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ETF ownership and stock liquidity: evidence from China

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ABSTRACT

Due to their low participation cost, exchange-traded funds (ETFs) are booming in China. We find that stocks with higher ETF ownership display higher liquidity while controlling for other institutional ownership. In the post-crash periods when ETF market evolves rapidly, the impact becomes greater. For large-capitalization stocks, ETF ownership has a stronger impact on stock liquidity. The liquidity shocks in the ETFs market can propagate to the underlying stocks through the instantaneous creation/redemption arbitrage mechanism. Moreover, ETF market makers create/redeem to manage their inventory risk, therefore introducing liquidity to stocks.

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ETF ownership; stock liquidity; instantaneous arbitrage; market maker; primary market

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1. Introduction

Over the past 15 years, Exchange-Traded Funds (ETFs) have become a major investment tool. With the management fee of about 0.3% to 0.5%, the commission of up to 0.2%, and the feature of directly tracking the index, ETFs have attracted many investors. By the end of 2021, there are 641 ETF products in China, with an asset size of RMB 1,419.7 billion, a year-on-year growth of 30.55%. Among all types, stock-based ETFs have the highest proportion of asset size, reaching 67.44%. As a special kind of open-ended fund, ETFs operate in two markets: the primary market is the creation/redemption market where ETF shares can be exchanged with a basket of stocks, and the secondary market is the market where ETF shares can be traded in real-time by retail and institutional investors. Therefore, ETFs have two levels of liquidity, one is the on-screen liquidity of the ETF itself and the other is the liquidity of the underlying assets.

When investors engage in ETF trading, they often face the problem of unmatched counterparties, for which China actively promotes the ETFs liquidity provider[1] business. Since the Shanghai Stock Exchange established guidelines for ETF liquidity services in 2012, brokerages have continuously applied to become ETF market makers. As of mid-2022, 145 equity ETFs have liquidity service providers. The involvement of liquidity service providers has become one of the necessary ways for the rapid development of ETFs: as the minimum unit of ETF creation/redemption is usually one million fund shares, the traders who can meet the requirements are basically institutional investors, while most individual investors trade in the ETF secondary market. Market makers can trade flexibly in both the primary and secondary markets, effectively acting as an intermediary between fund companies and individual investors.

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In the context of the high liquidity of ETFs, this paper examines whether the liquidity of the underlying assets is affected by ETF ownership. What role, if any, did market makers and instantaneous arbitrage play?

Based on data from 2005 to 2020 equity ETFs, we conduct our main test of the effect of ETF ownership, the fraction of the stock's capitalization held by ETFs, on stock-level liquidity. Using two-way fixed ordinary least squares (OLS), we find that this relation is positive and significant. To address the concern that the ETF ownership may be endogenous, we take the mean of ETF ownership of other stocks in the same industry as an instrumental variable (IV). The test confirms that the effect of the relation between ETF ownership and stock liquidity is positive and significant. Next, we take on the task of explore the channel linking ETF ownership to stock liquidity: creation/redemption arbitrage channel and the liquidity provider position management channel. On the one hand, the supply and demand in the secondary market of ETFs will cause the price of ETFs in the secondary market to deviate from their IOPV in the primary market, and when this deviation becomes large enough, investors will engage in instantaneous arbitrage. On the other hand, ETF market makers improve ETF liquidity, i.e. ETFs with market makers are more liquid than those without market makers. When they buy/sell too much, liquidity providers will redeem/create ETFs in order to manage their position risk. Whether it is intraday arbitrage of ETFs or position management of market makers, they must go through three processes: trading stocks, creation/redemption in the primary market of ETFs, and trading in the secondary market of ETFs. Both creation and redemption will lead to transactions involving the stock side, thus improving the liquidity of the underlying stocks.

Our study relates to several strands of the literature. We contribute to the broad literature on the determinants of stock liquidity. The influencing factors of the liquidity of individual stocks are mainly divided into four perspectives: Product market-related factors are, product market power (Kale and Cheng Loon 2011), foreign competition (Atawnah et al. 2018) and customer concentration (Do, Hongren Huang, and Le 2023); Macroeconomic conditions and policy-related factors include, monetary policy (Fernández-Amador et al. 2013), income inequality (Blau 2018), macro-financial informational shocks and volatility (Pan 2023), bank loan announcement (Pham, Singh, and Hoang Vu 2023) and voluntary disclosure (Schoenfeld 2017); The relevant factors of company characteristics are: state ownership (Boubakri et al. 2020), corporate social responsibility (Roy, Rao, and Zhu 2022), and corporate ESG (He, Feng, and Hao 2023; K. Wang et al. 2023); Investor related factors are investor attention trade imbalance (Chordia, Roll, and Subrahmanyam 2003), Investor attention (Aouadi, Arouri, and Roubaud 2018; Cheng et al. 2021), media coverage (Huang, Huang, and Ho 2024; Shyu et al. 2020). Since ETFs trade in two markets, we present two factors: cross-market arbitrage and market-maker position management. In addition, we have a new indicator, the high-low spread, which not only takes into account the bid-ask component, but also the volatility component of the stock price, which measures the broader liquidity.

Our finding relates to the studies on the effect of ETFs on the liquidity of the underlying securities. Israeli, Lee, and Sridharan (2017) argue that ETF ownership increases trading costs. Evans et al. (2019) show that ETF ownership increases intraday bid-ask spreads of the underlying securities. Ben-David, Francesco, and Moussawi (2018) document that ETFs propagate the non-fundamental liquidity shocks to the underlying assets. Building on these studies, our paper provides evidence that ETF ownership increases the liquidity of the underlying stocks while controlling other institutional ownership.

Recent empirical literature also studies the effect of market makers on liquidity. Wu et al. (2014) show that market makers' inventory changes decrease spread, because stable inventory position reduces the rebalancing cost. Zhang et al. (2017) document that market maker competition decreases transaction costs with China National Equities Exchange and Quotations (NEEQ) data, we use the ETF data instead. Xu (2023) argues that high frequency market makers improve market liquidity by decreasing the cross-subsidization between uninformed and informed investors. We find that market makers can increase not only the liquidity of the assets themselves, but the liquidity

of underlying assets as well. More importantly, we highlight a previously unexplored channel: in addition to instantaneous arbitrage, market makers' position management also affects the liquidity of the underlying assets.

The rest of the paper is organized as follows: Section 2 develops our research hypotheses. Section 3 defines the variables and describes the data. Section 4 documents the effects of ETF ownership on stock liquidity. Section 5 addresses endogeneity problem and provides robustness checks. Section 6 explores the two channels through which ETF ownership improves stock liquidity: the creation/redemption arbitrage channel and the market maker's position management channel. Finally, Section 7 concludes.

