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Signal or Noise: the effect of iShares ownership on the volatility of the underlying stocks during market turmoil

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Abstract

This paper analyses the impact, transmission mechanism and implications of US-traded iShares country exchange-traded funds for the return volatility of the underlying stocks during calm and volatile market periods in the US and local economies. We investigate whether iShares transmit adverse volatility developments to the underlying stocks and identify a potential channel for this transmission. Using a sample of 21 iShares funds with observations from December 2006 to December 2019, we employ monthly iShares ownership and creation-redemption intensity measure to study ETFs' impact on stock return volatility, pricing efficiency metrics and proxies for the riskiness of the underlying stocks. We identify that trading time discrepancy with the US and iShares' mispricing asymmetry are the main determinants of the extent of turmoil propagation via corresponding funds to the underlying securities. Overall, this research contributes to the literature by studying the impact of US-traded ETFs on their underlying foreign stocks during US and local turmoil periods and identifying the arbitrage channel as a potential determinant of this impact. In the light of increasing globalization and diminishing barriers to international arbitrage, the insights of this paper about the ability of the arbitrage mechanism to transmit US volatility to other markets could be of interest to investors and especially policymakers.

1. Introduction

Exchange-traded funds (ETFs) are increasing in popularity – since the introduction of ETFs in the early 1990s, they have become an integral part of the equities market – assets under management (AUM) in ETFs in the US has surpassed 2.5 trillion USD (3.5 trillion USD globally), taking 35% of total US equities market (Ben-David et.al., 2018).

What makes ETFs so popular is simple and cheap diversification this investment vehicle offers – by investing in an ETF, the investor gains exposure to several underlying securities at a time. In addition, ETFs offer increased liquidity and positions which are easy to liquidate on the stock markets, implying reduced holding risk. Moreover, retail investors can short-sell and leverage their investments – trading strategies which are often prohibited or limited in other investment vehicles (Ben-David et.al., 2017).

However, a growing concern for policymakers and regulators has been potential adverse effects of ETFs on the underlying securities and stock markets.

Country ETFs, in particular, allow investors to access foreign markets at low cost and in a convenient currency, as well as can be traded when underlying markets are closed (Tse & Martinez, 2007). However, the existence of country ETFs can have an unintentional impact on the underlying markets due to the mechanical nature of ETFs. Liquidity and low trading costs of ETFs attract high trading frequency and due to the arbitrage mechanism, prices of an ETF and its underlying move together, leading to increased volatility of the underlying (Ben-David et.al., 2018). Since the mechanics of exchange-traded funds involves intraday arbitrage enticed by a mispricing between an ETF and its underlying stocks, it is important to establish whether arbitrageurs can transmit non-fundamental volatility to the underlying securities by trading the underlying basket in response to shocks to ETF prices. In case of US-traded country ETFs, this propagation may result in the US market indirectly affecting the volatility of the foreign markets via ETF arbitrage, therefore distorting local equity markets and negatively affecting investor returns (Filippou et. al., 2019).

Therefore, the aim of this paper is to study whether such effect is possible and what its implications for the underlying stocks are. The effect we conjecture country funds can have on the underlying equities is similar to that of Ben-David et. al. (2018), i.e. ETFs can add *noise* to the underlying securities by increasing return volatility and diminishing pricing efficiency. We believe that while iShares give US investors access to the foreign markets, they also expose those markets to demand shocks from the US via arbitrage, thus serving as a conduit of unrelated shocks to the local markets, especially during times of high US market volatility, otherwise referred to as US *turmoil* throughout the paper.

Among other aspects, the effect of country ETFs has been explored by academic literature from the perspective of the funds' impact on the underlying securities' pricing efficiency. Since some US-listed country ETFs are traded when the underlying markets are closed, e.g. iShares tracking Asian equities, price discovery can happen at the ETF-level (Tse & Martinez, 2007). Moreover, arbitrage trading can make foreign equity markets more liquid; alternatively, ETFs can absorb some volatility from the underlying markets, which is an effect similar to the Grossman (1989) observations about the role of futures in the decrease of spot market volatility. Tse and Martinez (2007) show that country ETFs, in particular, may absorb some of the demand for the underlying securities by being a more liquid investment vehicle with broad exposure at low cost. This conjecture is labelled as the "liquidity buffer" hypothesis in this paper, similar to Ben-David et. al. (2018). Nevertheless, as Ben-David et. al. (2018) note, ETFs can be subject to liquidity shocks that could be transmitted to the underlying basket due to arbitrage (the "liquidity trading" hypothesis). Thus, in case of the country funds in particular, a shock unrelated to the fundamentals of the underlying foreign markets that hits country ETFs can be propagated to the respective stocks. Consequently, as the two hypotheses posit, the presence of a country fund can hypothetically both reduce and increase stocks' volatility. Moreover, implications of an increase in volatility can also vary. For instance, increased volatility may be a result of unnecessary trading that would distort informational efficiency of prices, thus propagating *noise*; or, this trading may impound relevant information thus improving pricing efficiency by being a *signal*. Therefore, in a similar fashion to Ben-David et. al. (2018), this study aims to separate the two opposite hypothetical effects of country ETFs on the underlying equities – the signal and the noise. Moreover, the mechanics of country ETFs, in particular, make them an especially interesting asset class to analyse with regard to assessing the impact of shocks in the ETFs' domestic market and constituents' home market. As emphasised earlier, since sample ETFs are traded in the US, their prices may be subject to both the US and foreign volatility and risks, as shown by Zhong and Yang (2005). Therefore, given the presence of sufficient arbitrage between an ETF and its basket, a US-related shock to ETF price can impact the underlying securities. Similarly, a shock to foreign underlying markets can either amplify the volatility impact or weaken the ETF effect on stocks' volatility due to riskier arbitrage.

The analysis of the impact of the country ETFs on the volatility of the underlying foreign equities in this paper thus tries to establish the effect that sample ETFs can have on the volatility of the foreign securities during periods of US and foreign market turmoil periods as well as identify one of the mechanisms behind this effect and emphasize its implications. Therefore, first, we analyse the impact of iShares ownership on a monthly level using a panel data of the underlying stocks. To capture the role of high market volatility, we employ dummy variables corresponding to US, local and joint market turmoil periods. In order to establish the role of arbitrage activity in the conjectured impact, this paper employs two methods. Firstly, we construct a measure of the intensity of the in-kind creation-redemption process, which serves as a proxy for arbitrage intensity. Secondly, we explore daily ETF mispricing as a metric of expected arbitrage activity. Finally, the implications of iShares ownership and arbitrage intensity for the foreign equities are studied by analysing their impact on several proxies of pricing efficiency and lower tail risk.

Primarily, our findings suggest that iShares tend to increase return volatility of North American country ETFs during high US and joint volatility periods, mostly via arbitrage activity, which results in negative autocorrelation of stock returns, resembling findings of Ben-David et. al. (2018). Secondly, we find that opposite to the first group, the impact of several European and large Asian funds on the constituents' volatility resembles the liquidity buffer hypothesis most. The presence of those ETFs leads to lower trading session return volatility during tranquil periods, especially for European securities, but comes at the cost of lower pricing efficiency or higher intraday volatility when ETFs are more likely to be distorted by US market-wide events. Finally, for Asian iShares traded at a premium during US market turmoil, arbitrage channel leads to higher return volatility without lower pricing efficiency. Therefore, our findings emphasize that local stock market's trading time difference with the US as well as the sign of ETF mispricing during US turmoil proxy for the extent and implications of market volatility transmission via iShares to the underlying stocks.

Only two papers to our knowledge have researched volatility spillover effects between international ETFs and their underlying indices – Rompotis (2018) and Chen & Huang (2010). Contribution to the existing research of this study is that it analyses the volatility effect of ETFs on the underlying foreign equities in both developed and emerging stock markets during turmoil periods captured in the selected time frame. Moreover, this research uses country iShares ownership in the underlying stocks as a proxy for ETF presence and analyses the role of arbitrage channel in a cross-country setting, unlike previous literature about international ETFs. Finally, this paper appears to be first to attempt to establish the role of the arbitrage channel in the fund's impact on the foreign underlying stocks. This novelty might be especially relevant due to increasing global stock market interconnectedness and diminishing impediments to international arbitrage. Consequently, the research addresses two major topics in the context of international ETFs: (1) the impact of ETFs on foreign stocks in the context of market volatility; (2) the effect of ETF presence on the volatility generating process of the underlying securities.

The research questions that this paper attempts to answer are defined as follows:

1. What is the effect of iShares ETFs during market turmoil on the volatility of the underlying securities?
2. What are the mechanisms and implications of the observed effect for the underlying stocks?

The remainder of this paper is organized as follows: Section 2 provides an overview of previous research on the topic and outlines three hypotheses for the paper. Section 3 summarises the data and sources used. Section 4 provides an overview of the methods used. Section 5 describes the main findings and results. Section 6 discusses the yielded results. Section 7 tests the robustness of the findings. Section 8 summarises the results and concludes.

2. Literature review and Hypotheses

The literature review is structured as follows – first, we explain the mechanics of ETFs. Second, the influence of ETFs on the market and underlying securities is discussed to grasp a better understanding of the focal part of the paper – volatility transmission between international ETFs and the underlying securities during market turmoil periods. As volatility impact of the international ETFs during market turmoil periods have not been broadly researched, we analyze prior relevant literature on the topic that is focused on ETFs without a specific emphasis on the effects of market stress.

2.1. The Mechanics of ETFs

ETFs are investment entities that issue securities – ETF shares – which are traded continuously on stock exchanges. ETFs usually track a securities index – it might consist of stocks, bonds, industries, commodities, currencies, and other financial assets. From a legal point of view, most ETFs are organized as open-ended investment firms – the number of shares issued and traded by an ETF theoretically are unlimited, that is, a fund can sell as many shares as necessary to make up to the demand of investors. Mutual funds operate similarly; however, ETFs are traded throughout the trading day, while mutual fund shares are redeemed only at the end of the trading day. It implies that ETF shares can be traded at a premium or discount as compared to the net asset value (NAV), unlike mutual fund shares which are traded at NAV at the end of the trading day (Ben-David et.al., 2017).

However, deviations of ETF prices from NAV are usually not significant – arbitrageurs and authorized participants (APs) correct the mispricing and drive the price close to NAV. That can be achieved due to the dual nature of ETFs – they possess characteristics of both open and closed-end funds. The openness – the unlimited issue of shares – allows ETF prices to deviate from the NAV much less than closed-end funds do, which have limited number of shares that are traded on public exchanges and the price of which is solely driven by market demand and supply (Thaler et.al., 1991).

APs are a small group of institutions that have the permission to trade with the ETF sponsor directly on the primary market and issue or redeem ETF shares in creation units (at a time up to 50,000 ETF shares are created/redeemed). These transactions usually happen in kind, not in cash – ETF shares are exchanged for the underlying securities by APs in the creation process and vice-versa for redemption. This mechanism permits APs to eliminate arbitrage opportunities – they buy the cheapest of the two and exchange it for the more expensive asset via an ETF sponsor. Then, on the secondary market, they sell the more expensive asset just bought, cashing in the profit. With supply rising in the more expensive asset and decreasing in the cheaper asset, the prices converge (Sushko & Turner, 2018). Secondary market arbitrageurs can track the price of ETF on public exchanges and the NAV of the underlying is calculated every 15 seconds over the trading day and use the arbitrage opportunity when transaction costs do not exceed the price discrepancy.

There are two main types of ETFs – physical and synthetic. Physical ETFs replicate the underlying basket of securities by holding all or majority of them in replicating weights with the purpose of reaching very similar returns to the underlying. In contrast, synthetic ETFs hold not individual securities, but their derivatives, usually total return swaps. As mentioned above, the creation and redemption of physical ETFs occurs in payments in kind, while the creation of synthetic ETFs occurs in cash (Antoniewicz, & Heinrichs, 2014).

Physical ETFs can be further split into two groups – those which require full replication and those which use optimization strategy. As the name says, replicated ETFs buy all securities that they track, as opposed to the optimized ETFs – they only purchase securities which create a representative selection of the underlying based on co-movements of prices, risk and exposure. Usually, the index size determines the replicating strategy – for larger indices, the optimization strategy is chosen. The main benefit of an optimization strategy is that it decreases transaction costs and increases returns – this strategy allows to replace mispriced, illiquid securities with similarly correlated securities which are liquid and, therefore, cheaper. However, the returns of ETFs with the optimization strategy may deviate significantly from the underlying (Petronio et.al., 2014).

2.2. Effects of ETFs on individual securities and the market

Via the continuous arbitrage between the ETF shares and their underlying securities, ETFs cause additional trading activity and liquidity for the underlying securities. This property of ETFs leads to two opposite effects in terms of price discovery – due to trading activity in ETFs, liquidity of the underlying increases, allowing for the price discovery process to occur more precisely and quickly via new information being compounded into prices more efficiently. In contrast, non-fundamental trading activity, e.g. caused by rebalancing, in ETFs could spread to the underlying, causing mispricing (Ben-David et.al., 2017).

Because of low costs and high liquidity of ETFs, investors prefer to trade them to impound their beliefs and information about index price movements. At the same time, APs and arbitrageurs use opportunities to profit on mispricing between the index and ETF. Therefore, systematic information is impounded into the index via trading in the ETF, increasing price discovery and liquidity of the ETF and underlying (Stratmann & Welborn, 2012).

An opposing view about price discovery of the underlying is that ETF trading does not enhance it, but rather degrade it. Da and Shive (2014) show that once a stock has been added to an index, the co-movements of returns of the stock with that of other stocks included in the index statistically significantly increases while individual stock volatility decreases, since the stocks are not perceived as separate securities anymore, but rather as a part of an index. Therefore, individual stock news may be impounded into the stock price slower and not to the full extent. Israeli et. al. (2017) document that stocks incorporated in ETFs possess higher trading costs (higher bid-ask spread), especially, in the moments when APs are actively involved in the creation-redemption process. In addition, co-movement with the index is enhanced, and by that, the underlying possesses lower informational efficiency (response to new information about earnings announcements is lagged).

