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International Portfolio Diversification through ETFs.

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INTERNATIONAL PORTFOLIO DIVERSIFICATION THROUGH ETFS

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Abstract

We examine whether for a US investor, investing in 15 country equity index ETFs traded on US exchange yields the same international diversification benefits as direct investments in these countries' equity markets. We document that the tracking errors between the ETF's NAV and market returns decrease with return horizons: they are large and significant at the daily horizon and become negligible at an annual horizon. Across countries, the tracking error magnitudes decrease as the overlap between the country's market trading hours and those of the US markets increase. These tracking errors lead to substantial differences in the correlations estimated between the US markets and the countries' ETF NAV and returns respectively, with similar patterns as the tracking errors: from large at the daily frequency to negligible at the quarterly frequency and decreasing as the trading hours overlap increases. We find that the tracking difference between a funds' ETF return and NAV return is significantly related to the contemporaneous S&P500 return, the Volatility index, and foreign exchange, which reflect US market news or US investor sentiment, as well as fund specific variables such as Asset under management, Volatility of the fund, and Relative Net Creations/Redemptions. The study concludes that the tracking difference in the short-run arises primarily due to the difference in trading hours and does not persist in the long run, and hence that ETF are as efficient as direct investments to achieve international diversification.

1. Introduction

Country Exchange-Traded Funds (ETFs) have been marketed as providing efficient investment vehicles to achieve bespoke international diversification. Investing in a country ETF is an alternative to direct investment in a foreign market to achieve the desired international exposure. The question arises whether the US market returns on the country ETF's or the return on the underlying country equity index returns provide the best gauge of the potential benefits to investing abroad. To this aim, we investigate the magnitude and patterns of the correlations between the S&P500 returns with each ETF's NAV and market returns at different returns horizons, and across regions. We also investigate the magnitude and pattern of the difference between each ETF's NAV returns and that ETF's market return at different horizons. We aim to assess whether these tracking errors are due only to is return asynchronicity, or can be explained by US market transitory effects, or ETF specific characteristics.

In our research, we evaluate the relation between ETFs and the underlying index to understand the sources of the tracking error. We also analyze the efficiency of using ETFs in international diversification through examining the significance of tracking errors. In our attempt to compute correlations, we model synchronous returns and conditional correlations using the DCC GARCH model. To understand the tracking difference and its sources, we regress the difference against explanatory variables pertaining to the US equity market and the fund. We analyze 15 country ETFs within three different time zones: Asia-Pacific, Europe and Americas relative to the S&P500.

The daily correlations between NAV and S&P500 differ by a large margin from the correlation between ETF's market price and S&P500 for funds originating in the Asia-Pacific region. The difference disappears as we move west. Also, the correlations at lower frequencies are similar to each other but higher than the daily returns' correlation. This trend is clearly visible for Asia-Pacific funds, partial in Europe and minor for the American funds. The tracking difference between ETF's NAV and market price, found in the daily return series, is found to be determined by the S&P500 returns, volatility index and the foreign exchange fluctuations. We find the tracking difference to be high for the funds in Asia-Pacific group, moderate for the European funds and low for the funds in Americas. We also observe the tracking difference reducing considerably at weekly frequency and almost disappear at quarterly returns.

Our thesis is constructed as follows, in the first section, we explain the fundamentals of ETFs, where we emphasis on the creation and redemption process of these open-end funds. Following that, we transcribe the previous studies and the prominent research in this field in the literature review section. The next section contains the hypotheses we intend to test and the empirical methods that we use. Following sections provide a detail of our processes and models. Data used in this study is documented along with the descriptive statistics. The results of the study follow with the findings from the analysis. The supplement pages include plots and tables that support our study.

2. Background and Literature

2.1. Background

In the past few decades, decreasing barriers to cash flows, declining transaction and information costs, and increasing capital market globalization trends have created great awareness and desire among investors for more international portfolio diversification. Various studies, such as (Grubel, 1968), (Levy & Sarnat, 1970), (Harvey, 1995), (DeSantis, 1997) and (Anderson, Coleman, Frohlich, & Steagall, 2000) demonstrate the benefits of international diversification via indirect foreign investments such as mutual funds, hedge funds, private equity and etc. However, finding the best overseas investments requires time and money. On the other hand, investment in ETFs offers attractive features for both individual and institutional investors, since ETFs require lower management fee and expenses, provide transparency and flexibility along with liquidity and diversification benefits.

An ETF is a security traded in the secondary market that is designed to track a given index. It does so by holding a portfolio of stocks that replicates the underlying index. The shares of an ETF can be bought and sold throughout the day at a market determined price. Managers of exchange-traded funds are, like mutual funds, are required by the Securities and Exchange Commission (SEC) to publish a “Net Asset Value” (NAV) for their funds. Investors can buy and sell shares in ETFs through a broker, just as they buy and sell shares of publicly listed companies.

The first ETF in the US was launched in January 1993 and was developed to track S&P500 index. Following which new ETFs were launched tracking broad domestic indices and specializing in sector, country or region. Over the years, ETFs have grown in size, diversity and market share among the investment community et al. (Lettau & Madhavan, 2018).

For open-ended mutual funds, all the transactions requested by investors are decided at the NAV price calculated at the end of the trading day. In contrast, ETFs are like closed-end mutual funds, that allow trading throughout the day. This reduces implicit cost of mutual funds and makes it easy for investors to buy at lower costs. While the closed-end funds have a fixed number of shares set at the creation of the fund, ETF shares are created and redeemed continuously. An exchange-traded fund, does not interact directly with capital markets, instead the ETF manager (or sponsor such as BlackRock or Vanguard) enters into a legal contract with one or several “Authorized Participants” (APs), typically large financial institutions or more specialized market-makers, who in turn interact with the markets. In particular, the ETF manager can issue or redeem shares with APs in large blocks, known as creation units, in exchange for a basket of securities and/or cash. This mechanism, by which the shares of the ETF are adjusted in response to supply and demand, is known as the creation/redemption mechanism. Here, “creations” refer to increasing the supply of ETF shares; “redemptions” refer to a decrease in the shares outstanding of the ETF.

The discipline of the creation and redemption process is a critical mechanism that ensures that the ETF prices remain as close as possible to their NAV. Any deviations between ETF’s NAV and market prices can be immediately exploited for arbitrage profits. Indeed, several studies have shown how ETFs are priced very closely to their NAV (Engle & Sarkar, 2006). In the context of an exchange-traded fund, deviations of price from the announced NAV do not necessarily imply the existence of arbitrage opportunities, especially for international funds and for funds whose constituents may be difficult to value because of infrequent trading.

Country ETFs are a sub-sector of the ETF market and are designed to track stock market indices of foreign countries. A special feature of country ETF is that the ETF shares and their underlying securities are traded in two different markets: the ETF is traded in the country of origin while the underlying portfolio is traded in a foreign country. Hence, for country ETFs the arbitrage mechanism described above suffers from the fact that the underlying portfolio and the ETF are often traded during different times in a day. For instance, Asian markets and US markets have no common trading hours; European markets and US markets have only partial overlap of trading hours. In such cases, the arbitrage mechanism described above essentially does not exist. Consequently, ETF prices fluctuate during the US trading day while their NAVs remain stale. Thus, country ETFs naturally trade at a premium or a discount compared to their underlying foreign stale NAVs. Indeed, several studies show that premiums and discounts are far more frequent among country ETFs compared to other ETF sectors, and that their premiums are larger in magnitude and more persistent (Ackert & Tian, 2008).

There are a number of papers that study weekly and monthly returns of country ETFs and find that they do not behave differently from their underlying NAVs and indices and find no evidence for excessive risk exposure to the US market (Phengpis & Swanson, 2009). Other studies have found evidence for higher correlation between daily returns of country ETFs and the US market returns. (Bailey & Lim, 1992) investigate 20 country funds traded on the NYSE and find that the country fund returns behave similar to the U.S. stock returns. Therefore, it is imperative for us to closely look at the structure of ETFs and characterize their ability to track the underlying index. One explanation suggested is that being traded on US equity markets, ETF prices are affected by local US transitory effects due to investor sentiment or other, that may lead to deviations from the local home market price linked to US market movements. An alternative explanation may be that local market returns from MSCI or FTSE are computed from local close to local close and since local market closing times are not synchronous with US market closing time, it may lead to a downward bias in the estimated correlations. In contrast since country ETFs are traded on the US markets, country ETF returns are exactly synchronous with US markets, and may thus measure more accurately the true correlation between international equity market returns and provide a more accurate measure of potential international diversification benefits.

2.2. Literature Review

The early international pricing models (e.g., (Black, 1974); (Stulz, 1981) and (Adler & Dumas, 1983)) posit the advantages of diversifying in foreign market as a means of reducing portfolio risk. This view states that markets are “segmented” because of geographical, economic, legal, and cultural reasons, and an investor obtains diversification by selecting securities in countries that are segmented from one another. This segmentation could occur on two levels: low correlations among markets or incomplete risk sharing leading to expected returns that do not reflect risk exposures.

(Levy & Sarnat, 1970) investigate potential gains obtained from international diversification. They use empirically determined optimal international portfolios. The data set includes 28 countries' common stocks for the period between 1951 and 1967. The empirical investigation results lead the authors to the conclusion that despite the relatively good performance of the U.S. market, American investors can still benefit from international diversification.

(Bailey & Lim, 1992) investigated 20 country funds traded on the NYSE. They find that the country fund returns behave similar to the U.S. stock returns. These findings are especially true for emerging markets funds. Bailey and Lim conclude that international portfolio diversification can be achieved only through direct security investments.

(Chang, Eun, & Kolodny, 1995), determine that the U.S. market betas of closed-end country funds are substantially higher than their local market betas. According to them, this fact tends to reduce the effectiveness of closed-end fund as an instrument for international portfolio diversification. However, the authors suggest that investors can achieve desired international portfolio diversification by investing across closed-end mutual funds.

(Bodurtha, Kim, & Lee, 1995) investigate the behavior of 31 closed-end country fund premiums between 1986 and 1990. Their empirical analysis shows that the closed-end country fund premium movements encompass the U.S. specific risk, and stock prices of closed-end country funds follow the U.S. market. Thus, the authors challenge the ability of closed-end country funds to be beneficial to American investors in achieving international diversification. Though ETFs have a creation/redemption process unlike the closed-end funds, the study can still be used to draw conclusions about funds as proxies for international diversification.

(Bekaert, Hodrick, & Zhang, 2009) in their study have used time-varying correlation measures and factor models to study international stock returns and diversification. They find that despite globalization, benefits of international diversification still persist. (Eiling & Gerard, 2015) extend the study of growing global integration to emerging markets and conclude that the rate of integration is increasing, and the potential benefits of diversification are fast decreasing.

As we stated earlier ETFs are still a relatively young instrument class. Therefore, nowadays research question on ETFs is a very relevant topic. Many research papers conduct empirical comparison between ETFs performance and mutual funds or closed-end funds (CECFs) trying to investigate the ability of ETFs to mimic its underlying index. In the paper by (Buetow & Henderson, 2012) it is shown that the diversification benefits of the fund are less than those implied by the benchmark indices. Authors also show that the ETFs composed of non-U.S. securities exhibit lower return correlations with the benchmark index. They suggest this may be due to asynchronicity between the ETFs. The study concludes the diversification effect but not the underlying reason, the presence of lower correlations and their effects on the tracking error is an area that is of wide importance.

(Johnson, 2008) examined the market segmentation theory proposed by (Bekaert & Harvey, 1995) – low tracking errors in highly integrated country financial markets and high tracking errors in less integrated financial markets. He finds that market integration hypothesis does not hold in this experiment, however, tracking errors are mostly explained by operating hours and relative return to the S&P 500.

(Cao, Fu, & Jin, 2017), in their study of international diversification found that despite ETFs exposure to U.S. market factor, iShares maintain significant exposure to domestic market factors. Main result within the study concludes that a combination of iShares, CECFs, and ADR portfolios could yield higher gains than direct foreign investment.

(Levy & Lieberman, 2012) in their study of overreaction of country ETFs and US market returns find a regime shift in the effect S&P 500 index has on country ETFs in countries with partial synchronized trading hours. Overall result suggests than in countries with partial/no overlap of trading hours with US, the effect of S&P 500 on ETF intraday returns exceeds the effect of the underlying indices.

For country ETFs that are based on Asian markets are not synchronously traded, the NAV of these ETFs based on the country index would be calculated before the trading of their ETFs opens in the US market. This might have a substantial effect on the correlations calculated to measure diversification. (Jared & Lavin, 2004) investigate the relation between discounts from NAV and ETF returns using Japan and Hong Kong equity markets. Based on their study results, one can state that exploitable inefficiencies occur when the ETF and the underlying portfolio do not trade synchronously, as in case with Japan and Hong Kong markets due to different trading hours (no time overlapping).

Research by (Martens & Poon, 2000) shows that the use of close-to-close returns can underestimate return correlations for markets that trade at different times. Moreover, previous studies, such as by (Hamao, Masulis, & Ng, 1990), investigate daily and intraday stock-price activity over the three-year period, April 1, 1985, to March 31, 1988 from Tokyo, London, and New York stock exchanges using an autoregressive conditionally heteroskedastic (ARCH) model. The empirical results suggest the presence of a spillover effect from New York to Tokyo, London to Tokyo, and New York to London.

(Koutmos & Booth, 1995), who only utilize opening and closing prices, have found it difficult to differentiate between contemporaneous and lagged spillover pricing effects from one market to another. Epps effect is the phenomenon where the correlations depend on the sampling frequency of the time series. In 1979 it was reported that as the sampling frequency increases the correlations decrease. (Toth & Kertesz, 2009) study the Epps effect and conclude that using synchronous returns lowers the Epps effect of cross-correlations among assets. The authors state that the impact of asynchrony is weak, in comparison to the impact of a static lag, for which they develop a model. The authors think that a diminution of the Epps effect with time is one consequence of increased market efficiency.

The main concept of the approach by (Munnix, Schafer, & Guhr, 2010) is that the observed correlation consists of a real correlation (the coefficient which would be observed if prices were quoted continuously and priced with a continuous value) and an uncorrelated part which is present because of asynchronous trading. The authors demonstrate that the asynchrony of trades as well as the decimalization of stock prices has a large impact on the decline of the correlation coefficients towards smaller return intervals i.e. the Epps effect. The contributors find that these distortions depend on the properties of the time series and are of a purely statistical origin. They also present parameter-free compensation methods and validate it in a model setup.

A study by (Fletcher, 2018) states that when the Closed-end Country Funds and ETF portfolios are added together there are substantial diversifications benefits and they are capturing different aspects of international investment opportunities in international equity markets.

Based on the existing literature we find evidence of tracking errors in country ETF's performance deviation from the underlying index, which is usually defined as a tracking error. This deviation affects the benefits of portfolio diversification and, thus, it is important for us to follow and investigate potential sources of it. For instance, (Johnson, 2008) in his research on tracking error of ETFs finds that variables such as foreign index and trading hours synchronicity with the US markets have significant explanatory power in the correlation coefficients between ETFs and their benchmarks.

(Osterhoff & Kaserer, 2016) examine the determinants of tracking errors in German ETFs and the significance of market liquidity on daily excess return. Special consideration in the study is given to the process of creation/redemption mechanism of ETFs shares as a potential source of tracking error. The findings include that tracking error of German ETFs depend on the liquidity of the underlying stocks irrespective of controlling the creation/redemption in the study. One of the possible explanations proposed is that when ETFs might fail to perfectly replicate the index weights or the internal rebalancing of weights causes liquidity costs.

(Chu P. , 2016) examines the tracking performance of two Hong Kong ETFs: Tracker Fund and X iShares A50. Tracking performance is assessed using pricing deviation, which is found to be nonzero and predictable. The study results suggest that the tracking performance deviation is caused by market value, dividend yield, trading volume, bid-ask spread, and market risk. All the variables are endogenous of a fund and is reiterating that the tracking error of ETF is arising from the fund and not explicit.

3. Theory and Hypothesis

3.1. Fundamentals of ETF

One of the main aspects of understanding how a ETF works is to consider its creation/redemption process. It is stated in the fund's prospectus that each fund issues shares in aggregation unit (or creation unit). All the fund shares are traded in the NYSE area. The shares are redeemable only by APs in exchange for cash or portfolio securities. Each fund is not actively managed and engages in representative sampling which indicates that the fund does not necessarily hold all the securities included in the underlying index. This can give rise to tracking difference based on the composition at any given time. Also, the fund anticipates risks associated with investing in non-US markets to be attributed to ETFs. Political instability, difference in accounting methods, changes in foreign exchange restrictions could have an impact on the fund's performance.

The fund's portfolio holdings information is distributed to the market makers, authorized participants and distributor agents every business day. This information is used in the creation and redemption process of the ETFs. Only an AP may engage in creation and redemption transactions directly with the fund on an agency basis. The AP deposits cash and securities to create respective number of shares. The same AP would also redeem the shares by depositing shares and receives a portfolio of securities and a net cash. Redemption in-house keeps the market price close to NAV and also aids in tax efficiency of the fund (Gastineau, 2001).

We choose to base our study on iShares country ETFs that are created by BlackRock Fund Advisors (BFA). The fund prospectus gives us an insight into the origination of the fund and the various mechanisms in the primary market that ensure the tracking error is minimum. The NAV of the ETF is the sum of all assets held by the fund net of liabilities divided by the number of shares outstanding. It is calculated at the end of each business day and fluctuates with changes in the market value of the ETF's holdings. The trading price or the ETF price of the Fund's shares fluctuates continuously throughout trading hours based on both market supply of and demand for fund shares and the underlying value of the fund's portfolio holdings or NAV. A provisional NAV (INAV) is distributed every 15 minutes based on which the trades take place. As a result, the trading prices of the fund's shares may deviate significantly from NAV during periods of market volatility. However, because shares can be created and redeemed in Creation Units at NAV, BFA believes that large discounts or premiums to the NAV of the fund are not likely to be sustained over the long term (unlike shares of many closed-end funds, which frequently trade at appreciable discounts from, and sometimes at premiums to, their NAVs). BFA also anticipates the tracking difference for the country ETFs to arise from using NAVs that are not continuously updated. While the creation/redemption feature is designed to make it more likely that the fund's shares normally will trade on stock exchanges at prices close to the Fund's next calculated NAV, for Asian and European funds, the NAV stops changing after their respective markets close. So, when the US markets open the ETF are adjusting to a price that is stale. Also, the exchange prices are not expected to correlate exactly with the fund's NAV due to timing reasons, supply and demand imbalances and other factors.

A creation transaction, which is subject to acceptance by the Distributor (an affiliate of BFA), generally takes place when an AP deposits into the fund a designated portfolio of securities (including any portion of such securities for which cash may be substituted) and a specified amount of cash approximating the holdings of the fund in exchange for a specified number of Creation Units. Similarly, shares can be redeemed only in Creation Units, generally for a designated portfolio of securities held by the fund and a specified amount of cash. The prices at which creations and redemptions occur are based on the next calculation of NAV after a creation or redemption order is received. Only an AP may create or redeem Creation Units with the fund.

