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ETF arbitrage and international diversification[☆]

Ilias Filippou[a,*], Arie Gozluklu[b], Hari Rozental[c]

[a] Florida State University, USA
[b] The University of Warwick, Warwick Business School, UK
[c] Ryedale Inc., UK

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ABSTRACT

We show that investment decisions of country ETF market participants measured by ETF market order imbalances are driven by global shocks rather than local risks. We argue that the ETF price discovery mechanism is one of the key channels through which global shocks propagate to local economies, leading to increased return correlation with the U.S. market and limiting the benefits of international diversification. ETF order imbalance is predictive of the underlying MSCI index returns. The staggered introduction of country ETFs alters return correlations between underlying foreign and U.S. market indices. We find that countries with stronger ETF price discovery have higher comovement with the U.S. market lending further support for the proposed mechanism.

1. Introduction

Significant innovations in financial products have made international investments increasingly possible. Over recent years, exchange-traded funds (ETFs) have experienced double-digit growth in assets under management. Low management fees allow ETFs to compete for market share with the more expensive mutual funds and futures contracts (Ben-David et al., 2017; Easley et al., 2021). However, trading across major country ETFs and its association with local and global uncertainty remains understudied. Country ETFs are a low-cost vehicle for foreign investments in benchmark country indices worldwide. Many ETF providers refer to international diversification as one of the key advantages of investing in this type of product.[1] While most earlier studies focus on the effects of ETFs on the underlying securities in the tracked basket, we propose a transmission mechanism of global shocks to foreign country equity markets via ETF trading.

We suggest that as the U.S. accommodates the largest share of ETF global trading volume, global shocks first affect the decisions of country ETF investors, which are then transmitted to local markets via ETF trading.[2] We show that international ETF market participants primarily trade based on CBOE Volatility Index (VIX)[3] shocks related to global fundamentals rather than local ones, and they propagate those shocks to local equity markets. The shock transmission is performed via the ETF arbitrage mechanism and the resulting price discovery in the ETF market. As a result, the order imbalance in the country ETF market contains information about the underlying MSCI returns. We argue that the price discovery mechanism of the global shocks in the country ETF market is translated into a higher correlation between the underlying U.S. market and the rest of the world. This increase in cross-country correlation limits the ability of investors to cheaply diversify via international ETF investments. Country ETFs often provide easier access to less integrated emerging markets and to countries where direct investments are costly (e.g., Brazil). Such ETFs have become increasingly popular, with iShares Emerging Markets ETF being in the top ten ETFs by trading volume in the world.[4] However, the

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* Corresponding author.
E-mail addresses: ifilippou@fsu.edu (I. Filippou), Arie.Gozluklu@wbs.ac.uk (A. Gozluklu), hari.rozental@ryedale.com (H. Rozental).

[1] Blackrock: https://www.ishares.com/us/strategies/international-etfs.

[2] According to Deutsche Bank's ETF Annual Review & Outlook (2017), U.S. equity ETFs turnover was \$16.38 trillion (90%) out of \$18.26 trillion globally in 2016.

[3] The VIX Index measures the implied volatility of options written on S&P 500, is often used as a measure of uncertainty, and is generally perceived as an indicator of market fear. VIX is significantly correlated with a global risk factor affecting international stock returns. Forbes and Warnock (2012) highlight the relationship between VIX and international capital flows. Rey (2015) shows that when VIX is low for a long time, there is a boom in the global financial cycle and inflation of stock prices.

[4] http://etfdb.com/compare/volume/.

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transmission of global shocks to those markets limits the diversification benefits of ETF investment strategies.

A large strand of literature focuses on the effect of one central economy (i.e., the U.S) on the rest of the world (Londono and Xu, 2023; Longstaff et al., 2011). A recent paper by Bekaert et al. (2023) documents the important role of euro area information shocks. Miranda-Agrippino and Rey (2015, 2020) examine the effect of the U.S. economy and monetary policy on global financial variables (e.g., cross-border credit flows, leverage). They highlight the role played by a global factor, which can explain a large portion of the variation in global asset returns and is related to global risk aversion and aggregate volatility. Other recent studies (Bekaert et al., 2022; Huang and Xu, 2023; Xu, 2019) also highlight the role of time-varying global risk aversion as a transmission mechanism. Atanasov (2014) shows that a single "global consumption factor" can explain more than 70% of cross-sectional variation in stock returns. Another set of literature studies the role of mutual funds on the international transmission of shocks (Jotikasthira et al., 2012; Raddatz and Schmukler, 2012; Bartram et al., 2015). However, the role of indirect investment via ETFs in the transmission of global shocks is often overlooked.

Most ETF research focuses on evaluating the negative and positive consequences of ETF trading on underlying securities (Ben-David et al., 2018; Karmaziene and Sokolovski, 2021; Filippou et al., 2022). Li and Zhu (2022) show that ETFs can help arbitrageurs alleviate short-selling constraints of the underlying stocks. Malamud (2016) theoretically shows that demand shocks can be propagated to the underlying markets. There is strong debate about whether such shocks reflect fundamental information being incorporated into ETF faster than into NAV, or if they reflect non-fundamental liquidity shocks that diminish the information efficiency of underlying stock prices. Evidence for both effects is mixed. Glosten et al. (2021) show that ETF trading can partially transmit information about systematic fundamentals to the underlying stocks leading to information efficiency improvement. Lettau and Madhavan (2016) and Wermers and Xue (2015) argue for the existence of price discovery in the ETF market. Madhavan and Sobczyk (2016) make a similar argument and develop a theoretical model incorporating both noise and price discovery in ETF prices. In contrast, Ben-David et al. (2018) show that ETFs increase the volatility of underlying assets due to the propagation of noise via an arbitrage mechanism. Brown et al. (2021) demonstrate that the ETF market's arbitrage activity in the primary market reflects non-fundamental demand. Our study complements this literature by testing whether the price discovery process in the ETF market helps transmit fundamental global shocks that lead to underlying cross-country return comovement.

We first test the hypothesis of whether country ETF investors react to changes in the VIX rather than to local economic uncertainty as measured by their local counterparts. To this end, we compute order imbalances of each country's ETF and the correlations of each underlying MSCI market return with the U.S. market proxied by S&P 500 index. Using a cross-section of 41 countries, we find a strong association between ETF order imbalances (return correlations) and the U.S. VIX, and its components, especially with economic uncertainty. This indicates that international investment decisions are mainly driven by the latter measure rather than by local shocks. We show that an increase in the VIX results in selling pressure in the country ETF and increases correlations between underlying foreign and U.S. stock market indices due to the ETF market's arbitrage mechanism. The result is robust to different volatility regimes and is consistent across different types of investors. We isolate pure U.S. shocks from VIX shocks that represent both U.S. and global shocks. Our results are mainly driven by global shocks rather than pure U.S. shocks. More specifically, we find that there is a transmission of both U.S. and global shocks to other economies but that global shocks have stronger economic effects.

We then show that ETF order imbalances carry fundamental information about future country MSCI index returns. We run both predictive panel regressions and a portfolio sort of MSCI returns on lagged ETF order imbalances. Both tests demonstrate the predictive ability of past ETF order imbalances on future MSCI returns. To test the transmission mechanism of global shocks to the changes in country returns correlating with the U.S. market through ETF trading, we exploit the fact that country ETFs were introduced at different times throughout the sample. We construct a dummy variable that takes the value of one at the fund's inception date and throughout its life. We regress our weekly correlation measure on the ETF introduction dummy, VIX shocks, and their interaction as well as other controls. We provide time-series evidence that the introduction of the ETF market increases such weekly correlation of the underlying country stock market indices. We repeat the analysis using the time-varying risk aversion and economic uncertainty components (Bekaert et al., 2022) and show that it is mainly uncertainty shocks about economic fundamentals that are transmitted to local markets, which is in line with our proposed mechanism. A higher frequency test incorporating daily volume in a one-year window around the staggered introduction of the country ETFs confirms our results on the effect of ETF trading and the increased comovement with the U.S. market. Our cross-sectional portfolio analysis lends further support for our proposed price discovery channel: gains from international diversification via country ETFs diminish for countries that benefit from better price discovery in the ETF market.

We perform several robustness tests and verify that our main results hold. Specifically, our results are robust for both developed and emerging economies. We also consider alternative specifications of the return correlation measure using different estimation windows, the Dynamic Conditional Correlation (DCC) model, and the Cochrane–Orcutt procedure and find similar results. Our results are robust to a battery of placebo tests. It can be argued that the VIX index, ETF flows, and country index returns are likely to be driven by the same fundamental force; hence we construct a news-based measure of economic uncertainty using articles from the *Wall Street Journal* and find similar results. Finally, we compute ETF order imbalances for different types of traders, such as retail and institutional investors, and we find that VIX shocks have a similar effect.

Our results are related to Levy and Lieberman (2013), who show overreaction to U.S. returns during non-synchronized trading hours. They observe that since ETF and local markets (mostly Asian) are open during different market hours, intra-day price formation is often driven by S&P 500 returns rather than by changes in the fund's net asset value. In contrast to their study, we focus on ETF order imbalances and underlying return correlations using returns at lower (weekly) frequencies. This approach allows us to assess ETF market participants' trading decisions that are not driven by non-synchronicity effects. Furthermore, we utilize a much broader cross-sectional sample. Our results are also in line with a recent study of Converse et al. (2023) who show that ETF fund flows are more (less) sensitive to global (local) risk factors than mutual funds. The authors relate this effect to ETFs attracting uninformed investors. However, our analysis shows that the reaction to VIX shocks is common to all investor types.

In what follows, Section 2 describes the link between ETF arbitrage and shocks to cross-country return correlations. Section 3 introduces the data sources and the construction of key variables. Section 4 provides empirical results. Section 5 shows the results of our robustness tests. Section 6 concludes.

2. Shock transmission mechanism

In this section, we briefly illustrate how adverse global shocks can be transmitted to local markets via the ETF price discovery process following the arbitrage mechanism. The ETF arbitrage mechanism is a unique market feature; it theoretically allows prices to track underlying stocks continuously. A fund is traded at a premium (discount) when the ETF price is higher (lower) than the NAV. The authorized participant (AP) – a designated dealer in the ETF market – has an incentive to correct the emergence of arbitrage by placing opposing trades in local and ETF markets. For example, to correct the ETF premium, AP can sell ETF shares and buy the securities of the underlying basket. This basket's constituents are published daily by ETF sponsors in the portfolio composition file (PCF). At the end of the day, AP can deliver the basket of securities to the ETF sponsor in exchange for newly created ETF shares ("in-kind" creation). This arbitrage activity should close the gap between ETF price and NAV.

