CFA Society Ireland

ETFs and the Pricing Efficiency of Large-Capitalisation Stocks

European QuantAwards 2018

Abstract

This paper investigates the impact of changes in the level of exchange traded fund ownership of securities comprising the Dow Jones Industrial Average between 2013 and 2017. Implications associated with the rise in ETF prominence over this period are examined with regards to trading costs of the underlying assets and, relatedly, to the informational efficiency of their share prices. Consistent with findings published in the study of Israeli, et al. (2017) and others, evidence supporting an ETF-driven increase in trading costs is found over quarterly and monthly observations. Association found between changes in ETF ownership and stock return synchronicity; defined as the extent to which variation in firm-level returns is explained by market and sector returns, indicates an increase in the incorporation of firm-specific information for large-cap stocks. This finding, albeit inconclusive, deviates from previous studies and suggests that compensation for costly information acquisition is sufficient to entice informed traders in large-cap stocks to the exchange traded fund vehicle.

Table of Contents

Introduction

A notable shift in the investment sphere, particularly since the financial crisis of 2008/09, has been centred on large flows of investment from actively managed equity mutual funds into more passively managed, indexed products. Indeed, Stambaugh highlights contemporary trends including reductions in retail investor fees, diminishing fractions of mutual assets that are actively managed and "active management's becoming less active" and "in aggregate more index-like" (2014, p. 1418). Within this movement, the exchange traded fund is finding favour among many investors. ETF assets have grown from just over $800bn before the financial crisis to over $4.2tn to the end of August 2017 (Smith, 2017). The increasing popularity of the exchange traded fund owes much to the product's convenience, relative cost advantages and tax efficiency.

The typical passive ETF consists of an underlying basket of securities which is set up to mirror the performance of a broad market index or benchmark, shares of the ETF are then traded on exchanges allowing investors to gain desired exposure with the comparable ease of purchasing shares in a listed equity security. While the ETF vehicle has enabled retail investors to feasibly broaden their investable universe to include previously inaccessible exposures such as to gold or oil, not to mention to the ill-advised triple-leveraged inverse and volatility products gaining notoriety, this research focuses solely on the passive, equity index-tracking, element of the ETF universe; the plain vanilla segment which provide foundations for investment portfolios.

The effects of passive indexed products continue to draw attention within the investment community despite basket securities such the index fund being in existence since the 1970s and ETFs since the late 80s. However, recent growth of the ETF has brought concerns to the forefront; concerns which include price discovery, pricing efficiency, transmission of non-fundamental shocks, increased correlations between underlying securities, contagion, reduced liquidity and others. Research motivation is found amid these apprehensions.

This study encompasses a firm-level investigation of the effects of exchange traded fund ownership on a subset of the U.S. large-capitalisation equity market as contained within the Dow Jones Industrial Average Index. The research seeks to expand upon previous studies into the effect of ETFs on firm-level liquidity and pricing efficiency such as that of Israeli, et al. (2017).

Literature Review

The diverse range of possible effects associated with the rise of ETFs have been traversed in academic literature with Wurgler attempting to provide a holistic review of the economic consequences of index-linked investing more generally. His review suggests that index-linked investing strategies, owing to their ever-increasing popularity, "are generating new stock market phenomena in their own right" and "distorting stock

prices and risk-return trade-offs" (Wurgler, 2010). Research in Glosten, et al. (2015) posits that ETF trading increases the informational efficiency of underlying stocks through the timely incorporation of aggregate, or systematic, information. They find support for such among small stocks and stocks with imperfectly competitive markets. Da & Shive (2018), conversely, find that return comovement of underlying assets is promoted by the ETF arbitrage mechanism and suggest that such comovement may be excessive; due to non-fundamental factors rather than the efficient transmission of systematic information. Similarly, Ben-David, et al. (2014) indicate that arbitrage drives an increase in the volatility of underlying ETF assets. Madhavan & Sobczyk suggest that ETF premiums reflect price discovery, opining that the result "should mitigate concerns that ETFs are the source of additional volatility or systemic risk (2015, p. 22). ETF demand shocks are shown to explain large parts of stock return correlations in Leippold, et al. (2016) and Bhattacharya & O'Hara (2018) explore ETF activity in more illiquid markets, demonstrating that distortion towards a systematic factor results in mispricing of fundamental factors.

Among the plethora of economic consequences of ETFs, the issue of pricing efficiency of underlying securities is significant. Pricing efficiency is concerned with the extent to which information is incorporated in stock prices. The existence of information asymmetries in financial markets and compensation for information acquisition, both directing the level of informed participation, are pivotal to pricing efficiency.

Arguably, the seminal contribution on the functioning of financial markets is that of the "efficient markets model" advanced by Eugene Fama and others which opines that "security prices at any time fully reflect all available information" (Fama, 1970, p. 383). However, the theoretical underpinnings of such rational expectations equilibrium models have been the subject of debate that has spawned a vast body of research into the informational role of security prices. The work of Grossman & Stiglitz on the "impossibility of informationally efficient markets" provided the foundation for such. Their principle conjecture directly challenged the "competitive equilibrium in which prices are such that all arbitrage opportunities are eliminated" by presenting a model in which there is an "equilibrium degree of disequilibrium", where "prices reflect the information of informed individuals (arbitrageurs) but only partially, so that those who expend resources to obtain information do receive compensation" (Grossman & Stiglitz, 1980, p. 393).

The work of Grossman & Stiglitz served to provide "critical parameters" upon which "the equilibrium number of informed and uninformed individuals in the economy will depend"; critical parameters which are of great significance to this research. Foremost in our attention are two such parameters, those being; "the higher the cost of information, the smaller the equilibrium percentage of individuals who are informed" and "the greater the magnitude of noise, the less informative will the price system be…in equilibrium the greater the magnitude of noise, the larger the proportion of informed individuals" (Grossman & Stiglitz, 1980, p. 404). This second parameter provides rationale to the contradictions of "fully revealing" rational expectations equilibrium models and the existence of information asymmetries in financial markets. They assert that noise; which can be defined as the liquidity trading of market participants for reasons such as exogenous hedging requirements, serves to interfere with the information conveyed in the price system, leading to greater informed market participation.

Developing the work in Grossman & Stiglitz, Hellwig (1980) attempts to alleviate the effect of what is termed as the "schizophrenia" problem whereby agents are assumed not to notice their effect on price by presenting a model of information aggregation in a large market, in which individuals have no effect on price; where they become "small in an appropriate sense" (Kyle, 1989, p. 317). Admati (1985) takes a similar approach by analysing a continuum of traders. Further contributions to the noisy rational expectations literature are provided by Verrecchia (1982), who highlights the link between noise trading and informational efficiency, and Kyle who investigates insider trading (1985) and informed speculation (1989) by advancing many of the models and theoretical approaches defined in the body of research.

The advantages of both existing and theoretically optimal market-based vehicles were outlined by Rubenstein (1989). These optimal properties, now mainly satisfied by the ETF, have given rise to the exponential growth in popularity of the vehicle and, importantly, amongst uninformed traders as a group. Gordon and Pennacchi document that such optimal composite securities enable liquidity traders to "minimise losses to insiders"; that is, they reduce "the information advantage of the insiders over the liquidity traders" (Gorton & Pennacchi, 1993, p. 3).

These properties have an interesting potential impact on financial markets in which "lesser informed agents will optimally switch to holding and trading this security

rather than the individual securities that make up the composite...this "migration" to the composite security reduces liquidity trading in the individual component securities". Hamm (2014) finds support for this migration and draining of liquidity. The result of which is that "insiders have less camouflage with which to disguise their trades" (Gorton & Pennacchi, 1993, p. 5). This adds a further layer of disincentive above that of increased trading costs which is described by Kyle in that "when there is little noise trading in competitive models...prices reveal so much of traders' private information that incentives to produce private information disappear" (Kyle, 1989, p. 318). Combination of disincentives to informed traders of increased trading costs and decreased relative levels of noise trading lead to the hypothesis of a reduction in the pricing efficiency of underlying assets.

Research Methodology

Complementing earlier literature, this paper considers the effects of ETFs following two hypotheses. Firstly, an increase in ETF ownership results in a reduction of firm-level liquidity which can be observed from increased trading costs. Secondly, disincentives to informed market participation stemming from a reduction in liquidity result in a deterioration in the informational efficiency of the underlying securities.

The underpinning driver of both hypotheses is a change in the level of ETF ownership. For the purposes of this study, changes in the level of ETF ownership are represented by observed changes in the percentage of shares held by a sample of ETFs in each of the individual equity securities that comprise the Dow Jones Industrial Average (DJIA) during the specified period under observation. The effect of trailing ETF ownership on both trading costs and stock return synchronicity is investigated on a monthly, quarterly and annual basis over the period commencing January 1st, 2013 and ending December 31st, 2017. In order for an individual firm to be included in testing in any observation period, the firm must have been a constituent of the DJIA for the entirety of that observation period. Figure 3 details the periods for which any additions/deletions from the index are included for testing.

To facilitate a robust study focussing solely on passive ETF ownership, the Fund Screening function (FSRC) within Bloomberg Professional Services was utilised to derive a tailored sample of ETFs matching desired characteristics for the proposed research. A preliminary screening based on passively-managed, fully-replicating, large-cap US equity-focussed ETFs which do not employ leverage nor invest in derivatives or swaps and which, as of June 2018, had total assets in excess of $100m yielded 177 unique ETFs. A minority of this sample did not hold shares in the firms under observation. Explanations of all exclusions are provided in Figure 2. The exclusion of such funds resulted in a final sample of 150 ETFs from which holdings of the target firms were obtained. Figure 1 depicts the 20 largest ETFs included in the sample by assets under management.

