School of Economics and Finance

Anticipatory Effects in the FTSE 100 Index Revisions

Marcelo Fernandes and João Mergulhão

Working Paper No. 773 December 2015 ISSN 1473-0278

Queen Mary
University of London

Anticipatory effects in the FTSE 100 index revisions

Marcelo Fernandes
Sao Paulo School of Economics, FGV
and Queen Mary University of London

João Mergulhão
Sao Paulo School of Economics, FGV

This version: October 26, 2015

Abstract: This paper examines the price impact of trading due to expected changes in the FTSE 100 index composition, which employs publicly-known objective criteria to determine membership. Hence, it provides a natural context to investigate anticipatory trading effects. We propose a panel-regression event study that backs out these anticipatory effects by looking at the price impact of the ex-ante probability of changing index membership status. Our findings reveal that anticipative trading explains about 40% and 23% of the cumulative abnormal returns of additions and deletions, respectively. The results are both statistically and economically significant.

JEL classification numbers: G12, G15, C14

Keywords: imperfect substitutes, index revision, liquidity, price pressure.

Contact information: Sao Paulo School of Economics – FGV, Rua Itapeva 474, office 1212, 01322-000 São Paulo, SP, Brazil; Phone: +55(11)37993350; joao.mergulhao@fgv.br.

1 Introduction

This paper examines price and volume reactions to entering or leaving the FTSE 100 index. We focus on the FTSE index mainly for two reasons. First, membership depends exclusively on relative market capitalization. As the latter is public information, changes in the index composition are in principle devoid of information and hence should not affect prices. This is contrast to membership in the S&P 500 index, which could well convey information about a stock's future performance given that the Standard & Poor's also minimizes turnover in index composition (see, e.g., Jain, 1987; Dhillon and Johnson, 1991). Second, the FTSE 100 index constituents are essentially very large UK-domiciled firms, accounting for about 85% of the market capitalization in the London Stock Exchange. As a result, it is not very compelling in principle to associate abnormal performance either with future increases in the monitoring of management (Denis, McConnell, Ovtchinnikov, and Yu, 2003) or with changes in investor awareness (Chen, Noronha, and Singal, 2004). Altogether, this makes the announcement of the FTSE 100 index composition a natural event for testing whether stocks indeed have perfectly elastic (i.e., horizontal) demand curves and whether investors anticipate revisions in the index composition.

The empirical findings in the literature are very much in line with a downward sloping demand curve in that inclusions and deletions command significant positive and negative wealth effects, respectively. On the one hand, Harris and Gurel (1986) and Blouin, Raedy, and Shackelford (2003) find that demand curves for stocks slope down only in the short run, with index effects dissipating in the long run. This is consistent with the price pressure hypothesis, according to which temporary effects are essentially due to index-related trading. On the other hand, Scholes (1972), Shleifer (1986), Beneish and Whaley (1996), Lynch and Mendenhall (1997), Kaul, Mehrotra, and Morck (2000), Wurgler and Zhuravskaya (2002), and Blume and Edelen (2004) document permanent effects consistent with a downward-sloping long-run demand curve. The latter implies that stocks are imperfect substitutes, contradicting to some extent the general notion that stock prices ensue from fundamental asset valuation.

Ahern (2014) puts forth two alternative explanations for why stocks exhibit downward sloping demand curves. The first considers a setup with asymmetric information, in which investors' demand for a stock becomes less sensitive to price movements if the available information is poor (Grossman and Stiglitz, 1980). The second story is in line with Harris and Raviv's (1993) model of investors with heterogeneous beliefs. If investors form different opinions about the value of a stock given common information, their reservation values must then differ and, at the aggregate level, demand curves for stocks should slope down. The second explanation is more plausible in the context of FTSE 100 index revisions. The index constituents are among the largest firms in the UK and hence it is hard to argue that the available information is poor.

Index revision also affects liquidity. The change in equity ownership composition due to index trading alters the proportion of liquidity-motivated trades as well as the degree of competition among informed traders (Kyle, 1985). Accordingly, liquidity should increase for stocks that enter the index and decrease for stocks that exit the index. This impact in liquidity explains, at least partially, price responses to index revisions (Beneish and Whaley, 1996; Erwin and Miller, 1998; Hegde and McDermott, 2003; Gregoriou and Ioannidis, 2006; Chordia, 2008). For instance, if the inclusion of a stock in the index leads to a lower bid-ask spread, stock prices should rise in a permanent fashion (Amihud and Mendelson, 1986; Brennan and Subrahmanyam, 1996). The same applies to variations in trading volumes and quoted depths (Stoll, 1972). As they increase, there is a significant reduction in the direct cost of trading. Moreover, the information gap between informed and uninformed traders also shrinks, lowering the asymmetric costs of trading (Kim and Verecchia, 1994).

This paper contributes to this literature by carrying out an event study that explicitly controls for anticipatory effects and hence for selection bias. Additions and deletions do not occur to random stocks, unfolding respectively because of relative increases and decreases in market value within the previous quarter. Given that the number of shares outstanding is typically stable over time, market value rises and drops mostly due to share price changes. Stocks with relatively high price increases (decreases) in the previous quarter are more likely to get into (exit, respectively) the FTSE 100 index. Standard event study analyses completely ignore this selection issue and hence presumably overestimate price and volume effects (Edmister, Graham, and Pirie, 1994).[1]

We account for anticipatory trading effects by means of a two-step panel-regression procedure. In the first step, we run panel probit regressions for each day in the pre-event window in order to estimate the conditional probability of a given stock to enter or leave the index in the next quarter. We thus end up with addition probability estimates for non-index stocks as well as with deletion probability estimates for the index constituents for each pre-event day. In the second step, apart from the standard dummy variables for pre- and post-announcement days, we also include addition/deletion probability estimates in the panel-regression event analysis. The probit estimates adjusts the event study for anticipative trading, whereas the coefficients of the dummy variables entail selection-adjusted estimates for the pre- and post-announcement effects. Our approach is to some extent similar in spirit to Heckman's (1976, 1979) two-part estimation procedure to correct for sample selection. The first step is indeed virtually identical. The only difference is that we have to run one probit model for each day within the pre-event window so as to cope with the time-varying uncertainty over index membership.

We unveil strong evidence in favor of a downward sloping demand curve even after controlling for the fact that investors can partly predict index revisions. The impact of index membership is not only strong, but also highly asymmetric. This is the only result we share in common with Chen, Noronha, and Singal (2004). In stark contrast to their findings, we show not only that the impact of index exclusions is much stronger than the effect of index additions, but also that there is no evidence of price reversals after the announcement. As in Lynch and Mendenhall (1997), we find that index revision commands a price impact that does not seem to revert even after 22 days of the announcement. In particular, the cumulative abnormal return (CAR) is of 13.34% for additions and -24.27% for deletions in the pre-event window. However, once we control for anticipatory trading, the pre-announcement CAR decreases to 7.94% for additions and -18.66% for deletions, amounting to 40% and 23% reductions, respectively. In the post-announcement window,

[1] Brown, Goetzmann, and Ross (1995) make the same point about price run-ups for stock splits, whereas Copeland and Mayers (1982) and Dimson and Marsh (1986) argue similarly for the case of press recommendations on stock returns. See also Ahern (2009) for a general discussion about selection bias within event study analyses.

the cumulative abnormal returns are 2.20% additions and -6.97% for deletions. These figures respectively imply a median elasticity of demand of 1.67 and -3.31, well in line with Ahern's (2014) elasticity estimates for a subset of the S&P 500 index constituents.

A liquidity-based explanation for the price impact of index revisions also does not seem to fit well in the context of the FTSE 100 index. A similar event analysis for volume uncovers a strong increase in the liquidity of the stocks that either enter or exit the index, even if one controls for anticipative trading. This is in stark contrast with previous results, such as Hegde and McDermott (2003), though the differences are partly due to the shorter post-event window we employ in our analysis. Given that deletion claims a much higher price impact, it is difficult to argue that the abnormal performance of stocks joining the index is partly due to the rise in liquidity. Further analysis is obviously in need given that volume is just one of the many dimensions of liquidity and hence it would be interesting to see what happens, for instance, with market depth and the bid-ask spread.

Although we are the first to propose a methodology that explicitly accounts for anticipatory effects, there are a few papers that raise similar concerns (see, among others, Edmister, Graham, and Pirie, 1994; Denis, McConnell, Ovtchinnikov, and Yu, 2003; Mase, 2007). The usual fix is to employ post-event data for the estimation of the market model so as to alleviate the dependence between additions/deletions and the parameter estimates. However, it is virtually impossible to have a decent sample size within a post-event estimation window that does not feature contamination from the next quarter's index revision. Mase (2007) also examines whether traders attempt to anticipate these announcement effects by looking at nearly in/out stocks. These stocks display significant anticipatory trading, though post-announcement effects revert the pre-announcement returns almost exactly. In addition, taking their difference with respect to the truly added/deleted stocks as a measure of the selection-adjusted impact reflects a pointwise reduction of about 47% of the pre-announcement effects for additions and of 17.5% for deletions. Although we do not observe price reversals as in Mase (2007), our estimates of the anticipatory effects are of similar magnitude.

Anticipatory trading aside, we still unveil significant price impacts for the index revisions after the index composition announcement. We thus ask whether it is possible to take advantage of these effects by means of a trading strategy. The primary motivation is to provide out-of-sample evidence that index revision effects indeed are economically significant. This is relevant because it is very difficult to pin down statistical significance of the anticipatory effects given that we focus on their impact on those very few stocks that are really likely to enter/exit the FTSE 100 index (rather than the usual average effect).

