Do ETFs increase the commonality in liquidity of underlying stocks?*

Vikas Agarwal,[a] Paul Hanouna,[b] Rabih Moussawi,[b] Christof Stahel,[c,†]

[a] J. Mack Robinson College of Business, Georgia State University
[b] Villanova School of Business, Villanova University
[c] Division of Economic and Risk Analysis, US Securities and Exchange Commission

This version: December 5, 2016

First draft: April 15, 2016

Abstract

We examine the impact of ETF ownership on the commonality in liquidity of the stocks held by ETFs. Our results indicate that ETF ownership significantly increases the liquidity commonality on account of the arbitrage mechanism inherent in ETFs that ensures that ETF prices are in line with the prices of the underlying stocks. We show that greater arbitrage activities in both the primary and secondary markets of ETFs are associated with an increase in the effect of ETF ownership on commonality in liquidity. We exploit a quasi-natural experiment based on ETF trading halts to establish a causal relation between ETF ownership and liquidity commonality. Furthermore, the effect of ETF ownership on liquidity commonality dominates that of the ownership by index funds, active open-end funds, and other institutional investors. Finally, the effect of ETF ownership on liquidity commonality is robust to a firm's size and to market conditions. Taken together, our results show that ETFs reduce the ability of the market participants to diversify liquidity shocks.

*Corresponding author, vagarwal@gsu.edu. Vikas Agarwal is also a Research Fellow at the Centre for Financial Research (CFR), University of Cologne.

†We wish to thank Serge Darolles, Caitlin Dannhauser, and seminar participants at the University of Buffalo for helpful discussions and comments. The Securities and Exchange Commission, as a matter of policy, disclaims responsibility for any private publication or statement by any of its employees. The views expressed herein are those of the authors and do not necessarily reflect the views of the Commission or of the authors' colleagues on the staff of the Commission.

Introduction

The growth in Exchange Traded Funds (ETFs) over the last several decades has been nothing short of remarkable.[1] While the popularity of exchange traded products directly speaks to their desirability, several recent academic studies have pointed out the effects these innovations have on the underlying securities they hold. So far this research has found that ETFs increase the volatility (Ben-David et al., 2014), reduce the liquidity (Hamm, 2010; Dannhauser, 2014), and increase the co-movement in returns (Da and Shive, 2012) of the underlying securities ETFs invest in. In this paper, we examine how ETFs affect the commonality in liquidity among their component securities. Commonality in liquidity has important asset pricing implications. Chordia et al. (2000) and Hasbrouck and Seppi (2001) find that liquidity co-moves across securities. As with the co-movement of returns, co-movement in liquidity reduces the possibility to diversify individual asset's liquidity risk, giving rise to a liquidity risk factor. Such a factor has been shown to be priced (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005) i.e., investors demand a risk premium for holding assets that are exposed to this factor.

We hypothesize that ETFs can increase the co-movement of liquidity through their inherent arbitrage mechanism that is designed to ensure that the difference between the prices of the ETF share and the component securities basket remains narrow. Authorized Participants (APs) attempt to arbitrage away the deviations between the ETF price and the value of the constituting basket.[2] When the ETF is trading at a premium during the day, APs sell the ETF short while simultaneously buying the basket. At the end of the day, the APs cover their short sales by delivering the basket to the ETF in exchange for ETF shares. Alternatively, when the ETF is trading at a discount, APs buy the ETF shares and short sell the basket. They unwind their positions at the end of the day by redeeming the ETF shares for the basket.[3] Additionally, high frequency

[1] Figure 1 shows that assets under management in ETFs have grown to over $2 trillion in 2016, or roughly 9% of the total market capitalization of the US equity market. More impressively, Figure 2 shows that ETF trading volume represents between 25% to 45% of all US equity trading volume and ETF short interest represents between 20% to 30% of all US equity short interest.

[2] It is possible that arbitrage activities are not affected on an ETF-by-ETF basis as we posit but rather simultaneously across many mispriced ETFs and their constituents using netting practices and less than perfect hedges to reduce the impact of transactions costs. However, such alternative arbitrage trading strategies would lead to lower commonality in liquidity and against finding significant results. A similar argument against finding significant results applies to situations when ETFs allow or effect creation unit transactions that are primarily in-kind, primarily in-cash or some more balanced combination of in-kind and cash or when ETFs allow customized or negotiated baskets.

[3] Note that if APs are not closing out their positions via a primary transaction with the ETF sponsors at the end of the trading day but rather close them out in the secondary market once the price discrepancy between the ETF and constituent basket securities disappears, the additional secondary market trading in the underlying securities would create stronger

traders can also take advantages of such arbitrage opportunities by taking long/short positions on the ETF and the main constituents of these ETFs. As a result, trading activity in the underlying securities is mechanically bound between them through common ETF ownership; resulting in greater commonality in liquidity between them.

We specifically address the following research questions in this paper. First, how does ETF ownership affect the commonality in liquidity of the stocks included in the ETF basket? Second, is the impact of liquidity commonality from ETFs distinct than that of other market participants such as passive and active open-end mutual funds, and other institutional investors? Third, can the arbitrage mechanism explain the effect of ETF ownership on the commonality in stock liquidity? Finally, is there a causal relation between ETF ownership and commonality in stock liquidity?

We measure how the liquidity of a stock with high ETF ownership co-moves with the liquidity of other stocks that also have high ETF ownership using a methodology similar to the one laid out in Coughenour and Saad (2004) and Koch et al. (2016). Coughenour and Saad (2004) examine how the liquidity of a stock co-moves with the liquidity of other stocks handled by the same specialist firm. Koch et al. (2016) show that the liquidity of stocks with high mutual fund ownership co-move with that of other stocks that also have high mutual fund ownership. Following the approach in these two papers, we construct our measure of commonality of liquidity. Our analysis reveals several interesting findings.

First, stocks having higher ETF ownership exhibit greater commonality in liquidity. This relation is not driven by small stocks alone but extends to the largest stocks. Moreover, the relation between ETF ownership and liquidity commonality is not confined to certain market conditions. We observe that the relation persists both during stressful and normal market environments.

Second, the relation between ETF ownership and commonality in liquidity does not seem to be an indexing phenomenon since the ownership by index funds is explicitly controlled for in the analysis. Likewise, the commonality in liquidity that arises from ETF ownership is distinct from that arising from the ownership of open-end mutual funds and non-mutual fund institutions.

Finally, we show that the unique arbitrage mechanism in ETFs is the underlying channel explaining the positive relation between the ETF ownership and commonality in stock liquidity. In particular, we show that during periods of greater arbitrage activity (corresponding to larger mispricing/deviation between the ETF price and the value of underlying stocks or higher

commonality in liquidity effects in those stocks.

level of activity in the primary and secondary market of ETFs), greater ETF flow activities (creation/redemption), greater ETF turnover, and greater shorting demand of ETF shares (due to the unique and efficient ability of ETFs to provide negative exposure through their share lending), we observe an increase in commonality in liquidity. This finding suggests that the underlying arbitrage mechanism in ETFs contributes to an increase in the commonality in liquidity of the stocks in the ETF portfolios.

We next establish a causal relation between ETF ownership and commonality in liquidity using a quasi-natural experiment. We use the events of August 24, 2015 when trading was halted in certain ETFs but not in their component securities to design the experiment. Consistent with the arbitrage mechanism driving the commonality in liquidity, we find that commonality in liquidity among the underlying securities declined significantly during the ETF trading halts when the arbitrage process is interrupted.

Our paper contributes to the broader literature examining the sources of liquidity commonality. For example, Koch et al. (2016) find that correlated trading activity by active mutual funds is a demand-side explanation of liquidity commonality. In the case of active mutual funds, managers can have a preference for similar securities and/or possess correlated information, which can induce them to trade together to increase the commonality in liquidity. In contrast, ETFs can induce liquidity commonality through the inherent arbitrage mechanism. Moreover, the paper speaks to a large literature examining the value of indexing (see for example, Wurgler, 2010; and Chang et al., 2015). In contrast to ETFs, index funds do not trade continuously and cannot be shorted. As a result there is no arbitrage-induced intraday trading. Consequently, we find that the impact of index funds on the commonality of stock liquidity is limited.

I. Data and Methodology

A. Sample

We start by identifying all ETFs traded on major US stock exchanges from CRSP and Compustat. In CRSP we use the historical share code 73, which exclusively defines ETFs. We then augment our sample from Compustat where we identify ETFs using the security-type variables. We exclude levered, inverse, fixed-income, and international equity ETFs from our sample. Therefore, we focus on the ETFs that are broad-, sector-, and style-based ETFs that physically own US stocks. This

process generates the initial sample which consists of 1,916 unique ETFs between January 1, 2000 and December 31, 2015.[4] The overall market capitalization of the sample ETFs is approximately \$1.25 trillion or about 93% of the assets under management (AUM) of all US-listed US equity ETFs, as of December 31, 2015. This suggests that our sample is comprehensive.