Trading Costs Hypothesis

The first hypothesis of this study is that as the proportion of firm-shares held by ETFs increases, there is a reduction in firm-level liquidity observable through increased trading costs. The first critical parameter of Grossman & Stiglitz states that "the higher the cost of information, the smaller the equilibrium percentage of individuals who are informed"; giving rise to the link between trading costs and pricing efficiency (Grossman & Stiglitz, 1980, p. 404).

This study adopts the bid-ask spread estimator developed by Corwin & Schultz (2012) to capture trading costs. In their paper, the authors provide a model for estimating bid-ask spreads from daily high and low stock prices. The "simple insight" upon which Corwin & Schultz base their high-low spread estimator of trading costs is that the "high-low price ratio reflects both the true variance of the stock price and the bid-ask spread" (Corwin & Schultz, 2012, p. 722). They note that as the stock price variance grows proportionately over time while the bid-ask spread element does not, a system of equations can solve for both components. The bid-ask spread is shown to be a function of both the sum of the high-low ratios on two consecutuve single days and the high-low ratio from a single two-day period. These components are represented by β and Y respectively in the following equations which determine the bid-ask spread (S);

$$\beta = \sum_{j=0}^{1} \left[\ln\left(\frac{H_{t+j}^{0}}{L_{t+j}^{0}}\right)\right]^{2}, \text{ and}$$

$$Y = \left[\ln\left(\frac{H_{t,t+1}^{0}}{L_{t,t+1}^{0}}\right)\right]^{2}, \text{ thus}$$

$$\alpha = \frac{\sqrt{2\beta}-\sqrt{\beta}}{3-2\sqrt{2}} - \sqrt{\frac{Y}{3-2\sqrt{2}}}, \text{ and}$$

$$S = \frac{2(e^{\alpha}-1)}{1+e^{\alpha}}$$

To estimate the bid-ask spread as above, daily high and low prices for each firm are obtained from Bloomberg Professional Services following the US Exchange (ex-US) calendar convention. Following the process in Corwin & Schultz (2012), all negative spreads are set to

zero and the variable HLSPREAD is obtained as the average of all bid-ask spreads over the specific period under observation.

To estimate the relationship between changes in the extent of ETF ownership of each individual security in the sample and changes in their respective bid-ask spreads the following regression is adopted from the study in Israeli, et al. (2017);

$$\Delta HLSPREAD_{it} = \beta_1 \Delta ETF_{it-1} + \beta_2 \Delta INST_{it-1} + \sum \beta_k \Delta Controls_{it-1} + \sum_j \beta_j FIRM\_FE_i + \sum_l \beta_l TIME\_FE_t + \varepsilon_{it}$$

The variable $\Delta HLSPREAD_{it}$ represents the change in firm i's bid-ask spread measure over the period t-1 to t while ΔETF_{it-1} represents the variable of interest in the defined hypothesis, that being; the change in ETF ownership of firm i from the end of the period t-2 to the end of the period t-1. The model in Israeli, et al. (2017) includes the level of institutional ownership in the regression to ensure that the results derived are not confounded by the relationship between ETF and institutional ownership. According with this intuition, the percentage of firm i's shares held by institutions including US and international mutual funds and others is gathered and from which the level of sample ETF ownership is subtracted. While the institutional ownership data provided by Bloomberg includes short interest and is not explicitly derived as a point estimate of institutional ownership in line with the sample ETF holdings, its inclusion is merited as the main control variable owing to the reliability of the Bloomberg Professional Services data source and to the absence of availability of more strictly conforming data.

The variable $\Delta Controls_{it-1}$ represents a series of controlling variables defined in the study of Israeli, et al. (2017) including the change in the annualized standard deviation of daily returns during period t-1, the change in average share turnover from year t-2 to year t-1, and the change in book-to-market ratio during year t-1. The reader is directed to Figure 5 for a detailed explanation of these control variables and the methods deployed in their calculation. In a deviation from the regression as in Israeli, et al. (2017) which includes industry fixed effects, this paper studies the effect of ETF ownership on trading costs while controlling for heterogeneity across firms.

Stock Return Synchronicity Hypothesis

The second hypothesis of the research states that an increase in ETF ownership is associated with an increase in the extent to which market and sector returns explain variation in firm-level returns, that is; an increase in stock return synchronicity. Reductions in firm-level liquidity imply a disincentive to information acquisition which, in turn, leads to a decline in the pricing efficiency of the underlying security.

As indicated in the study of Israeli, et al. (2017), a decline in the pricing efficiency of an individual security can be drawn by way of illustration of a reduction in firm-level information being impounded into its corresponding stock price. One proxy for such is the extent to which market and sector returns explain variation of firm-level stock returns. As such, this study tests the defined hypothesis by way of regressing changes in stock return synchronicity on changes in the level of ETF ownership over the sample time period. This process involves two steps;

First, adapting the method deployed in Piotroski & Roulstone (2004), for each firm-period observation, daily stock returns are regressed on the current and lagged market and sector returns, as given in the following equation:

$$RET_{it} = \alpha + \beta_1 MKTRET_{it-1} + \beta_2 MKTRET_{it} + \beta_3 SECTOR_{it-1} + \beta_4 SECTOR_{it} + \varepsilon_{it}$$

For each firm included in the sample, returns are calculated from closing prices with market returns calculated from S&P 500 Index closing prices and sector returns derived from the closing prices of indices for each of the Global Industry Classification Standard (GICS) sectors represented in the firm sample. Figure 4 provides details of the GICS hierarchical classification for each sample firm while also providing information as to the index used in the calculation of sector returns for such firms.

Following which, stock return synchronicity is defined as in the study in Piotroski & Roulstone (2004) as the adjusted coefficient of determination in the above equation such that;

$$SYNCH_{it} = log\left(\frac{R^2}{1-R^2}\right)$$

As discussed by the authors, the log transformation in this regard "creates an unbounded continuous variable out of a variable originally bounded by 0 and 1, yielding a dependent variable with a more normal distribution" (Piotroski & Roulstone, 2004, p. 1124). To facilitate such, this study truncates any negative adjusted R^2 values that arise at the 0.0001 level, as directed by the procedure in Israeli, et al. (2017). Negative values for the adjusted R^2 mainly arise from the regression of daily stock returns over the shorter monthly observation period, whereby the four predictors in the model are estimated on a small sample number of observations, typically 20 trading days.

The log transformation of the adjusted R^2 has the effect of assigning positive values of SYNCH for any observation period in which the regression of firm level returns on market and sector returns explains in excess of 50% of the variation in the dependent variable; an adjusted R^2 of 0.5 or above. Negative values for SYNCH are assigned to explanatory power below 0.5. Analysis of high values for the SYNCH variable above can be interpreted as representing firm's whose stock returns follow closely with that of market and sector returns, reflecting relatively less firm-specific information being impounded into the stock price.

I adapt the following regression from the study of Israeli, et al. (2017) to estimate the impact of ETF ownership on the level of firm-specific information being impounded into stock prices, hence, on stock return synchronicity;

$$\Delta SYNCH_{it} = \beta_1 \Delta ETF_{it-1} + \beta_2 \Delta INST_{it-1} + \sum_k \beta_k \Delta Controls_{it-1} + \sum_j \beta_j FIRM_{FE_i} + \sum_l \beta_l TIME_{FE_t} + \varepsilon_{it}$$

The variable $\Delta SYNCH_{it}$ represents the change in security i's measure of SYNCH over the period t-1 to t while ΔETF_{it-1} represents the variable of interest in the defined hypothesis as before. In accordance with the first hypothesis, the level of institutional ownership is also included in the regression as are firm and time fixed effects. The variable $\Delta Controls_{it-1}$ similarly represents a series of controlling variables defined in the literature including the skewness of firm i's returns over year t-1, the annual change in CAPM beta as a control for a firm's systematic risk, annual changes during year t-1 in the natural log of market value of equity, book to market ratio, and average share turnover.

Research Findings

Descriptive Statistics

Figure 6 through Figure 8 inclusive present annual, quarterly and monthly descriptive statistics of the variables included in testing. Summary statistics of note include average ETF ownership of 3.26% in the annual sample. The growth of exchange traded funds is supported by average increases in ETF ownership of 41 basis points annually. The extent of institutional ownership is markedly higher with mean annual ownership of 72.8% and annual increases of close to 1%. This concentrated level of institutional ownership is consistent with a sample of large cap firms; the mean annual market capitalisation of which is in excess of $168bn with a maximum of over $882bn in the monthly sample.

A mean HLSPREAD of 0.31% is lower than that reported in Israeli, et al. (2017), which averages 1.07%. This result is expected for a sample of large, blue-chip stocks for which an accompanying deep, highly liquid market should facilitate narrow trading spreads. Decreases in HLSPREAD are experienced in each observation period. Notably, decreases in stock return synchronicity are experienced in each observation period, contrasting the findings in Israeli, et al. (2017).

Pearson correlation coeeficients are included for level and change variables and illustrated in Figure 9. Weak positive relationships are displayed between changes in ETF ownership and HLSPREAD in quarterly and monthly samples, conflicting a weak negative relationship in the annual sample. A similarly inconclusive relationship is depicted between changes in ETF ownership and changes in SYNCH, shown as negative in annual and quarterly samples while positive in a monthly sample. Levels of ETF ownership display consistently negative relationships with both HLSPREAD and SYNCH across each sample.

Regression Estimates

Figure 10 through Figure 15 inclusive present the estimation of changes in trading costs and stock return synchronicity from individual and two-way (individual and time) error component regression models. The presentation of both models displays the comparative impact of time fixed effects with primary attention being directed to two-way model estimation. Equations (1) and (2) depict the impact of excluding and including changes in institutional ownership in the regression respectively.

Trading Costs Hypothesis

Annual changes in HLSPREAD display a statistically significant positive relationship with changes in book to market ratio as predicted with a similarly positive association shown with changes in standard deviation of returns. No statistically significant association is depicted between changes in ETF ownership and HLSPREAD during the observation period.