We first examine a very simple strategy in which we take a long position on the two stocks most likely to join the index and a short position on the two stocks with the highest chance to drop from the index in the next revision. After the announcement, we simply buy the additions, if any, and short the deletions, if any. Although this strategy seems to outperform the FTSE 100 index in the 2000s, it has two shortcomings. First, the turnover is very high and hence the profits evaporate once we control for transaction costs. Second, it turns out that most of the profits come from the short positions in periods of bearish markets. We thus modify the trading strategy slightly so as to circumvent these drawbacks. To alleviate the high turnover, we smooth the addition/deletion probability estimates at time t that we extract from the probit models by taking their average over the last three days. Smoothing makes the probability rankings more persistent and hence reduces the need for rebalancing the portfolio. In addition, to deal with the dependence of the short portfolio returns on the market cycle, we start taking short positions on the most likely stocks to exit the index only if the past 22-day return on the FTSE 100 index is negative. The resulting strategy performs very well, outclassing a passive strategy that buys and hold the FTSE 100 index even after controlling for transaction costs.

The remainder of this paper ensues as follows. Section 2 provides some institutional background concerning the FTSE 100 index revision. Section 3 describes the event-study methodology we employ to account for anticipatory effects. Section 4 first describes the data and then reports the findings of the event study analysis. Section 5 explores the economic significance of the cumulative abnormal returns we estimate by backing out the implied price elasticities of demand, and then by examining a trading strategy that takes advantage of these index revisions effects. Section 6 offers some concluding remarks.

2 Eligibility and membership to the FTSE 100 index

The FTSE Europe/Middle East/Africa Regional committee meets quarterly to review the compositions of the family of FTSE indices. This happens on the Wednesday after the first Friday in March, June, September and December. There is a public announcement of the revisions in the index memberships right after the meeting, even if the actual revision occurs only on the next trading day following the expiry of the LIFFE futures and options contracts. The latter normally takes place on the third Friday of the same month.

The FTSE 100 index consists of the largest 100 eligible companies in the UK, measured by market capitalization value. Only premium listed equity shares that trades on the London Stock Exchange are eligible for inclusion in the FTSE 100 index. Other eligibility criteria include price, size and liquidity aspects, including the following among others:

(*a*) The stock share must have a Sterling-denominated price that is accurate and reliable enough for the determination of the market value of the company.

(*b*) The company must have a free-float of at least 50% after adjusting for restrictions and cross-holdings.

(*c*) Securities must have a turnover of at least 0.035% of their shares in issue as measured by the median daily trade per month for at least 10 out of the 12 months prior to the annual index review in June. This threshold falls to 0.025% for at least 8 months in the case of index constituents.

The rules for adding and deleting securities are designed to provide stability in the selection of constituents of the FTSE family of indices. At the quarterly reviews, a given stock will join the FTSE 100 index if its market value ranking rises to the 90th position or above among the eligible stocks, whereas a constituent will exit the index if its market value ranking falls to 111th or below. This set of rules ensures that the index reflects significant rises or falls in market capitalization and thus market representativeness.

Given that the number of constituents is constant for the FTSE 100 index, there are special rules for situations of imbalance between the number of additions and deletions. If a greater number of companies qualify to join the index relative to those qualifying to exit the index, the lowest ranking constituents will also exit the index to equate the number of additions and deletions. Likewise, if there are more deletions than additions, the FTSE committee will insert the securities of the highest ranking companies that are currently not in the index so as to match the total number of deletions.[2]

Before moving to the event study analysis, it is important to stress once again that these rules are objective. They leave no discretionary power to the committee. This is very convenient because it rules out a situation in which index membership says something about the stock's future prospects.

3 Sample description and methodology

We consider changes in the index from June 1992 to March 2010. We exclude from the sample all unscheduled changes due to corporate action, such as mergers and acquisitions,[3] yielding a total of 138 additions and 146 deletions. To estimate probit models for the addition probabilities within the pre-announcement window, we also include eligible stocks that are out of the index in the sample. To ensure that the samples for computing addition and deletion probabilities have similar sizes, we attempt to consider in the overall sample the largest 200 firms in the UK as measured by market capitalization. We use the largest eligible stocks in the London Stock Exchange that are not part of the FTSE 100 index in the estimation of the probit models for additions and the index constituents in the estimation of the probit models for deletions. Retrieving a complete data set from Thomson Reuters Datastream is not straightforward, though. We first have to control for stock splits when computing returns, volume rate, and market values. Moreover, the panel is unbalanced not only because of the variations in the market value, but also because of delistings, mergers, and acquisitions. The latter events make it particularly difficult to keep the balance between the number of stocks in and out of the index.

Figure 1 depicts key quantiles for returns, market capitalizations and volume turnovers over time. The left panel reflects the subsample of firms not in the index and hence candidates for additions. The right panel corresponds to the subsample of stocks belonging

[2] See http://www.ftse.com/Indices/UK_Indices/Downloads/FTSE_UK_Index_Series_Index_Rules.pdf for more details.

[3] We exclude a single listing transfer, whereas there are no deletions due to bankruptcy in our sample.

to the index for which deletion is possible. Stock returns show a similar behavior in both subsamples for the median and the extreme quantiles. The former is always very close to zero, whereas the magnitude of the tail quantiles increase by very similar amounts within periods of market uncertainty. In contrast, the interquartile range is clearly higher for the addition subsample, reflecting the fact that smaller caps are typically riskier. Not surprisingly, market capitalization is much lower for stocks out of the index than for index constituents. There is also a big difference in market value between the lower and upper tails within both subsamples. As per the time-series dimension, it is interesting to observe that the recent credit crunch has a much stronger impact on the smaller caps, even relative to the previous financial crises. Finally, the last panel plots the distribution of the volume rate since January 2000. It is striking how liquidity decreases substantially throughout the recent credit crunch. It is worth noting that liquidity falls proportionally more for the most liquid stocks.

3.1 Regression-based event analysis

For the traditional event study, we employ a panel regression model with unit market beta for every stock and individual fixed effects. We include the latter to let at least alpha vary freely across stocks. As the committee meets every quarter to announce the index revisions, the event window ranges from 44 days before the announcement to 22 days after the announcement, with $\tau = 0$ denoting the day of the committee meeting. This ensures that the post-event window after any committee meeting does not overlap with the pre-event window of the next revision announcement. We then regress the excess returns on the individual stocks over the FTSE 100 index on dummy variables for pre- and post-event days ($D_{\tau,t}$ for $\tau = -44, \ldots, 22$) as well as to addition/deletion dummy variables for each day within the event window:

$$R_{i,t} - R_{M,t} = \alpha_i + \sum_{\tau=-44}^{22} \gamma_\tau \, D_{\tau,t} + \sum_{\tau=-44}^{22} \gamma_\tau^A \, D_{i,\tau,t}^A + \sum_{\tau=-44}^{22} \gamma_\tau^D \, D_{i,\tau,t}^D + e_{i,t} \tag{1}$$

where $D_{i,\tau,t}^A$ and $D_{i,\tau,t}^D$ with $\tau = -44, \ldots, 22$ are equal to $D_{\tau,t}$ if stock i respectively enters/exits the index at $\tau = 0$, zero otherwise. The addition/deletion dummy coefficients reflect the average abnormal return for every event time τ, e.g., γ_τ^A denotes the average abnormal return at calendar day t across stocks that join the index at time $t-\tau$. To obtain cumulative abnormal returns (CAR) from τ_1 and τ_2 ($-44 < \tau_1 < \tau_2 < 22$), it suffices to sum up the corresponding dummy coefficients, namely, $\sum_{\tau=\tau_1}^{\tau_2} \gamma_\tau^A$ for additions and $\sum_{\tau=\tau_1}^{\tau_2} \gamma_\tau^D$ for deletions.

Next, we propose a two-stage procedure to account for anticipatory trading effects. The idea is similar to the Heckit method for correcting sampling selectivity (Heckman, 1976; 1979). We initially estimate a probit model for each day in the pre-event window to back out the conditional probability of a given stock to change its membership status in the next FTSE committee meeting. This results in addition probability estimates for the sample of stocks that are not in the index as well as deletion probability estimates for the sample of index constituents.

In the second pass, we merge the two subsamples to run the regression-based event study analysis. By construction, constituents have zero probability of joining the index, whereas stocks that are not in the index have zero probability of exiting the index. Apart from the standard dummy variables for pre- and post-announcement days, we then include addition/deletion probability estimates in the panel regression, yielding

$$\begin{aligned} R_{i,t} - R_{M,t} = \alpha_i &+ \sum_{\tau=-44}^{22} \gamma_\tau \, D_{\tau,t} + \sum_{\tau=-44}^{22} \gamma_\tau^A \, D_{i,\tau,t}^A + \sum_{\tau=-44}^{22} \gamma_\tau^D \, D_{i,\tau,t}^D \\ &+ \sum_{\tau=-44}^{-1} \lambda_\tau^A \, \pi_{i,\tau,t}^A + \sum_{\tau=-44}^{-1} \lambda_\tau^D \, \pi_{i,\tau,t}^D + u_{i,t} \end{aligned} \tag{2}$$

with $\pi_{i,\tau,t}^A$ and $\pi_{i,\tau,t}^D$ denoting the probability at time t that stock i will respectively join/exit the index in the next index composition review at time $t-\tau$. The idea is essentially that the probability estimates will capture the anticipative trading effects, whereas the coefficients of the dummy variables will entail selection-adjusted estimates for the pre- and post-announcement effects.

