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International Portfolio Diversification Through ETFs

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Master Thesis

International Portfolio Diversification Through ETFs

An empirical analysis of transitory effects and asynchronous returns on US traded funds

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Table of Contents

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Abstract

This thesis investigates whether the difference in correlation between the US market and a country ETF or its underlying index is due to asynchronous returns or US transitory effects. We study the performance and diversification of twelve iShares funds issued by BlackRock. We include ETFs from different time zones to compare non-overlapping, partially overlapping and funds traded simultaneously. The study uses different frequencies of returns to capture the persistence of tracking errors and correlation characteristics over time. The annual tracking errors are low for all funds adjusted for transaction costs and correlations are similar to their underlying MSCI indices. The tracking difference of the funds are regressed upon several transitory variables. The S&P 500 has a significant effect upon tracking errors for all funds along with exchange rate fluctuations. We find no evidence of irrational pricing and suggest that differences in correlation are mainly due to the stale NAV quotes.

1. Introduction

Country exchange traded funds has been a desirable product among investors since its inception in the early 90s. ETFs are popular largely because they provide investors with diversification, daily portfolio transparency and liquidity in a low cost and tax efficient vehicle. The purpose of country ETFs is to track foreign equity indices and thereby offering international diversification possibilities for investors.

The country ETFs in the study are traded in the US. Due to differences in trading hours between international equity markets, asynchronous returns may have a significant impact on the ETF pricing and correlations. Also, the country ETF prices could be affected by US investor sentiment, while the Net Asset Value (NAV) is traded in its respective home market. Thus, the ETF prices may trade at a premium or discount relative to the NAV due to US transitory effects and asynchronous returns. Intuitively, an implication is that the correlation between the respective markets is lower than the correlation between the ETF and the local equity market. Hence, the country ETFs may provide a more accurate correlation measure between the international equity markets than the underlying index provides. Consequently, the question we want to address in our thesis is whether the difference in correlation between the US market and a country equity market index or its ETF is due to return asynchronicity or transitory effects.

Both institutional and retail investors have contributed to the growing demand in ETFs. Asset managers, including for instance mutual funds, pension funds and endowments use ETFs to invest in different markets, managing liquidity and investor flows, as well as hedging their exposures (ICI, 2017). Hence, being able to identify and estimate the correct correlation characteristics is important when investors are managing their portfolio. If the tracking error of the country ETF is significantly large, it indicates that the fund does not deliver the actual return and exposure the investor is looking for. As a consequence, investors may decide to not use ETFs as their preferred security to obtain index exposure but rather choose for instance index mutual funds or investing directly in the underlying.

The study contributes to existing literature by highlighting critical and important characteristics of country ETFs for investors seeking international exposure and diversification. This will be addressed through both quantitative and qualitative analysis of ETF prices, its underlying NAV, the correlations and

tracking efficiency of the funds.

The results show that the ETF offers a higher correlation than the underlying, implying short-term mispricing. Tracking errors are higher for funds with less overlapping trading hours and lower for funds that have synchronized returns. Over time, differences in correlation and tracking errors diminish. The S&P 500 has the largest effect on the country ETFs while the local market is closed. However, the ETF price has higher overnight return variance than daytime. That is, news released during local market trading hours has the largest influence. The findings of the study indicate that asynchronous returns are the main issue causing deviations.

The rest of the thesis is structured in the following way. The first section provides background information on the industry and the purpose of iShares country ETFs. The section explains the relevance of the study and the motivation behind. Furthermore, previous studies and important literature on the topic are presented. We proceed by introducing the theory of international diversification, passive investing, correlations and fundamentals on ETF structure and valuation. The hypotheses questions are stated at the end of the chapter. The third part presents the data used in the analysis, along with the descriptive statistics. Next part of the thesis provides the methodology applied to analyze asynchronous returns, correlations and tracking efficiency. Section five contains the results and analysis of the country ETFs. Lastly, we draw conclusion based on the results and propose improvements for the industry.

2. Background and Literature Review

2.1 Background

Exchange-traded funds have grown to be one of the biggest asset classes over the past couple of decades. Compared to foreign direct investments, country ETFs have made it easier for investors to gain exposure to international equity markets. Hence, it has become a popular alternative to index mutual funds. As well as being a desired investment choice among private and institutional investors, ETFs have gained increasing academic interest.

An exchange-traded fund is a pooled investment vehicle listed on a stock exchange allowing its shares to be bought and sold at a market-determined price throughout the trading day. The first US-listed ETF was the S&P 500 Depositary Receipt (SPDR), launched at NYSE in 1993. Today the SPDR ETF has the largest turnover on the market, trading for more than $14bn each day. Since 1993 the ETF market has grown tremendously, accounting for almost half of all trading in US stocks with over $3tn in assets under management.

The three biggest ETF providers are Blackrock, Vanguard and State Street which holds approximately 69% of all ETF assets (Authers & Newlands, 2016). The thesis investigates the iShares ETFs, initially created by Barclays in 1996. These are today issued by Blackrock.

An important part of portfolio management is to determine the optimal asset allocation across risky asset classes based on the risk and return characteristics of each asset class. A common practice is to measure the return and risk properties for each asset class using benchmark indices as proxies for the asset classes (see Chua et al., 2009; Campbell et al., 2002). This process, however, ignores the investability of each asset class because the indices themselves do not always reflect the actual investment experience. ETFs represent new opportunities for investors to diversify across asset classes that were previously unavailable or just accessible through actively or passively managed mutual funds. Therefore, it is of critical importance to quantitatively evaluate how closely ETF returns replicate the returns of their benchmark index. The results have important implications for the practical benefits of diversification because ETFs are investable, whereas the indices themselves are not for many investors (Buetow & Henderson, 2012).

It is important that ETFs track their underlying index as close as possible, and provide a consistent exposure. For instance, different investors may have opposite positions in the fund, and uses country ETFs to diversify or hedge risk. Hence, a clear motivation for this thesis is to understand how ETFs perform compared to their underlying index. If we find that there exists mispricing, it is of academic interest to understand causes and effects.

An interesting feature of country ETFs is that they can in some cases be viewed as price discovery vehicles. E.g. US listed ETFs with international constituents with partially or no overlapping trading hours. An event where this became highly visible was during Greece's debt crisis where the Greek market was closed for a week in 2015. During this week, the traded value of the ETF (GREK) deviated considerably from its NAV. When the market opened again, the ETF traded stable, meanwhile the actual underlying securities were highly volatile when re-establishing equilibrium (Nadig, 2015). In many ways, this could be an indication that the ETF ecosystem works well, which motivates further studies on the pricing of the funds and its underlying assets.

The discussion of passive investing, either mutual funds or ETFs is more relevant than ever. The dominant view is that active management does not pay, also for sophisticated investors, and is costly on net (Dyck et al., 2013). Both the ultimate stock picker, Warren Buffett, and the passive investing guru, Jack Bogle, has agreed that the average investor should choose passive and low-cost investments (Foley, 2016). Hence, the importance of passive investment vehicles to deliver what it aims to do, becomes even more crucial.

Lastly, by using historical data to show how transitory effects in the US economy and different time zones affect correlations between equity markets, we will gain a better understanding of the integration between equity markets and the implications for international diversification.

2.2 Literature Review

ETFs are considered a relatively new investment vehicle in finance, hence the research on these topics are quite recent. Over the last decade, research on passive country ETFs has become increasingly comprehensive. Considerably attention is paid to the performance comparisons to other passive investment options, e.g. foreign direct investments or international open end mutual funds. As

indexed ETFs are passive funds, many of the existing studies is determined to be based on their tracking performance to either domestic or foreign benchmarks.

Return synchronization or time alignment of data and correlation dynamics between different markets in general, are studies that have existed for a longer period. Adding these topics and components together are important to explain the diversification characteristics of country ETFs.

Comparison of international diversification options

When ETFs are compared with traditional index mutual funds, they are often described as more tax efficient. The arguments are that the transactions usually generate less distributions of realized and taxable capital gains than most mutual funds. Kostovetsky (2003) emphasized that in general the main differences lie in qualitative factors, i.e. management fees, shareholder transaction fees, taxation efficiency etc. Additionally, the author states that comparing tracking efficiency is challenging, as there is not a true benchmark for comparison.

Huang and Lin (2011) compare the international diversification benefits between country ETFs and foreign direct investments. They highlight the benefits of international diversification and proves that country ETFs offers the same performance as direct investments and may also provide a higher Sharpe ratio for some markets.

Tracking efficiency - magnitude, persistence and diversification

Pennathur, Delcoure and Anderson (2002) uses different methods to model tracking error. When using a single factor model, they find that iShares' country ETFs are doing well in tracking foreign MSCI indices. However, when applying a two-factor model which isolates the "true" diversification benefits, they find both iShares and closed end country funds to contain a considerable exposure to US risk. Thus, it offers limited international diversification benefits.

Jares and Lavin (2004) investigates ETFs that tracks Japan and Hong Kong equity markets. The feature of these ETFs is that they have no overlapping trading hours with US markets. The study shows that the ETFs contains deviations from the underlying NAV and proposes profitable trading opportunities. This is supported by Shin and Soydemir (2009) who find a greater divergence between the market price and the net asset value of ETFs for the Asian markets.

Engle and Sarkar (2006) investigates premiums and discounts of ETFs with both domestic and international exposure. They argue that premiums and discounts for domestic ETFs are typically small and only lasting several minutes. For ETFs with international exposure the case is different. The results show that premiums and discounts is more persistent and may last several days.

Delcoure and Zhong (2007) finds that iShares trade at significant premiums even after controlling for time differences and transaction costs. As suggested by related literature they find that price deviations are limited and converge to zero within two days.

A study by Phengpis and Swanson (2009) contradicts previous findings. They argue that iShares indeed offers international diversification benefits, and that the US exposure is weaker, less significant and less prevalent than previously suggested. However, the data used in their study is monthly, which most research emphasize is too wide to capture the effects of the home market.

Levy and Lieberman (2012) who studies the intraday price formation of US listed country ETFs, find that when the foreign market is closed the S&P 500 accounts for the largest part of country ETF returns. They suggest the existence of a behavioral bias where US investors ignore the long run correlation between the markets and rely too much on US sentiment. The authors agree with Engle and Sarkar (2006); a long investment horizon is needed to obtain the true foreign exposure. Furthermore, if country ETFs are added to a portfolio in order to obtain international diversification in the short term an investor may adding more US risk to the portfolio and not obtaining the correlation between the underlying net asset values.

Tracking efficiency - factors

Delcoure and Zhong's (2007) results from the panel regression suggest several transitory variables to explain the price deviations such as institutional ownership, bid-ask spreads, trading volume, exchange rate volatility and financial crises. However, all these factors alone cannot explain the premiums. Therefore, the authors propose behavioral factors as a possible explanatory variable.

Ackert and Tian (2008) suggested that the mispricing is related to momentum, size effects, in addition to illiquidity. A later study by Buetow and Henderson's (2012) supported that differences in daily returns tends to be larger for ETFs that invest in benchmark indices composed of less liquid assets.

Shin and Soydemir (2009) examined the degree of which frequently used factors, e.g. dividends, expense ratio, exchange rates and spreads, affects tracking errors. They found that exchange rates are a significant source. Delcoure and Zhong (2007) mention that investors face exchange rate risk by holding country ETFs. Exchange rate fluctuations may discourage arbitrage activities leading to mispricing. Hence, they include exchange rate volatility as a factor.

Synchronization

Time aligning the data and calculating the correct estimates is always a challenge in the studies of diversification and correlation dynamics of country ETFs. That is, the problem of stale prices or asynchronous returns complicate and bias research, and must therefore be corrected.

Some studies bypass the non-synchronicity problem by using weekly or monthly data. Some of the first empirical evidence for the dependence of correlation estimators of high-frequency stock returns on sampling frequency originates back to Epps work in 1979. Using intraday returns data on a few number of US stocks, Epps finds that correlations tend to decline when the frequency of the sample becomes higher, which is known as the "Epps effect" (Hayashi & Yoshida, 2005). In addition, to potential sample size issues, using weekly or monthly data will not help as we aim to capture the short-term correlation dynamics between the markets and the ETF.

There has been proposed different models that can give the expected prices at any time, given the most recent information and a covariance matrix for all future prices. In econometric terms, the main challenge is to specify how the information is used to forecast the mean and variance of the return, conditional on the past information. With reference to this, it worth mentioning Robert F. Engle (1982). Engle introduced the idea of modelling and forecasting volatilities and correlation. A lot of the research on return synchronization and daily correlation dynamics between markets bases their studies on Engle's work on ARCH and later generalized ARCH (GARCH) by Bollerslev (1986). The will not be applied in this study, but it is relevant and important to understand in an intermarket analysis. Further research that builds on these studies are Burns et al. (1998) and Riskmetrics^{TM} (1996;2007) that proposed a variety of procedure to treat the issue and to calculate a synchronized correlation from a data set containing non-synchronization assets on a daily basis. The first study presents an empirical

finding that the estimates of correlations for highly asynchronous markets are too low, and presents an alternative approach to adjust this. Riskmetrcics^{TM} delivers large estimations of variance-covariance estimates, and the objective is to produce VaR measures based on these short-term dynamics of correlation.

Goetzman et al. (2001) proposed to include the predictable portion of next day's NAV into today's NAV, in order to adjust the underlying NAV. Thus, the "true" NAV is used in the model describing premiums or tracking errors making it possible to isolate the transitory effects from the asynchronous returns.

Bergomi (2010) proposes an alternative solution when addressing the issue of asynchronous markets and the pricing of multi-asset options. The approach can be defined as more heuristic than the previous mentioned studies. Hence, the paper does not aim to find the "true" correlation. Nevertheless, he proposes a synchronous framework with the use of a special correlation estimator for assets with asynchronous return.

One of the later contributions to the research on US traded country funds is conducted by Levy and Lieberman (2012). They use several GARCH specifications. However, the paper presented in 2012, includes a simpler model of the price formation process of ETFs, in which they state gives the same qualitative results. While Levy and Lieberman used intraday return series in their model, Goetzman et al. (2001) argued that the problem of stale prices could not be eliminated with the use of intraday returns. Other papers, such as Kleimeier et al. (2008) and Martens and Poon (2001), argues that the use of daily close returns is not suitable and that stale pricing has to be corrected to obtain the true relationship.

3. Theory and Hypothesis

3.1 International diversification

Diversification is typically achieved through two main strategies: Either invest in different asset classes that have negative or low correlation with other assets in the portfolio, or invest in same asset classes across different markets internationally (Cappiello et al. 2003).