Similarly, the estimation of quarterly changes in HLSPREAD displays positive association between the dependent variable and changes in book to market ratio and changes in standard deviation of returns. While a positive relationship between changes in ETF ownership and changes in HLSPREAD is shown, the sensitivity of such to the inclusion of time fixed effects is apparent with individual error component estimation displaying a statistically significant relationship (coefficient = 0.068). This suggests that a one percentage point increase in ETF ownership in the previous quarter is accompanied by an increase of 6.8%

in the average change in HLSPREAD for Dow Jones Industrial Average firms in the subsequent quarter.

Further supporting evidence form this result is obtained from the regression of monthly changes in HLSPREAD. Once more, the exclusion of time fixed effects yields a statistically significant association between changes in HLSPREAD and changes in ETF ownership suggesting that a one percentage point increase in ETF ownership in a given month is accompanied by an increase of 17% in the average change in HLSPREAD in the following month.

Stock Return Synchronicity Hypothesis

Observed from the regression of annual changes in SYNCH, the predicted positive association between changes in SYNCH and firm size is shown to exist while negative association between changes in SYNCH and changes in ETF ownership is found, suggesting that as the extent of ETF ownership increases, stock prices display increased incorporation of firm-specific information. This result, while being more pronounced in the absence of control for institutional ownership, is, however, not statistically significant.

Similarly observed from the quarterly test is the positive association with changes in firm size, most notably this relationship is shown to be statistically significant at the 1% level when individual fixed effects only are controlled for. Of most interest from the regression of quarterly changes in SYNCH, however, is the negative association with the explanatory variable of interest; changes in ETF ownership. The association is shown to be statistically significant across each test iteration with two-way fixed effects estimation suggesting that a one percentage point increase in ETF ownership in one quarter results in a 44.9% decrease in the average change in stock return synchronicity in the following quarter.

Reservations are held as to the reliability of the measure of stock return synchronicity, SYNCH, in shorter observation periods. Derived from the adjusted coefficient of determination from a regression of daily stock returns in any period, SYNCH is impacted by the frequency of negative adjusted R^2 values from such regressions in shorter observation periods. Inference from the monthly sample is hindered by the effect of such on the dependent variable.

Analysis and Discussion

Efforts are made to empirically test the hypothesis of ETF-driven increases in underlying firm trading costs which is suggested in literature to date. With observable expansion of the popularity of ETFs, it is purported that the vehicle can starve liquidity in underlying market as greater number of firm-shares become locked-up in the ETF. Quarterly and monthly regression estimates of such point to existence of statistically significant positive association between changes in ETF ownership and changes in bid-ask spreads. Quarterly tests suggest that a one percentage point increase in ETF ownership in the previous quarter results in an increase of 6.8% in in the average change in bid-ask spread in the following quarter.

In the above tests of trading costs, the sensitivity to inclusion of time fixed effects is notable. The concern stemming from such which is raised in the study of Israeli, et al., that “the inclusion of year fixed effects limits our analysis to the variation in changes in ETF ownership relative to other firms in the same year, while ignoring the variation in total average year-over-year changes in ETF ownership” seems warranted (2017, p. 1059). When such variation in total average period-over-period changes are considered, as would seem prudent for investigation of the growth in ETFs, this paper finds support for an ETF driven increase in firm trading costs over quarterly and monthly testing periods. However, substantial increases to the sample size are required to validate the robustness and consistency of these findings.

The inconclusiveness reported in the tests of hypothesis 2; that of an ETF-driven increase in stock return synchronicity, may largely stem from the highlighted issue surrounding the calculation of SYNCH in shorter observation periods as well as a lack of a suitably large sample size from which to derive meaningful results. Despite this, the results suggest, if anything, a decrease in stock return synchronicity with statistical significance found in quarterly tests. This result favours rejection of the hypothesis set out in Israeli, et al. (2017) of a reduction in the level of firm-specific information that is impounded in stock prices.

The study of Cong & Xu (2016) perhaps assists in the analysis of these findings. The paper stipulates that the introduction of composite securities such as ETFs decrease firm-specific, while increasing systematic, informational efficiency, advocating increases in SYNCH as the systematic component plays a greater role in price. However, the impact of such is stated as being “bigger for relatively illiquid assets”; identified as assets traded less frequently by systematic speculators in the absence of composite securities (Cong & Xu, 2016, p. 18).

The authors express that relatively more illiquid assets, such as small-cap stocks, display greater increases in synchronicity relative to large stocks. They explain that the incorporation of systematic information dominates

the incorporation of firm-specific information for small stocks and note the scope for testing in this regard. The implications of firm size and whether the firm faces "imperfect market competition" because of size seem to dictate effects on informational efficiency and may explain the results found in this research (Cong & Xu, 2016, p. 19). Findings in swathes of informational efficiency literature, including Glosten, et al. (2015), find informational effects to be cross-sectionally variant across small- and large-cap, relatively illiquid- and liquid-, stocks.

Research by Subrahmanyam (1991) provides further support. The researcher investigates the effect of stock index futures and, by extension, basket securities such as the exchange traded fund. While detailing the role of basket securities in influencing the extent of involvement of distinct market participants, Subrahmanyam observes "interesting cross-sectional variation" in the extent of informed participation. The tendency for the number security-specific speculators to increase is stronger amongst heavily weighted securities in the basket than for smaller firms. Rather, for these small weighted securities, the tendency for the number of security-specific traders to decrease is most likely to hold. From this, the author extrapolates the finding that "the introduction of a basket therefore has a tendency to increase the number of security analysts for the most heavily weighted securities in the basket and to decrease the same for securities that have smaller weights in the index" (Subrahmanyam, 1991, p. 32).

Cong & Xu relate decreases in idiosyncratic efficiency with the introduction of composite securities to two causes; first, the overshadowing of such by increases in the incorporation of systematic information and, secondly, to the suggestion that asset-specific speculators no longer find it profitable to acquire costly information (Cong & Xu, 2016, p. 18). Similar intimations are offered in the literature traversed earlier. Subrahmanyam, on the contrary, finds that "profits of security-specific informed traders in heavily weighted securities are substantial in the market for the basket" (1991, p. 33). This opposing conclusion supports an increase in firm-specific information being incorporated in the share price of a sample of large-cap stocks as found herein. Given that the sample of firms in this paper represent those with heavier-weightings in the subset of ETF baskets investigated, the finding of decreases in stock return synchronicity may not be an anomoly.

Conclusion

This paper set forth to investigate the effect of exchange-traded fund ownership on a sample of large-cap stocks as contained within the Dow Jones Industrial Average. As the current investment climate is being transformed by a shift from expensive actively managed funds to low-cost, passive exchange-traded funds, this paper finds purpose primarily in modern portfolio management and investment. With increasing awareness and adoption of the buy-and-hold philosophies of renowned investors such as Warren Buffet and John Bogle, complemented by current regulatory measures promoting increased cost transparency such as MIFID II, the benefits of ETFs are likely to register with greater numbers of ordinary investors for whom cost considerations are imperative, if not yet widely appreciated.

In light of the above, this paper attempts to contextualize the effect of such a shift upon the trading costs and informational efficiency of firms underlying the largest modern-day ETFs. Statistically significant positive association between changes in the level of ETF ownership and changes in bid-ask spreads are found over quarterly and monthly observations. These findings accord with the hypothesis that as the proportion of firm-shares held by ETFs increases, there is a reduction in underlying firm-level liquidity observable through increased trading costs.

As greater proportions of firm shares become "locked up" within the ETF investment vehicle, there is purportedly a negative impact upon the extent of idiosyncratic information that is incorporated in the share price. Reduced liquidity and corresponding increases in trading costs are suspected to discourage firm-specific traders and, as such, a reduction in the informational efficiency of the underlying stocks is anticipated. Despite the theory hypothesised above, this paper finds no relationship between changes in ETF ownership and a reduction in informational efficiency of underlying large-cap stocks. Alternatively, the estimations provided here suggest possible increases in the extent of firm-specific information being incorporated in stock prices with increases in ETF ownership.

This study posits that the variability of informed market participation highlighted in Subrahmanyam (1991), whereby the introduction of basket securities may in fact increase the number of asset-specific informed traders for the largest securities in the basket, may hold true. This finding, albeit inconclusive, deviates from previous studies and suggests that compensation for costly information acquisition is sufficient to entice informed traders in large-cap stocks to the exchange traded fund vehicle.

References

Admati, A. R., 1985. A noisy rational expectations equilibrium for multi-asset securities markets. *Econometrica*, 53(3), pp. 629-658.

Ben-David, I., Franzoni, F. & Moussawi, R., 2014. Do ETFs increase volatility?. *National Bureau of Economic Research Working Paper 20071*, pp. 1-58.

Bhattacharya, A. & O'Hara, M., 2018. Can ETFs increase market fragility? Effect of information linkages in ETF markets. *https://ssrn.com/abstract=2740699*, pp. 1-55.

Cong, L. W. & Xu, D. X., 2016. Rise of factor investing: Asset prices, informational efficiency, and security design. *University of Chicago Working paper*.

Corwin, S. A. & Schultz, P., 2012. A simple way to estimate bid-ask spreads from daily high and low prices. *The Journal of Finance*, 67(2), pp. 719-759.

Da, Z. & Shive, S., 2018. Exchange traded funds and asset return correlations. *European Financial Management*, Volume 24, pp. 136-168.

Fama, E. F., 1970. Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, 25(2), pp. 383-417.

Glosten, L., Nallareddy, S. & Zou, Y., 2015. ETF trading and informational efficiency of underlying securities. *Columbia Business School Working Paper No. 16-71*, pp. 1-37.

Gorton, G. B. & Pennacchi, G. G., 1993. Security baskets and index-linked securities. *Journal of Business*, 66(1), pp. 1-27.