The average anticipatory effect is given by $\lambda_\tau^A \, \bar{\pi}_\tau^A$ for additions and $\lambda_\tau^D \, \bar{\pi}_\tau^D$ for deletions at any date prior to the meeting (i.e., $\tau < 0$). Note that we must average the addition/deletion probability estimates both across stocks and over the calendar time. To obtain cumulative average effects from τ_1 and τ_2 ($-44 < \tau_1 < \tau_2 < -1$), one must then sum up the corresponding average impacts, namely, $\sum_{\tau=\tau_1}^{\tau_2} \lambda_\tau^A \, \bar{\pi}_\tau^A$ for additions and $\sum_{\tau=\tau_1}^{\tau_2} \lambda_\tau^D \, \bar{\pi}_\tau^D$ for deletions.

The interpretation of these average effects (cumulative or not) is a bit tricky, however. The addition/deletion subsamples include many stocks that are very unlikely to move into/out the index, hence taking averages of the individual impacts may severely underestimate the anticipatory trading effects. Instead, it seems much more sensible to assess the latter by evaluating the addition/deletion probabilities only for the few stocks that are most likely to change their membership status.

Our methodology also resembles the antitrust analysis of mergers based on McGuckin, Warren-Boulter, and Waldstein (1992) event-probability case study procedure. The goal of their event-probability approach is to analyze the effect of merger announcements on stock returns of rival firms using a regression in calendar time. McGuckin, Warren-Boulter, and Waldstein replace the usual event-window dummy in the standard market model with the change in the probability that the merger will indeed take place. They interpret the corresponding coefficient as the change in the value of the rival firm in case the merger happens. Their framework differs from ours in several aspects. First, we include both the event-window dummy variables and the revision probabilities as regressors in the market model for returns. By adding the addition/deletion probability estimates to the event study we aim to account for anticipatory effects. We keep the pre-event dummy variables in the specification so as to capture the price runs (either up or down) that lead to the change in the index membership status. Second, they show that the return to a rival firm depends on the change in the merger probability, so that one is back to the standard market model if there is no change in information about the merger likelihood. In the context of additions and deletions, what matters for the investors is the stocks with the highest probability to change their membership status. That is why we add the probability levels rather than their first differences into the specification. Third, whereas we run probit regressions to obtain the addition/deletion probability estimates, McGuckin, Warren-Boulter, and Waldstein back out the merger probability using a valuation technique that relies on the estimation of the standard market model for a sample period prior to the event window.

3.2 Probit specification for additions and deletions

To determine the potential regressors for the probit specifications, we build on the FTSE rules of index revision. We thus rank the stocks in our sample every day by their total market value and then compute the difference in market capitalization relative to the firms ranked at the 85th, 90th, 95th, 100th, 105th and 110th positions. In addition, we construct binary variables indicating whether the above differences in market value are positive or not. We also consider the current ranking and market value as well as the change in the ranking position since the last committee meeting. The latter is useful because it conveys information on whether the stock has been experiencing a price run relative to the eligible stocks since the last index membership review, thereof controlling to some extent for momentum.

For each day in the pre-event window ($\tau = -44, \ldots, -1$), we then estimate the probability of a stock to enter the index as well as of a constituent to exit the index using a stepwise regression approach. The latter involves adding and/or deleting variables sequentially depending on their F-statistics. The advantage is that it ensures parsimonious probit models for every day within the pre-announcement window. The drawback is that statistical inference becomes nonstandard because of the sequentiality of the F-tests. The problem is that we could end up with probit models that fit the data well only within the sample period. We have two reasons to believe that the benefits outweigh the limitations of the stepwise regression approach in our case. First, the in-sample estimates of the anticipatory effects are in line with previous results by Mase (2007) and hence they do not appear to be an artifact due to data mining. Second, the trading strategy analysis we carry out in Section 5 replicates out of sample the performance of the stepwise regression. See Hocking (1976) for more details on statistical inference within stepwise regressions and, among others, Baker and Haslem (1974), Jobson and Korkie (1983), Fung and Hsieh (2000) and Agarwal and Naik (2004) for applications in finance.

4 FTSE 100 index revision and anticipatory effects

We start with the classical event study. Figure 2 plots the cumulative abnormal returns for additions and deletions in the pre- and post-announcement windows. Panel A displays the pre-announcement price impact of the additions, as measured by the cumulative abnormal return (CAR) from $\tau_1 = -44$ up to $\tau_2 = 0$, and their 95% confidence interval based on clustered standard errors. It amounts to a sizeable and very significant CAR of 13.34% over the 45 trading days prior to the FTSE committee meeting.[4] Panel B reveals that the post-announcement CAR from $\tau_1 = 1$ to $\tau_2 = 22$ is much smaller, even if one considers the difference in the length of the time interval. The 95% confidence interval reveals that the CAR is borderline significative over the 22 days after the committee review. Nevertheless, what really matters is that we find no evidence of price reversal in the post-event window. Panels C and D document similar patterns for deletions. The CAR over the 44 days prior to the announcement is of about -24.27%, whereas it is of -6.97% in the post-event window. This implies that the price impact of exiting the index is much stronger than the price impact of joining the index.[5] As before, there is no evidence of price reversals. Altogether, these preliminary results indicate that the impact of changing index membership status is permanent.

We next examine what happens with the cumulative abnormal returns if we control for the probability of changing the index membership status as in (2). We start with a brief discussion about the probit estimates we obtain for the likelihood of either joining or exiting the FTSE 100 index. The stepwise regression approach we employ to automatically select the variables that drive the addition/deletion likelihoods seems to work pretty well. The resulting probit models are not only parsimonious and congruent, but also very sensible as what concerns the choice of regressors over the different pre-event dates (and their signs). The main drivers are the current ranking, the variation in the ranking since the last meeting, and the dummy variables indicating whether the current position is above 80th, 90th and

[4] The abnormal return at the day of the announcement never differs from zero at the usual levels of significance.

[5] This is in line with the fact that abnormal returns on smaller-cap stocks are likely to be larger in magnitude than those of larger-cap stocks given that deleted stocks are by construction smaller than additions.

110th. The differences in market value relative to the firms at the 90th and 110th positions are also significant for the majority of the pre-event days. As expected, the predictive power of the probit models, as measured by the pseudo R^2 measure, increases linearly from about 25%-30% to 50% as the announcement date approaches.[6]

Table 1 reports some descriptive statistics for the probit estimates at different pre-event dates. The distributions are actually very similar in that the most pronounced feature is clearly the asymmetry. Both the mean and median probit estimates are about 1% for the additions and 2% for deletions regardless of how close we are to the announcement. This happens because only a few stocks within each subsample have real chances to join/exit the index. In fact, the probit estimates remain quite low up to the 90% percentile. It is striking how the not-so-large values of the 99% percentile are still about threefold the values of the 95% percentile. It is also interesting to observe that deletions are more predictable than additions in that their probit estimates are much larger for most days in the pre-event window. As expected, as the announcement approaches, the probit estimates become more divergent across stocks and hence the standard deviation increases. The skewness coefficient is nonetheless quite stable within the pre-event window, around 7 for deletions and slightly above 10 for additions (except to one day before the announcement).

We now turn our attention to the results of the event study after the inclusion of the probit estimates into the regression. Figure 3 shows that a large proportion of the ex-ante price impact of additions and deletions is actually due to anticipatory trading. The pre-announcement CAR now amounts only to 7.94% for additions and to -18.66% for deletions. This means that anticipatory trading effects respond for respectively 40% and 23% of the price impact for additions and deletions. It is also apparent from Panels B and D that, as expected, adding the addition/deletion probability estimates into the event-study regression has virtually no effect in the CAR over the post-announcement window. We thus conclude that index revisions entail a significant price impact in the stocks that either join or exit the FTSE 100 index despite controlling for anticipative trading. Even if most of the response takes place prior to the FTSE committee review, we are unable to uncover any price reversal

[6] The pseudo R^2 figures for deletions are on average about 5% higher than for additions.

in the post-announcement window for both additions and deletions.

To better understand the impact of anticipatory trading, Figure 4 depicts how it varies with the percentile of the addition/deletion probability estimates. Panels A and B display very similar patterns. The average repercussion is quite close to zero for both additions and deletions. It turns out that the same actually applies to the anticipative effects evaluated at the median and third quartile of the probit estimates. The impact becomes more material if we employ the 95% percentile, yielding a cumulative effect of 4.61% for additions and of -8.37% for deletions. As we move to the 99% percentile, the impact of anticipatory trading on returns becomes very large, namely, about 14.18% for additions and -21.31% for deletions. Given that the FTSE committee reviews normally change the membership status of at most 6 stocks (i.e., 3 additions and 3 deletions), it makes much more sense to assess the anticipatory trading effects by looking at the 95% and 99% percentiles than at the mean/median values.

The results so far indicate that index inclusions and exclusions entail significant wealth effects even after 22 days of the announcement. As in Chen, Noronha, and Singal (2004), we find that the price impact of a revision in the index composition is asymmetric. Perhaps surprisingly given previous results in the literature, we document that the CAR on deletions is much larger in magnitude than the CAR on additions. Given that the FTSE 100 index constituents are very large firms in the UK, attributing these wealth effects either to better monitoring or to changes in investor awareness is not very convincing. The certification hypothesis also does not hold much water because the FTSE index revision rules are 100% objective. Before concluding that stocks have downward sloping demand curves, it remains to check whether liquidity effects could also explain the market reaction to the FTSE 100 index additions and deletions. The next subsection examines this possibility.