Also, the effect of ETFs on liquidity of the underlying faces opposing views. Stahel et. al. (2016) and Marshall et. al. (2015) argue that liquidity of an ETF co-moves with liquidity of the underlying assets, which is explained by the arbitrage mechanism between the two. In contrast, since ETFs are cheap investment vehicles, investor activity is crowded out from the underlying securities to ETFs, decreasing liquidity of the underlying. The difference in prices for the ETF and underlying is amplified in illiquid stocks (Petajisto, 2017), and for some ETFs, the deviation of price from NAV of underlying is long-lasting due to market segmentation effects – market participants are satisfied with paying a premium for purchasing an asset with higher liquidity (Piccotti, 2017).

Trading in ETFs can also cause non-fundamental shocks to transmit from ETFs to the underlying, resulting in noise spillovers. Malamud (2015) argues that AP creation and redemption process results in ETF liquidity shocks to transmit to the underlying, observing a stronger effect for more liquid stocks. In addition, a short-term vision of investors and the usage of ETFs as a vehicle for betting on index movements due to their inexpensiveness amplify volatility of the ETF and transmit it to the underlying (Broman & Shum, 2016). Investors with short holding periods bring negative consequences for the market – informational efficiency decreases because of noise trading and long-term investors exit their positions (Stein, 1987); short term investors amplify the effects of price changes by entering the market when the price is rising and exiting during turmoil periods (Cella et. al., 2013).

Studies focusing on ETF inclusion effects on volatility of the underlying yield quite homogenous conclusions. There are several reasons for this adverse index inclusion effect, for instance, frequent ETF demand and supply shock propagation to the underlying, especially if there is limited liquidity in the underlying, which results in the price of the underlying deviating from the fundamental value even more. In the long run, liquidity restores to the underlying and prices are pushed back to NAV, causing additional volatility (Ben-David et.al., 2018). Also, the arbitrage and creation/redemption mechanisms increase the co-movement of prices of the underlying and ETF, amplifying volatility spillovers. A positive relationship between trading activity and price volatility was proven many decades ago by Karpoff (1987), Wang (1994) and others, and with ETFs growing in popularity, its constituents also experience increased trading activity. However, the efficient market hypothesis says that the movements in the price of the underlying should influence ETF price and volatility, not the other way around since ETFs consists of those securities, but the securities do not consist of the ETF (Ben-David et.al., 2017). The only influence on the underlying securities from ETFs should be indirect – via new market beliefs and other information being impounded in the ETF quicker.

2.3. Volatility spillovers: analysis of previous research

With the role of ETFs rising in the financial markets, researchers and regulators are becoming more interested in how ETFs could be related to stock and bond market volatility. In this section, previous related research on volatility spillovers between ETF and the underlying is analyzed.

Several papers examine the **existence of volatility spillovers between ETFs and the underlying and drivers of the co-movements**. Krause et. al. (2014) prove that volatility spillovers from ETFs to underlying securities are statistically significant. By using Diebold and Yilmaz model, they estimate volatility spillovers between nine S&P500 Select Sector SPDR ETFs and ten largest underlying stocks for each during

2003-2013. They show that the spillovers are driven by the liquidity of the ETF and its largest underlying stocks (investors want to trade in more liquid securities, propagating volatility from the ETF to the underlying), weight of the stock in the ETF (increased weight means higher ETF ownership, which in turn leads to higher ETF influence on the underlying), flow of funds (an indicator of high arbitrage activity, causing volatility), differences from NAV (more arbitrage opportunities, more trading, amplified volatility), size of the ETF. All these factors are also positively correlated with ETF trading activity. Their findings are insightful since shocks to ETFs are useful in modelling future volatility process for the underlying stocks and the results are in line with trading-based explanations of volatility and gives insights to market makers, investors and regulators. However, their model has a limitation – the authors assume the volatility shocks to be normally distributed, which may not be the case in real-life situations. Furthermore, Ben-David et.al. (2018) analyze 454 ETFs that are listed on the US stock exchanges and whose baskets contain domestic stocks between the years 2000-2015. The authors find that ETFs are preferred by high-frequency and volume traders, mainly because of the liquidity ETFs offer. With increased ownership of the stocks by ETFs, the volatility of these stocks is higher than for those stocks owned less by ETFs. Furthermore, they argue that non-fundamental volatility spillovers result in price reversion (the liquidity trading hypothesis), whereas price discovery-related volatility (the price discovery hypothesis) does not. The authors observe that demand shocks in ETFs cause a mean-reverting reaction in the underlying stocks, implying liquidity and arbitrage trading, which leads to extra noise. Lastly, they prove that ETF ownership causes observable alphas for the underlying stocks due to non-diversifiable risk (increased volatility) that ETF ownership introduces. Malamud (2015) creates a dynamic general equilibrium model of ETFs, which allows to analyze how ETF structure of being traded on primary markets (creation-redemption mechanism) and secondary markets (stock exchanges) influences shock propagation from ETFs to underlying securities. The author proves that primary trading leads to temporary ETF demand shocks being impounded in future stock prices over a long-time frame. Price of underlying stocks changes and does not revert over the short-term, while the ETF price does. Increased liquidity on the primary markets causes more trading and increased shock propagation to stock prices, increasing the tracking error (price gap) between the ETF and the underlying. These results signal that with ETFs growing more in popularity, the market could become less stable due to increased speculation of arbitrageurs and price discovery of the underlying could become flawed.

Another type of research is focused on **how different types of funds influence volatility spillovers** between the investment vehicle and underlying. Chen (2011) studies the difference in volatility spillovers between stock indices and ETFs for both ethical and non-ethical ETFs. The author finds that there is no statistically significant difference between these two ETF classes regarding volatility and return spillovers and leverage effects, implying no significant difference of the two ETF types in terms of volatility contagion mechanism. Moreover, lagged ETF returns one-sidedly influence the underlying index returns. Corbet & Twomey (2014) focus on forty-four ETNs (Exchange-traded notes) and ETFs in 17 commodity markets and their impact on pricing accuracy (via increased liquidity and quicker information impounding into prices) in international commodities markets. They find that larger volatility is experienced in commodities which are held by ETFs more widely, implying liquidity-trading effect. Furthermore, smaller commodities markets benefit from ETFs by increased liquidity and pricing efficiency. Chen et.al. (2014) research seasonal and spillover effects from returns of real estate investment trust exchange-traded funds (REIT-ETFs) and their benchmarks. The positive and strong bilateral relationship between the returns is proved, and unilateral influence from REIT-ETFs lagged returns to lagged returns of indices is found. Finally, they also find that volatility of REIT-ETFs is strongly seasonal, which is an important finding for investors – abnormal returns could be realized, and they should hedge accordingly, based on the timing of their investments.

Since the focus of this paper is spillover effects from international ETFs to the underlying, papers relating to **cross-country volatility spillover studies** are especially interesting to us. Kim (2011) researches spillover effects between the US and Asia-Pacific stock markets via trade in ETFs during 2004-2010. The author concludes that there are bilateral spillover effects between the two markets. In addition, the spillover effects have become stronger after the 2007-2008 economic crisis, signalling stronger interconnectedness of stock markets and economies. Krause & Tse (2013) study price discovery and volatility spillovers between the US and Canadian equity markets. Lead-lag price-discovery influence on Canadian stock market by the US stock market is discovered without the bilateral relationship being present. However, volatility spillovers between the two markets do have a bilateral relationship with asymmetric volatility being more profound in the US markets - volatility from US markets affects Canada more than Canadian volatility affects the US. These results raise a concern that Canada is too depended on US market conditions.

Most of the international ETFs analysed in this study include US-based ETFs, which track emerging markets; therefore, the **linkage between developed and emerging economies** is a particular interest of ours. Chen & Huang (2010) find that for developed stock markets, ETFs produce higher returns than the index mainly due to leverage effects – use of derivatives to replicate the underlying and debt to purchase the securities. Furthermore, previous unexpected index returns exert an opposite effect on returns of the ETF and volatility spillover effects have a positive bilateral influence between the index and ETF. Dheeriya et al. (2014) focus their research on linkages between daily equity returns and volatility spillovers between the US stock market and emerging markets, using data from 2012. They find significant co-movement of returns in ETFs analyzed between the markets; volatility spillovers between the emerging markets. The only country to which US volatility was transmitted from 7 analyzed ones was Indonesia, while volatility spillover to the US was observed only for Mexico. The authors note that investors should be aware of increasing co-movements of returns and volatility spillovers between different stock markets and diversify accordingly. Rompotis (2018) studies return and volatility spillovers between 40 US-listed international ETFs, with the benchmark indices tracking developing markets. Pearson's simple correlation coefficient, conditional constant correlation and dynamic conditional correlation analyses are carried out to distinguish a relationship between the two markets (the ETF listed market and the underlying index market). The author finds that there is a strong co-movement between the US ETF market and the underlying stocks' emerging market and that return and volatility spillovers are bilateral and statistically significant. The author accentuates that diversification strategies can be weakened by investing in emerging markets due to interconnectedness of them with developed markets. Ackert & Tian (2008) study mispricing of 28 US and country ETFs. The authors find that country ETFs more often exhibit deviation from NAV and display autocorrelation in fund premium, while that does not hold for the US ETFs. The persistent mispricing of country ETFs is explained by illiquidity, size and momentum effects.

Lastly, **impact on the underlying due to iShares country ETF owenrship** specifically are of an interest to us due to this paper's focus on iShares. Zhong and Yang (2005) focus their study on how iShares country ETFs allow investors to diversify their risks. They find that US market volatility is the primary driver of iShares returns, while the home market risk has just a transitory influence on ETF price, indicating limits of arbitrage persistent in iShares, which in turn leads to inefficient diversification. Filippou et. al. (2019) find that the ETF arbitrage mechanism leads to an increased correlation of returns between the US and iShares home country, deteriorating benefits of diversification. However, this effect is emphasized when limits to arbitrage are low, and ETF price discovery is high. Furthermore, VIX movements cause investors to exit the US market and move their funds to international stock markets, while local volatility has not such a significant effect on investor decision-making. Although it might seem that the recent paper by Filippou et. al. (2019) resembles our analysis closely, we note that our study focuses on the underlying stocks and underscores the impact of ETFs on the volatility of the underlying stocks, with implications for foreign equities, rather than markets, and has an specific focus on the role of the arbitrage mechanism as proxied by creation-redemption intensity and mispricing.

Based on academic literature analysed, the following hypotheses are defined:

H1: iShares adversely affect the volatility of the underlying stocks during volatile market periods;

H2: iShares affect volatility to the underlying stocks during market turmoil periods via the arbitrage channel;

H3: iShares negatively affect price efficiency of the underlying stocks during volatile market conditions.

3. Data and sample description

The main source of data used in this research is the Thomson Reuters Datastream database. The sample ETFs analysed are US-traded country iShares ETFs that employ physical replication, are not currency-hedged, and track different geographies around the world. As the sample time range analysed spans from December 2006 to December 2019, analysis-eligible ETFs should have an inception date before 2006, which results in 21 funds that constitute the final sample. Since the sample ETFs are traded with a different degree of time discrepancy between the US and a local stock market, which can impact the speediness of arbitrage, the models are analysed based on three geographical clusters: full trading hours overlap with the US, partial overlap (European equities) and no overlap. In line with the aforementioned reasoning, the results of this paper can be generalised based on a specific region.

Several key data types were collected in order to conduct the research. Firstly, the following fund-level and constituent stock-level data was gathered on a daily frequency: closing price, opening price, bid and ask prices, volume-weighted average price, turnover by volume, turnover by value, number of shares outstanding, market capitalisation, market-to-book ratio (stocks only), net asset value (ETFs only), relevant macroeconomic variables. Where necessary, the variables are winsorized at 99^{th} percentile. Secondly, in order to obtain the percentage of the company's shares owned by a respective iShares ETF, monthly derived holdings were extracted from Datastream.

One of the key explanatory variables of interest in this research, the iShares ownership variable, is then defined as follows:

$$ETF\ Ownership_{i,t} = \frac{Number\ of\ shares\ held_{i,j,t}}{Total\ shares\ outstanding_{i,t}} \quad (1)$$

where $Number\ of\ shares\ held_{j,t}$ is the number of shares of stock i held by iShares ETF j at the end of month t, extracted from monthly ETF holdings reports, $Total\ shares\ outstanding_{i,t}$ is the number of total shares of stock i outstanding at the end of month t. iShares holdings in constituent stocks are available at a monthly frequency.

In addition to iShares ownership, we employ another proxy for a potential iShares impact which is the intensity of iShares creation and redemption mechanism, used in Dannhauser (2017), which is labelled as *Activity* throughout the paper:

$$Activity_{i,t} = w_{i,j,t} * \frac{\sigma(Shares\ outstanding_{j,t})}{\mu(Shares\ outstanding_{j,t})} \quad (2)$$

where $Shares\ outstanding_{j,t}$ is the number of shares outstanding of an ETF j at the end of month t, $w_{i,j,t}$ is the weight of a stock i in the ETF j at the end of month t.

This metric serves as a proxy for the overall activity of authorized participants on the primary market since those agents are the ones involved in the creation and redemption process of ETF shares. Since the sample ETFs are physically replicated, creation and redemption of shares requires opposite trades in the underlying assets, which is incentivized by arbitrage opportunities. Thus, this metric can serve as a proxy for arbitrage intensity on a monthly level.

The data used in the upcoming analysis also includes proxies for market volatility and limits to arbitrage, which include market-specific volatility indices.

