HONG KONG INSTITUTE FOR MONETARY AND FINANCIAL RESEARCH

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Could ETFs make stock markets more vulnerable to systemic liquidity shock? - Evidence from Emerging Asia

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Abstract

Using a dataset on ETFs ownership of stocks in nine Emerging Asian markets, we find that stocks with a higher ETF ownership exhibit a greater commonality in liquidity to other stocks in the same market. The effect increases with the level of ETFs arbitrage activities, supporting the hypothesis that ETFs arbitrage mechanism is the source of commonality in liquidity. We also find that the effect is asymmetric; ETFs exert a stronger influence when stocks' liquidity decline. These findings are supported by a cross-market analysis, as we show that the effect is larger in market where stocks have more common exposures to ETFs, while tightened capital market condition could also amplify the effect of ETF ownership. Increased financial market openness, on the other hand, may ease the potential systemic impact. ETFs ownership of stocks also increases the commonality in liquidity of stocks across markets. The cross-markets impacts by ETFs present a channel via which financial market integration through ETFs could lead to a build-up of systemic liquidity risks and increase the vulnerability of liquidity shock spill-over to stock markets.

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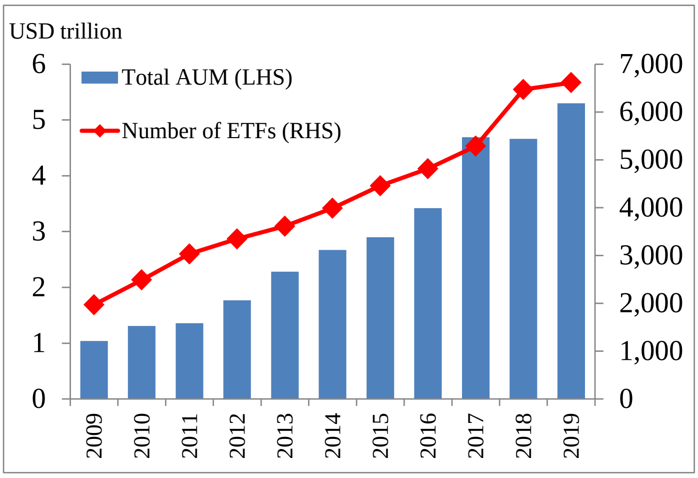
1. Introduction

An exchange traded fund (ETF) is an open-ended fund traded like a stock that tracks the performance of the underlying assets. The spectacular growth in ETFs over the last decade is testimony to ETFs as an important financial innovation (Chart 1). While ETFs offer benefits to investors such as better access to diversification of asset classes, markets and improved price discovery (Hill et al., 2015), there are concerns that the growing popularity of ETFs may lead to systemic stability issues arising from their impacts on underlying securities (Bhattacharya and O'Hara (2016), Pan and Zeng (2017)). A growing academic literature reveals better understanding of these consequences. A recent study by Agarwal et al. (2019) suggests that ETFs increase the commonality in liquidity of stocks in which these ETFs invest. This finding has implications for financial stability as commonality in liquidity of stocks could give rise to systemic liquidity risks in stock markets, increasing the fragility of stock markets to liquidity shock (Kamara et al., 2008). The increased commonality also has implications for investors as it could reduce their ability to diversify liquidity risk in investment portfolios. The incorporation of liquidity risks in asset pricing (Acharya and Pedersen, 2005) also implies that commonality in liquidity of stocks could indirectly induce systemic price fluctuations in the stock market.

Chart 1: ETFs in global markets



Source: ETFGI

How could ETFs induce commonality in the liquidity of their underlying stocks? The literature suggests that commonality in liquidity can arise from both supply-side and demand-side sources. Supply-side explanations build on the notion that financial intermediaries face systematic capital shocks and funding constraints which prevent them from providing market liquidity (Coughenour and Saad, 2004; Brunnermeier and Pedersen, 2009; Hameed et al., 2010), with the effect being more pronounced during stressful times which leads to systematic liquidity dry-ups. On the other hand, demand-side explanations build on the correlated trading among investors with similar holdings and trading patterns, which tend to trade in similar direction when faced with certain liquidity shocks. With institutional investors being the predominant source of such correlated trading activities, Kamara et al. (2008) and Koch et al. (2016) show that larger ownership by institutional investors increases commonality in stocks liquidity.

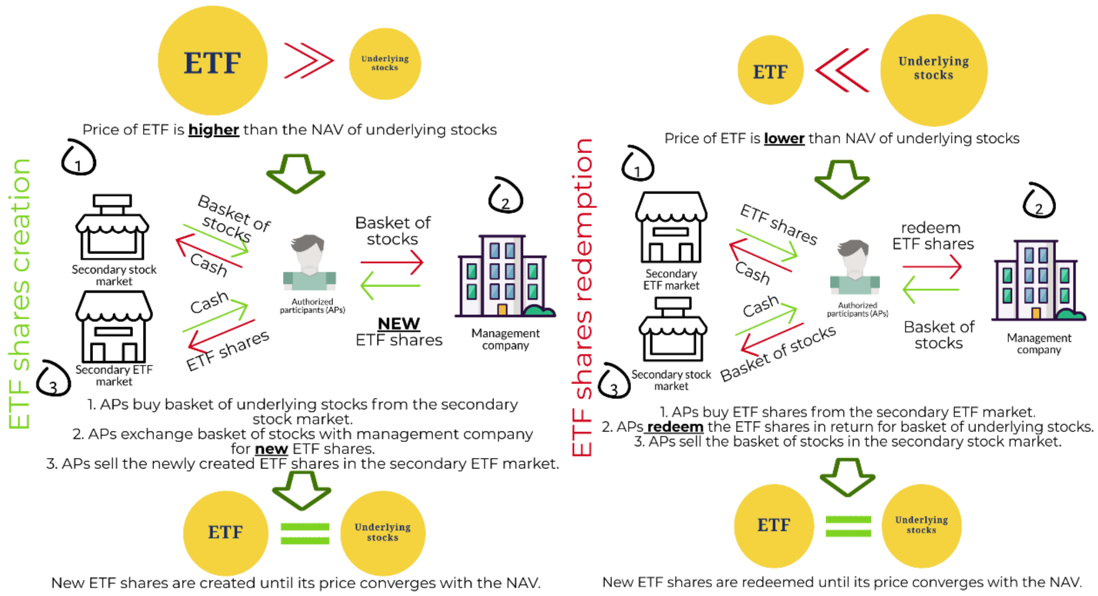
Like other investment funds, ETFs are regarded as a demand-side source of commonality. However, instead of the pure flow-driven commonality in Koch et al. (2016), Agarwal et al. (2019) suggest that through their inherent arbitrage mechanism, ETFs could drive the commonality even without investments coming in or out of ETFs. The arbitrage mechanism, which could take place in either the primary or secondary market of ETFs and throughout the trading day, is designed to ensure that the deviation between the price of ETF share and the net asset values (NAV) of the basket of ETF's underlying securities remains narrow (referred to as "ETF mispricing"). Appendix A describes the mechanism in detail while Chart 2 below illustrates the arbitrage undertaken in the primary market by the Authorized Participants (APs).[1] The extent of correlated trading on underlying stocks, which could take place with (in the primary markets by APs) or without flows in ETFs (in the secondary market by other market participants) as arbitrage opportunities arise, is then determined by the commonality in ETF ownership. These trading activities lead to correlated liquidity demand on these securities and therefore generate commonality in liquidity between them. Agarwal et al. (2019) have shown that the arbitrage mechanism is the underlying channel that ETFs generate commonality in liquidity of their underlying US stocks.