Similar to mutual funds, most ETFs are registered funds under the Investment Company Act of 1940 and are consequently required to report their quarterly portfolio holdings.[5] We collect the portfolio holdings for each identified ETF using the Thomson Reuters Mutual Fund Holding Database, which we match to the CRSP Mutual Fund Database. For each stock in the CRSP stock file universe, we construct the ETF ownership at the end of each calendar quarter by aligning the ownership of ETFs with different reporting fiscal period-end using the following methodology. For each stock i in a given calendar quarter end q, we compute the ETF Ownership ($ETFOWN$) as:

$$ETFOWN_{i,q} = \frac{\sum_j w_j \times MKTCAP_j}{MKTCAP_i} \tag{1}$$

Where w_j is computed as the portfolio weight of ETF j in stock i, using the most recent quarterly holding report disclosed by the ETF in the Thomson Reuters Mutual Fund Holding database. $MKTCAP_j$ and $MKTCAP_i$ are the updated market capitalization of ETF j and of stock i, respectively, at the end of the calendar quarter. Due to daily creation and redemption, the total shares outstanding of an ETF change on a daily basis, and we therefore use updated data from Bloomberg (as such data is not reported accurately in CRSP and Compustat according to Ben-David et al. (2014)). While w_j is computed from the most recent quarterly investment company report (at fiscal quarter end), $w_j \times MKTCAP_j$ reflects the dollar ownership of ETF j in stock i updated to the current month, assuming that w_j, being the percent weight of each stock in the ETF portfolio is constant between fiscal period end and calendar quarter end, since most ETFs track index portfolios.

Since ownership of other institutional investors can influence the commonality in liquidity, we control for the percent ownership of non-ETF index and active mutual funds. We identify

[4] We start our sample on January 1, 2000 because iShares entered the ETF market that year and very few ETFs existed prior to that date.

[5] Active ETFs are required to report their holdings daily; whereas passive ETFs are not subject to the daily reporting requirement. DTCC and ETF Global provide daily holdings on ETFs starting in 2008. We nonetheless maintain the analysis at the quarterly level because (a) we necessitate an estimation window to estimate our commonality in liquidity measure, which uses daily observation; (b) our ability to extend the analysis for 8 more years prior to 2008; and (c) maintain the ETF coverage to the universe of US-listed US equity ETFs.

index funds using the index fund flag in the CRSP Mutual Fund Database and classify all other mutual funds as active. Ownership data for non-mutual fund investors for each company is from Thomson Reuters Institutional Ownership Database.

The resulting sample consists of 298,095 stock-quarter observations over the period from January 1, 2000 to December 31, 2015 for which we have ETF, passive and active mutual fund, and other institutional investor ownership.

B. Commonality in Liquidity Measure

We construct our commonality in liquidity measure based on the approach used in Coughenour and Saad (2004) and Koch et al. (2016). Coughenour and Saad (2004) study how a stock's liquidity co-moves with the liquidity of other stocks handled by the same specialist firm, whereas Koch et al. (2016) study the extent to which mutual fund ownership determines the co-movement in liquidity of stocks. The basic idea behind the Koch et al. (2016) measure is that the more a stock is owned by mutual funds, the more its changes in liquidity should co-move with those of other stocks that also have high mutual fund ownership. Our measure uses the same intuition with the focus being on ETF ownership instead of mutual fund ownership.

We follow Kamara et al. (2008) and Koch et al. (2016) in selecting the Amihud (2002) liquidity measure as our proxy for liquidity because it can easily be estimated from daily data and yet performs well relative to intra-day measures of liquidity (Hasbrouck, 2009; Goyenko et al., 2009). Moreover, consistent with prior studies, we focus on changes as opposed to levels to reduce potential econometric issues such as non-stationarity (Chordia et al., 2000; Kamara et al., 2008; Koch et al., 2016; Karolyi et al., 2012).

Specifically, for each stock i on day d, we calculate the changes in the Amihud (2002) illiquidity measure for all ordinary common shares in CRSP (share code of 10 and 11) with stock prices greater than \$2 as follows:

$$\Delta illiq_{i,d} \equiv log \left[\frac{|R_{i,d}|}{P_{i,d} \times Volume_{i,d}} \Big/ \frac{|R_{i,d-1}|}{P_{i,d-1} \times Volume_{i,d-1}} \right] \tag{2}$$

where $R_{i,d}$, $P_{i,d}$, and $Volume_{i,d}$ are the CRSP return, price, and trading volume, on stock i on day d. We require the returns to be non-missing and the dollar volume to be strictly positive and non-missing. We take logs of the change in Amihud (2002) illiquidity measure to minimize the

impact of outliers and further winsorize the final measure at the 1% and 99% percentiles for the same reason.

We then estimate the following regression for each stock i in calendar quarter q:

$$\begin{aligned}\Delta illiq_{i,q,d} = \alpha + \beta_{HighETF,i,q,d=-1}\Delta illiq_{HighETF,q,d-1} + \beta_{HighETF,i,q,d=0}\Delta illiq_{HighETF,q,d} \\ + \beta_{HighETF,i,q,d=+1}\Delta illiq_{HighETF,q,d+1} + \beta_{m,i,q,d=-1}\Delta illiq_{m,q,d-1} + \beta_{m,i,q,d=0}\Delta illiq_{m,q,d} \\ + \beta_{m,i,q,d=+1}\Delta illiq_{m,q,d+1} + \beta_{mret,i,q,d=0}R_{m,q,d} + \beta_{mret,i,q,d=-1}R_{m,q,d=-1} \\ + \beta_{mret,i,q,d=+1}R_{m,q,d+1} + \beta_{iret,i,q}R^2_{i,q,d} + \epsilon_{i,q,d} \quad (3)\end{aligned}$$

where $\Delta illiq_{i,q,d}$ is the daily change in illiquidity of stock i within the calendar quarter q estimated using equation 2. $\Delta illiq_{HighETF,q,d}$ is the daily change in illiquidity on a equally-weighted basket of stocks in the top quartile of ETF ownership which excludes stock i (from the descriptive statistics, stocks with ETF ownership above 4.24%). $\Delta illiq_{m,q,d}$ is the daily change in market illiquidity where market illiquidity is calculated as the equally-weighted average illiquidity of all CRSP stocks in day d excluding stock i. Similar to Koch et al. (2016), we also include the lag and lead of the changes in illiquidity of the stocks with High ETF ownership as well as the lag and lead of the changes in market illiquidity. We also include the lag, contemporaneous, and lead of the value-weighted CRSP market return, and the contemporaneous squared stock i return. We require at least 10 days of non-missing observations to estimate the regression.

We use the contemporaneous $\beta_{HighETF,d=0}$ as our main measure of commonality in liquidity with high ETF ownership stocks. However, our results are qualitatively similar if we use the sum of the lag, contemporaneous, and lead coefficients. Table 1 provides summary statistics on $\beta_{HighETF}$.

II. Commonality in liquidity and ETF ownership

A. Baseline Results

Our main hypothesis is that ETFs increase the commonality of liquidity of the underlying basket of securities they hold. Consequently, a security that has a high level of ETF ownership will exhibit higher commonality in liquidity compared to that of a security with a low level of ETF

ownership. We conduct the initial test of this hypothesis by first regressing the commonality in liquidity measure ($\beta_{HighETF}$) on lagged ETF ownership ($ETFOWN$). We then subsequently introduce other independent variables in the regression. Our endeavor is to disentangle whether the relation between $\beta_{HighETF}$ and $ETFOWN$ is a result of ETF ownership or of other institutional ownership which happens to be correlated with ETF ownership. Therefore, we include the lagged passive mutual fund ownership ($INXOWN$), lagged active mutual fund ownership ($MFOWN$), and lagged ownership by other institutional investors, i.e., private funds, hedge funds, dark pools, closed-end mutual funds, etc. ($OTHROWN$). Each ownership variable is normalized prior to their inclusion in the model by demeaning the cross-sectional mean and dividing by the standard deviation, in order to facilitate the comparison of the economic significance of our results across different types of ownership. The comprehensive specification is as follows:

$$\beta_{Liq,i,q} = \gamma_0 + \gamma_1 ETFOWN_{i,q-1} + \gamma_2 INXOWN_{i,q-1} + \gamma_3 MFOWN_{i,q-1} + \gamma_4 OTHROWN_{i,q-1} + \sum_{k=5}^{K} \gamma_k CONTROLS_{i,q-1} + \epsilon \quad (4)$$

In all the specifications, we control for the logarithm of the market capitalization of the firm ($SIZE$) and the liquidity level of the stock using the Amihud (2002) illiquidity measure ($AMIHUD$). These controls aim to address the concern that firm size and stock liquidity characteristics determine both commonality and their selection into ETF baskets. Additionally, we use stock and quarter fixed effects and double-cluster the standard errors at the stock and quarter level.