Proponents of the efficient market hypothesis (EMH) argues that active management is largely wasted effort and unlikely to justify the expenses incurred. Therefore, they advocate a passive investment strategy that makes no attempt to outsmart the market. While the degree of market efficiency is, and always will be, a matter of debate, economists such as Eugene F. Fama, mentions the EMH as the fundamental premise in which justify the creation of index funds and ETFs (Murphy, 2014). According to EMH, as new information about a security becomes available, its price quickly adjusts so that at any time, the security price equals the market consensus estimate of the value of the security. Hence, there would be neither underpriced nor overpriced securities (Bodie et al., 2014). Previous literature and research on ETF pricing shows that premium and discounts do occur, however the persistence, magnitude and reasons of the mispricing or discrepancies is harder to explain. Therefore, in order to answer our question, it is important to study the fundamentals of ETFs.

3.2 ETF Fundamentals

3.2.1 Creation and Redemption Mechanism

The key to understanding how an ETF works is the creation and redemption mechanism. Both ETFs and mutual funds are similar when it comes to the market value being close to their NAV. However, unlike closed-end funds, ETF shares can be created and redeemed. Hence, the process explains how the funds acquire its underlying assets and hold anything of value, in addition to why ETF share prices are trading in line with the fund's underlying NAV ("CRM", 2016).

The creation mechanism starts with an ETF sponsor, e.g. iShares, which creates ETF shares and sends them to an authorized participant (AP), typically a large bank or institution. The AP sends back baskets of underlying securities in exchange for the ETF. They can trade bundles of ETF shares (called "creation units," typically 50,000 shares) with the ETF sponsor. Since the price of ETFs

shares are determined by the demand and supply in the secondary market, it may diverge from the value of the underlying securities. The AP can then create new ETF shares by transferring the securities in the underlying to the sponsor (Authers, 2016).

Symmetrically, the AP can redeem ETF shares, by sending back the ETF shares. The sponsor retires the unwanted shares from the market and gives the AP the underlying securities, or cash, in exchange. In an efficient market, the price of an ETF should have the price of its underlying portfolio, up to transaction costs, because the two assets have the same fundamental value.

An arbitrage process

The ability of authorized participants to create and redeem ETF shares, facilitates APs to engage in an arbitrage process that adjusts the supply of ETF shares in the market and helps the ETF to trade at a price that on average approximates its underlying value. Shares of the ETF are always created and redeemed at the official NAV of the fund. It is common to distinguish between the cases where ETFs are traded at a premium (the price of the ETF exceeds NAV) and at a discount (the price of the ETF is lower than NAV).

Therefore, when the ETF is traded at a premium in the secondary market, APs have an incentive to buy the underlying securities, while simultaneously short sell the ETF. At the end of the day the AP deliver the basket of underlying securities, and ask for newly created ETF shares in exchange to cover their short position. The authorized participant will receive a profit from having paid less for the underlying securities than it received for the ETF shares. The additional supply of ETF puts downward pressure on the price, in addition to a potential increase in the NAV, helps to reduce the premium.

Opposite, when an ETF is trading at a discount, APs may buy the ETF shares and sell short the underlying securities. At the end of the day, the AP will return ETF shares to the fund in exchange for the ETF's redemption basket of securities, which they will use to cover their short position. The AP will receive a profit from having paid less for the ETF shares than it received for the underlying security. The lower supply of shares generates a positive price pressure on the ETF, in addition to a possible negative pressure on the NAV, which reduces the discount (ICI, 2012; Itzhak, Franzoni & Moussawi, 2012). The total cost of the mechanism is paid by the APs, who then charge it either back to the initiating investor or in the spread of the ETF.

The APs are the only participant who takes part in the act of creation and redemption processes. However, they are not the only participant that are providing liquidity, lowering the spread and keeping the price in line with the underlying. There is an entire ecosystem of ETF liquidity providers, such as the lead market makers (LMMs), that are trading ETFs and making markets (Abner, 2016). The creation redemption mechanism facilitated by the AP, allows liquidity providers to exchange ETF shares for the underlying assets and vice versa. Nonetheless, providing liquidity for an ETF where the markets are open at the same time (e.g. Canada or Mexico) and international equity ETFs with overlapping or non-synchronized trading hours (e.g. Germany or Japan) is quite different.

The arbitrage process of creating and redeeming shares, and the transparency of ETFs holdings, allowing investors to help keep the ETF's market price in line with its underlying value through arbitrage strategies, is the most common explanation that ETFs have been so successful in tracking country indices over time.

3.2.2 ETF Valuation

NAV

Net Asset Value (NAV), whether for mutual funds or ETFs, is considered an indicator of the true value of that fund and is one of the most important data points when making investment decisions (Pekham & Pingali, 2016). NAVs for country ETFs are published daily and is based on the closing prices in the underlying stocks. The calculation is done using the creation unit and the total cash and the amount of shares of the ETF represented by the creation unit. In addition, there is a currency conversion (Abner, 2016). It follows that the formula for the NAV is:

$$NAV = \Big(\sum (Shares\ per\ each\ component\ stock * Last\ Price)/Currency\ Rate)\ /CU\ Shares + (Total\ Cash/CU\ Shares\Big)$$

Unlike traditional mutual funds however, few investors use this information for anything, since only market makers can transact at the NAV in international ETFs. E.g. with an Asian ETF, the NAV is not determined until the next day because of the underlying securities. Hence, the published NAV of an

international fund in the US is often stale. This is not helpful for investors that base their investing or trading on NAV prices. The investor would require an instantaneous and accurate NAV price during the day.

Intraday Indicative Value and the Estimated NAV

Country ETFs can be viewed as a price discovery vehicle, acting as a mechanism that estimates where the underlying basket will be trading at the local market open.

The intraday indicative value (IIV) for a fund is based on the most recent trading activity in the local market. Thus, the IIV on for instance the iShares MSCI Japan ETF, depend on trading activity in Japan during the trading day. The IIV shows where the basket traded at the close of the Japanese market, but significant events since then, may now have an influence on the price of the ETF. Hence, there is no real-time arbitrage available between the ETF and its underlying basket during the hours the ETF trades, so the two prices will move independently of each other.

The superior way to price an ETF with international equities as underlying, would be to estimate sentiment and market movements at the time of execution based on some proxy assets, often called estimated NAV or eNAV. The eNAV attempts to estimate factors that drives the value of the underlying basket, and build those factors into the pricing of the basket. The eNAV calculation process is in many ways subjective, i.e. it is not generalized or a standard way of valuing eNAV. In addition, this fair pricing model is relatively premature in the ETF universe and it is an ongoing arms race to calculate the most accurate eNAV (Abner, 2016).

3.3 Correlation

Correlation in portfolio management is often used to measure the amount of diversification among the assets contained in a portfolio. The correlation structure across assets is a key feature in managing a portfolio because it is a tool in determining risk. Samuelson (1965) states that since assets are held by investors in anticipations of payments to be made in the future, changes in the value of an asset is linked to changes in forecasts of the future prospects of the firm or a market. The information or "news" makes us change these forecasts (Engle, 2009). Correlation is in other words dynamic and varies over time.

A reason to investors' interest for international equity exposure have

traditionally been the belief that foreign stocks and stock markets is reasonable uncorrelated from our home. The theory is that stock markets in different countries tend to move in different times. Thus, the last couple of years we have seen more research on volatility and correlation dynamics in the financial market and how this affect ETFs tracking performance (see for example: Ang & Bekaert, 2003). Hence, the amount of diversification within an investor's international equity portfolio will change over time.

3.4 Asynchronous returns and transitory effects

The research question originates from the fact that the country ETF's traded on NYSE have no common or partially overlapping trading hours with the underlying market. Hence, there will be asynchronous returns between the ETF and the index since movements in returns happens at different times. News that influences the prices in the open market will also affect the price of the ETF in the closed market. If we illustrate this with the German stock exchange, which opens at 9:00 am in Frankfurt (3:00 am in New York) (Appendix 1). Thus, any news that occurs in Germany during the opening will not show up in the ETF price traded in the US before NYSE opens. A consequence of using close-to-close returns that have different trading hours is an underestimation of correlations between the respective markets (Martens & Poon, 2001).

Further, we will investigate the role of transitory effects in the US market and ETF returns. Transitory factors are defined as bypassing effects, regardless of time difference. As we have mentioned earlier, previous literature and findings indicate that country ETFs are more correlated with the US market than the foreign index. Hence, investors may ignore the long-run underlying correlations between the markets. I.e. investors are biased or rely more on the sentiment and information in the home market, which could lead to short term mispricing (Lieberman & Levy, 2012).

Returns measured in different times and potential transitory effects complicate and bias many of the tasks of financial management. The potential consequences are critical, since it is important for different investment strategies and investors managing their portfolios to have correct values, or estimates of these, at any given point in time. Both, in terms of knowing the true value of their assets and being able to monitor the performance and risk of the portfolio in an accurate manner. Thus, if prices are not measured at the same time for all assets in a portfolio, systematic errors can occur for the investor.

3.5 Hypothesis

The goal of the thesis is study whether country ETFs provide the same international diversification opportunities as the underlying. Further, we investigate whether differences in correlation between the ETF and NAV are attributed to asynchronous returns or transitory effects. The hypotheses questions are tested for each country separately. We have formed our hypotheses questions in the following order:

H_0: The risk return tradeoff of the underlying are obtained by investing in country ETFs

H_1: The risk return tradeoff of the underlying are not obtained by investing in country ETFs

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

H_A: Tracking errors are persistent in the long run.

As the statistical framework suggests, the null hypothesis represents the conservative approach. Hence, it is the theory that we are testing against. Due to the ETFs structure and since they are designed to track its benchmark index, they are known as being a consistent and reliable vehicle in replicating the underlying. Hence, our null hypothesis states that the iShares country ETFs will have similar risk adjusted returns as the MSCI index and tracking errors that do not last.

In addition to investigating performance, the correlation characteristics and tracking errors, we aim to explain the reasons behind the potential deviations in performance and risk measures. Consequently, we want to examine the determinants:

H_0: Asynchronous returns is the main source of tracking error.

H_A: Asynchronous returns is not the main source of tracking error

Again, research indicates that a conservative approach and the common expectations would be that the rise of tracking error are mainly due to unsynchronized pricing between the ETF and the constituents of the underlying basket.

4. Data

The sample used for analysis consists of 12 country ETFs listed on NYSE. All country ETFs are iShares, issued by BlackRock. These country ETFs are tracking the Morgan Stanley Capital Indexes (MSCI). The respective country indices track the performance of the large and mid-cap segments and covers approximately 85% of the free float-adjusted market capitalization (MSCI, 2017).

Table 1
Sample

Country	Ticker	Underlying Index	Start of Sample	End of Sample	Nr. of Obs.
Japan	EWJ	MSCI Japan Index	01.1997	12.2016	5034
Australia	EWA	MSCI Australia Index	01.1997	12.2016	5034
Hong Kong	EWH	MSCI Hong Kong Index	01.1997	12.2016	5034
Singapore	EWS	MSCI Singapore 25/50 Index	01.1997	12.2016	5034
Malaysia	EWM	MSCI Malaysia Index	01.1997	12.2016	5034
Sweden	EWD	MSCI Sweden 25/50 Index	01.1997	12.2016	5034
Germany	EWG	MSCI Germany Index	01.1997	12.2016	5034
Switzerland	EWL	MSCI Switzerland 25/50 Index	01.1997	12.2016	5034
Spain	EWP	MSCI Spain 25/50 Index	01.1997	12.2016	5034
Italy	EWI	MSCI Italy 25/50 Index	01.1997	12.2016	5034
Canada	EWC	MSCI Canada Index	01.1997	12.2016	5034
Mexico	EWW	MSCI Mexico IMI 25/50 Index	01.1997	12.2016	5034

Sample includes daily observations from 1997-2016. We have included 12 Country ETFs which are iShares issued by BlackRock. The funds aims to track the Morgan Stanley Capital Index for each respective country.

In order to have the largest possible sample size, we have included the ETFs with the earliest inception dates (12.03.1996). The sample includes the 1997 Asian financial crisis, The Dot-Com Bubble as well as the Financial Crisis of 2008. These are periods where indexing becomes difficult and we expect to see large excess returns. We use daily returns series to analyze the issues of stale prices and transitory effects.

The country ETFs are placed in three different categories. ETFs with no overlapping trading hours with the US: EWJ, EWA, EWH, EWS and EWM. These ETFs are expected to suffer most from the issues of stale prices and US short term effects. The European ETFs include EWD, EWG, EWL, EWP and EWI, which have partial overlapping trading hours. I.e. stale prices are limited to certain hours. The last category covers EWC and EWW. These ETFs have synchronous trading hours with the US, and we expect a higher tracking efficiency for these funds.

For all 12 funds, we have included daily observations of the index level, NAV per share, dividends, expense ratio and shares outstanding from iShares. The index level is the daily close of the underlying MSCI country index. NAV per share is the net asset value of the fund i.e. assets minus its liabilities divided by number of shares outstanding. NAV is calculated at local market close and may therefore deviate in time relative to the closing price of the ETF. ETFs collect dividends from the underlying companies and must thereby pay out these to its investors. This is typically on a semi-annual basis. It is important to consider dividends such that the return calculation of ETFs is comparable with the NAV returns. The expense ratio is the same for all funds (0,48% per annum). Shares outstanding are included to compute the size of the fund i.e. its assets under management (Appendix 2). Bid and ask quotes and exchange rates are retrieved from Bloomberg. The bid ask quotes are used to compute the spreads of the funds. The daily close of the S&P-500 and the VIX index are retrieved from Yahoo Finance. The VIX index shows the implied volatility of S&P-500 options, and is used as a proxy for US market volatility. The S&P-500 index is as a proxy for the American equity market and is used to measure correlations between the US and the other countries. In addition, used as an explanatory variable for potential tracking errors. ETF trading volume, open-, high-, low- and closing prices is downloaded from the Center for Research in Security Prices (CRSP Database).