Despite the existence of this mechanism, price deviations of the fund from the NAV are common and may last up to a week. Rappoport W and Tuzun (2020) show a strong link between ETF liquidity and mispricing. Pan and Zeng (2021) show that when there is a liquidity mismatch between ETF and the underlying market, APs may not be willing to correct the existing deviations. Petajisto (2017) highlights the existence of limits to arbitrage in the ETF market, especially for international funds. He shows that such deviations can last for days. We are interested in the consequences of such arbitrage incidents on the return correlations of the underlying index. When the arbitrage mechanism transmits non-fundamental shocks to the underlying stocks, over time the stock and ETF prices move back to fundamental levels (Ben-David et al., 2018). However, Madhavan and Sobczyk (2016) argue that although the indicative NAV is published throughout the day (every 15 s), the "true" NAV is often hard to estimate. The U.S. market often trades when the underlying markets are closed, in which case the NAV represents the closing value of a previous day corrected by foreign exchange return. International equity ETFs specifically suffer from this problem. In addition, for a basket with a large composition, the correct estimation of the total value of assets is often complicated. As such, the deviation between price and NAV may be due to transitory liquidity shocks or price discovery in the secondary ETF market.[5]

In this paper, we claim that any deviation between ETF price and NAV could potentially reflect a mix of noise and fundamental information. If fundamental information is transmitted, it will have a lasting impact on the return correlation between the underlying market indices. The mechanism is illustrated in Fig. 1. When investors experience an increase in VIX (e.g., the market receives bad news about future global fundamentals), the following happens:

1. Investors negatively react to an increase in market uncertainty and sell ETF of country A.[6] We show such a response in Section 4.2. Investors also sell S&P constituents (negative return of U.S. market).[7]
2. A sell-off of ETF leads to a decrease in its market price below the NAV of the fund. When the decrease is significant enough, and limits to arbitrage are low, AP intervenes, exploiting the ETF arbitrage mechanism outlined above.
3. AP buys ETF shares and short-sells (or reduces their inventory of) the underlying stocks of country A (in a correct proportion in line with the portfolio composition file). As a result, the prices of underlying stocks are reduced. ETF shares are delivered to the ETF sponsor and redeemed for the underlying stocks. AP closes her short position.
4. If a local dealer uses the ETF market to price the underlying market (i.e., price discovery happens in the secondary ETF market), the decrease in the underlying stocks' prices is permanent (negative return of county's A market). This leads to an increase in correlation between the U.S. market and country A returns. If the decrease in ETF price is considered noise – that is, VIX changes are not fundamental news for country A – both ETF and the underlying stock prices will move back to the fundamental level (as in Ben-David et al. (2018)). Therefore, there should not be a permanent change in correlation. This mechanism will be impaired if the ETF market's price discovery is distorted due to limits to arbitrage, which include noise trading.

The mechanism described here offers one new channel and testable empirical predictions on ETF trading through which fundamental global news is incorporated into local prices which would not be possible in the absence of ETF markets. In the empirical analysis, we will first test whether VIX shocks trigger foreign country ETF trading reflected in order imbalances that translate into changes in returns and correlations of the underlying country indices as described in the arbitrage mechanism. We then test whether the introduction of a country ETF changes the correlation between the U.S. market and foreign market returns. To lend further support for the mechanism, we also need to show whether the price discovery in the ETF market is linked to integration with the U.S. market in the cross-section of foreign markets.

3. Data and methodology

This section offers a detailed description of the data and the construction of the measures of order imbalances and economic uncertainty.

3.1. MSCI country indices and iShare ETFs

Our focus is on exchange-traded funds provided by iShares (Blackrock, Inc.) that track a general MSCI index of a single country, do not hedge their currency exposure, and are traded on one of the U.S. exchanges.[8] The final sample consists of 41 funds traded on NYSE Arca, NASDAQ or CBOE BZX (Bats). The U.S. ETF market is one of the most developed, representing a significant portion of the world's ETF trading volume. Our sample covers developed and emerging economies and has a broad geographical reach: 22 ETFs are from Europe, Middle East, or Africa; 13 ETFs are from Asia and Pacific regions; 6 ETFs are from Latin America and North America. The majority of our analysis is on a weekly level and covers January 2006–June 2018. We obtain ETF prices, the MSCI daily index (in USD), and its turnover from Thomson Reuters Datastream and Bloomberg. Officially published end-of-day net asset values (NAV) of funds are available directly from the iShares website.[9]

3.2. Order imbalance

We obtain intra-day quote and trade data for 41 ETFs from the TAQ database. We use the Lee and Ready (1991) algorithm to sign the trades but we match quote and trade data using the Holden and Jacobsen (2014) time interpolation method.[10] Thus, we measure the total ETF order imbalance (OI) as:

$$OI_t = \frac{buy_t - sell_t}{buy_t + sell_t} \tag{1}$$

where buy_t ($sell_t$) denotes the buy (sell) dollar volume at time t. We also consider order imbalances of different trader types based on trade size and retail investor identification (Boehmer et al., 2021). This differentiation allows us to conduct a deeper analysis of the similarities and differences in how these investors react to new information. We report these results in the Internet Appendix.

[5] Section A1 of the Internet Appendix describes the model of Madhavan and Sobczyk (2016).

[6] They could also sell the constituents of the benchmark country A index in local markets, however, it would be costly due to higher transaction costs and informational frictions.

[7] Investors, in principle, can also sell an ETF that tracks the S&P 500 index lowering the ETF price. However, this price move, that is, co-movement in ETF returns, is less consequential for the mechanism, given our focus on the underlying index returns.

[8] Many of the single-country ETFs in our sample are on the list of top 100 funds by traded volume on etfdb.com. Our sample's most popular countries are Brazil, Japan, China, Taiwan, India, Hong Kong, Mexico, Germany, and South Korea.

[9] Our analysis focuses on weekly frequencies. However, our results (available on demand) are robust to monthly frequencies.

[10] Section A2 of the Internet Appendix offers a detailed description of the two methods.

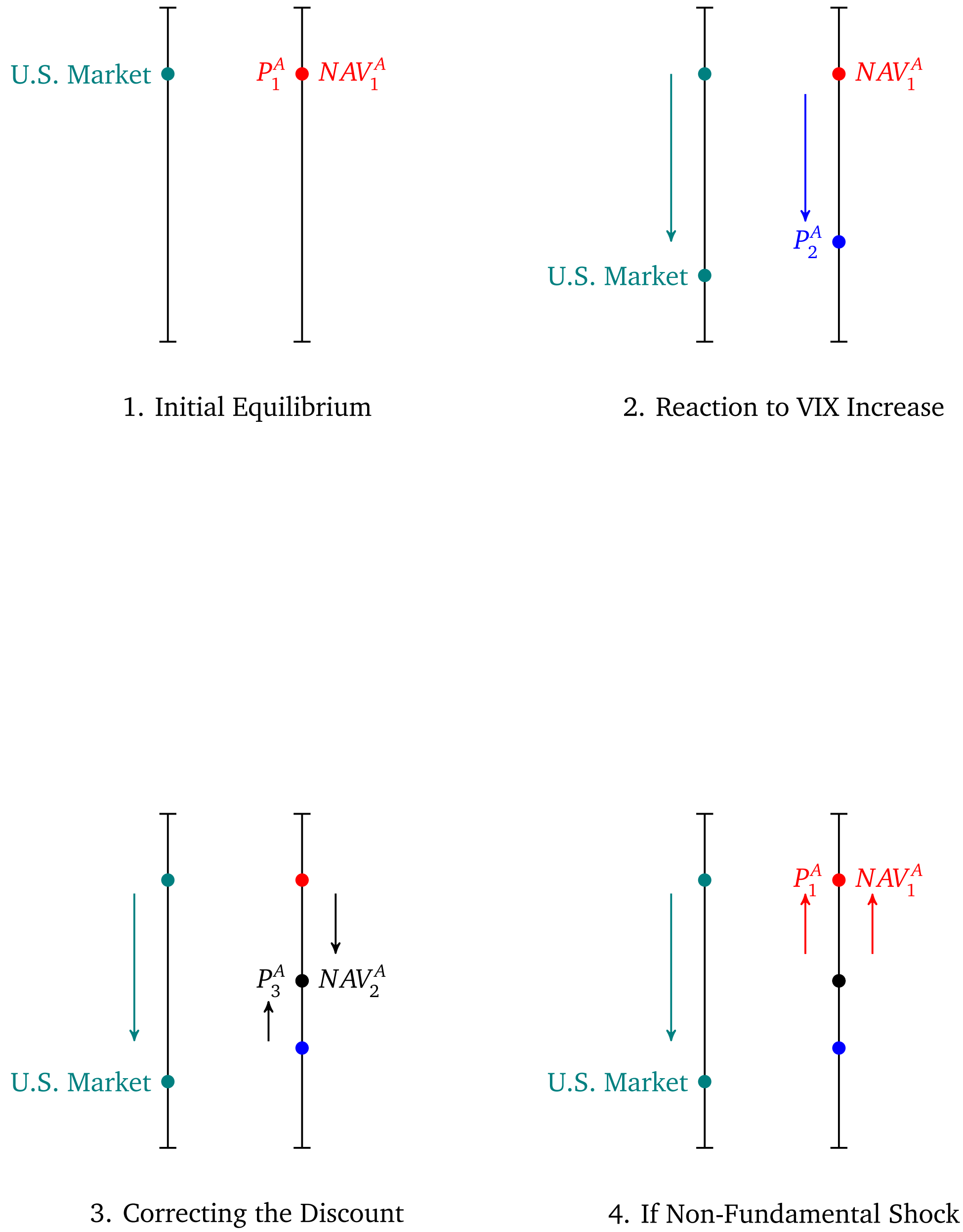

Fig. 1. Correlation mechanism.

3.3. Correlations

We estimate *conditional* correlations (henceforth correlations) using a 36-week (36-day) rolling window. To address concerns around the overlapping observations and persistence in correlations in the time series, we take the weekly (daily) residuals of an AR(1) process for the correlation level as a proxy of the stationary component of the correlations ($\tilde{\rho}$) that are not driven by secular trends or business cycle fluctuations. This measure can also be interpreted as the unexpected movement of the correlation. We use $\tilde{\rho}$ as our main correlation proxy in the panel regressions. For robustness, we also follow the Cochrane–Orcutt iterative procedure (Cochrane and Orcutt, 1949) to take into account serial correlation in our estimates ($\hat{\rho}$). In the cross-country analysis, we compute the average correlation levels ($\bar{\rho}$) of countries within each portfolio over the sample period.