Table 2, panel A reports the results. Model 1, is a regression of $\beta_{HighETF}$ on $ETFOWN$. The coefficient on $ETFOWN$ of 0.0659 is positive and significant at the 1% level. An increase in ETF ownership of 1% is associated with a 6.59% increase in the commonality in liquidity. Model 2 shows that the coefficient on $INXOWN$ is also positive and significant at the 1% level. However, the coefficient on $INXOWN$ of 0.0379 suggests the effect of passive mutual fund ownership on $\beta_{HighETF}$ is considerably smaller than for the ETF ownership. We next introduce $MFOWN$ in model 3. We find a positive coefficient of 0.0339, which is significant at the 1% level. Model 4 is the comprehensive specification corresponding to equation (4) above. $ETFOWN$ with a coefficient of 0.0583, $INXOWN$ with a coefficient of 0.0138, and $MFOWN$ with a coefficient of 0.0185, all

continue to be positive and significant at the 5% level or better. However, the effect of both $MFOWN$ and $INXOWN$ is less than half of that of $ETFOWN$ on $\beta_{HighETF}$. Ownership of other institutions, $OTHROWN$, does not have a significant impact on $\beta_{HighETF}$. Taken together, these findings provide preliminary support to the hypothesis that ETF ownership of a stock increases its commonality in liquidity.

In Table 2, panel B we include additional controls. Specifically, in model 1, we control for the stock's co-movement of returns with the market returns that exclude the given stock (β_{mxs}). Da and Shive (2012) find that ETFs increase the co-movement in returns of their underlying basket of stocks. To the extent that commonality in liquidity is related to commonality in returns, our results might be picking up the latter (Karolyi et al., 2012). Model 1 shows that there is indeed a positive and significant relation between commonality in liquidity and commonality in returns. However, our main variable of interest in the regression, $ETFOWN$, continues to be positive and significant in the same magnitudes as before. In model 2, we add the lagged value of the commonality in liquidity measure, $\beta_{HighETF}$, to control for persistence in the measure. Again, $ETFOWN$ continues to be significantly positive as in our earlier specifications.

Panel B also reports results that exclude stock fixed effects in models 3 to 5. In the three specifications that exclude stock fixed effects, the results remain similar with $ETFOWN$ increases slightly to 0.0688 in model 3 and 0.0656 in models 4 and 5. This suggests that the relation between the ETF ownership and liquidity commonality of a stock not only holds within the stocks but also across stocks.

Taken together, the results support our conjecture that (a) there is a significant correlation between ETF ownership and liquidity commonality; (b) the effect does not appear to be an indexing phenomenon as the inclusion of index fund ownership does not change the main finding; and (c) the relation between ETF ownership and liquidity commonality is substantially larger in magnitude than what has previously been documented by Koch et al. (2016) for mutual fund ownership.

B. ETF Ownership and Commonality in Liquidity by Index Membership

It is possible that the relation between ETF ownership and liquidity commonality is driven by small capitalization stocks even after controlling for their lower liquidity levels. Additionally, it

is also conceivable that this relation is confined to stocks belonging to certain popular indexes that ETFs track. We examine this possibility by separately estimating the baseline models on stocks that are part of the Russell 3000, the Russell 2000, and the S&P 500. The Russell 3000 index includes the 3000 largest publicly held US companies based on market capitalization. The Russell 2000 index includes the smallest 2000 companies belonging to the Russell 3000. The S&P 500 index includes 500 of the largest US companies by market capitalization. In contrast to the Russell indexes, S&P 500 members are not solely chosen on the basis of market capitalization. The other criteria are that at least 50% of the company's shares outstanding are available for trading; the company's as-reported earnings over the most recent quarter, as well as over the year, must be positive; and that the company's shares have active and deep markets. As of March 2016, the average (median) market capitalization for the Russell 3000, Russell 2000, and S&P 500 was $110 billion ($1.1 billion), $1.8 billion ($0.6 billion), and $35.2 billion ($17 billion), respectively.

We report the results in Table 3. Model 1 reiterates the baseline results for all stocks as a basis of comparison. Models 2 through 4 report the baseline model for the Russell 3000, Russell 2000, and S&P 500 index member stocks, respectively. As an additional control, we include the weight of the stock in the index it belongs to.

The coefficients on $ETFOWN$ remain positive and significant in all the sub-samples. The magnitude of the $ETFOWN$ coefficient appears stable across the different indexes. The effect is slightly weaker for the smaller capitalized Russell 2000 stocks as compared to the Russell 3000 stocks. Moreover, the magnitude of the coefficient is the largest for the larger S&P 500 stocks. Thus, the results do not support that stock size or index membership solely drives the observed relation between the ETF ownership and commonality in liquidity. Also, the magnitude of the relationship is substantially larger than for other institutional investors such as passive and active mutual funds ($INXOWN$ and $MFOWN$) or for other institutional investors ($OTHROWN$). As in Koch et al. (2016), the coefficient on $MFOWN$ is positive and statistically significant for all sub-samples.

C. ETF Ownership and Commonality in Liquidity and Market Conditions

We also examine whether the relation between ETF ownership and commonality in liquidity is confined to certain market conditions. To do so, we first reestimate the baseline model excluding

the crisis period 2007–2009. Panel A of Table 4 reports the results from model 2. Again, model 1 presents the results of the baseline specification as a basis of comparison. The coefficient on $ETFOWN$ in the sample excluding the crisis period is 0.0565 compared to 0.0583 for the entire period, and is highly significant. We also interact $ETFOWN$ with indicator variables corresponding to each period: pre-crisis, during crisis, and post-crisis and present the results in model 3. The coefficient on $ETFOWN$ interacted with an indicator variable equal to 1 for the pre-crisis period 2000–2006 ($ETFOWN \times D_{2000-2006}$) is 0.0216 and significant at the 5% level. The coefficient on $ETFOWN$ interacted with an indicator variable equal to 1 for the during-crisis period 2007–2009 ($ETFOWN \times D_{2007-2009}$) is markedly stronger at 0.0872 and is significant at the 1% level. The effect is even stronger in the post-crisis period with a coefficient on $ETFOWN$ interacted with an indicator variable equal to 1 for the post-crisis period 2010–2015 of 0.106, which is also significant at the 1% level.

Next, we examine the magnitude of the effect in stressed market conditions by splitting the sample period into quintiles of the VIX index and reestimating the baseline model in sub-samples. We present the results in the panel B of Table 4. The coefficients on $ETFOWN$ are stable and significant across all sub-samples ranging from 0.0388 in the fourth quintile to 0.0669 in the highest VIX quintile.

Taken together, these results suggest the relation between ETF ownership and commonality in liquidity is significant across different sub-periods and is most pronounced in recent years. Moreover, the relation is robust to different market conditions.

III. Arbitrage Channels

Our results in the previous section document a positive relation between ETF ownership and commonality in liquidity. In this section, we examine whether the unique structure of ETFs can explain this relation.

ETFs are fundamentally different from other passive or active funds registered under the Investment Company Act of 1940 since they are traded on a secondary exchange concurrently to the underlying basket of securities they hold, thereby providing intraday liquidity to their investors. Additionally, ETFs can be sold short which allows their inclusion in certain trading strategies that traditional funds cannot accomplish. The concurrent trading of ETFs and the

securities they hold presents the challenge to uphold the law of one price. Therefore, continuously in the trading day, ETF prices are kept in line with the intrinsic value of the underlying securities through a process of formal and informal arbitrage.

Formal arbitrage happens through the APs who can take advantage of their ability to create and redeem ETF shares. If ETFs are trading at a premium relative to the net asset value of their underlying securities, APs will buy the underlying securities while shorting the ETF in the secondary market until the two values equate. At the end of the day, the APs then deliver the underlying securities they accumulated during the day to the ETF sponsor in exchange for newly created ETF shares in the primary market. They then use these new shares to cover their ETF short positions. Conversely, if ETFs are trading at a discount relative to the underlying securities, the arbitrage process works in reverse: APs buy the ETF and short the underlying basket of securities during the day until the ETF price equates its intrinsic value. At the end of the day, the APs redeem the ETF shares they accumulated in exchange for the underlying basket. They then use the basket of securities they received to cover their short positions.[6]

Informal arbitrage happens exclusively in the secondary markets by high frequency traders and hedge funds using rich/cheap convergence strategies. Essentially, these arbitrageurs buy the cheaper portfolio while simultaneously shorting the more expensive portfolio.

We examine whether the ETF arbitrage mechanism, which partly makes ETFs unique, is the source of the observed relation between commonality in liquidity and ETF ownership. We argue that if the arbitrage mechanism is responsible for this relation, then everything else equal, stocks having an ownership composed of ETFs experiencing high arbitrage intensity will exhibit a stronger commonality in liquidity than other stocks.[7]

We hypothesize that arbitrage opportunities are greater over the course of a quarter in a given stock when the ETFs that own it experience large price deviations from the underlying basket's NAV over that quarter. To this end, we develop a measure that exploits the deviation between the ETF and the underlying basket prices. The measure is calculated as the sum of the absolute

[6] If APs are not closing out their positions via a primary transaction with the ETF at the end of the trading day but rather close them out in the secondary market once the price discrepancy between the ETF and constituent basket securities disappeared, commonality in liquidity across the constituent basket securities would be stronger.