2. Literature review and hypothesis development

The impact of ETFs on their underlying securities is a widely discussed topic. Mainstream literature suggests that ETFs exert a positive influence on the liquidity of the underlying stocks. This assertion is supported by the research of Hamm (2014), Israeli, Lee, and Sridharan (2017), and Bae and Kim (2020) concerning equity-based ETFs. Additionally, Dannhauser (2017) explore the impact of bond-based ETFs, while Bessembinder et al. (2016) investigate the effects of ETFs on the liquidity of New York Mercantile Exchange crude oil futures contracts. However, the results of some other studies suggest a more subtle relationship between the ETF ownership ratio and the liquidity of constituent stocks. Early studies such as Subrahmanyam (1991), Jegadeesh and Subrahmanyam (1993) and Gorton and Pennacchi (1993) use theoretical models to explain that compared to direct trading in the underlying securities, uninformed traders are more likely to profit from trading 'baskets' of securities, which indicates that a basket of securities such as ETFs attracts uninformed traders away from individual stocks, leading to a decrease in stock liquidity. Holden and Nam (2017) demonstrate that ETF ownership deteriorates (improves) liquidity of the underlying securities, when the underlying market is more (less) accessible.

China's stock market is currently in a developmental phase, characterized by a T + 1 trading system and regulatory limitations on short selling. The trading pattern of ETFs allow them to facilitate intraday trading through both primary and secondary markets, effectively addressing the absence of a short-selling mechanism in China. Consequently, ETFs may play a pivotal role in enhancing liquidity for underlying assets, forming the basis of our first hypothesis.

Hypothesis 1: An increase in ETF ownership will significantly enhance the liquidity of the underlying constituent stocks.

Much of the literature suggests that arbitrage activities have positive effect on the liquidity of equities. Early literature studies index arbitrage and find that arbitrageurs predict price movement and transmit the uninformed liquidity trades (Fremault 1991; Gromb and Vayanos 2002; Holden 1995; Kumar and Seppi 1994). Ben-David, Francesco, and Moussawi (2018) and Ben-David et al. (2021) argue that price shocks in ETFs are transmitted to their portfolios through arbitrage mechanisms, allowing uninformed, high turnover retail investors to introduce noise in the ETF's underlying stocks. In contrast, Box et al. (2021) use minute-level data to find that arbitrage opportunities arise from order imbalances and price movements in the underlying securities, i.e. ETFs can actually protect their portfolios from demand shocks by supporting the liquidity supply of the underlying securities, rather than transmitting irrational shocks to the underlying securities. Regarding the Chinese market, Liu and Ma (2013) and Wang and Xu (2019) emphasize that stock ETFs have a variety of arbitrage strategies in China's stock market, and because of their real-time trading characteristics and advantages, which can lead to a large amount of intraday arbitrage activities, and because of the continuous optimization of market mechanisms and policies that make arbitrage restrictions lower, ETFs bring liquidity to the underlying securities in the stock market.

The literature on market makers covers market makers' risk attitudes, position management, and market impact. Risk-averse market makers need to be compensated for holding risky inventories, and if they can easily hedge their holdings, they can effectively decrease costs (Grossman Sanford and Miller Merton 1988; Ho and Stoll 1981). Baltussen et al. (2021) discover that the gamma hedging demand from market makers of options and leveraged ETFs drives intraday momentum. Aliyev and He (2023) show that balanced order flow deteriorates liquidity when the market maker is pessimistic about her belief assessments. There is an academic consensus that market makers improve the liquidity of financial products in the same market. Eldor et al. (2006) find that the presence of market makers encourages trading among other participants far beyond their own trading. Conducting an event study of a Euronext roll-out of their Paris limit order market system to Amsterdam, Menkveld and Wang (2013) argue that delegated market makers improve liquidity levels and reduce liquidity risk for small-cap stocks. Taking advantage of trading halts forced by technological glitches, Clark-Joseph, Ye, and Zi (2017) find that designated market makers (DMMs) significantly improve stock liquidity. Zhang et al. (2017) find market maker competition increases price efficiency because uninformed market makers learn from the informed market makers' orders. Using data from Deutsche Börse's Xetra system, Theissen and ane Christian Westheide (2023) find that increases in additional DMMs significantly improve stock liquidity, especially in relatively illiquid and volatile stocks. In China, there are market makers for stock index options, ETFs, treasury bond futures, public REITS, NSSB, KICB, and there are no market makers for stocks. For this reason, we study the cross-market impact of market makers: ETF market makers will operate ETF creations/redemptions for inventory management purposes, thus improving individual stock liquidity.

There are certain differences between the two channels that ETF ownership increases stock liquidity. The former speculates that arbitrage improves stock liquidity from the perspective of profit maximization, while the latter considers inventory risk management and argues that ETF liquidity is transferred through liquidity providers. We therefore propose the Hypothesis 2.1 and Hypothesis 2.2 below.

Hypothesis 2.1: Instantaneous creation/redemption arbitrage mechanism between ETFs and stocks enables ETF ownership to increase stock liquidity.

Hypothesis 2.2: ETF ownership increases stock liquidity due to the position management of liquidity providers.

3. Data, variables and descriptive statistics

3.1. The data

We start by identifying ETFs and stocks from Wind and CSMAR. For funds, we obtain the historical list of stock ETFs, index funds, and active funds, and collect the fund size and the net value per unit for each type of funds in Wind. Since the earliest equity ETF in China was listed in 2005, we set the sample period to be between 2005 and 2020. We finally keep 253 stock-based ETFs. As for other types of equity funds, we have 381 active funds, and 205 index-based funds. For stocks, we use the list of stocks within various stock indices in WIND and extract the data of all listed companies in Shanghai and Shenzhen A-shares in CSMAR, including the number and the percentage of fund holdings, the daily high-low-close price, turnover ratio, spread, book-to-market ratio, total assets, etc. In terms of data cleaning procedures, we remove all ST, *ST, and delisted stocks. We follow Jin and Myers (2006) and Tan et al. (2019) in excluding stocks with less than 30 intra-year weekly returns. Stocks that are not held by the fund and with missing data related to control

variables are excluded from our sample. We winsorize the final measure at the 1% and 99% percentiles. The resulting sample consists of 3,006 stocks and the final sample size and observations may differ due to the different research designs in each part.

