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Abstract

Do digital payment technologies generate liquidity premia like cash and Treasury debt? We provide an estimate in the context of the world's largest digital payment platform, Alipay. Our empirical strategy exploits the variation in the timing of introduction of money market funds which users on this platform can hold and use for digital transactions. We find that, once a fund becomes eligible for these transactions, its size increases by 42 times on average. Through the lens of a demand system that models funds as imperfect substitutes, this size increase maps to a liquidity premium between 1.0% and 1.7% per annum.

Keywords: Digital Payment, Money Market Fund, Chinese Economy

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1 Introduction

Money facilitates trades in goods and services, and as a result earns a liquidity premium. While governments and banks traditionally fulfill the role of money provision, fintech companies start offering competing digital products. For example, in China, fintech firms create platforms that facilitate mobile payment transactions, whose volume in 2020 was over twice of China's GDP. Understanding the impact of these alternative technologies is relevant for two economic questions. First, it helps us understand the liquidity premium earned by digital payment vehicles, which could shed light on the role that inside and outside money plays in transactions. In particular, it informs the debate over the benefits and costs of central bank digital currencies, as they share many characteristics with these private-sector digital products. Second, these digital payment technologies represent a canonical service provided by fintech companies, which helps us evaluate how much value they create—a relevant policy question in regards to financial inclusion and access to financial services.

In this paper, we quantify how much liquidity value digital payment services create for households by studying Alipay, the world's largest digital payment service provider. Initially positioned as a subsidiary of the Alibaba Group to facilitate transactions on its E-commerce platform, its digital payment service became popular well beyond this platform and played a major role in China's transformation into a cashless economy.

Specifically, we study a revolutionary product that Alipay introduced in 2013. Prior to its introduction, there was a clear segmentation between balance accounts that offered transaction convenience and financial assets that offered higher returns. Alipay users had to choose between holding their money in a balance account that paid no interest but could be used for transactions, and in a digital brokerage account in which they could hold mutual funds but liquidation typically took two days. Because of such separation of functionality, Alipay users only put money in their balance accounts enough for their transactions on Alibaba's E-commerce platform.

The revolutionary product, named *Yu'ebao* in Chinese and meaning "leftover treasures",

allowed Alipay users to effectively merge their balance accounts and money market fund holdings. More precisely, Alipay users can hold a selected list of money market funds on this platform and earn returns from these funds. At the same time, Alipay users can directly use this account to make payments, instantly and free of charge. The product became a huge success soon after its launch, driving Alipay's eco-system to penetrate all aspects of life, including online purchases, bill payments, retail shopping and dining, and booking tickets. Moreover, its introduction also ignited a fast growth trajectory in China's money market fund industry. As of 2021 June, 712 million people were using this product and holding a particular money market fund called Tian-Hong, with an average holding of 1,100 RMB (roughly 170 U.S. dollar) per person.

This setting offers us a precious opportunity to study the liquidity value of a major digital payment vehicle. By comparing the returns and the sizes of the money market funds that are offered on this product to comparable funds that are not offered on this product, we can quantify how much households value the transaction convenience created by this digital product.

From the introduction of this product in 2013 until 2018, Alipay had a sole partnership with one money market fund called Tian-Hong. Conversely, this fund only sold shares on Alipay, and not on other brokerage platforms. Consistent with our hypothesis that this fund's share should enjoy a liquidity premium related to its transaction convenience, we find that this fund provided slightly lower returns and charged slightly higher management fees relative to the average money market fund. More strikingly, this single fund became very popular: in 2017Q4, it alone accounted for 35% of the aggregate market capitalization in China's retail money market fund and ETF industry. Its sheer size indicates not only a large amount of fees collected by this fund's managers, but also households' willingness to concentrate their money market portfolio on this unique product that provides transaction convenience.

While this fund provides suggestive evidence for the presence of a large liquidity pre-

mium, we cannot obtain a precise estimate of the liquidity premium because this fund's return and desirability may be influenced by confounding factors potentially unobservable to us. Fortunately, Alipay included 28 more money market funds into the list of eligible investments between 2018 and 2019. These funds were traded on other brokerage platforms before Alipay's inclusion, and they remained so afterwards. Throughout this paper, we refer to the inclusion of these money market funds into Alipay's Yu'ebao platform as the *Alipay inclusion events*. By studying the variations in these funds before and after the inclusion events, we provide a reliable estimate of the digital platform's liquidity premium.

Our analysis is organized in two steps. In the first step, we apply an event study method to exploit the variation in the timing of these funds' inclusion. We find that, one year after a fund is included by Alipay, its size increases by 3.7 in the log scale or 41.6 times in level. This dramatic increase in fund size is consistent with the giant size of the inaugural Tian-Hong fund. Moreover, we find no pre-trend before Alipay's inclusion, and we find no treatment effect on the fund's fees and returns except a small return increase in the quarter in which the fund is included, which is consistent with a flow-driven story.

We interpret this dramatic size increase at Alipay inclusion events as evidence for an increase in these funds' desirability due to the liquidity benefits provided by Alipay's digital payment platform. One plausible alternative explanation is based on an advertisement effect: Alipay is a famous company and has many users. Once it lists a new fund on its digital platform, this fund may become salient to investors. To rule out this alternative explanation, we note that Alipay also provides a separate mutual fund brokerage platform under *Ant Fortune*, a wealth management product offered by Alipay. On Alipay's app, Alipay users can access this mutual fund platform and buy funds in the same way as they access and buy funds on Yu'ebao, but fund shares held on this platform cannot be used directly for transactions. We apply a similar event study approach, and find that the money market funds included on this mutual fund platform do not experience a significant size increase. This result suggests that the mere effect of being listed on Alipay's platform and app, without

being connected to the digital payment services, is not enough to generate the increase in fund size.

Moreover, it is worth contrasting our interpretation of the size effect as liquidity premium with the traditional view of liquidity premium. For example, the liquidity premium of Treasury debt is directly measured from its value: the Treasury debt becomes more expensive when the demand for liquidity increases. The Treasury market clears by price adjustment because the quantity response in the supply of Treasury debt is often limited in the short run. In the mutual fund market, however, as Berk and Green (2004) point out, the market clears by quantity adjustment instead: when a fund becomes more desirable, due to either managerial skills as in Berk and Green (2004) or transaction convenience as in our case, we expect the fund size to grow.

In the second step, we adopt a demand system approach to map this size effect to a measure of liquidity premium. We estimate the demand elasticity between money market funds, and quantify the amount of return increase required to generate the same amount of size increase. In this demand system, the desirability of a fund depends on its expected return, its availability on Alipay's payment platform, and an unobserved latent demand. We estimate this system using instrumental variables, and find that the increase in a fund's desirability when it is included by Alipay's payment platform is comparable to an increase in the fund's expected return by 1.0% to 1.7% per annum. Since the fund's return does not change after the inclusion event, this effective return increase is our estimate of the payment vehicle's liquidity premium that households perceive to justify the increase in fund size.

To put this liquidity premium of 1.0% to 1.7% per annum into context, we note that the average nominal interest rate in our sample is 2.4% per annum, which is the forgone opportunity cost of holding fiat money. Therefore, the transaction convenience offered by Alipay's fintech network is about half of the liquidity premium of money. In the broader context, the U.S. Treasury has a convenience yield as high as 2% per annum in the most generous estimates (Jiang, Krishnamurthy and Lustig (2021); Koijen and Yogo (2020)). If

we compare these numbers literally, the liquidity premium of the private-sector payment platform, due to the transaction convenience it offers, is comparable to the convenience yield earned by the reserve asset *par excellence* in the international monetary system—the U.S. Treasury.

Lastly, based on our estimated demand system of money market funds, we compute the consumer surplus of the funds included by Alipay. We find that the convenience benefits of Alipay generated 12 billion RMB worth of consumer surplus in 2020. Divided by 712 million users on Alipay, this figure implies a consumer surplus of 17 RMB per user in 2020, or about 3 U.S. dollar. As the consumer surplus measures the difference between the price the consumer pays and the price he or she would be willing to pay rather than do without it, we interpret the 17 RMB as the liquidity value created by Alipay's digital transactions for each of its users in 2020.

Literature Review To our best knowledge, our paper is the first to quantify the liquidity premium of a digital payment vehicle. The liquidity premia of cash and near-money assets have been studied by a large literature (Krishnamurthy and Vissing-Jorgensen (2012); Greenwood, Hanson and Stein (2015); Nagel (2016)). These assets are mostly government liabilities, and they have high liquidity premia because they are safe and offer liquidity in financial markets. Our paper provides evidence that the transaction convenience arising from a private-sector digital payment vehicle also generates a very large liquidity premium. This result can shed light on the discussion of both the public and the private provision of digital payment technologies including digital currencies.

A related literature studies the private provision of liquidity, which is traditionally fulfilled by commercial banks (Diamond and Dybvig (1983)). More recently, non-bank entities such as mutual funds play an important role in providing safety and liquidity in the financial market (Sunderam (2015); Chernenko and Sunderam (2016); Moreira and Savov (2017); Cipriani and La Spada (2018); Xiao (2020); Ma, Xiao and Zeng (2020); Krishnamurthy

and Li (2021); He and Song (2022)). While our paper also studies money market funds, we uncover and quantify a new source of liquidity provision by their connection to digital transactions.

We also contribute to the literature on the value created by fintech. We focus on a novel aspect of its value creation, namely the liquidity convenience for providing a transaction vehicle. This result is complementary to an emerging literature that documents other benefits and costs that fintech platforms and digital services bring (Crouzet, Gupta and Mezzanotti (2019); Higgins (2019); Sockin and Xiong (2020); Jun, Hong and Lu (2021); Buchak, Hu and Wei (2021); Chen, Huang, Ouyang and Xiong (2021)). In this literature, the prior paper closest to ours is Jun, Hong and Lu (2020), which studies equity and bond mutual funds listed on fintech platforms. This paper shows that funds listed on fintech platforms have increased flow sensitivities to performance due to the salience of top performers.