[7] It is possible that arbitrage activities are not affected on an ETF-by-ETF basis as we posit but rather simultaneously across many mispriced ETFs and their constituents using netting practices and less than perfect hedges to reduce the impact of transactions costs. However, such alternative arbitrage trading strategies would lead to lower commonality in liquidity, which biases us against finding significant results. A similar argument against finding significant results applies to situations when ETFs allow or effect creation unit transactions that are primarily in-kind, primarily in-cash or some more balanced combination of in-kind and cash or when ETFs allow customized or negotiated baskets.

value of the daily difference between the ETF's end of the day price and its end of the day NAV aggregated over each quarter. We use the absolute value of the mispricing because a positive or a negative deviation from the NAV will result in arbitrage. We loosely use the word mispricing to refer to this imbalance in the ETF. The measure is then averaged at the stock level using the ETF ownership in that stock as weights to create the variable $ETFAMISPRC$.

Precisely, for each stock i in calendar quarter q:

$$ETFAMISPRC_{i,q} = \frac{\sum_{j=1}^{J} w_{j,q-1} \times \frac{1}{D} \sum_{d=1}^{D} \left| \frac{PRC_{j,d} - NAV_{j,d}}{PRC_{j,d}} \right|}{\sum_{j=1}^{J} w_{j,q-1}} \tag{5}$$

where $PRC_{j,d}$ and $NAV_{j,d}$ is the price and NAV of ETF j at the end of day d, respectively. J is the total number of ETFs present in the ownership of a given stock i, and D is the number of days in a given quarter q. Finally, $w_{j,q-1}$ is the percent ownership of the ETF in a given stock i at the end of the previous quarter and therefore the summation of $w_{j,q-1}$ over all ETFs in the denominator corresponds to the $ETFOWN$ measure.

We use the end of the trading day as our unit of observation for ETF mispricings. However, since both ETFs and the component stocks are trading simultaneously during the day we could alternatively compute the average mispricing at the intraday level. In fact to facilitate arbitrage, APs disseminate the Intraday Indicative Value (IIV) of the underlying basket every 15 seconds and the most sophisticated arbitrageurs calculate their own IIVs at higher frequencies using proprietary models to circumvent stale prices. So in theory we could create a more complete picture by matching the traded prices of ETFs to their IIVs and calculate the mispricing every 15 seconds or even at smaller intervals. This task is made difficult by the fact that ETF IIVs are not stored on TAQ, which explains our choice of using daily observations. Nonetheless, to the extent that a daily mispricing measure is coarser relative to a more refined one that would use intraday data, biases the analysis against finding significant results.

It is important to point that, in spite of arbitrage, substantial ETF mispricings can still exist. Petajisto (2013) estimates that deviations of 150 basis points exist on average between ETF prices and the basket's NAV. These deviations are larger for ETFs holding international or illiquid securities because the marginal cost of trading in the underlying nullifies the profits that would be earned through arbitrage. Therefore, it is conceivable that a given stock is part of an ETF which always exhibits a high mispricing. Our analysis controls for this possibility by including stock

fixed-effects so that a stock's average ETF mispricing is taken into account.

We present the results in Table 5. Columns 1 interacts $ETFAMISPRC$ with $ETFOWN$ in the baseline specification. Prior to their inclusion in the model, and consistent with previous analyses, $ETFAMISPRC$ and all ownership variables are normalized to facilitate comparison. The results indicate that everything else equal, stocks with ETF ownership experiencing high average price deviations over the quarter exhibit an additional increase in commonality in liquidity. The coefficient on $ETFOWN \times ETAMISPRC$ is 0.0147 and is positive and significant at the 10% level. The coefficient on $ETFOWN$ of 0.0537 remains positive and significant at the 1% level. This result points to imbalances inherent in ETFs as being responsible for the observed increase in commonality in liquidity.

As mentioned above, ETF mispricings are resolved by arbitrageurs in both the primary or secondary markets. It is natural therefore to examine activity in those two markets as further, albeit indirect, evidence of the arbitrage process at work. In the primary markets, we use the creation and redemption activity in an ETF as a measure of its arbitrage intensity. Recall that share creation and redemption activity is part of the arbitrage mechanism conducted solely by APs. In the secondary markets, we use the turnover and short interest in an ETF as additional proxies for arbitrage intensity.

For proxies of primary market activity, we compute the daily net share creation and redemption for each ETF, which we impute from the change in ETF shares outstanding obtained from Bloomberg. We then compute the sum of the absolute value of the flows for each ETF over each quarter. We next compute for each stock, the ETF ownership-weighted average of that measure ($ETFABSFLOWS$). We use the absolute value of the flows because net creation or net redemption of ETF units will induce trading in the underlying securities. As a fund is shrinking, or growing, it will have to dispose of, or purchase, the underlying securities – in both cases demanding liquidity to conduct these operations.

Formally, for each stock i in calendar quarter q

$$ETFABSFLOWS_{i,q} = \frac{\sum_{j=1}^{J} w_{j,q-1} \times \frac{1}{D} \sum_{d=1}^{D} \left| \frac{SHRSOUT_{j,d} - SHRSOUT_{j,d-1}}{SHRSOUT_{j,d-1}} \right|}{\sum_{j=1}^{J} w_{j,q-1}} \tag{6}$$

where $SHRSOUT_{j,d}$ is the number of shares outstanding of ETF j at the end of day d. J is the total number of ETFs present in the ownership of a given stock i, and D is the number of days in

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

APs hold the exclusive right to create and redeem ETF shares and they do so for two potential reasons. First, as discussed previously. they use the creation and redemption process to maintain the ETF price in line with the price of the underlying basket. We refer to this activity conducted by the APs as formal arbitrage. However, APs sometimes create (redeem) shares to meet increasing (decreasing) market demand of the ETF. Our computed flow measure is not able to distinguish between these two reasons. However, our understanding is that it is rare that APs grow or shrink the ETF by catering to specific client needs. Most often APs will act upon an increase or decrease in demand of their product through the arbitrage mechanism. Specifically, if a given ETF is popular, the price of the ETF will reflect the increased demand creating a positive mispricing between the prices of the ETF and the underlying basket. This mispricing is reduced through the formal arbitrage mechanism resulting in the creation of more units, which is captured in the absolute flow measure $ETFABSFLOWS$ in equation 6.

Column 2 of Table 5 reports the result for the interaction variable $ETFOWN \times ETFABSFLOWS$. Again, to facilitate comparison $ETFABSFLOWS$ and all ownership variables are normalized prior to their inclusion in the model. When added to the baseline model, the interaction variable coefficient of 0.0392 is positive and significant at the 1% level. Therefore, we find that creation and redemption activity in the ETFs that own a stock induce significantly higher commonality in liquidity for that given stock.

In the secondary markets, we examine the ETF-ownership-weighted average ETF turnover and ETF short interest in each stock. We collect data on turnover ($ETFTURN$) and short interest ($ETFSHORT$) for each ETF from Bloomberg. Columns 5 and 6 of Table 5 report the results for the inclusion of the interaction variables $ETFOWN \times ETFTURN$ and $ETFOWN \times ETFSHORT$. As before, all the relevant variables are normalized prior to their inclusion in the model. We again find positive and significant coefficients when both interaction variables are included in the baseline specification.

Overall, these results suggest that the arbitrage mechanism designed to reduce pricing imbalances between ETFs and their underlying securities contributes to increasing liquidity commonality among stocks.

IV. A Quasi-Natural Experiment

Our results so far show that ETF ownership increases the commonality of liquidity of their underlying basket of securities and the arbitrage mechanism unique to ETFs appears to be the source of this positive relation. To provide a causal interpretation of these findings, we use a natural experiment, which exploits a plausibly exogenous shock to the arbitrage mechanism which occurred on August 24, 2015 when trading temporarily halted on a large number of ETFs while the underlying stocks were still allowed to trade.[8]

On Monday, August 24, 2015, the U.S. equity and equity-related futures markets started the day with unusual price volatility. The December 2015, SEC Research Note, recounts the morning events as follows:[9]

- *Prior to 9:30, the most actively traded equity product–the SPDR S&P 500 ETF Trust ("SPY")–declined to more than 5% below its closing price on the previous trading day (Friday, August 21, 2015). The most actively traded equity-related futures contract–the E-Mini S&P 500 ("E-Mini")–declined to its limit down price of 5% below the previous trading day's closing price and was paused for trading from 9:25 to 9:30.*

- *At 9:30, SPY opened for regular trading hours at 5.2% below its previous day's close and then further declined to a daily low of 7.8% by 9:35. By 9:40, SPY recovered past its opening price and eventually closed down 4.2%. SPY's decline from previous day close to August 24 open was the second largest in the last decade, while SPY's decline from previous day close to August 24 daily low was the 10th largest in the last decade.*

- *From 9:30 to 9:45, more than 20% of S&P 500 companies and more than 40% of NASDAQ-100 companies reached daily lows that were 10% or more below their previous day's closing price.*

Events on this trading day allow us to directly test whether arbitrage trades that take advantage of the difference between the price of an ETF and the aggregated value of its constituents are indeed driving commonality in liquidity. When arbitrageurs are unable to establish arbitrage positions simultaneously in an ETF and its underlying constituent securities because of a trading

[8] Approximately 300 ETFs were halted over the course of August 24, 2015 according to "ETF performance in the highly volatile equity market of August 24, 2015", Blackrock report.