While Agarwal et al. (2019) and most prevalent studies on ETFs cover the US markets, this study focuses on stock markets in Emerging Asia. The ETF market has grown rapidly in Emerging Asia, with the share of ETFs (as total number of ETFs) listed in the Asia Pacific (excluding Japan) rising from 5% in 2009 to 20% in 2019 according to ETFGI. The larger share of institutions exposed to ETFs also reflect the importance of ETFs in the Asia-Pacific market. For instance, a survey by Greenwich

[1] APs are financial institutions capable of managing complex securities settlements that create and redeem ETF shares in the primary market in exchange for underlying securities. Each AP has an agreement with an ETF sponsor that gives it the right (but not the obligation) to create and redeem ETF shares, which may act either on their own behalf or on the behalf of market makers or institutional clients. APs can be regarded as the liquidity providers of ETFs where they have the exclusive right to change the supply of ETF shares on the market.

Associates finds that about a third of Asian institutions employ ETFs while only 14% of US institutions invest via ETFs. Finally, the effect of ETF ownership on the commonality in liquidity is also of high relevance to Emerging Asia's stock markets, where Brockman et al. (2009) document a stronger commonality in liquidity than exists in other regions.[2]

Chart 2: ETFs arbitrage by APs



In this paper we address the following questions: First, does ETF ownership increase the commonality in liquidity of stocks in the Emerging Asia markets? Second, can the arbitrage mechanism explain the effect of ETF ownership? Third, is the effect symmetric to the upside and downside movement in liquidity? Fourth, does the effect of ETF ownership differ across markets in Emerging Asia and if so, what are the factors that drive the differences? Finally, does higher ETF ownership also lead to larger commonality in liquidity of stocks across markets?

The contribution of this study is three-fold. First, unlike most prevalent studies on ETFs that focus on the US market, we utilize a comprehensive dataset on stocks ownership by ETFs and expand the analysis to nine stock markets in Emerging Asia. Second, by studying the effect of ETF ownership across markets and time, we supplement previous studies on the source of commonality in liquidity by analysing how other sources of commonality could interact with ETFs in affecting the commonality in liquidity. Finally,

[2] Covering 47 stock exchanges from around the world, Brockman et al. (2009) find that stock exchanges in Emerging Asia exhibit strongest commonality in stock liquidity, as measured by bid-ask spread.

by establishing the association between ETF ownership and commonality in liquidity of stocks across markets, we also present a channel via which financial markets integration through ETFs could result in the build-up of systemic liquidity risks between markets.

The remainder of the paper is structured as follows: Section 2 reviews the related literature; Section 3 presents the data and empirical methodology; Section 4 presents empirical findings to the various questions set out above and the final section concludes.

2. Literature review

This study relates to two strands of literature. First, how ETFs affect the underlying stocks. Prior literature finds that ETFs increase their non-fundamental volatility (Malamud, 2015 and Ben-David et al., 2018) and increases co-movement in returns (Da and Shive, 2017 and Israeli et al., 2017). It is also found that ETFs affect informational efficiency of underlying stocks but evidence on the direction of impacts is mixed (Israeli et al. (2017) find a negative effect while Glosten et al. (2017) find a positive effect on stocks with weaker informational environment). A number of studies instead focus on the effect of ETFs on the liquidity of underlying stocks. A theoretical model on uninformed traders by Subrahmanyam (1991) suggests financial products that group baskets of stocks may reduce the liquidity of individual stocks, as uninformed traders are likely to substitute trading on individual stocks with such "portfolio" products to reduce costs arising from adverse selection. Along this argument, both Hamm (2010) and Israeli et al. (2017) consistently find that ETFs reduce liquidity of stocks.

This study also relates to literature on the commonality in stocks liquidity. Early studies advocate a liquidity premium in assets expected returns (Amihud and Mendelson, 1986; Brennan et al., 1996, Jacoby et al. (2000), Jones (2002), Amihud (2002)). A number of papers have subsequently provided evidence that investors also demand a higher expected return when assets exhibit larger commonality in liquidity (Pastor and Stambaugh (2003), Acharya and Pedersen (2005)). Factors driving commonality in liquidity can be classified into supply-side and demand-side sources. Supply-side explanations build on the notion that financial intermediaries face systematic capital shocks and funding constraints, which prevent them from providing market liquidity. For instance, Coughenour and Saad (2004) show that liquidity of stocks handled by the same specialist firm co-moves in response to a funding shock faced by the specialist. From a broader perspective, Brunnermeier and Pedersen

(2009) and Hameed et al. (2010) argue that financial intermediaries, who provide liquidity across assets, can reduce the supply of liquidity across assets when faced with common funding constraints and this gives rise to commonality in liquidity. On the demand side, it has been shown that commonality in liquidity is driven by demand on liquidity due to correlated trading activities by investors (Chordia et al., 2000; Hasbrouck and Seppi, 2001), institutional ownership (Kamara et al., 2008; Koch et al., 2016) and arbitrageurs (Corwin and Lipson, 2011; Tomio, 2017). While most of the above studies focus on the US market, Karolyi et al. (2012) assess the relative importance of the supply and demand factors in determining the commonality for each market and find stronger support for the demand-side explanations. A similar study by Brockman et al. (2009) shows that commonality in liquidity also happens across markets, with the impact determined by all exchange, regional and global level factors. This implies that liquidity shocks in one market could spread to the others.

