark does not fully mean that the anomalous returns of those stocks cannot be attributed to change in the perceived fundamentals of the companies. It could be that the number of forecast changes is the same but the magnitude of new additions and deletions is much stronger. In Panel B we test for a difference in the magnitude of earnings forecast changes. We see that the earnings forecast of additions, deletions, and the benchmark have changed with 0.02, 0.01, and 0.06 U.S. dollars per share respectively. This confirms the previous conclusion that the positive price change of additions cannot be attributed to change in fundamentals. Deletions do exhibit worse forecasts but further tests for the significance of the difference between deletions and benchmark means show that it is not statistically significant (t-stat of -1.16).

Our sample of firms contains stocks from different regions that could have structurally different earnings per share levels. Therefore, in Panel C we scale earnings changes by price in U.S. dollars to look at the percentage changes. The results still indicate no significant difference between earnings forecast changes of factor index additions and deletions from the benchmark. With these results we present strong evidence that factor index rebalancing is information-free event of supply shocks. This allows us to overcome the weaknesses of previous literature, focused on S&P 500 additions, and propose a novel framework for testing demand curves for stocks.

2. Volume hypothesis

Knowing that the anomalous return patterns around index reshuffles are not attributable to new information flowing to the market we can focus on trading volume as an alternative explanation.

We then regress abnormal returns on our abnormal volume measure. The low tracking error requirements as well as the results of our abnormal volume and returns analysis suggest that index funds seem to include new stocks in the final day before the effective day. As such, the abnormal volume on that day can serve as a measure for index fund trading. If the permanent increase in prices is due to an exogenous shift in demand coming from index funds then the relationship between abnormal returns and abnormal volume should be in line with the side of the trade coming from index funds – positive for index additions and negative for index deletions.

[INSERT TABLE 5 ABOUT HERE]

Table 5 confirms this notion. The slope coefficient of abnormal volume is positive and significant meaning that their demand does affect stock prices. The opposite holds for index deletions as the coefficient is negative and highly significant. That is the high trading volume of index deletions come from the shock in supply coming from index trackers which puts negative pressure on prices. As index trackers step out of the stock the demand curve shifts left and prices stabilize at a lower level.

The specifications of Regression 3 and Regression 4 in Table 5 address possible alternative explanations of the observed effect. For instance, can it be attributed to other firm characteristics such as size, forward earnings valuations, and profitability. In both cases abnormal volume is still significantly related to abnormal returns, 0.10 (t -stat of 3.24) and -0.27 (t -stat of 3.38) for additions and deletions respectively. This reassures that the abnormal price reaction is really driven by index fund demand. However, firm size is also significantly related to abnormal returns at rebalancing moments meaning that part of the effect comes through a liquidity channel. Abnormal returns of additions are stronger for smaller stocks which are usually less liquid. As such the high additional demand of index trackers has a bigger impact on stock prices. The opposite is observed for index deletions – abnormal returns are negatively related to firm size. Given that short sale constraints are smaller for larger firms our results suggest that part of the abnormal negative returns of deletions are due to short sale pressure coming from hedge funds.

VI. Practical implications.

The results documented in this paper have strong practical considerations for index funds investors. They are the ones who ultimately bear the cost associated with price changes preceding index additions and deletions. For instance Chen et al (2006) estimate that the dollar losses to investors in indices tracking S&P 500 is 4 bps per year which translates to an annual loss of almost 4 billion U.S. dollars. To calculate the loss to factor fund investors we multiply index turnover due to index changes by the cumulative abnormal return between announcement and effective days.

$$\text{Performance drag} = \text{Turnover}_{\text{additions}} \times \text{CAR}_{\text{additions}} + \\ \text{Turnover}_{\text{deletions}} \times (-\text{CAR}_{\text{deletions}})$$

Table 6 presents the results for the four minimum volatility indices that we use. On average new additions represent 9.6% of the portfolio and new deletions 6.8%. This translates to an average performance drag of 16.5 bps which is the price investors pay to invest in public factor indices.