To control for the illiquidity effect in regressions, this research employs a measure of stock's illiquidity introduced by Amihud (2002) as a proxy:

$$ILLIQ_{i,t} = \frac{1}{D}\sum_{t=1}^{D}\frac{|r_{i,t}|}{V_{i,t}} \quad (3)$$

where $|r_{i,t}|$ is the return of a particular stock i on day t measured in absolute terms. V is the trading volume of a particular stock i on day t in a dollar equivalent. Lastly, D is the number of days in the observed month. This measure increases in line with stock's illiquidity.

Since market turmoil periods are of particular interest in this study, VIX and other local volatility indices are employed to proxy for respective markets' volatility. In particular, we construct dummy variables that take the value of 1 if on a particular day the index value is above the top quartile (75%) of all observations in the sample within the analysed time frame. In order to account for a possible correlation between the US and local volatility indices, High VIX dummy variable takes the value of one if on a given day VIX is above the top quartile, but the respective local volatility index is below the cut-off. Periods when both indices are in the top quartile are denoted with a separate dummy variable labelled *Joint*.

3.1 Dependent variables

The main dependent variables for testing the first hypothesis include monthly volatilities of daily, overnight and daytime stock returns.

For the second hypothesis we employ a regression on a daily frequency using ETF stock-level mispricing as explanatory variable. Since the associated regression employs intraday stock volatility as the dependent variable, due to the lack of access to high frequency data, daily volatility is calculated employing estimation outlined by Alizadeh et. al. (2002).

$$Daily\ variance_{it} = 0.361 * (ln\left(P_{i,t}^{high}\right) - ln\left(P_{i,t}^{low}\right))^2 \quad (4)$$

Where $P_{i,t}^{high}$ and $P_{i,t}^{low}$ are the intraday highest and lowest prices observed on a day t for a particular security i.

In order to test the third hypothesis, we employ two measures of pricing efficiency and a proxy for lower tail risk, calculated as stock's worst return in a month, which approximates value-at-risk of 5%. We take the absolute value of the lower tail risk proxy for the ease of interpretation.

Variance ratio is employed as a measure of autocorrelation that allows to proxy for the impact of ETF ownership on the underlying stock's price efficiency and is defined as follows:

$$\left|Variance\ Ratio_{i,t}\right| = \left|\frac{Var(r_{5,i,t})}{5 * Var(r_{1,i,t})} - 1\right| \quad (5)$$

Where $Var(r_{5,i,t})$ is the variance of a five-day return of a particular stock i over the sample period t and $Var(r_{1,i,t})$ is the variance of a daily return in the same sample period t. The measure is estimated using 1-day and 5-day periods returns.

Additionally, in order to capture a potential mean-reverting effect of iShares ownership and activity on the underlying securities, following Ben-David et. al. (2018) we also include a slightly modified version of the variable above, namely:

$$Variance\ Ratio_{i,t} = \frac{Var(r_{5,i,t})}{5 * Var(r_{1,i,t})} \quad (6)$$

In case iShares indeed impound a mean-reverting component, the explanatory variable should have a negative relationship with the aforementioned statistics. Finally, we employ a first-order monthly stock return autocorrelation as another proxy for pricing efficiency. Since any deviation from zero autocorrelation implies that a stock does not follow a random walk process, the absolute value of this measure is used as a dependent variable. A full list and definitions of variables used in regressions are available in Appendix 1.

4. Methodology

The main goal of this paper is to assess the impact of country iShares on the volatility of the underlying securities and analyse the effect's implications during market volatility periods, linking it to the arbitrage mechanism. Therefore, the methodology used consists of three main parts. Firstly, this paper explores the impact of iShares ownership and creation-redemption intensity on the volatility of the underlying stocks during market turmoil. Secondly, the analysis extends to the study of ETF arbitrage as a potential shock propagation channel from the ETF market to the underlying securities. Lastly, potential implications of iShares ownership for foreign stocks are analysed by looking at pricing efficiency and riskiness of the component stocks.

4.1 iShares and individual stock's volatility

One possible effect of country funds could be similar to the liquidity trading hypothesis, described by Ben-David et. al. (2018), which posits that holding other stock characteristics alike if a shock is transmitted via an ETF, it will translate into higher volatility of stocks with a larger proportion of shares owned by a sample country fund. In this research, we hypothesise that non-fundamental shocks to iShares could arise, among other reasons, due to non-fundamental demand shocks, unrelated to underlying stocks, hitting the ETF price, which could then be transmitted to the underlying foreign equity markets. An alternative inference about potential effect of ETF ownership would imply that iShares ownership could lead to lower volatility in the underlying stocks as the country funds would absorb some noise that arises from trading in the underlying markets. With regard to country ETFs in particular, Tse & Martinez (2007), using variance ratios, find that volatility shifts from foreign stocks to their respective iShares. Therefore, to separate the two conjectures, this research tries to establish the link between iShares presence and the underlying stocks' volatility. Following Ben-David et. al. (2018), the potential impact of iShares on the underlying foreign stocks is studied by using iShares ownership of stock as one of the proxies for the ETF effect. On the other hand, one of the distinctive features of ETFs is their in-kind creation-redemption process which implies the need for trading the underlying securities basket to create ETF shares. Therefore, to capture the effect of intensity of this mechanism, an additional explanatory variable of interest is *Activity*. To explore the effect, a panel regression is constructed where monthly volatility of the underlying stocks' returns is regressed on lagged values of iShares ownership and activity.

Importantly, Ben-David et. al. (2018) emphasise that ETF ownership per se might be endogenous to the volatility of the underlying stocks. In this research in particular, since only one fund's effect is studied per country, the main challenge is to decouple higher volatility that results from overall demand for the stock due to its attractiveness and the volatility that comes from iShares ownership. Since the former can create a misperception of ETF ownership effect via high correlation with overall popularity, similar to Ben-David et. al. (2018), this paper includes the following control variables: market capitalisation as a proxy for size, inverse stock price, the bid-ask spread and the Amihud ratio as proxies for stock illiquidity, lagged market-to-book ratio and past 12-month returns to account for profitability of each stock. With regard to variables transformation, in all regressions, a natural logarithm of iShares ownership and activity, as well as return volatilities and the risk proxy, is taken. Also, the Amihud ratio and the bid-ask spread are scaled, while the inverse price ratio is scaled and differenced to remove a trend. Full information about units of variables used in each regression can be found in Appendix 1, while Appendix 2 displays the iShares sample of this study and Appendix 3 reports summary statistics of the key variables employed in the regressions on a monthly frequency before removal of outliers. Additionally, explanatory variables include up to the third lag of a dependent variable to account for potential autocorrelation while panel regression specifications include time and stock fixed effects, errors are double-clustered by stock and month.

As this analysis is focused on the impact of high volatility periods in the US market and fund's underlying market, the model is further modified to include dummy variables for the periods of high market volatility, which is defined as top quartile (75%) of sample observations of the respective volatility indices. In order to test whether the effect of iShares ownership differs during market turmoil, interaction terms with VIX and respective foreign volatility index are included in the regression. On the other hand, an important characteristic of country ETFs is that their underlying securities may be traded when US markets are closed and vice versa. Therefore, there might exist an effect of iShares ownership on overnight and intraday return volatility. Therefore, this research includes three measures of returns and estimates their volatility: close-to-close returns (daily), close-to-open (overnight), and open-to-close (intraday). The importance of decoupling intraday returns is emphasised by Edelen & Warner (2001), while Tse & Martinez (2007) demonstrate that country iShares that track markets trading hours of which do not overlap with the US exhibit more noise relative to funds that benchmark partially overlapping markets. Therefore, the following regression model is estimated for each iShares ETF in the sample, where volatility is estimated for three types of returns:

$$Daily\,Volatility_{i,t} = \beta_1 * Ownership_{t-1} + \beta_2 * (Ownership_{t-1} X High\,VIX_{t-1}) + \beta_3 (Ownership_{t-1} X High\,Local\,VI_{t-1}) + \beta_4 * Controls_{i,t-1} + \tau_t + \gamma_i + \varepsilon_{i,t} \qquad (7)$$

4.2 The arbitrage channel during market turmoil

As Ben-David et. al. (2018) emphasise, a mispricing between ETFs and underlying securities could serve as a signal to arbitrageurs to correct the mispricing, thus incentivising them to engage in arbitrage activity. Absolute mispricing is defined as the absolute difference between iShares price and NAV divided by iShares price:

$$Mispricing_{j,t} = \left|\frac{Price_{j,t} - NAV_{j,t}}{Price_{j,t}}\right| \tag{8}$$

Since both premiums and discounts of ETFs relative to their NAVs serve as a signal for arbitrageurs, this study focuses on the absolute measure of mispricing. The dependent variable, shares turnover, is then expressed in percentage, consistent with Ben-David et. al. (2018). In order to capture the effect of ETF mispricing on each underlying stock, the measure is multiplied by the respective stock's weight. Since weights are reported monthly, the underlying assumption is that the weight of a stock in iShares throughout the month is roughly similar to that reported at the end of the respective month.

The ability of US-traded country funds to expose underlying foreign equity markets to a new layer of non-fundamental volatility coming from the US market's turbulence analysed further is this research. The preliminary conjecture of this paper is that high volatility in the US markets can induce non-fundamental shocks to iShares ETF prices that can be passed down to the underlying markets via arbitrage, which would then imply a more adverse impact of iShares ownership during US market volatility. High volatility in the domestic market, however, could lead to a lower impact of ETF ownership overall due two to main potential reasons. On the one hand, the arbitrage in foreign equities might be riskier when the underlying market is more volatile, which could, therefore, result in less arbitrage activity and therefore lower impact of iShares ownership on underlying stocks' volatility. Alternatively, during the periods of high volatility in the underlying foreign equity market, iShares may absorb some of the underlying stocks' volatility as investors may decide to trade the ETF instead of the more volatile underlying market. In order to disentangle the two potential reasons behind underlying stocks' market volatility impact, this study further analyses the limits to arbitrage during market turmoil periods. In particular, should the arbitrage mechanism drive the effect of iShares impact on the individual stock's volatility during market turmoil, the impact of ownership and activity should be consistent with the impact of arbitrage, e.g. if the effect of an ETF is lower during high volatility of the respective local market, the effect of arbitrage activity should be lower as well.

Primarily, since ETF arbitrage is mainly driven by the ETF mispricing, similar to Ben-David et. al. (2018), this research uses the effect of daily iShares mispricing as an indirect proxy of the impact of the arbitrage activity. However, as Ben-David et. al. (2018) note, large mispricing may instead serve as evidence of the absence of arbitrage activity between an ETF and its underlying stocks. Moreover, as Gagnon & Karolyi (2010) show, security's own volatility may affect arbitrage activity since arbitrageurs may withdraw from transacting volatile equities; therefore, control variables among the usual ones in this regression include lagged stock volatility and previous day stock return to account for volatility that is due to stock's own price dynamics. Since the analysis is performed on country ETFs, the underlying securities are denominated in foreign currencies, and some are traded during hours that do not overlap with the US market trading hours. Hence, this paper expands the set of control variables for this regression model to include applicable exchange rate percentage change and underlying stocks' home market short-term interest rate percentage change, consistent with Gagnon & Karolyi (2010). The dependent variable in this analysis is intraday individual stock volatility, while the main explanatory variable is the previous day absolute mispricing, which helps to establish the effect of a shock in mispricing on the following day stock volatility. To emphasise the role of arbitrage limits, the analysis includes an interaction of absolute mispricing with dummy variables that proxy for high arbitrage costs. Firstly, high-bid ask spread dummy is defined as equal one for stocks with bid-ask spread larger than the sample average on the previous day, consistent with Ben-David et. al. (2018). Secondly, the analysis includes a dummy variable for top quartile (75%) of VIX and underlying market's volatility index. In addition, another ETF-related explanatory variable, the ETF turnover, is included to account for the impact of ETF secondary market activity. The resulting regression enables us to have indirect evidence of the arbitrage channel role in the linkage between iShares and underlying stocks during periods of volatile markets to the extent that mispricing is indicative of arbitrage activity. In addition to stock's intraday volatility, stock turnover is used as a dependent variable as well to establish the presence of economically significant impact of mispricing on turnover. The two models are then estimated using two specifications: we first estimate a model with time fixed effects on a demeaned dataset, to approximate stock and day fixed effects, and then consider a model with time fixed effects only to allow for cross-sectional variation.