Grossman, S. J. & Stiglitz, J. E., 1980. On the impossibility of informationally efficient markets. *The American Economic Review*, 70(3), pp. 393-480.

Hamm, S. J., 2014. The effect of ETFs on stock liquidity. *Ohio State University Working Paper*, pp. 1-52.

Hellwig, M. F., 1980. On the aggregation of information in competitive markets. *Journal of Economic Theory*, Volume 22, pp. 477-498.

Israeli, D., Lee, C. M. C. & Sridharan, S. A., 2017. Is there a dark side to exchange traded funds? An information perspective. *Review of Accounting Studies*, 22(3), pp. 1048-1083.

Kyle, A. S., 1985. Continuous auctions and insider trading. *Econometrica*, 53(6), pp. 1315-1335.

Kyle, A. S., 1989. Informed speculation with imperfect competition. *The Review of Economic Studies*, 56(3), pp. 317-355.

Leippold, M., Su, L. & Ziegler, A., 2016. How index futures and ETFs affect stock return correlations. *Available at SSRN: https://ssrn.com/abstract=2620955*, pp. 1-52.

Madhavan, A. & Sobczyk, A., 2015. Price dynamics and liquidity of exchange-traded funds. *Blackrock, Inc.*, pp. 1-25.

Piotroski, J. D. & Roulstone, D. T., 2004. The influence of analysts, institutional investors, and insiders on the incorporation of market, industry, and firm-specific information into stock prices. *The Accounting Review*, 79(4), pp. 1119-1151.

Rubenstein, M., 1989. Market based alternatives. *Financial Analysts Journal*, 45(5), pp. 20-29.

Smith, I., 2017. How would ETFs Fare in a Market Downturn. *Financial Times*, 17 October.

Stambaugh, R. F., 2014. Presidential address: Investment noise and trends. *The Journal of Finance*, 69(4), pp. 1415-1453.

Subrahmanyam, A., 1991. A theory of trading in stock index futures. *The review of financial studies*, 4(1), pp. 17-51.

Verrecchia, R. E., 1982. Information acquisition in a noisy rational expectations economy. *Econometrica*, 50(6), pp. 1415-1430.

Wurgler, J., 2010. On the economic consequences of index-linked investing. *Nnational Bureau of Economic Research Working Paper No. 16376*, pp. 1-27.

Appendices

Figure 1: 20 Largest ETFs in Sample by AUM

Rank	Ticker	Name	AUM ($M)	Expense Ratio	Inception Date
1	SPY US Equity	SPDR S&P 500 ETF TRUST	261,166.81	0.09	22/01/1993
2	IVV US Equity	ISHARES CORE S&P 500 ETF	150,974.59	0.04	19/05/2000
3	VOO US Equity	VANGUARD S&P 500 ETF	92,108.45	0.04	09/09/2010
4	XLF US Equity	FINANCIAL SELECT SECTOR SPDR	29,538.96	0.13	22/12/1998
5	CSPX LN Equity	ISHARES CORE S&P 500	28,613.23	0.07	15/09/2010
6	VIG US Equity	VANGUARD DIVIDEND APPREC ETF	27,880.78	0.08	27/04/2006
7	VUSA LN Equity	VANGUARD S&P 500 UCITS ETF	23,953.16	0.07	22/05/2012
8	XLK US Equity	TECHNOLOGY SELECT SECT SPDR	22,116.39	0.13	22/12/1998
9	VYM US Equity	VANGUARD HIGH DVD YIELD ETF	21,054.82	0.08	16/11/2006
10	VGT US Equity	VANGUARD INFO TECH ETF	20,893.62	0.10	30/01/2004
11	DIA US Equity	SPDR DJIA TRUST	20,492.43	0.17	20/01/1998
12	IWB US Equity	ISHARES RUSSELL 1000 ETF	20,419.81	0.15	19/05/2000
13	XLE US Equity	ENERGY SELECT SECTOR SPDR	19,195.71	0.13	22/12/1998
14	XLV US Equity	HEALTH CARE SELECT SECTOR	15,891.08	0.13	22/12/1998
15	SDY US Equity	SPDR S&P DIVIDEND ETF	15,604.83	0.35	15/11/2005
16	RSP US Equity	INVESCO S&P 500 EQUAL WEIGHT	15,141.09	0.20	30/04/2003
17	USMV US Equity	ISHARES EDGE MSCI MIN VOL US	14,938.37	0.15	20/10/2011
18	XLY US Equity	CONSUMER DISCRETIONARY SELT	13,795.50	0.13	22/12/1998
19	VV US Equity	VANGUARD LARGE-CAP ETF	13,144.87	0.05	30/01/2004
20	SCHX US Equity	SCHWAB US LARGE-CAP ETF	12,947.07	0.03	03/11/2009

Figure 2: ETFs Excluded from Sample

Rank	Ticker	Name	AUM ($M)	Expense Ratio	Inception Date	Reason for Exclusion
24	287180 KS Equity	HH ARNG NASDAQ TECH SCTR ETF	9,741.09	0.50	12/13/2017	FUND INCEPTION DATE POST DEC 17
25	FDN US Equity	FIRST TRUST DJ INTERNET IND	9,276.92	0.54	6/23/2006	NO HOLDINGS OF SAMPLE FIRMS
30	XLU US Equity	UTILITIES SELECT SECTOR SPDR	7,295.98	0.13	12/22/1998	NO HOLDINGS OF SAMPLE FIRMS
40	XSP CN Equity	ISHARES CORE S&P 500 INDEX E	4,323.29	0.10	5/24/2001	INVESTS SOLELY IN IVV US (2)
47	VPU US Equity	VANGUARD UTILITIES ETF	2,543.66	0.10	1/30/2004	NO HOLDINGS OF SAMPLE FIRMS
56	VFV CN Equity	VANGUARD S&P 500 INDEX ETF	1,826.13	0.08	11/2/2012	INVESTS SOLELY IN VOO US (3)
68	OIH US Equity	VANECK VECTORS OIL SERVICES	1,476.61	0.35	12/21/2011	NO HOLDINGS OF SAMPLE FIRMS
94	VSP CN Equity	VANGUARD S&P 500 INDEX ETF C	679.77	0.08	11/2/2012	INVESTS SOLELY IN VOO US (3)
102	IDU US Equity	ISHARES US UTILITIES ETF	573.50	0.43	6/20/2000	NO HOLDINGS OF SAMPLE FIRMS
109	IEO US Equity	ISHARES U.S. OIL & GAS EXPLO	505.64	0.43	5/5/2006	NO HOLDINGS OF SAMPLE FIRMS
112	CLRG US Equity	IQ CHAIKIN US LARGE CAP ETF	443.11	0.25	12/13/2017	FUND INCEPTION DATE POST DEC 17
115	BBH US Equity	VANECK VECTORS BIOTECH ETF	425.37	0.35	12/21/2011	NO HOLDINGS OF SAMPLE FIRMS
122	VGG CN Equity	VANGUARD US DIVIDEND APPRECI	397.38	0.30	8/12/2013	INVESTS SOLELY IN VIG US (6)
123	EKUS FP Equity	BNPPEASY MKLD SRI-UCITS ETF	384.05	0.30	11/21/2017	NO HOLDINGS REPORTED
130	IEZ US Equity	ISHARES U.S. OIL EQUIPMENT &	306.00	0.43	5/5/2006	NO HOLDINGS OF SAMPLE FIRMS
134	FUTY US Equity	FIDELITY UTILITIES ETF	287.30	0.08	10/24/2013	NO HOLDINGS OF SAMPLE FIRMS
139	00702 TT Equity	CATHAY S&P 500 LOW VOL HI DV	276.28	N.A.	8/8/2017	NO HOLDINGS REPORTED
141	STX500 SJ Equity	SATRIX S&P 500 ETF	275.07	0.25	7/25/2017	NO HOLDINGS REPORTED
144	JUST US Equity	GOLDMAN SACHS JUST US LRG	256.00	0.20	6/13/2018	FUND INCEPTION DATE POST DEC 17
151	VGH CN Equity	VANGUARD US DIVIDEND APPRECI	208.03	0.30	8/12/2013	INVESTS SOLELY IN VIG US (6)
154	IUUS LN Equity	ISH S&P500 UTILITIES	188.91	0.15	3/22/2017	NO HOLDINGS OF SAMPLE FIRMS
162	SPXI11 BZ Equity	IT NOW S&P500 TRN FI	170.44	N.A.	2/2/2015	INVESTS SOLELY IN SPY US (1)
165	EQL US Equity	ALPS EQUAL SECTOR WEIGHT ETF	157.69	0.30	7/7/2009	INVESTS IN SECTOR SPECIFIC ETFS
171	QUU CN Equity	MACKENZIE US LARGE CAP EQUIT	144.69	N.A.	1/24/2018	FUND INCEPTION DATE POST DEC 17
172	MULC CN Equity	ML MULTIFAC US LCI ETF-HDG	142.40	N.A.	4/17/2017	NO HOLDINGS REPORTED
175	TMFC US Equity	MOTLEY FOOL 100 INDEX ETF	113.53	0.50	1/30/2018	FUND INCEPTION DATE POST DEC 17
177	STXNDQ SJ Equity	SATRIX NASDAQ 100 FEEDER POR	100.24	0.33	4/10/2018	FUND INCEPTION DATE POST DEC 17