2 Institutional Background and Data

2.1 Alipay Overview

Alipay is the largest online payment service provider in the world. It was first launched in 2004 by Ant Financial, a subsidiary of Alibaba Group, and grew at a tremendous speed since then. In 2013, it surpassed Paypal to become the largest mobile payment platform in the world with over 300 million registered users and over $150 billion transaction volume. Figure 1 plots the size of the total mobile payment transaction volumes in China since 2015. In 2020, the total transaction volume reached 252.8 trillion RMB (38.7 trillion dollar), more than doubling China's GDP (Source: Analysys International, a third-party market survey company). Out of this huge volume, Alipay's market share was 56%, or 21.5 trillion dollar. In comparison, PayPal's total transaction volume was only 0.9 trillion dollar in 2020, and Venmo's was only 0.15 trillion dollar.

Alipay was originally designed to facilitate payments between customers and sellers on

Taobao[1], the largest online shopping platform in China for about two decades and the largest one in the world for over a decade. However, Alipay quickly expanded beyond this platform and penetrated every scenario that involved mobile transactions, including paying bills, transferring money, and buying tickets. More surprisingly, Alipay's online payment app also dominated offline payments. Nowadays, Alipay is a major payment method at stores and restaurants. Even beggars and street artists use Alipay to receive money. Along with Wechat Pay, the second largest payment platform, Alipay almost entirely replaced cash, POS machines, and credit cards, transforming China into a cashless economy.

One critical innovation of Alipay that boosted its rapid growth is the introduction of Yu'ebao in late 2013, a financial product that enabled Alipay users to make payments directly from their money market investments on Alipay. Prior to the introduction of this product, Alipay users had a balance account for all transactions on Alipay. This account paid no interest and was similar to an e-checking account. Besides this liquid account, Alipay users could transfer money to a mutual fund account within Alipay and hold mutual fund shares for higher returns. However, the money put in mutual funds within Alipay could not be used directly for transactions. If a user wanted to purchase something from online vendors or transfer money to someone, she had to first liquidate her mutual fund holdings and then wait for two days before the proceeds became available. Therefore, before the introduction of Yu'ebao, Alipay users faced a trade-off between transaction convenience and portfolio returns.

Alipay's Yu'ebao enabled investors to simultaneously enjoy transaction convenience and portfolio returns. It is a transaction account on Alipay backed up by money market funds (MMFs) selected by Alipay. When a user puts money in her Yu'ebao account, she can hold one of the eligible MMFs of her choice and directly use her MMF holdings for payments[2].

[1]For readers who are not familiar with these companies, it may be useful to think about Alipay as China's Paypal, and Taobao as China's Amazon. Ant Financial is Alipay's holding company and Alibaba is Taobao's holding company, just as PayPal Holdings Inc. owns PayPal. However, there is an important difference: Ant Financial is an affiliate company of the Alibaba Group which also owns Taobao, whereas Amazon does not own Paypal.

[2]The exact mechanism works as following: when she makes a transaction with a merchant or another

Since the user also receives returns from the money market fund, Yu'ebao is dominant over the normal balance account on Alipay and becomes Alipay users' preferred choice. Since its inception in June 2013, the size of the Tian-Hong fund, the inaugural MMF partner of Yu'ebao, has skyrocketed. By the second quarter of 2014, the Tian-Hong fund had a size of 574 billion RMB, occupying over one-third of the entire MMF market in China.

Moreover, Yu'ebao does not charge any management fees on top of the regular management fees that money market funds charge. Nor does Yu'ebao charge any transaction fees from merchants or users, which is very different from the business model of credit cards. Yu'ebao users can also cash out their money directly back to their bank accounts free of charge if the money they put into Yu'ebao originally comes from the same bank accounts. However, more generally, starting from 2016 there is a flat fee of 0.1% after an exempt amount of 20,000 RMB if users cash out money to other bank accounts or the money comes from transactions.

It is worth noting that Alipay also offers a separate mutual fund platform operated under Ant Fortune which also hosts money market mutual funds[3]. The procedure to buy money market funds on this platform is the same as the procedure on Yu'ebao, and the Alipay app offers access to both platforms. The critical difference between these two platforms is that the funds purchased on Yu'ebao can be used directly for payments and transactions, while the funds on Ant Fortune cannot. On Ant Fortune's platform, the usual rule is T+2, meaning the investor needs to wait for two business days to receive the money after making the withdrawal request. Currently, this mutual fund platform grants access to 87 money market funds, which do not overlap with the money market funds on Yu'ebao.

Throughout this paper, when we refer to an *Alipay inclusion event* of a money market fund, we mean that this money market fund becomes available on Yu'ebao so that investors can use the fund shares directly for payments. When a fund is included on the Ant Fortune's

individual, Alipay relocates her MMF shares to the counterparty without liquidating the MMF holding.

[3]Although Yu'ebao is officially a product of Ant Fortune, it operates independently from Ant Fortune's mutual fund platform. Practically, Yu'ebao and Ant Fortune's mutual fund platform are two different products, but they are both accessible on Alipay's app.

mutual fund platform, we refer the event as *Ant mutual fund platform inclusion event*.

2.2 China's MMF Industry and Alipay Inclusion Events

China's money market fund industry was rather small before the introduction of Yu'ebao, but grew very fast later. Figure 2 illustrates the development of China MMF market. In 2013Q1, the total size of the retail MMF market was merely a quarter trillion RMB. After the introduction of Yu'ebao in late 2013, in 2014Q1 the total MMF size quadrupled relative to the previous year (1085 vs. 228 billion RMB), out of which half is the Tian-Hong fund (541 billion RMB), the sole partner of Yu'ebao at that time. Afterwards, the entire MMF market kicked off a rapidly growing trend.

Prior to Yu'ebao, there was not so much interest in the MMF industry among the public since its return was not much higher than bank deposits, and a bank account was more convenient for transaction purposes than a brokerage account. The returns on MMFs were also generally much lower than banks' wealth management products[4], which are the most popular choice for relatively risk-averse households. The launch of Yu'ebao completely changed the general perception and made MMFs on this platform more convenient than bank accounts, attracting a huge inflow of money from households.

Since its inception in late 2013, Yu'ebao had only one MMF partner, the Tian-Hong fund. All money that Alipay users stored in Yu'ebao accounts went to the Tian-Hong fund, and the Tian-Hong fund did not have alternative funding source other than Yu'ebao. In fact, the terms Yu'ebao and the Tian-Hong fund were used interchangeably. The exclusive partnership lasted until 2018 when the regulators became concerned that the Tian-Hong fund became too big and posed a potential threat to the stability of the financial system. In response to the regulators' concern, Alipay included *third-party* MMF partners in Yu'ebao to offer more options to its users. Consequently, 14 funds were included in 2018, and 14 more

[4]These wealth management products are essentially shadow banking deposits. They generally have a maturity of 30 days to 1 year. Longer maturity gives higher yields. They are not insured in the way bank deposits are, but they receive implicit guarantee from banks. Historically, almost no wealth management products have defaulted. See Acharya, Qian, Su and Yang (2021).

were included in 2019, and none after. These 28 funds were not directly related to Alipay or the Alibaba Group, and, unlike the Tian-Hong fund, these funds were also sold on many traditional brokerage platforms.

2.3 MMF Data

Our MMF data are from WIND Data Service. We exclude fund-quarter observations with missing size, missing return, funds whose purchase status is "closed", and wholesale share classes since the retail investors do not have access. We also exclude a fund's first observation if it was established in the middle of a quarter, because the return did not span the entire quarter. Our sample period is 2013Q1 to 2021Q2, covering the entire MMF market with a total of 438 share classes of 330 money market mutual funds classified by the China Security Regulation Commission.

Our data include the net-of-fee returns to investors and the fees charged by the MMF managers. A fund manager typically charges three types of annual fees: management fee, sales and service fee, and custodian fee. These fees are the only sources of revenue for these MMF managements, and we define their sum as the total fees. The rates of these fees are set at the inauguration of the fund and rarely change. In our panel, fee changes only occur in 1% of the observations; roughly speaking, an average fund only changes its fee every 100 quarters. Any change must be officially approved and then publicized in an official statement on all major media platforms.

Table 1 reports the summary statistics of China's MMF market. Table A1 provides variable definitions. On average, a fund grows by about 7.7% per quarter in the log scale. The average annualized return is 2.0% and the average annualized excess return over overnight SHIBOR (Shanghai Interbank Offered Rate) is -0.2%. These MMFs on average underperform relative to the risk-free benchmark since their investors are mostly retail and do not have access to wholesale rates.

There are also significant variations in the portfolio choices of the funds. The share of

bank deposit holdings is 35% on average with a relatively large standard deviation. As bank deposits offer a high degree of safety and liquidity and low returns, this pattern suggests that MMFs greatly value safety and liquidity, but the extent differs across all money market funds. For the other assets, financial debt takes the largest portion with an average share of 35%, followed by repo with an average share of 21%. MMFs in China hold much less government debt. The average asset maturity is about 73 days, with the 90th percentile at 108 days.

On the liability side, these MMFs are held by various investors. Management ownership is tiny, and, since we exclude wholesale share classes, the institutional ownership of these retail funds is about 30% on average. These funds also finance a small portion (on average 5%) of their asset under management from the repo market.

2.4 Our Exercise

Having described the institutional setting and the data, we next describe our approach. Our overarching hypothesis is that households value the convenience of being able to make payments directly from their MMF holdings on Alipay's Yu'ebao platform. As a result, the MMFs included by Alipay earn a liquidity premium. To provide some stylized evidence, we first study the Tian-Hong fund that was offered by Alipay from the beginning. Figure 3 plots its annualized after-fee return and management fee. For comparison, the figure also plots the value-weighted average return and management fee in our entire MMF sample. We observe that the Tian-Hong fund on average offers a lower after-fee return by about 10 bps per annum and a higher management fee by about 3.6 bps per annum relative to the sample average.