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$$IntradayVolatility_{i,t} = \beta_1 * Mispricing_{i,t-1} + \beta_2 * DailyOwnership_{i,t-1} + \beta_3 * Mispricing_{i,t-1}XHigh_{VIX_{t-1}} + \beta_4 * Mispricing_{i,t-1}XHigh_{LOCAL\ Volatility\ Index_{t-1}} + \beta_5 * Mispricing_{i,t-1}XHigh_{Joint_{t-1}} + \beta_6 * Mispricing_{i,t-1}XExchangeRate_{t-1} + \beta_7 * Mispricing_{i,t-1}XLendingRate_{t-1} + \beta_8 * MarketCap_{i,t-1} + \beta_9 * ETF\ turnover_{i,t-1} + \beta_{10} * BASpread_{i,t-1} + \beta_{11} * InvPrice_{i,t-1} + \beta_{12} * MtoB_{i,t-1} + \beta_{13} * Return_{i,t-1} + \beta_{14} * IntradayVolatility_{i,t-1} + \gamma_i + \varepsilon_{i,t} \quad (9)$$

$$StockTurnover_{i,t} = \beta_1 * Mispricing_{i,t-1} + \beta_2 * DailyOwnership_{i,t-1} + \beta_3 * Mispricing_{i,t-1}XHigh_{VIX_{t-1}} + \beta_4 * Mispricing_{i,t-1}XHigh_{LOCAL\ Volatility\ Index_{t-1}} + \beta_5 * Mispricing_{i,t-1}XHigh_{Joint_{t-1}} + \beta_6 * Mispricing_{i,t-1}XExchangeRate_{t-1} + \beta_7 * Mispricing_{i,t-1}XLendingRate_{t-1} + \beta_8 * MarketCap_{i,t-1} + \beta_9 * ETF\ turnover_{i,t-1} + \beta_{10} * BASpread_{i,t-1} + \beta_{11} * InvPrice_{i,t-1} + \beta_{12} * MtoB_{i,t-1} + \beta_{13} * Return_{i,t-1} + \beta_{14} * StockTurnover_{i,t-1} + \gamma_i + \varepsilon_{i,t} \quad (10)$$

4.3 The implications of iShares presence for underlying stocks

Lastly, this research analyses the effect of sample iShares on the pricing efficiency and riskiness of the underlying stocks using the two specifications of the variance ratio, similar to Ben-David et. al. (2018), autocorrelation and lower-tail risk. Primarily, variance ratio shows whether return autocorrelation is zero, as by construction it divides *n*-period return variance by variance of one-period return over the same estimation period multiplied by *n* (Lo and MacKinlay, 1988). Effectively, the variance ratio serves as a proxy for determining whether the stock prices follow a random walk. The conjecture of negative impact of iShares ownership on pricing efficiency of foreign stocks would be equivalent to obtaining a positive coefficient from ownership variable when the dependent variable is the absolute value of variance ratio, i.e. return reversal due to iShares presence produces autocorrelation in foreign stocks' returns on a daily basis, which would then support the *noise* hypothesis. This paper further estimates the impact of iShares presence on the riskiness of the constituent equities, proxied by tail risk in line with Ben-David et. al. (2018). Considering that on average one month contains 20 trading days, the lowest return of a stock in a particular month could be proxied for the 5% expected shortfall. This metric is then regressed on the previous month's iShares ownership and activity along with control variables, with stock and month fixed effects. On the other hand, one could wonder about the effect of iShares ETF ownership not only on the tail risk but also the overall distribution of returns. Therefore, similar regression is constructed for the highest observed return in a month and monthly return skewness.

$$Y_{i,t} = \beta_1 * Ownership_{t-1} + \beta_2 * (Ownership_{t-1} X High\, VIX_{t-1}) + \beta_3 (Ownership_{t-1} X High\, Local\, VI_{t-1}) + \beta_4 * Controls_{i,t-1} + \tau_t + \gamma_i + \varepsilon_{i,t} \quad (11)$$

Where $Y_{i,t}$ represents pricing efficiency proxies, lower and higher tail returns of a particular stock i in a month t.

5. Results

We find statistically insignificant impact of the following iShares on the component stocks' volatility on a monthly basis: EWG (Germany), EWQ (France), EWH (Hong Kong), EWJ (Japan) and FXI (China). We proceed with reporting only statistically significant results (at the 10% significance level) based on the local market's trading time discrepancy with the United States. Due to a large number of total regressions, instead of output tables, we provide plots of the obtained statistically significant coefficients in Appendix 4, while the shortened output tables can be found in the Internet Appendix (Appendix 5).

Full overlap group

For the Canadian iShares, we observe that ETF activity leads to higher volatility during high VIX and joint volatility periods (when iShares activity increases by 1% during high VIX periods [joint volatility periods], close-to-close volatility of stocks increases by 0.032% [0.029%] the following month, relative to more still periods), while an increase in iShares ownership when both markets are in flux also leads to higher volatility. Allowing for time fixed effects only, we find that the arbitrage-related monthly dynamics is observed on a daily basis when the indirect iShares arbitrage intensity proxy leads to higher ETF intraday volatility during high VIX and joint volatility periods. While we find no solid implications for pricing efficiency of the underlying stocks during market turmoil specifically, we note that an increase in arbitrage intensity leads to overall higher first-order autocorrelation in stock returns, while during market turmoil periods this increase leads to more positively skewed returns (when VIX is high 1% increase in iShares activity leads to 0.00049 higher skewness of returns the following month, relative to more tranquil periods). Creation redemption intensity and ownership of EWW (iShares Mexico) increase volatility even during tranquil times, while the effect of activity is exacerbated when both markets are influx and reduced when the Mexican market is volatile. Importantly, iShares activity during tranquil times leads to negative autocorrelation in stock returns, while this effect is even more pronounced when both markets are in flux; moreover, an increase in iShares ownership during high US volatility leads to lower variance ratio. We find that the impact of iShares on the underlying stocks is most adverse for the Mexican sample.

For EWZ, the Brazilian iShares, the effect of the ETF activity on volatility is negative, similar to that of iShares ownership increase during high local volatility. The impact of ownership is accompanied by lower absolute variance ratio and higher tail risk, while higher creation-redemption intensity leads to higher absolute first-order return autocorrelation and higher absolute lower tail as well. On a daily level, we find that increase in ETF turnover negatively impacts next day intraday volatility, consistent with a conjecture that iShares may serve as a liquidity buffer for its riskier or less liquid underlying stocks.

Partial trading times overlap (Europe)

Next, we find that iShares Sweden arbitrage intensity is associated with lower daily (similar to the effect of ownership) and in particular daytime volatility. From the regression at a daily frequency we infer that while ETF mispricing tends to increase stock intraday volatility and turnover, while increased ETF turnover lowers both next day intraday volatility and turnover. Moreover, both increased activity and ownership lead to lower absolute variance ratio. Therefore, we conjecture that EWD, similar to EWZ, acts as a liquidity buffer for its component stocks. This role, however, is accompanied by higher first-order return autocorrelation as a result of an increase in ownership and negative return autocorrelation when activity proxies increases during local turmoil.

For EWI, we find that iShares ownership is associated with lower daily and daytime volatility, while the effect is even larger when both markets are in flux. Notably, we note that both iShares ownership and activity are associated with an increase is return skewness, while during periods of instability in both markets, we observe that the decrease in volatility from an increase in ownership is associated with more negative autocorrelation in component stock returns; a similar effect is found from an increase in arbitrage intensity during US turmoil. By allowing for only time-fixed effects and asymmetric mispricing, we find that the negative impact of activity proxy is related to negative mispricing.

We find that an increase in iShares Belgium ownership results in lower overnight volatility when the local market is in flux; moreover, we further find support from the arbitrage channel regression that the effect is driven by limits to arbitrage, notably regardless of whether the mispricing is positive or negative. On the other hand, the impact on overnight volatility is positive when both markets are in turmoil. This effect is associated with a decrease in variance ratio. Interestingly, we find that iShares arbitrage activity during US turmoil impounds a mean-reverting component to stock returns, proxied by variance ratio. We conjecture that for EWK, iShares may serve as a vehicle for price discovery by supplying market participants with relevant information, while arbitrage activity, due to its mechanical nature, may, in fact, distort prices of the underlying stocks even during foreign market turmoil.

For EWL, EWN and EWU, we find that iShares ownership and activity reduce daytime and daily volatility, while ETF turnover is negatively related to the component stock turnover on a daily frequency, supporting the liquidity buffer hypothesis. While the effect of ownership and activity does not change depending on the state of market volatility, we find that the implications of the arbitrage intensity proxy impact vary. During high local volatility, iShares arbitrage intensity tends to an increase in absolute first-order return autocorrelation for EWN, while when both markets are in flux iShares presence leads to more negative return autocorrelation. During US turmoil, iShares activity impounds a mean-reverting component to the component stock returns and increases the skewness of returns for EWL. For EWU, regardless of the market state, iShares ownership is associated with negative autocorrelation and increased first order return autocorrelation when both markets are in flux.

Further, we find that the effect of iShares Austria (EWO) arbitrage during high VIX and turmoil in both markets results in higher daily and daytime volatility, which is associated with higher absolute variance ratio. By looking at the daily regression results, we note that the positive effect on the daytime volatility observed on the monthly frequency is in fact associated with negative mispricing. Moreover, since the iShares effect we observe is mainly driven by creation-redemption activity and not ownership, coupled with intraday evidence, we conjecture that the impact we observe is due to negative mispricing of Austrian iShares during market turmoil, both US and joint, which then could trigger the redemption mechanism.

For EWP, we find that ETF creation-redemption intensity leads to lower daytime and overnight volatility, which is associated with negative autocorrelation in returns. During market turmoil periods, either individual or joint, the effect of iShares activity is of lesser magnitude.

No trading hours overlap

We observe that both iShares Australia creation-redemption activity and iShares ownership result in lower daytime and daily volatility, while overnight return volatility is, in fact, increasing when both markets are in flux, relative to the effect during tranquil times. Additionally, an increase in iShares ownership during high VIX is associated with a negative impact of a lesser magnitude for daytime and daily volatility. By examining the arbitrage channel, we find that previous day mispricing is negatively associated with component stock turnover during next-day Australian trading session; in particular, this effect is attributable to the negative mispricing. For EWY, we observe that iShares presence leads to lower daytime and daily volatility, the effect does not change under different volatility states. Nevertheless, we find that an increase in creation-redemption activity increases first-order autocorrelation of constituent stocks and decreases return skewness, while an increase in ownership during high market volatility in the US induces a mean-reverting component to component stock returns, as proxied by variance ratio. At the daily level, we observe that positive mispricing leads to higher intraday volatility and turnover in component stocks; nevertheless, we note a statistically significant negative relation between ETF turnover and stock turnover of a large magnitude. Therefore, we conjecture that iShares serve as a liquidity buffer for Korean component stocks, but as a result may impede pricing efficiency when the US market is in flux.

For EWM, we find that an increase in iShares activity and ownership during high US market volatility is associated with higher daily, overnight and daytime stock return volatility. We find a similar relationship using regressions on a daily level, for both positive and negative mispricing. Additionally, we find that this increase negatively impacts pricing efficiency of the underlying stocks, as proxied by the variance ratio. Likewise, we find that an increase in iShares Singapore (EWS) activity and ownership leads to higher overnight volatility. However, this effect weakens during high VIX periods, while iShares creation-redemption activity during US turmoil leads to higher daytime return volatility, resulting in more negative component stock return autocorrelation. On a daily level, allowing only for time fixed effects, we note that an increase in negative mispricing during high US volatility results in higher stock turnover and intraday volatility, consistent with the results from the activity regression. For EWT, we find that an increase in iShares ownership leads to higher daily, overnight and intraday volatility. This effect is amplified during high VIX periods and is observable on a daily level as a result of positive mispricing.

6. Discussion

After analysing the individual iShares results, we identify two iShares ETFs, EWC (Canada) and EWW (Mexico), for which the iShares impact resembles the liquidity trading hypothesis, outlined by Ben-David et. al. (2018), most. For these funds, we find that adverse iShares impact, proxied by both ownership and activity, on return volatility increases when either VIX or both VIX and the local index are high. Moreover, the creation-redemption intensity proxy seems to be the main driver behind the observed effect, since when allowing for cross-sectional variation in the arbitrage channel regression we find that an increase in mispricing coupled with either high VIX or high joint volatility has a positive impact on the intraday volatility innovations. This effect can be indirectly linked to the mechanical arbitrage link between the ETFs and their respective component stocks. Importantly, we document that for both ETFs, iShares activity is associated with higher autocorrelation and more negatively skewed returns (Canada) and negative autocorrelation, as proxied by the variance ratio, during either high VIX or joint volatility periods (Mexico). Therefore, one could conjecture that for these two funds, the presence of iShares during market turmoil period increases volatility and impounds a mean-reverting component into returns, while also affecting the tail risk.

For the majority of European funds and the Brazilian iShares, the effect of ETFs can be characterised by "liquidity buffer hypothesis," when the fund absorbs some of the volatility of the underlying; in this case, the ETF performs the function of a liquidity buffer even during local turmoil. Partial trading time overlap between European iShares and the US helps to establish that the impact of lower volatility is associated with lower daytime return volatility, which we link to the demand for underlying stocks shifting to the respective iShares ETFs, which are frequently more liquid and relatively cheap investment vehicles. Meanwhile, the arbitrage channel analysis suggests that the for iShares that tend to be underpriced relative to the component stocks during either high US volatility or when both US and local markets are in flux, arbitrageurs tend to be more willing to exploit negative mispricing. Alternatively, market participants may be switching back to underlying securities, which experience either a negative pricing efficiency impact from US turmoil or less volatility absorption by respective iShares. Despite the seemingly positive impact of iShares on volatility for European component stocks during tranquil periods, we note that for some funds this impact entails larger autocorrelation in returns, while for others the liquidity buffer role of the iShares implies that arbitrage mechanism can propagate spurious information from the US market to the underlying stocks during volatile market conditions, despite lack of change in the impact on returns volatility.

For the third sample group, the iShares traded without an overlap with the underlying markets, we observe that an increase in iShares presence is associated with lower daytime returns volatility for Australian and Korean funds, but this volatility absorption comes at the cost of less pricing efficiency during US stock market volatility due to iShares impounding noise into the component stocks for South Korean equities. Although interpreted with caution for EWM, EWT and EWS knowing that we cannot control for local volatility, we observe an increase in the ownership of iShares during market turmoil in the US, which is associated with lower pricing efficiency only for the underpriced ETF (EWS). In a similar vein, by looking at the arbitrage channel we find that the main driver of increased volatility is respective iShares's overpricing during high VIX periods. Therefore, we again conjecture that for funds which serve as liquidity buffers, this role implies a propagation of a mean-reverting component to component securities when iShares prices are likely to be negatively distorted by US volatility. However, we also note that the overall pricing efficiency implications of iShares during both tranquil periods and US turmoil for underlying stocks are less severe relative to European funds. This effect, in turn, can be due to lack of trading hours overlap which may act as arbitrage impediment during turbulent periods.

Importantly, we note that most negative impact of iShares is observed for underpriced funds, generally regardless of the location. Moreover, the main driver behind the observed impact is the intensity of creation-redemption process. Therefore, the main inference from the analysis would be that ETF's sell-off in the US as a reaction to US volatility can negatively impact underlying foreign stocks via triggering redemption process and thus impounding *noise* to the constituents' prices.