3.2. High-low spread (HLSpread)

Based on only daily high prices and low prices, Corwin and Schultz (2012) derive the high-low spread estimator. In contrast to other liquidity indicators, this proxy does not depend on any specific market characteristics and is less data-intensive. They demonstrate that the high-low spread indicator is significantly better than the effective spread indicator of Roll (1984) and the bid-ask spread of Lesmond, Ogden, and Trzcinka (1999) and Holden (2009). Moreover, the high-low spread is a low-frequency spread, therefore it considers not only the bid-ask spread but also the stock price volatility, allowing for a broader measure of liquidity.

Assuming that the spread S% is constant over the 2-day estimation period and the daily high/low price is a buyer/seller-initiated trade, we construct the high-low spread as below:

$$HLSpread = \frac{2(e^{\alpha}-1)}{1+e^{\alpha}} \tag{1}$$

where $\alpha = \frac{\sqrt{2\beta}-\sqrt{\beta}}{3-2\sqrt{2}} - \sqrt{\frac{\gamma}{3-2\sqrt{2}}}$, $\beta = E\left\{\sum_{j=0}^{1}\left[\ln\left(\frac{H_{t+j}}{L_{t+j}}\right)\right]^2\right\}$, $\gamma = \left[\ln\left(\frac{H_{t,t+1}}{L_{t,t+1}}\right)\right]^2$. $H_{t,t+1}$ and $L_{t,t+1}$ are the high and low price for stock i over the 2 days t and $t+1$, respectively. In our stock-quarter panel, we use the average daily data calculated for each 2-day rolling window as the quarterly high-low spread.

3.3. ETF ownership

We construct the main explanatory variable, ETF Ownership, by aligning the ownership of ETFs in the same period using the following equation.

$$ETF\ Ownership_{i,t} = \frac{\sum_{j=1}^{J} w_{i,j,t} AUM_{j,t}}{Mkt\ Cap_{i,t}} \tag{2}$$

where $ETF\ Ownership_{i,t}$ denotes weight of market value held by all ETFs in the total market value of stock i at the end of quarter t, j denotes the j-th ETF, and J is the total number of ETFs that hold the stock i. $w_{i,j,t}$ is the portfolio weight of stock i, which is the amount of market value of stock i in the ETF_j's portfolio divided by the amount of the total ETF's portfolio size. $AUM_{j,t}$ is the ETF_j's market capitalization at the end of quarter t. $\sum_{j=1}^{J} w_{i,j,t} AUM_{j,t}$ is the sum of market value of stock i held by all ETFs in quarter t, and $Mkt\ Cap_{i,t}$ denotes the total market value of stock i at the end of quarter t. Therefore, the ETF ownership (also called ETF's holding ratio) $ETF\ Ownership_{i,t}$ for stock i in quarter t is defined as the sum of the market capitalization held by all ETFs invested in stock i in quarter t, divided by the total market capitalization of stock i at the end of quarter t.[2]

According to equation (2), the variation in ETF ownership stems from three sources. First, how many ETFs a stock is held by depends on how many indices the stock appears in. Larger, earlier listed, and more liquid stocks are more likely to appear in an index. This leads to a potential endogeneity problem due to reverse causality, which we will address in Section 5. Second, the total market capitalization of ETFs changes over time and across products. Investors may have specific industry or asset class preferences, such preferences may also have an impact on the relationship we want to test, and we will also address this concern in the subsequent sections. Finally, different

Table 1. Descriptive statistics of ETF ownership and stock liquidity.

Variables	Obs	Mean	Std.	Min	Max
HLSpread	36,397	0.018	0.007	0.003	0.053
Roll	36,397	0.050	0.020	0.000	0.233
ETF_raw	36,397	0.302	0.504	0.000	7.858
ETF	36,397	0.000	0.010	−0.031	0.052
Index_raw	36,397	0.470	1.032	0.000	15.599
Index	36,397	0.000	0.010	−0.026	0.061
Active_raw	36,397	0.474	0.822	0.000	10.212
Active	36,397	0.000	0.010	−0.022	0.056
LnFsize	36,397	15.672	1.057	13.437	18.717
ILLIQ	36,397	0.043	0.161	0.005	3.129
BM	36,397	0.620	0.258	0.116	1.160
Volatility	36,397	0.028	0.011	0.010	0.062

The table presents summary statistics for the variables used in the study. HLSpread measures the stock liquidity as in Corwin and Schultz (2012). Roll is the Roll effective spread. ILLIQ_N is the numerator of Amihud illiquidity. ETF_raw, Active_raw and Index_raw are the percent market capitalization ownership held by ETFs, active funds and index funds. ETF, Active, Index are the standardized ownerships. LnFsize is the logarithm of market value. LnILLIQ_D is the logarithm of the denominator of Amihud illiquidity. Volatility is the standard deviation of stock return. BM is the book-to-market ratio. The stock-quarter sample cover the period 2005–2020.

indices tracked by ETFs may differ in their weighting schemes, we therefore control for the market capitalization of the stocks.

3.4. Descriptive statistics

Table 1 presents the descriptive statistics for each of the main variables in this paper for the period January 2005–December 2020. We provide the definition of other regression variables and correlation matrix in Table IA.I in the Internet Appendix. The maximum value of the High-Low spreads is 5.3%, the minimum value is 0.3%, the mean value is 1.8%, and the standard deviation is 0.7%. The average ETF ownership is 0.302%, the average index funds ownership is 0.470%, and the average active funds ownership is 0.474%. The ETF ownership has a relatively low value compared to the other two types of fund ownership, there is still some room for future development for the ETF market. In order to avoid skewing the regression results toward larger or smaller values as well as to facilitate the interpretation of the results, we refer to the method in Ben-David, Francesco, and Moussawi (2018), where the ETF/index fund/active fund ownerships are mean-variance standardized, and divided by 100 to remove the percentage sign.

4. Main results

Our main hypothesis is that ETF ownership increases stock liquidity. We conduct an initial test of this hypothesis by regressing stock liquidity on ETF ownership. We then subsequently introduce the index fund ownership, active fund ownership, and the lagged stock liquidity in the regression. For each set of tests, we take the value at the end of the previous quarter for all control variables and we include stock fixed effects and quarterly fixed effects in the regressions.[3] The regression results are displayed in Table 2.

Model 1 is the benchmark regression, which indicates that the high-low spread of stocks decreases as the ETF ownership increases. Model 2 incorporates index fund ownership and active fund ownership, and we find that the regression coefficient is significant at the 1% statistical level, indicating that for every one standard deviation increase in ETF ownership, the high-low spread of stocks decreases by 4.0%. Model 3 adds the third-order lag term of the explanatory variables, which solves the problem of autocorrelation of the variables to some extent, and the regression coefficient

Table 2. The impact of ETF ownership on the liquidity of the underlying stocks.