This naive estimate of the liquidity premium is subject to two concerns. First, because the Tian-Hong fund is listed on Alipay since its inception, we cannot identify its liquidity premium without controlling for unobserved fund characteristics. For example, it may hold assets with different risk profiles relative to the average fund and as a result have a different

expected return. It is also possible that this fund's higher management fee is driven by its ability to generate a higher alpha.

Second, the liquidity premium may manifest itself not only in the return/fee dimension but also in the quantity dimension. As Berk and Green (2004) point out, with competitive provision of capital by investors to mutual funds, managerial ability is compensated by attracting higher flows to the funds and therefore earning more management fees. While we focus on the transaction convenience of the fund shares on Alipay platform instead of managerial ability, the premium for this fund characteristics can also manifest itself as investors' willingness to concentrate their holdings in this fund. As the Tian-Hong fund on average accounts for 30% of the total market size in our sample, it is possible the difference in return or fee only captures a small fraction of its liquidity premium.

Figure 4 provides a graphical illustration of this point. We assume that the demand for each MMF is downward sloping. The inclusion of a fund by Alipay raises the fund's liquidity benefit, leading to a parallel demand shift from D_0 to D. Panel (a) depicts our intuition about this demand shift in a market with fixed supply, which can for example be applied to the Treasury bond market. When there is a demand shift but the supply is fixed in the short run, the market clears at the same quantity and a higher premium for each unit of the asset. In comparison, Panel (b) depicts our intuition about the MMF market. The funds in this market have flexible supply, while they face high costs to adjust management fees. As a result, when there is a demand shift, the market clears at the same premium and a higher quantity. In other words, the increase in the fund size reflects the demand shift due to the transaction convenience offered by the fund shares, which is the liquidity premium that we want to capture.

Motivated by this discussion, we turn to the staggered introduction of MMFs by Alipay in 2018—2019 to provide a precise estimate of the liquidity premium. Our estimation involves two steps. First, we use an event study approach to isolate the effect of Alipay inclusion on fund size. This corresponds to quantifying the movement from point A to point C in

Figure 4(b). Second, we adopt a demand system approach to estimate investors' demand elasticity with respect to fund returns. Using the estimated demand curve, we compute how much higher return a fund has to offer in order to gain the same size increase as the increase resulting from Alipay inclusion. We interpret this amount of return increase as our estimate of the liquidity premium.

3 Effect of Alipay Inclusion on Fund Size

3.1 Method and Main Result

First, we apply a standard event study method to estimate the effect of Alipay inclusion on the fund size. We consider a panel of money market funds (MMFs) indexed by $i \in \{1, \ldots, N\}$, whose outcome variables are observed for quarters indexed by $t \in \{1, \ldots, T\}$ or a subset thereof. Our treatment is the inclusion of a MMF by Alipay's Yu'ebao platform in its list of eligible investments. A MMF can be treated at most once, and there is a large number of MMFs that never receive this treatment. If MMF i is treated, let E_i denote the event quarter and let $K_{i,t} = t - E_i$ denote the relative time, i.e., the number of quarters between time t and the event quarter. By construction, $K_{i,t} = 0$ in the event quarter.

Let $Q_{i,t}$ denote the size of MMF i at time t. Our regression equation is

$$\log Q_{i,t} = \alpha_i + \beta_t + \gamma_{-4} 1_{\{K_{i,t} \leq -4\}} + \sum_{k=-3,-2,0,1,2,3} \gamma_k 1_{\{K_{i,t}=k\}} + \gamma_4 1_{\{K_{i,t} \geq 4\}} + X_{i,t}\delta + \varepsilon_{i,t}. \quad (1)$$

We include the dummies for relative event-time $K_{i,t} \in \{-3, -2, 0, 1, 2, 3\}$ (in quarters) but leave out the dummy for $K_{i,t} = -1$ to obtain the relative effects. We also include the dummies for $K_{i,t} \leq -4$ and $K_{i,t} \geq 4$ to capture the longer-run pre-trend and effect. we include a vector of control variables $X_{i,t}$, as well as fixed effects for fund (α_i) and time (β_t) to capture the time-invariant heterogeneity across funds and the overall time trend.

In our benchmark specification, the control variables include each fund's asset allocation

into the six major asset categories: deposits, repo, corporate debt, financial debt, government debt, and other assets. These characteristics are available for the majority of the funds. We report the regression result in Table 2, Column (1), and plot the γ coefficients in Figure 5(a). In the figure, we cluster the standard errors at fund level and report the two-standard-error bands.

This figure reports our estimate of the average treatment effect. In the event quarter in which a fund is introduced to Alipay's list of eligible investments, its size goes up by about 2.1 in the log scale or $\exp(2.1) = 7.8$ times in level. Over the next four quarters, the fund size continues to expand, and our estimate of the long-run expansion is 3.7 in the log scale or $\exp(3.7) = 41.6$ times in level. These effects are economically large, as these funds were not tiny before they were included by Alipay. Their average size in the quarter before inclusion is 5 billion RMB, or roughly 0.77 billion dollar at the 2020/12/31 exchange rate.

We also note that the coefficient estimates for the pre-trend dummies for $K_{i,t} \leq -2$ are very close to zero and statistically insignificant, which suggests that the MMFs included by Alipay do not have noticeable difference in their growth trajectory prior to inclusion. This result alleviates the concern that Alipay's selection of funds or timing of inclusion is driven by the fund's past growth.

In an alternative specification, we consider additional control variables, including (1) the average maturity of the assets held by the MMF, (2) the ratio between funding raised from the repo market and the fund's total size, which is a measure of the fund's leverage, (3) the share of funds owned by the management team, and (4) the share of funds owned by institutional investors. We report this result in Table A2, Column (1). We lose about 25% of the observations after including these controls, but we obtain very similar point estimates for the effects of fund inclusion by Alipay.

We also apply this event study method to estimate the effect of Alipay inclusion on the

funds' net returns and fees. Our regression is

$$R_{i,t} \text{ or } fee_{i,t} = \alpha_i + \beta_t + \gamma_{-4} 1_{\{K_{i,t} \leq -4\}} + \sum_{k=-3,-2,0,1,2,3} \gamma_k 1_{\{K_{i,t}=k\}} + \gamma_4 1_{\{K_{i,t} \geq 4\}} + X_{i,t}\delta + \varepsilon_{i,t}, \quad (2)$$

where the net returns and fees are annualized and in percentage points. We illustrate the regression coefficients in Figure 5(b) and (c), and we report the detailed results in Table 2 and with additional controls in Appendix Table A2. Different from the effect on log fund size, the inclusion by Alipay has no effect on the fund returns and fees for periods $t \geq 1$ after the inclusion. The only exception is the response at the event quarter $t = 0$, which suggests a small increase in the quarterly return of $0.1\%/4 \approx 0.025\%$. The sign of this small effect is consistent with the mechanical flow-driven performance common in the mutual fund industry (Coval and Stafford (2007); Frazzini and Lamont (2008); Lou (2012)): as investments flow into a certain fund, it purchases more of the assets on its current portfolio, driving a concurrent increase in the returns of these assets. Moreover, we find no pre-trend in the fund returns and fees prior to inclusion by Alipay.

These results further support our assumption that the funds that are included by Alipay do not demonstrate strong growth or strong returns prior to inclusion. In addition, funds do not adjust their management fees around the Alipay inclusion events. Given that fund quantity is free to adjust while the adjustment in management fee is very sluggish, the situation illustrated by Figure 4(b) is a better description of our setting: we expect most of the liquidity premium to manifest itself in size rather than in fund return or fee.

3.2 Testing Alternative Mechanism: Advertisement Effect

A potentially competing mechanism that explains the size increase after the Alipay inclusion event is an advertisement effect brought by Alipay. Alipay is a giant platform with over 700 million users. When a fund becomes available on its app, the advertisement effect alone could lead to a dramatic increase in the fund's investor base, without requiring the investors

to value Alipay's liquidity benefits.

To test this alternative mechanism, we study the inclusion events of MMFs on Ant Fortune's mutual fund platform, which cannot be used directly for transactions. As explained in Section 2.1, funds listed on this platform are also accessible via Alipay app. In fact, it is very convenient for Alipay users to transfer money instantly from Yu'ebao to the mutual fund platform, and vice versa (with a one-day delay). If our result is driven by the advertisement effect from the wide usage of Alipay, we should observe a similar level of size increase when a fund joins Ant Fortune's mutual fund platform. If it is driven by the liquidity effect, then, we should expect the inclusion of funds by Ant Fortune to have much smaller size effects.

We repeat regressions Eq. (1) and (2) using the funds on the mutual fund platform and their inclusion events. Figure 6 reports the results. We find very weak evidence for this alternative advertisement channel: when a money market fund is included on Ant Fortune's mutual fund brokerage platform, it experiences a much smaller size increase and the effect becomes statistically insignificant after four quarters. The effects of these inclusion events on the fund's return and fee are also very close to zero.

Is it possible the difference in outcomes driven by the difference in the characteristics of the funds prior to the inclusion events? For example, one possibility is that Alipay's Yu'ebao tends to include funds with higher returns while Ant Fortune tends to include funds with lower returns, and the advertisement effect is stronger for the former funds. To test the ex-ante difference in money market funds before the inclusion events, we pool the quarter-fund observations of funds included by Yu'ebao and Ant Fortune within 1 year prior to the inclusion events together, and run a univariate regression for each fund characteristic on the dummy representing the inclusion events by Alipay's Yu'ebao. Then, the intercept captures the average characteristic of the funds included by the Ant Fortune mutual fund platform, and the slope coefficient captures the average difference between Alipay funds and Ant Fortune funds. Table 3 reports the regression results. We find no significant ex-ante difference in fund sizes and fund excess returns between these two sets of funds, while fund

management fees are different by small margin of 0.05%. Most of the other characteristics do not have significant difference, either. Therefore, these results allow us to rule out this alternative mechanism.