7. Alternative model specifications

The main focus of robustness checks performed in this paper is on the arbitrage channel regression. Additionally, we consider whether the choice of the number of the lags of dependent variables as controls in the ownership and creation-redemption intensity proxy regressions alters our results as well as consider a stock weighted increase in ETF shares outstanding as a proxy for daily ownership to explore how results observed on a monthly frequency hold on a daily basis. Finally, since the dummy variable creation procedure can be subject to certain assumptions, we consider two additional methods to account for volatility in the models. The results of robustness checks are available in the Internet appendix.

Firstly, we test whether the result obtained from monthly regressions of stock returns volatilities is affected by the number of lags of the dependent variables used as controls. Consequently, we run similar models with only one lag of the dependent variable for both iShares ownership and activity regressions. Separately, we replaced dummy interaction terms with continuous values of respective volatility indices, considering all regression models with continuous stock market volatility indices as proxies for increasing market volatility. Alternatively, to account for directional spillovers of volatility, we construct a Diebold-Yilmaz (2012) spillover model which effectively provides a time series of variance decompositions based on VAR. Instead of conventional volatility indices, the main inputs for the model are rolling monthly standard deviation of returns of country-specific equity indices. Similar to Krause et. al. (2014), we specify a rolling window of 200 days and a forecast period of 10 days; the underlying VAR model has 5 lags to represent one trading week. To account for inter-market volatility spillovers, the model is estimated between the US and respective country's region by calculating net volatility spillovers from the US to that region; therefore, there are three spillover indices that are used in continuous interaction terms in the main regression models. Notably, given the absence of conventional volatility indices for some of the sample countries, this method allows to account for local volatility and therefore test whether results of the main paper would hold. In general, the results we obtain in both alternative specifications are similar to that of the base models in the main part of this paper. Moreover, for the latter volatility specification, the results for some Asian equities are even more pronounced, which reinforces inferences from the main analysis.

Secondly, we turn to the regression performed on daily frequency observations. In particular, we first test whether the effect of iShares ownership on the daytime volatility that we find on a monthly basis pertains on a daily basis. Therefore, we run a regression similar to equation 10, but substitute iShares mispricing with the previous-day natural logarithm of shares outstanding. As a result, we find that iShares ownership impact observed during market turmoil on the daytime volatility of the component stocks is mostly consistent with the effect we observe on a monthly basis.

Next, we consider controlling for time-fixed effects only in the arbitrage channel regression to account for potential limitations that demeaning can have. We mostly observe that time-fixed effects model either does not qualitatively differ for the interpretation of the mispricing effect from the base specification or supports the inference observed on a monthly level.

Finally, we consider the sign of the mispricing in the analysis of the arbitrage channel, as partially reflected in the Results section. In particular, since for a number of ETFs the effect of creation-redemption activity is more pronounced than that of ownership, we conjecture that this impact may be due to iShares ownership being a proxy for iShares creation mechanism, while activity variable reflects both creations and redemptions. Therefore, using the sign of the mispricing, we try to indirectly explore whether the difference between ownership and activity is driven by redemptions and find some empirical support for this conjecture.

8. Conclusion

Our analysis of 21 different iShares funds tracking different countries around the world suggests that the role iShares play in the volatility of their constituents under different market volatilities varies greatly but can be established by linking the arbitrage mechanism between a fund and the underlying stocks with proxies for pricing efficiency of the stocks. Importantly, we find that the effect of iShares presence resembles the liquidity trading hypothesis outlined by Ben-David et. al. (2018) for North American funds, when increased US volatility is transmitted to the underlying securities throughout the trading day, impounding a mean-reverting component to the underlying stocks' returns and increasing tail risk. Thus, iShares add *noise* to the underlying equities. On the other hand, iShares tend to primarily play the role of a liquidity buffer for European stocks. Namely, we find that during tranquil markets, both ETF ownership and activity result in lower daily and daytime returns, consistent with ETFs absorbing part of the trading in the underlying securities; during market turmoil periods, especially in the US, we document that the impact of iShares is driven by the sign of mispricing and comes at the cost of lower pricing efficiency and partially higher riskiness even during tranquil periods. For funds tracking equities without trading hours overlap with the US, we find that negative implications of US turmoil transmit to the underlying stocks of underpriced funds, while we do not observe negative implications of an increase in volatility for funds trading at a premium. Thus, our analysis underscores the drastically different roles iShares can perform based on trading time discrepancy and riskiness of arbitrage. Importantly, we identify that these roles have different implications for the underlying securities during both local and US volatile market periods and their repercussions partially depend on the willingness of the arbitrageurs to profit from the mispricing. Essentially, sample ETFs seem to generally add noise to the constituents during high US volatility periods: we show that iShares ETFs can indeed transmit US volatility to the underlying stocks by triggering the redemption mechanism when a fund is under-priced as a result of US turmoil.

Nevertheless, there are several limitations to this study. Most importantly, iShares funds may not gauge the full effect that all US-traded ETFs may have on foreign underlying stocks, while other fund types, such as mutual funds and hedge funds, may have a more pertinent impact, for which we cannot control, than that of iShares presented in this paper. Additionally, the proxy for intraday volatility employed may not reflect actual intraday volatility accurately enough. Nonetheless, we believe that the analysis presented in this paper could be of interest to investors who seek international diversification via investing in country ETFs and investors in respective foreign economies since we show that equities tracked by iShares can be prone to US volatility and can be affected differently based on respective ETFs' premiums and discounts. Additionally, this study could be of use to policymakers from the perspective of both implications for foreign markets' stability in the light of increasing globalisation and, inherently related, the increasingly crucial role of the mechanical arbitrage link between ETFs and their underlying stocks, amplified by the rise of ETF popularity, in the stock markets interconnectedness.

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10. Appendices

Appendix 1. Variables used

Variable	Formula	Description	Units
Regression 1: ETF Ownership and individual stock return volatility (**monthly frequency**) (1) $Y_{i,t} = \beta * Ownership_{i,t-1} + \beta * Ownership_{i,t-1}XHigh_{VIX_{t-1}} + \beta * Ownership_{i,t-1}XHigh_{LOCAL\ Volatility\ Index_{t-1}} + \beta * Ownership_{i,t-1}XHigh_{BOTH_{t-1}} + \beta * Amihud_{i,t-1} + \beta * MarketCap_{i,t-1} + \beta * BASpread_{i,t-1} + \beta * InvPrice_{i,t-1} + \beta * MtoB_{i,t-1} + \beta * Return_{i,t-1} + \sum_{l=1}^{3} \beta * Y_{i,t-l} + \tau_t + \gamma_i + \varepsilon_{i,t}$ *ETF Creation-redemption intensity and individual stock return volatility* (**monthly frequency**) (2) $Y_{i,t} = \beta * Activity_{i,t-1} + \beta * iActivity_{i,t-1}XHigh_{VIX_{t-1}} + \beta * Activity_{i,t-1}XHigh_{LOCAL\ Volatility\ Index_{t-1}} + \beta * Amihud_{i,t-1} + \beta * MarketCap_{i,t-1} + \beta * BASpread_{i,t-1} + \beta * InvPrice_{i,t-1} + \beta * MtoB_{i,t-1} + \beta * Return_{i,t-1} + \sum_{l=1}^{3} \beta * Y_{i,t-l} + \tau_t + \gamma_i + \varepsilon_{i,t}$			
ETF Ownership	$ETF\ Ownership_{i,t} = \frac{Number\ of\ shares\ held_{i,j,t}}{Total\ shares\ outstanding_{i,t}}$ where: • $Number\ of\ shares\ held_{j,t}$ − number of shares of stock i held by ETF j at the end of month t, extracted from monthly ETF holdings reports • $Total\ shares\ outstanding_{i,t}$ − number of total shares of stock i outstanding at the end of month t	Stock-level ETF ownership reflects number of shares a respective ETF portfolio holds in a particular stock as a fraction of total shares outstanding of that stock. Therefore, it is a fraction of stock's shares held by the respective ETF.	Stock-level Fraction **Log**
ETF creation-redemption intensity	$Activity = \frac{\sigma(ETF\ shares\ outstanding)_{j,t} * w_{i,j,t}}{\mu(ETF\ shares\ outstanding)_{i,t}}$	Stock-level measure of intensity of ETF creation and redemption process	Stock-level Fraction **Log**
Daily Volatility	$Daily\ returns = \sigma\left(ln\frac{Closing\ Price_{i,t}}{Closing\ Price_{i,t-1}}\right)$ * t refers to a day in a month	Standard deviation of observed daily close-to-close returns within a month	Stock-level **Log**
Intra-day volatility	$Intraday\ returns = \sigma\left(ln\frac{Closing\ Price_{i,t}}{Opening\ Price_{i,t}}\right)$ * t refers to a day in a month	Standard deviation of observed daily open-to-close returns, i.e. returns that are observed from the start to the end of the trading session on a particular day, within a month	Stock-level **Log**
Overnight volatility	$Overnight\ returns = \sigma\left(ln\frac{Opening\ Price_{i,t}}{Closing\ Price_{i,t-1}}\right)$ * t refers to a day in a month	Standard deviation of observed daily close-to-open returns, i.e. returns that are observed from the end of the trading session on a previous day to the beginning of the trading session on the next day (during the time when respective exchange is closed), within a month	Stock-level **Log**
Bid-Ask spread	$BASpread_{i,t} = \frac{Bid_{i,t} - Ask_{i,t}}{MidPoint_{i,t}}$ $MidPoint_{i,t} = \frac{Bid_{i,t} + Ask_{i,t}}{2}$	Arithmetic mean of the daily bid-ask spreads observed during a particular month	Stock-level Fraction
1/Price	$Inverse\ Price_{i,t} = \frac{1}{Price_{i,t}}$	Arithmetic mean of the daily inverse prices observed during a particular month	Stock-level Scaled and differenced
Market-to-Book ratio		Arithmetic mean of the daily market-to-book ratios observed during a particular month	Stock-level Ratio
Market Capitalisation	$log(Market\ Capitalisation_{i,t})$	Arithmetic mean of the natural logarithm of daily market capitalisation observed during a particular month	Stock level Log
Amihud ratio	$ILLIQ = \frac{1}{D}\sum_{t=1}^{D}\frac{\lvert r_{i,t}\rvert}{V_{i,t}}$ Where $\lvert r_{i,t}\rvert$ is the return of a particular stock i on day t measured in absolute terms. V is the trading volume of a particular stock i on day t in a dollar equivalent. Lastly, D is the number of days in the observed month.	A measure of stock's illiquidity introduced by Amihud (2002) as a proxy for liquidity. This measure increases in line with stock's illiquidity.	Stock-level **Scaled**

High Volatility Index (HVI)	High Volatility Index is a proxy for a turmoil in the respective market. In the regressions, one volatility index is always VIX (the US where all sample ETFs are traded) and the other one is the respective local volatility index (such as VFTSE for the UK). When the US index value is in the upper quartile of the distribution of the values in the sample period, but the local volatility index is not, High VIX is used to denote high volatility periods. When both markets are in the top quartile for the sample period, dummy variable *Joint* is equal to one. In order to get the monthly variable, the daily dummy variables are averaged on a monthly frequency and if the mean is non-zero for a particular month, HVI is equal to 1 for that month		ETF-level Dummy
Regression 2: Analysis of the arbitrage channel (daily frequency)			
Log_H_L	$Daily\ variance_{it} = 0.361 * (ln\ (P_{i,t}^{high}) - ln\ (P_{i,t}^{low})\ )^2$	A proxy of intra-day stock's price volatility (i.e. volatility of a stock price throughout the trading session) Absent the access to high-frequency data, this measure from existing literature serves as an approximation	Stock-level Log
Turnover	$Turnover_{i,t} = \frac{Shares\ traded_{i,t}}{Total\ shares\ outstanding_{i,t}}$ where: $Shares\ traded_{i,t}$ – number of shares of stock i traded on day t $Total\ shares\ outstanding_{i,t}$ – number of total shares of stock i outstanding on day t	Number of shares traded on a particular day as a fraction of total shares outstanding on that day	Stock-level Fraction **Log**
Mispricing	$abs(Mispricing_{i,t}) = w_{i,j,m} * \lvert Mipricing_{j,t} \rvert$ $Mispricing_{j,t} = \frac{Price_{j,t} - NAV_{j,t}}{Price_{j,t}}$ where: • $Price_{j,t}$ – price of sample ETF j on day t • $NAV_{j,t}$ – net asset value of sample ETF j on day t • $Mispricing_{j,t}$ – mispricing of sample ETF j on day t • $AUM_{j,t}$ – assets under management of ETF j on day t • $Market\ Capitalisation_{i,t}$ – market capitalisation of stock i on day t • $w_{i,j,m}$ – weight of stock i in sample ETF j reported in m • *Underlying assumption:* weight of stock i in sample ETF j on day t within a month is equal to the weight reported by the ETF in the end of the month, since the weight variable is available only at the monthly frequency	Mispricing at the stock-level is defined as the absolute ETF mispricing (difference between the price of the ETF and its net asset value divided by the ETF price) times the weight of the respective stock in the ETF.	Stock-level Fraction **Log**
Market Capitalisation	$log(Market\ Capitalisation_{i,t})$	Natural logarithm of market capitalisation (expressed in thousands of currency units) of stock i on day t	Stock-level **Log**
Bid-Ask spread	$BASpread_{i,t} = \frac{Bid_{i,t} - Ask_{i,t}}{MidPoint_{i,t}}$ $MidPoint_{i,t} = \frac{Bid_{i,t} + Ask_{i,t}}{2}$	The difference between stock's highest buying and highest selling price on a particular day adjusted by the midpoint between the two	Stock-level Fraction **Scaled**
1/Price	$Inverse\ Price_{i,t} = \frac{1}{Price_{i,t}}$	Inverse of a stock's closing price on a particular day	Stock-level **Ratio** Scaled and differenced
Market-to-Book ratio			Stock-level **Ratio**
Return	$R = log\left(\frac{Price_{i,t}}{Price_{i,t-1}}\right)$	A one-day return of a stock based on closing prices	Stock-level