[INSERT TABLE 6 ABOUT HERE]

The CAR used for the estimation is from the announcement day to the close the day before the changes take place. Therefore, some index trackers are able to buy (sell) additions (deletion) before the close price which will lower the estimated performance drag. On the other hand, the 16.5 bps can be biased downwards as the actual number might be higher due to a number of reasons. First, new additions and new deletions correspond to less than half of the total turnover of the index. The remaining turnover comes from weight changes of existing stocks which are also announced in advance. This makes them attractive for arbitrageurs as well as forces index trackers to readjust their portfolio accordingly which could generate price impact even if it is lower than the one for added and excluded stocks. Second, we exclude stocks which are added (deleted) from the parent index to avoid overlap with the already documented ‘S&P 500’ effect. The stocks which are added to (deleted from) the parent index are expected to have much higher (lower) abnormal returns as they are bought (sold) by index trackers following the parent index and its multiple sub-indices. Finally, even though we don’t find evidence for it, it is possible that arbitrageurs replicate the index algorithm and start trading well before the index changes are announced. These points have significant implications for the pricing of publically available investment vehicles as return loss due to publically announced trades can be seen as a shadow fee.

VII. Conclusion

We propose a new information free event of supply shocks in the face of factor index rebalancing. Previous literature has been concentrated around large block sales and changes in S&P 500 index constituents but these events have been shown to contain information about the future earnings potential of companies. We show that there is no link between factor index additions and deletions and improved earnings expectations. This allows us to attribute the documented abnormal returns to a shift an exogenous shift in demand. The abnormal return for new additions (deletions) between announcement and effective day is 1.07% (-0.91%) as 0.73 (-0.42) percentage points of it persist after 3 weeks following the effective day. Similar pattern is seen for abnormal volume as at the effective day it is 74% (46) for additions (deletions). We document a direct relationship between abnormal returns and our proxy for the trading coming from index funds who seem to wait until the last day before adjusting their portfolio. Finally, we calculate the price of transparency for public factor indices to be 16.5 bps per annum which is a direct loss to index fund investors.

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Appendix A

TABLE 1. Descriptive statistics of MSCI Minimum Volatility indices

The table shows descriptive statistics of the 4 MSCI Minimum Volatility indices used to form our sample. Launch date is the official launching date of the index. Start date is the date when it was first included in our sample which corresponds with the date when holdings data are available on FactSet. All stocks, additions, and deletions are the average number of all stocks, new additions, and new deletions during the 11 rebalancing moments of our sample period. Sample period is November 2010 – December 2015. Turnover is the average annual one way turnover of the index.

Index name	Parent index	Launch date	Start date	All stocks	Additions	Deletions	Turnover %
MSCI World Minimum Volatility (USD) Index	MSCI World	Apr-08	Nov-10	246	29	24	20
MSCI USA Minimum Volatility (USD) Index	MSCI USA	Jun-08	Nov-10	140	14	10	20
MSCI Europe Minimum volatility (USD) Index	MSCI Europe	Nov-09	May-11	121	12	8	20
MSCI EM Minimum Volatility (USD) Index	MSCI Emerging Markets	Dec-09	Nov-10	224	25	15	20
average				183	20	14	20

TABLE 2. Abnormal return and abnormal volume for new factor index additions

The sample period is November 2010 – December 2015 including a total of 11 rebalancing moments. The table shows event study results of abnormal returns and abnormal volume surrounding MSCI Minimum Volatility index additions (factor index). The factor index is a combination of MSCI USA Minimum Volatility (USD) index, MSCI World Minimum Volatility (USD) index, MSCI Europe Minimum Volatility (USD) index, and MSCI Emerging Markets Minimum Volatility (USD) index. Abnormal return is calculated as the total USD return of the stocks in excess of the average total USD return of all stocks in the relevant factor index. For example if a stocks is added to MSCI USA Minimum Volatility index abnormal return is calculated over the average MSCI USA Minimum Volatility index, if it is added to MSCI Europe Minimum Volatility index, the abnormal return is calculated over MSCI Europe Minimum Volatility index. The abnormal returns of all new additions to the four indices are then pooled together to form the final sample. Abnormal volume is calculated as in equation 5. It requires a minimum of 10 observations for a stock to be included. Normal trading volume has a value of 1 and 1.30 means that the volume at the specific day is 30% higher than the normal trading volume. The final sample is formed in line with the abnormal return sample as the normal volume estimation is relative to the relevant region. CAR is cumulative abnormal return, AAR is average abnormal return, AV is average volume, AD-10:AD is 10 days prior the announcement day to the announcement day, AD:ED is announcement day to effective day, ED-1 is 1 day prior to the effective day, ED:ED+5 is effective day to 5 days after the effective day, ED:ED+15 is effective day to 15 days after the effective day.