4.1 Impact on market liquidity

To better understand what happens with market liquidity around the dates of the FTSE committee reviews, we carry out a further event analysis using the volume rate as the dependent variable. We measure the volume rate (or turnover) of a given stock by the ratio of the number of traded shares to the number of outstanding shares. As before, we start with a standard regression-based event study based on

$$\mathrm{VR}_{i,t} = \alpha_{V,i} + \beta_V \mathrm{VO}_{\mathrm{FTSE},t} + \sum_{\tau=-44}^{22} \gamma_{V,\tau} D_{\tau,t} + \sum_{\tau=-44}^{22} \gamma_{V,\tau}^{A} D_{i,\tau,t}^{A} + \sum_{\tau=-44}^{22} \gamma_{V,\tau}^{D} D_{i,\tau,t}^{D} + e_{V,i,t}, \quad (3)$$

where $\mathrm{VR}_{i,t}$ denotes the logit of the volume rate (or turnover) of the ith stock time t and $\mathrm{VO}_{\mathrm{FTSE},t}$ is the total number of shares traded within the index at time t. We find that the impact in market liquidity is quite asymmetric in that volume increases much more for deletions than for additions, especially prior to the announcement. In particular, the cumulative abnormal logit of the volume turnover is about 7.70 for additions within the pre-event window, whereas it amounts to 18.74 for deletions. The asymmetry subsides considerably within the post-event window, with cumulative logit effects of about 5.96 and 7.15 for additions and deletions, respectively.[7]

To control for anticipative trading effects in the market liquidity, we consider a second specification in which we include the addition/deletion probability estimates:

$$\begin{aligned} \mathrm{VR}_{i,t} = \alpha_{V,i} + \beta_V \mathrm{VO}_{\mathrm{FTSE},t} + \sum_{\tau=-44}^{22} \gamma_{V,\tau} D_{\tau,t} + \sum_{\tau=-44}^{22} \gamma_{V,\tau}^{A} D_{i,\tau,t}^{A} + \sum_{\tau=-44}^{22} \gamma_{V,\tau}^{D} D_{i,\tau,t}^{D} \\ + \sum_{\tau=-44}^{-1} \lambda_{V,\tau}^{A} \pi_{V,i,\tau,t}^{A} + \sum_{\tau=-44}^{-1} \lambda_{V,\tau}^{D} \pi_{V,i,\tau,t}^{D} + u_{V,i,t}. \end{aligned} \quad (4)$$

We then gauge the cumulative abnormal volume rate from τ_1 and τ_2 ($-44 < \tau_1 < \tau_2 < 22$) by summing up the corresponding dummy coefficients, viz., $\sum_{\tau=\tau_1}^{\tau_2} \gamma_{V,\tau}^{A}$ for additions and $\sum_{\tau=\tau_1}^{\tau_2} \gamma_{V,\tau}^{D}$ for deletions. In turn, the cumulative average anticipatory effect from τ_1 and τ_2, with $-44 < \tau_1 < \tau_2 < -1$, is given by $\sum_{\tau=\tau_1}^{\tau_2} \lambda_{V,\tau}^{A}\, \bar{\pi}_{V,\tau}^{A}$ and $\sum_{\tau=\tau_1}^{\tau_2} \lambda_{V,\tau}^{D}\, \bar{\pi}_{V,\tau}^{D}$, respectively. As before, it is perhaps more informative to consider anticipatory trading quantile effects so as to focus on the few stocks that are most likely to change their membership status.

Figure 5 reveals that liquidity, as measured by the volume rate, increases for both additions and deletions even after we correct for anticipatory trading. As before, the pre-event impact is massively asymmetric with cumulative logit effects of 6.94 for additions and 17.10 for deletions, whereas the post-announcement effects are more similar (viz., 6.17 for additions and 7.34 for deletions). Relative to the estimates we obtain without adjusting

[7] Note that we do not attempt to back out the cumulative abnormal volume rates from their logit counterparts given that the main goal of this exercise is to determine whether the liquidity effects are positive or negative.

for anticipatory effects, we observe a reduction of about 10% in the pre-announcement cumulative logit effect as well as a slight increase of about 3% in the post-event impact on the logit of the volume rate. The evidence of liquidity increase we uncover is pretty robust. First, we find similar results if we proxy liquidity by the bid-ask spread. It decreases for both additions and deletions, though significantly only for the latter. Second, the ex-ante increase in liquidity becomes insignificant for both addition and deletions if we also control for the market capitalization of the stocks. For the sake of brevity, we do not report these results, though they are obviously available from the authors upon request.

The boost in the volume rate for stocks that enter the index is consistent with the liquidity-based explanation for cumulative abnormal returns for additions. However, this is only the half of the story. Stoll (1972) and Kyle (1985) predict that liquidity and, in particular, volume and market depth should *decrease* for stocks that exit the index given that tracking funds will not trade them anymore. The fact that the volume rate grows for deletions does not bode well for their liquidity theory. In addition, alternative liquidity-based explanations based on trading costs (Amihud and Mendelson, 1986; Kim and Verecchia, 1994; Brennan and Subrahmanyam, 1996) do not seem to fit the data as well. Increases in the volume rate should bring about a hike in stock prices due to the lower costs of trading. In contrast, the cumulative abnormal returns and volume rates have opposite signs for stocks that exit the index.

We thus conclude that the wealth effects we observe for deletions are not consistent with liquidity effects and hence the cumulative abnormal performances we uncover for both additions and deletions are most likely due to downward sloping demand curves.

5 Are the index revision effects economically significant?

It is hard to establish statistical significance in our event study analysis not only because it depends on a series of first-stage probit estimates to control for anticipatory effects, but also because it makes much more sense to focus on the 95% and 99% percentiles of these estimates. This is why we next assess the economic relevance of the pre- and post-announcement effects from the previous section. First, we evaluate whether the magnitude of the price elasticities of demand implied by the abnormal returns at the announcement dates are reasonable enough. Second, we examine the performance of a simple trading strategy that exploits the anticipatory effects we uncover. The idea is to check whether our in-sample results remain economically significant out of sample.

5.1 Implied price elasticities of demand

Our empirical evidence is consistent with a downward sloping demand curve for stocks. In this subsection, we estimate by how much the demand curve slopes down by backing out price elasticities from individual cumulative absolute returns in the post-announcement window. Note that the probit estimates affect only the pre-announcement effects and hence these individual effects coincide with the (aggregate) panel-based estimates from the previous section.

As in Shleifer (1986) and Ahern (2014), we compute the price elasticity as the ratio of the abnormal turnover to the abnormal returns at the announcement date. Under the assumption of symmetric supply and demand functions, the greater is the magnitude of the ratio, the steeper is the slope of the supply curve in view that demand shifts should trace out the supply curve. In particular, we estimate abnormal turnover as the ratio of the turnover at the announcement date to the average turnover over the previous year. As before, we gauge the individual abnormal returns as the excess stock return over the FTSE 100 index.[8] As the latter estimates vary wildly in the cross-section, there are many outliers in the resulting price elasticities of demand, especially for deletions. The average elasticity is -44.03% for deletions and 2.77 for additions, though their medians are -3.31% and 1.67%, respectively.

The stock price elasticity estimates from the FTSE 100 index revisions are much lower than Ahern's (2014) elasticity estimates from the changes in the S&P 500 index composition. Using Chen, Noronha, and Singal's (2004) sample of 658 additions and 203 deletions from 1965 to 2000, Ahern finds average price elasticities of -6.2% for deletions and 16.3% for additions.[9] The difference is particularly striking for additions. This is in line with Chen,

[8] Ahern (2014) estimates the abnormal returns in a slightly different manner. He computes excess returns over a portfolio of 10 stocks matched by NYSE deciles of market capitalization and prior returns as in Ahern (2009).

[9] To control for outliers, Ahern trims the average by omitting the top and bottom one percent of the

Noronha, and Singal's (2004) investor awareness story given the much larger number of constituents in the S&P 500 index than in the FTSE 100 index.

5.2 Taking advantage of the addition/deletion price impacts

Our in-sample results identify substantial wealth effects for changes in the FTSE 100 index composition. Accounting for anticipatory trading effects reduce, but do not eliminate them. It rests to see whether these results remain significant out of sample. In what follows, we develop a simple trading strategy that attempts not only to anticipate additions and deletions to and from the FTSE 100 index before the committee reviews, but also to capitalize on the post-announcement cumulative abnormal returns. We assess our anticipative trading strategy from January 2000 to March 2010 using rolling estimation samples that span three years of data. The first step is to re-estimate the probit models using lagged explanatory variables. Given that market values are somewhat persistent, the hope is that replacing contemporaneous with lagged regressors will not affect too much the predictive ability of the probit models. As before, we employ a stepwise approach to select the set of explanatory variables we will use for each day within the pre-event window.

The next step is to define how to take benefit from the addition/deletion probit estimates. We start with a very simple trading strategy. Prior to the announcement date, we take equally-weighted long positions in the two stocks most likely to join the index and short the two stocks with the highest deletion likelihoods. After the announcement, if necessary, we rebalance the portfolio so as to hold long positions in every stocks that moves into the index and short positions in all stocks that drop from the index. Preliminary results show that this very simple strategy outperforms the FTSE 100 index in the 2000s. There are three caveats, though. First, this is a period of bearish markets in the UK and so it does not take much to beat the FTSE 100 index. Second, the excess returns over the FTSE 100 index depend heavily on the short positions, which obviously perform particularly well in bearish markets. Third, the turnover of the strategy is too high due to the wide variation in the early rankings of the addition/deletion probit estimates. As a result, transaction costs

price elasticity estimates. If we trim our estimates in a similar manner, we obtain average price elasticities that are very close to the median values we report above.

eat away and ultimately eliminate the excess return over the buy-and-hold passive strategy.