Exchange Rate	$Exchange\ rate\ \% = \frac{Exchange\ rate_t - Exchange\ rate_{t-1}}{Exchange\ rate_{t-1}}$	Exchange rate of the USD versus the respective local currency	ETF-level Units as reported
Lending rate	$Lending\ rate\ \% = \frac{Lending\ rate_t - Lending\ rate_{t-1}}{Lending\ rate_{t-1}}$	The bank interest rate proxy of the respective underlying market (e.g. LIBOR for the UK)	ETF-level Units as reported in Thomson Reuters

Appendix 2 (SAMPLE)

iShares ETF	Volatility Index	Interest rate proxy	Exchange rate
iShares EWA Australia	S&P/ASX 200 VIX	Interbank Overnight Cash Rate	AUD/USD
iShares EWC Canada	S&P/TSX 60	Overnight repo rate (CORRA)	CAD/USD
iShares EWD Sweden	VSTOXX	Lending rate	SEK/EUR
iShares EWG Germany	VSTOXX	EURIBOR	USD/EUR
iShares EWJ Japan	VXJ	*Indirect*: yen LIBOR	JPY/USD
iShares EWH Hong Kong	VHSI	-	HKD/USDs
iShares EWI Italy	VSTOXX	EURIBOR	USD/EUR
iShares EWK Belgium	VSTOXX	EURIBOR	USD/EUR
iShares EWL Switzerland	VSMI	SARON	CHF/USD
iShares EWM Malaysia	-	-	MYR/USD
iShares EWN the Netherlands	VSTOXX	EURIBOR	USD/EUR
iShares EWO Austria	VSTOXX	EURIBOR	USD/EUR
iShares EWP Spain	VSTOXX	EURIBOR	USD/EUR
iShares EWS Singapore	-	-	SGD/USD
iShares EWT Taiwan	-	-	TWD/USD
iShares EWQ France	CAC 40 VIX	EURIBOR	USD/EUR
iShares EWU United Kingdom	VFTSE	LIBOR	GBP/USD
iShares EWW Mexico	VIMEX	The overnight TIIE funding rate	PHP/USD
iShares EWY South Korea	-	-	KRW/USD
iShares EWZ Brazil	*Proxy*: VXEWZ	SELIC	BRL/USD
iShares FXI China	*Proxy*: VFXI	SHIBOR	CNY/USD

Appendix 3. Summary statistics before outliers removal

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
iShares ownership	160,985	0.003	0.003	0.000	0.001	0.004	0.060
Daily return volatility	203,894	0.018	0.011	0.000	0.012	0.022	0.565
Daytime return volatility	203,189	0.018	0.020	0.000	0.011	0.020	0.995
Overnight return volatility	203,177	0.012	0.020	0.000	0.006	0.013	0.996
log(Market capitalisation)	203,930	10.888	2.562	-3.219	8.938	12.903	19.695
Bid-ask spread	180,594	-0.026	0.113	-0.900	-0.004	-0.001	0.000
1/Price	203,930	0.071	0.501	0.00000	0.001	0.053	50.000
Amihud ratio	199,352	0.00003	0.001	0.000	0.00000	0.00000	0.213
Market-to-book	198,116	2.370	2.434	0.000	1.067	2.717	25.000
Highest return	203,656	0.039	0.027	0.000	0.022	0.047	0.938
Return kurtosis	203,732	0.288	1.657	-2.750	-0.693	0.658	16.255
Return skewness	203,732	0.054	0.738	-4.188	-0.330	0.455	4.188

Appendix 4. Plots of statistically significant regression coefficients

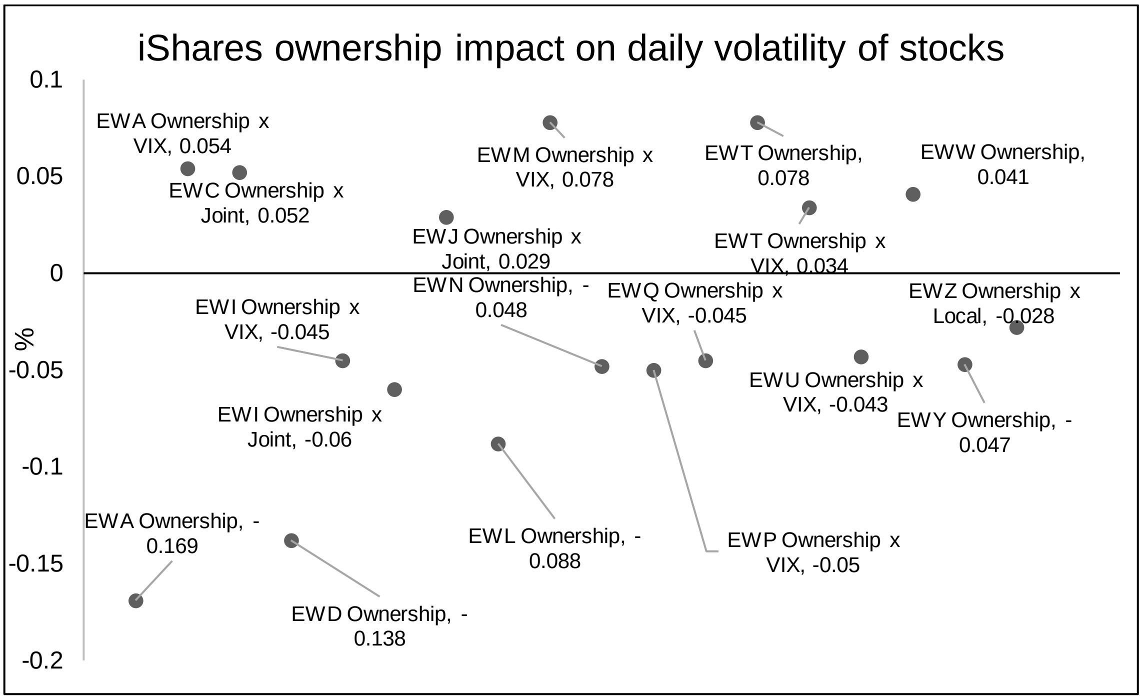

Table 1. iShares ownership impact on daily volatility of stocks.

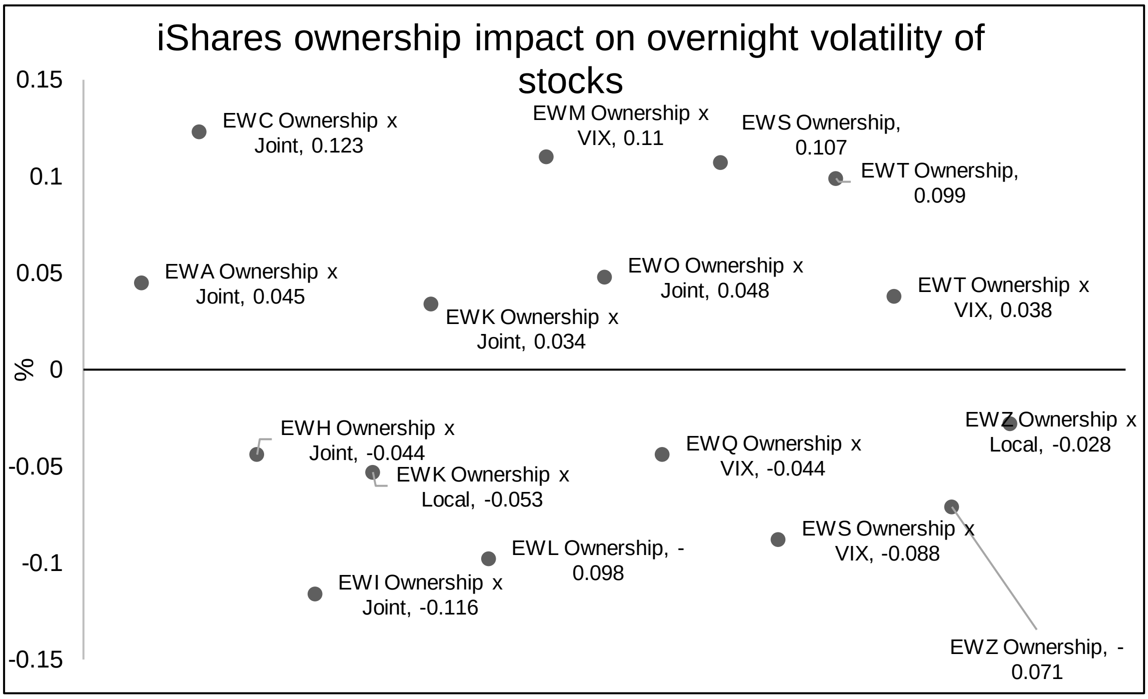

Table 2. iShares ownership impact on overnight volatility of stocks.

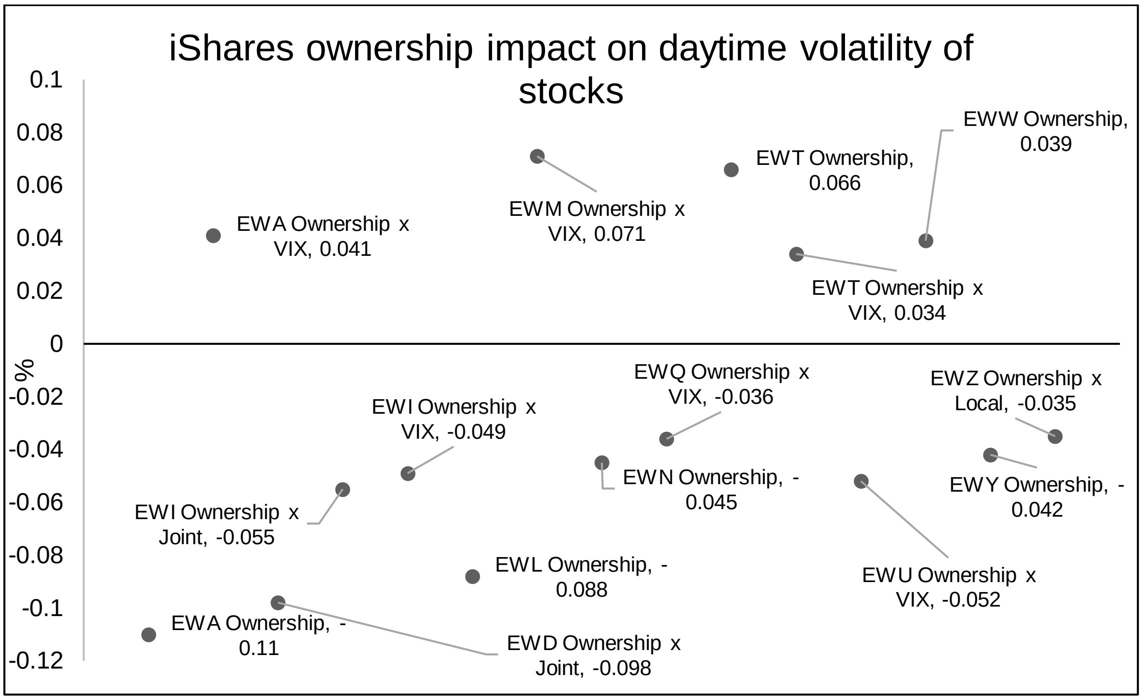

Table 3. iShares ownership impact on daytime volatility of stocks.

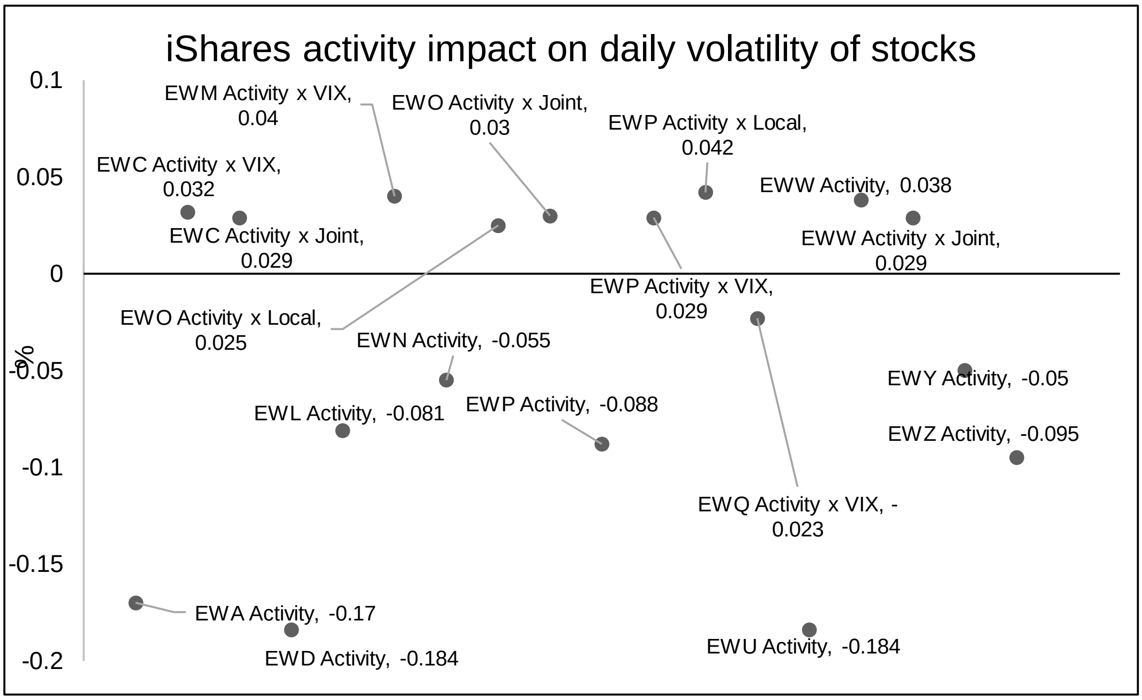

Table 4. iShares activity impact on daily volatility of stocks.