Figure 3: Periods under Observation: DJIA Member Additions/Deletions

Ticker	Name	Change	Date	First Year Tested	First Quarter Tested	First Month Tested
GS UN Equity	Goldman Sachs Group Inc/The	Addition	23/09/2013	2014	Q4 2013	October 2013
NKE UN Equity	NIKE Inc	Addition	23/09/2013	2014	Q4 2013	October 2013
V UN Equity	Visa Inc	Addition	23/09/2013	2014	Q4 2013	October 2013
AAPL UW Equity	Apple Inc	Addition	19/03/2015	2016	Q2 2015	April 2015
DWDP UN Equity	DowDuPont Inc	Addition	01/09/2017	Not Tested	Q4 2017	September 2017
Ticker	**Name**	**Change**	**Date**	**Last Year Tested**	**Last Quarter Tested**	**Last Month Tested**
AA UN Equity	Alcoa Corp	Deletion	22/09/2013	Not Tested	Q2 2013	August 2013
BAC UN Equity	Bank of America Corp	Deletion	22/09/2013	Not Tested	Q2 2013	August 2013
HPQ UN Equity	HP Inc	Deletion	22/09/2013	Not Tested	Q2 2013	August 2013
T UN Equity	AT&T Inc	Deletion	18/03/2015	2014	Q4 2014	February 2015
DD US Equity	EI du Pont de Nemours & Co	Deletion	31/08/2017	2016	Q2 2017	August 2017

Figure 4: Firm Sample and Global Industry Classification System

Ticker	Firm Name	GICS Sector Name	GICS Sector Index	GICS Industry Name	GICS Industry Group Name	GICS Sub-Industry Name
AA UN Equity	Alcoa Corp	Materials	S5MATR Index	Metals & Mining	Materials	Aluminum
AAPL UW Equity	Apple Inc	Information Technology	S5INFT Index	Technology Hardware, Storage &	Technology Hardware & Equipmen	Technology Hardware, Storage &
AXP UN Equity	American Express Co	Financials	S5FINL Index	Consumer Finance	Diversified Financials	Consumer Finance
BA UN Equity	Boeing Co/The	Industrials	S5INDU Index	Aerospace & Defense	Capital Goods	Aerospace & Defense
BAC UN Equity	Bank of America Corp	Financials	S5FINL Index	Banks	Banks	Diversified Banks
CAT UN Equity	Caterpillar Inc	Industrials	S5INDU Index	Machinery	Capital Goods	Construction Machinery & Heavy
CSCO UW Equit	Cisco Systems Inc	Information Technology	S5INFT Index	Communications Equipment	Technology Hardware & Equipmen	Communications Equipment
CVX UN Equity	Chevron Corp	Energy	S5ENRS Index	Oil, Gas & Consumable Fuels	Energy	Integrated Oil & Gas
DD US Equity	EI du Pont de Nemours & Co	Materials	S5MATR Index	Chemicals	Materials	Diversified Chemicals
DIS UN Equity	Walt Disney Co/The	Consumer Discretionary	S5COND Index	Media	Media	Movies & Entertainment
DWDP UN Equit	DowDuPont Inc	Materials	S5MATR Index	Chemicals	Materials	Diversified Chemicals
GE UN Equity	General Electric Co	Industrials	S5INDU Index	Industrial Conglomerates	Capital Goods	Industrial Conglomerates
GS UN Equity	Goldman Sachs Group Inc/The	Financials	S5FINL Index	Capital Markets	Diversified Financials	Investment Banking & Brokerage
HD UN Equity	Home Depot Inc/The	Consumer Discretionary	S5COND Index	Specialty Retail	Retailing	Home Improvement Retail
HPQ UN Equity	HP Inc	Information Technology	S5INFT Index	Technology Hardware, Storage &	Technology Hardware & Equipmen	Technology Hardware, Storage &
IBM UN Equity	International Business Machine	Information Technology	S5INFT Index	IT Services	Software & Services	IT Consulting & Other Services
INTC UW Equity	Intel Corp	Information Technology	S5INFT Index	Semiconductors & Semiconductor	Semiconductors & Semiconductor	Semiconductors
JNJ UN Equity	Johnson & Johnson	Health Care	S5HLTH Index	Pharmaceuticals	Pharmaceuticals, Biotechnology	Pharmaceuticals
JPM UN Equity	JPMorgan Chase & Co	Financials	S5FINL Index	Banks	Banks	Diversified Banks
KO UN Equity	Coca-Cola Co/The	Consumer Staples	S5CONS Index	Beverages	Food, Beverage & Tobacco	Soft Drinks
MCD UN Equity	McDonald's Corp	Consumer Discretionary	S5COND Index	Hotels, Restaurants & Leisure	Consumer Services	Restaurants
MMM UN Equity	3M Co	Industrials	S5INDU Index	Industrial Conglomerates	Capital Goods	Industrial Conglomerates
MRK UN Equity	Merck & Co Inc	Health Care	S5HLTH Index	Pharmaceuticals	Pharmaceuticals, Biotechnology	Pharmaceuticals
MSFT UW Equit	Microsoft Corp	Information Technology	S5INFT Index	Software	Software & Services	Systems Software
NKE UN Equity	NIKE Inc	Consumer Discretionary	S5COND Index	Textiles, Apparel & Luxury Goo	Consumer Durables & Apparel	Footwear
PFE UN Equity	Pfizer Inc	Health Care	S5HLTH Index	Pharmaceuticals	Pharmaceuticals, Biotechnology	Pharmaceuticals
PG UN Equity	Procter & Gamble Co/The	Consumer Staples	S5CONS Index	Household Products	Household & Personal Products	Household Products
T UN Equity	AT&T Inc	Telecommunication Services	S5TELS Index	Diversified Telecommunication	Telecommunication Services	Integrated Telecommunication S
TRV UN Equity	Travelers Cos Inc/The	Financials	S5FINL Index	Insurance	Insurance	Property & Casualty Insurance
UNH UN Equity	UnitedHealth Group Inc	Health Care	S5HLTH Index	Health Care Providers & Servic	Health Care Equipment & Servic	Managed Health Care
UTX UN Equity	United Technologies Corp	Industrials	S5INDU Index	Aerospace & Defense	Capital Goods	Aerospace & Defense
V UN Equity	Visa Inc	Information Technology	S5INFT Index	IT Services	Software & Services	Data Processing & Outsourced S
VZ UN Equity	Verizon Communications Inc	Telecommunication Services	S5TELS Index	Diversified Telecommunication	Telecommunication Services	Integrated Telecommunication S
WMT UN Equity	Walmart Inc	Consumer Staples	S5CONS Index	Food & Staples Retailing	Food & Staples Retailing	Hypermarkets & Super Centers
XOM UN Equity	Exxon Mobil Corp	Energy	S5ENRS Index	Oil, Gas & Consumable Fuels	Energy	Integrated Oil & Gas

Figure 5: Dependent and Independent Variable Definitions

Variable		Definition
$HLSPREAD_{it}$	=	Bid-Ask spread measure derived from the Corwin & Schultz (2012) estimator. Utilised as proxy for trading costs.
$SYNCH_{it}$	=	Measure of stock return synchronicity; the extent to which market and sector returns explain variation in stock returns. Derived from the adjusted coefficient of determination in a regression of daily firm returns on market and sector returns (contemporaneous and lagged one period). Expressed as the log transformation: $log\left(\frac{R^2}{1-R^2}\right)$.
ETF_{it}	=	Percentage of firm i's shares outstanding held by sample ETFs at the end of period t. Sample fund holdings, expressed as number of shares held, are obtained from Bloomberg's mutual fund holdings function (MHD) for individual ETFs at the end of each month and aggregated for each firm. Aggregate shares held are expressed as a percentage of firm i's shares outstanding at the end of the period under observation.
$INST_{it}$	=	Percentage of firm i's shares outstanding held by institutions including US and international mutual funds and others. Based on holdings data collected by Bloomberg and published weekly. Shown exclusive of percentage of firm shares held by the ETF sample at the end of period t.
MVE_{it}	=	Total market value of firm i's outstanding shares at the end of period t in USD.
$LNMVE_{it}$	=	Natural logarithm of the total market value of firm i's outstanding shares at the end of period t.
$STDRET_{it}$	=	Average standard deviation of firm i's daily stock returns during period t.
$TURN_{it}$	=	Firm i's average share turnover during period t. Expressed as a ratio of the total volume of firm i's shares traded during period t to its average shares outstanding during period t. Total trading volume is derived from the sum of daily trading volume during period t while average shares outstanding are calculated as the average of shares outstanding at the end of period t-1 and t.
BTM_{it}	=	Firm i's book to market ratio at the end of period t. Calculated as the inverse of the market capitalisation to book value ratio provided by Bloomberg which expresses firm i's market capitalisation to its total common equity.
$SKEW_{it}$	=	Average skewness of firm i's daily stock returns during period t.
BETAit	=	As in standard CAPM setting, measures the relative riskiness of firm i to the market index. Calculated simply as the slope of a regression of firm i's daily stock returns on market returns during period t.