[9] https://www.sec.gov/marketstructure/research/equity_market_volatility.pdf

halt in the ETF, trading across stocks referenced by the ETF will also not occur. Therefore, our experimental design helps us investigate whether liquidity commonality among the stocks referenced by the halted ETFs decreases and then subsequently increases when trading in the ETF is resumed.

Using high-frequency data from TAQ, we calculate for every stock i and second s an intra-day analog to the Amihud (2002) illiquidity measure, $illiq_{i,s}$.[10] Specifically, using every trade t reported to the consolidated tape on August 24, we calculate

$$illiq_{i,s} = \log\left[1 + \sum_{t \in s} \omega_{i,t} A_{i,t}\right] \tag{7}$$

where $\omega_{i,t}$ is the relative dollar trade size, $S_{i,t}$, of trade t within second s and $A_{i,t}$ is equal to $[|P_{i,t} - P_{i,t-1}| \cdot P_{i,t-1}^{-1}] \cdot [S_{i,t} \cdot 10^{-6}]^{-1}$ winsorized at the 99th percentile. Since multiple ETFs can include a given stock, we create a continuous variable, $H_{i,s}$, that takes values between zero and one and equals the ETF ownership-weighted average of indicator variables each reflecting a trading halt during second s in an ETF referencing stock i. We then estimate the following model in a pooled regression:

$$\Delta illiq_{i,s} = \alpha_i + \beta_{1,i} H_{i,s} + \beta_{2,i} EO_i \cdot \Delta illiq_{m,s} + \beta_{3,i} H_{i,s} \cdot \Delta illiq_{m,s} + \beta_{4,i} H_{i,s} \cdot EO_i \cdot \Delta illiq_{m,s} + FE_{i,s} + \epsilon_{i,s} \tag{8}$$

where $\Delta illiq_{i,s}$ and $\Delta illiq_{m,s}$ measure the change in the the high-frequency illiquidity measures for stock i and the market, EO_i the ETF ownership in stock i, and $H_{i,s}$ is an indicator variable representing the trading halts and $FE_{i,s}$ are stock and time fixed effects. Since we include stock and time fixed effect, we exclude $\Delta illiq_{m,s}$ on the right-hand side of equation (8). Standard errors are two-way clustered at the stock and time level. If commonality is driven by ETF arbitrage, we would expect $\beta_{4,i}$ to be negative.

We present the results from estimating model (8) in Table 6. The coefficient $\beta_{4,i}$ in model (3) is -15.780 and highly significant. This result implies that when trading in an ETF is halted for stocks with higher ETF ownership, commonality in liquidity decreases, and hence supports our hypothesis that ETF arbitrage drives commonality in liquidity across stocks. With a value of 6.429, the significant coefficient $\beta_{2,i}$ confirms our previous results that commonality in liquidity increases

[10] We drop all trades sold and reported out of sequence from the daily consolidated trades tape.

in ETF ownership. The last significant coefficient in model (3) is $\beta_{1,i}$ suggesting that liquidity improves in stocks referenced by ETFs when trading in the corresponding ETF is halted. This result is consistent with the findings in Dannhauser (2014) and Hamm (2010), who show that ETF ownership decreases liquidity in the underlying stocks.

During the course of the day on August 24, short-sale restrictions (SSRs) were invoked on 2,069 stocks. Under Rule 201 of Regulation SHO, SSRs are triggered when a stock price drops 10% below the previous day's closing price. When SSRs are triggered, short sale orders generally cannot be executed for the rest of the trading day at prices that are equal to or lower than the national best bid. The restrictions then carryover to the next trading day. We examine whether our results are robust to the exclusion of the stocks that experienced SSRs. We find that the results are qualitatively unchanged.

V. Conclusion

There is little doubt that ETFs have provided vast benefits to institutional and retail investors alike. The spectacular growth in ETFs over the last decade is a testimony to their merits as an important financial innovation. ETFs increase welfare by providing investors an inexpensive avenue to diversify their holdings and intraday liquidity. Nonetheless, their continued success requires a better understanding of the consequences of having an additional layer of ETF trading activity on top of the trading that already exists in the underlying securities. In that respect, a growing academic literature has made inroads in furthering our understanding of these consequences.

We show that the underlying arbitrage mechanism that ensures little deviation between the prices of the ETFs and the underlying securities, drives the commonality in liquidity of the securities included in the ETF portfolios. This result holds for different stock market capitalizations and different market conditions. Moreover, the effect of ETF ownership on liquidity commonality dominates that of the ownership by index funds, active funds, and other institutional investors. We establish a causal relation between ETF ownership and liquidity commonality through a quasi-natural experiment which exploits the recent events of August 24, 2015 when trading was halted in certain ETFs to demonstrate that such halts are associated with a decline in the commonality of the liquidity due to an interruption in the arbitrage mechanism. Finally, we shed light on the channels for changes in the liquidity commonality by showing that greater arbitrage activities both

in the primary and secondary markets of ETFs are associated with an increase in the commonality of stock liquidity. Taken together, our paper contributes to the policy debate of widespread implications of ETFs in security markets. Specifically, we show that as ETFs continue to grow and gain higher ownership of stocks, it can reduce the ability of the investors to diversify liquidity shocks due to an increase in the commonality in liquidity of stocks included in ETF portfolios.

References

Acharya, V. V. and L. H. Pedersen (2005). Asset pricing with liquidity risk. *Journal of Financial Economics 77*(2), 375 – 410.

Amihud, Y. (2002). Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets 5*(1), 31–56.

Ben-David, I., F. A. Franzoni, and R. Moussawi (2014, December). Do ETFs increase volatility? *Social Science Research Network Working Paper Series*.

Chang, Y.-C., H. Hong, and I. Liskovich (2015). Regression discontinuity and the price effects of stock market indexing*. *Review of Financial Studies 28*(1), 212–246.

Chordia, T., R. Roll, and A. Subrahmanyam (2000, April). Commonality in liquidity. *Journal of Financial Economics 56*(1), 3–28.

Coughenour, J. F. and M. M. Saad (2004). Common market makers and commonality in liquidity. *Journal of Financial Economics 73*(1), 37 – 69.

Da, Z. and S. Shive (2012, October). When the bellwether dances to noise: Evidence from Exchange-Traded funds. *Social Science Research Network Working Paper Series*.

Dannhauser, C. D. (2014, December). The equitization of the corporate bond market: The impact of ETFs on bond yields and liquidity. *Social Science Research Network Working Paper Series*.

Goyenko, R. Y., C. W. Holden, and C. A. Trzcinka (2009). Do liquidity measures measure liquidity? *Journal of Financial Economics 92*(2), 153–181.

Hamm, S. J. W. (2010, October). The effect of ETFs on stock liquidity. *Social Science Research Network Working Paper Series*.

Hasbrouck, J. (2009). Trading costs and returns for U.S. equities: Estimating effective costs from daily data. *The Journal of Finance 64*(3), 1445–1477.

Hasbrouck, J. and D. J. Seppi (2001, March). Common factors in prices, order flows, and liquidity. *Journal of Financial Economics 59*(3), 383–411.

Kamara, A., X. Lou, and R. Sadka (2008). The divergence of liquidity commonality in the cross-section of stocks. *Journal of Financial Economics 89*(3), 444–466.

Karolyi, G. A., K.-H. Lee, and M. A. van Dijk (2012). Understanding commonality in liquidity around the world. *Journal of Financial Economics 105*(1), 82–112.

Koch, A., S. Ruenzi, and L. Starks (2016). Commonality in liquidity - a demand-side explanation.

Review of Financial Studies 29(8), 1943–1974.

Pastor, L. and R. F. Stambaugh (2003, June). Liquidity Risk and Expected Stock Returns. *Journal of Political Economy 111*(3), 642–685.

Petajisto, A. (2013). Inefficiencies in the pricing of exchange-traded funds. *SSRN Working Paper*.

Wurgler, J. (2010, August). On the economic consequences of Index-Linked investing. *Social Science Research Network Working Paper Series*.