3.3 Robustness

Callaway and Sant'Anna (2020); De Chaisemartin and d'Haultfoeuille (2020); Goodman-Bacon (2021) highlight some issues with two-way fixed effects estimators in the simple form $y_{i,t} = \alpha_i + \beta_t + \gamma 1_{\{K_{i,t} \geq 0\}} + \varepsilon_{i,t}$. First, a negative weighting problem arises if the treatment effects vary over time. Our baseline results address this issue by following Goodman-Bacon (2021); Borusyak and Jaravel (2017) and estimating a more flexible specification with time-varying coefficient γ_k. We also extend the event-time dummies to include $K_{i,t} \in \{-3, -2, 0, 1, 2, 3, \ldots, 7\}$ and $K_{i,t} \geq 8$ and obtain similar results.

Moreover, the treatment effects may also vary across funds. To examine the heterogeneity in the effects across groups of funds that receive treatment at different times, we repeat our Eq. (1) but only include the funds that received treatment in one given quarter and all non-treated funds at a time. We report the results in Table A5. Across these subsamples, the regression coefficient γ_4 for the long-term effect on fund size ranges from 1.8 to 4.8, which are in line with our baseline estimate of 3.7.

4 Translating Size Increase to Liquidity Premium

In this section, we bring more structure to quantify the liquidity premium from the effect we identify from event studies. Specifically, we propose and estimate a logit demand system to capture the product competition between MMFs. We use this structure to trace out a downward-sloping demand curve for each MMF, which allows us to translate the effect on fund size to an equivalent premium that investors associate with Alipay inclusion. A growing recent literature uses this class of models in asset pricing settings, and in particular

to quantify demand for reserve assets (Koijen and Yogo (2019, 2020); Jiang, Richmond and Zhang (2020); Koijen, Richmond and Yogo (2020); Diamond, Jiang and Ma (2021)). Our model estimate implies a relatively elastic substitution pattern across money market funds, and an economically large liquidity premium assigned to funds that can be used for digital payments on Alipay.

4.1 Demand System Specification

There is only one market in which MMFs compete for investors. The investors have a total supply of funds F_t at time t, and they allocate these funds across the MMFs available. We index the MMFs by i. An observed quantity $Q_{i,t}$ is invested in MMF i at the end of period t. There is a unit measure of investors whose preference follow a standard logit demand system (Berry, 1994). Investor m investing in fund i has the following utility

$$u_{m,i,t} = \alpha\mu^e_{i,t} + X_{i,t}\beta + \delta_{i,t} + \varepsilon_{m,i,t}. \tag{3}$$

The first term is the expected excess return $\mu^e_{i,t}$ offered by fund i net of fees, which we assume is the most salient factor investors use when evaluating their utility of buying a particular fund. As Liao, Wang, Xiang, Yan and Yang (2021) document, returns or interest rates usually appear at the most prominent place on the screen when investors browse through the funds on an app. We expect a positive coefficient α since, all else equal, investors should prefer MMFs that provide higher expected returns.

The desirability of MMF i also depends on a vector of its observed characteristics, $X_{i,t}$. Moreover, investors also have latent demand for fund i based on its unobserved characteristics, $\delta_{i,t}$, and the investors' personal preference $\varepsilon_{m,i,t}$. We assume that the last term $\varepsilon_{m,i,t}$ is i.i.d. and follows a standard logit distribution with a cumulative distribution function $\Phi(\varepsilon) = \exp(-\exp(-\varepsilon))$. Investor m chooses to invest in fund i if $u_{m,i,t} \geq u_{m,j,t}\ \forall j$.

Moreover, we use 0 to denote an outside option, which is demand deposit in our setting.

We normalize the utility of the outside option to $u_{m,0,t} = 0$. Thus, we can aggregate across all households and derive the quantity of funds invested in MMF i to be

$$Q_{i,t} = F_t \frac{\exp(\alpha\mu^e_{i,t} + X_{i,t}\beta + \delta_{i,t})}{1 + \sum_{j>0} \exp(\alpha\mu^e_{j,t} + X_{j,t}\beta + \delta_{j,t})}, \tag{4}$$

where F_t is the aggregate size of the market.

Since the denominator is common across all funds i, this demand system implies a linear relationship between the log fund size and the fund characteristics. We introduce a time fixed effect to control for the common variation in the denominator in Eq. (4). Our fund characteristics $X_{i,t}$ includes a fund fixed effect and a time-varying variable indicating whether the fund is included by Alipay. Then, we arrive at the following specification:

$$\log Q_{i,t} = \kappa_t + \alpha\mu^e_{i,t} + X_{i,t}\beta + \delta_{i,t}. \tag{5}$$

4.2 Instruments and Estimation Results

Our goal is to estimate the price disutility parameter α in this equation. A standard concern in this setting is that the fund expected return $\mu^e_{i,t}$ is endogenous and responds to the latent demand $\delta_{i,t}$. For example, if we are studying equity mutual funds, a positive shift in demand for a certain type of funds can lower their expected returns while raising their market shares by increasing their latent demand.

In comparison, the money market funds that we study hold much safer assets whose returns, unlike typical equity returns, are highly persistent and predictable. As a result, we use each fund's excess return $R^e_{i,t}$ in period t as a proxy for its expected return $\mu^e_{i,t}$. Moreover, to address the endogeneity concern related to concurrent demand shocks, we use the fund's lag excess returns as an instrumental variable for the current period's excess return. That

is, we estimate the model using the following 2SLS (two-stage least squares):

$$R^e_{i,t} = \zeta_t + \gamma R^e_{i,t-j} + X_{i,t}\rho + \delta_{i,t}, \tag{6}$$

$$\log Q_{i,t} = \kappa_t + \alpha \hat{R}^e_{i,t} + X_{i,t}\beta + \delta_{i,t}. \tag{7}$$

We consider two versions of the lag excess return $R^e_{i,t-j}$ as instrument. First, we use the lag excess return in the previous period $t-1$. Second, we use the average lag excess return in the previous 4 periods (i.e., in the preceding year).

We report the first stage results in Table 4, Panel (a). First, to validate our instrument, we report the first-stage results in Panel (a). Consistent with our claim that money market fund returns are persistent and predictable, both instruments are strongly correlated with the concurrent excess return. The high R^2 above 80% in the first stage suggests that the money market funds' excess returns do not have large unexpected variations beyond the common movements captured by the time fixed effects. This feature is consistent with our understanding that these MMFs largely hold safe assets that have small return volatilities.

We report our main results with OLS and 2SLS in Table 4, Panel (b). In Column (1), we report the OLS result. The point estimate is around 1.1, suggesting that a 1% increase in the excess return expands the fund size by 1.1 in the log scale. Consistent with the results in our previous event study, we also find that the inclusion by Alipay raises the fund's log size by about 3. In Column (2), we use the lag excess return in quarter $t-1$ as an instrument for the excess return in quarter t. The point estimate doubles to 2.3. In Column (3), we repeat the 2SLS but use the average lag excess return in quarters $t-4$ to $t-1$ as an instrument for the excess return in quarter t. The point estimate rises further to 3.7. These estimates suggest that the investors' demand for money market funds are quite elastic.

4.3 Robustness

For robustness, we consider a different specification by exploiting variations in fund expected returns due to fee differences. We regress the log fund size on the fee, the time fixed effects, and the dummy indicating whether the fund is included by Alipay:

$$\log Q_{i,t} = \kappa_t + \alpha \cdot fee_{i,t} + X_{i,t}\beta + \delta_{i,t}. \quad (8)$$

As we discussed in Section 2.3, fee changes only occur in 1% of the observations, and the fees of the funds included by Alipay were determined long before the inclusion events. Accordingly, we do not include the fund fixed effects because they absorb the majority of the variation in fund fees. In this specification, we estimate the α coefficient based on cross-fund differences, whereas in the baseline specification, by controlling for fund fixed effects, we exploit the time-series variation within each fund.

We report the result in Appendix Table A6, Column (1). The coefficient estimate suggests that a 1% increase in fund fee lowers fund size by -3.0 in the log scale. As a 1% higher fee is a 1% lower expected excess return, this result is consistent with the results from our baseline specification, which suggest that a 1% increase in expected excess return increases fund size by 2.3 to 3.7 in the log scale.

Moreover, in Appendix Table A6, Column (2), we use the fund fee lagged by one quarter as the explanatory variable, to further address the concern that the fees/returns are correlated with the contemporaneous latent demand term $\delta_{i,t}$. We obtain very similar estimates.

4.4 Quantifying the Liquidity Premium

First, let us consider a very simple back-of-envelope calculation. Our 2SLS results suggest that a 1% increase in the excess return expands the fund size by 2.3 to 3.7 in the log scale. Given our previous estimate that the fund inclusion by Alipay raises the fund size by 3.7 in the log scale, this fund inclusion effectively increases the fund's liquidity premium by 1.0%

to 1.7% per annum. Given that these MMFs hold relatively safer assets and their value-weighted fund return is only 2.0% per annum, our estimate of the liquidity premium is very large.

In addition, we can assign a dollar value to the liquidity premium that investors derive from the convenience benefits of Alipay MMFs. We derive this dollar value from the standard *consumer surplus* based on the estimated demand curve. In Figure 4(b), this consumer surplus is captured by the area enclosed by the downward-sloping demand curve, the horizontal supply curve, and the y-axis at $Q = 0$. This measure captures the investors' valuation of the fund shares over their market prices.