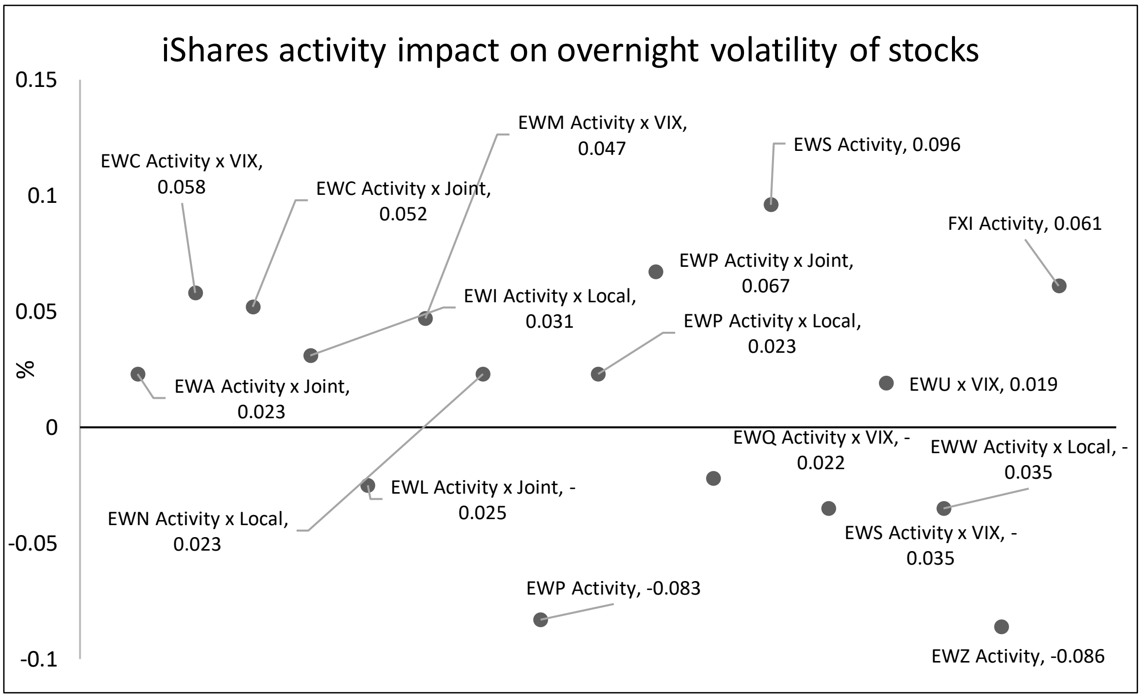

Table 5. iShares activity impact on overnight volatility of stocks.

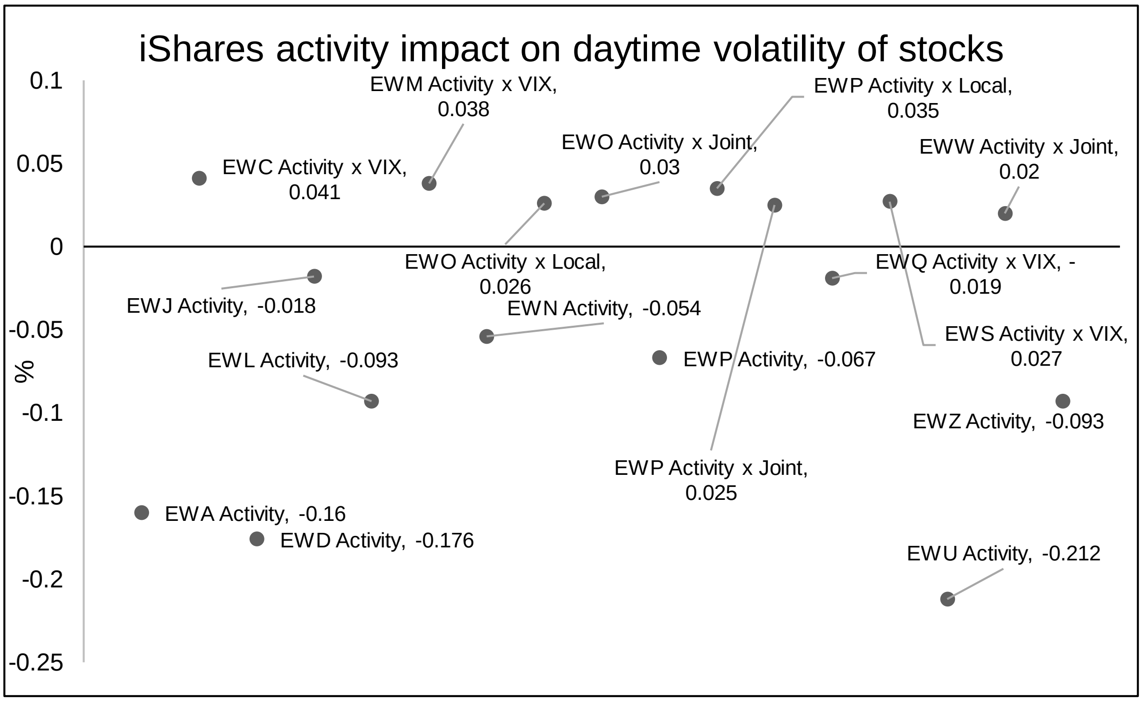

Table 6. iShares activity impact on daytime volatility of stocks.

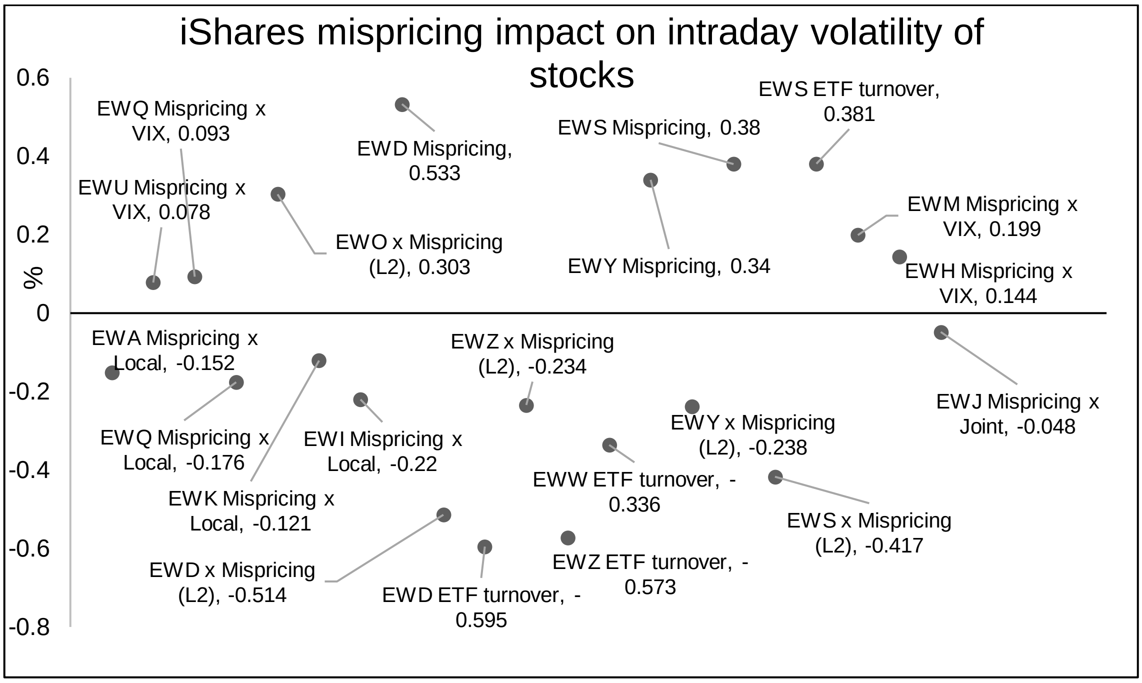

Table 7. iShares mispricing impact on intraday volatility of stocks.

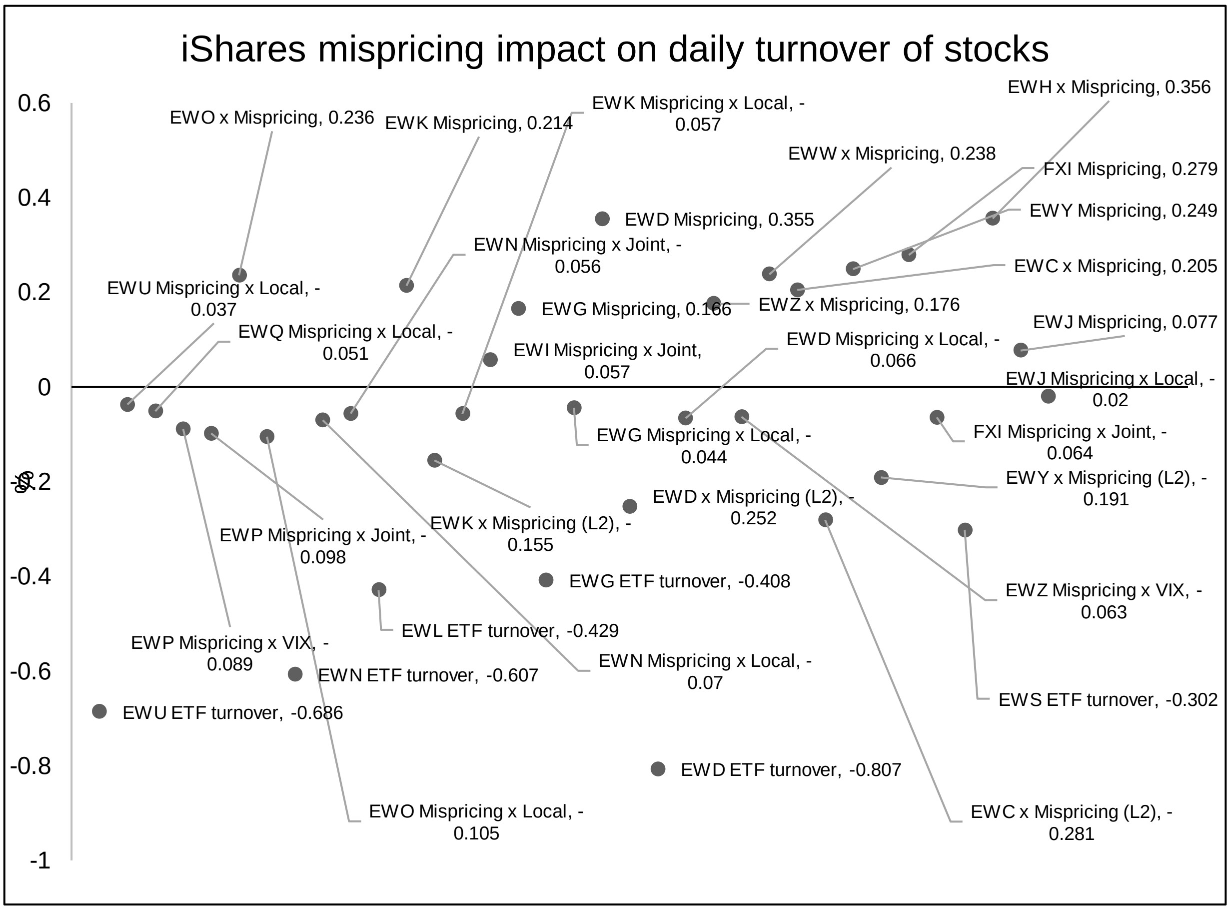

Table 8. iShares mispricing impact on daily turnover of stocks.

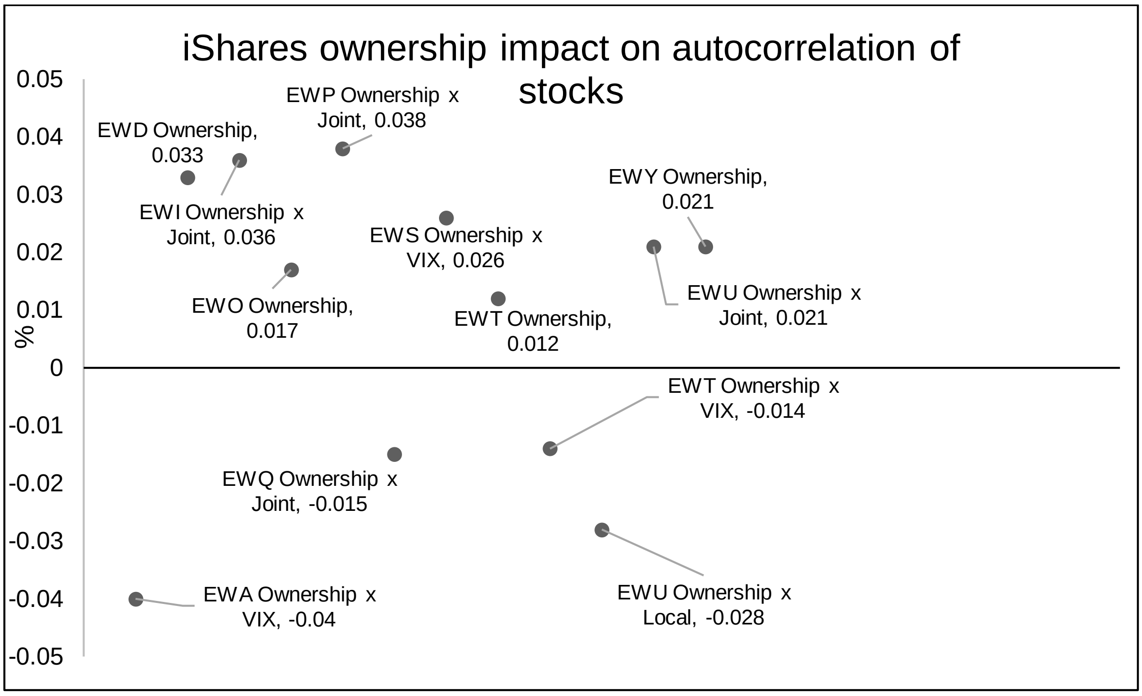

Table 9. iShares ownership impact on autocorrelation of stocks.