	AD-10 : AD	AD : ED	ED-1	ED : ED+5	ED : ED+15
Panel A: Abnormal returns					
CAR	0.12	1.07	0.63	-0.31	-0.34
AAR	0.01	0.12	0.64	-0.07	-0.03
st. dev	0.47	0.46	2.01	0.73	0.36
<i>t</i> -stat	0.69	7.16	8.55	-2.73	-2.03
% > 0	0.54	0.62	0.63	0.44	0.46
N	731	731	714	731	731
Panel B: Abnormal volume					
AV	1.07	1.30	1.74	1.16	1.15
st. dev	0.55	2.15	2.94	0.76	0.74
<i>t</i> -stat	3.33	3.81	6.82	5.74	5.53
% >1	0.45	0.58	0.67	0.53	0.54
N	730	730	727	730	730

TABLE 3. Abnormal return and abnormal volume for new factor index deletions

The sample period is November 2010 – December 2015 including a total of 11 rebalancing moments. The table shows event study results of abnormal returns and abnormal volume surrounding MSCI Minimum Volatility index deletions (factor index). The factor index is a combination of MSCI USA Minimum Volatility (USD) index, MSCI World Minimum Volatility (USD) index, MSCI Europe Minimum Volatility (USD) index, and MSCI Emerging Markets Minimum Volatility (USD) index. Abnormal return is calculated as the total USD return of the stocks in excess of the average total USD return of all stocks in the relevant factor index. For example if a stocks is added to MSCI USA Minimum Volatility index abnormal return is calculated over the average MSCI USA Minimum Volatility index, if it is added to MSCI Europe Minimum Volatility index, the abnormal return is calculated over MSCI Europe Minimum Volatility index. The abnormal returns of all new additions to the four indices are then pooled together to form the final sample. Abnormal volume is calculated as in equation 5. It requires a minimum of 10 observations for a stock to be included. Normal trading volume has a value of 1 and 1.30 means that the volume at the specific day is 30% higher than the normal trading volume. The final sample is formed in line with the abnormal return sample as the normal volume estimation is relative to the relevant region. CAR is cumulative abnormal return, AAR is average abnormal return, AV is average volume, AD-10:AD is 10 days prior the announcement day to the announcement day, AD:ED is announcement day to effective day, ED-1 is 1 day prior to the effective day, ED:ED+5 is effective day to 5 days after the effective day, ED:ED+15 is effective day to 15 days after the effective day.

	AD-10 : AD	AD : ED	ED-1	ED : ED+5	ED : ED+15
Panel A: Abnormal returns					
CAR	-0.27	-0.91	-0.57	0.17	0.49
AAR	-0.03	-0.11	-0.59	0.03	0.04
st. dev	0.62	0.59	2.35	0.96	0.47
<i>t</i> -stat	-1.11	-4.25	-5.67	0.82	1.75
% positive	0.47	0.43	0.36	0.54	0.55
N	527	528	517	527	527
Panel B: Abnormal volume					
AV	1.00	1.10	1.46	1.05	1.01
st. dev	0.48	0.64	1.32	0.74	0.50
<i>t</i> -stat	0.08	3.68	8.01	1.59	0.63
% >1	0.41	0.45	0.60	0.40	0.40
N	526	526	526	526	526

TABLE 4. Change in analyst earnings forecast for new additions and deletions to the factor index

Analyst earnings forecast change is calculated as the median analyst earnings forecast 10 days after the effective day minus the median analyst earnings forecast 10 days before the effective day (1 day before the announcement day). Current and following year median analyst earnings forecast is downloaded from IBES. Frequency of changes is the percentage of positive, negative and zero changes out of the total group which can be additions, deletions, or the factor index. Mean change in earnings forecast is measured in U.S. dollars per share, mean change in forecast standardized by price is measured as the change in eps forecast as percentage of price per share. Mean diff additions and deletions measures whether the number of additions and deletions is significantly different from the relevant number in the factor index. The sample consists of all new additions and deletion to MSCI Minimum Volatility index (factor index) during the period November 2010 – December 2015 including a total of 11 rebalancing moments. The factor index is a combination of MSCI USA Minimum Volatility (USD) index, MSCI World Minimum Volatility (USD) index, MSCI Europe Minimum Volatility (USD) index, and MSCI Emerging Markets Minimum Volatility (USD) index.