When a fund is included by Alipay, its demand function shifts outward and leads to an increase in the consumer surplus. We interpret this increase as the liquidity value that the Alipay inclusion event creates for the investors. Graphically, in Figure 4(b), this increase in consumer surplus corresponds to the area highlighted in light blue, which is the difference between the consumer surpluses from two demand curves D_0 and D. The demand curve D is the actual demand curve from our estimation, and the demand curve D_0 comes from a counterfactual scenario in which all Alipay funds do not provide additional liquidity benefits. In this counterfactual scenario, we consider a parallel shift in the demand curve by setting the coefficient β^{Alipay} in Eq. (7) associated with the characteristics of being included by Alipay to 0, and calculate the new equilibrium prices and quantities.

Formally, for a demand curve given by Eq. (4), the consumer surplus for fund i can be expressed as

$$S_{i,t} = \int_0^{Q_{i,t}} \frac{1}{4}(\mu^e_{i,t} - \mu^e(q))dq, \tag{9}$$

where $Q_{i,t}$ and $\mu^e_{i,t}$ are the actual size and expected excess return of fund i. Since expected returns are annualized in our sample, we divide the product by 4 to obtain quarterly surpluses. $\mu^e(q)$ is the hypothetical expected excess return corresponding to fund size q, which

comes from the inverse demand function that satisfies:

$$q = F_t \frac{\exp(\alpha\mu^e(q) + X_{i,t}\beta + \delta_{i,t})}{1 + \exp(\alpha\mu^e(q) + X_{i,t}\beta + \delta_{i,t}) + \sum_{j\neq i}\exp(\alpha\mu^e_{j,t} + X_{j,t}\beta + \delta_{j,t})}.$$

The sum of the increases in consumer surpluses from all Alipay funds after their inclusion is given by

$$\Delta S_t^{Alipay} = \sum_{i\in Alipay_t} S_{i,t} - S^0_{i,t},$$

where $Alipay_t$ is the set of money market funds included by Alipay at time t, $S_{i,t}$ is the fund's actual consumer surplus, and $S^0_{i,t}$ is the fund's counterfactual consumer surplus when we assume that being included by Alipay does not increase the fund's desirability (i.e., $\beta^{Alipay} = 0$).

To implement this estimation, we use the aggregate size of demand deposits in China as the size of the outside option. This outside option is quite large. In 2021Q2, the size of demand deposits is about 55 tillion RMB, whereas the size of retail money market funds is only 6.6 trillion RMB.

Figure 7 reports the results. When investors do not value the transaction convenience offered by Alipay funds, the size of Alipay funds and their consumer surpluses both shrink dramatically. This result implies that investors do not have strong demand for these funds if they do not offer liquidity benefits. Moreover, the decline in the size of Alipay funds does not lead to a significant increase in other money market funds that are not included by Alipay—The main substitution effect is between Alipay funds and the outside option (i.e., the deposits)[5]. Lastly, the aggregate consumer surplus of Alipay funds is about 2 to 3 billion RMB per quarter in 2020, which is roughly 0.3 to 0.5 billion dollar. This quantity again speaks to the significant magnitude of the liquidity premium associated with Alipay's

[5]Buchak, Hu and Wei (2021) document this substitution from deposits to Alipay money market funds in greater detail using more granular data.

transaction convenience.

5 Conclusion

In this paper, we develop a two-step approach to estimate the liquidity premium of the digital payment vehicle offered by the world's largest provider of digital payment services. Our estimate of the liquidity premium is between 1.0% and 1.7% per annum, implying that households derive large liquidity value from the convenience of this digital payment platform. Our estimate sheds light on the potential convenience yield that can be earned by other digital currencies or digital payment alternatives.

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Tables

Panel (a) Summary of Panel Data						
	Mean	Std Dev	10 Pct	50 Pct	90 Pct	Skew
Basic Info						
Fund Size (billion RMB)	11.81	62.41	0.01	0.55	21.59	16.57
Quarterly Log Growth (%)	7.67	89.83	-47.96	-0.97	68.97	2.19
Annualized Return (%)	2.02	0.64	1.32	1.84	2.88	0.53
Annualized Excess Return (%)	-0.20	0.48	-0.67	-0.24	0.30	0.96
Annual Management Fee (%)	0.56	0.13	0.37	0.60	0.68	-1.08
Asset Composition						
Deposit Share (%)	34.67	20.82	5.94	34.08	62.19	0.27
Repo Share (%)	21.37	13.86	2.80	21.32	38.33	0.44
Corporate Debt Share (%)	11.92	13.92	0.00	7.17	32.31	1.71
Financial Debt Share (%)	35.25	19.91	8.22	34.93	61.47	0.39
Government Debt Share (%)	1.19	3.14	0.00	0.00	3.73	11.40
Other Asset Share (%)	1.83	3.31	0.27	0.81	4.23	7.35
Other Fund Characteristics						
Asset Maturity (Days)	73.13	26.35	39.00	74.00	108.00	0.00
Repo Financing (%)	5.03	4.00	0.64	4.06	11.04	0.88
Management Ownership (%)	1.26	7.21	0.00	0.04	1.51	10.23
Institutional Ownership (%)	30.32	34.82	0.59	12.41	96.29	0.98
Panel (b) Summary of Time Series Data						
	Mean	Std Dev	Min	50 Pct	Max	Skew
Total Fund Size (billion RMB)	3483.76	2150.65	162.78	2985.70	6652.90	-0.04
Alipay Fund Size (billion RMB)	1339.05	880.40	0.00	1285.72	2726.75	0.10
Total Fund Count	295.03	134.38	60.00	350.50	432.00	-0.49
Alipay Fund Count	9.71	12.30	0.00	1.00	29.00	0.75
VW All Fund Return (%)	2.26	0.67	1.16	2.28	3.69	0.26
VW Alipay Fund Return (%)	2.17	0.72	1.07	2.08	3.76	0.39

Table 1: Summary Statistics of Fund Characteristics

Notes: We report the summary statistics for the quarter-fund observations in our sample. The sample period is 2012Q1 to 2021Q2. Please refer to Table A1 for variable definitions. Alipay Fund includes quarter-fund observations after the fund gets included into Alipay's Yu'ebao platform. The asset composition shares are computed as fractions of the fund's net asset value so they may add up over 100%.

Dep. Variable	(1) Log Size	(2) Fund Return	(3) Fund Fee
$t \leq -4$	0.401	0.019	0.005
	(0.256)	(0.031)	(0.004)
$t = -3$	0.136	-0.019	0.00005
	(0.129)	(0.037)	(0.0004)
$t = -2$	0.084	-0.049	-0.0002
	(0.081)	(0.042)	(0.0003)
$t = 0$	2.055^{***}	0.098^{***}	-0.004
	(0.334)	(0.033)	(0.005)
$t = 1$	2.815^{***}	0.035	-0.004
	(0.353)	(0.033)	(0.005)
$t = 2$	3.028^{***}	0.039	-0.008
	(0.350)	(0.035)	(0.006)
$t = 3$	3.205^{***}	0.044	-0.007
	(0.348)	(0.037)	(0.006)
$t \geq 4$	3.728^{***}	0.054	0.001
	(0.353)	(0.036)	(0.005)
Deposit Share	1.540^{***}	0.373^{***}	0.007
	(0.451)	(0.057)	(0.007)
Repo Share	1.197^{**}	0.314^{***}	0.011
	(0.521)	(0.063)	(0.007)
Corporate Debt Share	1.437^{***}	0.732^{***}	0.002
	(0.523)	(0.070)	(0.006)
Financial Debt Share	1.260^{***}	0.356^{***}	-0.0001
	(0.470)	(0.057)	(0.007)
Government Debt Share	-2.000^{**}	-0.397^{***}	0.032^{**}
	(0.801)	(0.140)	(0.015)
Other Asset Share	2.384^{***}	0.389^{***}	0.007
	(0.728)	(0.109)	(0.009)
Observations	10,031	10,031	9,803
Adjusted R^2	0.808	0.887	0.962

Table 2: Event Study Estimate

Notes: We report the results of the event study regressions Eq. (1) and Eq. (2). We control for time and fund fixed effects, and cluster the standard errors at fund level. Sample is quarterly, 2012Q1—2021Q2. *p<0.1, **p<0.05, ***p<0.01.

	N	Intercept	Slope
Fund Size (billion RMB)	316	3.173**	1.99
		(1.507)	(2.477)
Quarterly Log Growth (%)	316	6.767	-8.25
		(4.694)	(5.988)
Annualized Return (%)	316	2.158***	0.165
		(0.069)	(0.105)
Annualized Excess Return (%)	316	-0.202***	0.013
		(0.043)	(0.071)
Annual Management Fee (%)	312	0.589***	0.053***
		(0.014)	(0.018)
Deposit Share (%)	316	33.616***	-2.57
		(2.943)	(3.814)
Repo Share (%)	316	21.585***	-3.329
		(1.428)	(2.162)
Corporate Debt Share (%)	316	8.012***	1.009
		(1.294)	(1.825)
Financial Debt Share (%)	316	39.772***	7.805**
		(2.4)	(3.544)
Government Debt Share (%)	316	1.654***	-0.257
		(0.496)	(0.641)
Other Asset Share (%)	316	1.897***	-0.054
		(0.396)	(0.498)
Asset Maturity (Days)	316	64.578***	4.725
		(3.155)	(5.285)
Repo Financing (%)	302	5.725***	-0.02
		(0.561)	(0.956)
Management Ownership (%)	305	0.865***	-0.366
		(0.256)	(0.287)
Institutional Ownership (%)	301	31.379***	-14.396**
		(4.116)	(5.818)

Table 3: Comparing Alipay MMFs with Ant Fortune MMFs

Notes: This table presents the univariate regression results of fund characteristics on the dummy of whether the MMF is joining the Alipay Yu'ebao platform ($D_i = 1$) or the Ant Fortune mutual fund platform ($D_i = 0$): $Characteristic_i = \alpha + \beta D_i + e_i$. For each fund, the time period selected is the one year (4 quarters) prior to the inclusion events. Standard errors in parenthesis. We cluster the standard errors at fund level. *p<0.1, **p<0.05, ***p<0.01.