3.4. Economic uncertainty

Volatility measures. Our main goal is to identify the main economic forces that drive investor demand in the ETF market and its implications for the underlying indices around the world. To this end, we use the VIX shocks (ΔVIX) as an aggregate proxy of economic uncertainty and time-varying risk aversion worldwide, and examine the reaction of ETF traders to changes in U.S. VIX and local VIX measures (e.g., $\Delta LVIX$). We include in our analysis separate proxies for the time-varying risk aversion and economic uncertainty constructed by Bekaert et al. (2022).[11] We also report our results for different VIX levels to distinguish between good (risk-on) and bad (risk-off) states of the world

[11] We thank Nancy R. Xu for sharing the data on her website.

in terms of global equity investments (e.g., Caballero and Kamber, 2019; Chari et al., 2020).[12]

The data for the CBOE Volatility Index (VIX) is collected from the CBOE website. We also obtain a local alternative to VIX from Bloomberg. A few countries do not have a volatility measure similar to VIX. For such countries in Europe, we use the general European index (VSTOXX Volatility Index) as a proxy of VIX. For the other countries, we use shocks to realized volatility. Table A1 of the Internet Appendix provides a detailed description of the countries by name, ETF tickers, and the volatility measures used as a proxy of VIX. Table A2 of the Internet Appendix shows correlations between VIX and local VIX shocks. We find that for some countries, especially developed ones, the local VIX is highly correlated with U.S. VIX. Hence we orthogonalize changes in LVIX to changes in VIX and conduct our analysis using a measure of local VIX that is unrelated to VIX, denoted by $\Delta LVIX^o$.

News-based measure. We construct a weekly news-based measure of uncertainty using articles from Factiva that belong to the economics category. Our data contain articles from January 2006 to June 2018. Specifically, we collect 9472 articles from the *Wall Street Journal* that mention the word "uncertainty" and belong to the economics category.[13] Our original data are daily, and we convert them to weekly by aggregating all the available articles within a week. Then we calculate the percentage change in the number of articles every week. Thus, our uncertainty measure (ΔUNC) is defined as

$$\Delta UNC_t = \frac{n_t^{Articles} - n_{t-1}^{Articles}}{n_{t-1}^{Articles}}, \tag{2}$$

where ΔUNC_t represents the uncertainty in week t and $n_t^{Articles}$ denotes the number of articles in week t.[14]

4. Empirical results

This section evaluates the effects of changes in local and global economic uncertainty on the trading decisions of international ETF investors. We show the implications of such decisions (revealed via order imbalances) for the shocks to returns and correlation of underlying foreign markets with the U.S. market, and emphasize ETF trading's role as a transmission mechanism of global uncertainty to local markets.

4.1. Descriptive statistics

Table 1 provides the summary statistics of each country ETF's order imbalance, weekly returns of the underlying MSCI index, correlation of index returns with S&P 500 returns, and local uncertainty measures. On average, the order imbalance for all countries is small but positive (with a few exceptions such as Australia, Israel, and Peru), suggesting that investors are net buyers of ETFs over our sample. Among all countries, the largest average order imbalance is for Colombia (16.38%) and Saudi Arabia (14.16%). The ETF markets for Colombia and Saudi Arabia are relatively undeveloped and not very liquid. Over our sample, we observe a few days with a net order imbalance of 1 for such countries (likely due to only a few buy trades per day).[15]

The average MSCI index returns are positive for most countries (apart from Colombia, Qatar, and U.A.E.) over our sample period, with more considerable volatility for emerging markets. We see that the average correlations of the underlying MSCI index returns and S&P 500 return are all positive and relatively high, with a maximum correlation of 0.76 in Canada's case followed by the U.K. (0.74). This finding is not surprising and can be explained by geographic and cultural proximity and trade relations. Also, as expected, the developed markets are more correlated with the U.S. market than are the emerging markets. The local uncertainty measures, that is, local VIX or realized volatility shocks, fluctuate around zero, but with a larger standard deviation for countries where uncertainty is measured by local VIX shocks.[16]

4.2. The role of VIX: Panel results

We first analyze how ETF traders make their investment decisions. Our primary interest is to investigate the key risk factors affecting investors' order imbalances and changes in cross-market correlations. To understand how an increase in global uncertainty (vs. local uncertainty) affects foreign country ETFs, we first run panel regressions with fixed effects for all countries in our sample. In particular, we regress weekly total ETF order imbalances (Panel A of Table 2) and country-level MSCI return correlations with the S&P 500 returns (Panel B of Table 2) at time t on the percentage change in VIX and its local counterparts.

$$\begin{aligned} X_{i,t} = \alpha_i + \beta_1 \Delta VIX_t + \beta_2 \Delta LVIX^o_{i,t} + \beta_3 NFDemand_{i,t} + \beta_4 R_{ETF,i,t-1} \\ + \gamma' \boldsymbol{Z}_{i,t} + \varepsilon_{i,t}, \end{aligned} \tag{3}$$

where $X_{i,t}$ represents the ETF order imbalance ($OI_{i,t}$) or correlation ($\tilde{\rho}_{i,t}$) between MSCI returns of country i and S&P 500 at time t.

The mechanism described in Section 2 postulates that the ETF order flows in the secondary market reflect fundamental shocks transmitted via VIX shocks. Thus, we explicitly control for flows from the ETF primary market, which likely capture non-fundamental demand shocks. Following Brown et al. (2021) we measure non-fundamental demand ($NFDemand$) as the percentage change in the ETF shares outstanding for country i at time t,

$$NFDemand_{i,t} = \frac{SharesOutstanding_{i,t} - SharesOutstanding_{i,t-1}}{SharesOutstanding_{i,t-1}}. \tag{4}$$

Creation/redemption results in a change to the number of shares in the ETF, and therefore, this measure captures arbitrage trades due to excess demand (Brown et al., 2021).

We also control for lagged values of ETF returns to capture any effect of feedback trading and add other control variables. Our controls ($\boldsymbol{Z}_{i,t}$) include spot exchange rate changes and a price discovery proxy in the ETF market. We follow Broman (2016) to determine the degree of price discovery in each ETF. If a demand shock related to fundamentals increases the price of ETF above NAV (premium), faster incorporation of these prices reflects a price discovery. The next period, that premium (discount) should translate into a positive (negative) NAV return as new information gets to the underlying market. We measure price discovery by running 36-week rolling regressions of NAV returns of each country on the past ETF premium, using the rolling beta estimate as a control.

Table 2 shows the results of panel regressions with country-fixed effects.[17] The first specification includes only the shocks to local VIX. A positive shock to local VIX leads to a significant outflow in the foreign market ETF (Panel A) and increased correlations (Panel B). However, when we include U.S. VIX shocks and the other controls,

[12] The VIX is a measure of economic uncertainty and time-varying risk aversion (Bekaert et al., 2022; Bekaert and Hoerova, 2014; Bekaert et al., 2013); it is less related to other types of uncertainty such as political uncertainty (e.g., Filippou et al., 2018).

[13] Manela and Moreira (2017) construct a news-implied VIX index using articles from *Wall Street Journal*. In our setting, we construct a measure that proxies the level of economic uncertainty.

[14] Table A3 of the Internet Appendix provides summary statistics for the main predictor variables.

[15] This illiquidity problem is not significant in our sample with most of the countries (even Colombia and Saudi Arabia) having a significant number of buys and sells per day.

[16] Figures A3.3.2 and A2 of the Internet Appendix show the time-series of weekly shocks to correlation of each country in our sample.

[17] In Internet Appendix Table A4 we show the results with standardized variables. For example, one standard deviation increase in VIX changes results in a change of 0.08 standard deviations in order imbalance, that is, a 1.5% decrease from an average of 2% and a 0.147 standard deviation (0.5%) increase in the underlying return correlation (in the full specification).

Table 1
Summary statistics.

Country	OI		R_{MSCI}		$\rho(R_{MSCI}, R_{S\&P500})$		$\Delta LVIX$	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
AUS	1.57	9.38	8.73	25.91	60.44	16.55	0.67	12.62
AUT	−2.11	25.10	3.83	28.74	65.62	15.26	0.81	13.14
BEL	1.13	26.14	5.24	23.67	67.79	13.73	0.38	7.60
BRA	0.26	4.92	8.44	35.07	60.16	22.86	0.24	2.19
CAN	1.87	12.31	7.09	23.37	76.05	12.25	0.81	14.58
CHL	2.09	18.24	3.76	23.63	53.64	19.59	−0.31	1.65
CHN	6.19	20.56	7.89	22.10	50.53	15.85	0.52	10.56
COL	16.38	36.02	−5.44	25.27	36.97	22.24	−0.18	1.92
DNK	6.70	27.87	15.25	16.03	54.31	14.48	0.81	13.14
FIN	8.01	31.50	9.88	18.46	61.22	14.03	0.81	13.14
FRA	1.39	16.71	5.86	24.16	72.13	13.31	0.84	13.35
DEU	2.34	13.44	7.48	24.14	71.00	13.26	0.74	12.54
HKG	1.04	9.05	10.71	21.50	55.27	15.95	0.67	11.94
IND	8.34	21.94	5.87	19.52	38.32	16.69	0.41	11.01
IDN	4.20	19.05	3.96	23.59	39.00	15.88	0.11	2.51
IRL	2.75	28.68	12.42	19.84	65.57	11.76	0.81	13.14
ISR	−0.80	23.69	4.82	19.23	58.45	17.80	−0.41	1.57
ITA	1.93	17.62	1.12	28.55	63.01	15.39	0.11	2.23
JPN	0.68	7.71	3.90	19.63	47.80	17.43	0.84	15.42
MYS	0.40	10.79	8.88	18.02	46.08	16.60	−0.68	1.31
MEX	0.53	6.11	5.47	26.73	68.39	20.10	0.33	8.67
NLD	0.26	22.83	7.72	23.17	72.99	11.11	0.78	13.16
NZL	2.09	23.07	13.75	16.60	48.53	19.63	−0.55	1.24
NOR	9.06	28.58	4.97	20.99	53.44	20.52	0.81	13.14
PER	−2.49	24.74	9.99	21.63	50.37	19.12	0.73	2.97
PHL	2.28	17.42	5.41	20.13	40.62	15.85	−0.06	2.04
POL	2.88	17.82	4.92	25.80	50.13	17.74	0.08	2.16
QAT	6.99	36.97	−3.62	19.18	31.09	17.64	0.06	2.47
RUS	1.49	19.56	0.66	28.30	51.52	21.04	0.89	14.33
SAU	14.16	35.25	12.74	18.20	13.66	18.56	−0.04	2.00
SGP	1.19	10.79	8.82	21.08	57.29	17.10	−0.29	1.86
ZAF	0.34	11.68	8.59	30.89	58.58	16.50	0.16	6.51
KOR	0.03	6.64	9.38	28.98	49.41	17.04	0.60	12.05
ESP	1.27	18.49	5.48	28.83	60.54	14.99	0.81	13.14
SWE	1.11	19.47	5.22	28.33	68.60	13.11	0.93	13.85
CHE	2.88	15.88	6.60	17.69	66.29	14.42	0.71	12.40
TWN	0.49	6.65	8.41	22.87	49.75	15.22	−0.17	1.89
THA	2.49	17.47	9.95	24.44	41.62	16.03	0.06	2.20
TUR	0.21	15.12	4.19	34.93	44.82	21.15	0.44	2.61
ARE	1.30	33.80	−4.61	22.63	31.60	19.85	0.58	3.21
GBR	3.09	14.15	5.33	21.72	74.15	12.87	0.92	14.06