The NAV of the ETF normally is determined once daily as of the regularly scheduled close of business of the New York Stock Exchange ("NYSE") (normally 4:00 p.m., Eastern time) on each day that the NYSE is open for trading, based on prices at the time of closing. Fund assets or liabilities denominated in currencies other than the US dollar are translated into US dollars at the foreign currency exchange rates determined as of 4:00 p.m., London time. Hence, Japan fund's NAV is calculated using the closing price at 2:00 a.m., Eastern time (when Japan market closes) and translated to USD at 11:00 a.m., Eastern time. This would decrease the creation and redemption requests as the NAV is not changing and consequently the ETF price would be determined by other factors not fund related.

3.2. Hypotheses

We form the hypotheses based on the goal of the thesis to study whether country ETFs provide the same international diversification opportunities as direct investing in underlying. Firstly, we analyze the relation of the ETF's market price and NAV returns. This is tested through the pricing deviations and correlation of the respective funds to the US equity market.

H_0: *The correlation of ETF's NAV to S&P is not the same as ETF to S&P.*

H_1: *The correlation of ETF's NAV to S&P is the same as funds ETF to S&P.*

Secondly, the evolution of tracking errors is examined.

H_0: *Tracking errors are not persistent in the long run.*

H_1: *Tracking errors are persistent in the long run.*

In the end, we aim to explain the reasons behind the potential deviations in performance and risk measures and examine the determinants of the difference:

H_0: *Asynchronous returns is not the main source of tracking error.*

H_1: *Asynchronous returns is the main source of tracking error.*

4. Empirical Methods

4.1. Price deviation

We start with estimating return and risk characteristics of the ETFs NAV and market price returns. We compute logarithmic daily return series for all country ETFs market price and NAVs, as they are compounded returns and evolve with time. Our goal is to analyze ETFs' market price ability to mimic its NAV. To see the variation of results across the globe, we divide the country ETFs into three groups: Asia-Pacific, Europe and Americas. We start with calculating daily, weekly, monthly, quarterly returns to have a comparable analysis of results at multiple frequencies. We define weekly returns as 5 trading days, monthly – 22 trading days and quarterly – 65 trading days. In our study we focus on analyzing how the short-term and long-term deviations of the funds' performance vary if found. The correlation of ETF's market price and NAV returns to the S&P500 returns are also calculated. We choose S&P500 as proxy for the US economy.

$$R_{ETF,t} = ln\left(\frac{ETF_t}{ETF_{t-1}}\right) \tag{1}$$

$$R_{NAV,t} = ln\left(\frac{NAV_t}{NAV_{t-1}}\right) \tag{2}$$

$$R_{S\&P,t} = ln\left(\frac{S\&P_{,t}}{S\&P_{t-1}}\right) \tag{3}$$

The pricing deviation is calculated as the difference between ETF's market price and NAV price with respect to the NAV price on the same day.

$$dev_t = \frac{|P_{ETF,t} - P_{NAV,t}|}{P_{NAV,t}} \tag{4}$$

To capture the deviation and the risk characteristics of the series, we compute mean and standard deviations of differences over a period of 22 days, a working month. We expect minimal deviations for funds in the Americas group as opposed to the Asia-Pacific group.

4.2. Correlations

The key to diversification is reducing the overall volatility. It is known that adding an asset with a lower correlation will reduce the overall risk. Therefore, one should be able to measure the correlation between assets with maximum precision. If the markets are operating at the same time, then the correlation is calculated unconditionally between the ETF's NAV returns and the S&P returns. A 252-day rolling window correlation is calculated for the two series. This helps in visualizing the change in correlation over time as one knows that correlation is not static. Volatility clustering in financial series can influence the correlation to a large degree. The correlations calculated at multiple frequencies also provide the co-movement of the two series over time. This is also an insight to corroborate the studies by (Eiling & Gerard, 2015).

4.3 Synchronization of daily returns

The time of measurement of daily financial data is often different for markets as the closing time varies. For example, US-Asian countries have no overlap of trading hours, and US-European countries have partial overlap of trading hours. Hence, the real value of a portfolio or correlation for daily data is not known at a fixed point in time. A consequence of using asynchronous data is that the correlations are often small(Burns, Engle, & Mezrich, 1998). This would be particularly detrimental for short term investors who might be placing bets with incomplete information. For people looking to buy ETFs to obtain diversification, an inaccurate correlation is not a desirable property.

One of the solutions is to use lower frequency returns to compute correlations that are utilized for diversification. With various financial products that depend on daily volatility, it becomes imperative to have the correct number.

(Burns, Engle, & Mezrich, 1998) come up with a model to synchronize the returns and find conditional covariances using asynchronous GARCH and thereby conditional correlation between two assets. They recognize that the asset value changes even when the markets are closed. Synchronizing data involves estimation of asset values at a specified (synchronization) time point in every day; we use the closing time of the New York stock exchange, i.e. 4 p.m. local New York time, as the synchronization time point. This is to synchronize the country ETF's NAV price of the to the US time, thereby a better alignment with the ETF market price. ETF's NAV is calculated using the closing equity prices of the outstanding shares in the local market. The foreign exchange rate used is the rate prevalent at 4.00 p.m. London time. Thus, the NAV is not updated during the US market opening hours except during the translation to USD values for Asian funds. The American funds, who have partial overlap of trading hours provide the last updated NAV at the same time as the translation to USD values. As the ETF market price is decided by the bid ask spread in the US market, giving rise to a variation with the NAV. The creation/redemption process is only accepted at the closing NAV price, which is expected to remain stable, so the changes in ETF price of a fund when it is closed could influence the price of the shares when the local market opens next. For example, the US equity and ETF price that changes after Japanese market is closed should influence the opening prices of the underlying equities in the Japanese market the next day. In such cases, the correlation would be lower as the effects are staggered and not comprehensive. Therefore, a synchronized ETF's NAV price to the US equity price is a better indicator of the funds' NAV.

Burns et al treat the returns as first order moving average and a matrix with first order autocorrelation coefficients is estimated. In our study, we follow the same path but substitute the moving average model with an autoregressive model of first order (AR (1)) as was done by (Bühlmann & Audrino, 2001).

The goal is to construct synchronized prices to the US market closing time and a correlation coefficient that is consistent and uses all the information in the right period of time. The logarithms of daily returns are used to be consistent with continuously compounded returns which results in the following structure for observed returns:

$$X_t = \ log\, S_t - log\, S_{t-1} \quad (5)$$

and, in our study involving multivariate process, we synchronize ETF's NAV returns to the US closing time. If F_t is the complete information of all recorded prices up to time *t*, then the synchronized price is S_t^s for all $t \ \in N = \{1,2, ... \}$.

$$\log S_{t,j}^s = E\ [log\ S_{t,j}\,|F_t]\, , where\ F_t\ =\ S_{t_{j,}j}\, ;\ t_j\ \leq t, j = 1, \ldots, M\ . \quad (6)$$

As a simplifying but reasonable approximation, we assume that, given the information F_t the best predicted log-prices at *t* and at the nearest succeeding closing time *t+1* remain the same, saying that future changes up to *t + 1* are unpredictable.

$$\log S_t^s = E\ [log\ S_t\,|F_t]\ =\ E\ [log\ S_{t\ +\ 1}\,|F_t]. \quad (7)$$

Thus, given the information at time *t*, the next predicted future values are given by the log-transformed synchronized prices. The synchronized returns are defined as the change in the logarithms of the synchronized prices:

$$X_t^s\ =\ log\ S_t^s - log\ S_{t-1}^s \quad (8)$$

The synchronized returns depend on unknown conditional expectations and have to be modelled (and estimated). We assume a simple "auxiliary" multivariate AR (1) model for the synchronization, given by

$$X_t\ = A \cdot X_{t-1}\ \ + \varepsilon_t\, , \quad (9)$$

With errors ε_t such that $E[\varepsilon_t|F_{t-1}]$ = 0 and A is a 2x2 matrix corresponding to the two-return series used, one country ETF's NAV and the other S&P returns.

This method is simpler to estimate since $E[X_{t+1}|F_t]$ depends only on the previous X_t (as in a Markovian model). ETF's NAV is dependent only on the previous S&P price as the local market is closed.

Substituting the equation (7) in (6) we derive the synchronous return as an AR (1) process:

$$X_t^s = log\, S_t^s - log\, S_{t-1}^s = E\,[log\,(S_{t+1})|F_t] - E\,[log\,(S_t)\,|F_{t-1}]$$

$$= E\,[log\,(S_{t+1}) - log\,(S_t)\,|F_t] - E\,[log\,S_t - log\,S_{t-1}\,|\,F_{t-1}] + log\,\left(\frac{S_t}{S_{t-1}}\right)$$

$$= E\,[X_{t-1}\,|\,F_t] - E\,[X_t\,|\,F_{t-1}] + X_t = X_t + A\,X_t - A\,X_{t-1}\,, \qquad (10)$$

thus,

$$X^s{}_t = X_t + A \cdot (X_t - X_{t-1}\,) \qquad (11)$$

The A matrix is derived by fitting the AR(1) multivariate model using the NAV returns and the S&P returns, only the significant coefficients are selected. While using the same A matrix to calculate synchronous returns the bottom row is all zero as we synchronize to the US market times. The second series is always S&P500 daily returns, with the first series being the ETF's NAV returns. Therefore, S&P500 returns remain the same, while the NAV returns are transformed to be synchronized with the US equity market.

4.4. Conditional correlations

Now that we calculate the synchronous returns, DCC GARCH model developed by (Engle & Sheppard, 2001) is used to compute conditional covariances. MATLAB offers a tool box to calculate the DCC parameters using the method created by the duo in their working paper. The DCC model is a two-stage estimation process, where in the first stage univariate GARCH models are estimated for each series and in the second stage, residuals are transformed by their standard deviation estimated in the first stage.

The input to the model is a mean zero time-series and

$$rt\,|F_t \sim N(0, Ht)$$

$$Ht = DtRtDt \tag{12}$$

where

- Ht is the covariance matrix,
- Dt is the k×k diagonal matrix of time varying standard deviations from univariate GARCH models with $\sqrt{h_{it}}$ on the i^{th} diagonal, and
- Rt is the time varying correlation matrix.

The proposed dynamic correlation structure is:

$$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha\,(\epsilon\epsilon') + \beta Q_{t-1}$$

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{13}$$

and $\bar{Q} = Cov\,[\epsilon t\epsilon'\,t\,] = E\,[\epsilon t\epsilon'\,t\,]$ is the unconditional covariance of the standardized residuals resulting from the first stage estimation

The scalars α and β must be larger than zero, but the sum has to be less than one similar to a univariate GARCH process.

$$Q_t^* = \begin{pmatrix} \sqrt{q_{11}} & 0 \\ 0 & \sqrt{q_{kk}} \end{pmatrix} \tag{14}$$

The typical element of R_t will be of the form $\rho_{ijt} = \frac{q_{ijt}}{\sqrt{qiijj}}$.

The output from the model is a conditional covariance matrix. We tweak the code to get R_t as a vector of correlations over time. To compare, asynchronous returns are also sent to the model to compute correlation using close-close returns. The two correlations series are then compared to see the movement over time with and without incorporating past information to the ETF's NAV returns. We expect to see an increase in correlation for Asia-Pacific and European funds but no significant difference in the correlations for the American funds that trade parallel to the US equity market.

4.5. Measurement of tracking errors

Analyzing the existence and degree of tracking errors is a crucial part of our study. Following the majority of studies on tracking error, we use the ETF's NAV return to examine the tracking efficiency of the ETF. Few reasons we choose to conduct study on the ETF's NAV and market price returns are: (1) there is a mismatch between daily ETF closing price and the NAV price caused by high-frequency trading environment and exchange rates, (2) using ETF market price instead of NAV price would bear a risk of wrongfully attributing differences between the ETF return and benchmark return to tracking ability which are actually caused by non-arbitraged NAV-price deviations (Osterhoff & Kaserer, 2016) and (Milonas & Rompotis, 2006).

We define tracking difference as the difference between the ETF's market price and NAV returns over a stated period of time. Tracking difference is further used to calculate annualized tracking error. There are different approaches to measure tracking errors; (Harper, Madura, & Schnusenberg, 2006) examine tracking errors by simply using the difference between the return on the ETFs and their benchmarks. However, this method is too simplistic and can yield indistinct results as errors can overwrite each other. Therefore, we apply the method discussed by (Milonas & Rompotis, 2006) (Harper, Madura, & Schnusenberg, 2006)to estimate tracking errors, which is a standard deviation of return differences. Thus, we have the following formulas:

$$Tracking\ Difference\ ETF_t(TDF_t) = R_{ETF,t} - R_{NAV,t} \qquad (16)$$

$$Tracking\ Error\ ETF_t = \sqrt{\frac{\sum_{t=1}^{n}\left(R_{ETF,t}-R_{NAV,t}\right)^2}{n-1}} \qquad (17)$$

Our aim is to encompass funds from various time zones and include 15 country ETFs across the globe. We believe there is a higher tracking error in a country ETF with no-overlap of trading hours with US and a lower error in a country ETF with (partial)overlap of trading hours with the US market. Moreover, we presume that tracking errors would decrease with a lower time frequency of returns irrespective of hours' divergence between the home and the US market.

4.6. Tracking Difference determinants

Our next step is to investigate the potential sources of tracking differences. Based on the existing literature (Frino & Gallagher, 2001), and (Milonas & Rompotis, 2006) (BlackRock, 2019) and iShares prospectus we find the relevant factors that affect the fund's ability to track the benchmark to be: exchange rates, differences in transaction costs, differences in timing of the accrual of or the valuation of dividends or interest, changes to the underlying index or the costs to the fund of complying with various new or existing regulatory requirements, increased market volatility or other unusual market conditions, fees and expenses, fund's daily net creation/redemption of shares and etc.

Many studies have documented the role of fund's expense ratio, dividend yield to be prominent sources of tracking error. For, country funds there are more sources like the difference in market times and exchange rates. The tracking difference is seen to disappear at lower frequencies, so we choose daily returns to study the short term deviations present in ETF funds. To understand the role of US equity market in the tracking difference of a country ETF, we begin our analysis by regressing daily S&P500 returns on daily tracking difference of the ETF. The ETF price constantly adjusts to its NAV based on new information. The country ETFs' NAV is not a continuous development for many countries due to the non-overlap of trading hours. The market closes ahead of US market and the dollar value of NAV is calculated in the middle of the US trading time. ETF price first adjusts to the changes in the NAV price that is closed prior to the US market. ETF price may also adjust to the previous day premium/discount if it was not accounted for in the NAV price. Hence, there is a chance that the lagged S&P returns have an effect on the present-day ETF's NAV prices. We expect the S&P returns and its lagged value to be statistically significant in explaining the tracking difference and insignificant or a low coefficient beyond the first lag. The explanatory power of the S&P returns is expected to be higher for the countries with no overlap due to non-existence of a continuously updated ETF's NAV price.

$$R_{ETF,t} = \alpha + \beta_t * R_{S\&P500,t} + \varepsilon_t \quad (18)$$

$$R_{ETF,t} = \alpha + \beta_t * R_{S\&P500,t-1} + \varepsilon_t \quad (19)$$

Most importantly, we expect the effect of $R_{S\&P500,t-2}$ as a regressor to diminish for all the funds irrespective of market timings.

$$R_{ETF,t} = \alpha + \beta_t * R_{S\&P500,t-2} + \varepsilon_t \quad (20)$$

As our main goal is to judge the transitory effects of US and following the path of previous studies, we use variables such as daily return on exchange rates, volatility of ETFs' daily trading prices, log-transformed daily average trading volume among other factors. Thus, we construct the following model with eight variables, fund specific and US transitory, in attempt to explain the funds' performance deviations:

$$TDF_t = \alpha + \beta_1 VIX_t + \beta_2 FXrate_t + \beta_3 R_{S\&P500,t} + \beta_4 LogVolume_t + \beta_5 Vola_t + \beta_6 Spread_t + \beta_7 AUM_t + \beta_8 RelCRP_t + \varepsilon_t \quad (21)$$

(1) *VIX Index*. Increased market volatility can affect the fund's ability to properly track the underlying index. As we expect the US market to have an effect on the fund's deviation from the benchmark, we include the VIX index as one of the independent variables in the regression analysis to account for volatility in the US market. Moreover, volatility clustering is an important phenomenon that affects the correlation between two assets. As the sample data includes periods of economic instability (the dot-com bubble and financial crisis of 2007-2008), when the US market experienced extreme volatility we believe VIX index to have explanatory power.

(2) *Exchange rates*. Given ETFs creation/redemption mechanism it is expected that exchange rate volatility will have a significant effect on tracking difference. Because the ETF's NAV is determined on the basis of the US dollar, investors may actually lose

money if the currency of a non-US market in which the fund invests depreciates against the US dollar, even if such currency value of the Fund's holdings in that market increases. Currency exchange rates can be very volatile and change quickly and unpredictably. As a result, the ETF's NAV can change quickly in turn causing deviations in the fund's performance (BlackRock, 2019). Thus, we include foreign exchange return rates for local currencies of the respective funds.

(3) *S&P500 return.* Based on the existing literature, the US market has a high correlation to the ETF's daily return. We include S&P500 daily return as a proxy for the US market. We expect it to be a significant variable for country ETFs with no-overlapping trading hours and partially overlapping hours with the US market (Levy & Liberman, 2012). Let us consider an example of the ETF located in Japan (EWJ). Ideally, the fund's price should be equal to its quoted NAV including all relevant public information released during the trading day. However, given the integration of world equity markets, the US market has significant effect on foreign markets through trading and foreign investment in Japan. Therefore, we expect that when the local market in Japan is closed the US market return will have a high influence on ETF and its deviation from the benchmark.

(4) *Volume.* We measure the liquidity of the funds using log-transformed daily change in trading volume. Some studies suggest that high liquidity has a negative effect on the tracking difference since higher liquidity results in greater cash inflows to ETFs consequently reducing the trading costs and tracking difference. On the other hand, (Cho, 2013) concludes that high trading volumes have a positive effect on the level of tracking difference. Since there is a clear evidence of trading volume having an effect on the fund's performance deviations, we include this variable to find out the nature of this influence (positive/negative).

(5) *Volatility.* Intraday price volatility is expected to have significant influence on tracking difference. A study by (Shin & Soydemir, 2010) documents that the volatility of

the ETF intra-day price has a positive impact on the tracking error. However, we expect that only the most traded funds to show any daily price volatility and thus have a significant effect on tracking difference. We intend to include conditional volatility retrieved from the DCC-GARCH model to check significance of time varying changes to the tracking difference.

(6*) Spread.* Another proxy for market liquidity is bid-ask spread. Previous studies document that higher bid-ask spread indicates lower liquidity and supposedly increase the tracking error. On the other hand, some studies suggest that there is no significant relation between the spread on the tracking error. We expect bid-ask spread to have a positive effect on the excess return but not necessarily statistically significant.

(7) *Assets under management (AUM).* The number of shares outstanding of the fund are multiplied by its ETF market price to get the assets under management. We expect AUM to have positive effect on the tracking error as this variable indicates the ETF's size. Higher the ETF's size signifies the fund's ability to properly track the underlying index given economies of scale and etc.