	Additions	Deletions	Index	mean diff additions	mean diff deletions
Panel A: Frequency of eps forecast changes					
negative	47.2%	52.3%	47.1%		
zero	15.5%	14.1%	16.3%		
positive	37.3%	33.5%	36.6%		
Panel B: Mean eps forecast change					
mean	0.02	0.01	0.06	-0.04	-0.06
st. dev	0.52	0.68	3.15		
t-stat	1.08	0.28	1.72	-1.02	-1.16
N	716	516	7088		
Panel C: Mean eps forecast change standardized by price					
mean	-0.03%	-0.07%	-0.02%	-0.01%	-0.05%
st. dev	0.41%	2.72%	0.44%		
t-stat	-1.92	-0.57	-4.48	-0.37	-0.38
N	716	516	7088		

TABLE 5. Cross sectional regression of abnormal return on abnormal volume at the day of index changes (ED-1)

The sample consists of abnormal return and abnormal volume of all new additions and deletion to MSCI Minimum Volatility index (factor index) one day before the effective day during the period November 2010 – December 2015 including a total of 11 rebalancing moments. The factor index is a combination of MSCI USA Minimum Volatility (USD) index, MSCI World Minimum Volatility (USD) index, MSCI Europe Minimum Volatility (USD) index, and MSCI Emerging Markets Minimum Volatility (USD) index. Abnormal return is calculated as the total USD return of the stocks in excess of the average total USD return of all stocks in the relevant factor index. For example if a stocks is added to MSCI USA Minimum Volatility index abnormal return is calculated over the average MSCI USA Minimum Volatility index, if it is added to MSCI Europe Minimum Volatility index, the abnormal return is calculated over MSCI Europe Minimum Volatility index. The abnormal returns of all new additions to the four indices are then pooled together to form the final sample. Abnormal volume is calculated as in equation 5 and then 1 is subtracted from it. It requires a minimum of 10 observations for a stock to be included. Normal trading volume has a value of 0 and 0.30 means that the volume at the specific day is 30% higher than the normal trading volume. The final sample is formed in line with the abnormal return sample as the normal volume estimation is relative to the relevant region. Control variables are the natural logarithm of market capitalization, median earnings forecast for fiscal year one scaled by price, and return on equity.

	Additions		Deletions	
	Regression 1	Regression 2	Regression 3	Regression 4
intercept	0.50	2.71	0.04	-2.06
<i>t</i> -stat	5.78	4.69	0.25	-2.83
abnormal volume	0.08	0.10	-0.42	-0.27
<i>t</i> -stat	3.32	3.24	-5.59	-3.38
ln(mcap)		-0.25		0.20
<i>t</i> -stat		-3.94		2.57
eps forecast to price		0.11		2.18
<i>t</i> -stat		0.17		4.29
return on equity		-0.01		-0.09
<i>t</i> -stat		-0.65		-0.65
R-sqr	0.01	0.04	0.06	0.08

TABLE 6. Percentage losses to investors in MSCI Minimum Volatility indices due to price reaction before additions and deletions announcement.

The sample period is November 2010 – December 2015 including a total of 11 rebalancing moments. The table shows turnover, cumulative abnormal return, and performance drag of MSCI Minimum Volatility index additions and deletions. Turnover is the sum of the weight of all additions or deletions in the relevant index. CAR (AD:ED-1) is the cumulative abnormal return from the announcement day to one day before the effective day. Performance drag is calculated by multiplying the turnover and CAR of additions and adding the negative of the product of turnover and CAR of deletions. The four indices used are MSCI USA Minimum Volatility (USD) index (U.S.), MSCI World Minimum Volatility (USD) index (Global), MSCI Europe Minimum Volatility (USD) index (Europe), and MSCI Emerging Markets Minimum Volatility (USD) index (EM). Abnormal return is calculated as the total USD return of the stocks in excess of the average total USD return of all stocks in the relevant factor index. Performance drag is measure in basis points.

	Turnover		CAR (AD:ED-1)		Performance drag
	additions	deletions	additions	deletions	
U.S.	7.3	6.2	0.6	-0.5	7.4
Europe	7.8	6.2	0.9	-1.6	16.4
Global	11.5	9.2	1.2	-1.0	22.1
EM	11.6	5.7	1.4	-0.8	20.2
average	9.6	6.8	1.0	-1.0	16.5

FIGURE 1. Total Net Assets of iShares Edge MSCI Min Vol USA ETF

The figure shows the total net assets per year end of iShares Edge MSCI Min Vol USA ETF which tracks MSCI USA Minimum Volatility index. Scale is in million US dollars.