3. Data and Methodology

3.1 Sample

This study covers nine stock markets in Emerging Asia, including China (CN), Hong Kong (HK), Indonesia (ID), Malaysia (MY), Singapore (SG), South Korea (KR), Taiwan (TW), Thailand (TH) and Vietnam (VN). We select from each market the 500 largest stocks to narrow the scope of our analysis to form our sample. The selected stocks represent over 90% of the capitalization of each respective market, suggesting our coverage is still comprehensive.[3]

We next calculate the share of stocks owned by ETFs (denoted by *ETFown*). Information on stocks' ownership by ETFs is retrieved from Capital IQ, which compiles on a quarterly basis stocks' ownership by individual funds.[4] With this information we can narrow down the shares of stocks owned by ETFs.[5] Then, at the end of each quarter q, *ETFown* for stock i is calculated by the following formula,

$$ETFown_{i,q} = \frac{\sum_j shares_{i,j,q}}{CSO_{i,q}} \qquad (1)$$

[3] With the exception of China market where the largest stocks are dual-listed (i.e. listed in both China, known as A-shares and Hong Kong, known as H-shares), with Capital IQ providing only the mutual fund ownership data for the H-share counterpart but not for the A-share counterpart. The related stocks are therefore excluded from the analysis on China market. The selected Chinese stocks represent over 90% of the market capitalization of the remaining stocks.
[4] Information on stocks ownership by mutual funds is primarily sourced from funds' public disclosure.
[5] We identify the mutual funds that are ETFs in two steps. First, we filter those mutual funds with a stock exchange ticker. Then, with the given stock exchange ticker, we extract its vehicle type (e.g. ETFs, close-end funds) based on identification by Capital IQ.

Where $shares_{i,j}$ is the total share of stock i held by ETF j and CSO_i denotes the total common share outstanding for stock i.

3.2 Commonality in liquidity

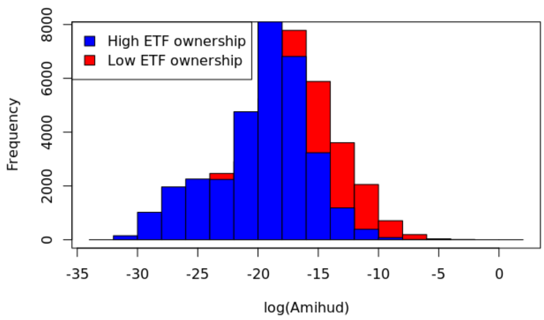
We follow Kamara et al. (2008) and Koch et al. (2016) in adopting the Amihud (2002) illiquidity measure as proxy of stock's liquidity (denoted by *liq*). Apart from the easiness in calculation using daily data, the Amihud measure also performs well relative to other intraday measures of liquidity (Goyenko et al. (2009)).

The Amihud illiquidity measure is a type of market impact measure (ESRB, 2016) that measures the sensitivity of stock's return to its turnover. When a stock is less liquid, turnover on the stock would have a greater impact on its price (and so the return) and thus a higher Amihud ratio. More specifically, the daily stock liquidity is calculated by the following formula:

$$liq_{i,d} = \frac{|R_{i,d}|}{Turonover_{i,d}} \quad (2)$$

$|R_{i,d}|$ and $Turnover_{i,d}$ denote the absolute daily return and turnover of stock i at day d respectively and their ratio defines the Amihud illiquidity measure. From Equation 2 we can also see that the Amihud measure is sensitive to the currency denomination due to the denominator (i.e. the stock's turnover, while the return is considered currency-free). Calculating the Amihud measure using raw data denominated in US dollar, Chart 3 shows that stocks that are more owned by ETFs tend to be more liquid than those with lower ownership (as they are more left-skewed), which is not surprising given that they are also the larger and more popular stocks.

Chart 3: Histogram of stocks liquidity



Note: Figures refer to the quarterly average of daily Amihud measure of individual stocks, calculated in terms of US dollar before converted into logarithm form.

We proceed to construct the commonality measure. In particular, for stock i in market m, we define the commonality in liquidity as the contemporaneous correlation between the daily movement in stock i liquidity and that for a portfolio of other stocks in market m. In practice, we estimate the following time-series regression in each quarter q;

$$\Delta liq_{i,m,d,q} = \alpha + \beta_{i,m,q}^{market} \Delta liq_{i,m,d,q}^{market} + \delta controls + \varepsilon_{i,q,m,d} \quad (3)$$

More specifically, $\Delta liq_{i,m,d}$ is the daily change in the logs of Amihud illiquidity measure of stock i. As with Agarwal et al. (2019), we focus on the change in liquidity as it matters more how similar a stock's liquidity moves to others.[6] Commonality in liquidity is then captured by $\beta_{i,m,q}^{market}$, which measures the correlation between the movement in the liquidity of stock i and the simple average (i.e. equal-weighted) movement in the liquidity of other stocks in the same market.[7] We opt against the approach in Agarwal et al. (2019), which captures the commonality in liquidity with respect to a subset portfolio of high-ETF owned stocks, as the commonality measure defined in this way would be harder to interpret and the results may be driven by other common unobserved characteristics among these high-ETF owned stocks.[8] Finally, as we are just comparing the change in liquidity of stocks from the same market, the currency issue discussed earlier is not relevant and we therefore construct the change in liquidity based on local currency. Using local currency measure could also avoid contaminations in the commonality measure due to the currency movement against the US dollar.

Meanwhile, $Controls$ is a vector of variables that control for other factors on stocks liquidity as in Chordia et al. (2000) and Koch et al. (2016).[9] Given the variance of the

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[6] Using liquidity in first-difference could also reduce potential econometric issues in time series regression such as non-stationarity. Meanwhile, we take the log differences so as to minimize the impact of outliers.

[7] Equal weighting liquidity across stocks could better address the question of how a particular stock co-moves with other stocks—without emphasizing or deemphasizing the stock's co-movement with other stocks based on the size of the latter. See Pirinsky and Wang (2006) and Chung and Kang (2016). The results remain robust if we use value-weighted measure instead.

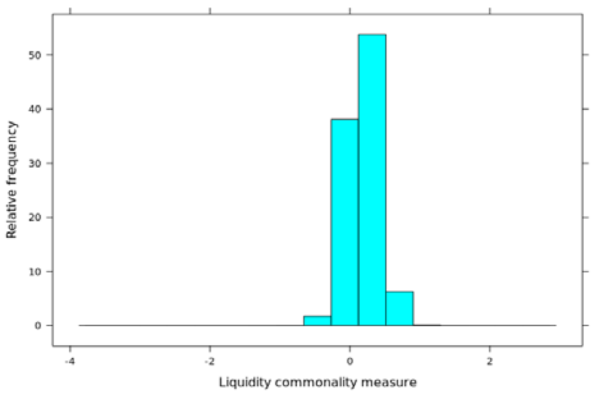
[8] Agarwal et al. (2019) defines the subset of high ETF-owned stocks in market m as those with ETF ownership ranked in the first quartile (after excluding stock i) in the given quarter. Nevertheless, we repeated the estimation using their approach and the results are robust. Results are available upon request.