To come around these shortcomings, we consider two adjustments to the above anticipatory trading strategy. We attempt to scale down the portfolio turnover by smoothing the addition/deletion probability estimates. In particular, we employ a three-day moving average of the addition/deletion probit estimates. The motivation is to increase the persistence in the probability rankings so as to lessen the rebalancing needs. Moreover, we also exploit the dependence of the short portfolio returns on the market cycle by shorting only if the past 22-day return on the FTSE 100 index is negative. More precisely, the trading strategy works as follows. We start with 100 in a cash account. At time $\tau = -30$, we purchase the two stocks with most likely to join the index, as measured by the smoothed probit estimates in the addition subsample. If the 22-day FTSE return is negative, we also short the same amount on the two stocks with highest smoothed probabilities of moving out the index. The criteria are the same for every date in the pre-event window. We rebalance our portfolio every day there is a change in the first two positions of the addition/deletion probability rankings, always reinvesting the proceedings. Note that we also close the short positions if the 22-day FTSE 100 index return becomes positive, cashing in/out the proceedings. After the announcement, in the absence of uncertainty, we simply purchase the additions and short the deletions. We cash in the long positions after 15 days (i.e., $\tau = 15$), whereas we close the short positions after at most 25 days (i.e., $\tau = 25$). We revert all proceedings to the cash account and then wait for the next round of trading around the following committee review. Finally, in the absence of better measures of trading costs, we discount either 10, 20 or 30 basis points of every transaction we make. Given that we are dealing with stocks from large UK firms, we believe that the above costs are quite on the conservative side.

Figure 6 shows that the resulting strategy performs very well, achieving a much higher cumulative return than simply buying and holding passively the FTSE 100 index. The turnover is much lower and, as such, the performance is much more robust to transaction costs. Indeed, excess returns over the FTSE 100 index are significantly positive even assuming very conservative costs of trading. Interestingly, it turns out that every component of the adjusted trading strategy yields positive excess return. Given that we trade only around FTSE committee review, there are many instances in which we have only cash in the portfolio, entailing a zero return.[10] The peaks in the long and short portfolios within the pre-event window are thicker than the ones in the post-announcement window due to the difference in their lengths.

Table 2 summarizes the main distributional features of the returns on the trading strategy. For the sake of comparison, we also report the corresponding statistics for the excess return over the FTSE 100 index as well as for the returns on the latter. The average return of our trading strategy is threefold the average return of the passive strategy. The standard deviation is also higher due to the fact that there is not much diversification going on. Interestingly, although there is a large positive difference between the maxima of the active and passive strategies, the difference between their third quartile is negative. Apart from inflating the spread in the data, the extremely high returns we observe for the anticipative trading strategy also lead to a very large positive skewness and excess kurtosis. In contrast, the distribution of the FTSE 100 index returns is much more symmetric, even if it exhibits some excess kurtosis. The Box plots in Figure 7 manifest this difference in the degrees of asymmetry and leptokurtosis.

Table 2 also reports some risk and performance measures. In particular, the anticipative trading strategy entails a market beta of 0.5498, showing that it has much less systematic risk despite the higher standard deviation. As for the performance measures, the annualized Jensen's alpha is pretty large at 45.89%, though it is only borderline significant at the 10% level due to the high residual volatility. Treynor and Black's (1973) appraisal ratio (or information ratio), as measured by annualized alpha divided by the annualized residual volatility in the CAPM regression, is of 56.47%. This is very close to Grinold and Kahn's (1999) out-of-sample estimate of the third quartile of the appraisal ratio of the after-fee data on active equity mutual funds in the US. The Sharpe ratio of the active strategy is almost threefold the one of the FTSE 100 index despite the higher standard deviation. Note

[10] Note that we could further improve on the trading strategy by investing in the overnight rate. We do not pursue such an approach for the sake of simplicity. Accordingly, we do not consider excess returns over the risk-free rate when we compute performance measures such as the Sharpe ratio.

that the Sharpe ratio is actually a very conservative performance measure of our anticipative trading strategy if one considers its very large positive skewness. For instance, the difference in the Sortino measures, which standardize the average returns by the semi-variance (rather than the standard deviation), is indeed even more extreme.

It is perhaps hard to assess the statistical significance of the cumulative abnormal returns and anticipative effects for the changes in the FTSE 100 index composition. However, the above out-of-sample analysis manifest their economic relevance given the excellent performance that we observe for our anticipative trading strategy. We take these results as conservative in that we did not attempt to optimize much the trading strategy. For instance, in view that there are usually two index changes per quarter, one could well advocate for a reduction in the number of stocks in each probit pass. However, by computing the cumulative abnormal returns for additions and deletions simultaneously using a large number of stocks, we are able not only to avoid sample selection bias, but also to capture, even if perhaps only partially, significant anticipatory effects. There is obviously room for improvements, though. One could perhaps set the number of stocks in the first stage of the model as a function of the distance to the announcement date. Uncertainty subsides as the latter approaches, and hence we may reduce the number of candidates for addition and deletion in each subsample without risking too much of a sample selection bias.

6 Conclusion

We show that additions and deletions to and from the FTSE 100 index command significant wealth effects from 44 days before to 22 days after the committee review meetings. Most of the impact is within the pre-event window, with cumulative abnormal returns stabilizing after the announcement. Anticipatory trading responds for a substantial part of these effects, viz., 40% for additions and 23% for deletions, reducing the cumulative abnormal returns from 13.34% to 7.94% for additions and from -24.27% to -18.66% for deletions. As for the post-event window, the cumulative abnormal return adds up to 2.20% for additions and -6.97% for deletions. These figures may seem small relative to the pre-announcement repercussion, but they are still economically significant, implying a median price elasticity of demand of -3.31% for deletions and 1.67% for additions. To provide further evidence of the relevance of index revision effects, we develop a simple trading strategy that attempts to anticipate the outcomes of the FTSE committee review. The out-of-sample analysis indicates that such a trading strategy easily outperforms a passive strategy that tracks the FTSE 100 index even after controlling for transaction costs in a very conservative manner.

There are several explanations for addition/deletion effects in the literature. We deem that our results are most likely due to downward sloping demand curves for a number of reasons. First, the FTSE index membership rules are completely objective and hence it does not make much sense to speak about the certification hypothesis. Second, the FTSE 100 index constituents are very large firms in the UK. It is thus hard to sell that the repercussion in stock prices stems from better monitoring in the future or from changes in investor awareness. The latter is also not in line with the fact we find no evidence of price reversal in the post-announcement window. Third, the liquidity-based explanation predicts that rises in the volume rate should lower transaction costs, therefore increasing prices permanently. This is in stark contrast with what we observe for stocks that exit the FTSE 100 index. Their stock prices actually go down in a very substantial manner as their volume rate grows, especially in the pre-event window. It is important to stress, however, that the volume rate is just one dimension of liquidity and hence one could well look at other liquidity indicators, such as market depth and bid-ask spread, before completely ruling out liquidity-based causes for these addition/deletion effects.

References

Agarwal, Vikas, and Narayan Y. Naik, 2004, Risks and portfolio decisions involving hedge funds, *Review of Financial Studies* 17, 63–68.

Ahern, Kenneth R., 2009, Sample selection and event study estimation, *Journal of Empirical Finance* 16, 466–482.

Ahern, Kenneth R., 2014, Do common stocks have perfect substitutes? Product market competition and the elasticity of demand for stocks, *forthcoming in the Review of Economics and Statistics*.

Amihud, Y., and H. Mendelson, 1986, Asset pricing and the bid-ask spread, *Journal of Financial Economics* 17, 223–249.

Baker, H. Kent, and John A. Haslem, 1974, Toward the development of client-specified valuation models, *Journal of Finance* 29, 1255–1263.

Beneish, M. D., and R. E. Whaley, 1996, An anatomy of the 'S&P game': The effects of changing the rules, *Journal of Finance* 51, 1909–1930.

Blouin, Jennifer L., Jana Smith Raedy, and Douglas A. Shackelford, 2003, Capital gains taxes and price and volume responses to quarterly earnings announcements, *Journal of Accounting Research* 41, 611–651.

Blume, M., and R. Edelen, 2004, On replicating the S&P 500 index, *Journal of Portfolio Management* 30, 37–46.

Brennan, Michael J., and A. Subrahmanyam, 1996, Market microstructure and asset pricing: On the compensation for illiquidity in stock returns, *Journal of Financial Economics* 41, 441–464.

Brown, Stephen J., William N. Goetzmann, and Stephen A. Ross, 1995, Survival, *Journal of Finance* 50, 853–873.

Chen, Honghui, Gregory Noronha, and Vijay Singal, 2004, The asymmetric price response to S&P 500 index additions and deletions: Evidence and explanation, *Journal of Finance* 59, 190l–1940.

Chordia, Tarun, 2008, Liquidity and returns: The impact of inclusion into the S&P 500 index, in François-Serge Lhabitant, and Greg N. Gregoriou, eds.: *Stock Market Liquidity* (John Wiley and Sons, Hoboken, NJ).

Copeland, Thomas E., and David Mayers, 1982, The valueline enigma (1965-1978): A case study of performance evaluation issues, *Journal of Financial Economics* 10, 289–321.

Denis, D. K., J. J. McConnell, A. V. Ovtchinnikov, and Y. Yu, 2003, S&P additions and earnings expectations, *Journal of Finance* 58, 1821–1840.

Dhillon, U., and H. Johnson, 1991, Changes in the Standard and Poor's 500 list, *Journal of Business* 64, 75–85.

Dimson, E., and P. Marsh, 1986, Event study methodologies and the size effect: The case of UK press recomendations, *Journal of Financial Economics* 17, 113–142.

Edmister, R. O., A. S. Graham, and W. L. Pirie, 1994, Excess returns of index replacement stocks: Evidence of liquidity and substitutability, *Journal of Financial Research* 17, 333346.

Erwin, G. R., and J. M. Miller, 1998, The liquidity effects associated with addition of a stock to the S&P 500 index: Evidence from bid/ask spreads, *Financial Review* 33, 131–146.