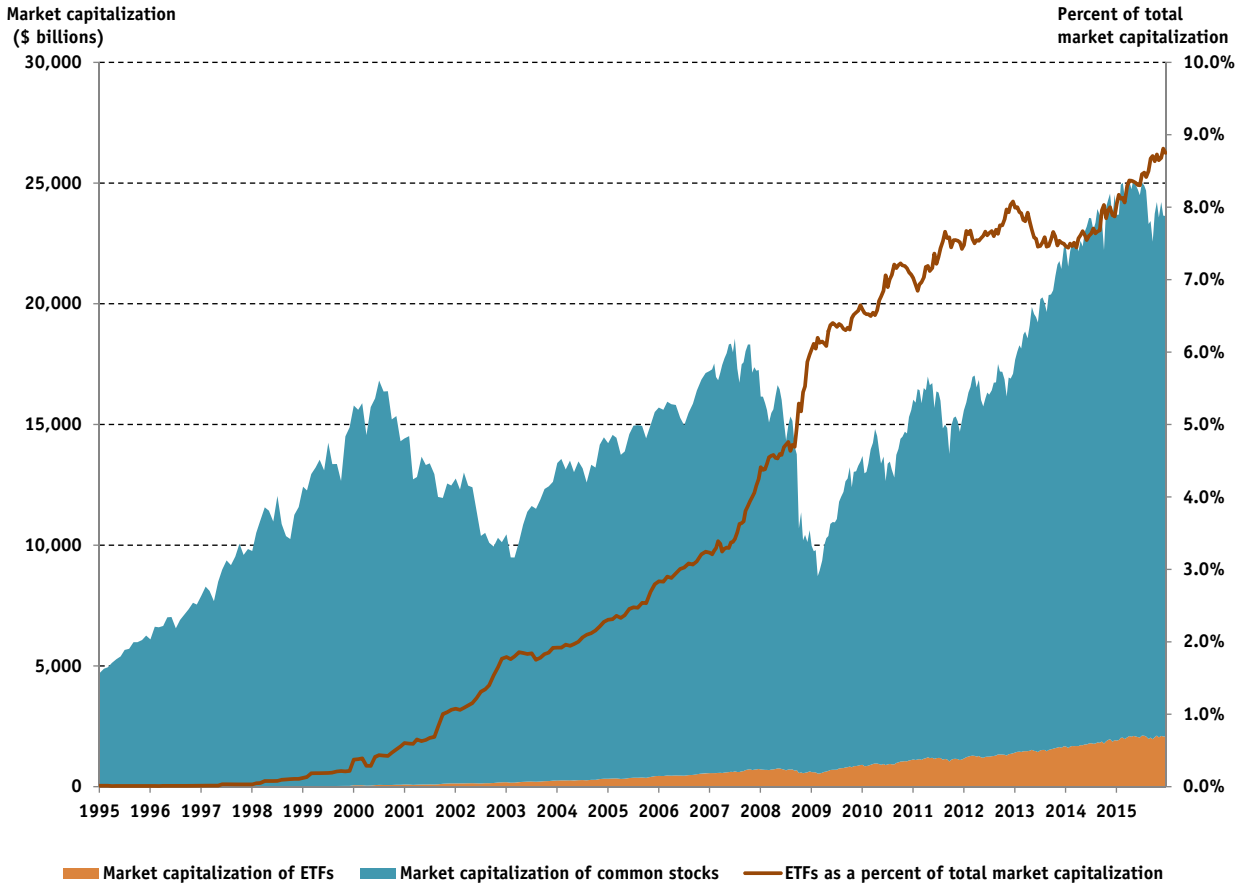

Figure 1: Assets Under Management (AUM) of ETFs trading on US stock exchanges relative to the total market capitalization of the US equity market.
Market capitalization information is obtained from CRSP on common shares (CRSP share code 10 and 11) and Exchange Traded Funds, which were identified using CRSP and Compustat. The bottom area uses the left scale and represents the growth in ETFs. ETFs as of December 31, 2015 have a market capitalization of about 2 trillion dollars. The top area uses the left scale and represents the market capitalization of all CRSP common shares. The line uses the right scale and represents the percentage of ETF market capitalization to the total market capitalization (common shares and ETFs). The line illustrates the steady and dramatic growth of ETF products, which as of December 31, 2015 had an AUM representing 8.75% of the US equity markets.

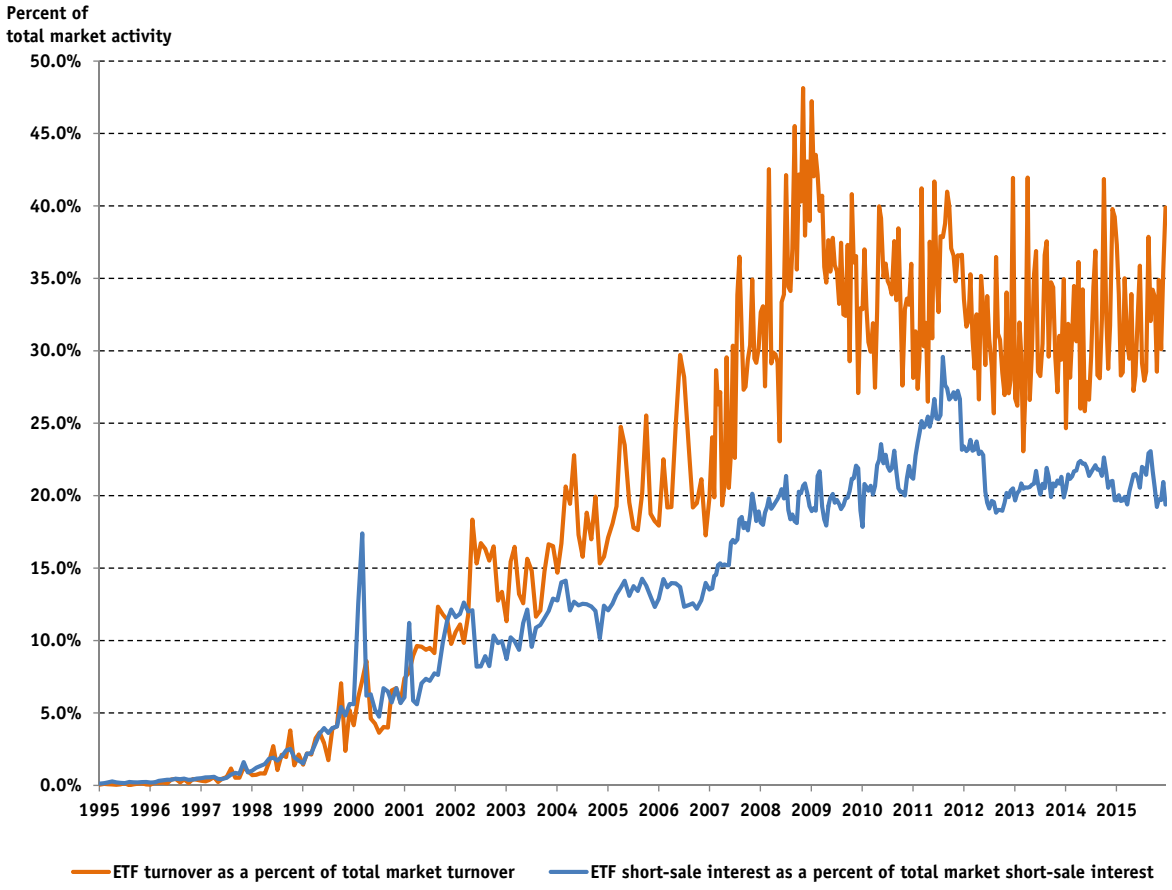

Figure 2: ETF turnover and short-sale interest as a percentage of total common share and ETF market turnover and short-sale interest (January 1995-December 2015)
Trading volume information is obtained from CRSP on common shares (CRSP share code 10 and 11) and Exchange Traded Funds, which were identified using CRSP and Compustat. Short-sale interest was obtained from Compustat on all common shares (CRSP share code 10 and 11) and Exchange Traded Funds, which were identified using CRSP and Compustat. The percentage of ETF trading volume as a percentage of total common share and ETF trading volume has increased from less than 5% from 1995 to 2000 to between 25% to 45% in the period 2008 to 2015. Similarly, ETFs represent a growing proportion of all equity sold short. Over the period 2008 to 2015 the short-sale interest on all ETFs has steadily represented about 20% of all equity short-sale interest.

Table 1: Descriptive Statistics

$\beta_{HighETF}$ measures the commonality in liquidity with respect to the illiquidity of stocks that are in the top quartile of ETF ownership as in Koch et al. (2016). $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ are the percent ownership in a stock held by ETFs, index open-end mutual funds, open-end mutual funds, and all other institutional investors, respectively. $SIZE$ is the stock's market capitalization in $ millions and $AMIHUD$ is the Amihud (2002) illiquidity level. β_{mxs} is the stock's beta calculated using the weighted-average returns excluding the given stock on all CRSP stocks as the proxy for market returns. $ETFAMISPRC$ measures the ETF ownership weighted average arbitrage opportunities of ETFs that hold a given stock, and is calculated as the sum of the absolute value of the daily difference between the ETF NAV and the ETF end of the day price (mispricing) aggregated over each quarter. $ETFMSPVOLAT$ is the standard deviation of the daily mispricing over the quarter. $ETFABSFLOWS$ represents for a given stock the absolute value of daily ETF net flows (creation-redemptions) summed over the quarter for the ETFs that hold the stock. $ETFTURN$ and $ETFSHORT$ are the ETF ownership-weighted average ETF turnover and ETF short-sale interest for a given stock. Panel B, reports the correlation matrix for the commonality in liquidity measures.