[9] These include the lead and lag term (at 1 day) of β^{market}, the lead, lag and contemporaneous market returns, and contemporaneous squared stock return,.The lag and lead terms of the change in market liquidity measure are added to control for lag and lead co-movement in liquidity, while the market returns are included to control for possible correlations between returns and our liquidity measure. Finally, squared stock return is included to capture price volatility that might be related to liquidity.

variables could vary a lot across both stocks and quarters, we standardise all variables in each time series regression with zero mean and unity variance for better comparability of the estimated commonality measure across stocks and time. Finally, we require complete data in at least 50% of the trading days for each firm-quarter regression, which amounts to about 30 observations, for better stability of the estimations. Our main results remain robust when we do not perform the standardisation in obtaining the commonality measure or when alternative minimum observation requirement is used.[10]

Charts 4 also shows that the outliers exist in the commonality measure estimated from the above procedure. To avoid the impact of such outliers in our analysis, we winsorized all commonality measures at 2% and 98% respectively.

Chart 4: Histogram of estimated commonality measure



4. Empirical results

4.1 Baseline analysis

We primarily investigate the relationship between ETF ownership and the commonality in liquidity of stocks in the same market by using the following cross-market panel regression model;

$$\beta_{i,q,m}^{market} = \gamma_1 ETFown_{i,m,q-1} + \gamma_2 NonETFown_{i,m,q-1} + \gamma_3 CONTROLS_{i,m,q-1} + FE_{stock} + FE_{time} + FE_{market*time} + \epsilon_{i,q} \quad (4)$$

$\beta_{i,q,m}^{market}$, $ETFown_{i,m,q-1}$ is the liquidity commonality measure and ETF ownership for stock i respectively. $NonETFown_{i,m,q-1}$ refers to the ownership by non-ETF mutual

[10] Specifically, we repeat the analysis using estimated commonality measure with minimum requirement of 20 and 40 observations and the results remain largely similar.

funds, added to control for ownership by other non-ETF funds as it could also induce commonality in liquidity (Koch et al., 2016).[11] The vector of control variables $CONTROLS_{i,m}$ includes the co-movement in stock's return with market return ($\beta_{i,m}^{return}$) obtained from Equation 3.[12] Other time-varying stock-level control variables include the logarithm of stock's market capitalization (*size*) and Amihud liquidity measure as defined in equation 3 (liq). As both *size* and liq vary with currency denomination, they are converted in terms of US dollar for comparability across markets. Elsewhere, stock-fixed effects and time-fixed effects (FE_{time}) are added to control for cross-sectional dependence and time-varying common factors respectively. Finally, as we analyse all nine markets jointly in the baseline model, the market-time ($FE_{market*time}$) fixed effects is also added to control for time-varying factors that affect the commonality in liquidity in individual markets. Table 1 gives some summary statistics of the variables.

Table 1: Summary statistics of variables

Variable	Obs	Mean	SD	Skewness	25p	Median	75p
β^{market}	49137	0.19	0.23	0.16	0.02	0.17	0.34
$ETFown$	49137	1.38	1.42	1.34	0.28	0.85	2.12
$NonETFown$	49137	9.67	8.82	1.60	2.97	7.06	14.05
liq	49137	-22.63	6.20	-0.47	-27.81	-21.08	-18.71
$size$	49137	7.24	1.42	0.24	6.10	7.16	8.29
β^{return}	49137	-0.04	0.19	0.08	0.17	-0.04	0.08

Table 2 reports the estimation results of the baseline model. Column 1 shows that stock with higher ETF ownership (*ETFown*) has a larger commonality in liquidity to other stocks in the same market. Specifically, one standard deviation (SD) increase in *ETFown* (i.e. 1.38%, see Table 1) is associated with an increase in commonality measure by 0.04 SD (i.e. 0.04*0.23 = 0.01, see Table 1). In terms of economic magnitude, this implies that a 1 p.p. increase in ETF ownership is associated with a 0.67% increase in commonality. Column 1 and 2 together show that the estimated effect of *ETFown* change little regardless of if *NonETFown* is included or not.

[11] Unlike Agarwal et al. (2019) where they further divide the non-ETF funds into index funds, active open-end mutual funds and other funds, we cannot perform similar division as relevant identification is not available in Capital IQ.

[12] To the extent that co-movement in liquidity is related to co-movement in returns (Karolyi et al., 2012) and that ETF ownership can also induce co-movement in stocks returns (Da and Shive, 2017), we follow Agarwal et al. (2019) and control for the co-movement in returns such that our estimated γ_1 is not picking up the effect on the latter . $\beta_{i,m}^{return}$ is captured by the contemporaneous coefficient from the regression of the daily return of stock i on the lead, contemporaneous and lag average daily return of all other sample stocks.

Consistent with Agarwal et al. (2019), this suggests the effect of ETF ownership is independent of the ownership of other mutual funds.

Table 2: Estimated effect of ETF ownership on commonality in liquidity in overall sample and by level of ETF ownership

	β^{market}	
Dependent variable	(1)	(2)
$ETFown_{t-1}$	**0.04*** **	**0.04*** **
$nonETFown_{t-1}$	**-0.06*** **	
$size_{t-1}$	**-0.15*** **	**-0.17*** **
liq_{t-1}	**-0.17*** **	**-0.17*** **
β_{t-1}^{return}	0.01	0.01
Observations	49137	49137
Time effect	Yes	Yes
Stock effect	Yes	Yes
Market-time effect	Yes	Yes
R-squared	0.055	0.055
Number of stocks	2523	2523
Clustering	Stock	Stock

Notes: (1) ***, ** and * denote statistical significance at 1%, 5% and 10% respectively. Standard errors are clustered at stock level.

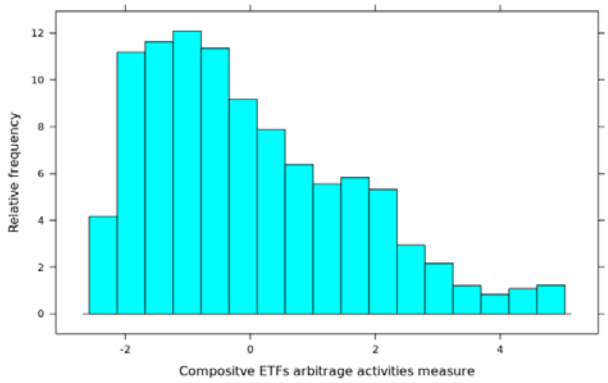
4.2 Effect of ETF ownership: what is the underlying channel?

In this section, we verify whether the arbitrage mechanism is the underlying channel via which ETFs drive the commonality in liquidity of stocks in Emerging Asian stock markets. In particular, we investigate whether the effect of ETF ownership is stronger on stocks facing more arbitrage activities in ETFs. To measure ETFs arbitrage activities faced by a particular stock, we consider a composite indicator that extracts common information on arbitrage activities measured from the five dimensions considered in Agarwal et al. (2019). They include i) average and ii) standard deviation of daily mispricing, iii) the average and iv) standard deviation of daily net share creation and redemption, and v) daily transaction of ETFs.[13] Appendix B provides the definitions of these five dimensions, where a higher value in all measures indicates potentially higher level of ETFs arbitrage activities. Chart 5 shows a histogram of our

[13] Agarwal et al. (2019) also consider the short interest ratio of ETFs as a measure of ETF arbitrage activities. However, we have not considered this measure in our analysis as this would greatly reduce the number of observations available.