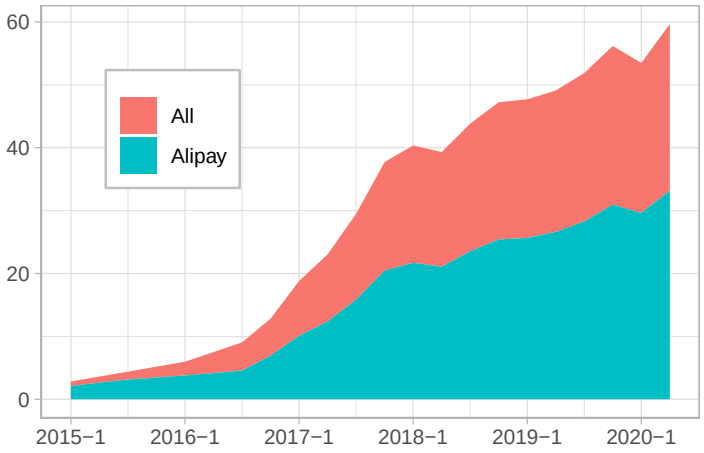
Panel (a) First Stage			
	(1)	(2)	(3)
	OLS	IV by $R^e_{t-2,t-1}$	IV by $R^e_{t-5,t-1}$
Instrument		0.432***	0.414***
		(0.018)	(0.023)
Alipay Fund		0.013	0.022
		(0.020)	(0.025)
Observations		8,299	8,299
Adjusted R^2		0.848	0.829
Panel (b) 2SLS			
	(1)	(2)	(3)
	OLS	IV by $R^e_{t-2,t-1}$	IV by $R^e_{t-5,t-1}$
Excess Return	1.113***		
	(0.202)		
Fitted Excess Return		2.250***	3.716***
		(0.405)	(0.680)
Alipay Fund	3.040***	3.016***	2.984***
	(0.317)	(0.310)	(0.308)
Observations	8,299	8,299	8,299
Adjusted R^2	0.857	0.853	0.834

Table 4: Demand System Estimate

Notes: We report the estimates of the demand system Eq. (5). We control for time and fund fixed effects, and cluster the standard errors at fund level. Sample is quarterly, 2012Q1—2021Q2. *p<0.1, **p<0.05, ***p<0.01.

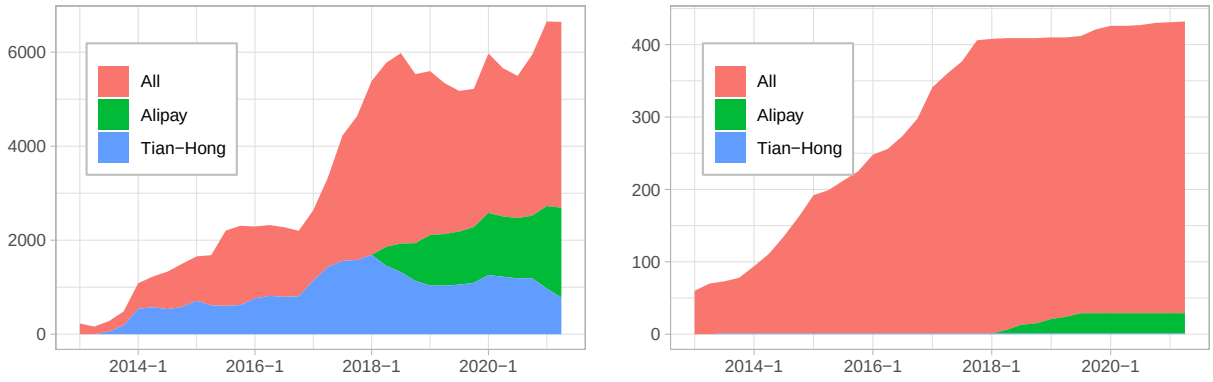
Figures

Figure 1: China's Mobile Payment Transaction (Per Quarter)



Notes: This figure plots the time series of the transaction volume of China's third party mobile payment. Unit: Trillion RMB. Source: Analysis International, and author's calculations.

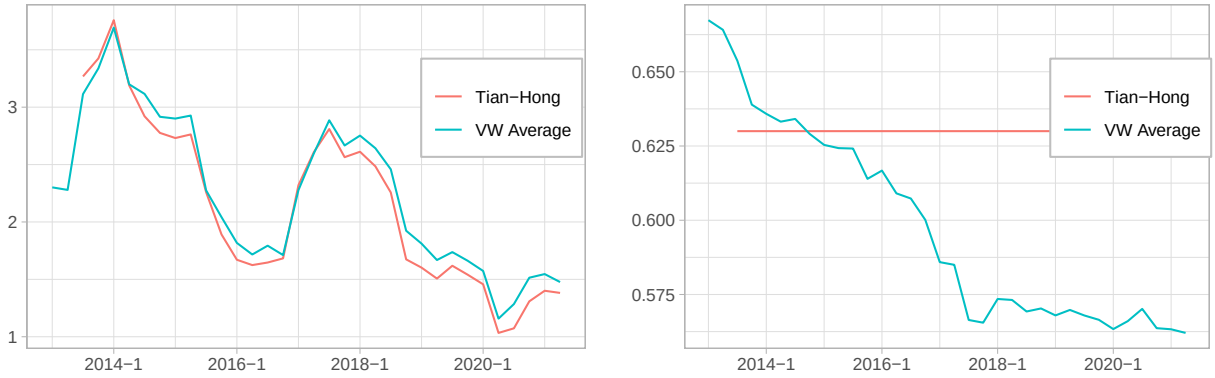
Figure 2: China's MMF Industry Breakdown



Panel (a) By Size (Billion RMB) *Panel (b) By Count*

Notes: This figure plots the time series of MMF size and count for all money market funds accessible to retail investors in China. Tian-Hong is a subset of the Alipay funds, and Alipay funds are a subset of all funds.

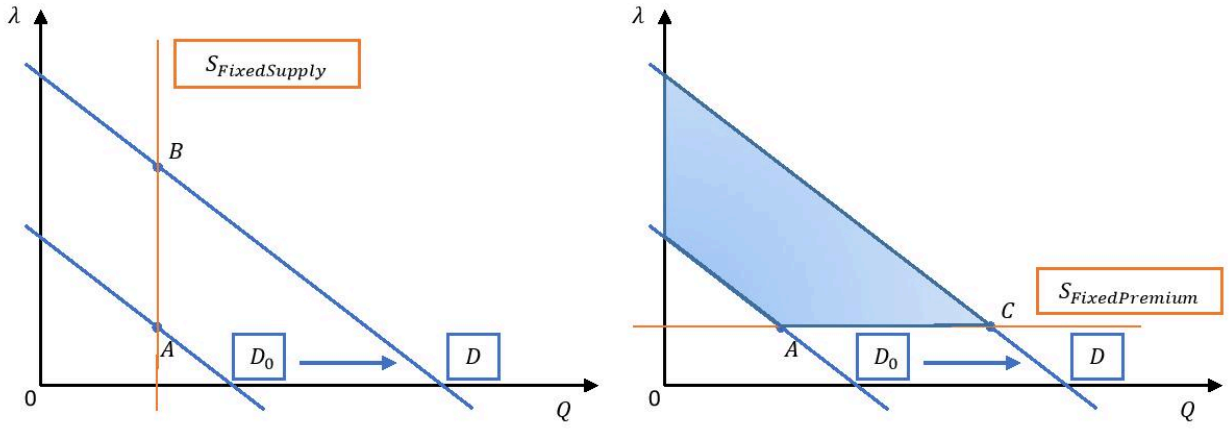
Figure 3: Comparing Tian-Hong Fund with Market VW Average



Panel (a) Return (%, per annum) *Panel (b) Management Fee (%, per annum)*

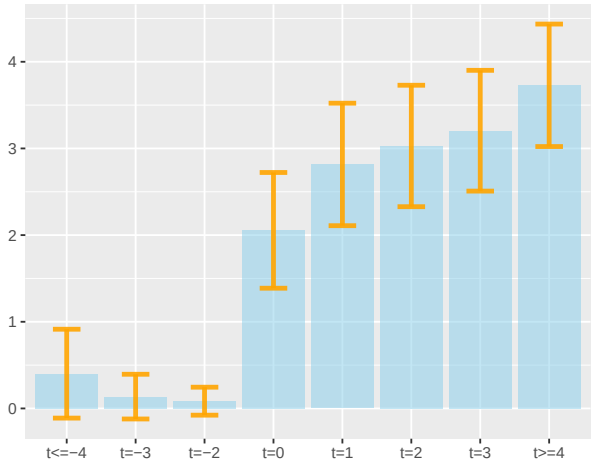
Notes: This figure plots the time series of return and management fee of the Tian-Hong fund and the value-weighted market average.