Table 2
Descriptive statistics with daily returns

Country	Ticker	Mean excess return	Std. Dev.	Max.
Japan	EWJ	0,0000 %	1,514 %	15,73 %
Australia	EWA	-0,0001 %	1,522 %	1,69 %
Hong Kong	EWH	-0,0001 %	1,722 %	31,85 %
Singapore	EWS	-0,0003 %	1,533 %	18,62 %
Malaysia	EWM	-0,0022 %	1,709 %	15,82 %
Sweden	EWD	-0,0004 %	1,012 %	7,34 %
Germany	EWG	-0,0002 %	1,079 %	11,76 %
Switzerland	EWL	0,0000 %	1,028 %	9,17 %
Spain	EWP	-0,0002 %	1,107 %	11,73 %
Italy	EWI	0,0000 %	1,100 %	11,73 %
Canada	EWC	0,0000 %	0,863 %	9,08 %
Mexico	EWW	-0,0002 %	1,014 %	7,02 %

Table 2 (Continued)

Country	Ticker	Min.	Kurtosis	Skewness
Japan	EWJ	-11,84 %	13,04	0,42
Australia	EWA	-12,30 %	16,15	0,50
Hong Kong	EWH	-28,61 %	47,60	0,67
Singapore	EWS	-13,32 %	14,77	0,48
Malaysia	EWM	-31,44 %	37,27	-1,11
Sweden	EWD	-9,79 %	10,36	-0,20
Germany	EWG	-1,08 %	13,21	0,45
Switzerland	EWL	-5,81 %	8,57	0,43
Spain	EWP	-8,77 %	10,97	0,56
Italy	EWI	-9,57 %	9,99	0,35
Canada	EWC	-13,99 %	22,31	-0,53
Mexico	EWW	-10,66 %	9,93	0,04

Table 2. Descriptive statistics of daily ETF excess returns. Excess returns has a mean of zero, with large positive and negative outliers. The standard deviation of the excess returns is the non-annualized tracking error with daily returns. They tend to decrease for markets that are more synchronized with the US.

The excess returns or tracking difference for the country ETFs is given in table 2. The tracking difference of all funds has a mean of zero, since premiums and discounts tend to cancel each other out in the long run. The standard deviation of the daily excess returns or tracking error is relatively high. Canada has the

lowest standard deviation (0,86%) and Hong Kong is the highest (1,72%). The standard deviation of excess returns is referred to as the tracking error of the funds.

All funds have high maximum and minimum values of excess returns as the ETFs ability to track the underlying is lower when markets are volatile (Appendix 3). These high max and min values are attributed to times of financial crisis. We see that all funds have high kurtosis and can be considered leptokurtic. Excess returns are centered around the mean of zero, with fat tails. Most of the funds exhibit positive skewness. That is, the mass of the distribution is concentrated left of the mean with negative excess returns.

5. Methodology

5.1 Risk and return

The first step in analyzing differences in correlations and potential tracking errors is to compute the daily return series for all ETFs, NAV, the underlying index and the S&P-500. We use daily returns as we are interested in capturing the effects of stale prices. Existing literature emphasize that a feature of the funds is that in a long enough time perspective (monthly or yearly), country ETFs is able to fulfill its purpose of tracking the underlying index. If the time series are found cointegrated they will be bound by a stationary linear relationship and deviations from this relationship is expected to be temporary (Engle and Granger, 1987). Hence, we establish that our statistical model will be used to explain short term deviations. We also include computations of weekly, monthly and yearly returns as we are interested in the behavior of correlations and tracking errors with different time frames. Weekly returns are defined as 5 trading days, monthly as 21 and yearly as 252. We use logarithmic returns due to log-normality.

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

$$R_{S\&P,t} = ln\left(\frac{S\&P_t}{S\&P_{t-1}}\right) \quad (2)$$

$$R_{NAV,i,t} = ln\left(\frac{NAV_{i,t}}{NAV_{i,t-1}}\right) \quad (3)$$

$$R_{I,i,t} = ln\left(\frac{Index_{i,t}}{Index_{i,t-1}}\right) \quad (4)$$

Standard deviations of returns are calculated in order to compare the risk and return between the series. Ideally, the ETF and NAV would offer the same risk-return relationship. To compare the risk adjusted returns for the ETF and the underlying, we calculate the information ratio:

$$IR = \frac{R_{ETF} - R_{NAV}}{SD_{ETF-NAV}} \quad (5)$$

5.2 Daytime and overnight variance

We perform a variance analysis of returns for the countries with zero or few overlapping trading hours with the US. By computing the standard deviation of daytime and overnight returns we are able to see if the return variance is higher during trading hours than non-trading hours. We expect the variance to be higher when local markets are open i.e. overnight returns are higher than daytime returns. If return variance is mainly driven by transitory effects in the US, we would find that the daytime return variance is higher than the overnight variance. For Mexico and Canada, we expect the daytime return variance to be the highest.

$$Daytime\ Return_{i,t} = \ln\left(\frac{ETF\ Close_{i,t}}{ETF\ Open_{i,t}}\right) \quad (6)$$

$$Overnight\ Return_{i,t} = \left(\frac{ETF\ Open_{i,t}}{ETF\ Close_{i,t-1}}\right) \quad (7)$$

5.3 Correlations

We calculate the correlation between the S&P 500 and the ETF and the S&P 500 and the NAV. The ETF and NAV are supposed to offer similar return series. Hence, any deviations between correlations are indicative of tracking errors. Correlations are computed with daily, weekly, monthly as well as yearly returns. We expect the ETF to offer a higher correlation with the American market than the NAV. This difference in correlation is expected to decrease as the frequency of return calculation is getting lower. Weekly and monthly returns are highly important for our correlations study as they do not suffer to the same extent from asynchronous returns. With different frequencies of returns we are able to explore whether the ETF consistently offers a higher correlation with the S&P 500.

The issue of asynchronous returns in the calculation of correlations is problematic. Different solutions have been proposed to obtain synchronized returns and thereby obtain an indication of accurate volatilities and correlations

(see: Burns, Engle and Mezrich, 1998 and Engle, 2002). Alternatively, the use of fair value NAV (eNAV) from industry would help obtain more precise daily correlations.

Bergomi's method (2010), originally derived for option delta-hedging, is used to illustrate the issue of asynchronous correlation and for comparison. The synchronization process separates the correlation calculation into two parts. Firstly, we calculate the close to close correlation between the series. The second correlations estimate are calculated using the covariance between the closing value of the "early opening" market at time t+1 (e.g. Japan), and the "late opening" market at time t (e.g. US). The synchronous correlation is given as the sum of the two measures:

$$r_1 = \frac{Cov(R_{NAV,t}, R_{S\&P,t})}{S.D.(R_{NAV})\ S.D.(R_{S\&P})} \tag{8}$$

$$r_2 = \frac{Cov(R_{NAV,t+1}, R_{S\&P,t})}{S.D.(R_{NAV})\ S.D.(R_{S\&P})} \tag{9}$$

$$r^* = r_1 + r_2 \tag{10}$$

5.4 Tracking Efficiency

We perform a preliminary tracking efficiency analysis by regressing the ETF return on the NAV return. A beta coefficient closer to 1 indicates better fund performance. The R^2 of the regression is useful as a measure for fund performance. The square root of R^2 is calculated and used as a correlation measure between the ETF and NAV.

$$R_{ETF,i,t} = \alpha + \beta_{i,t} \times R_{NAV,i,t} + \varepsilon_i \tag{11}$$

Existing literature argues both in favor of comparing NAV returns with the benchmark index and ETF prices with the NAV. With the use of NAV returns over index returns, we would be investigating the fund manager's performance in replicating the underlying index (see Appendix 4).

Our primary interest is the secondary market and the quoted prices of the ETFs. We are then able to investigate how different time zones and short-term effects in the market can drive the ETF prices out of equilibrium. Hence, we have the following formula for tracking difference:

$$Tracking\ Difference\ ETF_{i,t} = R_{ETF,i,t} - R_{NAV,i,t} \tag{12}$$

Tracking difference is the daily excess returns of the ETF relative to NAV. In order to investigate whether the differences in correlation is attributed to stale prices or transitory effects we will use this absolute difference as our dependent variable.

Further, we calculate the annualized tracking error, which is the standard deviation of tracking difference:

$$Tracking\ Error\ ETF_{i,t} = \sqrt{\frac{\sum(R_{ETF,i,t} - R_{NAV,i,t})^2}{n-1}} \quad (13)$$

$$Annualized\ Tracking\ Error_{i,t} = Tracking\ Error_{i,t} \times \sqrt{n} \quad (14)$$

With tracking errors for all the countries in our sample, we are able to observe how the different countries behaves relative to each other as well as how they behave with respect to time zones. When comparing the country ETFs, we expect to see a higher tracking error with a higher number of hours' divergence between the US and the home market. Also, we expect significantly lower tracking errors for returns with lower frequency.

5.5 Determinants of tracking error

After we establish that iShares ETFs demonstrate daily tracking difference and tracking errors, we test whether the deviations can be explained by transitory variables. We include several transitory variables as well as foreign exchange rates and NAV returns. The transitory variables included are measures of volatility in the US market, costs, volume and the size of the funds. Consequently, we have the following model with transitory variables explaining ETF tracking difference:

$$Tracking\ Difference\ ETF_{i,t} = \alpha_{i,t} + \beta_1 FXRate_{i,t} + \beta_2 LogVol_{i,t} + \beta_3 PriceVola_{i,t} + \beta_4 LogS\&P_{i,t} + \beta_5 VIX_{i,t} + \beta_6 Size_{i,t} + \beta_7 Spread_{i,t} + \beta_8 NAV_{i,t} + \varepsilon_i \quad (15)$$

Exchange rates

We expect a significant effect of exchange rate volatility on iShares tracking difference. The creation redemption process is directly affected by any fluctuations in the local currency. When the sponsor and the authorized participant engage in the arbitrage mechanism to cancel out any premiums or discounts they

have to buy or sell securities in local market currency. Hence, any appreciation or depreciation of local currency is expected to have an effect on tracking difference as all iShares are denominated in US dollars. Also, investors who hold iShares will incur a loss if the local currency depreciates against the dollar. For all the country ETFs, we have computed daily appreciation/depreciation of local currency. For the Eurozone countries, we have included currencies that was replaced by the Euro.

Volume

To measure the effect of liquidity on each ETF's tracking performance, we use log-transformed daily trading volume. Researchers have argued that investors use certain volume statistics to update their beliefs, and consequently affect the behavior of the market. Kundisch and Klein (2009) studied ETFs and different certificates on the DAX, and found that tracking errors tends to decrease with increasing trading volume. Other studies find the opposite; that there is significant positive relationship between tracking error and volume (e.g. Chu, 2013; Rompotis, 2006). Since the local market is closed, higher trading activity could indicate higher premiums or discounts. On the other hand, larger trading volume may suggest that arbitrageurs have erased or decreased any arbitrage opportunities or mispricing in the ETF.

Intraday Price Volatility

During financial crisis and highly volatile markets it is harder for ETFs to track the underlying as the creation redemption process is more difficult to implement with large deviations in asset prices. This difficulty is even more relatable for international ETFs than domestic, as the creation redemption mechanism must correct yesterday's stale quote as well as incorporate any public information available at the current hour. Thus, we anticipate larger tracking differences during the crisis periods of our sample and intraday price volatility to have a positive and significant effect on tracking difference.

$$Intraday\ Price\ Volatility_{i,t} = \frac{(Price\ High_{i,t} - Price\ Low_{i,t})}{Price\ Close_{i,t}} \qquad (16)$$

S&P 500 Return

The S&P 500 index is included as a proxy for the American market. If iShares are priced efficiently, the price should be equal to the last quoted NAV as

well as any new relevant public information released after local trading hours. As world equity markets are integrated, it may very well be that news released during US trading hours are relevant for companies that constitute the S&P as well as companies in the local market of the ETF. Hence, we expect that when foreign markets are closed the S&P 500 return will have a significant effect on ETF returns and tracking differences.

VIX Index

While the intraday price volatility measures the volatility for the particular ETF, the return of the VIX index is included to cover the volatility of the US market as a whole. The S&P 500 may reflect public information that is relevant for the pricing of ETFs. However, when markets become more fearful, mispricing may occur due to irrational behavior.

Asset under Management

Abner (2016) states that a significant misconception among certain investors is that they fear to invest in ETFs that have lower assets under management, since it could have larger impact on the ETF price (Osterhoff & Kaserer, 2016). This is not true, as the liquidity ecosystem transfers the liquidity from the underlying assets of the stocks into the ETF to facilitate the transaction. Grinblatt and Titman (1989) suggested that fund size or net assets gives the providers economies of scale which in turn allows them to lower the fees and improve net performance of their funds (Chu, 2011). To capture the log-transformed daily assets under management's effect on discrepancies, we multiply the ETF closing price with shares outstanding. All of the iShares country ETFs are considered to be in the top tier within net assets (Appendix 2).

Bid-Ask Spread

The ETF spreads applied on the respective day is the difference between the lowest ask and the highest bid. The additional costs of the trading in the primary market will also show up in the bid-ask spreads for the investors in the secondary market when the country ETFs are trading on NYSE. All of the expenses and nuances are built into the ETF spreads that the liquidity providers make (Abner, 2016). With the spreads, we can measure how the time-varying transaction cost affect the tracking error. This is the same approach as Zhong and Delcoure (2007). One may expect to see a positive effect between a higher spread

(transaction cost) and the magnitude of the mispricing, as liquidity providers would not have an incentive to arbitrage.

NAV Return

We run the regression with and without NAV returns. Firstly, we exclude the variable to isolate the effect of transitory variables. Secondly, we include the variable, as we expect the fundamental component to affect the direction of next day's ETF returns. NAV returns are for most funds stale, except Canada and Mexico. One could anticipate that the fundamental factor has a negative impact on excess returns when the markets are trading simultaneous.

6. Results and Analysis

6.1 Risk and return relationship

This section presents the overall daily risk and return relationships for the country ETFs and their respective NAVs. In addition, we document deviations in the risk return tradeoff for certain periods.

Table 3 reports the average daily returns and risk, and the ratio between them, over the whole period. We find that the ETF underperforms the returns of benchmark index in almost all cases. However, in periods with negative returns the pattern is opposite. Comparing the standard deviation, which is a proxy for risk, the results indicate that the dispersion of returns appears to be lower for the NAV. The same pattern tends to be the case if we examine each year alone. In other words, the volatility appears to be higher for the ETF than for its underlying assets regardless of opening hours, which is consistent with the results of previous research on excess volatility for ETFs (Josh, 2004). This difference could indicate that country ETFs experience more noise trading.

Deviations in the risk-adjusted returns between the countries with synchronized, partially synchronized and non-synchronized do not have a clear pattern when calculating the average daily returns for the whole period. Nonetheless, the table below shows that the reward-to-variability for NAV is slightly higher in cases with a positive ratio and the opposite when the ratios are negative. The differences in the reward-to-variability measures for the ETF and the NAV, previously defined as information ratio, are furthest away from each other for Malaysia and closest for Japan.