	HLSpread (t)	HLSpread (t)	HLSpread (t)	HLSpread (t)
Variables	(1)	(2)	(3)	(4)
ETF (*t*–1)	−0.039***	−0.040***	−0.035***	−0.036***
	(−13.55)	(−9.75)	(−11.32)	(−8.67)
LnFsize (*t*–1)	−0.001***	−0.001***	−0.001***	−0.001***
	(−14.53)	(−12.05)	(−14.68)	(−11.01)
BM (*t*–1)	0.003***	0.003***	0.002***	0.001***
	(10.00)	(6.19)	(6.37)	(2.87)
Volatility (*t*–1)	0.126***	0.156***	0.055***	0.080***
	(23.83)	(22.17)	(8.04)	(8.81)
Tover (*t*–1)	−0.000***	−0.000***	−0.000***	−0.000***
	(−7.38)	(−4.69)	(−8.37)	(−5.72)
Index (*t*–1)		−0.011***		−0.009***
		(−3.18)		(−2.58)
Active (*t*–1)		0.028***		0.024***
		(7.92)		(6.62)
HLSpread (*t*–1)			0.158***	0.161***
			(15.49)	(12.42)
HLSpread (*t*–2)			0.006	0.004
			(1.09)	(0.56)
HLSpread (*t*–3)			−0.013**	−0.012*
			(−2.56)	(−1.93)
Constant	0.038***	0.039***	0.034***	0.034***
	(25.19)	(19.67)	(21.43)	(16.61)
Observations	36,397	23,104	33,284	21,971
R-squared	0.57	0.59	0.58	0.60
Number of stocks	3,006	2,661	2,882	2,562
Stock FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

This table presents results of regressions of liquidity on lagged ETF ownership. HLSpread measures the stock liquidity as in Corwin and Schultz (2012). Active and Index are the percent market capitalization ownership held by active funds and index funds. All these ownerships are standardized and controls for the market capitalization (LnFsize), turnover rate (Tover), volatility (Volatility) and book-to-market ratio (BM) are included. We consider quarter, stock and industry fixed-effects in all these model specifications and double cluster the standard errors by quarter and stock. The t-test statistics are presented in parentheses in this table, where ***, ** and * indicate that the regression coefficients are significant at the 1%, 5% and 10% statistical levels, respectively.

remains negatively significant. Model 4 includes both the ownership of the two types of funds and the lagged third-order variables of the explanatory variables based on the base regression model. Under this relatively strict model setting, the regression results are still significant, indicating that ETF ownership has a significant improvement on stock liquidity. In addition, the regression coefficient values of the explanatory variable high-low spread and other control variables show the expected relationship, with HLSpread being negatively associated with an increase in firm size and positively associated with an increase in the book-to-market ratio.

5. Robustness checks

The robustness checks focus on four key identification assumptions and perform placebo test, endogeneity test, substitution of explanatory variables, and substitution of sample periods to verify that the results of the benchmark regression still hold.

5.1. Placebo test

Following Agarwal et al. (2021), we design a placebo test to determine whether the effect of ETF ownership on stock liquidity is driven by other stochastic factors. We randomly assign the value of ETF ownership throughout the whole sample period and repeat the regression

1000 times to see whether the coefficient of 'pseudo-ETF ownership' is significant. We also control for three lags of the explanatory variable, HLSpread, in the model to reduce the serial autocorrelation problem. If the regression coefficient of the 'pseudo-ETF ownership' is significant in the fictitious scenario, it suggests that the changes in the explanatory variable liquidity may be influenced by other policy or stochastic factors in the original estimation results.

Figure 1 shows the distribution of the t-statistic of the estimated coefficient of the 'pseudo-ETF ownership' after randomly assigning the value of the ETF ownership 1000 times, where the x-axis indicates the magnitude of the t-statistic of the coefficient and the y-axis is the number of occurrences. The estimated coefficients in the placebo test are concentrated around 0, indicating that the regression coefficients are no longer significant when the ETF ownership is randomly assigned several times, i.e. the placebo test using random assignment of ETF ownership to stocks does not produce a significant relationship between ETF ownership and liquidity. Thus, when the ETF ownership is not the original true value state, the effect in the benchmark regression will no longer exist, indicating that the estimation results are unlikely to be influenced by other policy or stochastic factors.

5.2. Endogeneity test

ETFs are funds that track indices, when a stock is larger, well-developed, and liquid, it is more likely to enter an index and thus be held by an ETF, then ETF ownership in more liquid stocks may be larger, and there would be an inverse effect of liquidity affecting the ETF ownership. To address the potential endogeneity of reverse causation between ETF ownership and stock liquidity, we rely on Xu, Yin, and Zhao (2019) to use the average value of the ETF ownership indicator of other firms in the same industry in the same quarter as an instrumental variable for the ETF ownership.[4]

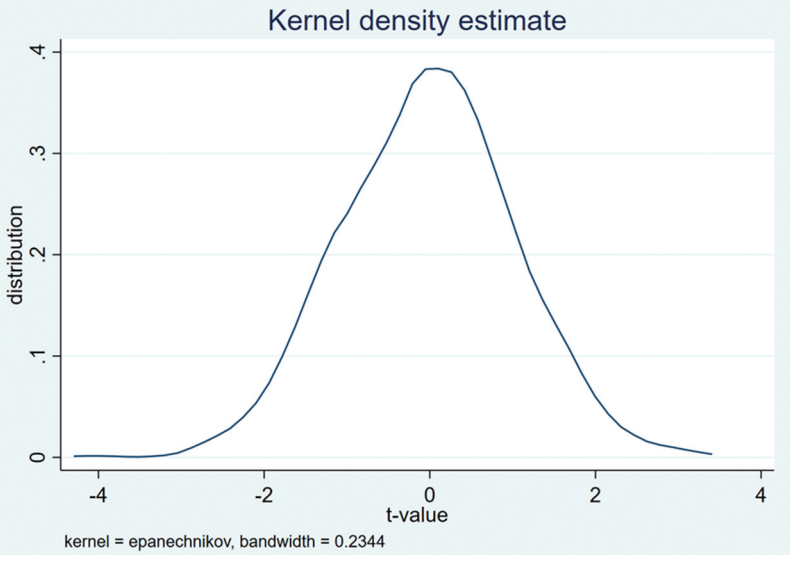

Figure 1. Robustness test: placebo test.