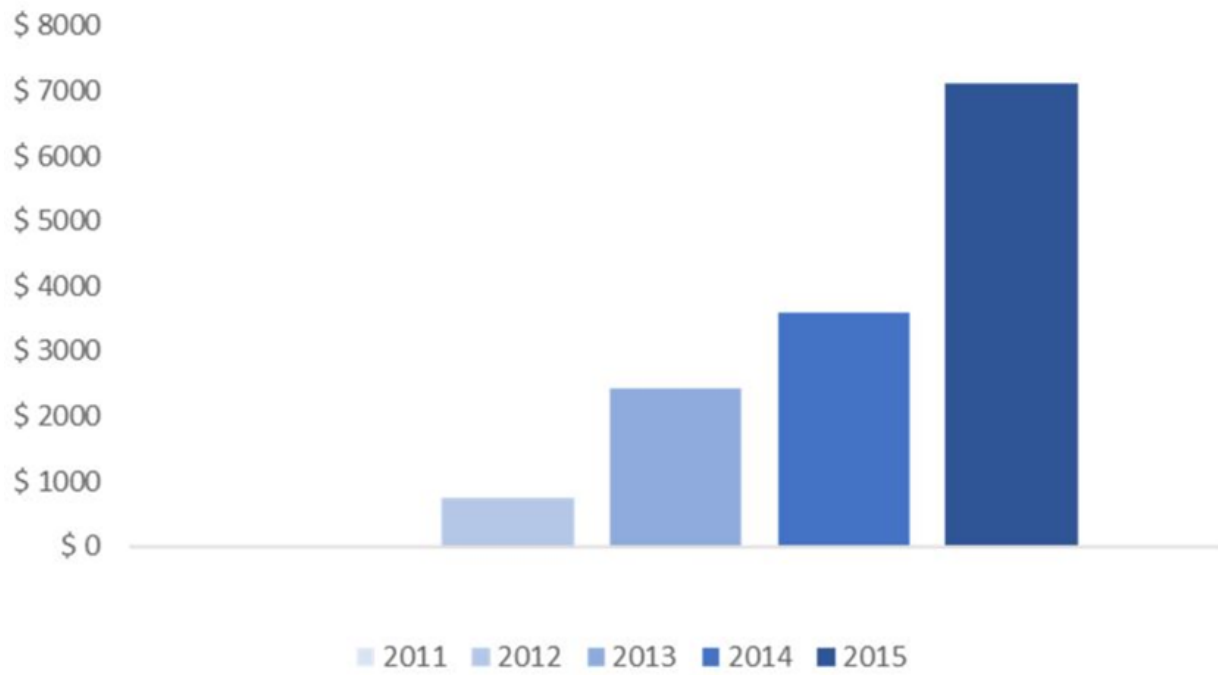
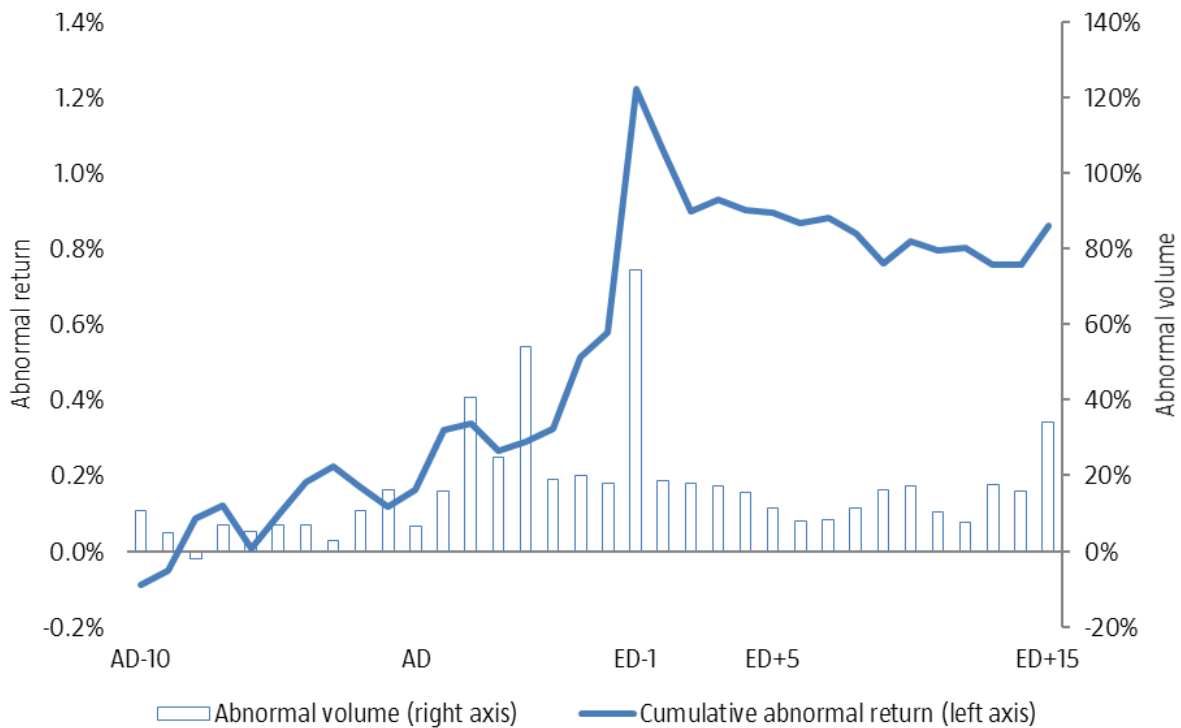