The key takeaways from Table 3 is that country ETFs have nearly as high risk return tradeoff as the underlying MSCI indices. For investor seeking to invest in the underlying market, country ETFs prove themselves as a reliable alternative when assessing risk adjusted returns alone. Nevertheless, investors trading funds in the US expose themselves to more daily volatility.

Table 3
Risk return relationship

Country	Ticker	Return ETF	Std. ETF	Return NAV	Std. NAV
Japan	EWJ	-6,708 %	1,563 %	-6,804 %	1,475 %
Australia	EWA	63,226 %	1,769 %	63,935 %	1,517 %
Hong Kong	EWH	25,304 %	1,915 %	26,021 %	1,543 %
Singapore	EWS	-18,061 %	1,925 %	-16,503 %	1,521 %
Malaysia	EWM	-86,558 %	2,026 %	-75,308 %	1,682 %
Sweden	EWD	52,473 %	2,086 %	54,483 %	1,882 %
Germany	EWG	61,963 %	1,735 %	62,722 %	1,631 %
Switzerland	EWL	90,860 %	1,436 %	90,664 %	1,203 %
Spain	EWP	42,249 %	1,820 %	43,407 %	1,657 %
Italy	EWI	-20,606 %	1,828 %	-20,456 %	1,696 %
Canada	EWC	76,344 %	1,540 %	76,484 %	1,448 %
Mexico	EWW	282,348 %	1,989 %	285,292 %	1,767 %

Table 3 (Continued)

Country	Ticker	Mean Ret. ETF	Mean Ret. NAV	ETF Ret/Std	NAV Ret/Std
Japan	EWJ	-0,0013 %	-0,0014 %	-0,00085 %	-0,00092 %
Australia	EWA	0,0126 %	0,0127 %	0,00710 %	0,00837 %
Hong Kong	EWH	0,0050 %	0,0052 %	0,00263 %	0,00335 %
Singapore	EWS	-0,0036 %	-0,0033 %	-0,00186 %	-0,00216 %
Malaysia	EWM	-0,0172 %	-0,0150 %	-0,00849 %	-0,00889 %
Sweden	EWD	0,0104 %	0,0108 %	0,00500 %	0,00575 %
Germany	EWG	0,0123 %	0,0125 %	0,00710 %	0,00764 %
Switzerland	EWL	0,0181 %	0,0180 %	0,01257 %	0,01498 %
Spain	EWP	0,0084 %	0,0086 %	0,00461 %	0,00521 %
Italy	EWI	-0,0041 %	-0,0041 %	-0,00224 %	-0,00240 %
Canada	EWC	0,0152 %	0,0152 %	0,00985 %	0,01050 %
Mexico	EWW	0,0266 %	0,0268 %	0,01340 %	0,01516 %

Table 3. Risk return-relationship between the ETF price and its NAV. Returns are calculated for the whole sample period, 1997-2016, using daily logarithmic returns. ETF prices are more volatile than NAV. The risk return relationship between the two are almost similar.

As the volatility of daily ETF returns is higher compared to its underlying NAV, we investigate whether this can be attributed to local or US trading hours. Our hypothesis is that US transitory effects may drive the ETF price out of equilibrium. If daytime return variance for ETFs with zero, or few, overlapping trading hours were higher than the variance during local trading hours, it would help explain that trading during US opening hours have the largest impact on the volatility. It follows that this is not the case for our sample of ETFs (Table 4). The results for countries with zero or few overlapping trading hours, i.e. Europe and Asia, shows that the US overnight volatility is higher. Opposite, for countries that trade simultaneous with the US, we find that daytime return variance is higher. Based on this analysis, information released during local market trading hours seems to have the biggest impact on the ETFs. However, even though local market information has larger impact, it does not imply daytime volatility is fully rational or that temporary mispricing is non-existent.

Table 4
Daytime and overnight return variance

Country	Ticker	Daytime Return Variance	Overnight Return Variance
Japan	EWJ	0,900 %	1,257 %
Australia	EWA	1,150 %	1,443 %
Hong Kong	EWH	1,305 %	1,544 %
Singapore	EWS	1,326 %	1,585 %
Malaysia	EWM	1,365 %	1,718 %
Sweden	EWD	1,301 %	1,627 %
Germany	EWG	1,203 %	1,350 %
Switzerland	EWL	1,082 %	1,202 %
Spain	EWP	1,137 %	1,421 %
Italy	EWI	1,148 %	1,413 %
Canada	EWC	1,224 %	1,136 %
Mexico	EWW	1,681 %	1,338 %

Table 4. Overnight variance is higher for all countries trading non-simultaneously with the US. For countries that trade simultaneously with the US, the daytime return variance is higher. This implies that news released during local trading hours has the largest impact. Returns are daily logarithmic returns from 1997-2016.

6.2 Correlations

The first column of table 5 shows the daily correlation between the ETF and the S&P 500. The two series trade simultaneously and is therefore not affected by asynchronous returns. Correlation varies around 0,6 for most of the ETFs, with Malaysia as the lowest (0,41) and Germany the highest (0,76).

Column "ii" shows the correlation between closing values of NAV and the S&P 500. For countries with zero overlapping trading hours, close to close values underestimates correlations and is not adequate for analysis.

Column "iii" provides a better estimate. As the local market adjusts to news released the previous day in the US, we see that the correlation between the series is much higher. Following Bergomi's (2010) method, we add the two measures together in "iv" to get an approximation of the synchronous correlation. Even after the synchronization method, Japan, Hong Kong, Singapore and Malaysia demonstrates a lower correlation for NAV than for the ETF.

For the European countries, which have partial overlapping trading hours, we discover deviations between the ETF and the close to close values of NAV. This indicates that there may exist tracking errors with the use of daily returns series for the European countries. After the synchronization process, the correlation estimates for the ETF and NAV becomes closer. Hence, an indication that the method is more suitable than using close to close values.

Canada, which trades simultaneous with the US, shows the exact same correlation of 0,66 with the S&P 500 both for the ETF and NAV. Mexico also has quite similar correlations with 0,69 for the ETF and 0,64 for NAV using the close to close values. When funds are tradeable at the same time, we find correlations to be almost identical.

Table 5 illustrates that there exist deviations in daily correlations and possible tracking errors. Based on the comparison of the daily correlation estimates, the country ETFs are likely illustrate a more precise measure of the correlation which drives the motion of securities – even when the local market is closed. It is therefore of interest to study the correlations with different frequencies of returns.

Table 5
Correlations with daily returns

Country	Ticker	i ETF/S&P	ii NAV(t)/ S&P(t)	iii NAV(t+1)/ S&P(t)	iv NAV/S&P
Japan	EWJ	0,625	0,043	0,394	0,437
Australia	EWA	0,637	0,198	0,492	0,689
Hong Kong	EWH	0,676	0,182	0,378	0,560
Singapore	EWS	0,624	0,241	0,321	0,562
Malaysia	EWM	0,408	0,061	0,252	0,313
Sweden	EWD	0,686	0,466	0,272	0,738
Germany	EWG	0,761	0,546	0,219	0,765
Switzerland	EWL	0,647	0,435	0,272	0,706
Spain	EWP	0,676	0,468	0,214	0,682
Italy	EWI	0,668	0,461	0,201	0,662
Canada	EWC	0,660	-	-	0,669
Mexico	EWW	0,694	-	-	0,648

Table 5. ETF and NAV correlations with the S&P 500. NAV/S&P is the synchronized correlation which is the sum of column ii and iii. Columns ii and iii are correlation computed with close-to-close values and correlation between todays S&P and next day NAV. When correlations are computed from close to close values, the ETF offers substantially higher correlation with the S&P500 than for the NAV. When NAV is synchronized the correlations is quite similar. Canada trades simultaneous with the US and offers almost the exact same correlation. Returns are daily logarithmic returns (1997-2016)

In table 6 we present correlations using weekly, monthly and yearly returns for all funds.

For weekly returns, we find that the ETF has a higher correlation with the S&P 500 than the underlying NAV for all asynchronous funds. In addition, the weekly NAV correlation is quite similar to the synchronized daily NAV correlation. Furthermore, the ETF correlation increases. Canada and Mexico still shows similar correlations.

The correlation gap between the series decreases further for monthly returns and is less affected by the synchronization issue. Still, all of the funds shows a higher correlation with the S&P 500 than the NAV.

With yearly returns, correlations are almost identical. NAV correlations now exceeds the ETF correlation for all funds except Malaysia. Due to the stale prices, we see that the unsynchronized NAV correlation substantially increases as sampling frequency decreases. This is the so-called “Epps effect”. In addition, the daily ETF correlation tends to be lower than the yearly ETF correlation for many

of the funds, which indicates that investors do not overly rely on the S&P 500 when the underlying market is closed.

Table 6
Correlations with different frequencies of returns

		Weekly		Monthly		Yearly	
Country	Ticker	ETF	NAV	ETF	NAV	ETF	NAV
Japan	EWJ	0,621	0,434	0,602	0,559	0,595	0,621
Australia	EWA	0,721	0,639	0,778	0,737	0,672	0,674
Hong Kong	EWH	0,652	0,531	0,660	0,634	0,665	0,672
Singapore	EWS	0,649	0,525	0,657	0,637	0,559	0,561
Malaysia	EWM	0,434	0,295	0,344	0,285	0,212	0,193
Sweden	EWD	0,776	0,727	0,819	0,808	0,832	0,846
Germany	EWG	0,806	0,760	0,812	0,790	0,882	0,892
Switzerland	EWL	0,733	0,689	0,776	0,757	0,789	0,805
Spain	EWP	0,705	0,653	0,709	0,690	0,734	0,742
Italy	EWI	0,718	0,675	0,730	0,708	0,799	0,805
Canada	EWC	0,768	0,773	0,773	0,763	0,735	0,747
Mexico	EWW	0,731	0,728	0,721	0,709	0,354	0,356

Table 6 reports correlations with different frequencies of return calculations. The ETF has a higher weekly correlation with the S&P 500. With monthly returns the gap in correlation decreases. With yearly returns, correlations are highly similar. Weekly returns are 5 trading days, monthly 21 and yearly 252 trading days.

6.3 ETF/NAV-Relationship

Before analyzing the actual tracking errors of the funds, a regression is conducted to examine the tracking efficiency. Table 7 presents the relationship between daily ETF and NAV returns.

Table 7
ETF NAV Relationship with daily returns

Country	Ticker	Correlation	Beta Coefficient	R^2
Japan	EWJ	0,504	0,5275	0,25
Australia	EWA	0,580	0,6763	0,34
Hong Kong	EWH	0,521	0,6469	0,27
Singapore	EWS	0,627	0,7929	0,39
Malaysia	EWM	0,594	0,7214	0,35
Sweden	EWD	0,781	0,8654	0,61
Germany	EWG	0,796	0,8471	0,63
Switzerland	EWL	0,710	0,8419	0,50
Spain	EWP	0,801	0,8802	0,64

Italy	EWI	0,808	0,8717	0,66
Canada	EWC	0,835	0,8886	0,70
Mexico	EWW	0,927	0,9686	0,74

Table 7 shows the result from the regression: $ETF\ Return_{i,t} = \alpha + \beta \times NAV\ Return_{i,t} + \varepsilon$. The regression reports the relationship between daily logarithmic ETF returns and daily logarithmic NAV returns (1997-2016). The first column reports the close to close correlation. The last two columns provides the beta coefficient and R^2. The results indicate that the correlation, beta coefficient and the R^2 increases as the funds trades closer to US opening hours.

The correlation is ranging from 0,504 to 0,927. Once again, using close to close values underestimate the correlation. After performing Bergomi's asynchonicity adjustment, the estimates range from 0,804 to 0,979. Daily mispricing prevents the funds from having correlation equal to 1. If the frequency of returns decreases, the correlation would likely move closer to 1.

The effect of asynchronous returns is also observable for the beta coefficients and the explanation power of the regression. We notice that the countries with no overlapping trading hours has the lowest coefficients and R^2, the European countries with partial overlapping trading hours has the second highest coefficients and R^2 while the countries trading simultaneous with the US clearly has the highest coefficients as well as R^2. The results suggest that asynchronous returns play a major role in the efficiency of the funds. Based on the preliminary examination, further analysis of tracking error is needed.

6.4 Tracking Error

Table 8 presents the tracking errors for the countries with no overlapping trading hours. That is, the annualized standard deviation of the funds excess returns. Appendix 4 shows the tracking errors in numerical form. We find the annualized daily tracking errors to be higher than expected. Ranging around 25% for all funds. Honk Kong and Malaysia has the highest with 27%. These numbers show that the country ETFs ability to track the underlying indices is limited on a daily basis. Daily tracking errors of this magnitude also support our findings of differences in correlation. There is reason to believe that the high daily tracking error will affect weekly and possibly monthly correlations.

We find that tracking errors follows the same pattern as correlations. With lower frequency of returns, the tracking error diminish. For weekly returns we see a substantial drop in tracking error, ranging between 10-15% (except Malaysia with 18%). With monthly returns these tracking errors are 5-10% (14 % for Malaysia).

With yearly returns tracking errors decline to 1,4% for Japan, 1,6% for Australia, 1,5% for Hong Kong, 1,6% for Singapore and 3,9% for Malaysia. These are all low tracking errors, and in line of what we would expect from our sample of funds.