First, we conduct the following first-stage regression using the average value of the ETF ownership indicator of other firms in the same industry in the same quarter as the instrumental variable for the ETF ownership:

$$ETF\ Ownership_{i,t-1} = \beta_0 + \beta_1 InavgETF_{i,t-1} + \beta_2 LnFsize_{i,t-1} + \beta_3 BM_{i,t-1} + \beta_4 Tover_{i,t-1} + \beta_5 Volatility_{i,t-1} + \beta_6 Index\ Ownership_{i,t-1} + \beta_7 Active\ Ownership_{i,t-1} + \sum_i \eta_i a_i + \sum_t \theta_t T_t + \sum_i \xi_i Ind_i + \varepsilon_{i,t} \quad (3)$$

In the second stage, we regress 3 different liquidity measures on the fitted value of ETF Ownership from the first stage, including the same set of controls as in the OLS regression. This regression is given by:

$$HLSpread_{i,t} = \beta_0 + \beta_1 \widehat{ETF\ Ownership}_{i,t-1} + \beta_2 LnFsize_{i,t-1} + \beta_3 BM_{i,t-1} + \beta_4 Tover_{i,t-1} + \beta_5 Volatility_{i,t-1} + \beta_6 Index\ Ownership_{i,t-1} + \beta_7 Active\ Ownership_{i,t-1} + \sum_i \eta_i a_i + \sum_t \theta_t T_t + \sum_i \xi_i Ind_i + \varepsilon_{i,t} \quad (4)$$

From Column (2)–(4) in Table 3, the instrumental variable regressions confirm that the ETF ownership enhances the stock liquidity.

Table 3. Robustness test: endogeneity test.

	ETF(*t*–1)	HLSpread (t)	ILLIQ (t)	Roll (t)
	1st stage	2nd stage	2nd stage	2nd stage
Variables	(1)	(2)	(3)	(4)
IndavgETF (*t*–1)	0.304***			
	(16.26)			
$\widehat{ETF}(t-1)$		−0.213***	−0.572***	−0.348***
		(−6.29)	(−3.54)	(−3.37)
LnFsize (*t*–1)	0.004***	−0.000****	−0.016***	−0.001**
	(19.24)	(−4.38)	(−8.24)	(−1.99)
BM (*t*–1)	0.005***	−0.002***	−0.009*	−0.003**
	(7.63)	(−4.01)	(−1.94)	(−2.36)
Tover (*t*–1)	0.000***	−0.000***	−0.002***	0.000**
	(6.06)	(−3.18)	(−5.28)	(2.14)
Volatility (*t*–1)	−0.125***	0.133**	−0.141*	0.353***
	(−10.80)	(17.22)	(−1.65)	(14.84)
Index (*t*–1)	0.194***	0.022***	−0.201**	0.040*
	(32.00)	(3.07)	(−2.49)	(1.78)
Active (*t*–1)	−0.011*	0.026***	0.079**	0.046***
	(−1.73)	(7.28)	(2.04)	(4.30)
Number of stocks	2,396	2,396	2,396	2,396
R-squared	0.47	0.54	0.69	0.48
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

The table reports the estimates from the instrumental variable regression that takes the average value of the lagged ETF ownership indicator of other firms in the same industry in the same period, IndavgETF, as an instrumental variable for the ETF ownership. The sample is at the stock-quarter level. The controls in all columns are log of market capitalization, book-to-market ratio, turnover rate, stock price volatility, index fund ownership and active fund ownership. Finally, industry and quarterly fixed effects are added to the equation. The dependent variable and the ownership variables are standardized by subtracting the mean and dividing by the standard deviation. $\widehat{ETF}$is the fitted value of ETF Ownership from the first stage. Standard errors are double-clustered at the stock and quarter levels. t-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4. Robustness test: post-subprime crisis period (2009–2020).

	HLSpread (t)	HLSpread (t)	HLSpread (t)	ILLIQ (t)	ILLIQ (t)	ILLIQ (t)
Variables	(1)	(2)	(3)	(4)	(5)	(6)
ETF (*t*–1)	−0.039***	−0.040***	−0.036***	−0.281***	−0.249***	−0.181***
	(−13.17)	(−9.81)	(−8.72)	(−3.73)	(−2.95)	(−2.73)
LnFsize (*t*–1)	−0.001***	−0.001***	−0.001***	−0.018***	−0.014***	−0.015***
	(−13.69)	(−11.59)	(−10.61)	(−7.91)	(−7.89)	(−6.14)
BM (*t*–1)	−0.003***	−0.002***	−0.001**	−0.009**	−0.009**	−0.011***
	(−8.78)	(−5.71)	(−2.45)	(−1.89)	(−2.14)	(−2.68)
Volatility (*t*–1)	0.126***	0.157***	0.081***	−0.113*	−0.117	−0.132**
	(23.10)	(22.06)	(8.74)	(−1.64)	(−1.45)	(−1.96)
Tover (*t*–1)	−0.000***	−0.000***	−0.000***	−0.003***	−0.003***	−0.003***
	(−6.87)	(−4.83)	(−5.83)	(−3.50)	(−4.81)	(−5.43)
Index (*t*–1)		−0.011***	−0.009**		−0.067	−0.005
		(−3.12)	(−2.51)		(−1.50)	(−1.09)
Active (*t*–1)		0.028***	0.024***		0.063	0.058
		(7.86)	(6.51)		(0.88)	(0.86)
HLSpread (*t*–1)			0.163***			
			(12.41)			
HLSpread (*t*–2)			0.003			
			(0.46)			
HLSpread (*t*–3)			−0.012*			
			(−1.89)			
ILLIQ (*t*–1)						0.354***
						(3.55)
ILLIQ (*t*–2)						−0.011
						(−1.27)
ILLIQ (*t*–3)						−0.014
						(−0.99)
Constant	0.043***	0.043***	0.041***	0.290***	0.277***	0.281***
	(24.54)	(19.19)	(17.37)	(8.83)	(8.61)	(6.85)
Observations	34,870	22,774	21,688	34,870	22,774	21,688
R-squared	0.54	0.58	0.59	0.71	0.74	0.80
Number of stocks	2,996	2,659	2,561	2,996	2,659	2,561
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES

This table presents results of regressions of liquidity on lagged ETF ownership with the post-subprime crisis sample period: from 2009 to 2020. HLSpread is the High-low spread. ILLIQ is the Amihud illiquidity. The other variables are consistent with the control variables in the benchmark regression and include the log of equity market capitalization of stock i in period *t*–1, because we expect larger companies to exhibit less trading price impact; the book-to-market ratio of stock i in period *t*–1 to control for the impact of financial distress, growth opportunities; the model also controls for stock turnover rate and stock price volatility variables; in addition to the index fund ownership to exclude the effect of index effects and to control for active fund ownership. Finally, industry and quarterly fixed effects are added to the equation. We consider quarter, stock and industry fixed-effects in all these model specifications and double cluster the standard errors by quarter and stock. The t-test statistics are presented in parentheses in this table, where ***, ** and * indicate that the regression coefficients are significant at the 1%, 5% and 10% statistical levels, respectively.