This table presents summary statistics of weekly order imbalances (OI) which are defined as the difference between buy and sell dollar volume over the sum of the buy and sell dollar volume. We also report summary statistics of MSCI returns (R_{MSCI}), conditional correlations between MSCI return of foreign countries with S&P500 ($\rho(R_{MSCI}, R_{S\&P500})$) and local VIX innovations ($\Delta LVIX$). We report the mean and standard deviation of each measure in percent. The average returns and the corresponding standard deviations are annualized. The data span the period of January 2006 to June 2018.

we see that global shocks dominate the effect of local VIX shocks, and $\Delta LVIX$ becomes insignificant in both order imbalance and correlation regressions. Importantly, VIX shocks significantly reduce capital flows to country ETFs and increase correlations with the U.S. market, even once all controls are included. We can also clearly reject the null hypothesis that local and global uncertainty have the same effect on order imbalances and cross-country correlations. Overall, the results suggest that ETF traders mainly react to changes in global uncertainty. Local news has only a second-order effect on order imbalances of country ETF investors and cross-country correlations of the underlying country indices.[18]

We next test whether the above results depend on the VIX states. In particular, we rank the time series of VIX levels and show results for low, medium, and high VIX states using the same specification of Table 2. The results are reported in Table 3. Panel A shows that the effect of global uncertainty on ETF order imbalances is lower (nearly half) in low VIX states. The difference between the effect of local and global VIX shocks is not significant. This result is consistent with the risk-off idea of Caballero and Kamber (2019) that ETF investors exit the equity ETF market in bad states of the world.

[18] In Table A5 of the Internet Appendix, we show the results for predictive panel regressions.

Panel B of Table 3 shows that local VIX shocks reduce foreign market correlations with the U.S. market in low VIX (risk-on) states. In contrast, global VIX shocks increase such correlations. The effect of VIX shocks on correlations is much stronger (four times) in high (risk-off) VIX states, reflecting bad economic outcomes (Bloom, 2009). In such bad states, local VIX shocks have the opposite effect on correlations in the same direction as the VIX shocks. However, the effect of global shocks dominates the local ones in magnitude. Therefore, while it is important to highlight different VIX states' effects on both country ETF flows and cross-country correlations, the importance of the global VIX prevails regardless of the VIX state.

4.3. MSCI returns and country ETF trading

In the previous section, we establish the link between VIX shocks, ETF order imbalances and changes in cross-country correlations. We now test whether ETF order imbalances carry any information about the future returns of the underlying country indices. We do this by first running predictive panel regressions with fixed effects, and then conducting a portfolio sort based on lagged order imbalance information. In particular, in Table 4, we show the panel regressions results where we regress underlying MSCI index returns on lagged ETF order imbalance, lagged shocks to VIX and local VIX, and lagged MSCI

Table 2
Panel regressions.

Panel A: Order imbalances

	(1) $OI_{i,t}$	(2) $OI_{i,t}$	(3) $OI_{i,t}$
ΔVIX_t		−0.104***	−0.101***
		(−8.63)	(−7.82)
$\Delta LVIX_{i,t}$	−0.114***	−0.034**	−0.020
	(−7.74)	(−2.41)	(−1.32)
$NFDemand_t$			0.471***
			(7.57)
$\hat{R}_{ETF,i,t-1}$			0.519***
			(6.41)
Constant	0.020***	0.021***	0.051***
	(399.01)	(187.85)	(7.19)
$H_0: \beta_1 \geq \beta_2$			{0.00}
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	20,684	20,684	19,318
R-squared	0.3%	0.9%	4.5%

Panel B: Correlations

	(1) $\tilde{\rho}_{i,t}$	(2) $\tilde{\rho}_{i,t}$	(3) $\tilde{\rho}_{i,t}$
ΔVIX_t		0.033***	0.033***
		(13.97)	(13.92)
$\Delta LVIX_{i,t}$	0.031***	0.006	0.006
	(7.62)	(1.12)	(1.15)
$NFDemand_t$			−0.002
			(−0.28)
$\hat{R}_{ETF,i,t-1}$			−0.042***
			(−5.35)
Constant	−0.000***	−0.000***	−0.000
	(−6.47)	(−15.67)	(−0.27)
$H_0: \beta_1 \leq \beta_2$			{0.00}
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	19,427	19,427	18,817
R-squared	0.8%	2.5%	2.8%

This table presents contemporaneous panel regressions with country fixed effects of ETF order imbalances (*Panel A*) and country-level MSCI index return (in local currency) correlations with the S&P 500 return (*Panel B*) on U.S. and orthogonalized local VIX changes, non-fundamental demand ($NFDemand$), lagged values of ETF returns, and other control variables. We consider the model (and nested specifications) below:

$$X_{i,t} = \alpha_i + \beta_1 \Delta VIX_t + \beta_2 \Delta LVIX_{i,t} + \beta_3 NFDemand_{i,t} + \beta_4 R_{ETF,i,t-1} + \gamma' \boldsymbol{Z}_{i,t} + \varepsilon_{i,t},$$

where $X_{i,t}$ represents the ETF order imbalance ($OI_{i,t}$) or correlation ($\tilde{\rho}_{i,t}$) of country i at time t. Other controls ($\boldsymbol{Z}$) include spot exchange rate changes and a price discovery proxy in the ETF market. We report t-statistics with clustered standard errors by country. We include in curly brackets *p-values* that are associated with a hypothesis test of higher (lower) beta coefficients of VIX relative to local VIX – in panel regressions with order imbalances (correlations) as independent variables – under the null hypothesis. ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 2006 to June 2018.

returns. We include the same controls as previously, spot exchange rate changes, non-fundamental demand, and price discovery.

In the first specification, we only include the lagged order imbalance, to which we gradually add other variables and controls. Each specification includes country-fixed effects. We note that past ETF order imbalance predicts a higher return for the underlying country index, and this result is robust when we include other variables in the specification. We also see that VIX shocks predict lower returns. In contrast, past local VIX shocks are not significant in the last column of Table 4, which reports the full specification of the model.[19]

In Table 5, we show the results of single portfolio sorts (Panel A) of MSCI returns based on lagged ETF order imbalance, double-sorts using both past order imbalance and VIX betas (Panel B), and non-fundamental demand (Panel C). VIX betas are measured by contemporaneously regressing MSCI returns on VIX innovations using a 36-week rolling window while non-fundamental demand is defined in Eq. (4).

The single portfolio sorts reveal an almost monotonic (apart from portfolio 2) relation between past ETF order imbalances and future MSCI returns. A long-short (HML) portfolio, purchasing (selling) the country indices with the highest (lowest) past week ETF order imbalance delivers 6.34% (p.a.) and a Sharpe ratio of 0.72.[20] On the other hand, double-sorts in Panel B show that past ETF order imbalances are particularly informative for countries whose returns are sensitive (high VIX betas) to VIX shocks. This finding confirms the close link between global uncertainty shocks, ETF order imbalances, and underlying MSCI country index returns. The last panel shows that this link is not driven by non-fundamental demand shocks.

4.4. Staggered introduction of country ETFs

In order to pin down the effect of the ETF market to the changes in foreign market (MSCI) return correlations with the U.S. market, we exploit the fact that ETFs were introduced at different times throughout the sample (see Table A1 of the Internet Appendix for fund inception dates). We create a dummy variable $Intro^{ETF}$ that takes the value of one at the fund's inception date and throughout its life. The dummy reflects if the ETF is traded in the market. Note that iShares needs to file registration forms (Form N1-A and Form N-8 A) with the U.S. Securities and Exchange Commission (SEC) before listing, and it takes at least a few months (varying across funds) until the ETF is traded on the exchange. While the decision to introduce an ETF might not be random (e.g., response to market demand), the actual first trading day (i.e., inception date) is beyond the control of the ETF sponsor, thus alleviating concerns around endogeneity.

In the specification reported in Table 6, we include shocks to the VIX index and their interaction with the ETF introduction dummy. We also control for past return correlations and past MSCI returns.

$$\tilde{\rho}_{i,t} = \alpha_i + \beta_1 Intro^{ETF}_{i,t} + \beta_2 \Delta VIX_t + \beta_3 Intro^{ETF}_{i,t} \times \Delta VIX_t + \beta_4 \tilde{\rho}_{i,t-1} + \beta_5 R_{MSCI,i,t-1} + \varepsilon_{i,t}, \quad (5)$$

where $\tilde{\rho}_{i,t}$ represents correlations between MSCI returns of country i and S&P 500 at time t.

Our sample for this regression is extended from January 1992 until June 2018 to ensure that we have at least four years of data before the introduction of the first ETF. Table 6 shows the panel regression results using VIX index (Panel A) and separate proxies for time-varying risk aversion and economic uncertainty (Panel B).[21] The ETF market's introduction leads to a higher correlation with the U.S. market, but the interaction term is only significant at 10%. When we include the time-varying risk aversion and economic uncertainty proxies (Bekaert et al., 2022) separately in the specification, we see that it is the shocks to uncertainty around economic fundamentals that are transmitted to other markets, which is consistent with the mechanism described in Section 2.

We also test the relationship between correlations and changes in daily ETF trading volume in both the full sample and a 250-day window around the staggered ETF introductions. Incorporating country-fixed effects, we run contemporaneous panel regressions of MSCI country index return correlations on ETF volume changes, VIX changes, lagged

[19] In Internet Appendix Table A6 we show the results with standardized variables. One standard deviation increase in order imbalance predicts on average a 13.5 basis points increase in underlying MSCI returns.

[20] We repeat the same analysis (Internet Appendix Table A7) using order imbalance of different trader types. Neither retail order imbalance, measured using either the Boehmer et al. (2021) methodology or small trades, nor large institutional trades contain information hinting at stealth trading activity by informed traders (Barclay and Warner, 1993; Chakravarty, 2001).

[21] In online Appendix Table A8, we also show the results separately for developed and emerging markets and document stronger results for developed markets.

Table 3
Panel regressions: VIX States.