Table 8
Annualized ETF Tracking Error with different frequencies of returns

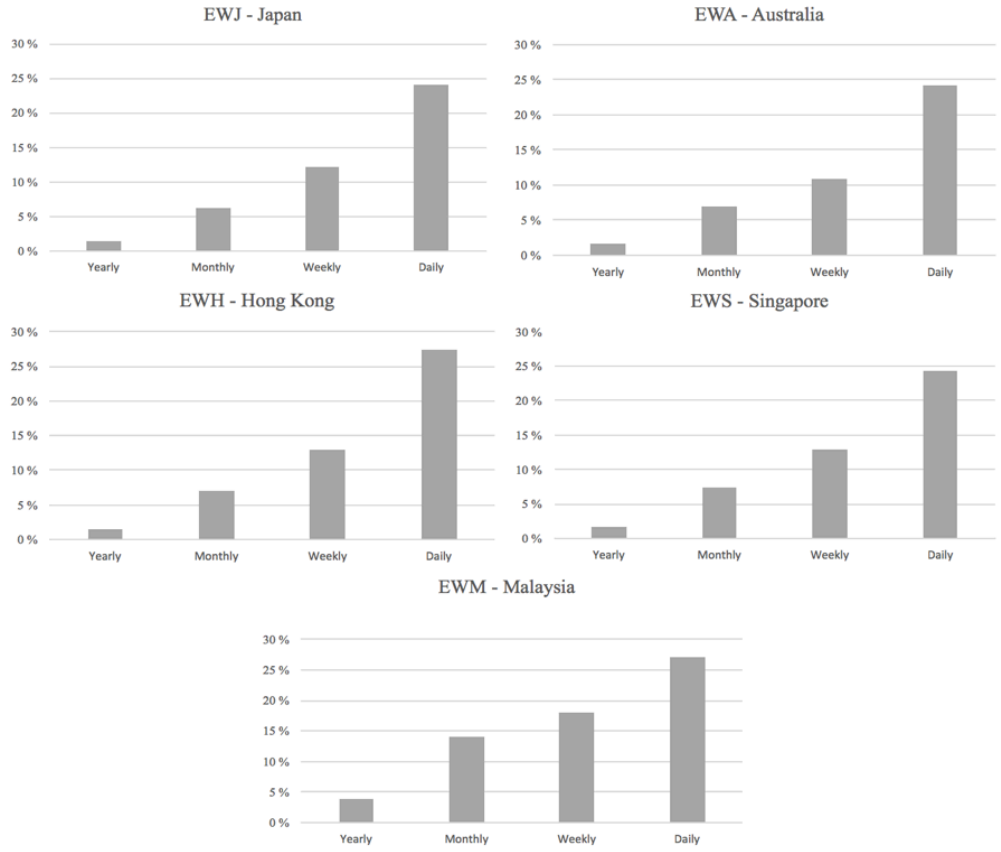

Table 8. Annualized tracking errors for funds with no overlapping trading hours with the US. Calculated with 1, 5, 21 and 252 days of returns. Tracking error is the standard deviation of the funds excess returns. The result shows a decline in tracking error over time.

Table 9 shows the European funds with partial overlapping trading hours, while table 10 shows the countries with overlapping trading hours. We see that all funds follow the same pattern as table 8. The difference is that tracking errors are decreasing with the synchronicity. For the European ETFs, daily tracking error lies in a range of 16-21%. Further, with yearly returns all funds provide more or less the same tracking error ranging between 1-2%.

This shows that all funds are able to track its underlying index and provide the desired exposure with a long enough time perspective. In addition, the funds are sensitive to the number of hours with stale NAV quotes.

Table 9
Annualized ETF Tracking Error with different frequencies of returns

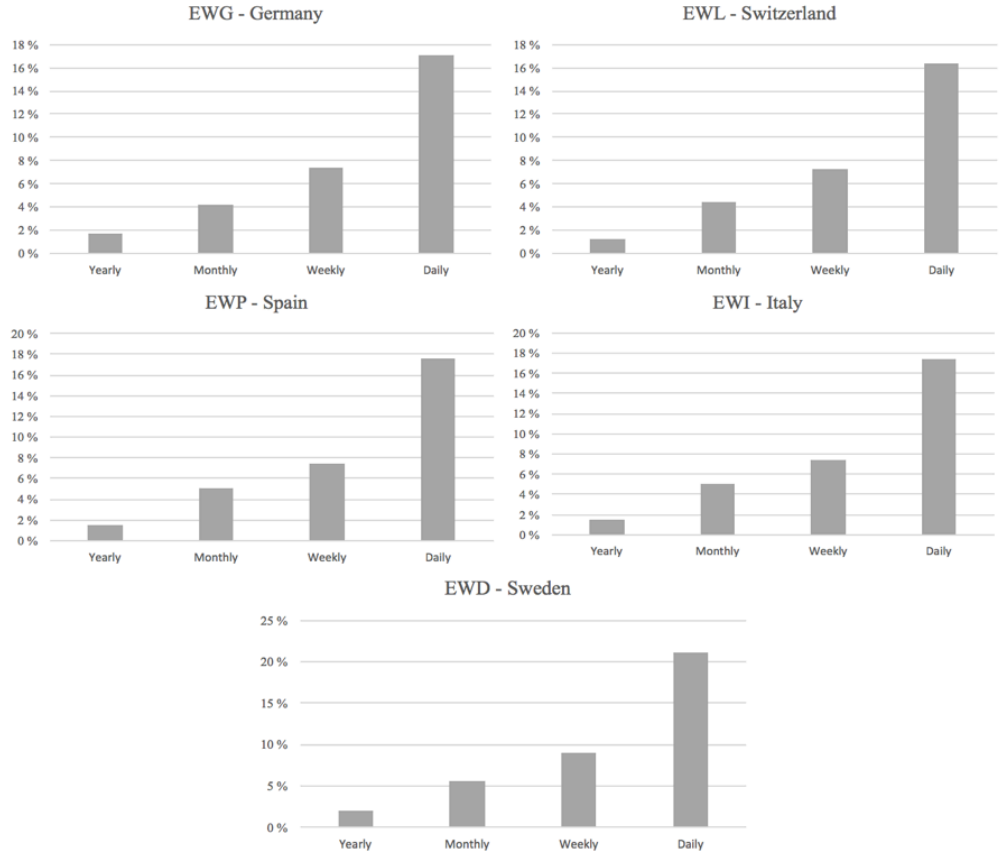

Table 9. Annualized tracking errors for funds with some overlapping trading hours with the US. Calculated with 1, 5, 21 and 252 days of returns. Tracking error is the standard deviation of the funds excess returns.

An interesting finding is the high daily tracking errors of Canada and Mexico. The ETF price and quoted NAV are both tradeable at the same time and we would initially believe that the tracking errors were lower for these two funds. In the next section (6.5) we will look at the determinants of tracking errors and propose possible explanations for these high numbers.

Table 10
Annualized ETF Tracking Error with different frequencies of returns

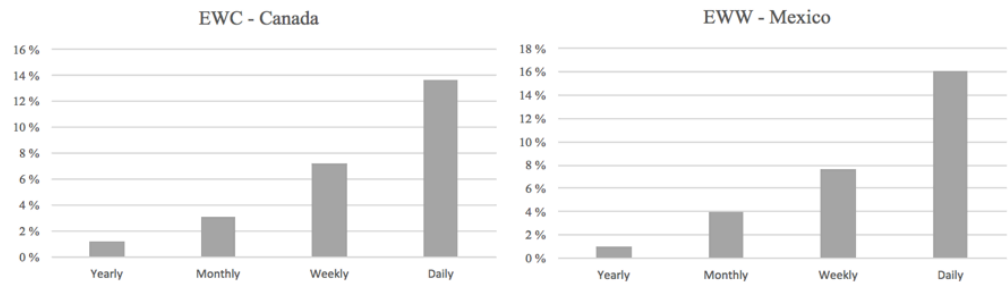

Table 10. Annualized tracking errors for funds trading simultaneous with the US. Calculated with

1, 5, 21 and 252 days of returns. Tracking error is the standard deviation of the funds excess returns.

Appendix 6 includes bi-weekly and quarterly returns for Japan, Germany and Canada. The graphs show the same trend of declining tracking error.

6.5 Determinants of tracking error

Having established that there exist short-term differences in correlations and short-term tracking errors, we wish to gain insight into the determinants.

Table 11 includes exchange rates and US-specific variables proposed to have an effect on premiums and discounts. Table 12 also includes the fundamental component given by daily NAV return.

Table 11 shows that the S&P 500 has a significant effect at the 1% level for all funds. The variable accounts for the largest part of the tracking difference when we exclude the fundamental component. We find that the S&P 500 has a positive effect on the tracking difference for all countries, except Canada. The factor loadings are lower for the ETFs that are traded simultaneously with the US market. This could imply that investors rely more on information in the local market. Hence, tracking difference could be attributed to factors that typically have an impact on domestic funds. For instance, the fund manager's performance and variables such as securities lending, cash drag etc. could be suitable.

Changes in exchange rates are significant for all funds at the 1% level, except Singapore. Along with the return of the S&P 500, exchange rates are found to be the most important variables impacting tracking difference. Currency fluctuations affects tracking difference regardless of hours of asynchronicity.

The trading volume of the funds, their size and bid ask-spread are not found significant for the majority of the ETFs. We would expect to find these variables significant if there existed irrational pricing.

The VIX return and intraday price volatility are variables that we find significant for most of the funds. The significance of these variables could be attributed to the periods of high volatility and crises in our sample (see Appendix 3). When investors are fearful and markets are volatile, index tracking becomes harder and deviations in terms of tracking differences occur.

Furthermore, we find a pattern where R^2 is decreasing with the level of synchronicity. For funds that trade simultaneously with the US, the explanatory power of the regression is weak. Another indication that US-specific factors are not as important for these funds.

Table 11
Regression results – Dependent variable: Tracking Difference ETF

Country	Ticker	Constant	Exchange Rate	Volume	Intraday Price Volat.
Japan	EWJ	-0,0099**	0,1507***	-0,0001	0,6477***
		(0,0039)	(0,0254)	(0,0002)	(0,0865)
Australia	EWA	-0,0006	0,1138***	0,0001	0,1336***
		(0,0040)	(0,0242)	(0,0002)	(0,0175)
Hong Kong	EWH	-0,0280***	1,9989***	-0,0009***	0,2365***
		(0,0042)	(0,6281)	(0,0003)	(0,0181)
Singapore	EWS	-0,0078*	-0,0080	-0,0002	0,1058***
		(0,0040)	(0,0498)	(0,0002)	(0,0250)
Malaysia	EWM	0,0135**	0,7653***	0,0007***	-0,0527
		(0,0060)	(0,0604)	(0,0002)	(0,0629)
Sweden	EWD	-0,0035	-0,0798***	-0,0003	0,0858***
		(0,0028)	(0,0238)	(0,0002)	(0,0157)
Germany	EWG	-0,0024	0,1410***	0,00004	0,0954***
		(0,0025)	(0,0221)	(0,0002)	(0,0134)
Switzerland	EWL	-0,0049**	-0,0942***	-0,0002	0,0785***
		(0,0025)	(0,0181)	(0,0001)	(0,0157)
Spain	EWP	-0,0033	0,1599***	-0,0003**	0,1077***
		(0,0023)	(0,0227)	(0,0001)	(0,015)
Italy	EWI	-0,0032	0,1702***	-0,0002	0,0844***
		(0,0032)	(0,0226)	(0,0001)	(0,0159)
Canada	EWC	0,0001	-0,1768***	-0,00001	-0,0166
		(0,0016)	(0,0252)	(0,0001)	(0,0113)
Mexico	EWW	-0,0024	-0,3629***	-0,0001	0,0332***
		(0,0024)	(0,0235)	(0,0002)	(0,0104)

Table 11 (Continued)

Country	Ticker	S&P Ret.	VIX Ret.	Size	BidAsk-Spread	R^2
Japan	EWJ	0,6347***	-0,0193***	0,0004	0,0044	0,37
		(0,0216)	(0,0040)	(0,0003)	(0,0049)	
Australia	EWA	0,5610***	-0,0181***	-0,0001	0,0006	0,30
		(0,0233)	(0,0042)	(0,0003)	(0,0003)	
Hong Kong	EWH	0,8006***	-0,0107**	0,0018***	0,0007	0,36
		(0,0249)	(0,0047)	(0,0003)	(0,0001)	
Singapore	EWS	0,6613***	-0,0054	0,0005	-0,0010	0,29
		(0,0235)	(0,0044)	(0,0003)	(0,0010)	
Malaysia	EWM	0,4948***	-0,0246***	-0,0012***	-0,0000	0,24

		(0,0261)	(0,0048)	(0,0004)	(0,0005)	
Sweden	EWD	0,4220***	-0,0053	0,0003	0,0009	0,18
		(0,0217)	(0,0040)	(0,0002)	(0,0008)	
Germany	EWG	0,3068***	-0,0116***	0,00003	0,0001	0,18
		(0,0176)	(0,0033)	(0,0002)	(0,0004)	
Switzerland	EWL	0,3116***	-0,0054**	0,0003	-0,0001	0,16
		(0,0174)	(0,0031)	(0,0002)	(0,0004)	
Spain	EWP	0,3125***	-0,0146***	0,0003	-0,0001	0,19
		(0,0180)	(0,0033)	(0,0001)	(0,0006)	
Italy	EWI	0,3036***	-0,0123***	0,0002	-0,0006	0,18
		(0,0180)	(0,0033)	(0,0002)	(0,0005)	
Canada	EWC	-0,0582***	-0,0134***	0,0000	-0,0004	0,02
		(0,0158)	(0,0029)	(0,0001)	(0,0004)	
Mexico	EWW	0,0741***	-0,0053	0,0001	0,0013	0,10
		(0,0183)	(0,0033)	(0,0002)	(0,0031)	

Table 11 reports the results from the regression: $TD\ ETF_{i,t} = \alpha_{i,t} + \beta_1 FXRate_{i,t} + \beta_2 LogVol_{i,t} + \beta_3 PriceVola_{i,t} + \beta_4 LogS\&P_{i,t} + \beta_5 VIX_{i,t} + \beta_7 Size_{i,t} + \beta_8 Spread_{i,t} + \varepsilon_{i,t}$. All variables are daily observations from 1997-2016. The table shows the coefficients of the independent variables where *, **, *** denotes significance at the 10%, 5% and 1% level. Standard errors are given in parentheses. This table includes US transitory effects i.e. it does not include NAV returns. We find that S&P 500 returns, exchange rates and VIX returns is the dominant factors explaining ETF tracking difference. We also see that the model 's explanatory power declines as the level of asynchronicity decreases.

Table 12 includes the local NAV return. We find that NAV returns have significantly negative effect on tracking difference at the 1% level. The R^2 increases for all funds. When both the US and the local markets are synchronized (Canada and Mexico), the NAV has larger effect on tracking difference than other transitory variables. For the asynchronized and partially synchronized markets, the S&P500 becomes a more dominant factor.