Variable	N	Mean	Std. Dev	25th Pct.	Median	75th Pct
Commonality in Liquidity Measures						
$\beta_{HighETF}$	290,918	0.18	1.88	-0.84	0.27	1.34
Institutional Ownership						
$ETFOWN$	293,450	2.72%	2.92%	0.38%	1.66%	4.24%
$INXOWN$	282,092	2.27%	1.76%	0.81%	2.10%	3.28%
$MFOWN$	273,659	14.29%	11.93%	2.97%	12.51%	23.37%
$OTHROWN$	278,988	29.72%	18.68%	13.27%	29.99%	44.21%
Controls						
$SIZE$	309,473	$3,375.5	$16,507.9	$68.080	$296.240	$1,345.565
$AMIHUD$	302,987	0.17	0.26	0.00	0.02	0.28
β_{mxs}	302,262	0.90	0.73	0.39	0.87	1.35
Arbitrage Channels						
$ETFAMISPRC$	242,663	0.07%	0.10%	0.01%	0.04%	0.09%
$ETFMSPVOLAT$	242,663	0.06%	0.07%	0.01%	0.04%	0.09%
$ETFABSFLOWS$	242,663	0.47%	0.53%	0.07%	0.31%	0.64%
$ETFTURN$	242,663	4.57%	6.28%	0.20%	2.34%	6.80%
$ETFSHORT$	242,663	13.22%	15.20%	0.49%	7.77%	21.16%

Table 2: ETF ownership and Commonality in Liquidity

This table presents baseline results of regressions of commonality in liquidity $\beta_{HighETF}$ on ownership. Panel A, reports results on the effect of $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ on commonality in liquidity $\beta_{HighETF}$. $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ are the percent ownership in a stock held by ETFs, index open-end mutual funds, open-end mutual funds, and all other institutional investors, respectively. $\beta_{HighETF}$ measures the commonality in liquidity with respect to the illiquidity of stocks that are in the top quartile of ETF ownership as in Koch et al. (2016). Controls for the stock's market capitalization ($SIZE$) and Amihud (2002) illiquidity levels are included. In models (1) through (3), we include each category of institutional investor separately and in model (4) we examine include all of them together. Quarter and stock fixed-effects are included in all specifications and standard errors are double clustered by quarter and stock.

Panel B, reports results with additional controls, and using only time fixed-effects. Model (1), adds β_{mxs} the stock's beta calculated using the weighted-average returns excluding the given stock on all CRSP stocks as the proxy for market returns. Model (2), adds $\beta_{HighETF,t-1}$ the lagged value of the commonality in liquidity measure. Models (3) through (5), report results using only quarter fixed-effects. T-statistics are reported in parenthesis below the coefficients with ***, **, and * denoting statistical significance at the 1%, 5%, and 10%, respectively.

Panel A: Baseline Regressions

	(1)	(2)	(3)	(4)
	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$
$ETFOWN$	0.0659***			0.0583***
	(9.746)			(8.671)
$INXOWN$		0.0379***		0.0138**
		(7.009)		(2.649)
$MFOWN$			0.0339***	0.0185***
			(6.078)	(3.647)
$OTHROWN$				-0.000871
				(-0.155)
$SIZE$	0.0239**	0.0332***	0.0187*	0.0202*
	(2.417)	(3.244)	(1.691)	(1.911)
$AMIHUD$	-0.0488*	-0.0576*	-0.0891***	-0.0581*
	(-1.706)	(-1.887)	(-2.695)	(-1.801)
N	271,682	257,616	251,325	242,731
R^2	0.055	0.055	0.055	0.057
Period	2000-2015	2000-2015	2000-2015	2000-2015
Fixed Effects	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock
Clustering	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock

Panel B: Baseline Regressions with Additional Controls and Excluding Stock Fixed-Effects

	(1)	(2)	(3)	(4)	(5)
	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$
$ETFOWN$	0.0549***	0.0557***	0.0688***	0.0656***	0.0656***
	(7.955)	(8.546)	(9.980)	(9.922)	(10.22)
$INXOWN$	0.0143***	0.0145***	0.00380	0.00493	0.00419
	(2.726)	(2.701)	(0.872)	(1.143)	(0.993)
$MFOWN$	0.0190***	0.0188***	0.0209***	0.0205***	0.0197***
	(3.703)	(3.550)	(5.009)	(4.948)	(4.782)
$OTHROWN$	-0.000960	-0.00168	-0.00527	-0.00562	-0.00554
	(-0.169)	(-0.285)	(-1.208)	(-1.301)	(-1.285)
$SIZE$	0.0213**	0.0231**	-0.0169***	-0.0161***	-0.0158***
	(2.038)	(2.290)	(-4.529)	(-4.277)	(-4.175)
$AMIHUD$	-0.0470	-0.0541	-0.210***	-0.194***	-0.196***
	(-1.461)	(-1.636)	(-5.891)	(-5.785)	(-5.906)
β_{mxs}	0.0181**	0.0186***		0.0229**	0.0238***
	(2.647)	(2.682)		(2.584)	(2.770)
$\beta_{HighETF,t-1}$		-0.0198***			0.0228***
		(-6.364)			(7.361)
N	239,287	234,363	243,123	239,697	234,776
R^2	0.058	0.059	0.009	0.010	0.011
Period	2000-2015	2000-2015	2000-2015	2000-2015	2000-2015
Fixed Effects	Date and Stock	Date and Stock	Date Only	Date Only	Date Only
Clustering	Date and Stock	Date and Stock	Date and Stock	Date and Stock	Date and Stock

Table 3: ETF ownership and Commonality in Liquidity by Index Membership

This table reports results on the effect of $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ on commonality in liquidity $\beta_{HighETF}$ for stocks that are members of the Russell 3000 (model 2), Russell 2000 (model 3) and S&P 500 (model 4). $\beta_{HighETF}$ measures the commonality in liquidity with respect to the illiquidity of stocks that are in the top quartile of ETF ownership as in Koch et al. (2016). Model (1), reports the baseline results of model 4 in Table 2, Panel A. $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ are the percent ownership in a stock held by ETFs, index open-end mutual funds, open-end mutual funds, and all other institutional investors, respectively. Controls for the stock's market capitalization ($SIZE$) and Amihud (2002) illiquidity levels ($AMIHUD$) are included. The index membership weight, $RUSSELL3000.WEIGHT$, $RUSSELL2000.WEIGHT$, $SP500.WEIGHT$ for each stock are included as an additional control in model (2), (3), and (4), respectively. Quarter and stock fixed-effects are included in all specifications and standard errors are double clustered by quarter and stock. T-statistics are reported in parenthesis below the coefficients with ***, **, and * denoting statistical significance at the 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$
$ETFOWN$	0.0583***	0.0415***	0.0327***	0.0611***
	(8.671)	(5.774)	(3.943)	(3.540)
$INXOWN$	0.0138**	0.0129**	-0.000232	-0.00863
	(2.649)	(2.162)	(-0.0411)	(-0.334)
$MFOWN$	0.0185***	0.0204***	0.00578	0.00945
	(3.647)	(3.373)	(0.848)	(0.577)
$OTHROWN$	-0.000871	0.00237	-0.00717	-0.00114
	(-0.155)	(0.349)	(-0.904)	(-0.0626)
$SIZE$	0.0202*	0.00249	0.0580***	-0.0242
	(1.911)	(0.240)	(4.618)	(-0.984)
$AMIHUD$	-0.0581*	-0.0907	0.143*	3.971
	(-1.801)	(-1.350)	(1.932)	(0.456)
$RUSELL3000.WEIGHT$		-17.45		
		(-1.508)		
$RUSELL2000.WEIGHT$			-21.73	
			(-0.991)	
$SP500.WEIGHT$				-7.160
				(-0.749)
N	242,731	160,130	107,256	26,703
R^2	0.057	0.060	0.071	0.063
Period	2000-2015	2000-2015	2000-2015	2000-2015
Fixed Effects	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock
Clustering	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock
Universe	All Stocks	Russell 3000	Russell 2000	S&P500

Table 4: ETF Ownership and Commonality in Liquidity by Market Condition

Panel A, reports results on the effect of $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ on commonality in liquidity $\beta_{HighETF}$ for different time periods. $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ are the percent ownership in a stock held by ETFs, index open-end mutual funds, open-end mutual funds, and all other institutional investors, respectively. $\beta_{HighETF}$ measures the commonality in liquidity with respect to the illiquidity of stocks that are in the top quartile of ETF ownership as in Koch et al. (2016). Controls for the stock's market capitalization ($SIZE$) and Amihud (2002) illiquidity levels are included. Quarter and stock fixed-effects are included in all specifications and standard errors are double clustered by quarter and stock. Model (1) recalls the baseline results from Table 2, Panel A, Model (4). Model (2), excludes the crisis period 2007-2009 from the sample. Model (3), interacts $ETFOWN$ with pre-crisis (2000-2006), during crisis (2007-2009) and post-crisis (2010-2015) period dummies.