Figure 6: Annual Descriptive Statistics

Summary Statistics: Level and Change Variables

Statistic	N	Mean	St. Dev.	Min	1st Quartile	Median	3rd Quartile	Max
HLSPREAD	145	0.310	0.054	0.173	0.269	0.303	0.346	0.445
SYNCH	145	0.025	0.391	-1.214	-0.215	0.061	0.278	0.994
ETF	145	3.257	0.861	0.844	2.703	3.240	3.807	6.632
INST	145	72.821	11.877	49.132	64.394	72.153	80.553	108.670
MVE ($m)	145	168,374.300	104,159.900	27,395.670	93,300.170	158,781.100	212,418.900	617,588.500
LNMVE	145	25.671	0.615	24.034	25.259	25.791	26.082	27.149
STDRET	145	1.186	0.253	0.610	0.999	1.179	1.355	1.818
TURN	145	35.660	20.949	13.282	24.397	31.295	39.171	166.600
BTM	145	33.647	22.520	-2.181	17.271	29.772	42.409	116.672
SKEW	145	-0.091	0.709	-2.088	-0.476	-0.088	0.229	2.542
BETA	145	0.916	0.235	0.415	0.792	0.917	1.069	1.515
ΔHLSPREAD	145	-0.012	0.054	-0.167	-0.044	-0.012	0.028	0.159
ΔSYNCH	145	-0.071	0.310	-0.960	-0.275	-0.039	0.170	0.544
ΔETF	145	0.412	0.324	-0.259	0.238	0.389	0.535	2.156
ΔINST	145	0.976	4.886	-18.764	-0.932	0.554	2.405	19.474
ΔLNMVE	145	0.079	0.162	-0.344	-0.014	0.081	0.169	0.590
ΔSTDRET	145	-0.075	0.318	-0.857	-0.248	-0.045	0.153	0.697
ΔTURN	145	-2.508	10.360	-50.666	-7.127	-2.428	2.474	51.381
ΔBTM	145	-2.835	7.111	-26.949	-5.563	-2.348	0.931	17.099
ΔSKEW	145	0.032	0.916	-2.435	-0.426	0.085	0.453	3.745
ΔBETA	145	0.002	0.178	-0.518	-0.115	-0.007	0.141	0.356

Correlation Matrix: Level Variables

	HLSPREAD	SYNCH	ETF	INST	LNMVE	STDRET	TURN	BTM	SKEW	BETA
HLSPREAD		0.154	-0.268	0.161	-0.022	0.436	0.250	0.229	0.136	0.316
SYNCH	0.154		-0.134	-0.200	0.252	-0.089	-0.112	0.352	0.057	0.154
ETF	-0.268	-0.134		-0.043	-0.311	0.020	0.170	0.047	-0.168	0.054
INST	0.161	-0.200	-0.043		-0.364	0.280	0.063	-0.009	0.177	0.197
LNMVE	-0.022	0.252	-0.311	-0.364		-0.059	-0.485	-0.065	0.061	-0.081
STDRET	0.436	-0.089	0.020	0.280	-0.059		0.333	0.169	0.012	0.694
TURN	0.250	-0.112	0.170	0.063	-0.485	0.333		-0.019	0.001	0.227
BTM	0.229	0.352	0.047	-0.009	-0.065	0.169	-0.019		-0.072	0.327
SKEW	0.136	0.057	-0.168	0.177	0.061	0.012	0.001	-0.072		0.026
BETA	0.316	0.154	0.054	0.197	-0.081	0.694	0.227	0.327	0.026	

Correlation Matrix: Change Variables

	HLSPREAD	SYNCH	ETF	INST	LNMVE	STDRET	TURN	BTM	SKEW	BETA
HLSPREAD		0.291	-0.110	0.146	-0.068	0.155	0.005	0.212	0.030	0.137
SYNCH	0.291		-0.048	0.174	0.212	0.015	0.012	-0.126	0.160	-0.186
ETF	-0.110	-0.048		-0.386	0.162	-0.222	-0.159	-0.144	-0.242	-0.207
INST	0.146	0.174	-0.386		0.068	0.178	0.072	0.0004	0.224	0.175
LNMVE	-0.068	0.212	0.162	0.068		-0.251	-0.230	-0.636	0.266	-0.022
STDRET	0.155	0.015	-0.222	0.178	-0.251		0.668	0.162	-0.123	0.403
TURN	0.005	0.012	-0.159	0.072	-0.230	0.668		0.042	-0.002	0.018
BTM	0.212	-0.126	-0.144	0.0004	-0.636	0.162	0.042		-0.146	0.037
SKEW	0.030	0.160	-0.242	0.224	0.266	-0.123	-0.002	-0.146		0.045
BETA	0.137	-0.186	-0.207	0.175	-0.022	0.403	0.018	0.037	0.045	

Figure 7: Quarterly Descriptive Statistics

Summary Statistics: Level and Change Variables

Statistic	N	Mean	St. Dev.	Min	1st Quartile	Median	3rd Quartile	Max
HLSPREAD	595	0.312	0.083	0.129	0.256	0.302	0.355	0.718
SYNCH	595	0.011	0.560	-4.000	-0.234	0.057	0.316	1.177
ETF	595	3.318	0.929	0.795	2.711	3.251	3.838	8.835
INST	595	73.213	11.988	35.983	64.733	73.385	80.853	109.272
MVE ($m)	595	172,848.300	113,548.700	9,110.660	93,193.270	158,847.300	216,133.100	796,064.900
LNMVE	595	25.683	0.643	22.933	25.258	25.791	26.099	27.403
STDRET	595	1.135	0.357	0.504	0.881	1.081	1.330	3.153
TURN	595	8.829	5.243	2.887	6.104	7.469	9.761	47.846
BTM	595	34.137	25.316	-2.740	17.137	28.717	41.783	174.520
SKEW	595	-0.065	1.070	-4.169	-0.571	-0.117	0.284	4.448
BETA	595	0.912	0.303	0.070	0.723	0.907	1.095	2.088
ΔHLSPREAD	595	-0.002	0.092	-0.427	-0.062	-0.001	0.056	0.297
ΔSYNCH	595	-0.022	0.541	-3.345	-0.268	-0.019	0.232	3.899
ΔETF	595	0.105	0.193	-0.633	0.009	0.106	0.181	1.855
ΔINST	595	0.189	3.504	-36.910	-0.718	0.036	0.963	23.004
ΔLNMVE	595	0.020	0.090	-0.283	-0.038	0.018	0.073	0.741
ΔSTDRET	595	-0.010	0.360	-1.211	-0.244	-0.019	0.208	1.257
ΔTURN	595	-0.067	2.093	-17.165	-0.891	-0.097	0.761	10.737
ΔBTM	595	-0.871	5.459	-69.782	-2.146	-0.433	1.156	19.104
ΔSKEW	595	-0.017	1.523	-6.097	-0.843	-0.041	0.806	5.795
ΔBETA	595	-0.008	0.271	-0.955	-0.184	-0.008	0.167	0.982

Correlation Matrix: Level Variables

	HLSPREAD	SYNCH	ETF	INST	LNMVE	STDRET	TURN	BTM	SKEW	BETA
HLSPREAD		0.109	-0.162	0.114	-0.076	0.491	0.252	0.208	0.035	0.301
SYNCH	0.109		-0.181	-0.130	0.196	0.118	-0.036	0.234	0.007	0.233
ETF	-0.162	-0.181		-0.059	-0.341	-0.132	0.145	0.127	-0.024	-0.039
INST	0.114	-0.130	-0.059		-0.343	0.130	0.064	-0.069	0.047	0.169
LNMVE	-0.076	0.196	-0.341	-0.343		-0.134	-0.496	-0.159	0.078	-0.119
STDRET	0.491	0.118	-0.132	0.130	-0.134		0.383	0.181	-0.009	0.491
TURN	0.252	-0.036	0.145	0.064	-0.496	0.383		0.053	-0.013	0.189
BTM	0.208	0.234	0.127	-0.069	-0.159	0.181	0.053		-0.081	0.321
SKEW	0.035	0.007	-0.024	0.047	0.078	-0.009	-0.013	-0.081		0.008
BETA	0.301	0.233	-0.039	0.169	-0.119	0.491	0.189	0.321	0.008	

Correlation Matrix: Change Variables

	HLSPREAD	SYNCH	ETF	INST	LNMVE	STDRET	TURN	BTM	SKEW	BETA
HLSPREAD		0.032	0.127	0.108	0.015	-0.054	-0.025	0.041	-0.003	0.076
SYNCH	0.032		-0.141	0.049	0.102	-0.009	-0.003	-0.041	0.007	-0.164
ETF	0.127	-0.141		-0.037	0.094	0.083	0.035	-0.091	-0.038	-0.035
INST	0.108	0.049	-0.037		-0.189	-0.065	-0.043	0.257	0.003	-0.012
LNMVE	0.015	0.102	0.094	-0.189		-0.155	-0.146	-0.721	0.340	-0.093
STDRET	-0.054	-0.009	0.083	-0.065	-0.155		0.542	0.105	-0.049	0.232
TURN	-0.025	-0.003	0.035	-0.043	-0.146	0.542		0.037	-0.047	-0.038
BTM	0.041	-0.041	-0.091	0.257	-0.721	0.105	0.037		-0.160	0.103
SKEW	-0.003	0.007	-0.038	0.003	0.340	-0.049	-0.047	-0.160		-0.045
BETA	0.076	-0.164	-0.035	-0.012	-0.093	0.232	-0.038	0.103	-0.045	

Figure 8: Monthly Descriptive Statistics

Summary Statistics: Level and Change Variables

Statistic	N	Mean	St. Dev.	Min	1st Quartile	Median	3rd Quartile	Max
HLSPREAD	1,796	0.313	0.117	0.046	0.232	0.297	0.373	1.089
SYNCH	1,796	-0.087	1.005	-4.000	-0.288	0.112	0.445	1.861
ETF	1,796	3.352	0.962	0.794	2.727	3.277	3.886	9.361
INST	1,796	73.965	12.112	35.983	65.230	73.933	81.694	115.898
MVE ($m)	1,796	173,666.700	115,055.700	8,362.680	93,719.790	158,690.600	213,563.100	882,331.500
LNMVE	1,796	25.685	0.649	22.847	25.264	25.790	26.087	27.506
STDRET	1,796	1.077	0.439	0.255	0.766	0.992	1.288	3.626
TURN	1,796	2.941	1.805	0.879	1.981	2.502	3.272	18.345
BTM	1,796	34.258	25.819	-2.740	16.858	28.583	41.907	180.245
SKEW	1,796	0.003	0.959	-3.826	-0.489	-0.005	0.449	4.008
BETA	1,796	0.900	0.490	-1.550	0.633	0.894	1.168	4.584
ΔHLSPREAD	1,796	-0.001	0.140	-0.733	-0.086	0.0004	0.087	0.600
ΔSYNCH	1,796	-0.005	1.203	-5.260	-0.405	0.000	0.401	4.898
ΔETF	1,796	0.039	0.112	-0.674	-0.009	0.033	0.084	1.898
ΔINST	1,796	0.075	3.371	-35.759	-0.451	-0.034	0.553	32.157
ΔLNMVE	1,796	0.008	0.055	-0.262	-0.021	0.008	0.039	0.711
ΔSTDRET	1,796	-0.007	0.493	-1.952	-0.283	-0.016	0.269	2.346
ΔTURN	1,796	-0.011	0.925	-10.936	-0.442	-0.019	0.382	8.691
ΔBTM	1,796	-0.329	3.005	-65.826	-1.141	-0.160	0.650	14.322
ΔSKEW	1,796	0.011	1.358	-4.790	-0.764	-0.012	0.798	5.437
ΔBETA	1,796	0.001	0.577	-3.506	-0.299	0.010	0.311	3.344