Table 12
Regression results: Dependent variable: Tracking Difference ETF

Country	Ticker	Constant	Exchange Rate	Volume	Intraday Price Vola.
Japan	EWJ	-0,0050	-0,1952***	0,0001	0,2141***
		(0,0032)	(0,0216)	(0,0002)	(0,0702)
Australia	EWA	0,0019	0,7089***	0,0001	0,0146
		(0,0031)	(0,0219)	(0,0002)	(0,0139)
Hong Kong	EWH	-0,0193***	1,1577**	-0,0006***	0,1423***
		(0,0036)	(0,5406)	(0,0002)	(0,0157)
Singapore	EWS	-0,0075**	-0,5117***	-0,0003	0,0545**
		(0,0037)	(0,0478)	(0,0002)	(0,0227)
Malaysia	EWM	0,0166***	0,3718***	0,0008***	-0,0673

		(0,0059)	(0,0639)	(0,0002)	(0,0612)
Sweden	EWD	-0,0024	-0,4321***	-0,0002	0,0349***
		(0,0024)	(0,0222)	(0,0002)	(0,0135)
Germany	EWG	-0,0024	0,3861***	0,0001	0,0479***
		(0,0019)	(0,0181)	(0,0001)	(0,0107)
Switzerland	EWL	-0,0031	-0,3033***	-0,0002	0,0267**
		(0,0022)	(0,0174)	(0,0001)	(0,0142)
Spain	EWP	-0,0016	0,4250***	0,0001	0,0473***
		(0,0021)	(0,0208)	(0,0001)	(0,0131)
Italy	EWI	-0,0014	0,4083***	-0,0001	0,02285
		(0,0027)	(0,0203)	(0,0001)	(0,0138)
Canada	EWC	-0,0002	-0,4696***	-0,00003	-0,0301***
		(0,0015)	(0,0256)	(0,0001)	(0,0105)
Mexico	EWW	-0,0008	-0,5587***	-0,00003	0,0137
		(0,0022)	(0,0232)	(0,0001)	(0,0098)

Table 12 (Continued)

Country	Ticker	S&P Ret.	VIX Ret.	Size	Bid Ask
Japan	EWJ	0,6952***	-0,0223***	0,0001	0,0082
		(0,0175)	(0,0032)	(0,0002)	(0,0038)
Australia	EWA	0,5286***	-0,0228***	-0,0002	0,0004
		(0,0183)	(0,0033)	(0,0002)	(0,0005)
Hong Kong	EWH	0,9021***	-0,0102**	0,0013***	0,0004
		(0,0216)	(0,0040)	(0,0003)	(0,0009)
Singapore	EWS	0,7315***	-0,0069	0,0006**	-0,0011
		(0,0214)	(0,0039)	-0,0005	(0,0009)
Malaysia	EWM	0,4913***	-0,0264***	-0,0014***	-0,00001
		(0,0254)	(0,0047)	(0,0004)	(0,0005)
Sweden	EWD	0,6357***	-0,0103***	0,0002	0,0010
		(0,0193)	(0,0034)	(0,0002)	(0,0007)
Germany	EWG	0,6078***	-0,0134***	0,0001	0,0005
		(0,0151)	(0,0026)	(0,0002)	(0,0004)
Switzerland	EWL	0,4832***	-0,0091***	0,0003	0,0001
		(0,0164)	(0,0028)	(0,0002)	(0,0004)
Spain	EWP	0,4755***	-0,0253***	0,0001	0,0000
		(0,0162)	(0,0029)	(0,0002)	(0,0006)
Italy	EWI	0,4562***	-0,0241***	0,0001	-0,0001
		(0,0159)	(0,0029)	(0,0002)	(0,0004)
Canada	EWC	0,1546***	-0,0108***	0,0001	-0,0003
		(0,0165)	(0,0027)	(0,0001)	(0,0004)
Mexico	EWW	0,2514***	-0,0089***	0,0001	0,0020
		(0,0184)	(0,0031)	(0,0002)	(0,0029)

Table 12 (Continued)

Country	Ticker	NAV Return	R^2
Japan	EWJ	-0,5053*** (0,0099)	0,59
Australia	EWA	-0,6209*** (0,0114)	0,56
Hong Kong	EWH	-0,4696*** (0,1145)	0,53
Singapore	EWS	-0,3956*** (0,0123)	0,42
Malaysia	EWM	-0,2445*** (0,0156)	0,28
Sweden	EWD	-0,4089*** (0,0099)	0,39
Germany	EWG	-0,4544*** (0,0086)	0,48
Switzerland	EWL	-0,4118*** (0,0122)	0,32
Spain	EWP	-0,3616*** (0,0091)	0,39
Italy	EWI	-0,3539*** (0,0087)	0,39
Canada	EWC	-0,3294*** (0,0118)	0,16
Mexico	EWW	-0,2707*** (0,0103)	0,21

Table 12 reports the regression results from: $TD\ ETF_{i,t} = \alpha_{i,t} + \beta_1 FXRate_{i,t} + \beta_2 LogVol_{i,t} + \beta_3 PriceVola_{i,t} + \beta_4 LogS\&P_{i,t} + \beta_5 VIX_{i,t} + \beta_6 Size_{i,t} + \beta_7 Spread_{i,t} + \beta_8 NAV_{i,t} + \varepsilon_{i,t}$. All variables are daily observations from 1997-2016. The table shows the coefficients of the independent variables where *, **, *** denotes significance at the 10%, 5% and 1% level. Standard errors are given in parentheses. This table includes NAV returns which has a negative significant effect at the 1% level for all funds. The R^2 is higher as this regression includes NAV returns. We find that exchange rates, S&P 500 returns, intraday price volatility, VIX returns and NAV returns are the dominant factors when explaining ETF tracking difference.

The analysis of determinants shows that the level of synchronicity has a large effect on whether the independent variables has explanatory power. For asynchronous markets, tracking difference are mainly driven by public information released in the US, the local market as well as currency fluctuations. Moreover, how volatile and fearful the markets are, determine the funds ability to trade close to its underlying. We find that volume, bid ask-spreads and fund size

has less explanatory power. Hence, the results indicate that investor sentiment has limited effect upon tracking differences.

That leads us to the question if the short-term deviations between ETF prices and the fundamental value of the benchmarks are rational or irrational. Due to asynchronicity, the S&P 500 returns accounts for the largest part of the ETF returns while the local market is closed. Nonetheless, one should not exclude that this is reasonable reactions to information that also affect the underlying stock markets.

7. Conclusion

The iShares country ETFs proves themselves as a reliable investment vehicle to obtain nearly the same risk return tradeoff as the underlying MSCI indices. For investors seeking to invest in the underlying market, country ETFs are beneficial alternatives when assessing risk adjusted returns alone. Nevertheless, investors trading funds in the US expose themselves to slightly more daily volatility.

The daily return series shows that the ETF offers a higher correlation with the US market than its underlying. For weekly and monthly returns, the correlation is still higher than the underlying correlation. With yearly returns the two series offers the same correlation with the US market. For countries that trade simultaneous with the US there exist no difference in correlations.

Differences in correlations implies the existence of tracking errors. We find that tracking errors diminish over time. In addition, tracking errors are higher for funds with less overlapping trading hours. Hence, we can conclude that country ETFs provide the same international diversification opportunity and nearly the same risk return tradeoff as investing in the MSCI indices in the long run.

We find that exchange rates, S&P 500 returns, intraday price volatility, VIX returns and NAV returns are significant variables explaining ETF tracking difference. The variables have more explanatory power for countries that do not trade simultaneous with the US.

Volume, bid ask-spread and assets under management are not found to have a significant effect upon tracking difference. Also, in asynchronous markets the overnight return variance of the ETF is higher than daytime variance. This indicates that public news released during local trading hours are most relevant in

the pricing of ETFs. The tests conducted in the thesis and in previous research struggles to provide sufficient evidence to explain if US-specific variables represents irrational pricing. Hence, we can only conclude that differences in correlation are mainly due to asynchronous returns.

Future improvement for the ETF industry could be to incorporate reliable and precise estimated NAV values. When this data becomes available to the public, the predictability of international diversification through ETF will increase and make the funds even more attractive.

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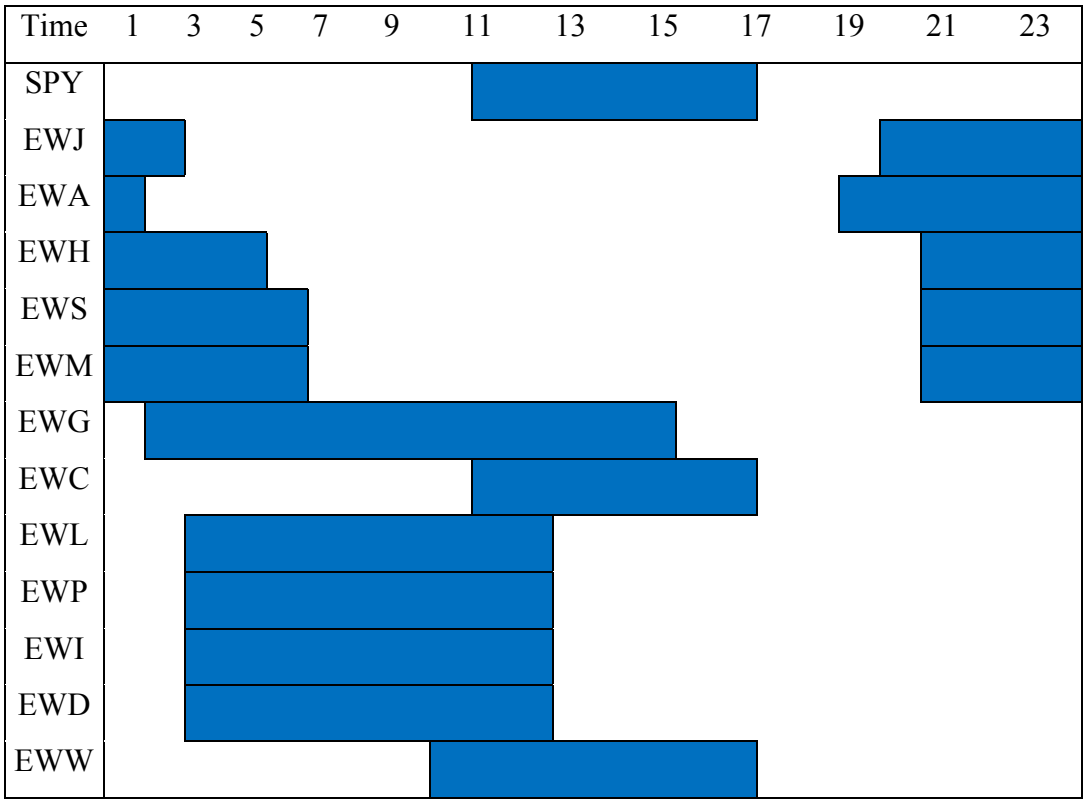
9. Appendix

Appendix 1

Trading Hours Eastern Time (New York)

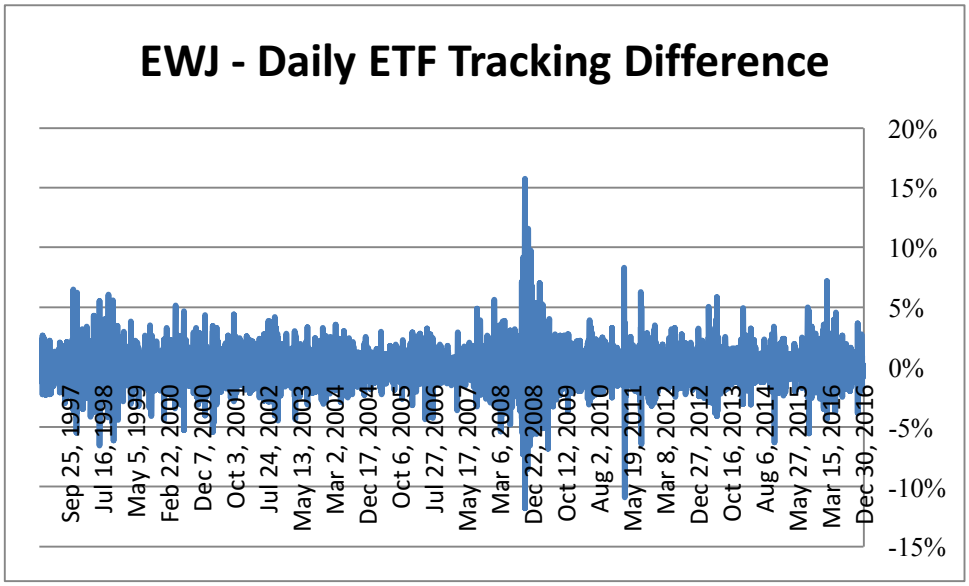


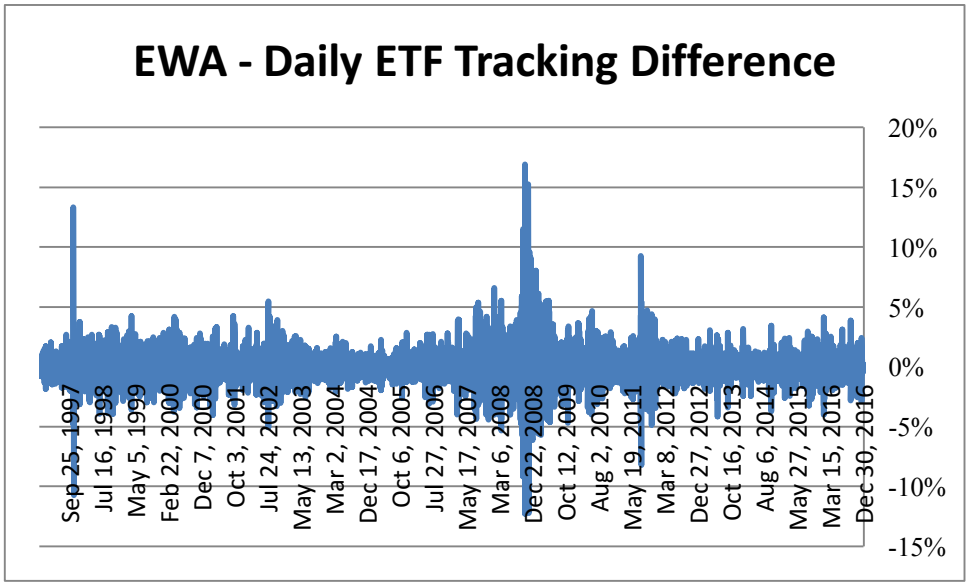
Appendix 2

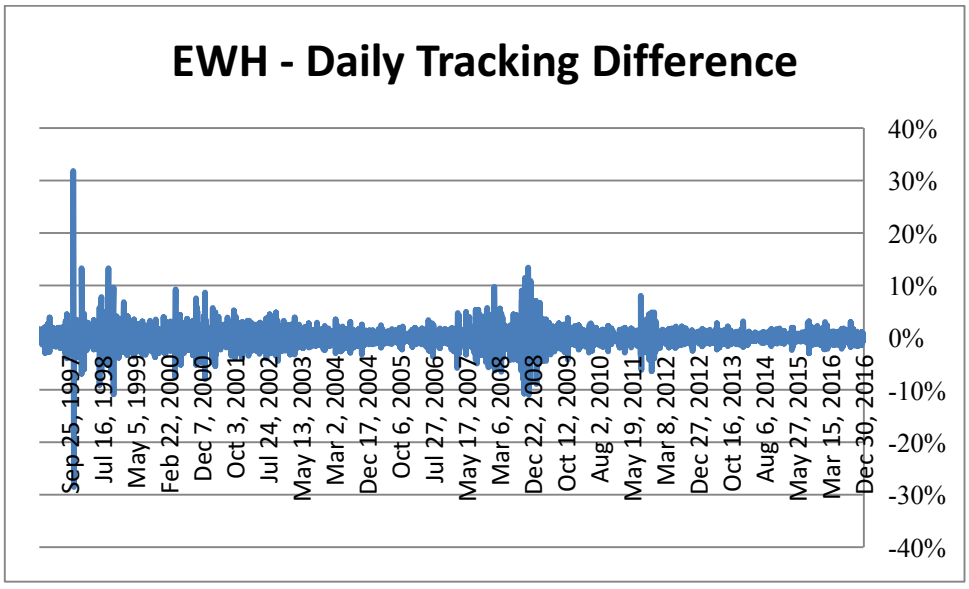
Assets under management

Country	Ticker	Assets under management (USD)
Japan	EWJ	15 894 090 933,85
Australia	EWA	1 745 599 079,08
Hong Kong	EWH	1 843 449 388,70
Singapore	EWS	598 986 676,21
Malaysia	EWM	437 227 308,69
Sweden	EWD	455 811 464,82
Germany	EWG	4 818 847 373,99
Switzerland	EWL	1 252 305 283,33
Spain	EWP	1 520 255 244,41
Italy	EWI	826 825 448,20
Canada	EWC	3 093 287 470,98
Mexico	EWW	1 323 874 960,97