Fung, William, and David A. Hsieh, 2000, Performance characteristics of hedge funds and commodity funds: Natural vs. spurious biases, *Journal of Financial and Quantitative Analysis* 35, 291–307.

Gregoriou, Andros, and Christos Ioannidis, 2006, Information costs and liquidity effects from changes in the FTSE 100 list, *European Journal of Finance* 12, 347–360.

Grinold, Richard C., and Ronald N. Kahn, 1999, *Active Portfolio Management.* (McGraw-Hill, New York) 2nd edn.

Grossman, Sanford J., and Joseph E. Stiglitz, 1980, On the impossibility of informationally efficient markets, *American Economic Review* 70, 393–408.

Harris, L. E., and E. Gurel, 1986, Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures, *Journal of Finance* 41, 815–829.

Harris, L. E., and A. Raviv, 1993, Differences of opinion make a horse race, *Review of Financial Studies* 6, 473–506.

Heckman, James, 1976, The common structure of statistical models of truncation, sample selection, and limited dependent variables and a simpler estimator of such models, *Annals of Economic and Social Measurement* 5, 475–592.

Heckman, James, 1979, Sample selection bias as a specification error, *Econometrica* 47, 153–161.

Hegde, S., and J. B. McDermott, 2003, The liquidity effects of revisions to the S&P 500 index: An empirical analysis, *Journal of Financial Markets* 6, 413–459.

Hocking, R. R., 1976, The analysis and selection of variables in linear regression, *Biometrics* 32, 1–49.

Jain, P., 1987, The effect on stock price of inclusion in or exclusion from the S&P 500, *Financial Analysts Journal* 43, 58–65.

Jobson, J. D., and Bob Korkie, 1983, Statistical inference in two-parameter portfolio theory with multiple regression software, *Journal of Financial and Quantitative Analysis* 18, 189–197.

Kaul, A., V. Mehrotra, and R. Morck, 2000, Demand curves for stocks do slope down: New evidence from an index weights adjustment, *Journal of Finance* 55, 893–912.

Kim, O., and R. E. Verecchia, 1994, Liquidity and volume around earnings announcements, *Journal of Accounting and Economics* 17, 41–67.

Kyle, A. S., 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315–1335.

Lynch, A., and R. Mendenhall, 1997, New evidence on stock price effects associated with changes in the S&P 500, *Journal of Business* 70, 351–384.

Mase, Bryan, 2007, The impact of changes in the FTSE 100 index, *The Financial Review* 42, 461–484.

McGuckin, Robert H., Frederik R. Warren-Boulter, and Peter Waldstein, 1992, The use of stock market returns in antitrust analysis of mergers, *Review of Industrial Organization* 7, 1–11.

Scholes, M., 1972, The market for securities: Substitution versus price pressure and the effects of information on share prices, *Journal of Business* 45, 179–211.

Shleifer, A., 1986, Do demand curves for stocks slope downward?, *Journal of Finance* 41, 579–590.

Stoll, H., 1972, The supply of dealer services in securities markets, *Journal of Finance* 33, 1133–1151.

Treynor, Jack, and Fischer Black, 1973, How to use security analysis to improve portfolio selection, *Journal of Business* 46, 66–86.

Wurgler, J., and E. Zhuravskaya, 2002, Does arbitrage flatten demand curves for stocks?, *Journal of Business* 75, 583–608.

Figure 1: Distributional features of the addition and deletion subsamples
We plot the time series of the 5th, 25th, 50th, 75th and 95th quantiles of the daily returns, market capitalization and volume rate for the addition and deletion subsamples. Panels (A), (C) and (E) refer to the addition subsample, whereas Panels (B), (D) and (F) relate to the deletions sample.

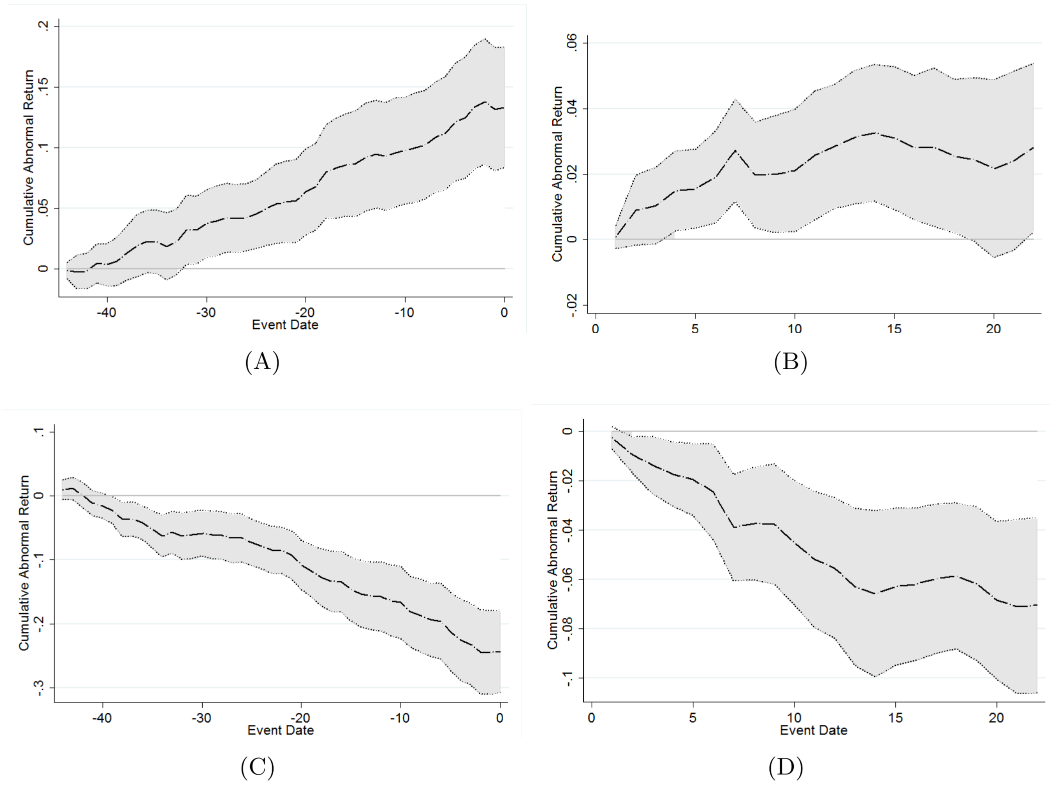

Figure 2: Average cumulative abnormal returns
We depict the average cumulative abnormal returns for changes in the index composition from 44 days before to 22 days after the FTSE committee announcements based on the traditional event-study regression. Panels (A) and (B) refer to the pre- and post-event cumulative abnormal performance for stocks joining the index, whereas Panels (C) and (D) relate to corresponding figures for stocks that exit the index.

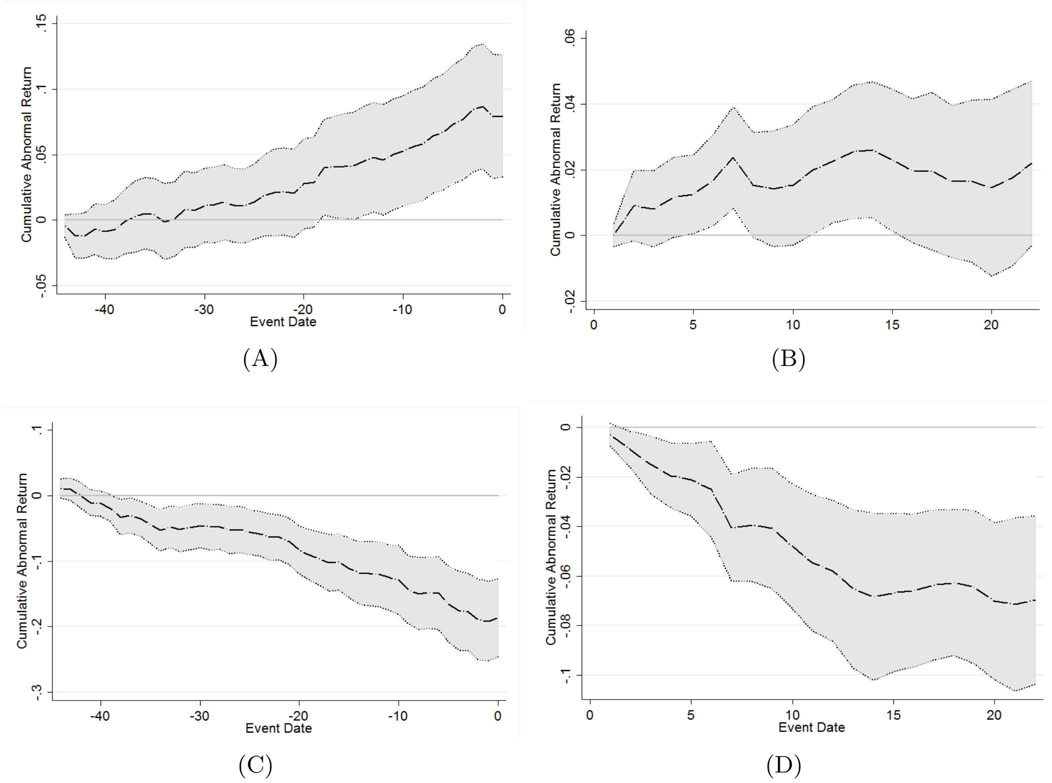

Figure 3: Average cumulative abnormal returns adjusted for anticipatory trading effects
We display the average cumulative abnormal returns for changes in the index composition from 44 days before to 22 days after the FTSE committee announcements based on the event-study regression including addition/deletion probability estimates. Panels (A) and (B) refer to the pre- and post-event cumulative abnormal performance for stocks joining the index, whereas Panels (C) and (D) relate to corresponding figures for stocks that exit the index.