Figure 4: Different Responses to a Demand Shift

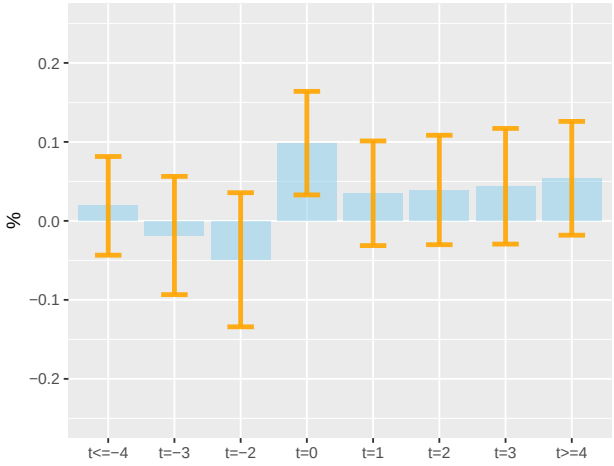


Panel (a) Fixed Supply *Panel (b) Fixed Premium*

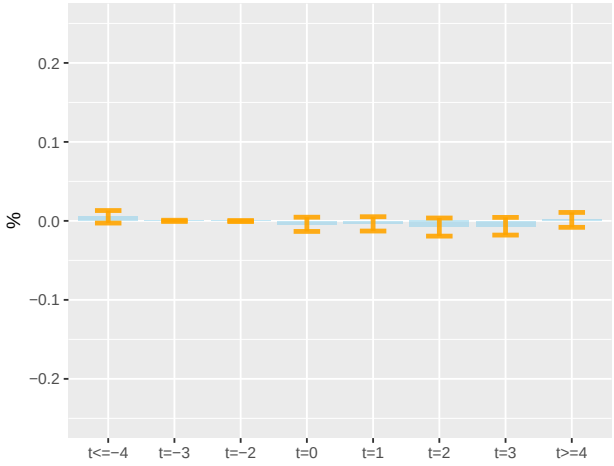
Figure 5: Event Study Coefficients



Panel (a) Effect on Fund Size



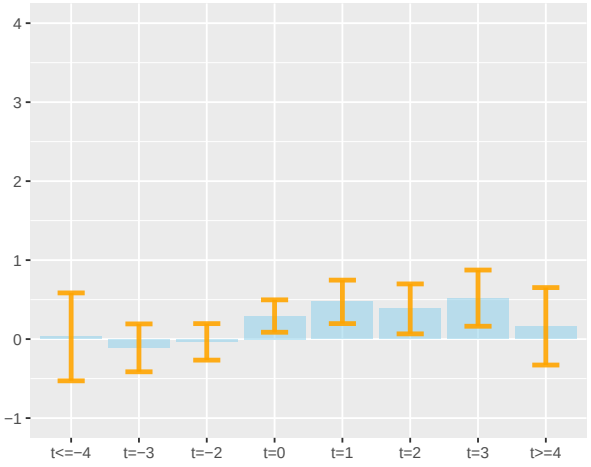
Panel (b) Effect on Fund Return



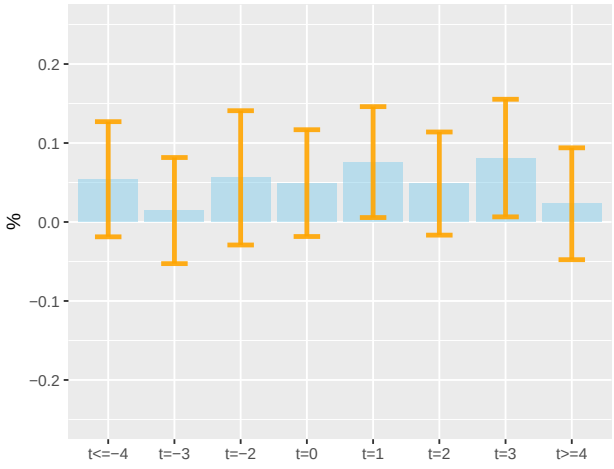
Panel (c) Effect on Fund Fee

Notes: This figure plots the event study regression coefficients from Eq. (1) and (2). The dependent variables are the log fund size, the fund return, and the fund fee. The return and fee are annualized and in percentage points. Data are quarterly, 2013Q1—2021Q2. Two-standard-error confidence intervals are represented with the vertical lines; standard errors are clustered at the fund level.

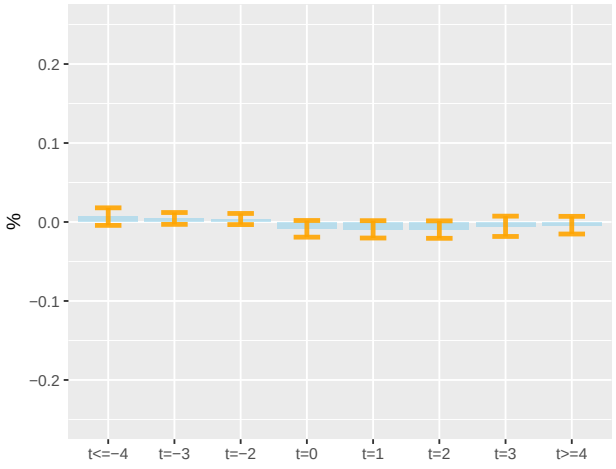
Figure 6: Testing Alternative Mechanism: Mutual Fund Account Inclusion



Panel (a) Effect on Fund Size



Panel (b) Effect on Fund Return



Panel (c) Effect on Fund Fee

Notes: This figure plots the event study regression coefficients from Eq. (1) and (2) for testing the alternative mechanism. We use events of money market fund inclusion into Alipay's mutual fund brokerage platform. The dependent variables are the log fund size, the fund return, and the fund fee. The return and fee are annualized and in percentage points. Data are quarterly, 2013Q1—2021Q2. Two-standard-error confidence intervals are represented with the vertical lines; standard errors are clustered at the fund level. The values are reported in Appendix Table A4.

Figure 7: Fund Size and Consumer Surplus with and without Transaction Convenience

(a) Size, Alipay Funds

(b) Size, Other Funds

(c) Consumer Surplus, Alipay Funds

(d) Consumer Surplus, Other Funds

Notes: This figure plots the total size and our measure of consumer surplus under the actual case against the hypothetical case where Alipay does not have liquidity value. The values are all in billion RMB. The consumer surplus is computed using equation (9).

Appendix

A Additional Tables

Variable Name	Variable Description
Fund Size (billion RMB)	The Net Asset Value (NAV) of the share class of the fund.
Quarterly Log Growth (%)	The quarterly log growth rate of the NAV
Annualized Return (%)	The annualized fund return net of fees in each quarter, based on cumulative sum of daily returns
Annualized Excess Return (%)	The annualized return minus cumulative daily returns of overnight SHIBOR rate
Annual Management Fee (%)	Total fee charged by fund management
Deposit Share (%)	The sum of bank deposits and reserves as a percentage of the fund's NAV
Repo Share (%)	Repurchase agreement contracts as a percentage of the fund's NAV
Corporate Debt Share (%)	Corporate debt as a percentage of the fund's NAV, including corporate bonds, commercial papers and short-term notes
Financial Debt Share (%)	Debt issued by financial institutions as a percentage of the fund's NAV
Government Debt Share (%)	General Government debt as a percentage of the fund's NAV
Other Asset Share (%)	Other types of assets a percentage of the fund's NAV, including debt not classified above, unpaid interest credits, etc.
Asset Maturity	The value-weighted average maturity of the fund portfolio, calculated at the filing date
Repo Financing (%)	The percentage of funds raised through the repo market as a percentage of the fund's NAV
Management Ownership (%)	The percentage of NAV held by members of the management team
Institutional Ownership (%)	The percentage of NAV held by institutional investors

Table A1: Variable Description

Notes: This table describes the definition of variables that appear in the summary statistics tables and regression tables.

Dep. Variable	(1) Log Size	(2) Fund Return	(3) Fund Fee
$t \leq -4$	0.451^{***}	0.013	0.002
	(0.169)	(0.030)	(0.003)
$t = -3$	0.109	-0.015	0.0002
	(0.113)	(0.037)	(0.001)
$t = -2$	0.053	-0.045	-0.0001
	(0.071)	(0.039)	(0.0004)
$t = 0$	1.755^{***}	0.041	-0.005
	(0.328)	(0.029)	(0.005)
$t = 1$	2.379^{***}	-0.015	-0.004
	(0.327)	(0.026)	(0.005)
$t = 2$	2.499^{***}	-0.007	-0.009
	(0.325)	(0.032)	(0.006)
$t = 3$	2.697^{***}	-0.003	-0.008
	(0.332)	(0.033)	(0.006)
$t \geq 4$	3.076^{***}	0.005	0.002
	(0.326)	(0.032)	(0.005)
Deposit Share	-0.108	0.043	0.002
	(0.319)	(0.049)	(0.006)
Repo Share	-0.081	0.099	0.006
	(0.373)	(0.065)	(0.007)
Corporate Debt Share	-1.342^{***}	0.207^{***}	0.002
	(0.364)	(0.063)	(0.007)
Financial Debt Share	-0.815^{***}	-0.057	-0.004
	(0.295)	(0.051)	(0.007)
Government Debt Share	-3.592^{***}	-0.647^{***}	0.030^{*}
	(0.654)	(0.149)	(0.018)
Other Asset Share	0.416	0.103	0.003
	(0.619)	(0.110)	(0.009)
Asset Maturity	0.013^{***}	0.002^{***}	0.00001
	(0.002)	(0.0003)	(0.00003)
Repo Financing	1.916^{**}	1.155^{***}	-0.002
	(0.813)	(0.126)	(0.017)
Management Ownership	-5.268^{***}	0.098	-0.012^{**}
	(1.139)	(0.065)	(0.006)
Institutional Ownership	0.110	-0.076^{***}	0.001
	(0.230)	(0.024)	(0.005)
Observations	7,955	7,955	7,791
Adjusted R^2	0.874	0.909	0.964

Table A2: Event Study Estimate: Additional Controls

Notes: We report the results of the event study regressions Eq. (1) and Eq. (2). We control for time and fund fixed effects, and cluster the standard errors at fund level. Sample is quarterly, 2012Q1—2021Q2. *p<0.1, **p<0.05, ***p<0.01.