5.3 Changing the sample period

After the subprime crisis, ETF market evolves rapidly. The asset size of equity ETFs in 2009 is 66.2 billion yuan, tripling from the previous year, and all of them grow significantly in asset size after 2009. Table 4 reports the regression results for the post-subprime crisis period (2009–2020) using the High-low spread and the numerator of Amihud illiquidity as explanatory variables, respectively. The 'stock market crash' in 2015 brought tremendous shocks to the Chinese stock market, initially many stocks showed a surge, and the CSI 300 index once achieved a short-term growth of 1,500 points, however, from June 2015, thousand stocks drop to the limit, the CSI 300 index from above 5,000 points quickly falling below 3,000 points, causing unprecedented stock market shocks and a shortage of market liquidity. Table 5 presents the impact of ETF ownership on

Table 5. Robustness test: post-crash period (2015–2020).

	HLSpread (t)	HLSpread (t)	HLSpread (t)	ILLIQ (t)	ILLIQ (t)	ILLIQ (t)
Variables	(1)	(2)	(3)	(4)	(5)	(6)
ETF (*t*–1)	−0.038***	−0.044***	−0.044***	−0.351***	−0.355***	−0.358***
	(−7.80)	(−7.12)	(−6.94)	(−5.70)	(−4.57)	(−4.62)
LnFsize (*t*–1)	−0.001***	−0.001***	−0.001***	−0.002***	−0.002***	−0.002***
	(−4.74)	(−4.78)	(−4.93)	(−6.61)	(−5.89)	(−5.48)
BM (*t*–1)	−0.002***	−0.001	−0.001	−0.005***	−0.004***	−0.005***
	(−3.67)	(−0.73)	(−0.86)	(−4.67)	(−3.11)	(−3.22)
Tover (*t*–1)	−0.000***	−0.000	−0.000	−0.000***	−0.000*	−0.000**
	(−2.83)	(−1.46)	(−1.40)	(−2.65)	(−1.96)	(−2.34)
Volatility (*t*–1)	0.067***	0.095***	0.078***	0.101***	0.394***	0.473***
	(6.82)	(6.68)	(4.45)	(12.99)	(18.60)	(16.20)
Index (*t*–1)		−0.007	−0.008		−0.015	−0.014
		(−1.10)	(−1.27)		(−1.40)	(−1.29)
Active (*t*–1)		0.019***	0.022***		0.050***	0.055***
		(2.62)	(2.95)		(4.74)	(5.07)
HLSpread (*t*–1)			0.035			
			(1.43)			
HLSpread (*t*–2)			−0.056***			
			(−3.73)			
HLSpread (*t*–3)			−0.037***			
			(−2.65)			
ILLIQ (*t*–1)						−0.055***
						(−4.47)
ILLIQ (*t*–2)						−0.016**
						(−2.24)
ILLIQ (*t*–3)						−0.003
						(−0.40)
Constant	0.050***	0.047***	0.048***	0.079***	0.080***	0.087***
	(16.74)	(10.78)	(10.45)	(15.64)	(11.62)	(15.22)
Observations	24,317	17,528	16,805	24317	17528	16805
R-squared	0.62	0.67	0.67	0.53	0.58	0.62
Number of stocks	2,947	2,617	2,522	2947	2617	2522
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES

This table presents results of regressions of liquidity on lagged ETF ownership with the post-crash sample period: from 2015 to 2020. HLSpread(t) is the High-low spread. The other variables are consistent with the control variables in the benchmark regression and include the log of equity market capitalization of stock i in period *t*–1, because we expect larger companies to exhibit less trading price impact; the book-to-market ratio of stock i in period *t*–1 to control for the impact of financial distress, growth opportunities; the model also controls for stock turnover rate and stock price volatility variables; a three-period lagged term for Amihud illiquidity to prevent serial autocorrelation problems; in addition to the index fund ownership to exclude the effect of index effects and to control for active fund ownership. Finally, industry and quarterly fixed effects are added to the equation. We consider quarter, stock and industry fixed-effects in all these model specifications and double cluster the standard errors by quarter and stock. The t-test statistics are presented in parentheses in this table, where ***, ** and * indicate that the regression coefficients are significant at the 1%, 5% and 10% statistical levels, respectively.

the liquidity of the underlying stocks in the post-crash period (2015–2020). The results in Tables 4 and 5 confirm that in the post-crash periods when ETF market evolves rapidly, an increase in ETF ownership significantly enhances stock liquidity.

We replace the liquidity proxy High-Low spread with Amihud illiquidity numerator and Roll effective spread in Table IA.II and Table IA.III in the Internet Appendix. We consider size and industry sector heterogeneity in Table IA.IV and Table IA.V in the Internet Appendix. The results show that the larger the market size of the stock, the larger the impact of ETF ownership on stock liquidity.

6. Mechanisms analysis

6.1. ETFs improve liquidity of constituent stocks through arbitrage channel

Since supply and demand influence the price of ETFs in the secondary market, market price of ETFs may deviate from their IOPV. When this deviation becomes large enough, investors will carry out arbitrage. Specifically, when the price in the secondary market of an ETF is less (higher) than the IOPV in the primary market of an ETF, the ETF is trading at a discount (premium). Arbitrageurs buy (sell) ETF shares in the secondary market, redeem the current ETF shares (create new ETF shares), and sell (buy) in the stock market to gain profit. Instantaneous arbitrage raises (decreases) the price of ETF, thus the price of ETF converges to its IOPV over time. Instantaneous arbitrage must go through three processes: stock trading, ETF creation/redemption in the primary market, and ETF trading in the secondary market. Thus, both the ETF creation and redemption will bring about trading on the stock side, thereby increasing the liquidity of the underlying stock. Accordingly, we formulate the following two models to test the Hypothesis 2.1:

$$\begin{aligned} Creation_{i,t} = {} & \beta_0 + \beta_1 ETF\ Ownership_{i,t-1} + \beta_2 LnFsize_{i,t-1} + \beta_3 BM_{i,t-1} + \beta_4 Volatility_{i,t-1} \\ & + \beta_5 Tover_{i,t-1} + \beta_6 Index\ Ownership_{i,t-1} + \beta_7 Active\ Ownership_{i,t-1} \\ & + \beta_8 HLSpread_{i,t-1} + \beta_9 HLSpread_{i,t-2} + \beta_{10} HLSpread_{i,t-3} \\ & + \sum_i \eta_i a_i + \sum_t \theta_t T_t + \sum_j \xi_j Ind_j + \varepsilon_{i,t} \end{aligned} \tag{5}$$

$$\begin{aligned} Redemption_{i,t} = {} & \beta_0 + \beta_1 ETF\ Ownership_{i,t-1} + \beta_2 LnFsize_{i,t-1} + \beta_3 BM_{i,t-1} + \beta_4 Volatility_{i,t-1} \\ & + \beta_5 Tover_{i,t-1} + \beta_6 Index\ Ownership_{i,t-1} + \beta_7 Active\ Ownership_{i,t-1} \\ & + \beta_8 HLSpread_{i,t-1} + \beta_9 HLSpread_{i,t-2} + \beta_{10} HLSpread_{i,t-3} \\ & + \sum_i \eta_i a_i + \sum_t \theta_t T_t + \sum_j \xi_j Ind_j + \varepsilon_{i,t} \end{aligned} \tag{6}$$

