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Digital Money Demand and Monetary Policy

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Abstract

This paper examines how households' money demand responds to monetary policy changes using a unique dataset on household digital money balances from Alipay, a leading e-wallet provider in China.[1] We find that approximately 71% of household assets in our sample are allocated to E-wallet Yu'E Bao balances, which can be used for digital payments and are interest bearing, typically offering a higher return than traditional bank deposits. In stark contrast, a mere 2.3% of assets are held in non-interest-bearing E-wallet balances, which are a digital form of money with characteristics similar to proposed Central Bank Digital Currencies (CBDCs). The remaining balances are held in E-wallet Ant Fund investment funds which are less liquid but earn investment returns. Our analysis reveals substantial inflows into Alipay E-wallets in response to monetary policy tightening, mostly into highly liquid Yu'E Bao accounts. Furthermore, these shifts indicate an increase in the sensitivity of bank deposits and therefore bank profits to monetary policy changes as a result of intensified competition in retail funding markets.

Keywords: FinTech, Bank deposit, monetary policy transmission, CBDC.
JEL classification: E52; E58; G21; G23; G28

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[1]The authors acknowledge and appreciate the supports from the ***Digital Economy Open Research Platform*** (www.deor.org.cn). All data was sampled and desensitized, and was remotely analyzed on the ***Ant Open Research Laboratory*** in an Ant Group Environment which is only remotely accessible for empirical analysis.

1 Introduction

Technological developments have catalysed a significant shift in households' demand for digital cash. In the past, households faced a trade-off between holding cash and putting their savings into interest-bearing assets, primarily due to the fixed costs associated with cash withdrawals. However, the evolution of digital money platforms has reduced the cost to households of transferring their savings between different asset classes. In China, a country at the vanguard of digital payment systems, this shift is exemplified by financial products like Alipay's money market fund "Yu'E Bao," which allows for digital payments and offers a yield, offering returns that surpass those of traditional bank deposits. The potential introduction of Central Bank Digital Currencies (CBDCs) in many countries is poised to further disrupt cash demand. CBDCs could reduce search costs and enhance competition in monetary and financial markets, representing a significant step forward in the digital financial landscape.

These changes are likely to significantly alter the sensitivity of household demand for cash to interest rate changes, thereby affecting the transmission of monetary policy changes to the financial and real economy (Erel et al. (2023)). When policy rates rise, banks typically adjust their deposit interest rates by less than money market rates, leading households to reduce their deposit holdings—a dynamic known as the deposit channel of monetary policy transmission (Drechsler et al. (2017)). This channel could be markedly enhanced due to lower fixed costs associated with reallocation of assets within digital platforms, making households more sensitive to changes in interest rates. Given that banks heavily rely on household deposits for funding, and considering the unique stability of deposits as a funding source, any changes in the deposit channel could have significant implications for bank intermediation activity and the real economy. Therefore, it is crucial for policymakers to understand the implications of technological developments in digital money for the transmission of monetary policy changes to the economy.

Our study aims to bridge the existing knowledge gap by examining money demand through a dual lens using household level and bank-level data. This approach offers a more comprehensive analysis and controls for potential factors that impact household asset allocation decisions, such as lending opportunities (Drechsler et al. (2017)). Our household data is sourced from Alipay, a leading e-wallet provider in China, ensuring a comprehensive and representative sample for our empirical analysis. We analyse monthly observations from a random sample of 100,000 active Alipay users, spanning from January 2018 to December 2021. Our focus is on the detailed asset allocation of household funds within the Alipay wallet. Within Alipay, households can allocate their funds into three distinct categories: the E-wallet balance, which is non-interest-bearing and fully deposited in reserves with the People's Bank of China; the E-wallet Yu'E Bao, embodied by the money market fund Yu'E Bao which facilitates digital payments and is interest bearing; and Ant Fund, an investment platform for various mutual funds, which cannot be used for digital payments without being liquidated.

To evaluate the impact on this digital money platform on the traditional banking system and FinTech, our analysis is supplemented with quarterly data from listed banks and FinTech development indices. We integrate bank-specific information at the bank-branch level with regional FinTech developments, taking into account the geographical diversification of banks' operations. Such a comprehensive approach allows us to assess the interaction more accurately between traditional banking practices and emerging FinTech trends.

We find that the majority of household funds within Alipay are allocated to the E-wallet Yu'E Bao, an option that allows households to generate interest on their assets and maintain payment functionality. A smaller portion of funds is invested in Ant Fund, which earns higher returns but cannot be used as a means of payment. The E-wallet balance within Alipay which is non-interest-bearing holds the least amount of funds. These findings suggest a distinct household preference for means of payment options that yield a return.

Our analysis investigates the impact of monetary policy changes on households' asset allocation decisions. We find that as monetary policy tightens, there is an increased propensity for households to move funds out of banks and into Alipay wallets. This shift is primarily towards Yu'E Bao, as these offer returns that are more aligned to market rates compared with traditional bank deposits. In addition, we observe inflows into money market funds and outflows from higher-risk funds, reflecting households' rebalancing of yields preferences amidst changing monetary conditions. Interestingly, the inflows into Yu'E Bao considerably outweigh those into other money market funds available through the Ant investment platform, emphasizing a strong household preference for liquidity.

Digital money also enhances the interest rates liberalization within the bank deposit market. Our results suggest that the development of FinTech solutions, such as Alipay, alters the effectiveness of the deposit channel of the monetary policy transmission mechanism. In particular, using bank-level data coupled with regional FinTech development indices, we observe that, in regions with advanced FinTech development, bank deposits exhibit greater responsiveness to monetary policy changes. This heightened sensitivity is particularly noticeable among smaller banks, which generally wield less market power in terms of attracting household deposits.