(8) *Relative Creation/Redemption Process or RelCRP*. One of the most important aspects of the ETFs is the creation and redemption mechanism, or the fund's ability to create and redeem shares throughout the trading day. To use this mechanism as an explanatory variable in our regression analysis we multiply the absolute change in shares outstanding on day t with the ETF's NAV price on the same day and divide the by assets under management. We expect this variable to be statistically significant and explain performance deviation of the country ETF.

$$RelCRP_t = NAV_t * \frac{|Shares\ outstanding_t - Shares\ outstanding_{t-1}|}{AUM_t} \qquad (22)$$

Empirical research has shown that volatility spill over is high during times of financial distress. We test the effect of US financial crisis on the tracking difference during the 2008 US recession using a dummy variable $UScrisis_t$. The variable is given a value of 0 and 1 from September 2008, 2 days before the Lehmann bankruptcy episode to July 2009 when the first signs of stabilization are seen.

$$TDF_t = \alpha + \beta_1 VIX_t + \beta_2 FXrate_t + \beta_3 R_{S\&P500,t} + \beta_4 LogVolume_t + \beta_5 Vola_t + \beta_6 Spread_t + \beta_7 AUM_t + \beta_8 RelCRP_t + \beta_9 UScrisis_t + \varepsilon_t \quad (23)$$

(9) *US crisis*. We use dummy variable to represent the US crisis in the regression analysis, as one would assume that the tracking difference to be higher in times of economic instability owing to the financial contagion. Therefore, we cover the 2008-2009 world financial crisis to investigate the impact of US crisis in the movement of the tracking difference.

5. Data

iShares, an open-end management company was developed by Barclays Global Investors (BGI) when it acquired Wells Fargo Nikko Investment Advisors in 1995. In 2011, following the financial crisis BlackRock acquired BGI and continued to offer ETFs under the brand name iShares. The company has developed multiple Country ETFs that track the MSCI world indices. Morgan Stanley Capital International (MSCI) benchmark indexes were founded in 1969 to facilitate comparison in the world market. Most countries' local markets use different calculation methods, base dates and methods of adjusting for capital changes. However, MSCI applies the same criteria and calculation methodology to all country across the globe both developed and emerging. Although FTSE also provides global benchmark indices, there are not any major differences between the two. Hence, we choose to focus our analysis on country ETFs issued by iShares, which is the world largest ETFs provider owned by BlackRock but can easily be replicated with ETFS that track FTSE indices. The variation in a fund's performance due to differing management styles can also be eliminated by sticking to one sponsor**.**

5.1. Sample selection

The sample we use in our analysis includes 15 different country ETFs broadly divided into three groups (Figure 1) based on their equity market trading hours.

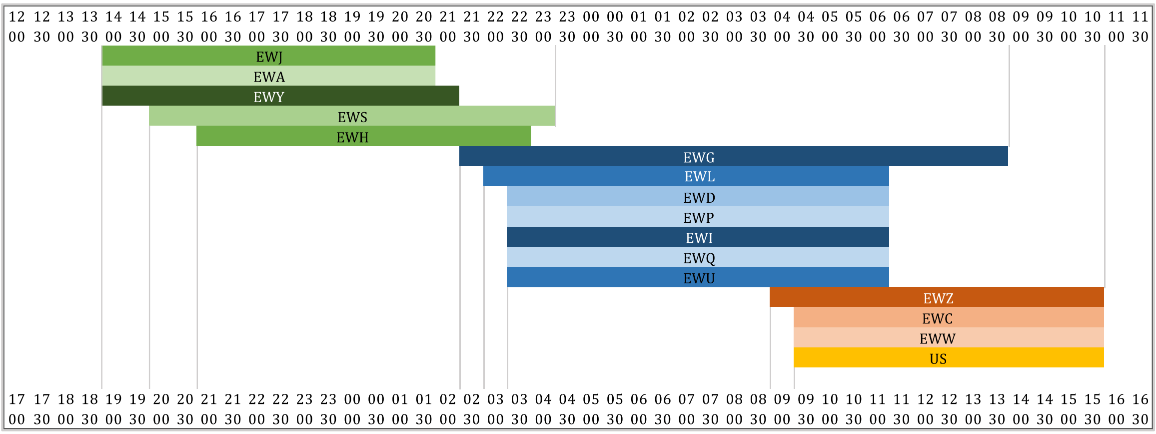


Figure 1: Map of world markets trading hours.
The lower bar represents trading hours in US Eastern standard time. The three groups are shown: the Asia Pacific group in green, the Europe group in blue and the Americas group in orange.

The Asia-Pacific group consists of Japan, Australia, South Korea, Singapore and Hong Kong, with no overlap of trading hours with US. The Europe group includes Germany, Switzerland, Sweden, Spain, Italy, France and UK, and has partial overlap of trading hours with the US market. The Americas group is Brazil, Mexico and Canada that have markets parallel to US. The study period runs from Q2 1996 to Q1 2019 except for 2 ETFs, dates of inception for which are from 2000. This selection offers as many data points necessary which aids our research at multiple frequencies (Table 1).

Table 1: Overview of ETF fund sample selected.
The following table contains the 15 iShares country ETFs along with their tickers. The table includes the start date and the end date of our selected sample for each fund. South Korea and Brazil funds were incepted late and have a smaller data series compared to other funds.

Fund	Ticker	Start of sample	End of sample	N of observations
iShares MSCI Japan ETF	EWJ	March 29, 1996	March 29, 2019	5790
iShares MSCI Austalia ETF	EWA	March 29, 1996	March 29, 2019	5790
iShares MSCI South Korea ETF	EWY	May 5, 2000	March 29, 2019	4744
iShares MSCI Singapore ETF	EWS	March 29, 1996	March 29, 2019	5790
iShares MSCI Hong Kong ETF	EWH	March 29, 1996	March 29, 2019	5790
iShares MSCI Germany ETF	EWG	March 29, 1996	March 29, 2019	5790
iShares MSCI Switzerland ETF	EWL	March 29, 1996	March 29, 2019	5790
iShares MSCI Sweden ETF	EWD	March 29, 1996	March 29, 2019	5790
iShares MSCI Spain ETF	EWP	March 29, 1996	March 29, 2019	5790
iShares MSCI Italy ETF	EWI	March 29, 1996	March 29, 2019	5790
iShares MSCI France ETF	EWQ	March 29, 1996	March 29, 2019	5790
iShares MSCI UK ETF	EWU	March 29, 1996	March 29, 2019	5790
iShares MSCI Brazil ETF	EWZ	April 12, 1996	March 29, 2019	4597
iShares MSCI Canada ETF	EWC	March 29, 1996	March 29, 2019	5790
iShares Mexico	EWW	March 29, 1996	March 29, 2019	5790

We retrieve daily ETF's NAV per share, index level, dividends, expense ratio and shares outstanding for each fund from iShares database. Additionally, for the regression analysis we retrieve FX rates, VIX index, S&P 500 daily prices, bid-ask spread and ETFs' close, high-, low- prices from Bloomberg. The expense ratio for all the ends is similar at 0.47% except for South Korea, Brazil (0.59%) and Sweden (0.53%).

5.2. Descriptive Statistics

The logarithmic daily, weekly, monthly and quarterly returns of ETF's NAV and market price are calculated for each fund. Along with this S&P500 logarithmic returns are also calculated at all the above-mentioned intervals. The missing values if any have been eliminated to have an uninterrupted data series.

To provide an overview of the data we choose to analyze we document descriptive statistics summary in Table 2. The ETF's NAV and market price returns are "monthalized" and reported in the table. Alongside we also report the summary statistics of S&P returns.

We see the ETF market returns display higher volatility compared to ETF's NAV returns. The maximum and minimum values have a larger spread for ETF market price returns than the NAV returns. The difference in volatility between the ETF's NAV and market price returns is positive for all funds but low without any discernible trend across regions. Even though the maximum values are different for ETF's market price and NAV returns, the median value remains the same.

The series show signs of being leptokurtic or high kurtosis. Fatter tails suggest there might be occasional large fluctuations, a feature of volatility clustering. Except for Mexican ETF all the other funds are moderately skewed and most of them are left-skewed.

Table 2: Descriptive statistics.

The table reports the descriptive statistics of the "monthalized" daily returns for each country fund. Panel A shows summary of the ETF price returns and Panel B – the NAV price returns. The last column is the difference in the standard deviation between the two returns of a fund. The summary for S&P500 returns is included in the Panel A. The number of observations varies across funds as mentioned in Table 1.

Panel A: ETF returns summary

Country ETF	Mean return	Median return	St. Deviation	Skewness	Kurtosis	Min Value	Max Value
Japan	-0,0006	0,0016	0,0578	-0,1411	1,7078	-0,3582	0,3096
Australia	0,0027	0,0087	0,0659	-0,9187	5,0716	-0,5952	0,2933
South Korea	0,0054	0,0096	0,0863	-0,6481	4,2423	-0,7282	0,4286
Singapore	-0,0002	0,0055	0,0762	-0,2996	4,2791	-0,5268	0,4324
Hong Kong	0,0025	0,0077	0,0739	-0,5083	3,1865	-0,4831	0,4117
Germany	0,0027	0,0103	0,0713	-0,9820	3,4130	-0,5358	0,2436
Switzerland	0,0040	0,0094	0,0539	-0,7641	2,6000	-0,3338	0,2627
Sweden	0,0031	0,0093	0,0795	-0,8192	3,2033	-0,6174	0,3406
Spain	0,0028	0,0063	0,0741	-0,4807	1,8314	-0,5169	0,2773
Italy	-0,0002	0,0045	0,0767	-0,6245	2,1855	-0,5177	0,3289
France	0,0030	0,0089	0,0635	-0,9010	3,1043	-0,5010	0,2139
UK	0,0010	0,0066	0,0542	-1,0105	4,9696	-0,5055	0,2041
Brazil	0,0037	0,0098	0,1077	-0,7023	2,3131	-0,7592	0,3124
Canada	0,0051	0,0126	0,0856	-1,0431	4,7078	-0,6772	0,3294
Mexico	0,0037	0,0094	0,0655	-1,2536	6,2156	-0,5960	0,2335
S&P500	0,0056	0,0117	0,0476	-1,0850	7,4439	-0,3537	0,2022

Panel B: NAV returns summary

Country ETF	Mean return	Median return	St. Deviation	Skewness	Kurtosis	Min Value	Max Value	St.Deviation (ETF)-St.Deviation(NAV)
Japan	-0,0006	0,0019	0,0563	-0,1906	4,3676	-0,3164	0,2656	0,0015
Austalia	0,0028	0,0087	0,0644	-0,9713	8,4957	-0,5589	0,2765	0,0015
South Korea	0,0053	0,0096	0,0853	-0,7005	7,1957	-0,6678	0,3786	0,0011
Singapore	-0,0002	0,0052	0,0742	-0,3955	7,5935	-0,5239	0,4201	0,0020
Hong Kong	0,0025	0,0077	0,0718	-0,6980	6,7094	-0,4831	0,3180	0,0021
Germany	0,0028	0,0107	0,0707	-0,9836	6,2989	-0,5224	0,2344	0,0007
Switzerland	0,0041	0,0096	0,0527	-0,8143	5,6386	-0,3160	0,2616	0,0012
Sweden	0,0031	0,0100	0,0780	-0,8684	6,3424	-0,5975	0,3094	0,0015
Spain	0,0028	0,0061	0,0731	-0,5218	4,9808	-0,5053	0,2605	0,0009
Italy	-0,0002	0,0049	0,0759	-0,6512	5,2940	-0,5130	0,3073	0,0008
France	0,0031	0,0092	0,0629	-0,9363	6,2387	-0,4892	0,2205	0,0006
UK	0,0011	0,0063	0,0531	-1,0738	8,1949	-0,4748	0,2143	0,0011
Brazil	0,0037	0,0098	0,1062	-0,7186	5,4168	-0,7705	0,3175	0,0015
Canada	0,0052	0,0130	0,0834	-1,0856	7,7461	-0,6470	0,3271	0,0023
Mexico	0,0038	0,0097	0,0646	-1,3270	9,7938	-0,6080	0,2283	0,0008

6. Results and Analysis

6.1. Price deviation

The mean and standard deviation of the ETF market price form NAV price are calculated as per equation (4) and the deviations over a monthly horizon is plotted in Figure 2 and Figure 3. We group countries with similar trading hours to show the similarities across countries in a region. Between 1997 and 2004, almost all countries had independent movement of the mean and volatile price deviations. We observe a large increase during the financial crisis period in 2008-2010. All the countries irrespective of the region are affected by the contagion. Post, 2011 the countries belonging to the same group start to move in tandem. The Asian crisis in 1997 has affected the Asian market prices compared to the US and we see the volatility in the early days of the sample period in Figure 3. Additionally, the Mexican peso crisis in the mid-nineties and the Brazilian political crisis from 2014-16 explain the spikes in the deviation of the Mexican and Brazilian ETFs respectively. (Musacchio, 2012) (Nassif, 2017).

We observe the mean deviation decrease over the sample period in absolute terms for all the groups, though it is still larger for the Asian countries followed by European and then American countries. We deduct from the plots a higher tracking difference is present for Asian funds compared to the American funds.

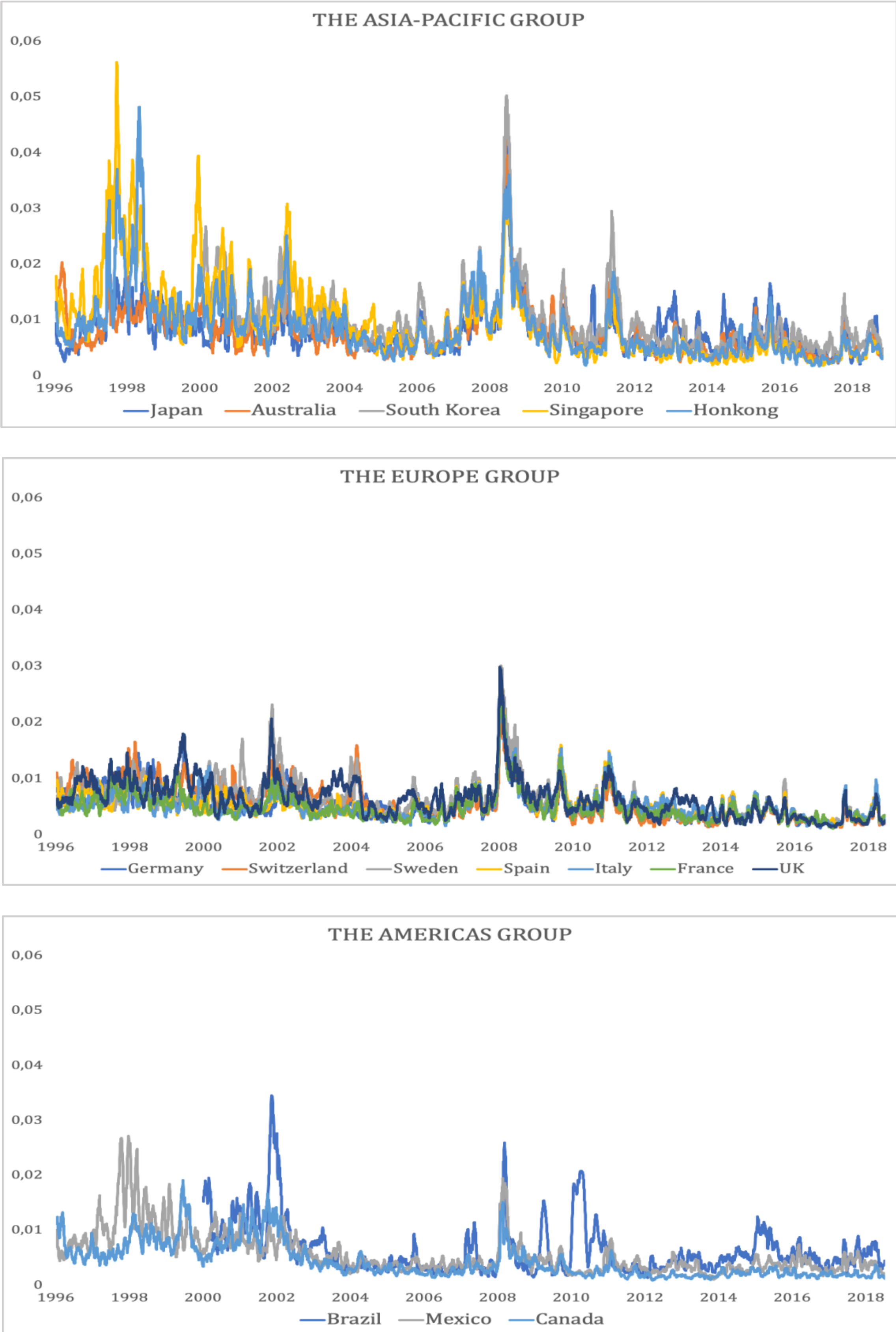


Figure 2: Time varying average deviation between ETF's NAV and market prices.
First chart gives average time varying deviation of the five funds from Asia-Pacific region. Second chart represents the Europe group with the seven funds. Bottom chart is the Americas group that include 3 funds from countries with parallel trading hours with US.

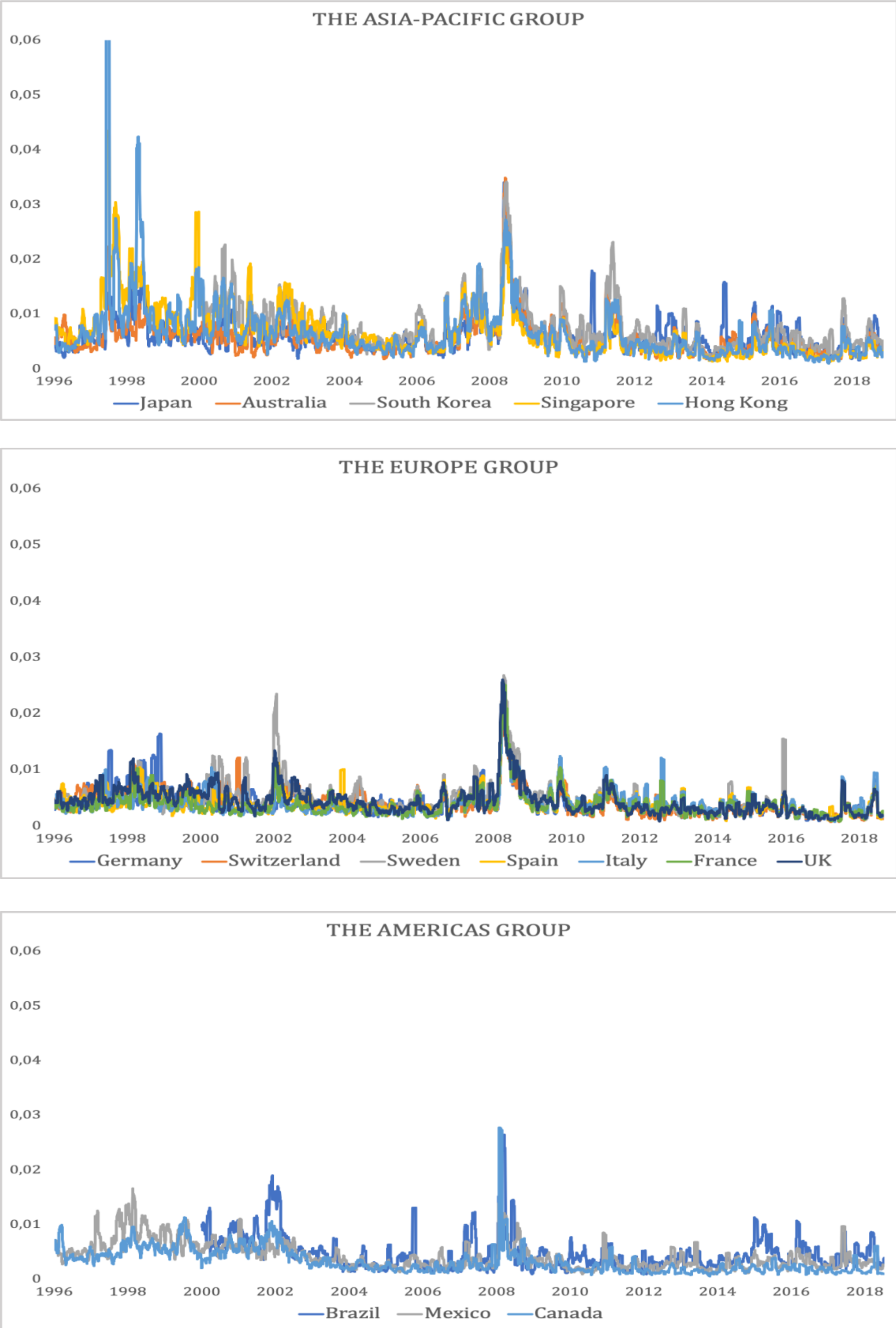


Figure 3: Time varying volatility of deviation between ETF's NAV and market prices.
First chart gives time varying volatility of deviation of the five funds from Asia-Pacific region. Second chart represents the Europe group with the seven funds. Bottom chart is the Americas group that include 3 funds from countries with parallel trading hours with US.