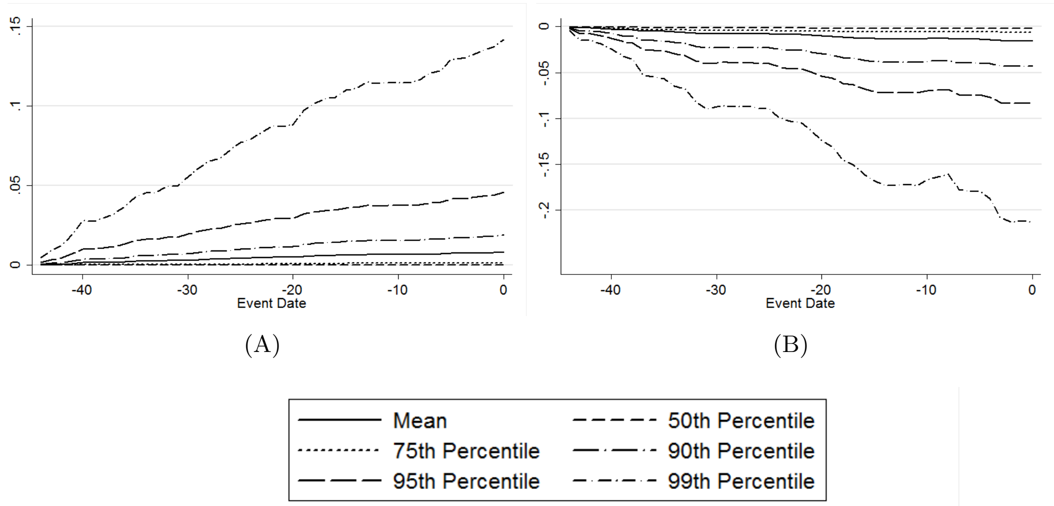

Figure 4: Cumulative anticipatory effects
We plot the cumulative anticipatory trading effects at different percentiles of the addition/deletion probability estimates in the pre-event window. Panel (A) refers to the impact of anticipative trading for the addition subsample, whereas Panel (B) illustrates the corresponding impact for the deletion subsample.

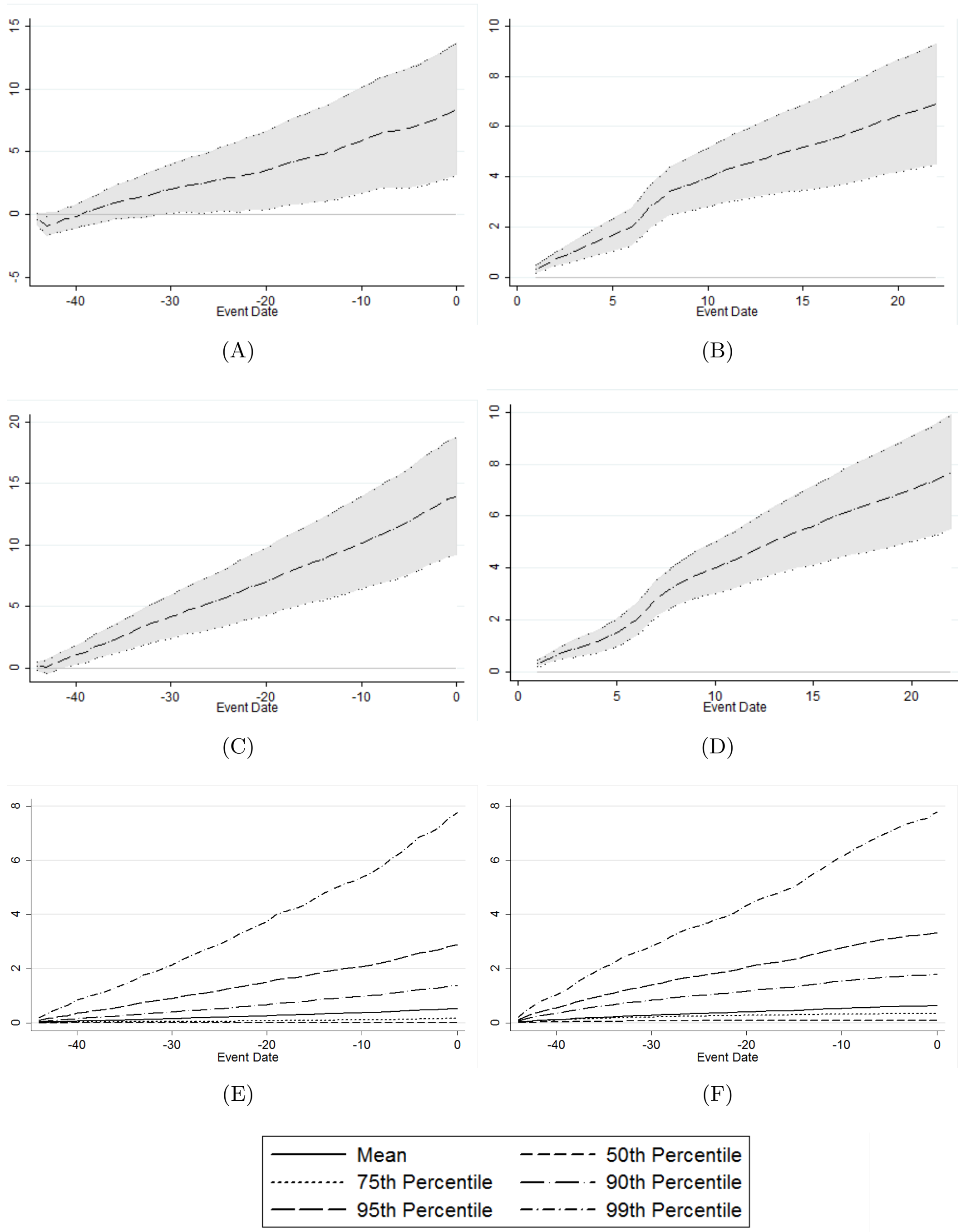

Figure 5: Cumulative abnormal volume rates and anticipatory trading effects
We depict the average cumulative abnormal volume rates for changes in the index composition from 44 days before to 22 days after the FTSE committee announcements based on the event-study regression including addition/deletion probability estimates. Panels (A) and (B) respectively display the cumulative abnormal logit of the volume turnover for additions and deletions within the pre-event window, whereas Panels (C) and (D) plots the analogous statistics for the post-announcement window. Panels (E) and (F) reveals the percentiles of the anticipative trading effects for additions and deletions, respectively.

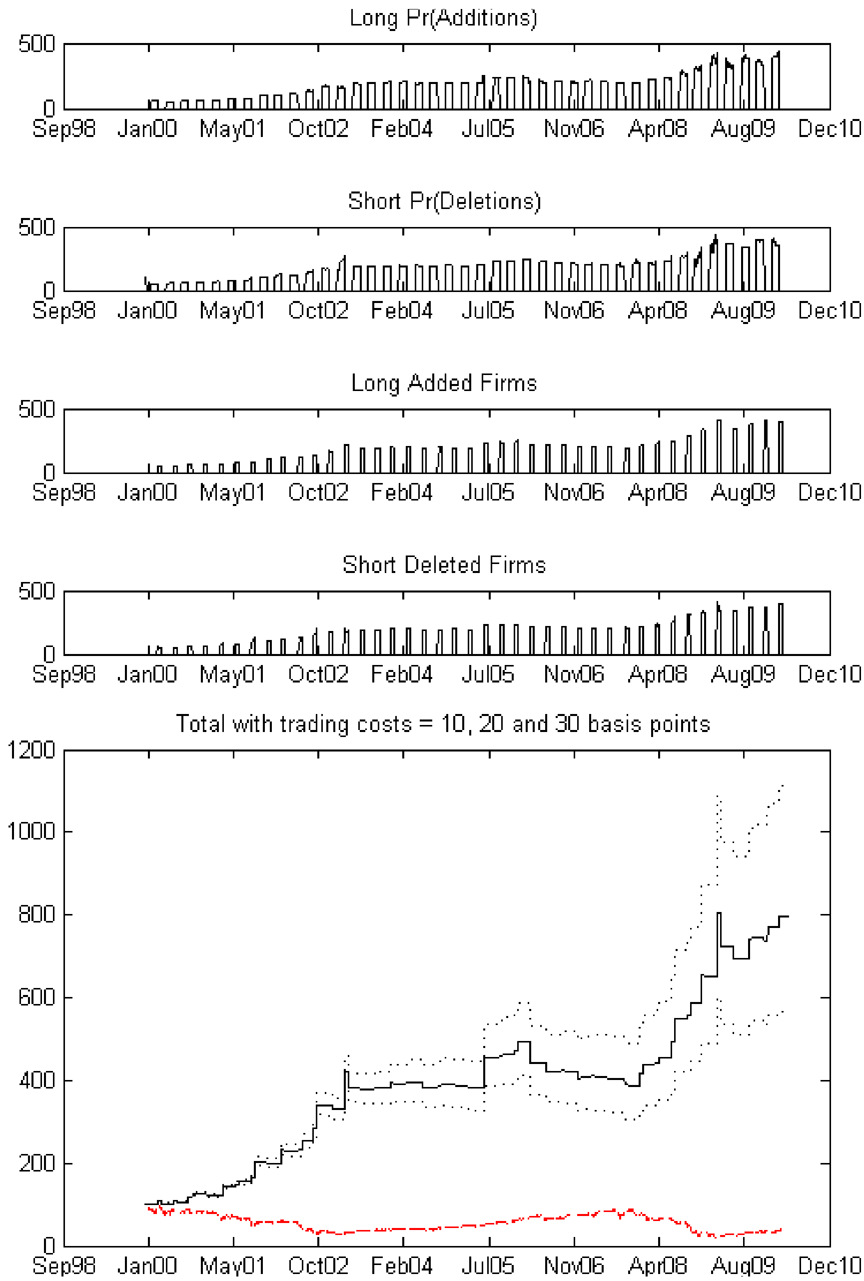

Figure 6: Performance of the anticipatory trading strategy
The first two plots respectively display the cumulative returns to the portfolios that trade on the pre-event addition and deletion probit estimates from January 2000 to March 2010. The third and fourth plots depict the performance of the portfolios that trade on the the effective additions and deletions, respectively. The last plot gives the cumulative return on the overall portfolio considering different trading costs (viz., 10, 20 and 30 bps) as well as the cumulative return to a passive strategy that buys and holds the FTSE 100 index.