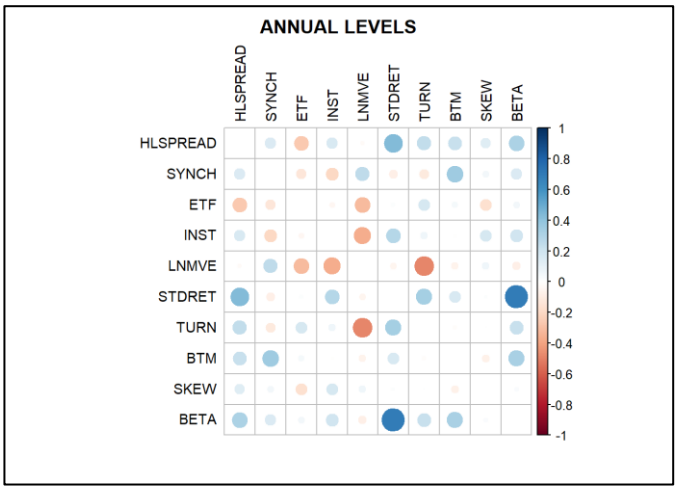
Correlation Matrix: Level Variables

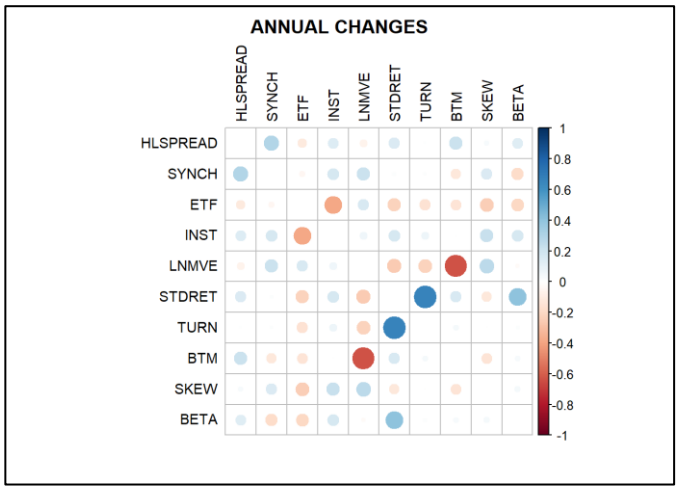
	HLSPREAD	SYNCH	ETF	INST	LNMVE	STDRET	TURN	BTM	SKEW	BETA
HLSPREAD		0.075	-0.101	0.071	-0.062	0.334	0.209	0.145	0.062	0.116
SYNCH	0.075		-0.115	-0.099	0.122	0.015	-0.044	0.160	0.023	0.114
ETF	-0.101	-0.115		-0.060	-0.357	-0.100	0.159	0.150	-0.007	-0.015
INST	0.071	-0.099	-0.060		-0.326	0.106	0.050	-0.081	0.038	0.108
LNMVE	-0.062	0.122	-0.357	-0.326		-0.097	-0.494	-0.179	0.017	-0.051
STDRET	0.334	0.015	-0.100	0.106	-0.097		0.345	0.145	0.030	0.373
TURN	0.209	-0.044	0.159	0.050	-0.494	0.345		0.087	0.032	0.120
BTM	0.145	0.160	0.150	-0.081	-0.179	0.145	0.087		-0.013	0.185
SKEW	0.062	0.023	-0.007	0.038	0.017	0.030	0.032	-0.013		0.065
BETA	0.116	0.114	-0.015	0.108	-0.051	0.373	0.120	0.185	0.065	

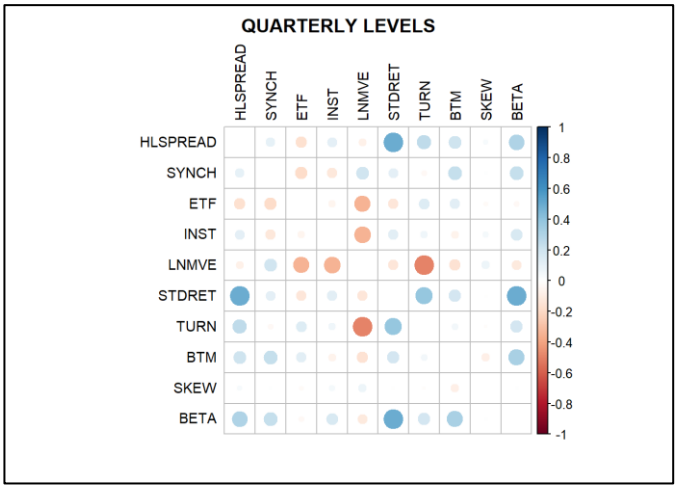
Correlation Matrix: Change Variables

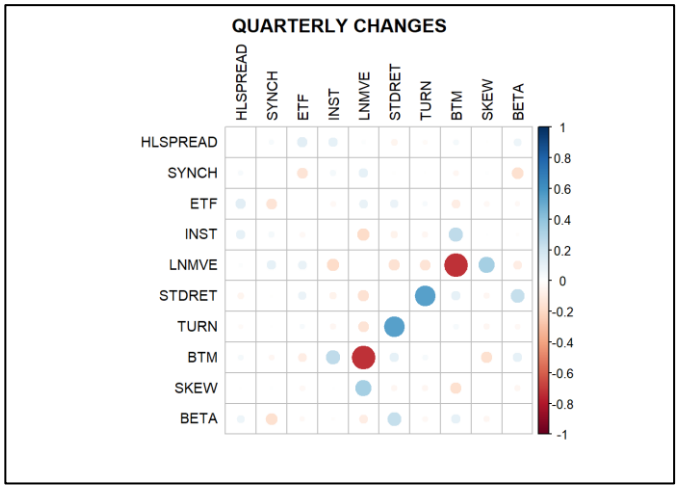
	HLSPREAD	SYNCH	ETF	INST	LNMVE	STDRET	TURN	BTM	SKEW	BETA
HLSPREAD		0.037	0.137	-0.043	0.061	-0.055	-0.012	-0.014	0.030	-0.008
SYNCH	0.037		0.014	0.033	0.019	-0.109	-0.098	-0.008	0.030	-0.164
ETF	0.137	0.014		-0.037	0.114	-0.048	0.036	-0.131	0.063	-0.026
INST	-0.043	0.033	-0.037		-0.130	0.080	-0.066	0.203	-0.060	-0.048
LNMVE	0.061	0.019	0.114	-0.130		-0.151	-0.104	-0.753	0.295	0.025
STDRET	-0.055	-0.109	-0.048	0.080	-0.151		0.435	0.124	-0.015	0.303
TURN	-0.012	-0.098	0.036	-0.066	-0.104	0.435		0.079	-0.027	0.067
BTM	-0.014	-0.008	-0.131	0.203	-0.753	0.124	0.079		-0.180	-0.009
SKEW	0.030	0.030	0.063	-0.060	0.295	-0.015	-0.027	-0.180		0.062
BETA	-0.008	-0.164	-0.026	-0.048	0.025	0.303	0.067	-0.009	0.062	

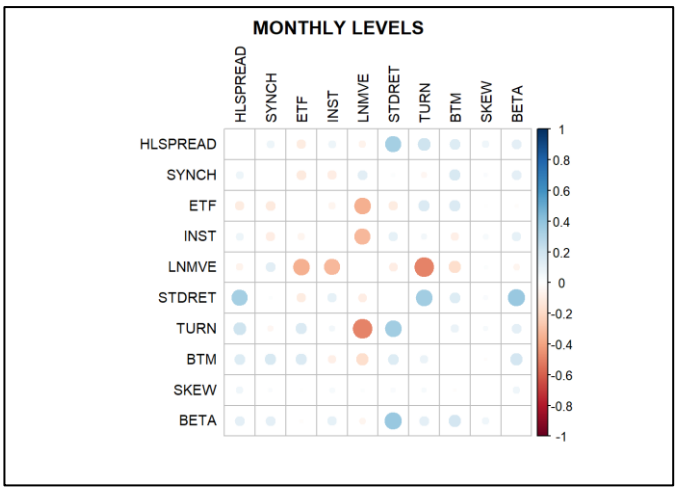
Figure 9: Correlation Plots: Level and Change Variables