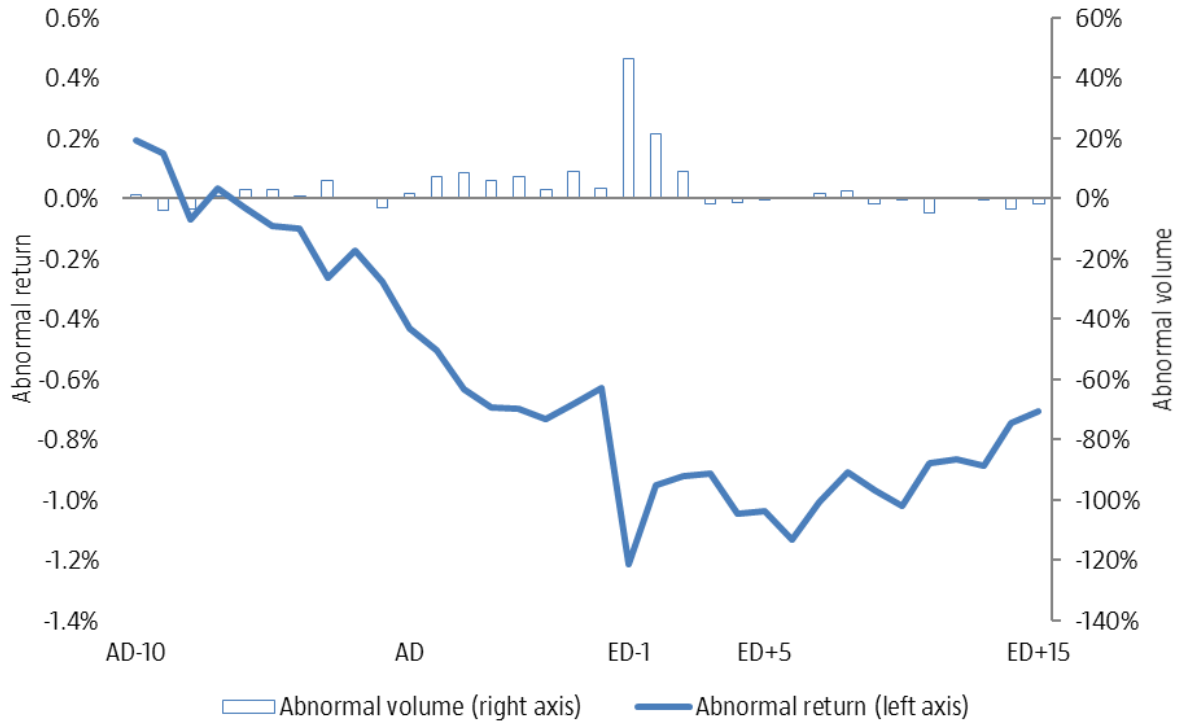
FIGURE 2. Cumulative abnormal return and abnormal volume around factor index rebalancing