Notes: We report the results of the event study regressions Eq. (1) and Eq. (2) under PSM matched control group. We control for time and fund fixed effects, and cluster the standard errors at fund level. Sample is quarterly, 2012Q1—2021Q2. *p<0.1, **p<0.05, ***p<0.01.

	Dependent variable:		
	log.size	return	fee
	(1)	(2)	(3)
$t \leq -4$	0.168	−0.010	0.00004
	(0.282)	(0.045)	(0.005)
$t = -3$	−0.090	−0.021	0.0003
	(0.148)	(0.045)	(0.003)
$t = -2$	−0.064	−0.050	0.0002
	(0.097)	(0.044)	(0.002)
$t = 0$	1.765***	0.048	−0.003
	(0.339)	(0.031)	(0.005)
$t = 1$	2.412***	−0.005	0.0003
	(0.371)	(0.032)	(0.006)
$t = 2$	2.581***	0.006	−0.002
	(0.381)	(0.031)	(0.007)
$t = 3$	2.849***	−0.001	0.002
	(0.395)	(0.034)	(0.008)
$t \geq 4$	3.134***	−0.004	0.019
	(0.446)	(0.041)	(0.011)
Deposit Share	0.742	0.219	−0.017
	(0.715)	(0.153)	(0.015)
Repo Share	0.649	0.082	−0.003
	(0.833)	(0.176)	(0.021)
Corporate Debt Share	−1.570*	0.194	−0.013
	(0.801)	(0.152)	(0.028)
Financial Debt Share	−0.365	0.085	−0.001
	(0.734)	(0.147)	(0.017)
Government Debt Share	−2.620*	−1.303**	0.034
	(1.449)	(0.582)	(0.042)
Other Asset Share	4.341**	0.286	−0.016
	(1.838)	(0.359)	(0.033)
Asset Maturity	0.011***	0.001	−0.0001
	(0.003)	(0.001)	(0.0001)
Repo Financing	2.090	1.008***	0.015
	(1.987)	(0.352)	(0.045)
Management Ownership	−5.957***	−0.065	−0.013
	(0.510)	(0.119)	(0.011)
Institutional Ownership	−0.227	−0.009	0.003
	(0.398)	(0.052)	(0.014)
Observations	1,238	1,238	1,238
Adjusted R^2	0.896	0.909	0.935
Note:			*p<0.1; **p<0.05; ***p<0.01

Table A3: Event Study Estimate: PSM Sample

Dep. Variable	(1) Fund Size	(2)	(3) Fund Return	(4)	(5) Fund Fee	(6)
$t \leq -4$	0.028	0.196	0.054	0.053	0.007	0.006
	(0.278)	(0.204)	(0.036)	(0.035)	(0.006)	(0.006)
$t = -3$	−0.111	0.009	0.014	0.016	0.004	0.006
	(0.152)	(0.165)	(0.034)	(0.036)	(0.004)	(0.004)
$t = -2$	−0.035	0.136	0.056	0.052	0.004	0.005
	(0.116)	(0.125)	(0.043)	(0.048)	(0.004)	(0.004)
$t = 0$	0.292***	0.127	0.049	0.042	−0.009	−0.009
	(0.103)	(0.124)	(0.034)	(0.035)	(0.005)	(0.006)
$t = 1$	0.471***	0.300**	0.076**	0.061*	−0.009*	−0.010*
	(0.138)	(0.151)	(0.035)	(0.035)	(0.005)	(0.006)
$t = 2$	0.383**	0.226	0.049	0.035	−0.010*	−0.011*
	(0.158)	(0.161)	(0.033)	(0.034)	(0.006)	(0.006)
$t = 3$	0.519***	0.326*	0.081**	0.067*	−0.005	−0.006
	(0.178)	(0.175)	(0.037)	(0.036)	(0.006)	(0.007)
$t \geq 4$	0.162	0.055	0.023	0.022	−0.004	−0.006
	(0.245)	(0.210)	(0.035)	(0.033)	(0.006)	(0.006)
Deposit Share	1.546***	−0.131	0.370***	0.038	0.006	−0.0001
	(0.478)	(0.339)	(0.056)	(0.049)	(0.006)	(0.006)
Repo Share	0.952*	−0.174	0.307***	0.093	0.010	0.004
	(0.557)	(0.409)	(0.063)	(0.065)	(0.006)	(0.007)
Corporate Debt Share	0.953*	−1.917***	0.724***	0.203***	0.003	0.0003
	(0.560)	(0.390)	(0.070)	(0.063)	(0.006)	(0.007)
Financial Debt Share	0.873*	−1.211***	0.349***	−0.062	−0.00001	−0.006
	(0.498)	(0.321)	(0.056)	(0.050)	(0.007)	(0.007)
Government Debt Share	−2.467***	−3.861***	−0.404***	−0.648***	0.031**	0.027
	(0.832)	(0.682)	(0.141)	(0.149)	(0.014)	(0.017)
Other Asset Share	1.356*	−0.424	0.375***	0.101	0.010	0.003
	(0.765)	(0.616)	(0.109)	(0.111)	(0.009)	(0.010)
Asset Maturity		0.016***		0.002***		0.00001
		(0.002)		(0.0002)		(0.00003)
Repo Financing		1.610*		1.164***		0.002
		(0.869)		(0.126)		(0.018)
Management Ownership		−5.628***		0.101		−0.013*
		(1.226)		(0.064)		(0.007)
Institutional Ownership		−0.024		−0.075***		0.0004
		(0.236)		(0.024)		(0.005)
Observations	10,031	7,955	10,031	7,955	9,803	7,791
Adjusted R^2	0.792	0.860	0.887	0.909	0.962	0.964

Table A4: Testing Alternative Mechanism: Mutual Fund Account Inclusion

Notes: We report the results of the event study regression Eq. (1) for testing the alternative mechanism. We use events of money market fund inclusion into Ant Fortune mutual fund platform. We control for time and fund fixed effects, and cluster the standard errors at fund level. Sample is quarterly, 2012Q1—2021Q2. *p<0.1, **p<0.05, ***p<0.01.

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable				Fund Size		
Treatment Quarter	2018 Q2	2018 Q3	2018 Q4	2019 Q1	2019 Q2	2019 Q3
$t \leq -4$	0.332	−0.229	0.862	0.952***	−0.246	0.540
	(0.589)	(0.764)	(0.711)	(0.235)	(0.323)	(0.418)
$t = -3$	0.008	0.476	0.029	−0.018	0.324***	−0.109
	(0.245)	(0.410)	(0.243)	(0.144)	(0.080)	(0.121)
$t = -2$	0.129	0.188	0.085	0.018	0.228*	−0.121
	(0.164)	(0.249)	(0.134)	(0.114)	(0.124)	(0.141)
$t = 0$	4.085***	1.722**	1.760	1.944***	0.535*	1.734**
	(0.480)	(0.691)	(1.201)	(0.546)	(0.290)	(0.736)
$t = 1$	4.448***	3.431***	2.201	2.702***	0.772**	2.030***
	(0.511)	(0.619)	(1.705)	(0.596)	(0.380)	(0.757)
$t = 2$	4.562***	3.787***	2.210	2.784***	1.226**	2.214***
	(0.507)	(0.630)	(1.666)	(0.588)	(0.493)	(0.750)
$t = 3$	4.782***	3.856***	2.388	2.998***	1.340**	2.442***
	(0.516)	(0.619)	(1.665)	(0.561)	(0.560)	(0.734)
$t \geq 4$	4.823***	3.978***	2.756*	3.531***	1.804***	3.589***
	(0.558)	(0.652)	(1.409)	(0.632)	(0.600)	(0.956)
Deposit Share	1.522***	1.477***	1.547***	1.493***	1.524***	1.543***
	(0.471)	(0.467)	(0.473)	(0.468)	(0.472)	(0.466)
Repo Share	1.266**	1.248**	1.301**	1.209**	1.298**	1.302**
	(0.545)	(0.542)	(0.546)	(0.539)	(0.544)	(0.541)
Corporate Debt Share	1.563***	1.540***	1.575***	1.544***	1.584***	1.623***
	(0.550)	(0.546)	(0.553)	(0.545)	(0.551)	(0.542)
Financial Debt Share	1.374***	1.334***	1.402***	1.325***	1.362***	1.383***
	(0.489)	(0.487)	(0.491)	(0.486)	(0.488)	(0.484)
Government Debt Share	−1.910**	−1.954**	−1.864**	−1.885**	−1.877**	−1.962**
	(0.829)	(0.824)	(0.829)	(0.821)	(0.827)	(0.820)
Other Asset Share	2.504***	2.429***	2.533***	2.533***	2.490***	2.443***
	(0.742)	(0.754)	(0.744)	(0.740)	(0.742)	(0.730)
Observations	9,341	9,415	9,264	9,384	9,275	9,357
Adjusted R^2	0.809	0.805	0.806	0.807	0.806	0.805

Table A5: Event Study Robustness Check: Heterogeneous Effects

Notes: We report the results of the event study regression Eq. (1), but only include funds that are treated in a given quarter and all non-treated funds. We control for time and fund fixed effects, and cluster the standard errors at fund level. Sample is quarterly, 2012Q1—2021Q2. *p<0.1, **p<0.05, ***p<0.01.

	(1)	(2)
Dep. Variable	Fund Size	
Fee	-2.989^{***}	
	(0.881)	
Lag Fee		-3.162^{***}
		(0.884)
Alipay Fund	4.773^{***}	4.785^{***}
	(0.352)	(0.351)
Observations	8,107	8,107
Adjusted R^2	0.097	0.099

Table A6: Demand System Robustness Check: Fees as Fund Characteristics

Notes: We report the results of the regression Eq. (8). We control for time fixed effects, and cluster the standard errors at fund level. Sample is quarterly, 2012Q1—2021Q2. *p<0.1, **p<0.05, ***p<0.01.