Panel A: Order imbalances

	(1) $OI_{i,t}$	(2) $OI_{i,t}$	(3) $OI_{i,t}$	(4) $OI_{i,t}$	(5) $OI_{i,t}$	(6) $OI_{i,t}$	(7) $OI_{i,t}$	(8) $OI_{i,t}$	(9) $OI_{i,t}$
	Low VIX			Medium VIX			High VIX		
ΔVIX_t		−0.031	−0.057**		−0.100***	−0.106***		−0.110***	−0.102***
		(−1.21)	(−2.19)		(−5.57)	(−6.11)		(−5.13)	(−4.96)
$\Delta LVIX_{i,t}$	−0.038**	−0.026	−0.038*	−0.103***	−0.024	0.001	−0.108***	−0.011	−0.004
	(−2.54)	(−1.29)	(−1.82)	(−4.31)	(−0.91)	(0.04)	(−5.23)	(−0.47)	(−0.16)
$NFDemand_{i,t}$			0.527***			0.448***			0.403***
			(3.70)			(4.47)			(5.95)
$\hat{R}_{ETF,i,t-1}$			0.475***			0.588***			0.433***
			(3.16)			(4.90)			(6.48)
Constant	0.039***	0.038***	0.088***	0.022***	0.023***	0.048***	−0.005***	−0.001	0.047***
	(302.69)	(85.20)	(5.87)	(317.79)	(161.56)	(4.84)	(−12.15)	(−1.15)	(4.29)
$H_0: \beta_1 \geq \beta_2$			{0.32}			{0.00}			{0.01}
Controls	No	No	Yes	No	No	Yes	No	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7314	7314	6707	7325	7325	6861	6045	6045	5750
R-squared	0.0%	0.0%	3.0%	0.2%	0.7%	3.7%	0.5%	1.5%	6.4%

Panel B: Correlations

	(1) $\tilde{\rho}_{i,t}$	(2) $\tilde{\rho}_{i,t}$	(3) $\tilde{\rho}_{i,t}$	(4) $\tilde{\rho}_{i,t}$	(5) $\tilde{\rho}_{i,t}$	(6) $\tilde{\rho}_{i,t}$	(7) $\tilde{\rho}_{i,t}$	(8) $\tilde{\rho}_{i,t}$	(9) $\tilde{\rho}_{i,t}$
	Low VIX			Medium VIX			High VIX		
ΔVIX_t		0.011**	0.013***		0.006**	0.006**		0.049***	0.049***
		(2.55)	(2.92)		(2.49)	(2.46)		(10.04)	(9.33)
$\Delta LVIX_{i,t}$	−0.025***	−0.029***	−0.030***	0.003	−0.002	−0.004	0.068***	0.025**	0.025**
	(−4.78)	(−5.55)	(−5.59)	(0.69)	(−0.39)	(−0.64)	(10.64)	(2.62)	(2.51)
$NFDemand_{i,t}$			0.002			0.006			−0.009
			(0.24)			(0.95)			(−1.01)
$\hat{R}_{ETF,i,t-1}$			−0.035**			−0.020			−0.035***
			(−2.45)			(−1.63)			(−3.16)
Constant	−0.004***	−0.004***	−0.006***	−0.001***	−0.001***	−0.003**	0.004***	0.002***	0.005***
	(−81.62)	(−38.27)	(−4.36)	(−49.26)	(−30.72)	(−2.66)	(32.22)	(12.13)	(3.05)
$H_0: \beta_1 \leq \beta_2$			{0.00}			{0.09}			{0.05}
Controls	No	No	Yes	No	No	Yes	No	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6833	6833	6640	6860	6860	6657	5734	5734	5520
R-squared	0.3%	0.4%	1.0%	0.0%	0.1%	0.4%	5.5%	10.6%	11.1%

This table presents contemporaneous panel regressions with country-fixed effects of ETF order imbalances (*Panel A*) and country-level MSCI index return (in local currency) correlations with the S&P 500 return (*Panel B*) on U.S. and orthogonalized local VIX changes as well as non-fundamental demand ($NFDemand$), lagged ETF returns, and other control variables. We show results for low, medium, and high VIX regimes. We consider the model (and nested specifications) below:

$$X_{i,t} = \alpha_i + \beta_1 \Delta VIX_t + \beta_2 \Delta LVIX_{i,t} + \beta_3 NFDemand_{i,t} + \beta_4 R_{ETF,i,t-1} + \gamma' \boldsymbol{Z}_{i,t} + \epsilon_{i,t},$$

where $X_{i,t}$ represents the ETF order imbalance ($OI_{i,t}$) or correlation ($\tilde{\rho}_{i,t}$) of country i at time t. Other controls ($\boldsymbol{Z}$) include spot exchange rate changes and a price discovery proxy in the ETF market. We report t-statistics with clustered standard errors by country. We include in curly brackets *p-values* that are associated with a hypothesis test of higher (lower) beta coefficients of VIX relative to local VIX – in panel regressions with order imbalances (correlations) as independent variables – under the null hypothesis. ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 2006 to June 2018.

return correlations, and lagged MSCI returns. We consider the model (and nested specifications) below:

$$\tilde{\rho}_{i,t} = \alpha_i + \beta_1 \Delta Vol_{i,t} + \beta_2 \Delta VIX_t + \beta_3 \Delta Vol_{i,t} \times \Delta VIX_t + \beta_4 \tilde{\rho}_{i,t-1} + \beta_5 R_{MSCI,i,t-1} + \epsilon_{i,t}, \quad (6)$$

where $\Delta Vol_{i,t}$ denotes ETF daily volume changes. *Panel A* shows results for the full sample, and *Panel B* displays results for a window of one year before and after the inception date.

The results reported in Table 7 show a strong relation between shocks to daily ETF trading volume and underlying return correlations in both the full sample and the 250-day window around the staggered ETF introductions, providing higher frequency evidence for the link between ETF trading and the underlying MSCI return correlations.

4.5. Cross-country differences

We explore the cross-country differences in ETF markets and their effect on underlying MSCI return correlations with the U.S. market. Bhattacharya and O'Hara (2018) show that when the underlying assets are hard to trade (e.g., fixed income), price discovery happens in the ETF market. A "hard to trade" situation also arises in international funds with non-overlapping trading hours. As already mentioned, Madhavan and Sobczyk (2016) show that a price discovery component of the ETF premium is negatively related to the variance in transitory liquidity shocks and positively related to the efficiency of arbitrage. We hypothesize that countries with exchange-traded funds that have a high price discovery component and therefore where market makers are closely following ETFs to price the underlying assets have a higher correlation with the U.S. stock market. Since all types of investors trade based on global risks, they affect the ETF price with global fundamentals. In such cases, the ETF arbitrage works as a transmission mechanism of global risk to foreign countries. However, if the noise in the ETF market (e.g., via retail participation) clouds the price discovery process, we expect the transmission mechanism to be weaker. Overall, we expect the magnitude of correlation to be related to price discovery and the ease of arbitrage in the ETF market.

Price Discovery. To test this, we follow Broman (2016) to determine the degree of price discovery in the ETF market. If a demand

Table 4
MSCI returns and ETF trading: Predictive panel regressions.

Returns of underlying indices	(1) $R_{MSCI,i,t}$	(2) $R_{MSCI,i,t}$	(3) $R_{MSCI,i,t}$	(4) $R_{MSCI,i,t}$	(5) $R_{MSCI,i,t}$
OI_{t-1}	0.006***	0.008***	0.005***	0.005***	0.007***
	(4.01)	(4.45)	(3.52)	(3.63)	(4.15)
ΔVIX_{t-1}			−0.011***	−0.016***	−0.021***
			(−5.54)	(−5.79)	(−7.60)
$\Delta LVIX_{i,t-1}$				0.016***	0.003
				(5.30)	(0.71)
$\hat{R}_{MSCI,i,t-1}$		−0.152***			−0.185***
		(−7.99)			(−8.80)
$NFDemand_{i,t-1}$		−0.004			−0.004
		(−0.98)			(−0.86)
Constant	0.001***	0.001	0.001***	0.001***	0.002*
	(36.82)	(1.55)	(34.13)	(32.55)	(1.98)
Controls	No	Yes	No	No	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Observations	21,148	19,666	21,148	20,659	19,282
R-squared	0.1%	2.3%	0.4%	0.5%	3.0%

This table presents predictive panel regressions with country-fixed effects of MSCI index returns (in local currency) on lagged ETF order imbalances, U.S. (ΔVIX) and local VIX ($\Delta LVIX$) changes as well as non-fundamental demand ($NFDemand$), lagged MSCI returns, and other control variables. We consider the model (and nested specifications) below:

$$R_{MSCI,i,t} = \alpha_i + \beta_1 OI_{i,t-1} + \beta_2 \Delta VIX_{t-1} + \beta_3 \Delta LVIX_{i,t-1} + \beta_4 NFDemand_{i,t-1} + \beta_5 R_{MSCI,i,t-1} + \gamma' \boldsymbol{Z}_{i,t} + \epsilon_{i,t},$$

where $R_{MSCI,i,t}$ represents the MSCI return of country i at time t. Other controls ($\boldsymbol{Z}$) include spot exchange rate changes and a price discovery proxy in the ETF market. We report t-statistics with clustered standard errors by country. ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 2006 to June 2018.

Table 5
MSCI Returns and ETF Trading: Portfolio sorts.

Panel A: ETF Order imbalance portfolios	P1	P2	P3	P4	P5	HML
Mean	1.24	4.78	3.69	5.45	7.58	6.34***
						[2.36]
Std	20.39	19.75	19.55	20.38	19.72	8.77
SR	0.06	0.24	0.19	0.27	0.38	0.72***

Panel B: Double-sorts based on ETF order imbalances and VIX betas	Low OI	Mid OI	High OI	HML
Mean β_{VIX}^{Low}	0.68	5.33	4.31	3.63
				[1.14]
Std	24.15	23.55	24.17	9.68
SR	0.03	0.23	0.18	0.37
Mean β_{VIX}^{High}	−1.60	6.41	12.20	13.80***
				[4.94]
Std	16.75	17.88	16.58	9.38
SR	−0.10	0.36	0.74	1.47

Panel C: Double-sorts based on ETF order imbalances and non-fundamental demand	Low OI	Mid OI	High OI	HML
Mean $\beta_{NFDemand}^{Low}$	1.53	6.62	7.44	5.90**
				[2.27]
Std	20.21	20.08	20.13	8.83
SR	0.08	0.33	0.37	0.67
Mean $\beta_{NFDemand}^{High}$	0.81	4.34	9.89	9.08**
				[2.05]
Std	20.53	20.57	20.79	12.74
SR	0.04	0.21	0.48	0.71

This table presents summary statistics of MSCI index returns (in USD) portfolios which are sorted into quintiles based on their previous week's ETF order imbalance. *Panel A* reports annualized return, standard deviation, and Sharpe ratio of portfolio sorted on order imbalances. We rebalance our portfolios weekly. *Panel B* shows the corresponding results of unconditional sorts of MSCI index returns which are sorted based on VIX betas and order imbalances. *Panel C* shows results of unconditional sorts of MSCI index returns which are sorted based on non-fundamental demand and order imbalances. We estimate VIX betas by regressing contemporaneous MSCI returns on VIX innovations using a 36-week rolling window. We report in squared brackets t-statistics with HAC standard errors (Newey and West, 1987) where the bandwidth has been selected following Newey and West (1994). ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 2006 to June 2018.

shock related to fundamentals increases the price of ETF above NAV (premium), faster incorporation of prices reflects price discovery. Next period, the premium (discount) should translate into a positive (negative) NAV return, as new information reaches the underlying market. To compare the extent to which price discovery happens in the ETF market, we regress NAV return on the past ETF premium. Higher β loading represents a stronger adjustment to NAV and higher price discovery in ETF.

$$R_{i,t}^{NAV} = \alpha + \beta_i \left(\frac{P_{i,t-1} - NAV_{i,t-1}}{NAV_{i,t-1}} \right) + \epsilon \tag{7}$$

Table 8 shows the average correlations of three portfolios that form based on the degree of price discovery. We pre-sort countries into

Table 6
Staggered ETF introductions.