6.2. Correlations

We see the 252 day rolling window correlations between ETF's NAV and market price returns for each fund in the Figures 4, 5 and 6. The correlations are based on close-to-close returns of each fund. Figure 4 shows the correlation for countries in Asia-Pacific group. We see a big jump upwards in the correlation when we change to weekly horizon from daily. The monthly correlation is at a higher level than the weekly numbers. In Figure 5 the correlations for the European countries are plotted. We observe monthly correlation to be in the range of 0.7-0.8 signifying a lower tracking difference or pricing deviation. The difference between the daily and weekly correlation values is also smaller than the difference for Asian countries. We observe a similar pattern in the Americas group where the daily correlations are lower than weekly and monthly correlations. The difference is smaller than that observed for European countries. Again, we see high correlation between ETF's NAV and market price monthly returns. For all the three groups, the plots suggest a good tracking ability of ETF market price to its NAV at monthly and weekly horizon. The correlations are lower for daily returns indicating a higher tracking difference for short term investors. The magnitude of correlations is lower for the Asian countries suggesting a possibility of higher tracking difference as compared to other funds. Thus, ETFs do offer better diversification at longer horizon compared to shorter horizons. We conclude that the daily returns to be the aberration among returns at other frequencies. This could be due to the Epps effect where the correlation decreases for higher frequencies or the daily returns are slow to adjust to the complete information. We know that the ETF's NAV is calculated at the end of the market day, with a provisional NAV updated every 15 minutes. For Asian and European funds, the NAV ceases to change after the local market closes and only the currency effects are present. The difference in timing of ETF's NAV is one of the reasons for the lower correlation of Asian and European funds compared to American funds.

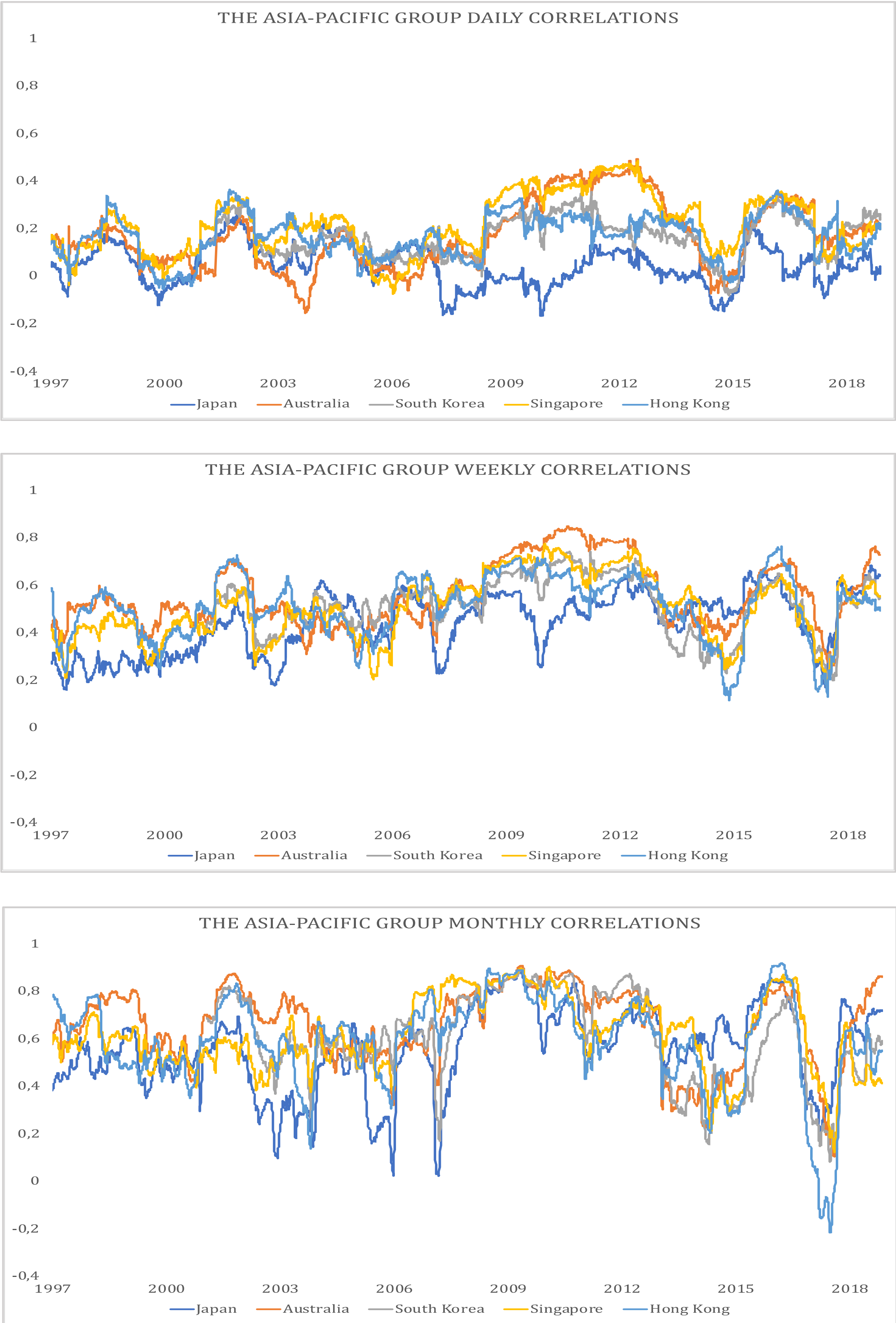
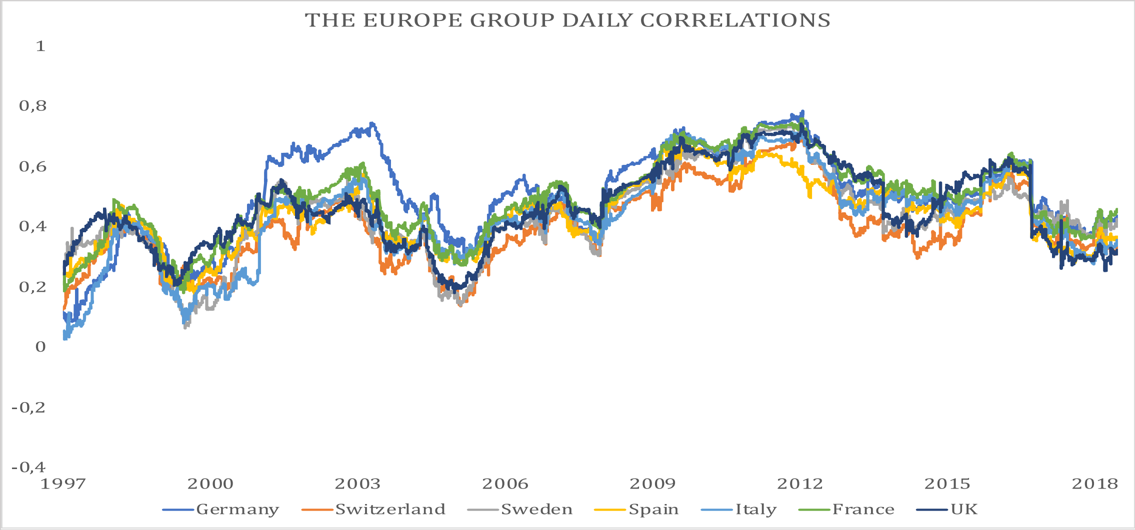
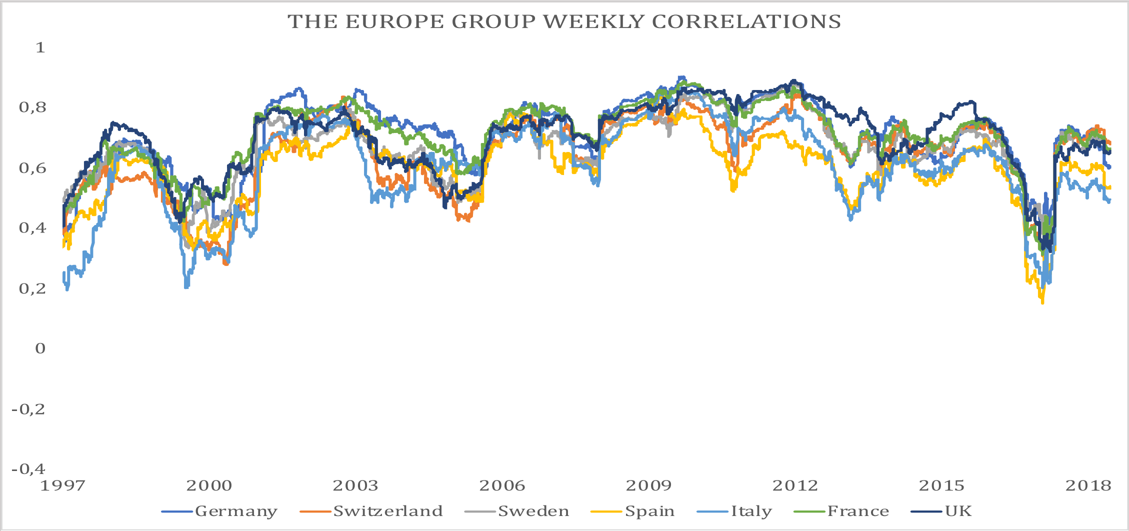


Figure 4: Correlations between ETF's NAV and market price.
First chart displays correlation of returns on a daily horizon. Second chart is returns on weekly horizon. Bottom chart is the correlations for monthly returns.





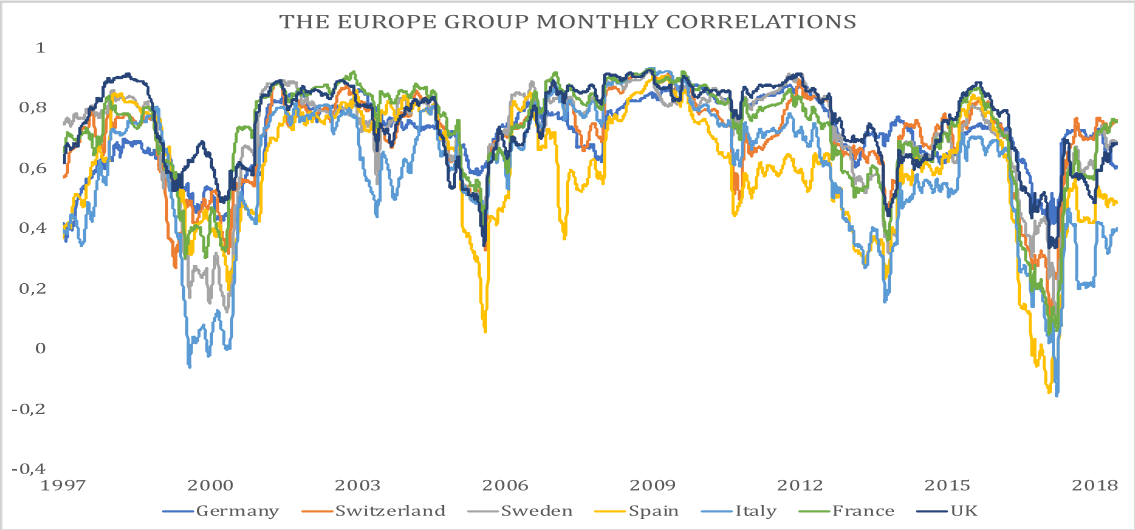
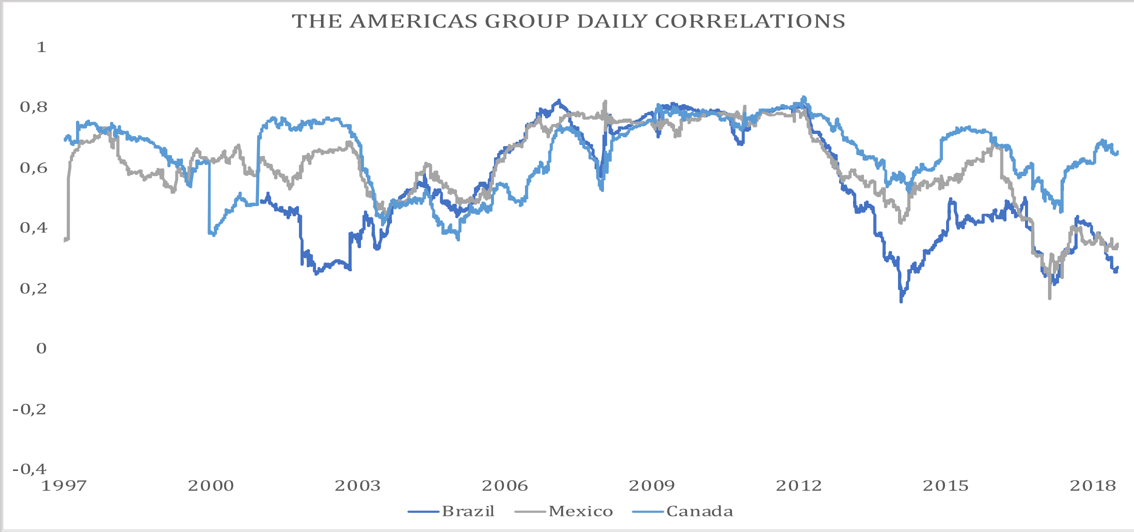
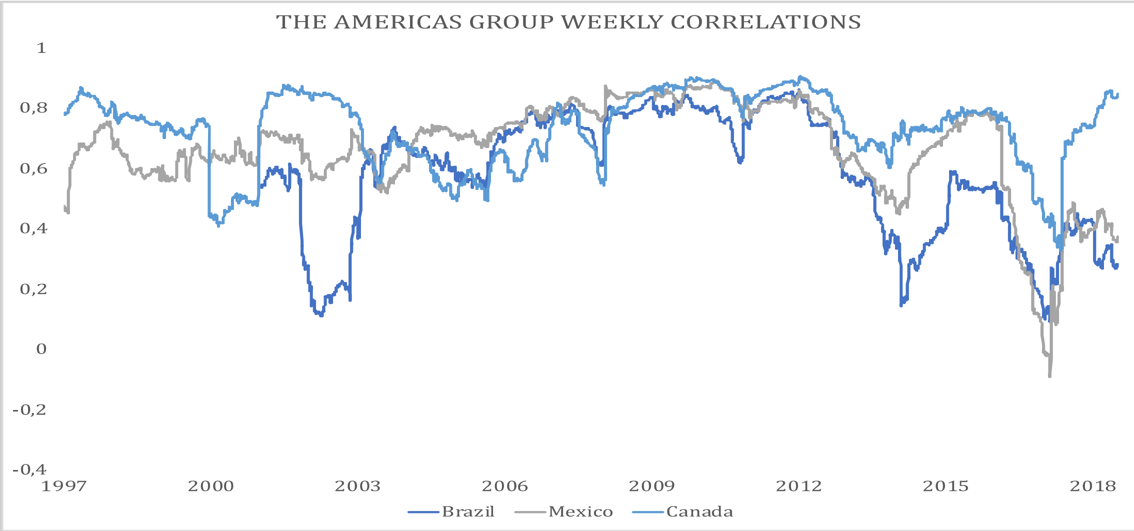


Figure 5: Correlations between ETF's NAV and market price.
First chart displays correlation of returns on a daily horizon. Second chart is returns on weekly horizon. Bottom chart is the correlations for monthly returns.





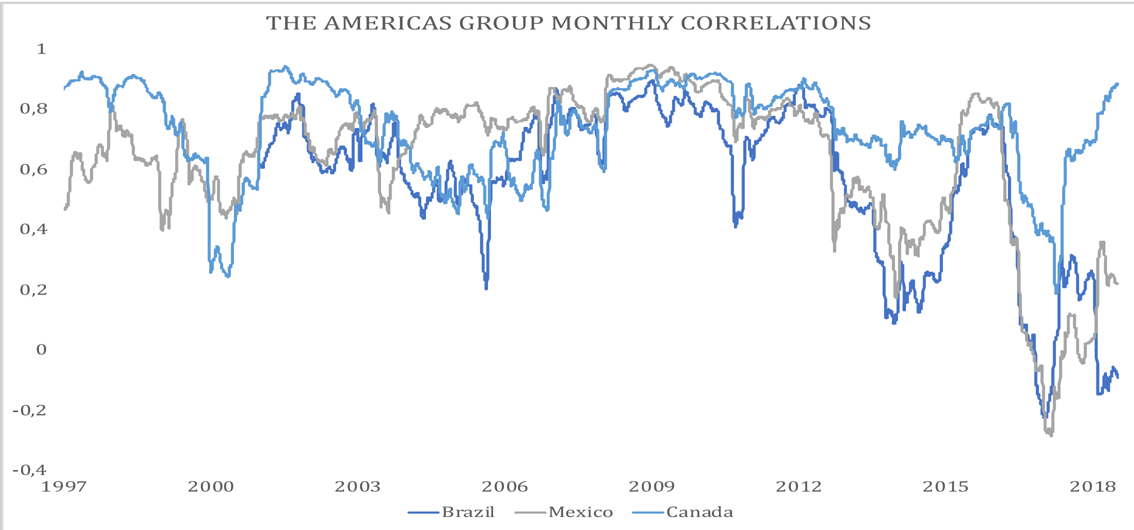


Figure 6: Correlations between ETF's NAV and market price.
First chart displays correlation of returns on a daily horizon. Second chart is returns on weekly horizon. Bottom chart is the correlations for monthly returns.