Panel B, reports results on the effect of $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ on commonality in liquidity β_{Liq} by quintiles of the VIX index. β_{mxs} is the stock's beta calculated using the weighted-average returns excluding the given stock on all CRSP stocks as the proxy for market returns. Every specification includes time and stock fixed effects and standard errors are double-clustered by time and stock. T-statistics are reported in parenthesis below the coefficients with ***, **, and * denoting statistical significance at the 1%, 5%, and 10%, respectively.

Panel A: ETF Ownership and Commonality in Liquidity by Different Periods

	(1)	(2)	(3)
	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$
$ETFOWN$	0.0583***	0.0565***	
	(8.671)	(7.567)	
$ETFOWN \times D_{2000-2006}$			0.0216**
			(2.523)
$ETFOWN \times D_{2007-2009}$			0.0872***
			(6.225)
$ETFOWN \times D_{2010-2015}$			0.106***
			(8.160)
$INXOWN$	0.0138**	0.0194***	0.0168***
	(2.649)	(3.522)	(3.312)
$MFOWN$	0.0185***	0.0215***	0.0180***
	(3.647)	(3.840)	(3.624)
$OTHROWN$	-0.000871	-0.00173	0.00590
	(-0.155)	(-0.304)	(1.065)
$SIZE$	0.0202*	0.0173	0.0130
	(1.911)	(1.453)	(1.176)
$AMIHUD$	-0.0581*	-0.0329	-0.0613*
	(-1.801)	(-0.911)	(-1.922)
N	242,731	213,344	242,731
R^2	0.057	0.061	0.058
Period	2000-2015	excl 07-09	2000-2015
Fixed Effects	Quarter & Stock	Quarter & Stock	Quarter & Stock
Clustering	Quarter & Stock	Quarter & Stock	Quarter & Stock

Panel B: ETF Ownership and Commonality in Liquidity by VIX Index Quintiles

VIX Rank	Low	2	3	4	High
	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$
$ETFOWN$	0.0484***	0.0507**	0.0630***	0.0388*	0.0669***
	(3.732)	(2.270)	(3.776)	(2.223)	(9.057)
$INXOWN$	0.0226	0.0278**	-0.0119	0.0209	0.0190
	(1.521)	(2.939)	(-0.954)	(1.384)	(1.488)
$MFOWN$	0.0244*	0.0451***	0.00179	0.0281**	0.0213*
	(1.835)	(4.555)	(0.176)	(2.307)	(2.182)
$OTHROWN$	0.00887	0.00338	0.00396	-0.00462	0.00322
	(0.804)	(0.337)	(0.219)	(-0.257)	(0.273)
$SIZE$	0.0449**	0.0211	0.0370*	-0.0270	0.0219
	(2.267)	(1.169)	(1.989)	(-0.943)	(0.631)
$AMIHUD$	-0.0560	-0.0922	0.0304	-0.154*	0.00555
	(-0.709)	(-0.995)	(0.387)	(-1.880)	(0.0671)
N	49,346	52,916	45,901	41,758	45,555
R^2	0.148	0.147	0.166	0.173	0.171
Period	2000-2015	2000-2015	2000-2015	2000-2015	2000-2015
Fixed Effects	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock
Clustering	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock

Table 5: Proxies for stock liquidity demand originating from ETFs

This table reports results on the effect of $ETFOWN$ and $ETFOWN$ interacted with proxies for ETF-induced stock liquidity demand ($\times CHANNEL$) on commonality in liquidity. $ETFOWN$, $INXOWN$, $MFOWN$ and $OTHROWN$ are the percent ownership in a stock held by ETFs, index open-end mutual funds, open-end mutual funds, and all other institutional investors, respectively. $\beta_{HighETF}$ measures the commonality in liquidity with respect to the illiquidity of stocks that are in the top quartile of ETF ownership as in Koch et al. (2016). Controls for the stock's market capitalization ($SIZE$) and Amihud (2002) illiquidity levels ($AMIHUD$) are included. The proxies for ETF-induced liquidity demand are: $ETFDMISPRC$, $ETFMSPVOLAT$, $ETFABSFLOWS$, $ETFTURN$ and $ETFSHORT$. $ETFAMISPRC$ measures the ETF ownership weighted average arbitrage intensity of ETFs that hold a given stock, where arbitrage intensity is calculated as the sum of the absolute value of the daily difference between the ETF NAV and the ETF end-of-the day price aggregated over each quarter. $ETFMSPVOLAT$ is the standard deviation of that daily difference over the quarter. $ETFABSFLOWS$ represents for a given stock the absolute value of daily ETF net flows (creation-redemptions) summed over the quarter for the ETFs that hold the stock. $ETFTURN$ and $ETFSHORT$ are the ETF ownership-weighted average ETF turnover and ETF short-sale interest for a given stock. Quarter and stock fixed-effects are included in all specifications and standard errors are double clustered by quarter and stock. T-statistics are reported in parenthesis below the coefficients with ***, **, and * denoting statistical significance at the 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)
	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$	$\beta_{HighETF}$
$ETFOWN$	0.0537***	0.0383***	0.0293***	0.0413***	0.0320***
	(6.755)	(4.896)	(3.856)	(5.646)	(4.449)
$CHANNEL$	-0.00763	-0.0173**	-0.00818	0.00927*	0.00109
	(-1.280)	(-2.645)	(-1.328)	(1.682)	(0.159)
$ETFOWN \times CHANNEL$	0.0147*	0.0392***	0.0594***	0.0367***	0.0547***
	(1.730)	(5.067)	(5.826)	(4.089)	(5.540)
$INXOWN$	0.0144**	0.0136**	0.0138**	0.0152***	0.0130**
	(2.542)	(2.431)	(2.454)	(2.723)	(2.327)
$MFOWN$	0.0200***	0.0196***	0.0171***	0.0189***	0.0163***
	(3.595)	(3.588)	(3.055)	(3.447)	(3.004)
$OTHROWN$	0.00185	0.00171	-0.00154	0.000484	-0.00181
	(0.312)	(0.289)	(-0.261)	(0.0825)	(-0.319)
$SIZE$	0.0182*	0.0178	0.0173	0.0173	0.0181*
	(1.721)	(1.642)	(1.617)	(1.633)	(1.703)
$AMIHUD$	-0.0916**	-0.0839**	-0.0677*	-0.0696*	-0.0617*
	(-2.446)	(-2.221)	(-1.813)	(-1.896)	(-1.703)
N	210,556	210,197	210,264	211,957	210,593
R^2	0.061	0.061	0.062	0.062	0.062
Period	2000-2015	2000-2015	2000-2015	2000-2015	2000-2015
Fixed Effects	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock
Clustering	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock	Quarter & Stock
Channel	$ETFAMISPRC$	$ETFMSPVOLAT$	$ETFABSFLOWS$	$ETFTURN$	$ETFSHORT$

Table 6: Trading Halts

The table reports results using high-frequency second-by-second data from TAQ to estimate in a pooled regression the impact of ETF trading halts on commonality in liquidity. H is the ETF ownership-weighted average of dummy variables each reflecting a trading halt during second s in an ETF referencing stock i; $ETFOWN$ is the ETF ownership in the stock; and $\Delta Illiq_m$ is the change in market-wide liquidity. The regressions contain time and stock fixed effects, and errors are clustered at the time and stock level. t-statistics are reported in parenthesis below the coefficients with ***, **, and * denoting statistical significance at the 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
	$\Delta Illiq_i$	$\Delta Illiq_i$	$\Delta Illiq_i$
H	-0.0091***	-0.0102***	-0.0104***
	(-3.138)	(-3.460)	(-3.545)
$ETFOWN \times \Delta Illiq_m$		5.4450***	6.429***
		(5.632)	(6.282)
$H \times \Delta Illiq_m$		-0.867**	0.420
		(-2.262)	(0.761)
$ETFOWN \times H \times \Delta Illiq_m$			-15.7800***
			(-3.256)
N	8,229,545	8,229,545	8,229,545
R^2	0.012	0.012	0.012
Period	Aug. 24, 2015	Aug. 24, 2015	Aug. 24, 2015
Fixed Effects	Time and Stock	Time and Stock	Time and Stock
Clustering	Time and Stock	Time and Stock	Time and Stock