The sample period is November 2010 – December 2015 including a total of 11 rebalancing moments. The cumulative abnormal return and abnormal volume surrounding MSCI Minimum Volatility index (factor index) additions and deletions. The factor index is a combination of MSCI USA Minimum Volatility (USD) index, MSCI World Minimum Volatility (USD) index, MSCI Europe Minimum Volatility (USD) index, and MSCI Emerging Markets Minimum Volatility (USD) index. Cumulative abnormal return is calculated as sum of the total USD return of the stocks in excess of the average total USD return of all stocks in the relevant factor index. For example if a stocks is added to MSCI USA Minimum Volatility index abnormal return is calculated over the average MSCI USA Minimum Volatility index, if it is added to MSCI Europe Minimum Volatility index, the abnormal return is calculated over MSCI Europe Minimum Volatility index. The abnormal returns of all new additions to the four indices are then pooled together to form the final sample. Cumulative return from AD-10 to ED+15 is the sum of the abnormal returns from AD-10 to ED+15. Abnormal volume is calculated as in equation 5 and then 1 is subtracted from it. It requires a minimum of 10 observations for a stock to be included. Normal trading volume has a value of 0 and 0.30 means that the volume at the specific day is 30% higher than the normal trading volume. The final sample is formed in line with the abnormal return sample as the normal volume estimation is relative to the relevant region. AD-10 is 10 days prior the announcement, AD is the announcement day, ED-1 is 1 day prior to the effective day, ED+5 is 5 days after the effective day, ED+15 is 15 days after the effective day.

A. Additions



B. Deletions



Appendix B

TABLE 7. Market model abnormal return for new factor index additions and deletions

The sample period is November 2010 – December 2015 including a total of 11 rebalancing moments. The table shows event study results of abnormal returns surrounding MSCI Minimum Volatility index additions and deletions. The four indices used are MSCI USA Minimum Volatility (USD) index (U.S.), MSCI World Minimum Volatility (USD) index (Global), MSCI Europe Minimum Volatility (USD) index (Europe), and MSCI Emerging Markets Minimum Volatility (USD) index (EM). Abnormal return is calculated as the total USD return of the stocks in excess of the expected return based on the following equation

$$AR_{it} = TR_{it} - [b_i \cdot (R_{m,t} - R_f) + R_{ft}],$$

where b_i is calculated based on the 250 trading days ending 1 days before the announcement day using the following equation:

$$TR_t - R_f = a + b \cdot (R_{m,t} - R_f) + \varepsilon_t$$

where TR_t is the total return of stock i at month t , R_f is the U.S. risk-free rate as provided on the Kenneth French website, $R_{m,t}$ is the relevant market portfolio (United States, Global developed markets, Europe, and Emerging markets). AAR is average abnormal return, AV is average volume, AD-10:AD is 10 days prior the announcement day to the announcement day, AD:ED is announcement day to effective day, ED-1 is 1 day prior to the effective day, ED:ED+5 is effective day to 5 days after the effective day, ED:ED+15 is effective day to 15 days after the effective day.

	AD-10 : AD	AD : ED	ED-1	ED : ED+5	ED : ED+15
Panel A: Additions					
CAR	0.47	1.03	0.50	-0.37	-0.21
AAR	0.05	0.11	0.50	-0.07	-0.01
St. dev	0.42	0.45	1.96	0.65	0.35
t-stat	2.93	6.72	6.81	-3.05	-1.05
% > 0	0.59	0.64	0.62	0.43	0.47
N	700	700	700	700	700
Panel B: Deletions					
CAR	0.59	-0.73	-0.63	-0.01	0.71
AAR	0.06	-0.09	-0.63	0.00	0.05
St. dev	0.57	0.59	2.29	0.89	0.43
t-stat	2.30	-3.30	-6.23	-0.08	2.47
% > 0	0.56	0.44	0.34	0.52	0.54
N	508	509	509	508	508

TABLE 8. Abnormal return and abnormal volume for new additions and deletions to the individual MSCI Minimum Volatility indices

The sample period is November 2010 – December 2015 including a total of 11 rebalancing moments. The table shows event study results of abnormal returns and abnormal volume surrounding MSCI Minimum Volatility index additions and deletions. The four indices used are MSCI USA Minimum Volatility (USD) index (U.S.), MSCI World Minimum Volatility (USD) index (Global), MSCI Europe Minimum Volatility (USD) index (Europe), and MSCI Emerging Markets Minimum Volatility (USD) index (EM). Abnormal return is calculated as the total USD return of the stocks in excess of the average total USD return of all stocks in the relevant factor index. For example if a stocks is added to MSCI USA Minimum Volatility index abnormal return is calculated over the average MSCI USA Minimum Volatility index, if it is added to MSCI Europe Minimum Volatility index, the abnormal return is calculated over MSCI Europe Minimum Volatility index. Abnormal volume is calculated as in equation 5. It requires a minimum of 10 observations for a stock to be included. Normal trading volume has a value of 1 and 1.30 means that the volume at the specific day is 30% higher than the normal trading volume. The normal volume estimation is relative to the relevant region. AAR is average abnormal return, AV is average volume, AD-10:AD is 10 days prior the announcement day to the announcement day, AD:ED is announcement day to effective day, ED-1 is 1 day prior to the effective day, ED:ED+5 is effective day to 5 days after the effective day, ED:ED+15 is effective day to 15 days after the effective day.