Appendix 3


EWJ - Daily ETF Tracking Difference
20%
15%
10%
5%
0%
-5%
-10%
-15%
Sep 25, 1997
Jul 16, 1998
May 5, 1999
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
Oct 12, 2009
Aug 2, 2010
May 19, 2011
Mar 8, 2012
Dec 27, 2012
Oct 16, 2013
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016


EWA - Daily ETF Tracking Difference
20%
15%
10%
5%
0%
-5%
-10%
-15%
Sep 25, 1997
Jul 16, 1998
May 5, 1999
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
Oct 12, 2009
Aug 2, 2010
May 19, 2011
Mar 8, 2012
Dec 27, 2012
Oct 16, 2013
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016


EWH - Daily Tracking Difference
40%
30%
20%
10%
0%
-10%
-20%
-30%
-40%
Sep 25, 1997
Jul 16, 1998
May 5, 1999
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
Oct 12, 2009
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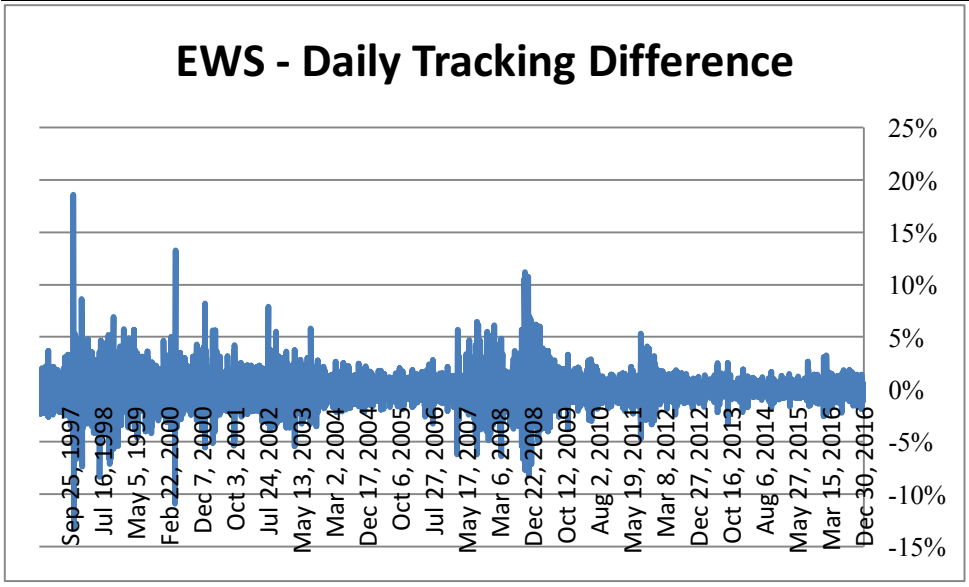
May 19, 2011
Mar 8, 2012
Dec 27, 2012
Oct 16, 2013
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016


EWS - Daily Tracking Difference
25%
20%
15%
10%
5%
0%
-5%
-10%
-15%
Sep 25, 1997
Jul 16, 1998
May 5, 1999
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
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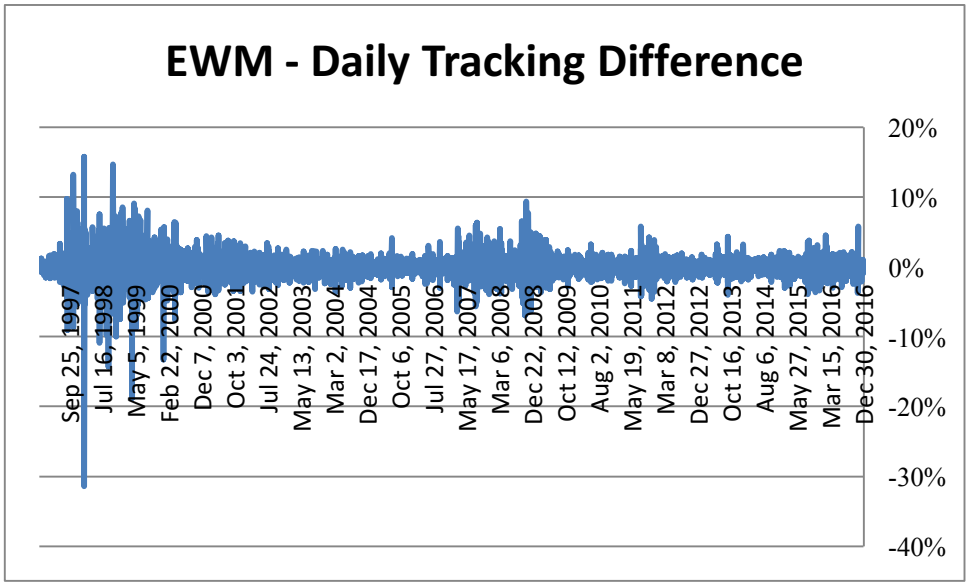
Aug 2, 2010
May 19, 2011
Mar 8, 2012
Dec 27, 2012
Oct 16, 2013
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016


EWM - Daily Tracking Difference
20%
10%
0%
-10%
-20%
-30%
-40%
Sep 25, 1997
Jul 16, 1998
May 5, 1999
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
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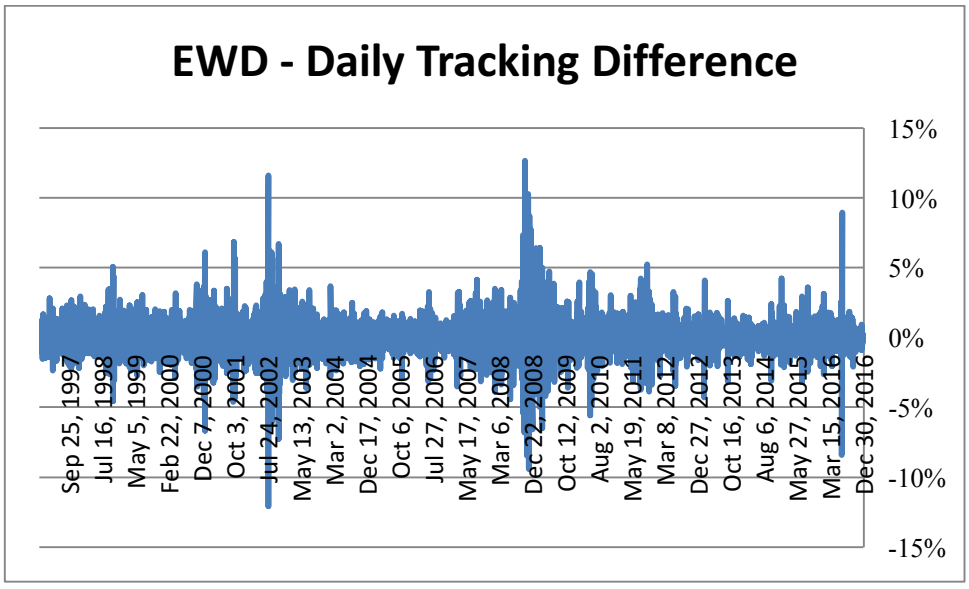
Mar 8, 2012
Dec 27, 2012
Oct 16, 2013
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016


EWD - Daily Tracking Difference
15%
10%
5%
0%
-5%
-10%
-15%
Sep 25, 1997
Jul 16, 1998
May 5, 1999
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
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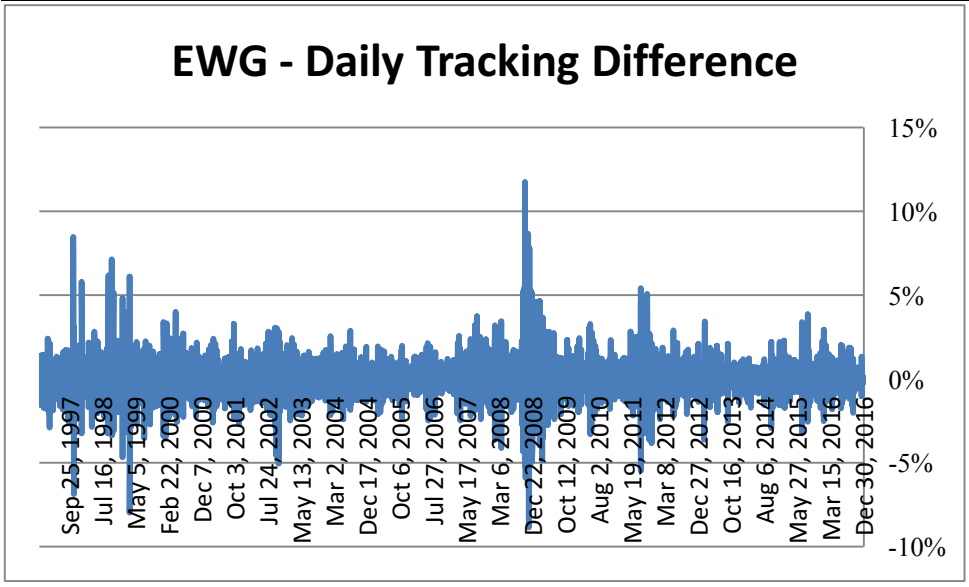
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016


EWG - Daily Tracking Difference
15%
10%
5%
0%
-5%
-10%
Sep 25, 1997
Jul 16, 1998
May 5, 1999
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
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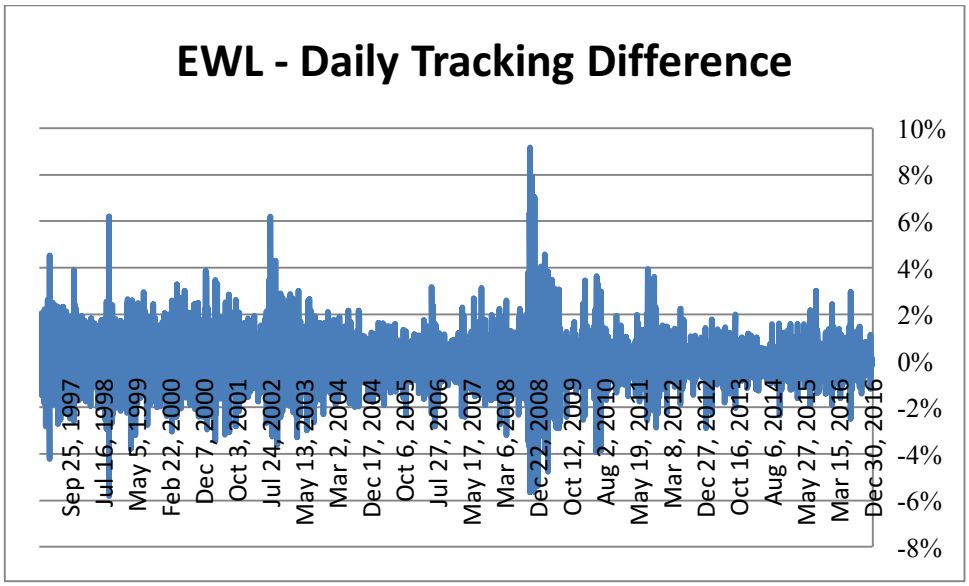
Mar 8, 2012
Dec 27, 2012
Oct 16, 2013
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016