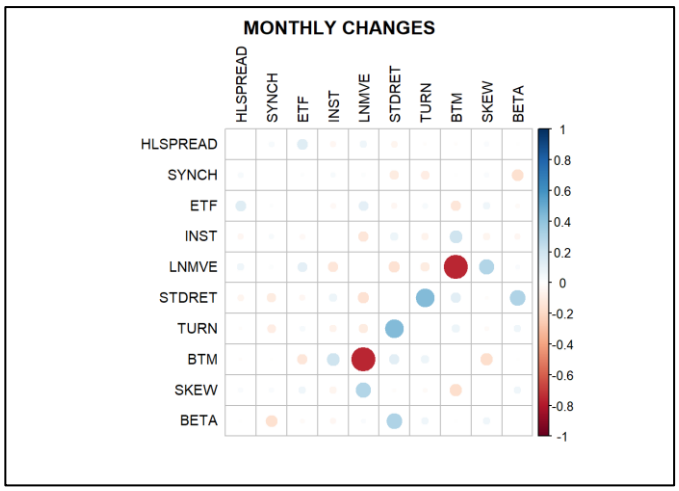


Figure 10: Regression Estimates of Annual Trading Costs

ANNUAL TRADING COSTS			**ANNUAL TRADING COSTS**		
	Dependent variable: ΔHLSPREAD			*Dependent variable:* ΔHLSPREAD	
	INDIVIDUAL FIXED EFFECTS			TWO-WAY FIXED EFFECTS	
	(1)	(2)		(1)	(2)
ΔETF	-0.012	-0.002	ΔETF	-0.001	0.005
	(0.017)	(0.018)		(0.015)	(0.016)
ΔINST		0.001	ΔINST		0.001
		(0.001)			(0.001)
ΔLNMVE	0.065	0.057	ΔLNMVE	0.041	0.032
	(0.044)	(0.045)		(0.044)	(0.045)
ΔSTDRET	0.047**	0.043*	ΔSTDRET	0.035	0.036
	(0.022)	(0.022)		(0.025)	(0.025)
ΔTURN	-0.001	-0.001	ΔTURN	-0.0004	-0.0004
	(0.001)	(0.001)		(0.001)	(0.001)
ΔBTM	0.003**	0.003**	ΔBTM	0.002***	0.002***
	(0.001)	(0.001)		(0.001)	(0.001)
Observations	145	145	Observations	145	145
R^2	0.117	0.130	R^2	0.097	0.108
Adjusted R^2	-0.167	-0.160	Adjusted R^2	-0.238	-0.235
F Statistic	2.878**	2.688**	F Statistic	2.261*	2.098*

Figure 11: Regression Estimates of Quarterly Trading Costs

QUARTERLY TRADING COSTS			**QUARTERLY TRADING COSTS**		
	Dependent variable: ΔHLSPREAD			*Dependent variable:* ΔHLSPREAD	
	INDIVIDUAL FIXED EFFECTS			TWO-WAY FIXED EFFECTS	
	(1)	(2)		(1)	(2)
ΔETF	0.067***	0.068***	ΔETF	0.022	0.024
	(0.021)	(0.021)		(0.022)	(0.022)
ΔINST		0.004***	ΔINST		0.001
		(0.001)			(0.001)
ΔLNMVE	0.065	0.070	ΔLNMVE	-0.016	-0.014
	(0.068)	(0.067)		(0.065)	(0.065)
ΔSTDRET	-0.020	-0.018	ΔSTDRET	0.001	0.001
	(0.013)	(0.013)		(0.014)	(0.014)
ΔTURN	0.001	0.001	ΔTURN	0.001	0.001
	(0.002)	(0.002)		(0.002)	(0.002)
ΔBTM	0.002	0.001	ΔBTM	0.001	0.001
	(0.001)	(0.001)		(0.001)	(0.001)
Observations	595	595	Observations	595	595
R^2	0.024	0.038	R^2	0.006	0.008
Adjusted R^2	-0.045	-0.032	Adjusted R^2	-0.101	-0.102
F Statistic	2.675**	3.628***	F Statistic	0.658	0.675

Figure 12: Regression Estimates of Monthly Trading Costs

MONTHLY TRADING COSTS			**MONTHLY TRADING COSTS**		
	Dependent variable: ΔHLSPREAD			*Dependent variable:* ΔHLSPREAD	
	INDIVIDUAL FIXED EFFECTS			TWO-WAY FIXED EFFECTS	
	(1)	(2)		(1)	(2)
ΔETF	0.170***	0.170***	ΔETF	0.019	0.020
	(0.030)	(0.030)		(0.033)	(0.033)
ΔINST		-0.002	ΔINST		0.0003
		(0.001)			(0.001)
ΔLNMVE	0.273***	0.280***	ΔLNMVE	0.230**	0.228**
	(0.094)	(0.094)		(0.095)	(0.095)
ΔSTDRET	-0.014*	-0.013*	ΔSTDRET	0.010	0.010
	(0.007)	(0.008)		(0.008)	(0.008)
ΔTURN	0.001	0.0004	ΔTURN	-0.007*	-0.007*
	(0.004)	(0.004)		(0.004)	(0.004)
ΔBTM	0.004**	0.004**	ΔBTM	0.004**	0.004**
	(0.002)	(0.002)		(0.002)	(0.002)
Observations	1,796	1,796	Observations	1,796	1,796
R^2	0.027	0.028	R^2	0.006	0.006
Adjusted R^2	0.005	0.006	Adjusted R^2	-0.051	-0.052
F Statistic	9.611***	8.447***	F Statistic	2.171*	1.819*

Figure 13: Regression Estimates of Annual Stock Return Synchronicity

ANNUAL STOCK RETURN SYNCHRONICITY			**ANNUAL STOCK RETURN SYNCHRONICITY**		
	Dependent variable: ΔSYNCH			*Dependent variable:* ΔSYNCH	
	INDIVIDUAL FIXED EFFECTS			TWO-WAY FIXED EFFECTS	
	(1)	(2)		(1)	(2)
ΔETF	-0.123	-0.066	ΔETF	-0.030	-0.010
	(0.104)	(0.110)		(0.078)	(0.081)
ΔINST		0.010	ΔINST		0.005
		(0.006)			(0.005)
ΔSKEW	0.033	0.027	ΔSKEW	0.032	0.030
	(0.034)	(0.034)		(0.025)	(0.025)
ΔBETA	-0.409**	-0.428***	ΔBETA	-0.461***	-0.461***
	(0.163)	(0.163)		(0.121)	(0.121)
ΔLNMVE	0.432	0.394	ΔLNMVE	0.091	0.063
	(0.265)	(0.265)		(0.229)	(0.231)
ΔBTM	0.001	0.001	ΔBTM	-0.003	-0.002
	(0.006)	(0.006)		(0.004)	(0.004)
ΔTURN	0.002	0.002	ΔTURN	0.005*	0.005*
	(0.003)	(0.003)		(0.003)	(0.003)
Observations	145	145	Observations	145	145
R^2	0.109	0.127	R^2	0.178	0.185
Adjusted R^2	-0.188	-0.175	Adjusted R^2	-0.138	-0.140
F Statistic	2.202**	2.219**	F Statistic	3.759***	3.335***

Figure 14: Regression Estimates of Quarterly Stock Return Synchronicity

QUARTERLY STOCK RETURN SYNCHRONICITY			**QUARTERLY STOCK RETURN SYNCHRONICITY**		
	Dependent variable: ΔSYNCH			*Dependent variable:* ΔSYNCH	
	INDIVIDUAL FIXED EFFECTS			TWO-WAY FIXED EFFECTS	
	(1)	(2)		(1)	(2)
ΔETF	-0.459***	-0.454***	ΔETF	-0.451***	-0.449***
	(0.119)	(0.119)		(0.143)	(0.144)
ΔINST		0.009	ΔINST		0.002
		(0.007)			(0.007)
ΔSKEW	-0.020	-0.021	ΔSKEW	-0.015	-0.015
	(0.016)	(0.016)		(0.016)	(0.016)
ΔBETA	-0.329***	-0.326***	ΔBETA	-0.331***	-0.331***
	(0.083)	(0.083)		(0.081)	(0.081)
ΔLNMVE	1.096***	1.113***	ΔLNMVE	0.719	0.724
	(0.413)	(0.413)		(0.441)	(0.442)
ΔBTM	0.008	0.008	ΔBTM	0.004	0.004
	(0.008)	(0.008)		(0.008)	(0.008)
ΔTURN	0.005	0.005	ΔTURN	0.021*	0.021*
	(0.011)	(0.011)		(0.012)	(0.012)
Observations	595	595	Observations	595	595
R^2	0.064	0.067	R^2	0.059	0.059
Adjusted R^2	-0.004	-0.002	Adjusted R^2	-0.045	-0.047
F Statistic	6.321***	5.662***	F Statistic	5.599***	4.797***

Figure 15: Regression Estimates of Monthly Stock Return Synchronicity

MONTHLY STOCK RETURN SYNCHRONICITY		
	Dependent variable: ΔSYNCH	
	INDIVIDUAL FIXED EFFECTS	
	(1)	(2)
ΔETF	0.120	0.122
	(0.257)	(0.257)
ΔINST		0.008
		(0.009)
ΔSKEW	0.032	0.033
	(0.022)	(0.022)
ΔBETA	-0.335***	-0.333***
	(0.049)	(0.049)
ΔLNMVE	0.341	0.306
	(0.827)	(0.828)
ΔBTM	0.009	0.006
	(0.015)	(0.016)
ΔTURN	-0.112***	-0.110***
	(0.031)	(0.031)
Observations	1,796	1,796
R^2	0.036	0.037
Adjusted R^2	0.014	0.014
F Statistic	10.990***	9.529***

MONTHLY STOCK RETURN SYNCHRONICITY		
	Dependent variable: ΔSYNCH	
	TWO-WAY FIXED EFFECTS	
	(1)	(2)
ΔETF	-0.096	-0.071
	(0.289)	(0.289)
ΔINST		0.021*
		(0.011)
ΔSKEW	0.008	0.008
	(0.021)	(0.021)
ΔBETA	-0.316***	-0.311***
	(0.046)	(0.046)
ΔLNMVE	-0.660	-0.784
	(0.856)	(0.858)
ΔBTM	0.004	-0.002
	(0.014)	(0.015)
ΔTURN	0.087***	0.086**
	(0.034)	(0.034)
Observations	1,796	1,796
R^2	0.031	0.034
Adjusted R^2	-0.025	-0.024
F Statistic	9.149***	8.393***