		AD-10 : AD	AD : ED	ED-1	ED : ED+5	ED : ED+15
Panel A: Additions						
U.S.	AAR	-0.02	0.07	0.24	-0.04	-0.01
	t-stat	-0.63	2.38	2.91	-1.06	-0.58
Global	AAR	0.02	0.13	0.76	-0.07	-0.01
	t-stat	0.73	5.16	6.09	-1.83	-0.56
Europe	AAR	0.02	0.10	0.63	0.05	0.00
	t-stat	0.54	2.92	3.95	0.80	-0.08
EM	AAR	0.02	0.15	0.76	-0.16	-0.07
	t-stat	0.50	3.73	4.30	-2.31	-2.20
U.S.	AV	1.12	1.16	1.47	1.13	1.12
	t-stat	2.61	4.71	7.62	3.32	3.69
Global	AV	1.03	1.21	1.74	1.15	1.10
	t-stat	1.26	5.79	9.91	5.22	4.66
Europe	AV	1.05	1.39	1.39	1.15	1.23
	t-stat	1.31	1.69	3.81	2.96	1.88
EM	AV	1.10	1.49	2.10	1.20	1.20
	t-stat	1.83	1.93	2.99	2.38	2.98

Exhibit 6 - *continued*

Panel B: Deletions

U.S.	AAR	-0.06	-0.07	-0.14	-0.10	-0.02
	t-stat	-1.11	-1.45	-0.96	-0.86	-0.46
Global	AAR	-0.02	-0.11	-0.49	0.02	0.04
	t-stat	-0.46	-2.86	-3.71	0.35	1.30
Europe	AAR	0.03	-0.18	-0.94	-0.07	0.02
	t-stat	0.44	-2.30	-2.32	-0.88	0.34
EM	AAR	-0.06	-0.10	-0.91	0.22	0.08
	t-stat	-1.01	-1.78	-3.67	2.51	1.82
U.S.	AV	1.04	1.02	1.26	1.10	1.03
	t-stat	0.80	0.44	3.57	1.02	0.58
Global	AV	1.04	1.21	1.63	1.11	1.09
	t-stat	1.13	4.38	7.68	2.16	2.46
Europe	AV	0.95	1.06	1.24	1.01	0.96
	t-stat	-1.53	0.85	2.45	0.21	-0.96
EM	AV	0.93	1.00	1.41	0.93	0.89
	t-stat	-1.64	-0.07	2.49	-1.31	-3.20

TABLE 9. Change in analyst earnings forecast for new additions and deletions to the MSCI Minimum Volatility indices

Analyst earnings forecast change is calculated as the median analyst earnings forecast 10 days after the effective day minus the median analyst earnings forecast 10 days before the effective day (1 day before the announcement day). Current and following year median analyst earnings forecast is downloaded from IBES. Mean change in earnings forecast is measured in U.S. dollars per share, mean change in forecast standardized by price is measured as the change in eps forecast as percentage of price per share. Mean diff additions and deletions measures whether the number of additions and deletions is significantly different from the relevant number in the factor index. The sample consists of all new additions and deletion to one of the MSCI Minimum Volatility indices during the period November 2010 – December 2015 including a total of 11 rebalancing moments. MSCI USA Minimum Volatility (USD) index (U.S.), MSCI World Minimum Volatility (USD) index (Global), MSCI Europe Minimum Volatility (USD) index (Europe), and MSCI Emerging Markets Minimum Volatility (USD) index (EM).

		Δ eps forecast		Δ eps over P forecast	
		mean diff additions	mean diff deletions	mean diff additions	mean diff deletions
U.S.	mean	0.06	0.00	0.01%	0.00%
	t-stat	1.00	-0.04	0.59	-0.05
Global	mean	-0.15	-0.11	-0.02%	0.00%
	t-stat	-1.92	-1.14	-0.94	0.02
Europe	mean	-0.15	-0.26	0.02%	-0.20%
	t-stat	-0.94	-1.78	0.47	-1.79
EM	mean	0.09	0.07	-0.01%	-0.10%
	t-stat	1.44	1.31	-0.20	-2.07