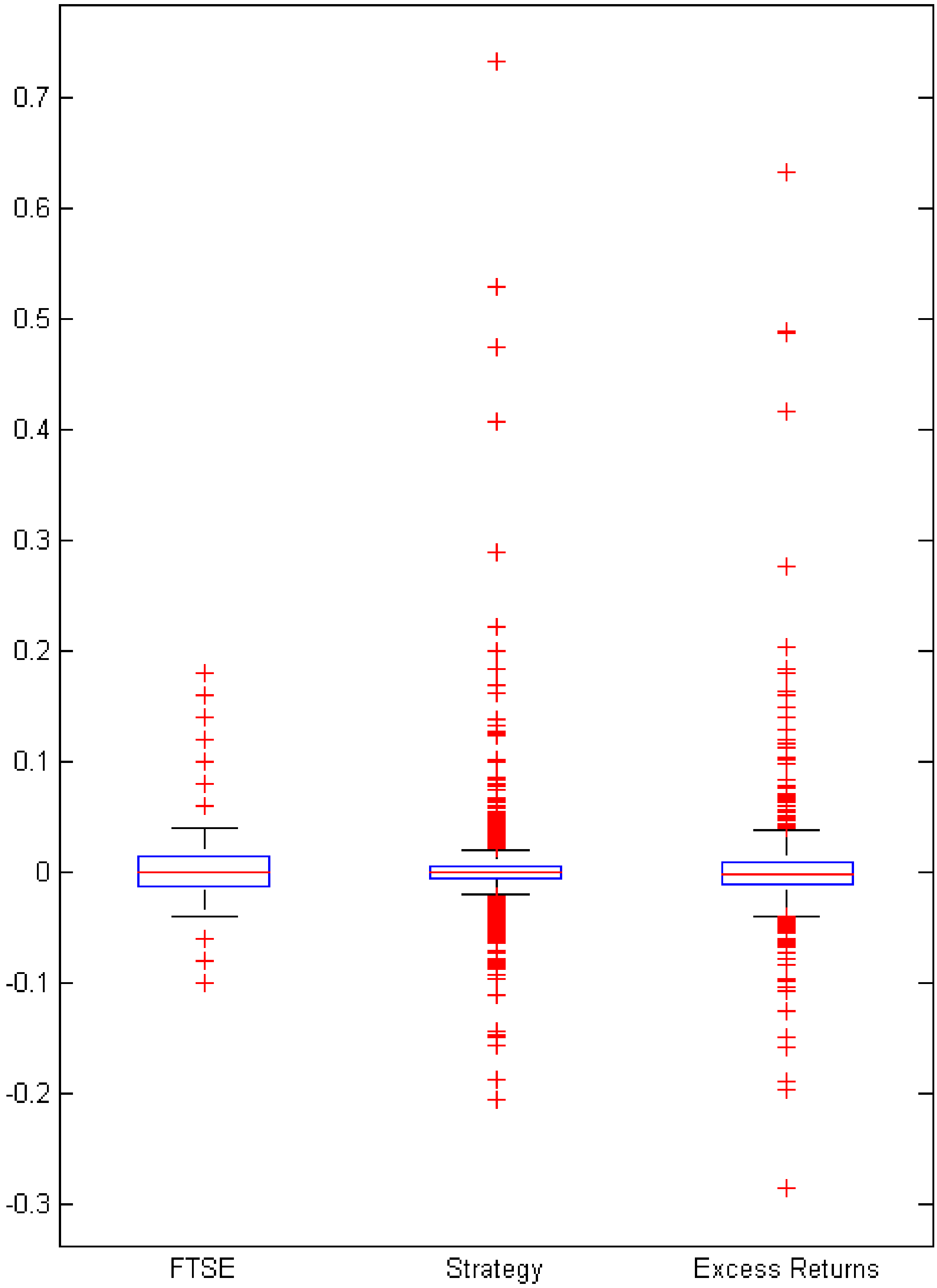

Figure 7: Distribution of the active and passive trading strategy returns
We characterize by means of Box plots the distribution of the returns and excess returns on the anticipative trading strategy over the passive strategy that simply buys and holds the FTSE 100 index from January 2000 to March 2010.

Table 1

Descriptive statistics for the addition/deletion probability estimates

Apart from the mean, median, standard deviation and skewness of the probit estimates at different pre-event days, we report the first and third quartiles as well as the upper tail percentiles of their distribution.

probability	percentile						mean	standard deviation	skewness
	25%	50%	75%	90%	95%	99%			
addition									
$\tau = -1$	1.57E-31	1.10E-03	0.021	0.083	0.16	0.51	0.03	0.09	5.83
$\tau = -5$	7.96E-31	1.56E-23	3.59E-13	0.023	0.06	0.21	0.01	0.05	10.04
$\tau = -10$	3.42E-08	3.33E-06	2.23E-04	0.017	0.04	0.15	0.01	0.04	12.18
$\tau = -20$	2.06E-05	1.31E-04	7.23E-04	0.018	0.04	0.14	0.01	0.04	12.36
$\tau = -30$	3.80E-05	2.47E-04	1.20E-03	0.019	0.05	0.15	0.01	0.04	10.91
$\tau = -40$	8.77E-06	2.02E-04	2.34E-03	0.019	0.05	0.14	0.01	0.03	10.66
deletion									
$\tau = -1$	8.60E-07	6.53E-05	1.61E-03	0.037	0.09	0.38	0.02	0.08	7.76
$\tau = -5$	7.81E-06	1.73E-04	1.22E-03	0.037	0.10	0.37	0.02	0.08	7.53
$\tau = -10$	7.87E-07	7.87E-05	8.20E-04	0.050	0.12	0.33	0.02	0.07	7.39
$\tau = -20$	1.75E-04	9.94E-04	4.00E-03	0.057	0.12	0.30	0.02	0.07	7.57
$\tau = -30$	5.73E-04	3.64E-03	0.010	0.062	0.12	0.29	0.02	0.06	6.92
$\tau = -40$	4.85E-04	5.23E-03	0.014	0.068	0.11	0.23	0.02	0.05	7.68

Table 2

Performance of the anticipative trading strategy

Apart from the mean, standard deviation, skewness and kurtosis of the annualized returns on the anticipative trading strategy and on the FTSE 100 index, we also report the minimum, first quartile, median, third quartile, and maximum values of the daily returns. We consider a transaction cost of 20 basis points. In addition, we also relay the corresponding figures for the excess returns of the anticipative trading strategy over the the FTSE 100 index. Lastly, we compute some annualized performance and risk measures for the active trading strategy, namely, market beta, Jensen's alpha, appraisal ratio, Sharpe ratio, and Sortino ratio.

	FTSE 100 index		trading strategy		excess return	
	all	open	all	open	all	open
mean	−0.0213	0.0710	0.3527	0.1924	0.2137	0.2818
semi-variance	0.0661	0.0350	0.0418	0.0418	0.0683	0.0471
standard deviation	0.3528	0.3637	0.4558	0.6172	0.5033	0.6073
skewness	−0.0138	0.0247	0.7369	0.5417	0.4247	0.4327
kurtosis	3.0295	3.0384	3.9949	3.5363	0.4707	0.4008
minimum	−0.1800	−0.1000	−0.2065	−0.2065	−0.2865	−0.2865
first quartile	−0.0122	−0.0128	−0.0008	−0.0052	−0.0108	−0.0107
median	0.0000	0.0008	0.0000	−0.0002	−0.0004	−0.0001
third quartile	0.0126	0.0139	0.0006	0.0053	0.0099	0.0090
maximum	0.1800	0.1800	0.7341	0.7341	0.6341	0.6341
beta	1	1	0.3168	0.5457		
alpha	0	0	0.2008	0.3140		
appraisal ratio	0	0			0.4245	0.4640
Sharpe ratio						
Sortino ratio					0.8177	1.2989

Acknowledgments

We are grateful to Pedro Saffi, Ana Paula Serra and Pedro Valls for helpful comments as well as to seminar participants at Queen Mary, São Paulo School of Business (FGV), University of Porto, Insper Business School as well as at the Luso-Brazilian Finance conference (Bũzios 2013), and at the meetings of the European Financial Management Association (Barcelona 2012), the Brazilian Finance Society (São Paulo 2012), ANPEC (Iguazu Falls 2011), and the Midwest Finance Association (New Orleans 2011). Both authors thank FAPESP for financial support under the grant 2013/22930-0. Fernandes also acknowledges support from CNPQ under the grant PQ302272/2014-3. The usual disclaimer applies.

Queen Mary
University of London

This working paper has been produced by
the School of Economics and Finance at
Queen Mary University of London

School of Economics and Finance
Queen Mary University of London
Mile End Road
London E1 4NS
Tel: +44 (0)20 7882 7356
Fax: +44 (0)20 8983 3580
Web: www.econ.qmul.ac.uk/research/workingpapers/