Panel A: Correlations and staggered ETF introductions	(1)	(2)	(3)	(4)
	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$
$Intro^{ETF}_{i,t}$	0.002***	0.002***	0.002***	0.002***
	(8.02)	(7.45)	(7.22)	(7.34)
ΔVIX_t		0.043***	0.043***	0.039***
		(25.34)	(25.84)	(13.51)
$Intro^{ETF}_{i,t} \times \Delta VIX_t$				0.006*
				(1.92)
$\tilde{\rho}_{i,t-1}$		0.003	0.000	0.001
		(0.44)	(0.08)	(0.10)
$\hat{R}_{MSCI,i,t-1}$			−0.036***	−0.036***
			(−7.01)	(−7.00)
Constant	−0.002***	−0.002***	−0.002***	−0.002***
	(−9.14)	(−10.21)	(−9.62)	(−9.87)
Country FE	Yes	Yes	Yes	Yes
Observations	53,251	53,210	53,210	53,210
R-squared	0.1%	2.3%	2.5%	2.5%

Panel B: Correlations, Staggered ETF introductions and VIX decomposition	(1)	(2)	(3)	(4)
	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$
$Intro^{ETF}_{i,t}$	0.002***	0.003***	0.003***	0.002***
	(8.02)	(8.19)	(7.95)	(7.83)
ΔVIX^{RA}_t		0.049***	0.050***	0.051***
		(15.56)	(16.11)	(7.29)
ΔVIX^{UNC}_t		0.003***	0.003**	0.001
		(2.71)	(2.48)	(0.35)
$Intro^{ETF}_{i,t} \times \Delta VIX^{RA}_t$				−0.003
				(−0.43)
$Intro^{ETF}_{i,t} \times \Delta VIX^{UNC}_t$				0.008***
				(4.10)
$\tilde{\rho}_{i,t-1}$		−0.003	−0.005	−0.005
		(−0.46)	(−0.84)	(−0.81)
$\hat{R}_{MSCI,i,t-1}$			−0.035***	−0.035***
			(−7.13)	(−7.11)
Constant	−0.002***	−0.002***	−0.002***	−0.002***
	(−9.14)	(−10.35)	(−9.74)	(−9.68)
Country FE	Yes	Yes	Yes	
Observations	53,251	52,598	52,598	52,598
R-squared	0.1%	1.5%	1.6%	1.7%

This table presents contemporaneous panel regressions with country-fixed effects of MSCI country index return correlations on a dummy variable that takes a value of one during the life of the ETF, VIX changes, lagged return correlations, and lagged MSCI returns. We consider the model (and nested specifications) below:

$$\tilde{\rho}_{i,t} = \alpha_i + \beta_1 Intro^{ETF}_{i,t} + \beta_2 \Delta VIX_t + \beta_3 Intro^{ETF}_{i,t} \times \Delta VIX_t + \beta_4 \tilde{\rho}_{i,t-1} + \beta_5 R_{MSCI,i,t-1} + \varepsilon_{i,t},$$

where $\tilde{\rho}_{i,t}$ represents correlations between MSCI returns of country i and S&P 500 at time t. $Intro^{ETF}$ is a dummy variable that takes the value of 1 throughout the life of an ETF (from the inception date until the fund end date) and 0 otherwise. *Panel B* displays results including a VIX decomposition, that is, time-varying risk aversion and uncertainty components shown separately. We report t-statistics with clustered standard errors by country. ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 1992 to June 2018.

Table 7
ETF trading volume and MSCI return correlations.

Panel A: Daily correlations and ETF volume (Full sample)	(1)	(2)	(3)
	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$
$\Delta Vol_{i,t}$	0.026***	0.015***	0.013**
	(4.63)	(2.96)	(2.54)
$\tilde{\rho}_{i,t-1}$		−0.010***	−0.010***
		(−2.84)	(−2.93)
ΔVIX_t		0.053***	0.052***
		(30.71)	(29.11)
$\Delta Vol_{i,t} \times \Delta VIX_t$			1.319***
			(3.88)
$\hat{R}_{MSCI,i,t-1}$			−0.019***
			(−3.54)
Constant	−0.000***	−0.000***	−0.000***
	(−4.63)	(−30.25)	(−14.93)
Country FE	Yes	Yes	Yes
Observations	257,256	256,983	256,983
R-squared	0.0%	0.8%	0.8%

Panel B: Daily correlations and ETF volume (250-day window)	(1)	(2)	(3)
	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$
$\Delta Vol_{i,t}$	0.024**	0.020**	0.020**
	(2.66)	(2.20)	(2.15)
$\tilde{\rho}_{i,t-1}$		0.011	0.011
		(1.14)	(1.14)
ΔVIX_t		0.054***	0.053***
		(8.38)	(8.40)
$\Delta Vol_{i,t} \times \Delta VIX_t$			0.681**
			(2.25)
$\hat{R}_{MSCI,i,t-1}$			−0.005
			(−0.29)
Constant	0.000*	−0.000***	−0.000***
	(1.99)	(−5.67)	(−5.21)
Country FE	Yes	Yes	Yes
Observations	20,442	20,407	20,407
R-squared	0.0%	0.8%	0.8%

This table presents contemporaneous panel regressions with country-fixed effects of MSCI country index return correlations on ETF volume changes, VIX changes, lagged return correlations and lagged MSCI returns. We consider the model (and nested specifications) below:

$$\tilde{\rho}_{i,t} = \alpha_i + \beta_1 \Delta Vol_{i,t} + \beta_2 \Delta VIX_t + \beta_3 \Delta Vol_{i,t} \times \Delta VIX_t + \beta_4 \tilde{\rho}_{i,t-1} + \beta_5 R_{MSCI,i,t-1} + \varepsilon_{i,t},$$

where $\tilde{\rho}_{i,t}$ represents correlations between MSCI returns of country i and S&P 500 at time t. $\Delta Vol_{i,t}$ denotes ETF volume changes. *Panel A* shows results for the full sample, and *Panel B* displays results for a window of one year before and after the inception date. We report t-statistics with clustered standard errors by country. ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 1992 to June 2018.

portfolios one week before the computed correlation. The low group correlation (ρ^L_t) is defined as the average correlation across all counties within this group:

$$\rho^L_t = \frac{1}{N^L_t} \sum_{i=1}^{N^L_t} Corr(\Delta MSCI_i, \Delta S\&P500) \quad (8)$$

where N^L_t is the number of countries in the group L in week $t-1$. The correlation of returns is computed using a 36-week rolling window (we test alternative measures in Section 5). The correlation between medium and high groups is defined in the same manner.

In the last step of the mechanism described in Section 2, the (lack of) effect on correlations with the U.S. market depends on whether the ETF market helps with the price discovery of the fundamentals of underlying country indices. If the ETF market incorporates not just noise but also information about global shocks into the prices of the underlying indices, then we should see an impact on the correlations. The first sort based on β from Eq. (7) shows a significant increase in correlation for funds with high price discovery. The difference in average correlation across low and high groups is 0.106 (t-statistics = 22.57). We repeat the same sorting exercise in different VIX states. Although correlations are higher across all portfolios in high VIX states, the mechanism works regardless of the VIX state.

Pukthuanthong and Roll (2009) and Berger et al. (2011) argue that the correlation is not a good measure of market integration and propose a measure based on the first principal component (PC1) of equity returns. To this end, Table 8 offers average adjusted R-squares that are estimated based on 36-week rolling contemporaneous regressions of MSCI index returns on the PC1 (also estimated based on 36-week rolling window) of all available stock index returns in our sample. We find that the average adjusted R-squares follow the same direction as the average rolling correlations.[22]

[22] In online Appendix Table A9 we show the portfolio sort results based on Amihud's illiquidity ratio (Amihud, 2002) as a proxy for limits to arbitrage.

Table 8
Market integration and ETF price discovery.

	Low β_{PD}	Medium β_{PD}	High β_{PD}	HML	t-stat
Panel A: Price discovery - Full sample					
	Correlations				
$\bar{\rho}$	0.533	0.590	0.639	0.106	(8.64)
	Adjusted R-squared based on PC1				
$\overline{\text{Adj } R^2}$	51%	61%	67%	16%	(9.04)
Panel B: Price discovery - Low VIX					
	Low β_{PD}	Medium β_{PD}	High β_{PD}	HML	t-stat
	Correlations				
$\bar{\rho}$	0.398	0.480	0.535	0.138	(10.77)
	Adjusted R-squared based on PC1				
$\overline{\text{Adj } R^2}$	41%	53%	60%	19%	(8.55)
Panel C: Price discovery - High VIX					
	Low β_{PD}	Medium β_{PD}	High β_{PD}	HML	t-stat
	Correlations				
$\bar{\rho}$	0.632	0.672	0.724	0.092	(5.53)
	Adjusted R-squared based on PC1				
$\overline{\text{Adj } R^2}$	59%	68%	75%	16%	(7.15)

This table presents average correlations of MSCI index returns (in local currency) on S&P 500 returns. We also report average adjusted R-squares of MSCI index returns on the first principal component (PC1) of all available countries. The correlations are estimated based on a 36-week rolling window. We allocate countries, on a weekly basis, into terciles based on their price discovery. Our price discovery proxy is defined as the NAV sensitivity to the ETF premium. Specifically, we regress NAV returns of each country on their past ETF premium and use the estimated beta as a proxy of price discovery. The estimation of the beta coefficient is based on a 36-week rolling window. A higher beta coefficient represents a stronger adjustment to NAV implying a higher price discovery in the ETF market. The regression takes the form:

$$R_t^{NAV} = \alpha + \beta_{PD}\left(\frac{P_{t-1} - NAV_{t-1}}{NAV_{t-1}}\right) + \varepsilon_t,$$

where β_{PD} denotes ours proxy of price discovery. We estimate the measure for all the countries in our sample. *Panel A* shows results for the full sample. *Panel B* (*Panel C*) shows results for low (high) VIX states. We report in squared brackets t-statistics with HAC standard errors (Newey and West, 1987) where the bandwidth has been selected following Newey and West (1994). The data contain weekly series from January 2006 to June 2018.