Considering data availability, the explanatory variables $Creation_{i,t}$ and $Redemption_{i,t}$ in the model denote the total number of ETF creations and redemptions of stock i in quarter t, respectively, and the indicators are calculated as follows:

$$Creation_{i,t} = \sum_{j=1}^{J} ETFOwnership_{i,j,t} \cdot creation_{j,t} \tag{7}$$

$$Redemption_{i,t} = \sum_{j=1}^{J} ETFOwnership_{i,j,t} \cdot redemption_{j,t} \tag{8}$$

where $Creation_{i,t}$ denotes total ETF creations for stock i in quarter t, $creation_{j,t}$ refers to ETF_j creations in quarter t, $Redemption_{i,t}$ denotes total ETF redemptions for stock i in quarter t, $redemption_{j,t}$ refers to ETF_j redemptions in quarter t, $ETFOwnership_{i,j,t}$ denotes the percentage of stock i held by ETF_j in quarter t, and J denotes the total of all ETFs holding stock i. We take logarithms of the values for regression.[5]

Table 6 indicates that, given other things being equal, for every 1% standard deviation increase in ETF ownership in the previous period, the expected creation in the current period increases by 79.765 and the expected redemption increases by 89.187. The larger the ETF ownership, the larger the creation/redemption volume, i.e. ETF ownership effectively enhances stock liquidity.[6]

Table 6. Mechanism analysis: ETFs influence equity liquidity through arbitrage channel.

	Creation (t)	Redemption (t)	Creation (t)	Redemption (t)
Variables	(1)	(2)	(3)	(4)
ETF (*t*–1)	79.765***	89.187***	79.677***	89.193***
	(22.19)	(26.99)	(22.16)	(26.91)
LnFsize (*t*–1)	1.598***	1.393***	1.583***	1.380***
	(14.40)	(14.51)	(14.28)	(14.37)
BM (*t*–1)	0.210	−0.140	0.337	0.031
	(0.61)	(−0.45)	(0.91)	(0.09)
Tover (*t*–1)	0.175***	0.161***	0.177***	0.161***
	(6.23)	(6.61)	(6.20)	(6.56)
Volatility (*t*–1)	−5.005	−1.200	−3.460	−1.359
	(−1.02)	(−0.28)	(−0.56)	(−0.25)
Index (*t*–1)	20.170***	11.542***	19.977***	11.378***
	(6.72)	(4.42)	(6.65)	(4.35)
Active (*t*–1)	−2.214	−1.480	−2.478	−1.900
	(−0.76)	(−0.57)	(−0.85)	(−0.73)
HLSpread (*t*–1)			−6.230	−2.277
			(−0.71)	(−0.29)
HLSpread (*t*–2)			12.613**	11.689***
			(2.50)	(2.59)
HLSpread (*t*–3)			9.430**	11.935***
			(2.04)	(2.87)
Constant	−9.789***	−7.471***	−9.951***	−7.733***
	(−5.56)	(−4.90)	(−5.59)	(−5.02)
Observations	16,077	16,077	16,077	16,077
R-squared	0.44	0.47	0.44	0.470
Number of stocks	2,494	2,494	2,494	2,494
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

The table reports the estimates of how ETF ownership increases creation and redemption. We take logarithm of the Creation and Redemption variables. The sample is at the stock-quarter level. The controls in all columns are log of market capitalization, book-to-market ratio, turnover rate, stock price volatility, high-low spread, index fund ownership and active fund ownership. Finally, industry and quarterly fixed effects are added to the equation. The dependent variable and the ownership variables are standardized by subtracting the mean and dividing by the standard deviation. Standard errors are double-clustered at the stock and quarter levels. t-statistics are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

6.2. ETFs improve constituent liquidity through the liquidity provider position management channel

Unlike most equity products in China, ETFs have liquidity providers. Since market makers of ETFs need to satisfy the requirement of maintaining a certain daily pending order volume or turnover, ETFs with market maker services have better liquidity than those without market makers. On one hand, ETF market makers increase the liquidity of ETFs, which will attract new investors to enter the market. On the other hand, to control inventory risk, when market makers buy (sell) too many ETFs, they will redeem (create) ETFs, and both creation and redemption operations will involve buying and selling transactions on the stock side, which will inevitably raise the liquidity of individual stocks.[7] We set the following two corresponding models to test:

$$\begin{aligned} Num\_LP_{i,t} = {} & \beta_0 + \beta_1 ETF\ Ownership_{i,t-1} + \beta_2 LnFsize_{i,t-1} + \beta_3 BM_{i,t-1} + \beta_4 Volatility_{i,t-1} \\ & + \beta_5 Tover_{i,t-1} + \beta_6 Index\ Ownership_{i,t-1} + \beta_7 Active\ Ownership_{i,t-1} \\ & + \beta_8 HLSpread_{i,t-1} + \beta_9 HLSpread_{i,t-2} + \beta_{10} HLSpread_{i,t-3} \\ & + \sum_i \eta_i a_i + \sum_t \theta_t T_t + \sum_j \xi_j Ind_j + \varepsilon_{i,t} \end{aligned} \tag{9}$$

where Num_LP (t) denotes the number of liquidity providers after weighting by ETF ownership.

Table 7. Mechanism analysis: ETF ownership influences stock liquidity through the liquidity service provider channel.