To see the effect of S&P returns on other countries after the market closes, we calculate the correlation of the ETF's NAV return with the previous day S&P returns. We find them to be higher at around 0.4 than the same day correlation for Asian countries. The largest increase is observed for Japan from 0.04 to 0.4. No overlap of trading hours results in NAV adjusting to the previous day information completely when the market opens next day. For European countries, which have partial overlap the correlations *t-1* are lower than at *t* but still substantial at an average of 0.25 for the seven funds. The American funds that trade parallel to US have low correlation with previous day S&P returns. This is because the ETF's NAV price adjusts in real time without much delay like in other funds. Therefore, we synchronize the ETF's NAV returns to the US market times using the procedure describe in the sections 4.3 and 4.4. Table 3 reports the correlations between ETF's market price, NAV and S&P returns at daily horizon. The synchronized conditional correlations using synchronized NAV prices are also reported along with the lagged S&P returns. Tables 4 has correlations of weekly, monthly and quarterly returns without synchronization. All the country funds report higher correlation across sections at lower frequencies than daily. Synchronized NAV (sNAV) prices that are transformed with respect to the S&P returns, see a higher correlation between NAV-S&P that is similar to their weekly correlation numbers for Asian countries. An interesting observation is the larger change in European funds correlation than American as a result of synchronization. We see similar values between NAV-ETF and sNAV-ETF for American funds which we know should be true as they trade simultaneously to the US markets. The results show that the daily correlations are underestimated when we take contemporaneous returns for markets with asynchronous trading hours. The correlations get adjusted to their actual values when synchronized NAV is used.

In table 4 the correlation for NAV-ETF is almost 1 for quarterly horizon as stated in fund's prospectus that the pricing deviations are removed at lower frequencies.

Table 3: Daily Correlations.
The following table is the correlation of daily returns. The first three columns are the correlation between NAV-S&P, NAV-ETF and ETF-S&P returns for all the funds. The fourth column is the correlation of NAV returns on day t with S&P returns on day t-1. The last two columns report the correlation between synchronized NAV with S&P and ETF price returns respectively.

Country ETF	ρ(NAV,SP500)	ρ(NAV,ETF)	ρ(ETF,SP500)	ρ(NAV,SP500 t-1)	ρ(sNAV,SP500)	ρ(sNAV,ETF)
Japan	0,043	0,500	0,627	0,399	0,488	0,782
Australia	0,198	0,583	0,633	0,485	0,682	0,820
South Korea	0,192	0,632	0,681	0,384	0,586	0,868
Singapore	0,238	0,628	0,616	0,322	0,535	0,790
Hong Kong	0,183	0,527	0,670	0,377	0,564	0,789
Germany	0,539	0,795	0,754	0,218	0,753	0,891
Switzerland	0,427	0,709	0,640	0,267	0,686	0,804
Sweden	0,467	0,780	0,684	0,266	0,730	0,872
Spain	0,462	0,799	0,669	0,207	0,654	0,873
Italy	0,452	0,809	0,661	0,196	0,654	0,883
France	0,515	0,788	0,741	0,258	0,772	0,888
UK	0,490	0,723	0,736	0,279	0,768	0,849
Brazil	0,572	0,881	0,643	0,071	0,620	0,893
Mexico	0,629	0,859	0,677	0,129	0,696	0,872
Canada	0,668	0,834	0,658	0,148	0,774	0,841

We also observe that all the countries do not report higher correlations between NAV-S&P across time or horizons. This result is in line with the study by (Bekaert, Hodrick, & Zhang, 2009) that the world markets have not seen a shift in integration reducing the diversification benefits. The plots in fact show a cyclical trend across the sample period selected. One important observation is the lower correlation reported by Brazil and Mexico funds between NAV-S&P compared to the European funds. This is due to the other factors like political influencing the local markets as opposed to the developed markets. It is the same trend we observe in synchronized NAV-S&P daily return correlations for Brazil and Mexico.

Table 4: Correlations at multiple frequencies.
This table reports the correlation of the NAV-S&P, NAV -ETF and ETF-S&P returns at multiple frequencies.

Panel A: Weekly returns

Country ETF	ρ(NAV,SP500)	ρ(NAV,ETF)	ρ(ETF,SP500)
Japan	0,423	0,865	0,589
Australia	0,605	0,901	0,699
South Korea	0,547	0,906	0,680
Singapore	0,505	0,900	0,612
Hong Kong	0,527	0,877	0,649
Germany	0,735	0,957	0,784
Switzerland	0,666	0,928	0,718
Sweden	0,695	0,951	0,749
Spain	0,619	0,957	0,673
Italy	0,633	0,959	0,683
France	0,733	0,952	0,783
UK	0,726	0,930	0,787
Brazil	0,590	0,973	0,608
Mexico	0,678	0,968	0,688
Canada	0,751	0,964	0,745

Panel B: Monthly returns

Country ETF	ρ(NAV,SP500)	ρ(NAV,ETF)	ρ(ETF,SP500)
Japan	0,574	0,963	0,618
Australia	0,712	0,974	0,731
South Korea	0,687	0,975	0,727
Singapore	0,611	0,973	0,649
Hong Kong	0,622	0,969	0,659
Germany	0,778	0,990	0,793
Switzerland	0,744	0,981	0,758
Sweden	0,767	0,988	0,778
Spain	0,660	0,990	0,672
Italy	0,672	0,991	0,682
France	0,791	0,988	0,802
UK	0,807	0,981	0,823
Brazil	0,623	0,994	0,629
Mexico	0,676	0,991	0,680
Canada	0,774	0,991	0,772

Panel C: Quarterly return

Country ETF	ρ(NAV,SP500)	ρ(NAV,ETF)	ρ(ETF,SP500)
Japan	0,567	0,987	0,584
Australia	0,736	0,991	0,743
South Korea	0,688	0,991	0,706
Singapore	0,612	0,992	0,627
Hong Kong	0,608	0,990	0,625
Germany	0,798	0,997	0,804
Switzerland	0,764	0,993	0,772
Sweden	0,797	0,996	0,800
Spain	0,675	0,996	0,679
Italy	0,719	0,997	0,723
France	0,817	0,996	0,820
UK	0,858	0,993	0,864
Brazil	0,650	0,998	0,655
Mexico	0,711	0,996	0,709
Canada	0,791	0,997	0,790

6.3. Synchronization of daily returns

We see the data from the previous day S&P returns having a significant effect on Asia-Pacific funds and a partial effect on European funds, hence we run a vector auto regression process of order 1 for each fund NAV returns with the S&P returns to find the AR (1) matrix to be used in calculating synchronized returns. Table 5 contains the A-matrix elements for each of the ETF's with null second row for no synchronization of US returns. Statistically significant parameters AR (1) coefficients are selected and used in the A-matrix equation (11) to calculate the synchronous return. Synchronous returns at time t are the sum of asynchronous return at t and an error term (difference in *t* and *t-1* returns) multiplied by the A-matrix. The largest beta/loading of the S&P returns is observed for the Australian fund and the lowest for the Brazilian fund. Just like the results of the correlations in previous tables, the loading of S&P decreases for European funds compared to Asian and lowest for the American funds. Amongst the European funds, only Sweden has the highest loadings and is more than the Asian funds too. All the funds have a negative coefficient for their respective change in the ETF's NAV returns. This is true as we synchronize to the US market and account for information that is present when the local markets are closed. In the American group we see the factor loadings of Brazil and Mexico to be lower than Canada as was observed in correlations suggesting a closer integration between Canada and US economies beyond the parallel trading hours.

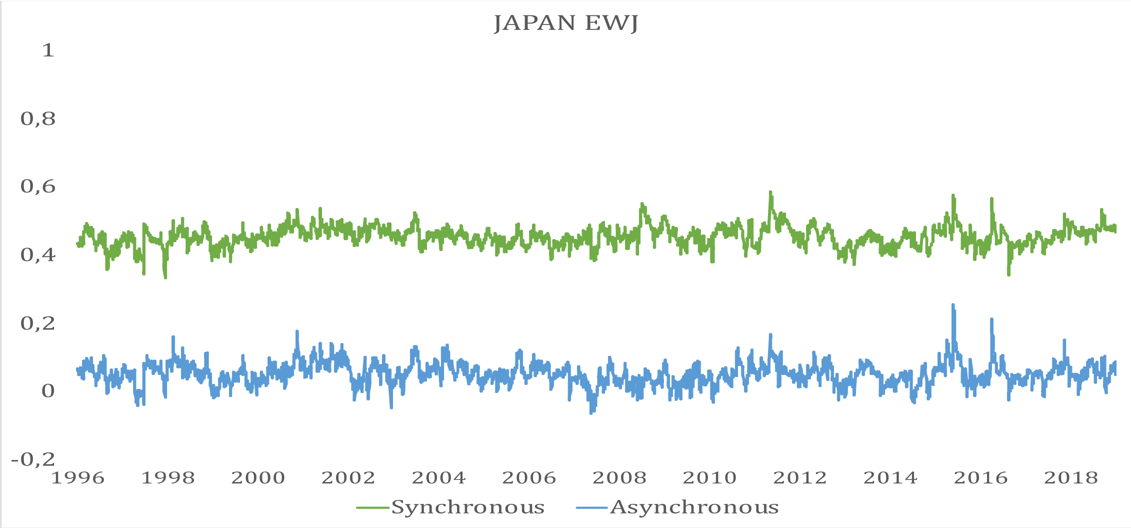
6.4. Conditional correlations

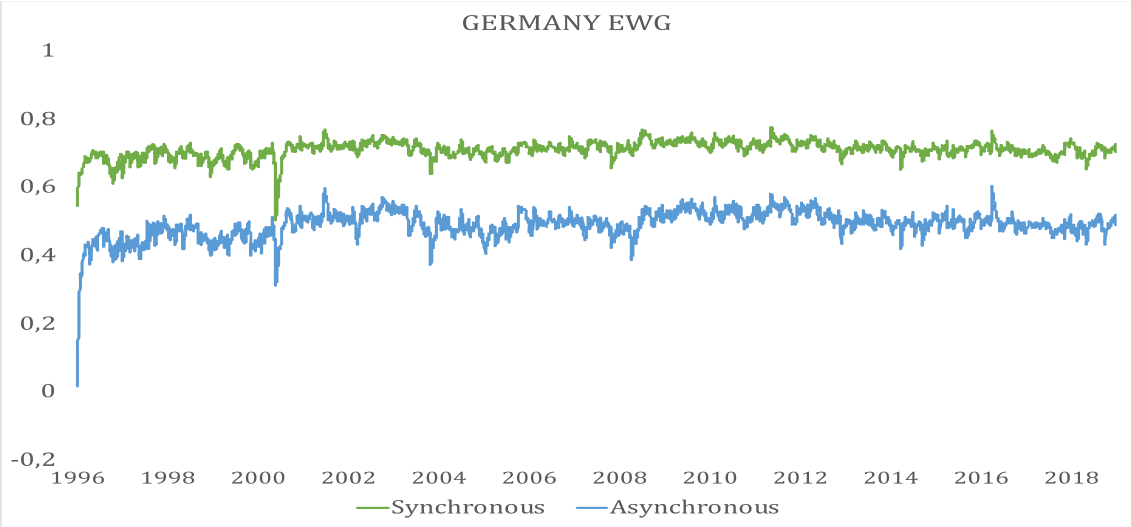
The synchronized ETF's NAV returns from the previous section are used in DCC-GARCH model to calculate time-varying conditional correlation. Appendix B reports the parameters of the univariate GARCH processes in the first stage of DCC model and the two DCC parameters estimated using the log-likelihood function. In all the cases the beta is higher suggesting that the conditional variance is persistent between ETF's NAV returns and S&P returns that increases the correlation for daily returns.

Table 5: A-Matrix with t-statistics.
The table is the A-matrix used in calculating synchronized returns. Only the significant elements are chosen for the first row as the S&P influence for each fund is measured. The second row is made null to have the synchronization at US equity market hours.

Country ETF	AR {1} (1,1)	AR {1} (2,1)	AR{1} (1,2)	AR {1} (2,2)
Japan	-0,0864	0,0000	0,4778	0,0000
	-(7,189)		(33,522)	
Austalia	-0,0917	0,0000	0,6149	0,0000
	-(7,851)		(43,087)	
South Korea	-0,0606	0,0000	0,6324	0,0000
	-(4,448)		(29,060)	
Singapore	0,0062	0,0000	0,3918	0,0000
	(0,480)		(25,033)	
Hong Kong	-0,0565	0,0000	0,4808	0,0000
	-(4,569)		(31,358)	
Germany	-0,1555	0,0000	0,3936	0,0000
	-(10,238)		(19,856)	
Switzerland	-0,1116	0,0000	0,3051	0,0000
	-(7,969)		22.504	
Sweden	-0,1480	0,0000	0,5054	0,0000
	-(10,316)		(23,349)	
Spain	-0,0761	0,0000	0,3233	0,0000
	-(5,208)		(16,604)	
Italy	-0,1122	0,0000	0,3389	0,0000
	-(7,780)		(17,107)	
France	-0,1839	0,0000	0,4438	0,0000
	-(12,555)		(24,093)	
UK	-0,1844	0,0000	0,4059	0,0000
	-(12,855)		(25,728)	
Brazil	0,0060	0,0000	0,1266	0,0000
	(0,340)		(3,789)	
Canada	-0,0683	0,0000	0.22342	0,0000
	-(3,878)		(10,987)	
Mexico	0,0440	0,0000	0,1461	0,0000
	(2,624)		(6,055)	

We present three plots of comparing the time varying daily correlations of asynchronous returns to synchronized returns in Figure 7. We select Japan, Germany and Canada representing the three groups. The results are similar for all countries across their respective regions. We see the conditional correlations to be more smoothed than the unconditional correlations. Also, the difference between the two can be seen explicitly for almost all the funds except for the ETFs in Americas. Complete overlap of trading hours removes the effect of stale NAVs and the previous day S&P returns.





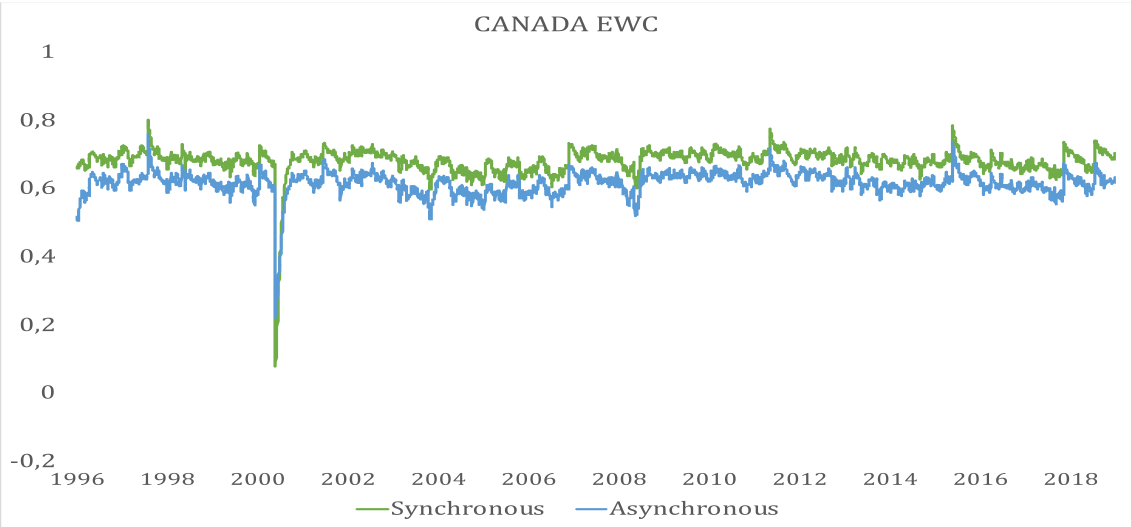


Figure 7. Correlations between daily synchronous/asynchronous ETF'sNAV returns and S&P500 returns.
Three selected representative ETFs are shown: Japan EWJ from the Asia-Pacific group, Germany EWG from the Europe group and Canada EWC from the Americas group.

As expected, Asia-Pacific funds show a larger variation than the American funds while the European funds have a varied effect based on the number of hours overlapped with US. This puts the synchronized ETF's NAV correlations on par with the ETF's market price correlations. This result also indicates that using the close-to-close NAV returns to calculate daily correlation would underestimate the result, while the synchronized NAV returns give the same result as the ETF's market price returns. Thus, concluding that the ETFs offer the same diversification as the underlying market but not in the daily scenario due to no fixed time of measurement of returns. The issue disappears for lower frequencies and long-term investors do not worry about the difference in ETF's NAV and market price present on a daily basis. Therefore, we test the hypothesis on correlation and conclude that the NAV-S&P and ETF-S&P do report almost similar values. Though it differs on daily horizon, the values get adjusted when synchronous NAV returns are used in place of close-to-close NAV returns.

. The plots also show that the estimated correlations display very little variation over time and remain at a very stable level over the whole sample period. This is in line with the results from (Bekaert, Hodrick, & Zhang, 2009) and suggests that the benefits of international diversification have not declined from 1997 to 2019.

6.5. Measurement of tracking errors

We calculate annualized tracking errors using the equation (17) and present the results for all 15 country ETFs in Table 6. The value measures the deviation of the ETF market return from the NAV return over the whole sample period.

We observe the tracking errors for daily returns of the ETFs in the Asia-Pacific region to be higher compared to the American funds. For instance, the daily tracking error of Hong Kong ETF is around 20%, whereas German ETF has 12% and Canadian ETF has 10%. This indicates that country ETFs with no-overlap of trading hours have larger performance deviation, which is also consistent with our findings in daily correlation analysis.

Table 6: Tracking errors between ETF's NAV and market price returns at multiple frequencies.
The table reports the tracking errors calculate using the whole sample for each fund. It is change of ETF's NAV return and market price return. The daily, weekly, monthly and yearly values are tabulated.

Country ETF	Daily	Weekly	Monthly	Yearly
Japan	16,64 %	7,56 %	3,63 %	1,05 %
Australia	17,24 %	7,83 %	3,76 %	1,09 %
South Korea	20,46 %	9,29 %	4,46 %	1,29 %
Singapore	17,47 %	7,94 %	3,81 %	1,10 %
Hong Kong	20,28 %	9,21 %	4,43 %	1,28 %
Germany	12,19 %	5,54 %	2,66 %	0,77 %
Switzerland	11,31 %	5,14 %	2,47 %	0,71 %
Sweden	15,24 %	6,92 %	3,33 %	0,96 %
Spain	12,45 %	5,66 %	2,72 %	0,78 %
Italy	12,78 %	5,80 %	2,79 %	0,80 %
France	11,99 %	5,45 %	2,62 %	0,76 %
UK	12,64 %	5,74 %	2,76 %	0,80 %
Brazil	14,30 %	6,49 %	3,12 %	0,90 %
Mexico	11,29 %	5,13 %	2,46 %	0,71 %
Canada	9,98 %	4,57 %	2,20 %	0,63 %

However, if we look at the tracking error with lower frequencies, we find that the errors of weekly and monthly returns decreasing. The monthly tracking errors of Japan, Germany and Canada ETFs are found to be around 5%, 3%, 2% respectively. When comparing the annual tracking error across the whole sample we find that it decreases to around 1% for all 15 country ETFs, which means that in the long-run country ETFs mimic the underlying fund comprehensively (Appendix C).

The high tracking error of Brazil is an aberration in our results given that the ETF's NAV has parallel trading hours with US. We observe high performance deviation of ETF's price from the NAV even though other funds in the same group do not exhibit such behavior. One possible reason might be the lack of economic freedom and political stability, which is known to be one of potential sources of tracking error of country funds in general.