5. Robustness tests

In this section, we perform numerous robustness tests to ensure that the results found in the previous sections are not sensitive to our choice of methodologies. We first investigate the different components of VIX and distinguish between US and global uncertainty shocks, controlling for US macroeconomic news. We offer an alternative text-based economic uncertainty measure and conduct placebo tests for the staggered introduction of ETF markets. We conclude this section by exploring alternative specifications, namely, estimation windows, a Dynamic Conditional Correlation (DCC) model, and order imbalance constructed for different trader types.

5.1. VIX decomposition

Here, we examine which part of the VIX shocks explains ETF order imbalances, shocks to underlying return correlations, and future MSCI returns. In particular, we include in contemporaneous and predictive panel regressions the *economic uncertainty* and *risk aversion* proxies implied by the dynamic no-arbitrage asset pricing model proposed by Bekaert et al. (2022). We run contemporaneous panel regressions with fixed effects in the case of ETF order imbalances and shocks to MSCI return correlations, as well as predictive panel regressions for future MSCI returns.

Table 9 shows the results of these panel regressions. We find that the time-varying risk aversion and the economic uncertainty components of VIX have a strong effect on both ETF order imbalances and shocks to return correlation in contemporaneous panel regressions (see Panel A). Adding two VIX components does not change the conclusion about the predictive ability of ETF order imbalance on underlying future MSCI returns. It seems that both components of VIX contain important information about future returns.

5.2. U.S. or Global shocks?

Our analysis highlights that shocks to the global component of U.S. VIX are transmitted to other economies driving trading patterns in the ETF market. Here, we examine whether U.S. shocks that are unrelated to the global economy are also transferred to other markets. To this end, we construct a measure of U.S. VIX that is orthogonal to information content in global VIX shocks. We construct two different measures of U.S. VIX that isolate its global component.

U.S. VIX and country-level VIX. In the first measure, we regress U.S. VIX changes contemporaneously on the first three principal components of a panel of VIX shocks to G10 countries in our sample, excluding U.S. VIX. Thus, our orthogonalized VIX measure is the residual of the regression, as mentioned above. Panel A of Table 10 shows the results of contemporaneous regressions of ETF order imbalances on orthogonalized U.S. VIX, orthogonalized local VIX, and several controls. We find that the U.S. component of VIX also affects the trading activity in the ETF market. However, in terms of economic value, we find that the global component of U.S. VIX demonstrates a stronger impact on ETF trading (the coefficient in Table 2 is −0.104 as opposed to −0.002 for the orthogonalized VIX changes measure). Interestingly, the country-level VIX changes become negative and statistically significant, indicating that once we isolate the U.S. component of VIX in the regression model, local shocks drive ETF traders' trading activity. Panel B shows the corresponding results when the response variable is the return correlation. Similar to our previous findings, we observe that the orthogonalized U.S. VIX has a positive and statistically significant impact on return correlations. However, the orthogonalized U.S. VIX's economic value is not as strong as in the VIX measure that includes its global component. The local VIX measure is highly positive and significant.

U.S. VIX and macro announcements. Our second measure of U.S. VIX is the residual of a contemporaneous regression of U.S. VIX on a dummy variable that takes a value of one if there is a macro news announcement in that week and zero otherwise. We collect daily data on U.S. macroeconomic announcements from S&P Capital IQ, focusing on General Macro announcements. These announcements include FOMC meetings, Fed presidents' speeches, auctions, and releases of the Fed's Beige Book and related conferences. Panel A of Table 11 displays results for ETF order imbalances, and Panel B shows results for return correlations. We find that our results are not affected by U.S. macroeconomic announcements. Table A11 of the Internet Appendix shows the corresponding results if we define the macro announcements variable as the number of announcements each week. Our results are robust to this alternative definition.

5.3. News-based uncertainty

One could argue that the same fundamental force drives the VIX index, ETF flows, and country index returns. Moreover, the VIX index captures both economic uncertainty and time-varying risk aversion, as discussed earlier. To isolate the uncertainty component, we construct a news-based measure of economic uncertainty (please see the data section for a detailed explanation of the measure). *Panel A* of

Table A10 shows double sort results using price discovery and two measures of limits to arbitrage, Amihud's illiquidity ratio and liquidity mismatch (Pan and Zeng, 2021).

Table 9
Panel regressions: *VIX Decomposition*.

Panel A: Order imbalances and correlations

	(1) $OI_{i,t}$	(2) $OI_{i,t}$	(3) $\tilde{\rho}_{i,t}$	(4) $\tilde{\rho}_{i,t}$
ΔVIX_t^{UNC}	−0.116***	−0.087***	0.012***	0.011***
	(−6.58)	(−5.21)	(3.12)	(2.72)
ΔVIX_t^{RA}	−0.052***	−0.054***	0.038***	0.039***
	(−3.21)	(−2.87)	(15.13)	(15.79)
$\Delta LVIX_{i,t}$	−0.066***	−0.056***	0.015***	0.015***
	(−4.45)	(−3.48)	(3.31)	(3.35)
$NFDemand_{i,t}$		0.473***		−0.003
		(7.53)		(−0.44)
$\hat{R}_{ETF,i,t-1}$		0.487***		−0.037***
		(6.04)		(−4.99)
Constant	0.020***	0.051***	−0.000***	0.000
	(260.11)	(7.08)	(−12.99)	(0.10)
Controls	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes
Observations	20,617	19,253	19,362	18,754
R-squared	0.7%	4.3%	2.1%	2.3%

Panel B: Returns of underlying securities

	(1) $R_{MSCI,i,t}$	(2) $R_{MSCI,i,t}$	(3) $R_{MSCI,i,t}$
$OI_{i,t-1}$	0.005***	0.005***	0.007***
	(3.22)	(3.51)	(4.27)
ΔVIX_{t-1}^{CV}	−0.023***	−0.026***	−0.031***
	(−6.73)	(−6.84)	(−7.62)
ΔVIX_{t-1}^{RA}	−0.022***	−0.027***	−0.033***
	(−5.80)	(−6.80)	(−7.90)
$\Delta LVIX_{i,t-1}$		0.020***	0.004
		(7.90)	(1.19)
$NFDemand_{i,t-1}$			−0.004
			(−0.89)
$\hat{R}_{MSCI,i,t-1}$			−0.202***
			(−9.84)
Constant	0.001***	0.001***	0.002**
	(38.36)	(38.06)	(2.26)
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	21,081	20,592	19,217
R-squared	1.1%	1.4%	4.1%

Panel A of this table presents contemporaneous panel regressions with country-fixed effects of ETF order imbalances and country-level MSCI return correlations with the S&P 500 return on U.S. and local VIX changes, non-fundamental demand ($NFDemand$), lagged values of ETF returns, and other control variables. *Panel B* shows predictive panel regressions with country-fixed effects of MSCI index returns (in local currency) on lagged ETF order imbalances as well as lagged values of MSCI returns, non-fundamental demand, and several other control variables. Our models include both components of VIX. We consider the model (and nested specifications) below:

$$X_{i,t} = \alpha_i + \beta_1 \Delta VIX_t^{UNC} + \beta_2 \Delta VIX_t^{RA} + \beta_3 \Delta LVIX_{i,t} + \beta_4 NFDemand_{i,t} + \beta_5 R_{ETF,i,t-1} + \gamma' \boldsymbol{Z}_{i,t} + \epsilon_{i,t},$$

where $X_{i,t}$ represents the ETF order imbalance ($OI_{i,t}$) or correlation ($\tilde{\rho}_{i,t}$) of country i at time t. Other controls ($\boldsymbol{Z}$) include spot exchange rate changes and a price discovery proxy in the ETF market. We report t-statistics with clustered standard errors by country. ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 2006 to December 2018.

Table 10
Panel regressions: *U.S.* VIX shocks.

Panel A: Order imbalances

	(1) $OI_{i,t}$	(2) $OI_{i,t}$	(3) $OI_{i,t}$
ΔVIX_t^{US}		−0.002***	−0.002***
		(−2.75)	(−3.10)
$\Delta LVIX_{i,t}$	−0.114***	−0.114***	−0.096***
	(−7.74)	(−7.64)	(−5.90)
$NFDemand_{i,t}$			0.474***
			(7.62)
$\hat{R}_{ETF,i,t-1}$			0.495***
			(6.13)
Constant	0.020***	0.020***	0.050***
	(399.01)	(376.88)	(7.04)
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	20,684	20,684	19,318
R-squared	0.3%	0.4%	4.0%

Panel B: Correlations

	(1) $\tilde{\rho}_{i,t}$	(2) $\tilde{\rho}_{i,t}$	(3) $\tilde{\rho}_{i,t}$
ΔVIX_t^{US}		0.002***	0.002***
		(15.83)	(15.03)
$\Delta LVIX_{i,t}$	0.031***	0.031***	0.031***
	(7.62)	(7.65)	(7.57)
$NFDemand_{i,t}$			−0.003
			(−0.51)
$\hat{R}_{ETF,i,t-1}$			−0.039***
			(−4.83)
Constant	−0.000***	−0.000**	0.000
	(−6.47)	(−2.26)	(0.29)
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	19,427	19,427	18,817
R-squared	0.8%	1.7%	2.0%

This table presents contemporaneous panel regressions with country fixed effects of ETF order imbalances (*Panel A*) and country-level MSCI index return (in local currency) correlations with the S&P 500 return (*Panel B*) on orthogonalized U.S. and orthogonalized local VIX changes as well as non-fundamental demand ($NFDemand$), lagged values of ETF returns, and other control variables. We consider the model (and nested specifications) below:

$$X_{i,t} = \alpha_i + \beta_1 \Delta VIX_t^{US} + \beta_2 \Delta LVIX_{i,t} + \beta_3 NFDemand_{i,t} + \beta_4 R_{ETF,i,t-1} + \gamma' \boldsymbol{Z}_{i,t} + \epsilon_{i,t},$$

where $X_{i,t}$ represents the ETF order imbalance ($OI_{i,t}$) or correlation ($\tilde{\rho}_{i,t}$) between MSCI returns of country i and S&P 500 at time t. ΔVIX^{US} represents U.S. VIX changes that are orthogonal to global shocks. Other controls ($\boldsymbol{Z}$) include spot exchange rate changes and a price discovery proxy in the ETF market. We report t-statistics with clustered standard errors by country. ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 2006 to June 2018.

Table 12 show contemporaneous regressions of ETF order imbalances on economic uncertainty, local VIX and several controls. As with the VIX measure, economic uncertainty is a strong negative predictor of ETF order imbalances. *Panel B* shows contemporaneous regressions of correlations on economic uncertainty, local VIX, and several controls. Consistent with our previous findings, we find that economic uncertainty has a strong positive relation with correlations.