ETF arbitrage measure, with the density decreasing gradually with the level of arbitrage activities.

Chart 5: Histogram of ETFs arbitrage activities



Nonetheless, our approach to measure ETF arbitrage activities is also different from Agarwal et al. (2019) in two aspects. First, Agarwal et al. (2019) consider these measures separately while we condense them into one composite indicator by taking their first principal component (PC).[14] It is arguable that a higher value at each measure alone may not necessarily reflect a higher level of arbitrage activities.[15] Second, instead of using the weighted sum (weight by individual ETF's ownership) of arbitrage activities across ETFs, we calculate the weighted average (i.e. weight sum divided by total ETF ownership) such that they are comparable across stocks with different levels of ETF ownership.[16]

We then verify the effect of ETF arbitrage activities with an extended form of the model in Equation 4, as follow;

$$\beta_{i,q,m}^{market} = \gamma_1^{Low} ETFown_{i,m,q-1} * (1 - Dummy_{i,m,q}^{High}) + \gamma_1^{High} ETFown_{i,m,q-1} * Dummy_{i,m,q}^{High} + \gamma_2 NonETFown_{i,m,q-1} + \gamma_3 CONTROLS_{i,m,q-1} + FE_{stock} + FE_{time} + FE_{market*time} + \epsilon_{i,q} \quad (5)$$

$Dummy_{i,m,q}^{High}$ is a dummy variable that equals one when the level of ETF arbitrage activities faced by stock i in quarter q is higher than the designated threshold, and zero

[14] The first principal component captures over 85% of the variances in the underlying dimensions. Refer to appendix C for further details.
[15] For instance, the high level of ETF mispricing may be a result of lack of arbitrage rather than a trigger for arbitrage. On the other hand, higher level of ETF share creation or redemption may be a result of market demands on ETFs, rather than driven by profitable arbitrage opportunities.
[16] Agarwal et al. (2019) account for the cross-sectional variation in the ETF ownership across stocks by dividing the samples into groups of high and low arbitrage activity within each decile of ETF ownership.

otherwise. Given this dummy approach γ_1^{High} (γ_1^{Low}) represents the effect of ETF ownership on stocks facing high (low) level of arbitrage activities in ETFs holding them. Similar to Agarwal et al. (2019), Column 1 of Table 3 shows that the effect of ETF ownership is stronger on stocks facing more arbitrage activities by ETFs. In particular, the estimated γ_1^{High} (i.e. 0.05 in Column 1) is more positive than γ_1^{Low} (i.e. 0.03). The result of Wald test confirms their differences are significantly different from 0 (i.e. last row of column 1), we could therefore attribute the positive association between ETF ownership and commonality in liquidity to ETFs arbitrage mechanism.

Furthermore, the significance of ETFs arbitrage activities is not affected by the level of ETF ownership. Specifically, we focus on a sub-sample of high "*ETF-arbitraged*" stocks where the level of ETF arbitrage activities is higher than sample median. We further categorise the observations in this sub-sample by their median value of *ETFown* and re-estimate Equation 5. Column 2 of Table 2 shows that both γ_1^{High} (i.e. 0.07 in Column 2) and γ_1^{Low} (i.e. 0.05 in Column 2) are statistically significant and not different from zero. This suggests the effect on the high "*ETF-arbitraged*" stocks is not altered by the level of ETF ownership. When we switch to the sub-sample of low "*ETF-arbitraged*" stocks (i.e. sample observations whose level of ETF arbitrage activities is lower than sample median), Column 3 again shows that both estimated γ_1^{High} and γ_1^{Low} are not statistically different from each other. This provides further support that the arbitrage mechanism is the underlying channel by which ETFs drive the commonality in stocks' liquidity.

Table 3: Estimated effect of ETF ownership on commonality in liquidity by level of ETF arbitrage activities

Dependent variable	β^{market}		
	(1)	(2)	(3)
$ETFown_{t-1}$			
γ_1^{High}	**0.05*** **	**0.07*** **	0.03
γ_1^{Low}	**0.03** **	**0.05** **	0.03
$nonETFown_{t-1}$	**-0.064*** **	**-0.08*** **	**-0.07*** **
$size_{t-1}$	**-0.15*** **	**-0.19*** **	-0.06
liq_{t-1}	**-0.17*** **	**-0.19*** **	**-0.08** **
β_{t-1}^{return}	0.01	**0.02*** **	0.01
Observations	49137	24568	24568
Time effect	Yes	Yes	Yes
Stock effect	Yes	Yes	Yes
Market-time effect	Yes	Yes	Yes

R-squared	0.055	0.073	0.048
Number of stocks	2523	2358	2383
Sample	All	High ETF-arbitraged	Low ETF-arbitraged
Clustering	Stock	Stock	Stock
$\gamma_1^{High} - \gamma_1^{Low}$	**0.02***	0.017	-0.002

Notes: (1) ***, ** and * denote statistical significance at 1, 5 and 10% respectively. (2) The last row of Column 1 reports the difference of γ_1^{High} and γ_1^{Low}, the difference in the effect of ETF ownership on high and low "*ETF-arbitraged*" stocks. Indication on statistical significance refers to the result of Wald test with the null hypothesis of $\gamma_1^{High} - \gamma_1^{Low}$ equals 0. (3) Columns 2 and 3 report the differences in the effect of ETF ownership on stocks with high and low level of ETF ownership, using sub-sample of high and low "*ETF-arbitraged*" stocks respectively.

4.3 Effect of ETF ownership: is it symmetric?

We next examine whether the effect of ETF ownership is symmetric, specifically whether the effect differs between the upside and downside movement in stocks' liquidity. From the financial stability perspective, one would not worry too much about stocks improving in liquidity in tandem. Instead, it is more relevant to see whether ETFs amplify the downside commonality in stocks' liquidity. The analysis is achieved by studying the relationship between ETF ownership and the commonality measure, conditioning on the downside and on the upside movement in liquidity.