The results from the analysis of correlation and the tracking errors of ETF's NAV and market price aid in rejecting our hypothesis that the tracking error of country ETFs are persistent in the long run suggests. Therefore, that country ETFs can be used to provide desirable diversification benefits for a long-term investor. However, in the short-run the substantial tracking difference makes it not capable of complete diversification.

6.6. Tracking Difference determinants

Once we establish an issue of asynchronicity and existence of tracking errors, we run a regression to determine transitory variables which might affect the deviations in fund's performance. We see strong correlation between ETF-S&P returns and thus perform the regressions from equations (18,) (19) and (20) mentioned in section 4.6. The results are documented in the Table 7. We see that the US market has larger loadings in ETFs from the Asia-Pacific group, same conclusion is derived from R-squared coefficient. We also observe $R_{S\&P500,t-1}$ to have explanatory power as the NAV prices in the local markets when they open next day adjust to the ETF prices from previous day. In the European group, $R_{S\&P500,t-1}$ has a higher coefficient than $R_{S\&P500,t}$. However, it is clear that this relation diminishes if we use $R_{S\&P500,t-2}$ as a regressor. One reason is the currency effects that affect the ETF's NAV after the market closes. These results suggest that US market has significant influence on the tracking difference, especially for ETFs with no-overlapping trading hours but this effect does not persist longer than for 2 days. In Asia-Pacific group, the ETF price does not react to the intraday NAV prices and only the currency effect. The next day opening times see the effect of the previous day NAV orders. Thus, $R_{S\&P500,t-1}$ is still significant for the tracking difference. For, European countries the ETF's price partially adjusts to NAV, but the currency effects are after the UK market closes as mentioned in the fund prospectus. Also, the forex market of developed markets is integrated closer than the Asian economies. This explains the behavior of $R_{S\&P500,t-1}$ in the second regression. The R-squared values for in the American group for all the three regressions is same and very low at an average 0.06 which is the factor loading of $R_{S\&P500,t-2}$ for all the funds.

The results for regressions in equations (21) and (22) are shown in Panels A and B in Table 8. Here we include the all the fund's specific variables in addition to the US specific variables $R_{S\&P500,t}$, VIX index and FX rates to see how well the tracking difference is explained.

We find that the VIX volatility is significant at 1% level for most of the funds, which implies that the tracking difference is especially large during periods of economic instability. We observe large deviations between the ETF's NAV and market price returns during 1998-2000 and 2007-2008 in all the funds. The exchange rate daily return is also found to be significant at 1% level for 13 out 15 funds. This is line with our expectation given that local currency appreciation or depreciation compare to USD. Moreover, this relation holds irrespectively of trading hours overlap or no-overlap with the US market.

The S&P 500 daily returns have substantial explanatory power in the regression. Thus, documented coefficients are significant at 1% level for all funds. We observe that factor loadings are much lower in the Europe and the Americas group. This is explained by the return asynchronicity, since country funds in the Asia-Pacific have no overlap of trading hours their ETF returns are influenced by news released in the US while local market is closed. Contrary, the returns of the funds in the Europe and Americas group are determined by the domestic market factors.

Table 7: Regression results.

The following tables report the betas and tstats for three regressions. The independent variable – S&P500 returns is lagged by a day in every regression. The tables also contian the R^2 for each fund. The US returns are considered a proxy for the US market and is used to check the integration of each fund with the US market.

Panel A: $TDF_t = \alpha + \beta_t * R_{S\&P500,t} + \varepsilon_t$

Country ETF	Intercept	RetSP500,t	R-squared
Japan	0,0054 (0,0002)	0,5821 (0,0137)	0,24
Austalia	0,0049 (0,0002)	0,5910 (0,0143)	0,23
South Korea	0,0057 (0,0002)	0,7781 (0,0177)	0,29
Singapore	0,0049 (0,0002)	0,5769 (0,0147)	0,21
Hong Kong	0,0044 (0,0002)	0,7162 (0,0167)	0,24
Germany	0,0041 (0,0001)	0,3494 (0,0106)	0,16
Switzerland	0,0044 (0,0001)	0,3039 (0,0098)	0,16
Sweden	0,0047 (0,0002)	0,4415 (0,0131)	0,17
Spain	0,0043 (0,0001)	0,3634 (0,0110)	0,16
Italy	0,0044 (0,0001)	0,3497 (0,0108)	0,16
France	0,0039 (0,0001)	0,3495 (0,0104)	0,16
UK	0,0037 (0,0001)	0,3899 (0,0105)	0,19
Brazil	0,0051 (0,0002)	0,2693 (0,0140)	0,07
Canada	0,0040 (0,0001)	0,1776 (0,0091)	0,06
Mexico	0,0051 (0,0001)	0,2185 (0,0103)	0,07

Panel B: $TDF_t = \alpha + \beta_{t-1} * R_{S\&P500,t-1} + \varepsilon_t$

Country ETF	Intercept	RetSP500,t-1	R-squared
Japan	0,0058 (0,0002)	0,5211 (0,0142)	0,19
Austalia	0,0048 (0,0002)	0,6069 (0,0142)	0,24
South Korea	0,0062 (0,0002)	0,7088 (0,0184)	0,24
Singapore	0,0053 (0,0002)	0,5181 (0,0150)	0,17
Hong Kong	0,0046 (0,0002)	0,6815 (0,0169)	0,22
Germany	0,0041 (0,0001)	0,3564 (0,0106)	0,16
Switzerland	0,0043 (0,0001)	0,3365 (0,0098)	0,17
Sweden	0,0048 (0,0002)	0,4531 (0,0132)	0,17
Spain	0,0043 (0,0001)	0,3563 (0,0110)	0,16
Italy	0,0043 (0,0001)	0,3499 (0,0108)	0,16
France	0,0039 (0,0001)	0,3529 (0,0104)	0,17
UK	0,0038 (0,0001)	0,4066 (0,0106)	0,21
Brazil	0,0052 (0,0002)	0,2787 (0,0140)	0,08
Canada	0,0040 (0,0001)	0,1903 (0,0092)	0,07
Mexico	0,0051 (0,0001)	0,2163 (0,0103)	0,07

Panel C: $TDF_t = \alpha + \beta_{t-2} * R_{S\&P500,t-2} + \varepsilon_t$

Country ETF	Intercept	RetSP500,t-2	R-squared
Japan	0,0077 (0,0002)	0,2935 (0,0152)	0,06
Austalia	0,0067 (0,0002)	0,3660 (0,0156)	0,09
South Korea	0,0089 (0,0002)	0,3753 (0,0204)	0,07
Singapore	0,0069 (0,0002)	0,3201 (0,0160)	0,07
Hong Kong	0,0072 (0,0002)	0,3638 (0,0186)	0,06
Germany	0,0052 (0,0001)	0,2194 (0,0112)	0,06
Switzerland	0,0052 (0,0001)	0,2109 (0,0103)	0,06
Sweden	0,0059 (0,0002)	0,3079 (0,0138)	0,08
Spain	0,0053 (0,0001)	0,2219 (0,0116)	0,06
Italy	0,0053 (0,0001)	0,2165 (0,0114)	0,07
France	0,0050 (0,0001)	0,2186 (0,0110)	0,06
UK	0,0049 (0,0001)	0,2546 (0,0113)	0,08
Brazil	0,0056 (0,0002)	0,2113 (0,0142)	0,05
Canada	0,0043 (0,0001)	0,1493 (0,0093)	0,04
Mexico	0,0054 (0,0001)	0,1789 (0,0104)	0,05

The volatility of the fund is significant at 1% level for all funds. We observe that in general, the volatility has positive effect on the tracking difference across all country ETFs. This is consistent with our assumption that higher volatility affects the fund's ability to properly track the underlying index. For instance, we see that Brazilian fund has the highest loading compare to the rest of the sample, this can be attributed to the extreme volatility during Brazilian political crisis of 2014.

We also observe that the variable assets under management is significant at 1% level for all funds. This is also in line with our expectation given that all the funds in our sample have large size, which should positively influence the tracking difference due to substantial economies of scale.

The variable relative net creation/redemption mechanism is found to be significant at 1% level for all funds, though the loadings are not high. This signifies that the fund's ability to create and redeem shares during the trading day effect the fund's performance deviation. We see a negative relation here, which is in line with our expectation given that this mechanism allows for correction in difference between ETF and NAV price. Thus, the higher the relative change in CRP the lower should the tracking difference be.

We add an extra dummy variable to the previous regression to account for US crisis and results reported in Panel B Table 8. We find the variable to be significant at 1% level. We observe low coefficient across the whole sample, but all of them are statistically significant. This suggest that the tracking difference is influenced by financial crisis and economic turmoil can be used to explain large deviation in the funds' ability to properly track the underlying index. The correlations between ETF's NAV and market price also low during the period 2008-2009 which is peak crisis in US economy.

Table 8: Regression results.

The following table reports the betas and the t stats for all the variable in the regression. The significance at 10%. 5% and 1% level are specified with *, **, *** respectively. Panel A contains the US specific variables $R_{S\&P500}$, VIX and the fund specific variables logVolume, Volatility, Bid-Ask Spread, Assets Under Management and Relative Creation/Redemption process. Panel B is the same regression, with an extra dummy variable to signify the US financial crisis from September 2008 to July 2009.

Panel A: $TDF_t = \alpha + \beta_1 VIX_t + \beta_2 FXrate_t + \beta_3 R_{S\&P500,t} + \beta_4 logVolume_t + \beta_5 Vola_t + \beta_6 Spread_t + \beta_7 AUM_t + \beta_8 RelCRP_t + \varepsilon_t$

Country ETF	Intercept	VIX	FX	SP500	Volume	Volatility	Bid-Ask spread	AUM	RelCRP	R-squared
Japan	-0,0002	0,0058**	0,0145***	0,3829***	-0,0015***	0,4125***	-0,0004***	0,1050***	-0,0744***	0,33
	(0,4464)	(2,6477)	(0,5910)	(23,0160)	-(6,1546)	(15,4310)	-(5,3516)	(8,7732)	-(5,1843)	
Austalia	-0,0030***	0,0362***	0,0802***	0,2167***	-0,0008***	0,1316***	-0,0002*	0,1811***	-0,1841***	0,37
	-(9,2211)	(16,3620)	(3,2552)	(12,8720)	-(5,3246)	(4,9704)	-(1,8049)	(16,4150)	-(12,4340)	
South Korea	-0,0015***	0,0341***	0,2741***	0,4980***	0,0409***	-0,0008**	-0,00003**	0,0410***	-0,0434***	0,37
	-(3,8114)	(14,9620)	(8,7417)	(22,9850)	(9,2897)	-(2,0989)	-(2,1002)	(4,9082)	-(4,7746)	
Singapore	-0,0020***	0,0062**	0,0352	0,3725***	0,0004**	0,4012***	0,0002*	0,0196***	-0,0033***	0,34
	-(5,8037)	(2,4919)	(0,7543)	(22,6210)	(1,9920)	(18,8610)	(1,8260)	(6,6832)	-(5,1029)	
Hong Kong	-0,0023***	0,0004	2,024***	0,3243***	-0,0001	0,3845***	0,0003	0,2811***	-0,2474***	0,41
	-(5,9047)	(0,1599)	(4,1642)	(16,6500)	(0,6226)	(15,9840)	(1,2727)	(23,9170)	-(18,0010)	
Germany	-0,0021***	0,0220***	0,0580***	0,1217***	0,0004***	0,1565***	-0,00001**	0,0668***	-0,0563***	0,28
	-(8,3649)	(10,6740)	(2,6212)	(9,1577)	(3,0991)	(6,7330)	(0,5099)	(8,2254)	-(6,8260)	
Switzerland	-0,0023***	0,0004***	2,0240	0,3243***	-0,0001***	0,3845***	0,0003***	0,2811***	-0,2475***	0,33
	-(5,9047)	-(0,1599)	-(4,1642)	-(16,6500)	-(0,6226)	-(15,9840)	-(1,2727)	-(23,9170)	-(18,0010)	
Sweden	-0,0026***	0,0275***	0,0242	0,1414***	-0,0004***	0,1977***	0,0000	0,0692***	-0,0666***	0,32
	-(8,7416)	(10,7550)	(1,0531)	(9,0493)	-(3,2792)	(9,6291)	(1,4723)	(8,6335)	-(7,2792)	
Spain	-0,0022***	0,0183***	0,0720***	0,1577***	-0,0003***	0,2411***	0,0000	0,0389***	-0,0290***	0,28
	-(8,2282)	(10,0680)	(3,1189)	(11,9900)	-(3,0578)	(12,0630)	(0,1488)	(5,5613)	-(3,9140)	
Italy	-0,0020***	0,0194***	0,0985***	0,1478***	-0,0002***	0,2043***	0,0000	0,0440***	-0,0375***	0,27
	-(7,6155)	(11,0850)	(4,3442)	(11,2750)	-(2,2936)	(10,8300)	(0,5092)	(5,7959)	-(4,7016)	
France	-0,0019***	0,0179***	0,0848***	0,1383***	-0,0002**	0,2233***	0,0000	0,0406***	-0,0302***	0,28
	-(7,7443)	(9,0108)	(3,8960)	(10,8710)	-(1,8904)	(9,8456)	-(1,1394)	(5,5960)	-(4,4139)	
UK	-0,0022***	0,0155***	-0,0497***	0,0871***	0,0001	0,2911***	0,0000	0,1613***	0,1332***	0,35
	-(9,1491)	(7,5556)	-(2,1981)	(6,4844)	(0,7473)	(11,8080)	(0,5710)	(15,7060)	-(12,3750)	
Brazil	0,0004	0,0188***	0,0986***	0,0577***	0,0216***	1,03***	0,0001***	0,0365***	-0,008***	0,16
	(1,2676)	(9,0689)	(5,4208)	(3,2898)	(6,9754)	(3,7368)	(2,4068)	(5,7276)	(0,9526)	
Canada	-0,0010***	0,0241***	-0,1269***	0,0027	0,0009***	0,0328*	0,0001*	0,0800***	-0,0588***	0,21
	-(4,5295)	(14,4270)	-(5,6529)	(0,2426)	(9,7681)	(1,6708)	(1,7721)	(11,0890)	-(9,1016)	
Mexico	-0,0008***	0,013037***	0,0637***	0,0078	0,0009***	0,1814***	0,0000	0,0780***	0,0703***	0,22
	-(3,5145)	(8,0319)	(3,5188)	(0,6275)	(8,4031)	(11,9510)	-(1,3655)	(12,0510)	-(10,3780)	

Panel B: $TDF_t = \alpha + \beta_1 VIX_t + \beta_2 FXrate_t + \beta_3 R_{S\&P500,t} + \beta_4 logVolume_t + \beta_5 Vola_t + \beta_6 Spread_t + \beta_7 AUM_t + \beta_8 RelCRP_t + \beta_9 UScrisis_t + \varepsilon_t$

Country ETF	Intercept	VIX	FX	SP500	Volume	Volatility	Bid-Ask spread	AUM	RelCRP	US crisis	R-squared
Japan	0,0007**	0,0003	-0,0040	0,3791***	-0,0012***	0,4063***	-0,0003***	0,1085***	-0,0782***	0,0043***	0,33
	(2,1364)	(0,1297)	(0,1615)	(22,8760)	-(5,1316)	(15,2520)	-(4,7724)	(9,1012)	-(5,472)	(7,3552)	
Austalia	-0,001***	0,0289***	0,0481*	0,2185***	-0,0005***	0,1070***	-0,0002***	0,1827***	-0,1902***	0,0071***	0,38
	-(4,0625)	(12,4780)	(1,9483)	(13,0850)	-(3,5808)	(4,0547)	-(2,4298)	(16,6930)	-(12,9380)	(9,6768)	
South Korea	0,0007	0,0298***	0,2520***	0,4984***	0,0420***	-0,0008**	-0,00003**	0,0418***	-0,0444***	0,0032***	0,37
	-(1,5968)	(11,3380)	(7,8776)	(23,0200)	(9,4781)	-(1,9952)	-(1,9966)	(5,0071)	-(4,8819)	(3,3575)	
Singapore	-0,0028***	0,0107***	0,0363	0,3738***	0,0003	0,4049***	0,0002	0,0194***	-0,0033***	-0,0038***	0,34
	-(7,2819)	(4,0092)	(0,7796)	(22,7510)	(1,4750)	(19,0600)	(1,6023)	(6,6586)	-(5,0970)	-(4,7536)	
Hong Kong	-0,0026***	0,0028	2,0164***	0,3258***	-0,0002	0,3865***	0,0002	0,2803***	-0,2471***	-0,0019***	0,41
	-(6,3275)	(0,9656)	(4,1495)	(16,7180)	(0,8379)	(16,0560)	(1,2440)	(23,8510)	-(17,9750)	-(2,2992)	
Germany	-0,0019***	0,0212***	0,0558***	0,1211***	0,0004***	0,1510***	0,0000	0,0671***	-0,0567***	0,001	0,28
	-(6,6947)	(9,9818)	(2,5181)	(9,1082)	(3,1929)	(6,4278)	(0,4982)	(8,2627)	-(6,8715)	(1,6311)	
Switzerland	-0,0012***	0,0184***	0,0114	0,0359***	0,0005***	0,1312***	0,0000	0,1971***	-0,1822***	0,0023***	0,34
	-(5,0224)	(8,8119)	(0,7413)	(3,1355)	(5,3415)	(4,8722)	(0,2371)	(21,0800)	-(17,6280)	(4,4592)	
Sweden	-0,0021***	0,0259***	0,0120	0,1401***	-0,0003***	0,18242***	0,0000	0,0709***	-0,0689***	0,0023***	0,32
	-(6,2214)	(9,9914)	(0,5167)	(8,9675)	-(2,7475)	(8,6519)	(1,6917)	(8,8356)	-(7,5103)	(3,1724)	
Spain	-0,0015***	0,0150***	0,0651***	0,1564***	-0,0002***	0,2305***	0,0000	0,0402***	-0,0302***	0,0031***	0,28
	-(5,0809)	(7,7751)	(2,8214)	(11,9130)	-(2,2804)	(11,4830)	(0,1350)	(5,7506)	-(4,0803)	(5,0662)	
Italy	-0,0014***	0,0168***	0,0929***	0,1460***	-0,0002	0,1909***	0,0000	0,0451***	-0,0387***	0,0027***	0,28
	-(4,6887)	(9,1404)	(4,1037)	(11,1780)	-(1,8334)	(10,0210)	(0,6129)	(5,9574)	-(4,8627)	(4,5648)	
France	-0,0011***	0,0149***	0,0771***	0,1366***	-0,0001	0,2011***	0,0000	0,0415***	-0,0313***	0,0036***	0,29
	-(4,1146)	(7,3241)	(3,5454)	(10,7690)	-(1,2165)	(8,7766)	-(1,1593)	(5,7378)	-(4,5967)	(6,2461)	
UK	-0,0018***	0,0148***	-0,0583***	0,0865***	0,0001	0,2710***	0,0000	0,1619***	-0,1337***	0,0016***	0,35
	-(6,7434)	(7,1326)	-(2,5548)	(6,4483)	(1,1105)	(10,5680)	(0,5362)	(15,7680)	-(12,4250)	(2,8374)	
Brazil	-0,0009***	0,0256***	0,0948***	0,0538***	0,0203***	1,913***	0,0001	0,0367***	-0,0093***	-0,0071***	0,17
	-(2,4719)	(11,6510)	(5,2558)	(3,0939)	(6,5804)	(6,5711)	(1,6431)	(5,8492)	-(1,1101)	-(8,8142)	
Canada	-0,0016***	0,0253***	-0,1103***	0,0027	0,0008***	0,0685***	0,0002***	0,0798***	-0,0586***	-0,0028***	0,21
	-(6,5391)	(15,0400)	-(4,8734)	(0,2469)	(8,8066)	(3,2865)	(2,0196)	(11,0760)	-(9,0855)	-(5,1415)	
Mexico	-0,0013***	0,0152***	0,0720***	0,0084	0,0008***	0,1847***	-0,0001	0,0767***	-0,0677***	-0,0018***	0,22
	-(4,6216)	(8,6750)	(3,9371)	(0,6759)	(7,8208)	(12,1380)	-(1,4736)	(11,6470)	-(9,9385)	-(3,2530)	

When we compare R-squared in regression from Table 7 to Panel A, Table 7, there is an increase for all funds. Sweden and Switzerland ETFs record the lowest increase of 0.06 and largest increase is by Hongkong and Singapore ETFs. The spread is narrow across all countries, suggesting that the fund specific variables behave similarly for all ETFs. Hong Kong FX variable is high as the contributing to the tracking difference beyond the US variables. Both AUM and RelCRP coefficients are low for the Singapore ETF compared to the other funds in the Asia-Pacific region and require a closer inspection of the funds' constituents. It is the same case for Switzerland ETF, which explains its behavior compared to the other funds in its region. Overall, one can conclude that the tracking difference comes from not only US transitory variable but also fund's specific characteristics, such as assets under management, volatility and creation/redemption process. Moreover, the regression analysis shows that US transitory variable (S&P500 as a proxy for US market) is statistically significant for country ETFs with no-overlap and partial overlapping trading hours. This is in line with our results from study of synchronous and asynchronous return correlation. The significance of FX variables across all funds explains the importance of translating local NAV to USD and the timing of the conversion. Therefore, we reject the hypothesis that the asynchronous returns do not explain the tracking difference. We also report the short-term deviation observed in the ETF price to its NAV is explained by S&P returns is due to the difference in the timing of calculation of ETF's NAV and ETF market prices and disappears at a lag of 2 days.