5.4. Placebo tests

As we explain in Section 2, the transmission mechanism is specific to ETF trading, so the introduction of other derivative products should not lead to the same increase in country return correlations. To test this claim, we collect country index futures inception days on the EUREX platform. Table A12 of the Internet Appendix examines the role played by country index futures introductions on underlying return correlations. We find that the coefficient of a dummy variable, which takes a value of one for periods after the introduction of country index futures, is not statistically different from zero, suggesting that a similar transmission mechanism is not in place to explain country return correlations.

We further examine the impact of VIX on return correlations around ETF introductions. Table A13 of the Internet Appendix shows contemporaneous panel regressions with country-fixed effects of return correlations on a dummy variable $Intro^{ETF}$ which takes a value of one during the life of the ETF, VIX changes and their interaction as well as lagged MSCI returns, lagged correlations and other control variables. We also consider different specifications of the dummy variable. Our goal is to examine whether the increase in return correlation is truly due to the introduction of ETFs. Thus, we construct dummy variables with lead and lag specifications. Specifically, $Intro_{-24}^{ETF}$ ($Intro_{-12}^{ETF}$) is a dummy variable that takes a value of one, 24 months (12 months) before an ETF introduction, and until the end of the sample. Similarly,

Table 11
Panel regressions: *U.S. Macro announcements.*

Panel A: Order imbalances			
	(1)	(2)	(3)
	$OI_{i,t}$	$OI_{i,t}$	$OI_{i,t}$
$\Delta VIX_t^{o,\ US\ Macro}$		−0.104***	−0.100***
		(−8.53)	(−7.76)
$\Delta LVIX_{i,t}$	−0.114***	−0.035**	−0.020
	(−7.74)	(−2.41)	(−1.32)
$NFDemand_t$			0.471***
			(7.57)
$\hat{R}_{ETF,i,t-1}$			0.519***
			(6.41)
Constant	0.020***	0.020***	0.050***
	(399.01)	(367.70)	(7.08)
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	20,684	20,684	19,318
R-squared	0.3%	0.9%	4.5%

Panel B: Correlations			
	(1)	(2)	(3)
	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$
$\Delta VIX_t^{o,\ US\ Macro}$		0.033***	0.033***
		(13.94)	(13.89)
$\Delta LVIX_{i,t}$	0.031***	0.006	0.006
	(7.62)	(1.12)	(1.14)
$NFDemand_t$			−0.002
			(−0.28)
$\hat{R}_{ETF,i,t-1}$			−0.042***
			(−5.35)
Constant	−0.000***	0.000	0.000
	(−6.47)	(0.95)	(0.14)
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	19,427	19,427	18,817
R-squared	0.8%	2.5%	2.8%

This table presents contemporaneous panel regressions with country fixed effects of ETF order imbalances (*Panel A*) and country-level MSCI index return (in local currency) correlations with the S&P 500 return (*Panel B*) on orthogonalized U.S. and orthogonalized local VIX changes as well as non-fundamental demand ($NFDemand$), lagged ETF returns, and other control variables. We consider the model (and nested specifications) below:

$$X_{i,t} = \alpha_i + \beta_1 \Delta VIX_t^{o,\ US\ Macro} + \beta_2 \Delta LVIX_{i,t} + \beta_3 NFDemand_{i,t} + \beta_4 R_{ETF,i,t-1} + \gamma' \boldsymbol{Z}_{i,t} + \varepsilon_{i,t},$$

where $X_{i,t}$ represents the ETF order imbalance ($OI_{i,t}$) or correlation ($\tilde{\rho}_{i,t}$) between MSCI returns of country i and S&P 500 at time t. $\Delta VIX_t^{o,\ US\ Macro}$ represents the U.S. VIX that is orthogonal to U.S. macro announcements. We define macro announcement based on a dummy variable that takes the value of 1 if there is an announcement and zero otherwise. Other controls ($\boldsymbol{Z}$) include spot exchange rate changes and a price discovery proxy in the ETF market. We report t-statistics with clustered standard errors by country. ***,**,* denote 1%, 5%, and 10% significance levels. The data contain weekly series from January 2006 to June 2018.

Table 12
Panel regressions: *News-based uncertainty*.

Panel A: Order imbalances			
	(1)	(2)	(3)
	$OI_{i,t}$	$OI_{i,t}$	$OI_{i,t}$
ΔUNC_t		−0.278***	−0.283***
		(−3.28)	(−3.55)
$\Delta LVIX_{i,t}$	−0.114***	−0.112***	−0.093***
	(−7.74)	(−7.61)	(−5.87)
$NFDemand_t$			0.474***
			(7.63)
$\hat{R}_{ETF,i,t-1}$			0.478***
			(6.02)
Constant	0.020***	0.020***	0.051***
	(399.01)	(94.02)	(7.10)
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	20,684	20,666	19,318
R-squared	0.3%	0.4%	4.0%

Panel B: Correlations			
	(1)	(2)	(3)
	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$	$\tilde{\rho}_{i,t}$
ΔUNC_t		0.108***	0.107***
		(8.03)	(7.52)
$\Delta LVIX_{i,t}$	0.031***	0.030***	0.030***
	(7.62)	(7.46)	(7.20)
$NFDemand_t$			−0.003
			(−0.53)
$\hat{R}_{ETF,i,t-1}$			−0.027***
			(−3.47)
Constant	−0.000***	−0.000***	−0.000
	(−6.47)	(−9.51)	(−0.24)
Controls	No	No	Yes
Country FE	Yes	Yes	Yes
Observations	19,427	19,427	18,817
R-squared	0.8%	0.9%	1.2%

This table presents contemporaneous panel regressions with country-fixed effects of ETF order imbalances (*Panel A*) and country-level MSCI index return (in local currency) correlations with the S&P 500 return (*Panel B*) on U.S. news-based uncertainty changes (ΔUNC) and orthogonalized local VIX changes ($\Delta LVIX$), non-fundamental demand ($NFDemand$), lagged ETF returns, and other control variables. We consider the model (and nested specifications) below:

$$X_{i,t} = \alpha_i + \beta_1 \Delta UNC_t + \beta_2 \Delta LVIX_{i,t} + \beta_3 NFDemand_{i,t} + \beta_4 R_{ETF,i,t-1} + \gamma' \boldsymbol{Z}_{i,t} + \varepsilon_{i,t},$$

where $X_{i,t}$ represents the ETF order imbalance ($OI_{i,t}$) or correlation ($\tilde{\rho}_{i,t}$) between MSCI returns of country i and S&P 500 at time t. Other controls ($\boldsymbol{Z}$) include spot exchange rate changes and a price discovery proxy in the ETF market. We report t-statistics with clustered standard errors by country. ***,**,* denote 1%, 5% and 10% significance levels. The data contain weekly series from January 2006 to June 2018.

$Intro_{24}^{ETF}$ ($Intro_{12}^{ETF}$) is a dummy variable that takes a value of one, 24 months (12 months) after the introduction and until the end of the sample. Finally, we construct a dummy variable that we label as $Intro_{Random}^{ETF}$ in which we randomly assign value one in the dummy variable 12 months or 24 months before or after an ETF introduction. Our model takes the form below:

$$\tilde{\rho}_{i,t} = \alpha_i + \beta_1 Intro_{LeadLag,i,t}^{ETF} + \beta_2 Intro_{LeadLag,i,t}^{ETF} \times \Delta VIX_t + \beta_3 \Delta VIX_t + \beta_4 \tilde{\rho}_{i,t-1} + \beta_5 R_{MSCI,i,t-1} + \varepsilon_{i,t}, \tag{9}$$

where $LeadLag$ represents the number of months before or after the ETF introduction.

We find that the interaction between $Intro^{ETF}$ and VIX changes is highly positive and significant. This result is stronger when we consider dummy variables that take a value of one, 12 months, or 24 months after an ETF introduction, indicating that the introduction of an ETF, especially after some initial period, has a strong positive impact on return correlations when VIX increases. On the other hand, we find that the interaction is not statistically significant when we include interactions that take a value of one, 12 months, or 24 months before an ETF introduction. We also find the interaction of the $Intro_{Random}^{ETF}$ with changes in VIX to be not statistically significant which reinforces our previous findings regarding the role of ETFs on the correlations of the underlying securities.

5.5. Alternative specifications

Estimation windows. In the main analysis, we have used a 36-week rolling window to compute time-varying correlations. As part of the robustness checks, we compute MSCI return correlations using longer estimation windows: 60-week and 100-week rolling windows. The results are reported in Table A14 of the Internet Appendix. Our main results are not sensitive to the choice of window length.

Correlation estimates. To overcome the need to choose the length of the rolling window (a longer length may result in smoother correlation estimates), we employ an alternative measure of correlation: a Dynamic Conditional Correlation (DCC) of Engle (2002). We also estimate the correlations following the Cochrane–Orcutt procedure (Cochrane and

Orcutt, 1949) to take into account the persistence of correlation measures. Table A15 and Table A16 of the Internet Appendix show that the mechanism we describe in the paper does not depend on how we measure time-varying correlations.

Different types of traders. Country ETF products offer diversification benefits to both retail and institutional investors. However, their order flows are likely to react to different types of news, and hence, the effect of VIX shocks might differ across trader types. Section A4 of the Internet Appendix describes how we construct the proxies for order imbalance measures of different trader types. Table A17 of the Internet Appendix shows that VIX shocks have a similar effect, albeit smaller for small investors, on the order imbalances of different ETF traders.

6. Conclusion

In this paper, we investigate how country ETF traders make investment decisions. We analyze the effect of those decisions on the returns of the underlying country index. We show that the order imbalance of country ETF trades mainly reflects changes in the U.S. implied volatility index rather than in the local VIX. The result is robust to different volatility regimes.

We use these results to investigate the mechanism whereby global shocks are transmitted to foreign countries, thus resulting in high cross-country correlation. We argue that such shocks are propagated to different countries via price discovery in the ETF facilitated by the arbitrage mechanism. Consistent with this argument, our time-series analysis shows that the ETF market's introduction increases the country's stock market correlation with the U.S. market.

Finally, we investigate the cross-sectional differences in countries' correlations with the U.S. market. ETF trading in the secondary market plays an important role in price discovery. Authorized participants engage in arbitrage activity in the primary market to correct deviations between the ETF price and the NAV. If such deviation is due to transitory liquidity shock, the adjustment to ETF price and NAV should revert. However, if such deviation results from faster incorporation of fundamentals in ETF price, arbitrage should lead to a higher correlation of a country with the U.S. equity market. In support of this hypothesis, we find that countries with higher price discovery in the ETF market have a higher correlation with the U.S. market.

Our work is important for international investors seeking to diversify their U.S. exposure by investing in international ETFs. While previous research focuses on the role of global banks and the U.S. as the central economy on cross-country correlation, our study's novelty is that we discover a new channel of market integration via ETF trading.

CRediT authorship contribution statement

Ilias Filippou: Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Arie Gozluklu:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Hari Rozental:** Writing – original draft, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jbankfin.2024.107274.

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