More specifically, we consider a revised form of Equation 3 to derive the conditional commonality measure;

$$\Delta liq_{i,m,d,q} = \alpha + \beta_{i,m,q}^{market,downside} \Delta liq_{i,m,d,q}^{market} * I(\Delta liq_{i,m,d,q}^{market} > 0) + \beta_{i,m,q}^{market,upside} \Delta liq_{i,m,d,q}^{market} * I(\Delta liq_{i,m,d,q}^{market} \leq 0) + \delta controls + \varepsilon_{i,q,m,d} \quad (6)$$

This follows Chung and Kang (2016) where $I(\cdot)$ is an indicator variable. Given a positive $\Delta liq_{i,m,d,q}^{market}$ denotes a decline in liquidity, $\beta_{i,m,q}^{market,downside}$ would measure the commonality in liquidity when other stocks' liquidity declines (i.e. downside commonality in liquidity), and vice versa for $\beta_{i,m,q}^{market,upside}$ (i.e. upside commonality liquidity). We then repeat the estimations of Equation 4 and 5 by replacing $\beta_{i,q,m}^{market}$ with $\beta_{i,m,q}^{market,downside}$ and $\beta_{i,m,q}^{market,upside}$.

Table 4 shows the results. Columns 1 and 3, which correspond to Equation 4 when $\beta_{i,m,q}^{market,downside}$ and $\beta_{i,m,q}^{market,upside}$ is used respectively, show that the estimated γ_1 is significant on downside commonality liquidity (i.e. 0.04 in Column 1) but not the upside one (i.e. 0.01 in Column 3). This suggests ETF ownership increases only downside commonality in liquidity in general. This result could be attributed to the use of ETFs for liquidity management by institutional investors (ECB, 2018). In particular, when stocks' liquidity declines these institutions may opt to consume ETFs for liquidity. This may exert downward pressure on ETFs price, widen ETFs mispricing and finally, trigger arbitrage activities in ETFs. This would in turn lead to correlated selling on underlying stocks and amplify their commonality in liquidity. Meanwhile, investors may be more flexible in consuming either individual stock's holding or ETF for liquidity when stocks liquidity improves and may therefore result in the insignificant impact of ETF ownership. Nevertheless, Column 4 shows that ETFs could still exert influence on upside commonality in liquidity when arbitrage activities in them are sufficiently active (i.e. 0.02 for γ_1^{High} in Column 4).

Table 4: Estimated effect of ETF ownership on downside and upside commonality in liquidity

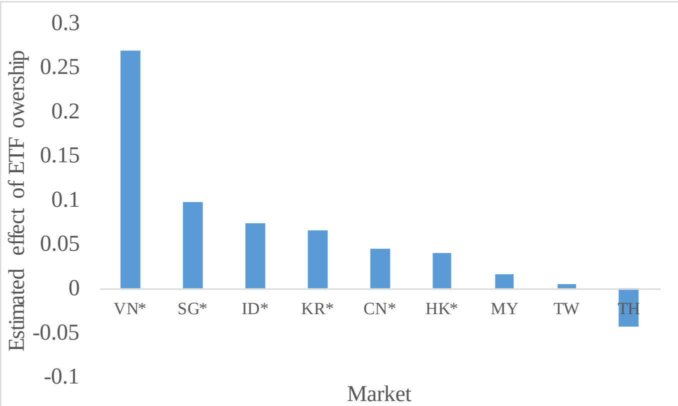
Dependent variable	$\beta^{market,downside}$		$\beta^{market,upside}$	
	(1)	(2)	(3)	(4)
$ETFown_{t-1}$				
γ_1	**0.04*** **		0.01	
γ_1^{High}		**0.04*** **		**0.02***
γ_1^{Low}		**0.04** **		-0.01
$nonETFown_{t-1}$	**-0.04*** **	**-0.04*** **	**-0.03** **	**-0.03*** **
$size_{t-1}$	**-0.13*** **	**-0.13*** **	-0.03	-0.02
liq_{t-1}	**-0.1*** **	**-0.1*** **	**-0.1*** **	**-0.1*** **
β_{t-1}^{return}	0.01	0.01	0.01	0.01
Observations	49137	49137	49137	49137
Time effect	Yes	Yes	Yes	Yes
Stock effect	Yes	Yes	Yes	Yes
Market-time effect	Yes	Yes	Yes	Yes
R-squared	0.03	0.03	0.04	0.04
Number of stocks	2523	2523	2523	2523
Clustering	Stock	Stock	Stock	Stock
$\gamma_1^{High} - \gamma_1^{Low}$		0.00		**0.03*** **

Notes: (1) ***, ** and * denote statistical significance at 1, 5 and 10% respectively. (2) The last row in Columns 2 and 4 reports the difference of γ_1^{High} and γ_1^{Low}, the difference in the effect of ETF ownership on high and low "*ETF-arbitraged*" stocks. Indication on statistical significance refers to the result of Wald test with the null hypothesis of $\gamma_1^{High} - \gamma_1^{Low}$ equals 0. (3) Standard errors are clustered at stock level.

4.4 Effect of ETF ownership: same across markets?

Having established a general positive association between ETF ownership and commonality in liquidity in our sample of Emerging Asian markets, we investigate further if the impact of ETF ownership is similar across markets. By estimating Equation 4 separately for each market, Chart 6 shows that the commonality in liquidity increases with ETF ownership in all markets except for Thailand, with magnitudes of estimated γ_1 differing vastly across markets.

Chart 6: Estimated effect of ETF ownership by individual market



Note: Market with * denote the estimated effect is significantly different from 0 at 10% level.

To identify any market factors that drive the differences, we estimate for each market and quarter the cross-section form of Equation 4 to obtain a panel data of the estimated γ_1. Instead of using the estimated γ_1 in Chart 6, which could be regarded as the time-average impact for each market, the panel set-up could provide richer information for estimation. We also standardise the variables into zero mean and unity variance in each cross-section regression for better comparability of estimated γ_1 across markets and time. Then, we regress the panel data of estimated γ_1 on various explanatory variables in Equation 6 below;

$$\gamma_{1_{m,t}} = \beta_1 ETFexp_{m,t-1} + \beta_2 GROSSflow_{m,t-1} + \beta_3 int_{m,t-1} + \beta_4 return_{m,t-1} + \beta_5 vol_{m,t-1} + \beta_8 GDP_{m,t-1} + FE_{market} + FE_{time} + \varepsilon_{m,t} \quad (6)$$

Like Karolyi et al. (2012) on the sources of commonality in stock liquidity across markets, the explanatory variables in Equation 6 can be classified into demand and supply side factors, as well as capital market condition. In particular, the demand side factors include common exposure to ETFs (*ETFexp*) and gross capital flows (*GROSSflow*). Supply side factors include short-term interest rate (*int*) while factors for capital market condition include stock market return (*return*) and volatility (*vol*). Table

5 shows the definitions of these variables with the expected sign of coefficients. The panel model also includes real GDP growth (*GDP*), market (FE_{time}) and time-fixed (FE_{time}) effects as control variables. All market-specific variables enter in lagged term to avoid potential endogeneity issue.