7. Conclusion

Following our extensive analysis of the correlations and tracking difference study, conclude that though, market integration has increased over the years, correlation among the country ETF's NAV and S&P returns has not seen a significant shift. The similarity in synchronous NAV and S&P returns correlations with ETF's market price - S&P return correlations is reason enough to believe in diversification benefits of international portfolios. Though the ETF's NAV and market price returns show wide variation in smaller horizon like daily, it is minimal at longer horizons. When it comes to regions, the Asia-Pacific group shows the higher deviation of ETF's price from NAV owing to the difference in trading hours. European funds have a moderate deviation due to the partial overlap of trading hours. American funds' ETF's market price is almost on par with its NAV. For all the ETFs the synchronized NAV returns give a higher correlation than asynchronous NAV. The difference in timing of the calculation of the ETF's NAV price, the translation of the assets and liabilities from the local currency to USD at London time influences the arbitrage trades in ETFs. The NAV that remains stagnant after the local market closes is adjusted for US market factors in the next day opening time. The ETF price of Asian and European funds is unable to update in tandem with the NAV due to difference in trading hours. The ETF prices, we observe are then influenced largely by the US market variables rather than the local market. When we adjust the NAV of the Asian and European ETF's to the US market times, we observe a marked improvement in the daily ETF's NAV and market price correlation that is more in tune with the weekly and monthly return correlation. It should be noted that the returns at lower frequency do not suffer from asynchronicity as there is sufficient time for the markets to price in all the information.

The tracking error of ETFs disappears at lower frequencies and is explained by US transitory variables like S&P return and VIX index along with exchange rate fluctuations for all the funds in the daily returns. The American ETFs have negligible tracking difference and the US explanatory variables have low coefficients in the regression. For European and Asia-Pacific ETFs the US variable coefficients are higher and significant. All the funds have FX rate explaining a part of the tracking difference. The financial crisis has an inverse effect on the ETF's tracking ability where the markets are volatile and segmented. Adding other financial crises data to the regression could explain the change in correlation over time for other country ETFs.

Thus, in the long run ETFs provide international diversification benefits with the ETF price mimicking the funds' NAV. In the short run, asynchronicity is present and visible in the correlation and the tracking difference.

We did not account for the missing values in the series and is a potential study further to incorporate extrapolation of returns. this maintains the uniformity of the sample size across funds. The GARCH model used in conditional correlation model could be improved by adding restrictive constraints so that the log likelihood function runs the same across funds. The conversion of ETF's NAV and the timing affects the ETF price deviations and is a field that needs further investigation. The US economy and the Forex market interactions need to be separated and observed for each fund.

Bibliography

Data retrieved from Bloomberg.

Ackert, L. F., & Tian, Y. S. (2008). Arbitrage, Liquidity, and the Valuation of Exchange Traded Funds. *Financial Markets, Institutions & Instruments*.

Adler, M., & Dumas, B. (1983). International Portfolio Choice and Corporation Finance: A Synthesis. *Journal of Finance*.

Anderson, S. C., Coleman, B., Frohlich, C. J., & Steagall, J. W. (2000). A Multi-Factor Analysis of Country Fund Returns. *Journal of Financial Research*.

Audrino, F. & Bühlmann, P., (2001). Synchronizing Multivariate Financial Time Series. *Journal of Risk* .

Bailey, W., & Lim, J. Y. (1992). Evaluating the Diversification in Benefits of the New Country Funds. *Journal of Portfolio Management*.

Bekaert, G., & Harvey, C. (1995). Time-Varying World Market Integration. *Journal of Finance*.

Bekaert, G., Hodrick, R. J., & Zhang, X. (2009). International Stock Return Comovements. *The Journal of Finance, 64*(6).

Black, F. (1974). International capital market equilibrium with investment barriers. *Journal of Financial Economics*.

BlackRock. (2019). Retrieved from https://www.ishares.com/us

Bodurtha, J. N., Kim, D.-S., & Lee, C. M. (1995). Closed-end Country Funds and U.S. Market Sentiment. *The Review of Financial Studies*.

Buetow, & Henderson. (2012). An Empirical Analysis of Exchange- Traded Funds. *The Journal of Portfolio Management*.

Buetow, G. W., & Henderson, B. J. (2012). An Empirical Analysis of Exchange-Traded Funds. *JOURNAL OF PORTFOLIO MANAGEMENT* .

Cao, J., Fu, R., & Jin, Y. (2017). International diversification through iShares and their rivals. *Journal of Risk*.

Chang, E., Eun, C. S., & Kolodny, R. (1995). International diversification through closed-end country funds. *Journal of Banking and Finance*.

Chen, J., Chen, Y., & Frijns, B. (2017). Evaluating the tracking performance and tracking error of New Zealand exchange traded funds. *Pacific Accounting Review*.

Chen, M.-P., Lee, C.-C., & Hsu, Y.-C. (2017). Investor sentiment and country exchange traded funds: Does economic freedom matter? *North American Journal of Economics and Finance*.

Chu, P. (2016). Analysis and Forecast of Tracking Performance of Hong Kong Exchange-Traded Funds: Evidence from Tracker Fund and X iShares A50. *Review of Pacific Basin Financial Markets and Policies, 19*(4), 1.

DeSantis, G. (1997). Asset pricing and portfolio diversification: Evidence from emerging financial markets. In M. Howell, *Investing in Emerging Markets.*

Eiling, E., & Gerard, B. (2015). Emerging Equity Market Comovements: Trends and Macroeconomic Fundamentals. *Review of Finance, 19(4)*, 1543-1585.

Engle, R. F., & Sheppard, K. K. (2001). Theoretical and Empirical Properties of Dynamic Conditional Correlation Multivariate GARCH . *IDEAS Working Paper Series from RePEc*.

Engle, R., & Sarkar, D. (2006). Premiums-Discounts and Exchange Traded Funds. *The Journal of Derivatives*.

ETFs. (n.d.). Retrieved from https://www.etf.com/etf-education-center/7540-what-is-the-etf-creationredemption-mechanism.html?nopaging=1

Fletcher, J. (2018). An empirical examination of the diversification benefits of U.K. international equity closed-end funds. *International Review of Financial Analysis*.

Frino, A., & Gallagher, D. (2001). Tracking S&P 500 index funds. Journal of Portfolio Management, 28(1), 44-55.

Gastineau, G. L. (2001). Exchange-traded funds: An introduction. Journal of Portfolio Management, 27(3), 88.

Grubel, H. (1968). Internationally Diversified Portfolios: Welfare Gains and Capital Flows. The American Economic Review.

Hamao, Y., Masulis, R., & Ng, V. (1990). Correlations in Price Changes and Volatility across International Stock Markets. *Review of Financial Studies*.

Harper, J. T., Madura, J., & Schnusenberg, O. (2006). Performance comparison between exchange-traded funds and closed-end country funds. *Journal of International Financial Markets, Institutions and Money, 16*(2), 104-122.

Harvey, C. R. (1995). Predictable Risk and Returns in Emerging Markets. *Review of Financial Studies*.

Jared, T. E., & Lavin, A. M. (2004). Japan and Hong Kong Exchange-Traded Funds (ETFs): Discounts, Returns, and Trading Strategies. *Journal of Financial Services Research*.

Jares, & Lavin. (2004). Japan and Hong Kong Exchange-Traded Funds (ETFs): Discounts, Returns and Trading Strategies. *Journal of Financial Services Research*.

Johnson, W. J. (2008). Tracking Errors of Exchange Traded Funds. *Journal of Asset Management*.

Kostovetsky, L. (2003). Index mutual funds and exchange-traded funds. *Journal of Portfolio Management, 29*(4), 80-92.

Koutmos, G., & Booth, G. (1995). Asymmetric volatility transmission in international stock markets. *Journal of International Money and Finance*.

Lettau, M., & Madhavan, A. (2018). Exchange-Traded Funds 101 for Economists. *Journal of Economic Perspectives*, 135-154.

Levy, A., & Lieberman, O. (2012). Overreaction of country ETFs to US market returns: Intraday vs. daily horizons and the role of synchronized trading. *Journal of Banking and Finance*.

Levy, H., & Sarnat, M. (1970). International Diversification of Investment Portfolios. *The American Economic Review*.

Martens, M., & Poon, S.-H. (2000). Returns synchronization and daily correlation dynamics between international stock markets. *Journal of Banking and Finance*.

Milonas, T. N., & Rompotis, G. G. (2006). Investigating European ETFs: The Case of the Swiss Exchange Traded Funds . *2006 Annual Conference of HFAA* .

Munnix, M. C., Schafer, R., & Guhr, T. (2010). Compensating asynchrony effects in the calculation of financial correlations. *Physical A*.

Musacchio, Aldo. "Mexico's Financial Crisis of 1994-1995." Harvard Business School Working Paper, No. 12–101, May 2012.

Nassif, Andre. “An analysis of Brazil’s economic situation: 2014-2017, the short-term outlook and policy alternatives”. Brazilian Keynesian Review. p. 95-108. 2017.

Osterhoff, F., & Kaserer, C. (2016). Determinants of tracking error in German ETFs – the role of market liquidity. *Managerial Finance*, *42*(5), 417-437.

Phengpis, C., & Swanson, P. E. (2009). iShares and the US Market Risk Exposure. *Journal of Business Finance and Accounting*.

Returns synchronization and daily correlation dynamics between international stock markets. (n.d.).

Stulz, R. (1981). A model of international asset pricing. *Journal of Financial Economics*.

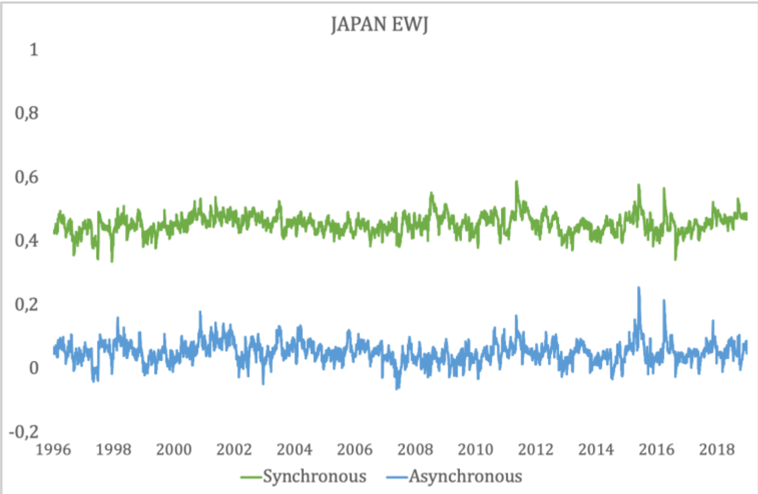
Thanakijsombat, T., & Kongtoranin, T. (2017). Performance and diversification benefits of foreign-equity ETFs in emerging markets .

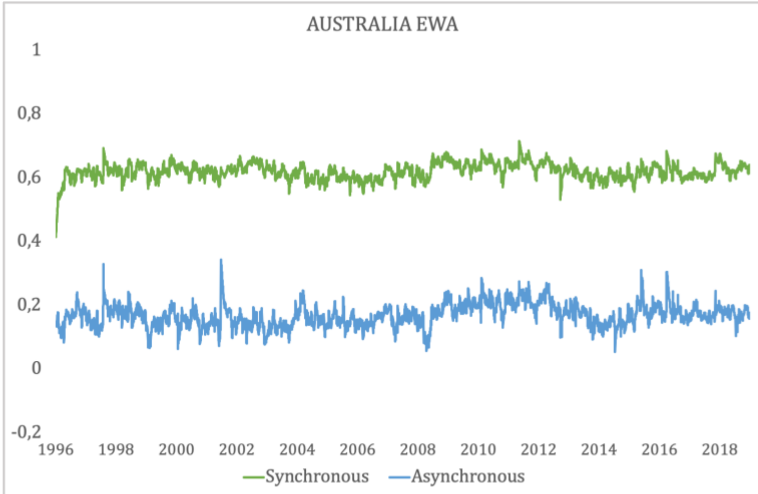
Toth, B., & Kertesz, J. (2009). The Epps effect revisited. *Quantitative Finance*.

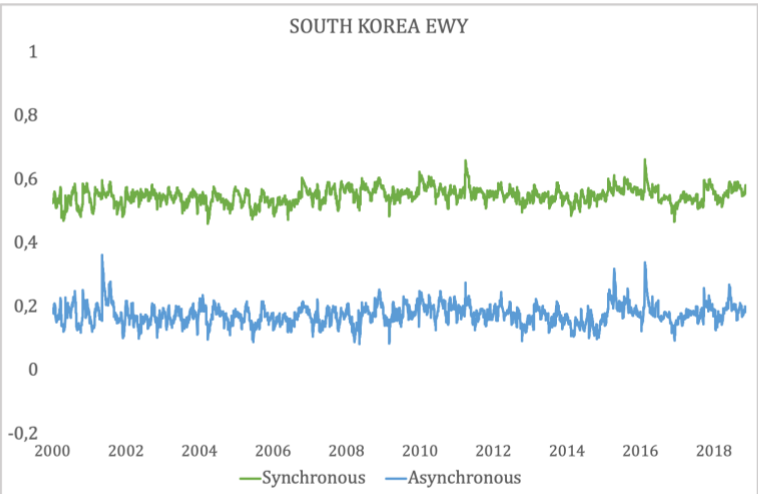
Appendices

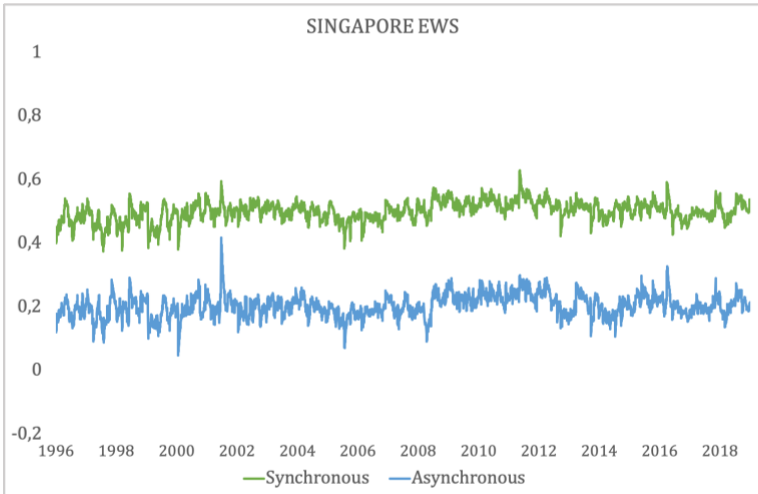
Appendix A: Time varying correlation between fund ETF's NAV returns and S&P500 returns Synchronous vs asynchronous