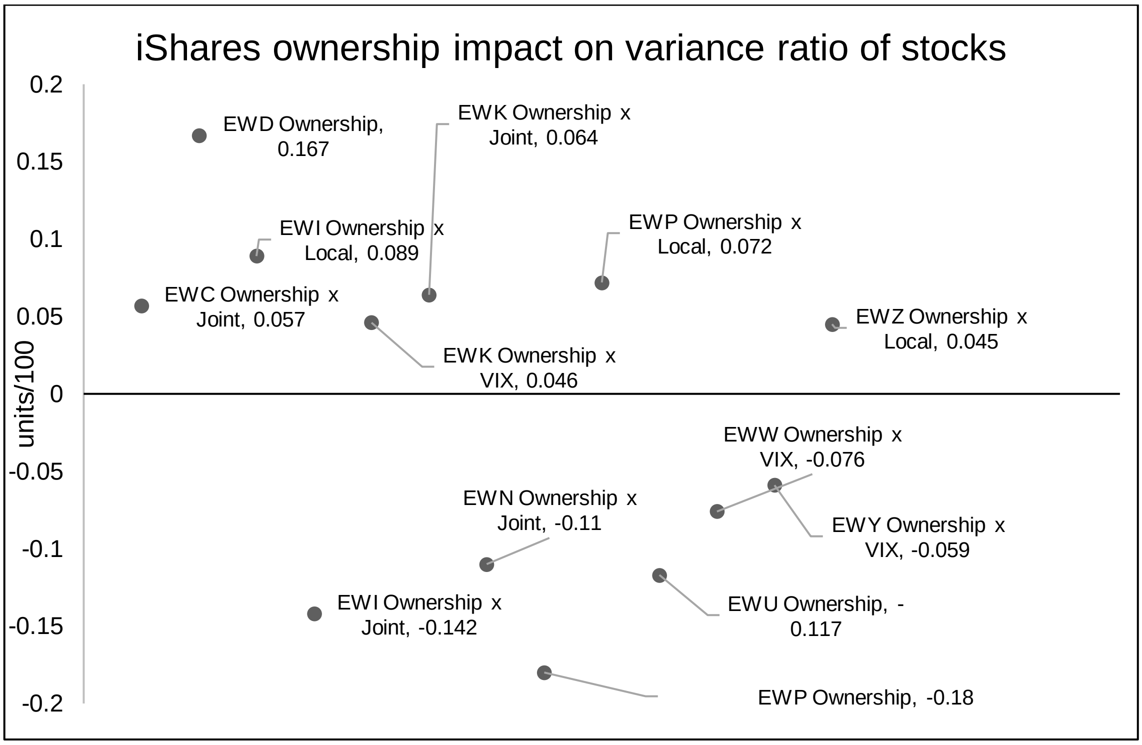

Table 10. iShares ownership impact on variance ratio of stocks.

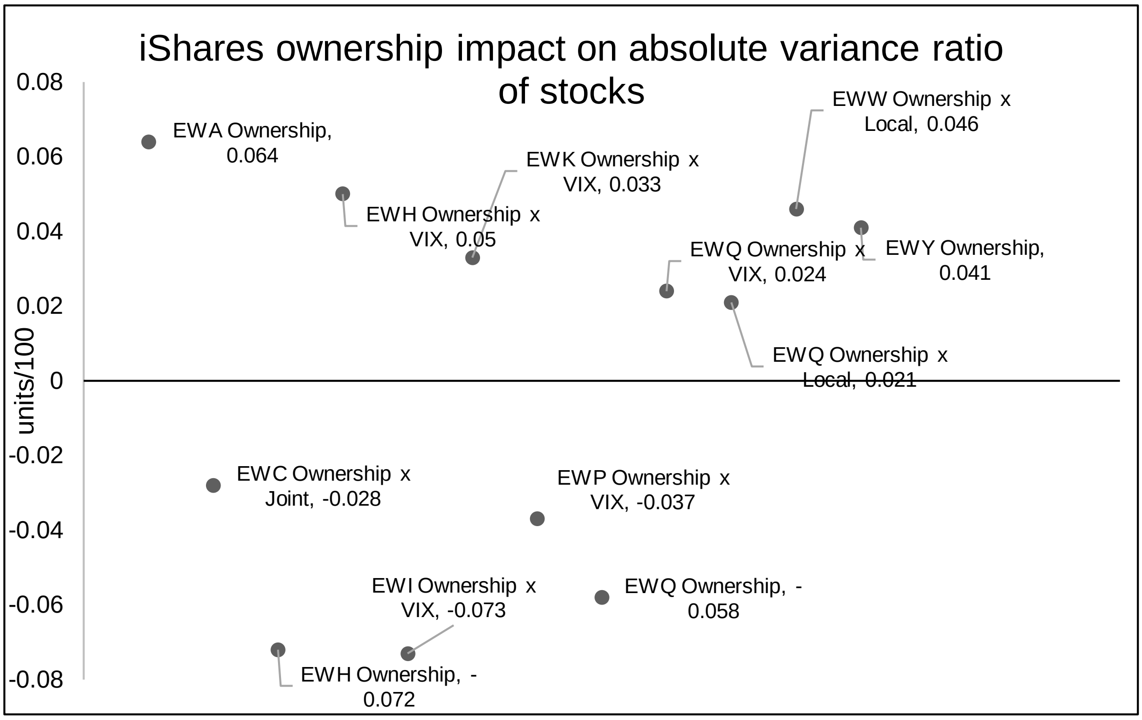

Table 11. iShares ownership impact on absolute variance ratio of stocks.

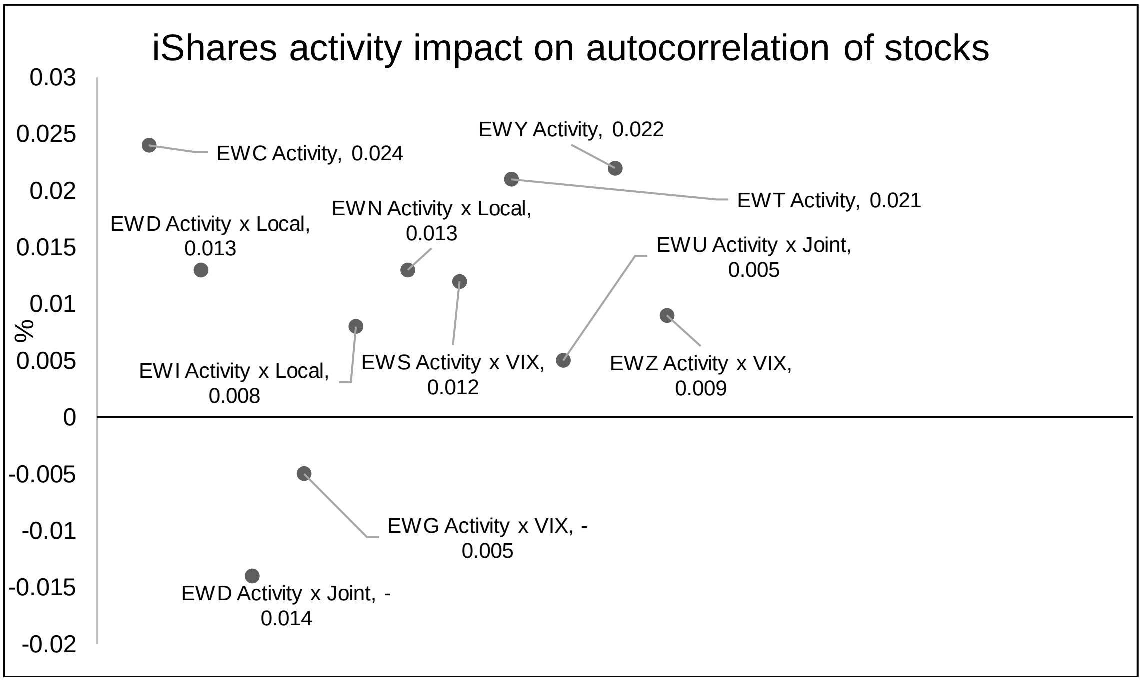

Table 12. iShares activity impact on autocorrelation of stocks.

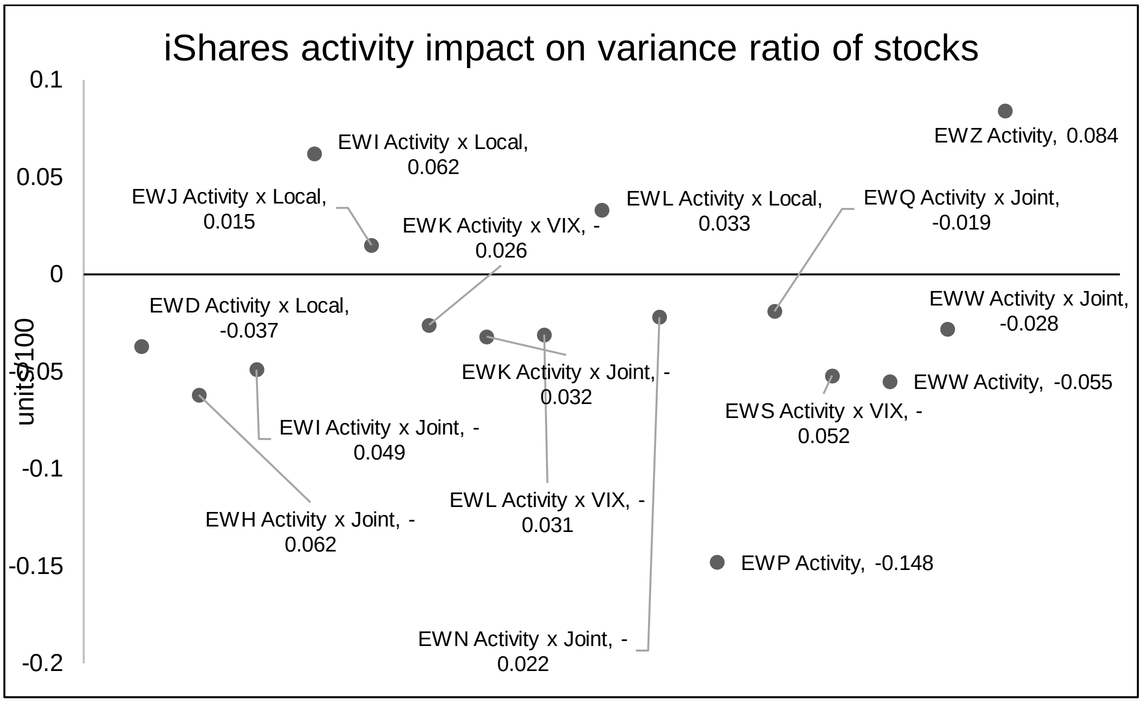

Table 13. iShares activity impact on variance ratio of stocks.

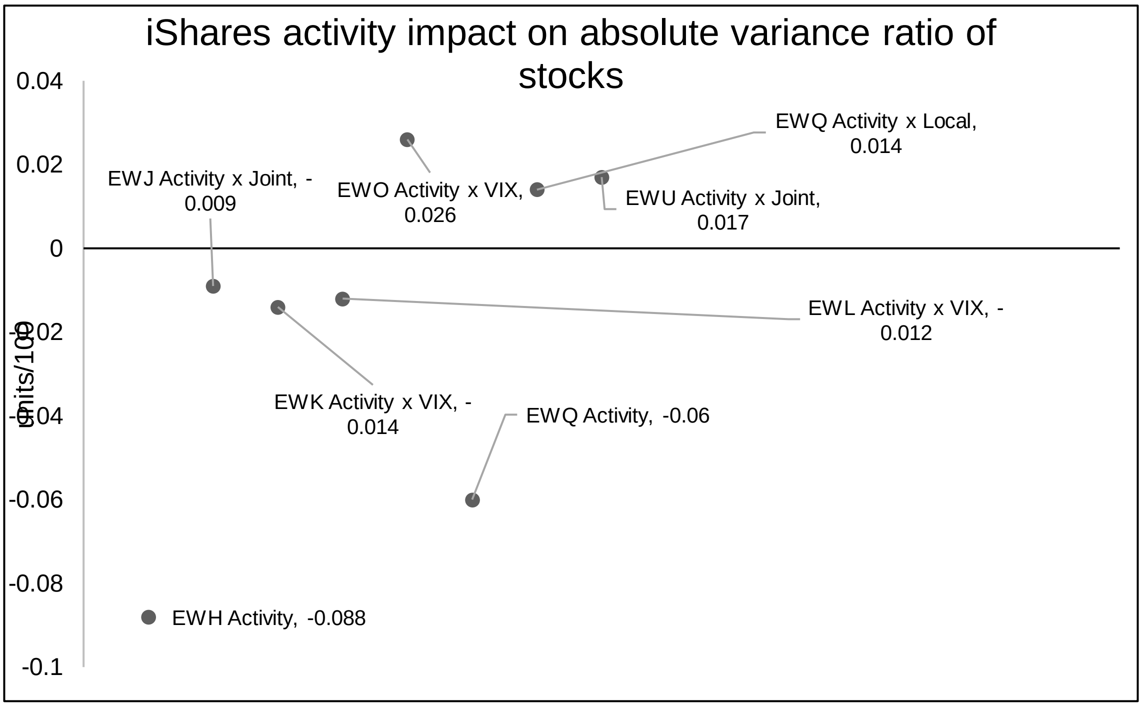

Table 14. iShares activity impact on absolute variance ratio of stocks.

Appendix 5. Internet appendix of shortened output tables

https://drive.google.com/open?id=139k7K9HPOVSfX-SxneXEaTMWklavcgx9