	Num_LP (t)	Num_LP (t)
Variables	(1)	(2)
ETF (*t*–1)	16.472***	16.331***
	(12.13)	(12.07)
LnFsize (*t*–1)	0.398***	0.395***
	(8.77)	(8.77)
BM (*t*–1)	0.384***	0.339***
	(3.23)	(2.73)
Tover (*t*–1)	0.045***	0.048***
	(3.71)	(3.96)
Volatility (*t*–1)	5.875***	9.104***
	(3.68)	(4.63)
Index (*t*–1)	−3.027***	−3.130***
	(−3.54)	(−3.62)
Active (*t*–1)	2.764***	3.088***
	(2.92)	(3.21)
HLSpread (*t*–1)		−7.076**
		(−2.49)
HLSpread (*t*–2)		−0.535
		(−0.26)
HLSpread (*t*–3)		1.934
		(1.20)
Constant	−6.263***	−6.172***
	(−8.81)	(−8.72)
Observations	16,035	16,035
R-squared	0.38	0.38
Number of stocks	2,494	2,494
Firm FE	YES	YES
Time FE	YES	YES
Industry FE	YES	YES

The regression results in Table 7 demonstrate that a rise in ETF ownership leads to an improvement in the number of market makers Num_LP (t) weighted by ETF ownership in the next period at the 1% level of significance. It is worth noting that, in terms of lagged one-period short-term liquidity and lagged individual stock market capitalization LnFsize (*t*–1), ETF market makers tend to participate in stocks that are inherently more liquid, which is consistent with the logic of our hypothesis: liquidity providers are risk averse traders and thus need to control daily positions, which in turn results in unilateral holdings of ETFs that are too large for creation (redemption) operations and buying (selling) stocks.

7. Conclusion

The success of ETFs is due in large part to the fact that these financial products provide both institutional and retail investors with inexpensive avenues to diversify positions and manage intraday liquidity. This necessitates a better comprehension of the consequences of ETF trading activity on the underlying stocks. Due to the low barrier to participation, ETFs seem to attract a new breed of high-frequency investors therefore increasing the stock liquidity, meanwhile, however, such investment vehicles have the potential to drive away investors who want to hold individual stocks, thereby reducing the liquidity of individual stocks. For this reason, the consequence remains ambiguous.

This paper contributes to the literature by investigating the impact and the underlying mechanism of increasing ETF ownership on the liquidity of underlying stocks. We employ the high-low spread measure as the dependent variable to quantify the liquidity of the stocks. Unlike other liquidity indicators, this measure not only incorporates bid-ask spread components but also

considers stock price volatility, thereby providing a more comprehensive measure of liquidity. We establish a two-way fixed-effects model and conduct OLS regression on a sample of stocks between 2005 and 2020. Our main findings indicate that an increase in ETF ownership significantly improves the liquidity of underlying stocks. Moreover, the effect of ETF ownership on stock liquidity is independent of that of the ownership by index funds and active funds.

This conclusion still holds even after several robustness tests. First, we randomly assign the values of ETF ownership to implement a placebo test. After conducting multiple regressions with the randomly assigned values, the t-values of the estimated coefficients centered around zero, indicating that the current estimated results are unlikely to be affected by other policy or random factors. Second, we use the mean ownership of other stocks in the same industry as the instrument variable and obtain consistent results with the baseline regression. Subsequently, we conduct sensitivity analyses by replacing the dependent variable with two other liquidity indicators and using different sample periods. The results showed that an increase in ETF ownership still significantly improves the liquidity of the underlying stocks.

Furthermore, we consider firm heterogeneity in terms of firm size and industry sector, respectively. We found that large-cap stocks are more significantly affected by ETF ownership in terms of liquidity, and the magnitude of the increase in liquidity is greater for underlying stocks. In addition, except for financial stocks, the liquidity of stocks in other industry sectors is significantly enhanced by the increase in ETF ownership, and the degree of impact on the liquidity of technology stocks shows the greatest variation.

Finally, we examine the mechanism through which ETF ownership improves stock liquidity: instantaneous creation/redemption arbitrage and position management by market makers. We regress the weighted total creation and redemption value of stocks on ETF ownership and find that stocks with higher ETF ownership tend to have larger creation/redemption volume. We use the number of market makers as proxies for their position management activities, and find that market makers are risk-averse traders and need to control their daily position exposure: they tend to create (redeem) ETF shares and buy (sell) stocks when they hold an excessive number of ETF shares.

Future investigation may delve deeper into the channels linking ETF ownership to intraday stock liquidity. For example, evidence on the level of potential stock traders attracted by ETFs remains to be established.

Notes

1. We use the 'market maker' and 'liquidity provider' interchangeably later in the article.
2. The current estimates regarding ETF ownership are available at Wind, and the missing data can be supplemented by CSMAR's institutional holdings data and data calculations from quarterly reports. Although ETFs are created/redeemed on a daily basis and the total number of ETFs shares outstanding changes on a daily basis, we are limited by the availability of data and use quarter-end data for our calculations. We apply the same method to construct the Index Ownership of index funds and Active Ownership of active funds.
3. The selection of control variables refers to Ben-David, Francesco, and Moussawi (2018) and Agarwal et al. (2021). We do not include time-series variables like macroeconomic policy uncertainty. In each of our models, the quarterly time fixed effect is added to the panel regression of quarterly data. For variables like macroeconomic policy uncertainty, which is only related to time, they will be absorbed by quarterly fixed effects.
4. We choose this instrumental variable because: (1) Correlation condition is satisfied. The average characteristics of other individuals in the group will affect the characteristics of individuals. (2) Exogenous condition is satisfied. The average characteristics of other individuals in the group do not directly affect the results of individuals. Although Gormley and Matsa (2014) criticized such instrumental variables, it can be seen from the author's original text that for the management research is not suitable to use this kind of instrumental variable, because the industry has a strong fixed effect on the dependent variable (productivity profit rate). The dependent variable, stock liquidity, in this paper does not have such a problem.
5. We take logarithms of the values for two reasons: first, the magnitude of creations and redemptions is too large compared to other variables, and second, to circumvent possible heteroskedasticity problems.

6. There are two reasons for the increase in the number of the creation/redemption: an increase in frequency or an increase in the amount of a single creation/redemption. In fact, a better measure of ETF arbitrage activity is the real-time difference between price and IOPV (as a signal variable for arbitrage initiation). Based on data availability, we only use the process variable: creation and redemption.
7. The exchange approves the qualification of ETF market makers and publishes the list of ETF market makers on a daily basis (Shenzhen Stock Exchange: http://fund.szse.cn/marketdata/asp/index.html, Shanghai Stock Exchange: http://etf.sse.com.cn/marketer/). Exchanges may conduct supervisory checks on the risk manage ment of market makers, and position management is the most important part of market maker risk manage ment. A more intuitive indicator to measure the market maker's position management is to calculate the number of the creation/redemption made by the market makers when the unilateral position exceeds the minimum creation/redemption unit through the market maker's position details. Based on data availability, we measure this activity using only the number of market makers.

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