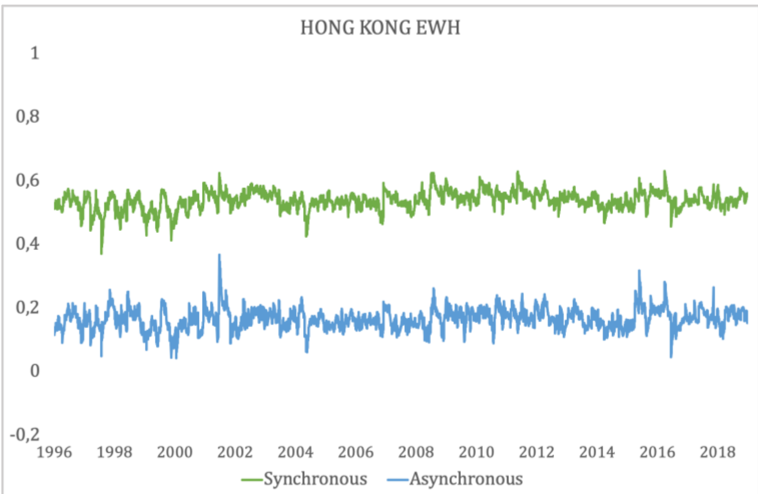
A.1**:** The Asia-Pacific Group



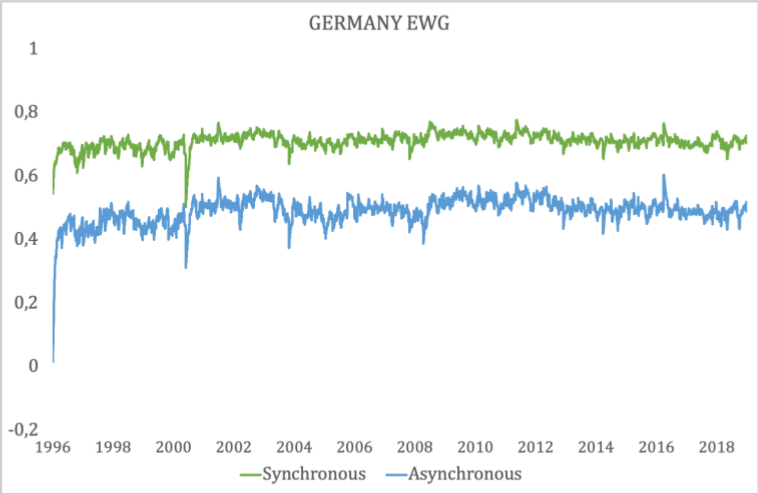


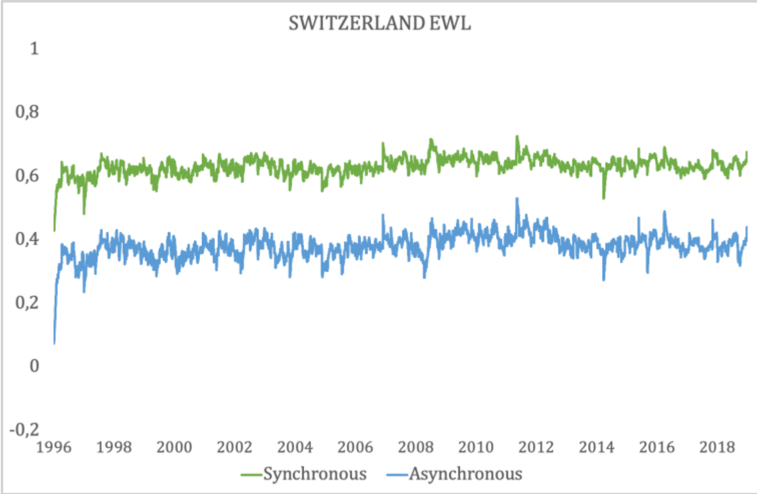


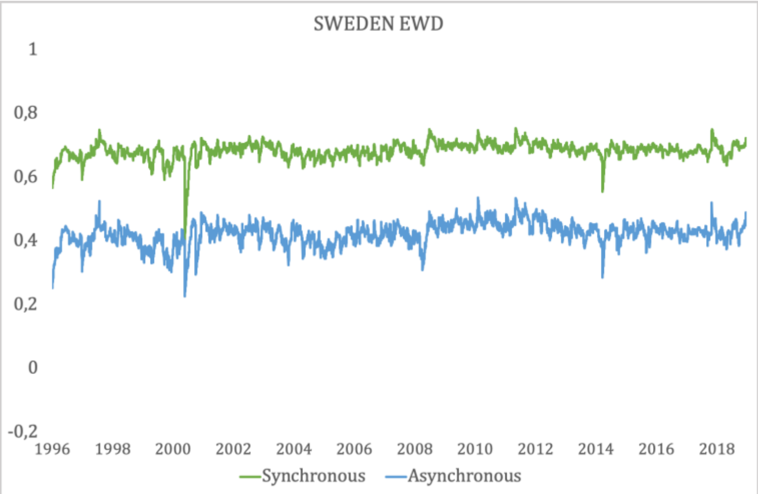


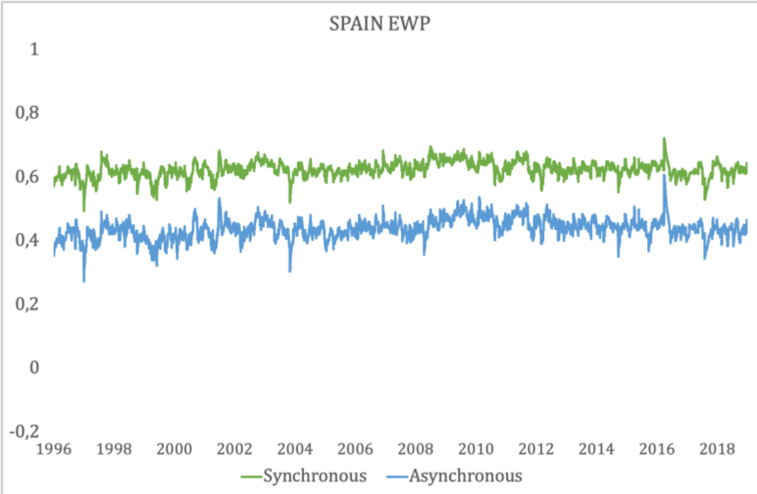


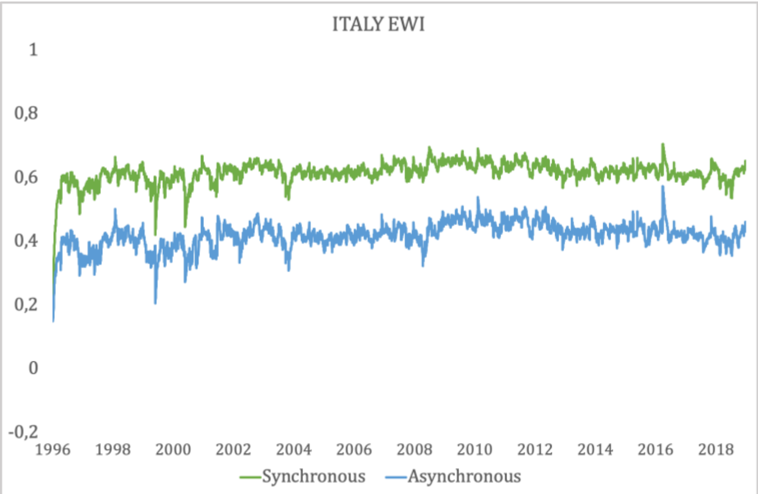
A.2: The Europe Group

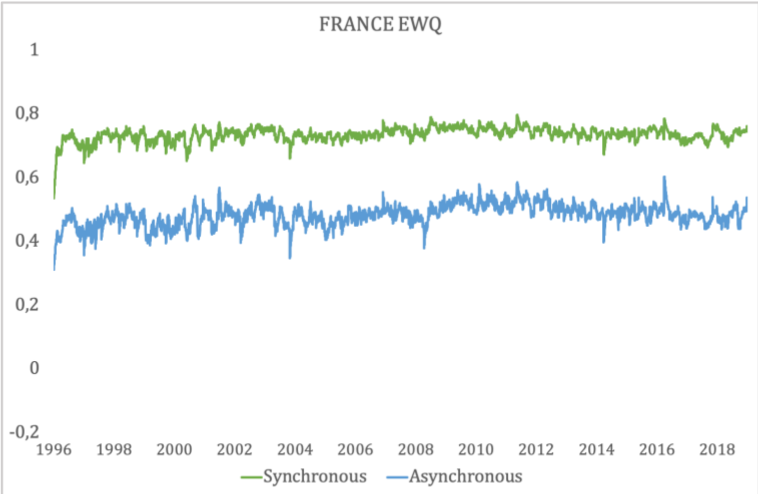


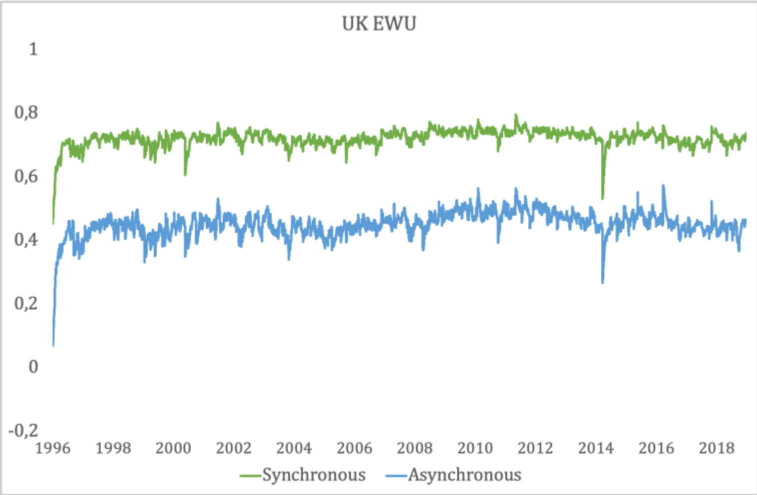




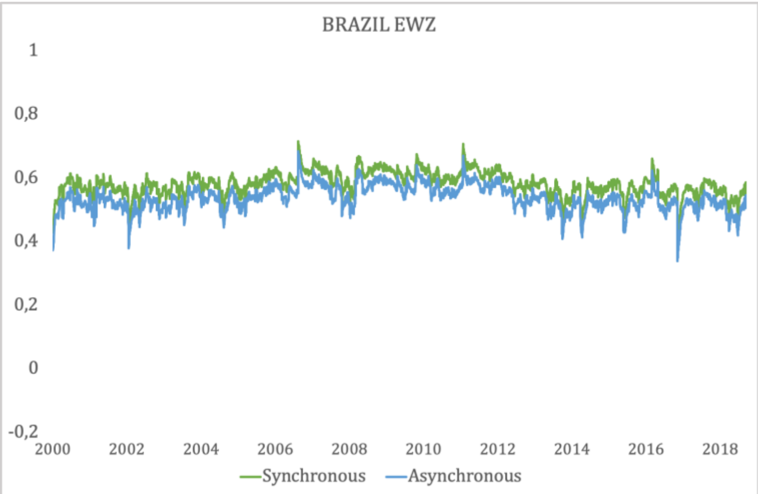


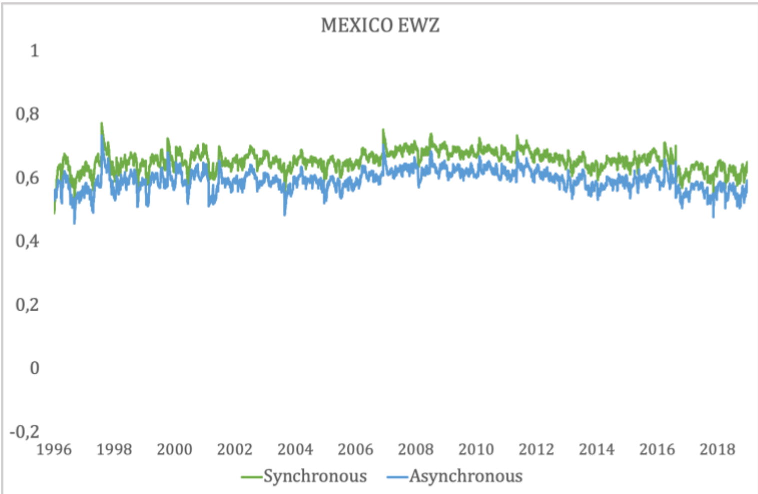


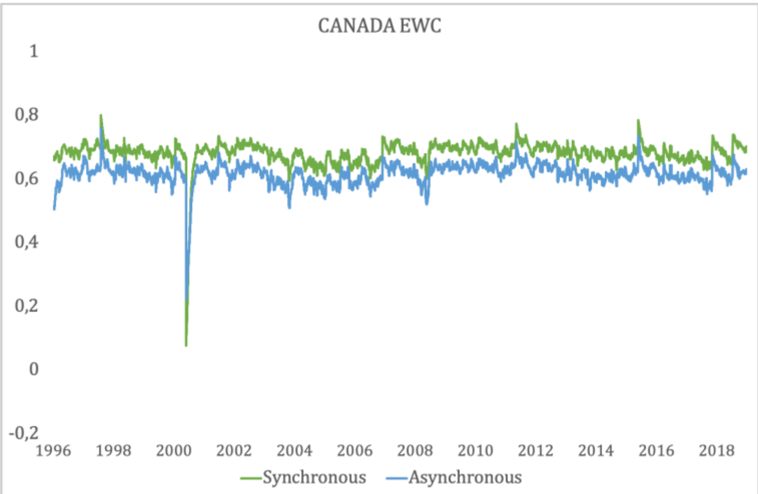




A.3: The Americas Group





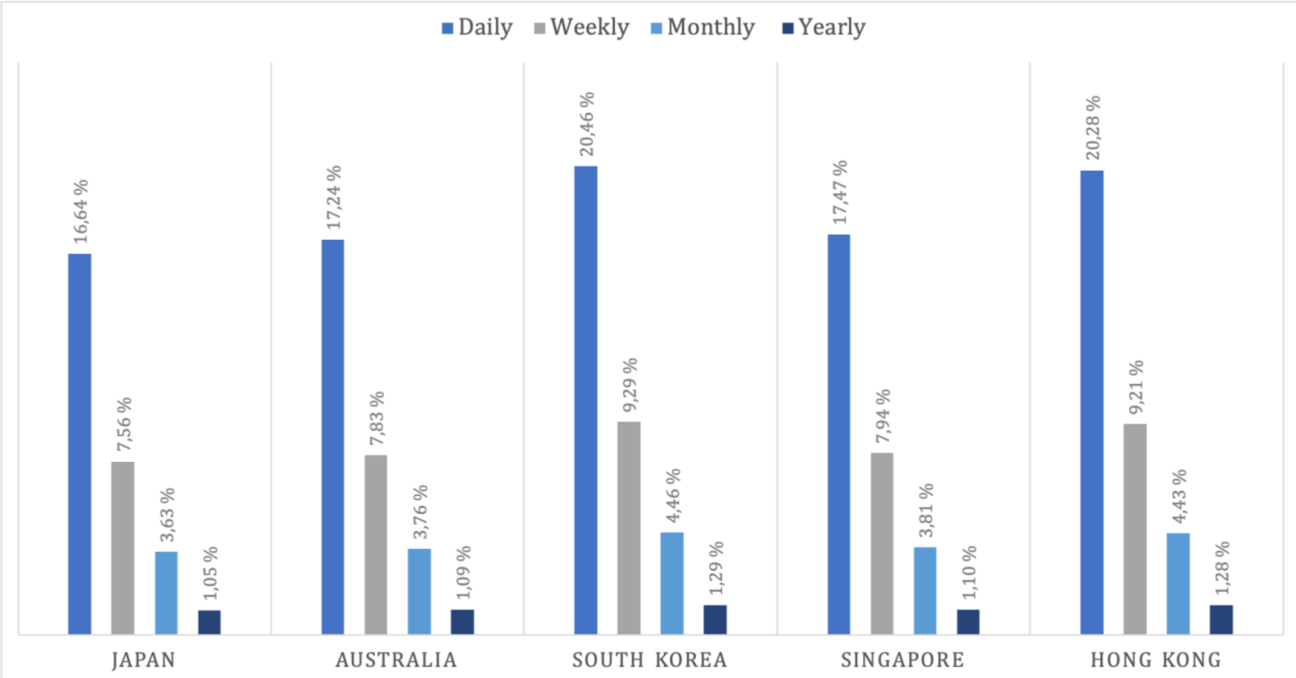


Appendix B: DCC GARCH parameters for the synchronized ETF's NAV returns and S&P500 returns

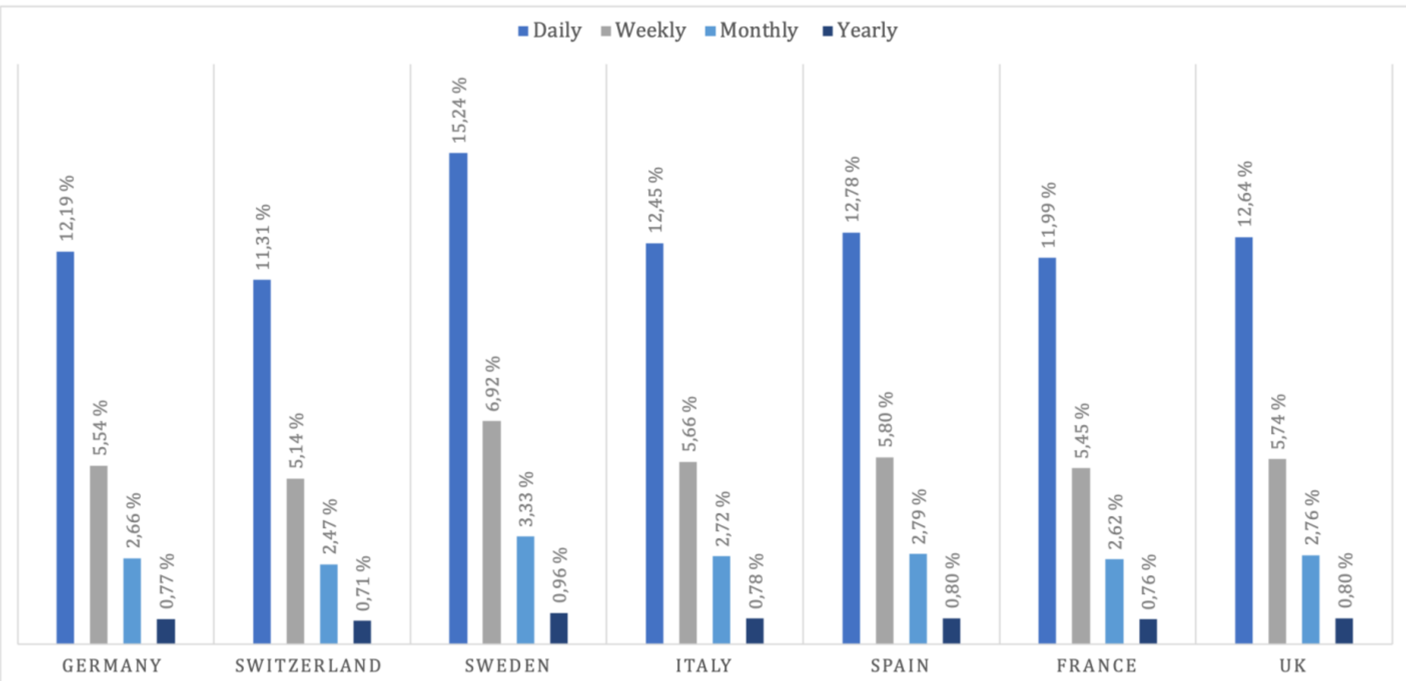
Country ETF	GARCH(1,1)			GARCH(1,1) S&P500			DCC	
	Alpha 0	Alpha	Beta	Alpha 0	Alpha	Beta	Alpha	Beta
Japan	0,0000	0,1030	0,8806	0,0000	0,1032	0,8831	0,0107	0,9785
Australia	0,0000	0,0834	0,8994	0,0000	0,1034	0,8828	0,0146	0,9789
South Korea	0,0000	0,0711	0,9242	0,0000	0,1049	0,8789	0,0080	0,9872
Singapore	0,0000	0,1005	0,8959	0,0000	0,1034	0,8828	0,0053	0,9942
Hong Kong	0,0000	0,1020	0,8896	0,0000	0,1031	0,8831	0,0205	0,9677
Germany	0,0000	0,0783	0,9169	0,0000	0,1045	0,8810	0,0223	0,9725
Switzerland	0,0000	0,0976	0,8867	0,0000	0,1047	0,8812	0,0084	0,9889
Sweden	0,0000	0,0645	0,9307	0,0000	0,0999	0,8871	0,0273	0,9641
Spain	0,0000	0,0788	0,9116	0,0000	0,1044	0,8823	0,0220	0,9653
Italy	0,0000	0,0882	0,9015	0,0000	0,1046	0,8816	0,0210	0,9732
France	0,0000	0,0890	0,9031	0,0000	0,1033	0,8829	0,0239	0,9649
UK	0,0000	0,0931	0,8923	0,0000	0,1064	0,8796	0,0132	0,9811
Brazil	0,0000	0,0752	0,9033	0,0000	0,1067	0,8770	0,0255	0,9714
Mexico	0,0000	0,1200	0,8588	0,0000	0,1023	0,8838	0,0257	0,9658
Canada	0,0000	0,0341	0,9657	0,0000	0,1059	0,8811	0,0546	0,9340

Appendix C: Tracking errors of ETF's market price to NAV at multiple horizons.

C.1: The Asia-Pacific Group



C.2: The Europe Group



C.3: The Americas Group