Table 6 shows that while not all factors are statistically significant, the directions of estimated effects are all in line with our expectation. Comparing the magnitude of estimated coefficients, which is possible given all variables are standardised into zero mean and unity variance, stocks' common exposure to ETFs has the largest impact among the factors investigated (with an estimated coefficient of 0.47). This provides another support to the hypothesis that ETFs induce commonality in stocks' liquidity via their inherent arbitrage mechanism. In particular, the extent of correlated trading by ETFs arbitrage activities is expected to be larger if stocks are more commonly exposed to ETFs.

Meanwhile, the negative coefficient for gross capital flow (a proxy for financial market openness, with an estimated coefficient of -0.08) supports our prediction that the ETFs induce commonality to a lesser extent when the financial market is more open. Market transparency, which is associated with lower commonality in liquidity (Karolyi et al., 2012), is likely to improve as the market opens to foreign investors. Lastly, the significant coefficient on short-term interest rate (*int*) and market volatility (*vol*) suggest the supply-side source of commonality would interact with the demand-side source of commonality as driven by ETF ownership. In particular, the positive coefficients on both variables suggest the tightening in capital market condition (i.e. either a higher interest rate or increased market volatility) would amplify the effect of ETF ownership on the commonality in stocks' liquidity. The effect of tighter capital market condition is also consistent with the earlier finding that ETF ownership exert a stronger influence on downside commonality in liquidity.

Table 5: Definitions of market-level determinants

Variable	Definition	Expected sign
Common Exposure to ETFs	For each market m, the ratio of stock-ETF pairs to number of stocks. Stocks are more likely to be exposed to same ETFs if the ratio is higher	The extent of ETFs arbitrage activities is larger if stocks are more commonly exposed to ETFs (+)
Gross capital flow	Sum of the absolute value of net acquisition of assets and net incurrence of liabilities from BOP's portfolio investment statistics, and expressed as % of annual GDP	Proxy of financial market openness, Karolyi et al. (2012) show that commonality in liquidity decreases with market openness (-)
Short-term interest rate	3-month interbank interest rate	Intermediaries are more likely to hit their capital constraints during tighter credit conditions and result in greater commonality (+)
Market return	Quarterly stock market return	Capital market could be tightened when the value of assets decrease, making intermediaries more likely to hit their capital constraints and result in greater commonality (-)
Market volatility	Standard deviation of daily stock market return	Reduced inventory holdings by market makers during volatile market (Stoll, 1978) could lead to larger commonality (+)

Table 6: Determinants on the effect of ETF ownership at market-level

Dependent variable	$\gamma_{1m,t}$
$ETFexp_{t-1}$	**0.47***
$GROSSflow_{t-1}$	**-0.08***
int_{t-1}	**0.37*****
$return_{t-1}$	-0.12
vol_{t-1}	**0.25***
GDP_{t-1}	**0.14***
Observations	200
Time-fixed effect	Yes
Market-fixed effect	Yes
R-squared	0.1
Number of markets	9
Clustering	Market

Notes: (1) ***, ** and * denote statistical significance at 1, 5 and 10% respectively. (2) Standard errors are clustered at market-level.

4.5 Effect of ETF ownership: liquidity spill-over to other markets?

We wrap up the analysis by investigating whether ETFs ownership increases the commonality in liquidity of stocks across markets. Brockman et al. (2009) document the first empirical evidence of a distinct, global component in stock market liquidity which supports the hypothesis that commonality in liquidity could spill-over national borders. While the study does not study further the underlying channel of spill-overs, the evidence we found earlier suggests ETFs, especially those holding securities across markets, may offer a channel for spill-overs.

To this end, we repeat the baseline market-level analysis but pool our sample stocks from nine Emerging Asia markets together as if they are in the same market. This means the commonality measure of a particular stock is now measured with respect to stock from all markets instead of the same market only. Unlike the baseline analysis where the commonality measure is derived using Amihud measure in local currency, the potential incomparability in liquidity measure due to different currency denomination cannot be ignored when we pool stocks from all markets together. While there is no perfect way to adjust for the currency effect, we test the sensitivity of our results to the currency issue by repeating the estimation using commonality measure based on Amihud measure in US dollar and local currency, respectively.

The first two columns of Table 7 show the estimation results using the commonality measure based on Amihud measure in US dollar. Specifically, the first column shows that we do not find a significant relationship between ETF ownership and commonality in liquidity for all sample stocks (0.02 for γ_1 in Column 1). Nevertheless, we do see a positive and significant effect on stocks facing more ETFs arbitrage activities (0.04 for γ_1^{High} in Column 2). This suggests that, when ETFs arbitrage activities create correlated liquidity demand on stocks across markets, ETFs ownership could also induce commonality in liquidity of these stocks. In addition, the last two Columns of Table 6 show that the effect of ETF ownership, as driven by ETF arbitrage mechanism, holds if we derive the commonality measures using Amihud measure in local currency. This confirms our results are not sensitive to the currency effects.

Table 7: Effect of ETF ownership on commonality in liquidity of stocks across markets

Dependent variable	β^{market}			
	(1)	(2)	(3)	(4)
$ETFown_{t-1}$				
γ_1	0.02		**0.02***	
γ_1^{High}		**0.04*****		**0.05*****
γ_1^{Low}		0.02		**0.03****
$nonETFown_{t-1}$	**-0.03****	-0.01	-0.01	**-0.02****
$size_{t-1}$	**-0.13*****	**0.06****	-0.01	0.04
liq_{t-1}	**-0.18*****	0.01	**-0.23*****	**-0.09****
β_{t-1}^{return}	**0.05*****	0.01	**0.04*****	0.01
Observations	46101	46101	46091	46091
Time effect	Yes	Yes	Yes	Yes
Stock effect	Yes	Yes	Yes	Yes
Market-time effect	Yes	Yes	Yes	Yes
R-squared	0.05	0.05	0.04	0.04
Number of stocks	2423	2423	2422	2422
Currency denomination of Amihud measure	US dollar		Local currency	
Clustering	Stock	Stock	Stock	Stock
$\gamma_1^{High} - \gamma_1^{Low}$		**0.02****		**0.03****

Notes: (1) ***, ** and * denote statistical significance at 1, 5 and 10% respectively. (2) The last row in Columns 2 and 4 reports the difference of γ_1^{High} and γ_1^{Low}, the difference in the effect of ETF ownership on high and low "*ETF-arbitraged*" stocks. Indication on statistical significance refers to the result of Wald test with the null hypothesis of $\gamma_1^{High} - \gamma_1^{Low}$ equals 0. (3) Standard errors are clustered at stock level.

5. Conclusion

Using a dataset on ETF ownership of stocks in nine Emerging Asian markets, we find that stocks with a higher ETF ownership exhibit a greater commonality in liquidity to other stocks in the same market. The effect increases with the level of ETFs arbitrage activities, supporting the hypothesis that ETFs arbitrage mechanism is the source of commonality in liquidity. We also find that the effect of ETF ownership is asymmetric; they exert a stronger influence on downside commonality in liquidity (i.e. when stocks liquidity declines).