EWL - Daily Tracking Difference
10%
8%
6%
4%
2%
0%
-2%
-4%
-6%
-8%
Sep 25, 1997
Jul 16, 1998
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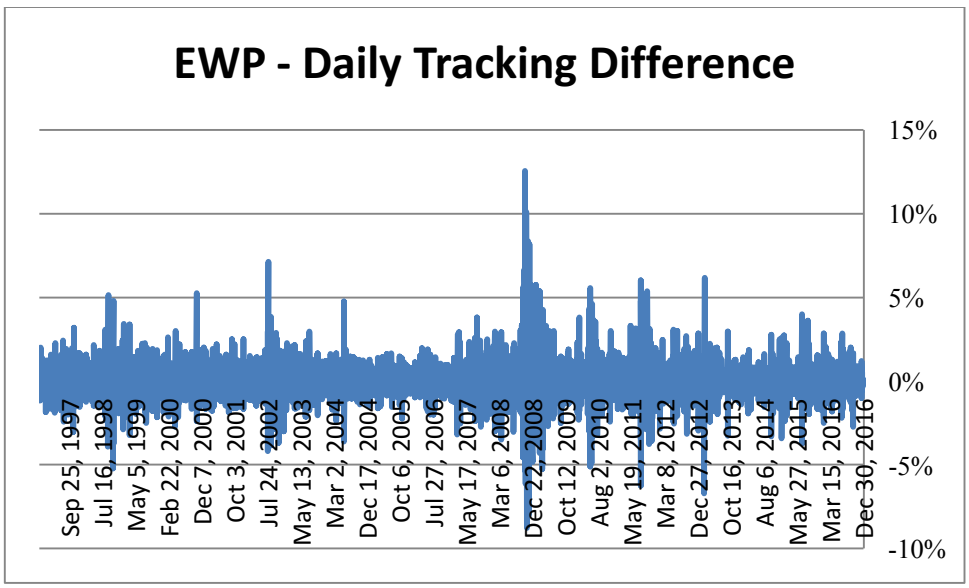
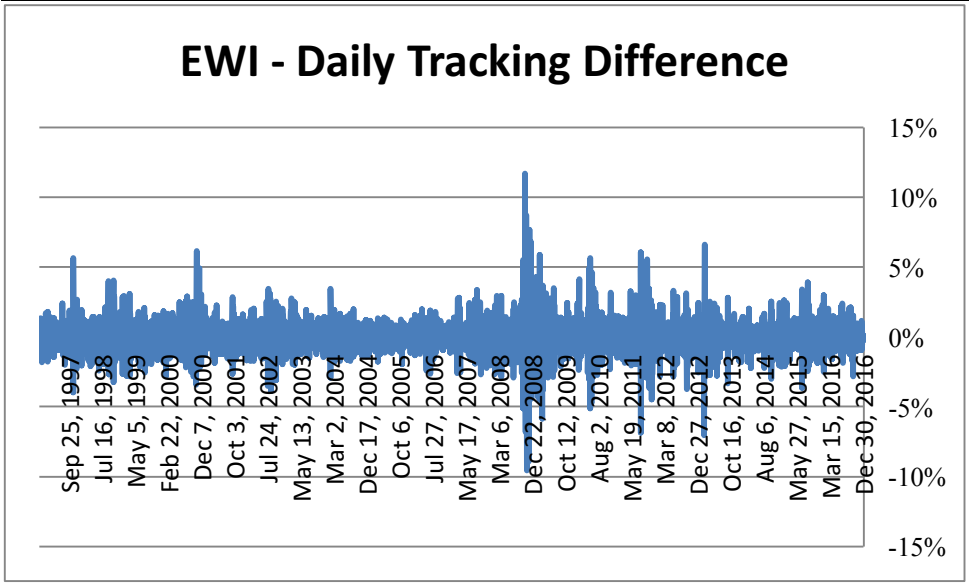
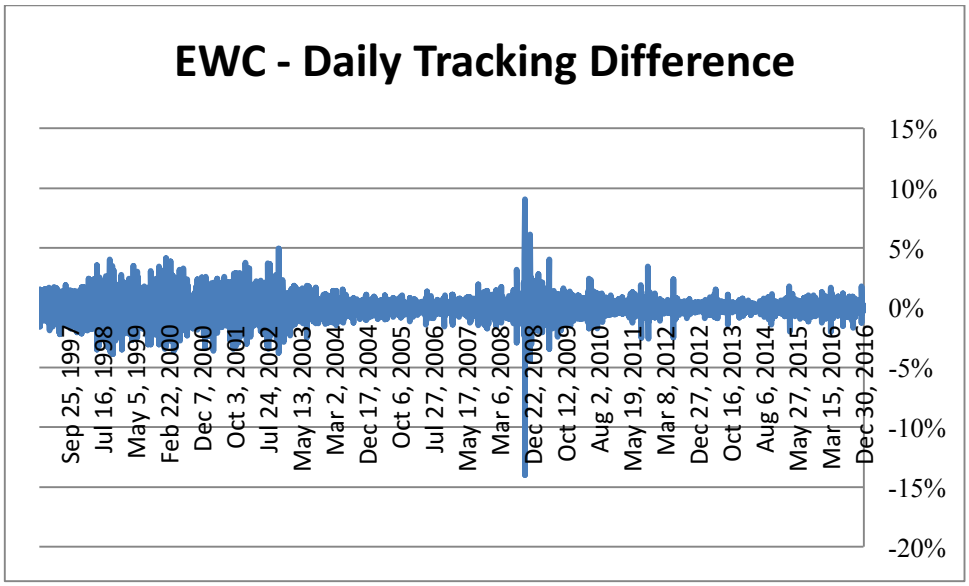
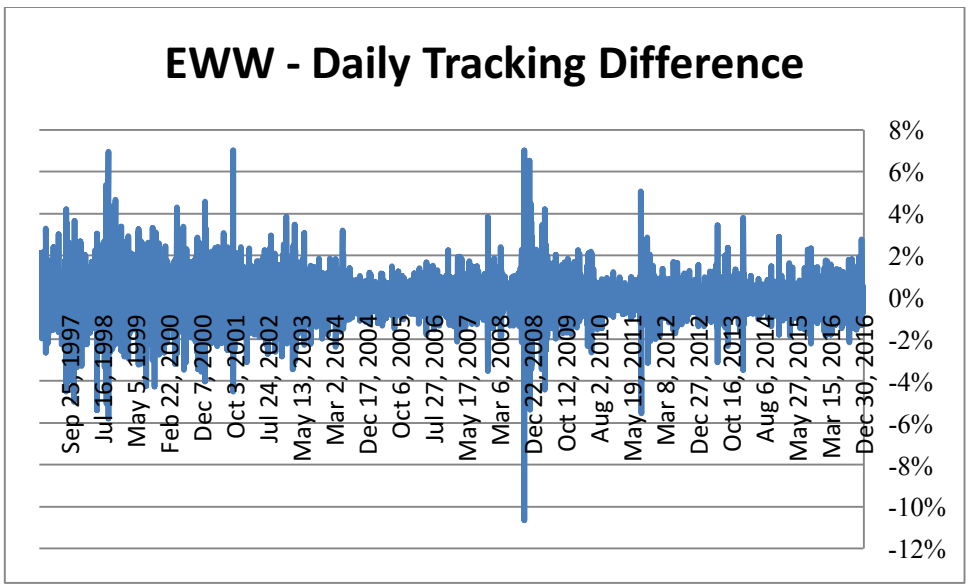
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
Oct 12, 2009
Aug 2, 2010
May 19, 2011
Mar 8, 2012
Dec 27, 2012
Oct 16, 2013
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016


EWP - Daily Tracking Difference
15%
10%
5%
0%
-5%
-10%
Sep 25, 1997
Jul 16, 1998
May 5, 1999
Feb 22, 2000
Dec 7, 2000
Oct 3, 2001
Jul 24, 2002
May 13, 2003
Mar 2, 2004
Dec 17, 2004
Oct 6, 2005
Jul 27, 2006
May 17, 2007
Mar 6, 2008
Dec 22, 2008
Oct 12, 2009
Aug 2, 2010
May 19, 2011
Mar 8, 2012
Dec 27, 2012
Oct 16, 2013
Aug 6, 2014
May 27, 2015
Mar 15, 2016
Dec 30, 2016







Appendix 3. (Tracking Difference=ETF return–NAV return). Returns are daily logarithmic returns (1997-2016)

Appendix 4

NAV Tracking Error with daily returns

Country	Ticker	NAV Tracking Error
Japan	EWJ	2,273 %
Australia	EWA	4,073 %
Hong Kong	EWH	5,610 %
Singapore	EWS	-0,041 %
Malaysia	EWM	14,326 %
Sweden	EWD	6,701 %
Germany	EWG	-0,020 %
Switzerland	EWL	3,597 %
Spain	EWP	4,414 %
Italy	EWI	5,356 %
Canada	EWC	6,916 %
Mexico	EWW	4,068 %

Appendix 4 reports the NAV tracking error with daily logarithmic returns. NAV tracking error is not affected by asynchronous returns and varies between all funds with no clear pattern. These numbers are much lower than the ETF tracking error. With yearly return series the numbers are substantially declines, which indicates that the funds NAV trades close to its underlying MSCI index.

We apply the formula: $Tracking\ Error\ NAV_{i,t} = \sqrt{\frac{\sum(NAV\ Return_{i,t} - Index\ Return_{i,t})^2}{n-1}}$

Appendix 5

Annualized Tracking Error with different frequencies of returns

Country	Ticker	Daily	Weekly	Monthly	Yearly
Japan	EWJ	24,0359 %	12,0837 %	6,2292 %	1,4300 %
Australia	EWA	24,1606 %	10,8778 %	6,9986 %	1,6289 %
Hong Kong	EWH	27,3394 %	12,9142 %	7,0664 %	1,5233 %
Singapore	EWS	24,3283 %	12,8190 %	7,3448 %	1,6000 %
Malaysia	EWM	27,1336 %	17,9657 %	13,9759 %	3,9566 %
Sweden	EWD	21,0845 %	8,9334 %	5,6725 %	2,0873 %
Germany	EWG	17,1195 %	7,3462 %	4,2408 %	1,7445 %
Switzerland	EWL	16,3170 %	7,3033 %	4,4305 %	1,2807 %
Spain	EWP	17,5778 %	7,4906 %	5,0347 %	1,5554 %
Italy	EWI	17,4545 %	7,3644 %	5,0952 %	1,5251 %
Canada	EWC	13,6943 %	7,2217 %	3,0859 %	1,2061 %
Mexico	EWW	16,0936 %	7,6873 %	3,9855 %	1,0132 %

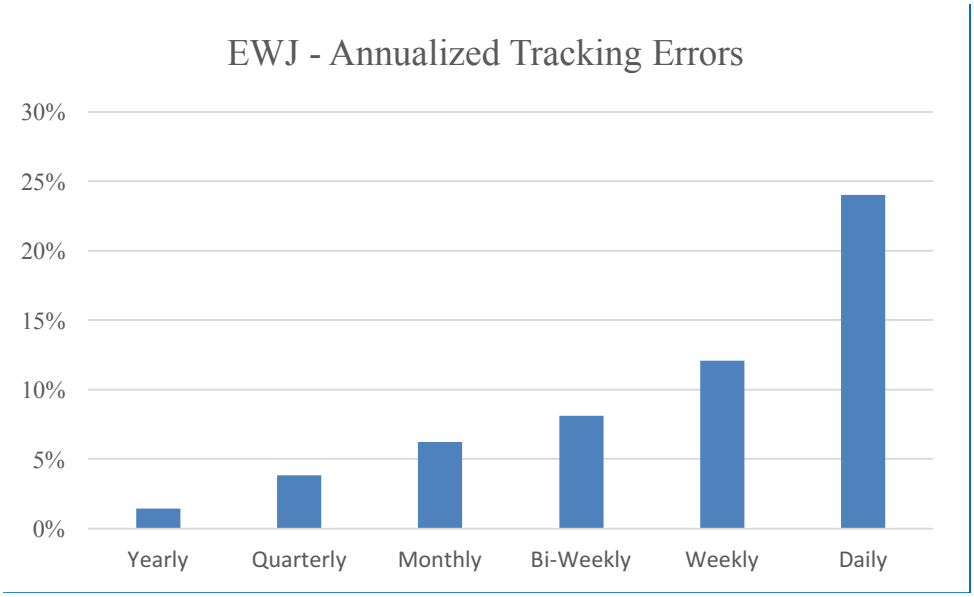
Appendix 5. Tracking Errors for all funds with different frequencies of returns. Graphically displayed in table 8,9,10

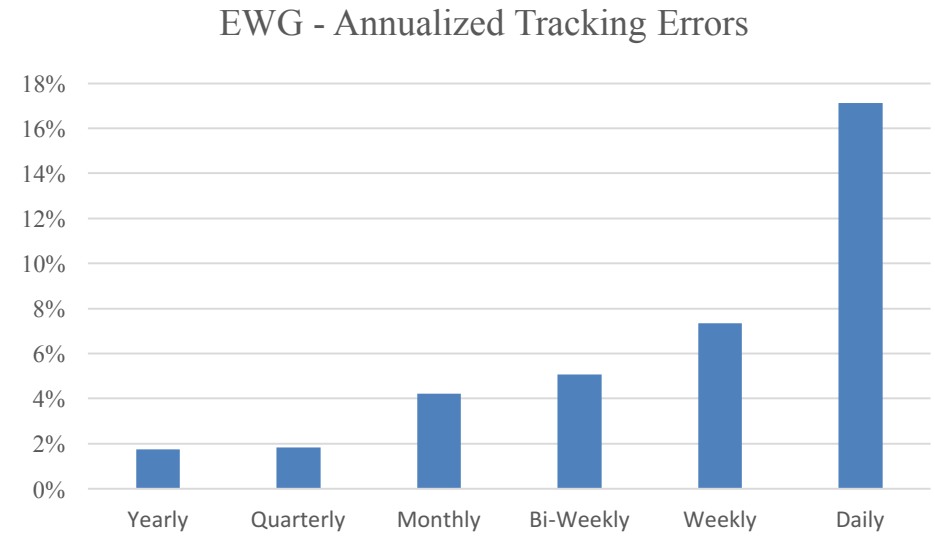
Appendix 6

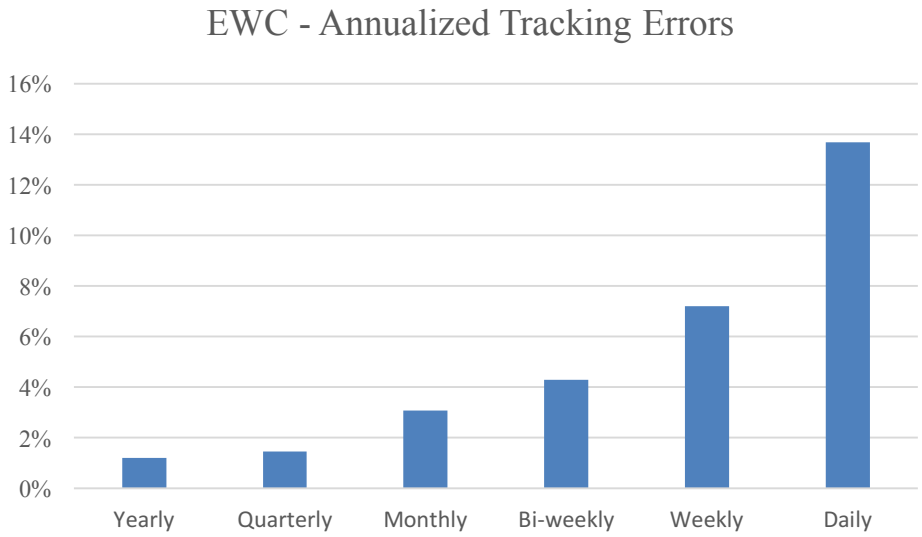
Quarterly and bi-weekly tracking errors

Country	Ticker	Tracking Error (bi-weekly)	Tracking Error (quarterly)
Japan	EWJ	8,0956%	3,8284%
Germany	EWG	5,0724%	1,8400%
Canada	EWC	4,2882%	1,4559%

Appendix 6. Bi-weekly and quarterly returns (10 and 63 days) shows that the annualized tracking errors follows the pattern as for daily, weekly, monthly and yearly returns. The three countries represent the three different time zones.






EWC - Annualized Tracking Errors
16%
14%
12%
10%
8%
6%
4%
2%
0%
Yearly
Quarterly
Monthly
Bi-weekly
Weekly
Daily