While ETF ownership increases the commonality in liquidity in general, magnitudes of effect differ across markets. We investigate the sources of differences between markets using a host of demand and supply-side factors, as well as factors relating to capital market condition. A simple panel regression analysis suggests that stocks' common exposure to ETFs has the largest impact among the factors investigated, which provides another support to the hypothesis that ETFs induce commonality in stocks' liquidity via their inherent arbitrage mechanism. The effect of ETF ownership would also be amplified under a tighter capital market condition, specifically higher interest rate and higher stock market volatility, suggesting the supply-source of commonality in liquidity could interact with demand side source of commonality in ETF ownership. The effect of a tighter capital market condition is also consistent with our finding that ETFs exert a stronger influence on downside commonality in liquidity. Increased financial market openness, on the other hand, may ease the potential systemic impact. Finally, we present evidence to the notion that ETFs arbitrage activities also exert a similar effect on the commonality in liquidity of stocks across markets, and again via ETFs arbitrage activities.

Overall, this study contributes to the debate whether fast-rising ETFs could lead to a build-up of systemic liquidity risks at the regional or even global level. Our results show that, like Agarwal et al. (2019) on the US market, ETFs arbitrage activities could also increase the commonality in liquidity of Emerging Asian stock markets. More importantly, the stronger influence on downside commonality liquidity implies not only a reduction in investors' ability to diversify liquidity risks in their portfolios, but also a potential amplification of systemic liquidity risk when liquidity tightens. The magnitudes of the effects differ across markets and are dependent on factors such as interest rate, market volatility and level of financial market openness. Apart from the impact on stocks in the same market, we find that the liquidity of stocks across markets could also become more co-moved with each other due to ETFs arbitrage activities.

This presents a channel by which financial market integration through ETFs could lead to a build-up of systemic liquidity risks and increase the vulnerability of liquidity shock spill-over across stock markets.

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Appendix

A. Arbitrage mechanism of ETFs

The arbitrage mechanism could work through two channels, i) the creation or redemptions of ETF shares in the primary ETF market by the APs, and ii) buying (selling) of ETF shares in the secondary ETF market and simultaneous selling (buying) the basket of constituent securities by other market participants, such as hedge funds or high-frequency traders.

Chart 2 in the *Introduction* section presents the first channel in more detail. More specifically, the picture on the left shows that when ETF is trading at a premium (i.e. the price of ETF share is higher than the market value of constituent securities), APs would sell the ETF short while simultaneously buying the basket. At the end of the trading day, the APs cover their short sales by delivering the basket to the ETF in exchange for ETF shares and new ETF shares are created. The opposite applies to the situation when ETF is trading at a discount with ETF shares being redeemed (right hand side of Chart 2).

On the other hand, ETF arbitrage could also take place continuously throughout the day by other market participants such as hedge funds and high-frequency traders. Unlike APs, these investors do not have the right to engage in ETF shares creation or redemption in the primary market. Nevertheless, they can undergo the arbitrage via the ETF secondary market. More specifically, these participants may sell (buy) the ETF shares and buy (sell) the basket of underlying securities when ETF is trading at a discount (premium). They then hold the positions until the price of ETFs and the basket of underlying securities converge, at which point they close the positions to realise a profit.[17] While the actions taken by APs or these market participants are similar, a key difference with the former case is that no ETF shares are created or redeemed in the second channel.

In both cases, the trading activities in the underlying securities are linked through common ETF ownership. In particular, simultaneous trading in these stocks translates into correlated demand for the liquidity of these stocks and therefore, greater co-movement in liquidity.

[17] Of course, the uncertainty involved in these profits does not qualify these trades as an arbitrage in a strict sense. ETF sponsors facilitate arbitrage activity by disseminating NAV values at a 15-second frequency throughout the trading day. They have the incentive to do so because the smooth functioning of arbitrage is what brings about the low tracking error of ETFs.

B. The five dimensions of ETF arbitrage activities

Measure	Definition	Rationale
Average ETF mis-pricing	$\frac{\sum_{j=1}^{J} w_{j,q-1} * \frac{1}{D}\sum_{d=1}^{D}\left\lvert\frac{P_{j,d}-NAV_{j,d}}{P_{j,d}}\right\rvert}{\sum_{j=1}^{J} w_{j,q-1}}$	A larger deviation between ETF price and its NAV signals arbitrage profitability
Standard deviation ETF mis-pricing	$\frac{\sum_{j=1}^{J} w_{j,q-1} * \sigma(\left\lvert\frac{P_{j,d}-NAV_{j,d}}{P_{j,d}}\right\rvert)}{\sum_{j=1}^{J} w_{j,q-1}}$	
Average turnover	$\frac{\sum_{j=1}^{J} w_{j,q-1} * \frac{1}{D}\sum_{d=1}^{D} TURNOVER_{j,d}}{\sum_{j=1}^{J} w_{j,q-1}}$	Trading or short interest on ETFs could lead to deviation between the price and NAV of the ETFs, thus leading to arbitrage opportunities.
Average ETF net share creation	$\frac{\sum_{j=1}^{J} w_{j,q-1} * \frac{1}{D}\sum_{d=1}^{D}\left\lvert\frac{Shrout_{j,d}-Shrout_{j,d-1}}{Shrout_{j,d-1}}\right\rvert}{\sum_{j=1}^{J} w_{j,q-1}}$	APs create or redeem ETFs due to profitable arbitrage opportunities
Standard deviation of ETF net share creation	$\frac{\sum_{j=1}^{J} w_{j,q-1} * \sigma(\left\lvert\frac{Shrout_{j,d}-Shrout_{j,d-1}}{Shrout_{j,d-1}}\right\rvert)}{\sum_{j=1}^{J} w_{j,q-1}}$	

$P_{j,d}$ = Price of ETF J at day D

$NAV_{j,d}$ = Net asset value (NAV) of ETF J at day d

$TURNOVER_{j,d}$ = Turnover of ETF J (as % of share outstanding) at day d

$Shrout_{j,d}$ = Outstanding share of ETF J at day d

J = Total number of ETFs that own a given stock i

D = Number of days in a given quarter q

$w_{j,q-1}$= Percent ownership of the ETF in a given stock i at the end of the previous quarter.

C. Principal component Analysis on five dimensions of arbitrage activities

Variable	P1	P2	P3	P4	P5
Average ETF mispricing	0.43	0.63	0.00	0.65	-0.01
SD ETF mispricing	0.45	0.47	-0.06	-0.76	-0.08
ETF turnover	0.44	-0.29	0.80	-0.01	0.29
Average ETF net share creation	0.46	-0.43	-0.13	0.10	-0.76
SD ETF net share creation	0.45	-0.34	-0.59	0.04	0.58
Percentage of variance explained (%)	85.5	8.7	3.8	1.5	0.5