Our study helps to better understand the functioning of the monetary and financial system in the digital currency era. By analysing how monetary policy changes influence asset allocation within household digital wallets, we provide a valuable insight into household financial behaviour in an era of increasing digital wallet adoption. The characteristics of E-wallet balances can be used to understand the potential impact of Central Bank Digital Currencies (CBDCs) on the financial sector. Furthermore, our analysis extends to the banking sector, underscoring how digital platforms enable rapid transfers of funds away from traditional bank accounts in monetary tightening scenarios and then change bank's liability structure.

Literature review. Our paper contributes to four distinct but interrelated strands of the literature. The first relates to the intersection of technology and digital money demand. The Baumol-Tobin model lays the foundational framework for analysing the transaction demand for money centred on the fixed costs incurred when agents withdraw money (Baumol (1952); Tobin (1956)). This model presents a dichotomy between liquid money and interest-bearing assets. Our work parallels that of Alvarez and Lippi (2009), who investigate the impact of financial innovations — specifically, advancements in withdrawal technology like the proliferation of bank branches and ATM terminals —on the transactions demand for cash. They find that technological advancements lead to a reduction in the expenditure elasticity of money demand. Our contribution to this body of literature lies in leveraging a unique dataset on one of the world's largest digital wallets to understand how monetary policy changes influence digital money demand.

Second, our paper contributes to a broad literature that investigate the functioning of the monetary policy transmission mechanism. Several studies have highlighted how financial frictions influence the pass-through of monetary policy changes to the economy (Beck et al. (2014); search costs (Duffie and Krishnamurthy (2016)); lender market power (Scharfstein and Sunderam (2016)); and market concentration (Drechsler et al. (2017)). A particular focus has been on the role of the shadow banking sector in the monetary policy transmission mechanism. Chen et al. (2018) observe that contractionary monetary policy between 2009 and 2015 led to an increase in shadow banking loans, offsetting the expected decline in the volume of traditional bank lending and impacting the effectiveness of monetary policy on total bank credit. Xiao (2020) use a structural model of bank competition to demonstrate how episodes of monetary tightening could inadvertently heighten financial fragility in an economy by shifting retail deposits to the uninsured shadow banking sector. Deposits play a crucial role in the monetary policy transmission mechanism, as posited by Drechsler et al. (2017) in their 'deposits channel' theory. According to this, when the Fed funds rate rises,

banks narrow their deposit spreads (the difference between deposit and money market rates), triggering an outflow of deposits from the banking system and a reduction in money creation. Recent papers like Begenau and Stafford (2022) and Granja and Paixao (2023) provide evidence of uniform deposit pricing across banking markets, especially among large banks.

Current research also explores how financial technology (FinTech) could reshape the monetary policy transmission mechanism. De Fiore et al. (2023) examine big techs' response to monetary policy changes, modelling big techs' role in facilitating the matching of sellers and buyers across digital platforms. Zhou (2022) highlights the significance of social networks in enabling FinTech to enhance the transmission of monetary policy changes to the mortgage market. Erel et al. (2023) found that during periods of monetary tightening, online bank deposits experience inflows, whereas traditional banks face outflows. Our study adds to this body of work by investigating how financial technology via the creation of digital wallet platforms can amplify the deposit channel of monetary policy transmission by reducing search costs and enhancing the interest rates liberalization.

Third, our paper contributes to the extensive literature exploring the relationship between FinTech and the banking sector. On one hand, emerging FinTech innovations have brought significant benefits to traditional financial institutions. Feyen et al. (2021) note the achievement of cost efficiency through the reduction of transaction and monitoring costs. Chen et al. (2019) highlights the substantial value that these innovations bring to their creators, helping them maintain market competitiveness. More recent evidence from China, as reported by Wang et al. (2021), indicates that commercial banks' adoption of FinTech can lower operating costs, enhance service efficiency, bolster risk control capabilities, and lead to the development of more customer-oriented business models, thereby improving overall competitiveness.

On the other hand, the development FinTech will affect the performance of traditional banks. Buchak et al. (2018) observe that FinTech lenders offer greater convenience to bor-

rowers. Fuster et al. (2019) point out that FinTech platforms in the US mortgage lending sector can process applications 20 percent faster than traditional lenders. Following the financial crisis, stricter regulatory requirements have led to either a decline in bank lending (Cortés et al. (2020)) or increased costs for certain borrower categories, resulting in a shift in credit intermediation towards unregulated financial institutions (Irani et al. (2021)). While much of the existing literature focuses on FinTech's role in enhancing lending efficiency and expanding access to credit, there is a noticeable knowledge gap regarding FinTech's impact on funding side of banks, such as household demand for deposits. These deposits form the foundation of traditional banking activities. Our paper aims to address this gap by examining the influence of financial technology on the deposit base of banks.

Finally, our study contributes to the growing body of literature on CBDCs, and their implications for banking systems and financial stability. Several studies have suggested a potential negative effect of CBDCs on banking systems. Fernández-Villaverde et al. (2021) contend that consumers may perceive the central bank as more stable than commercial banks, potentially leading them to view the central bank as a deposit monopolist and migrate their deposits away from commercial banks, which could jeopardize banks' maturity transformation. Agur et al. (2022) argue that a CBDC that closely competes with bank deposits could depress bank credit and economic output, while one that offers a means of payment could lead to cash's obsolescence. Parlour et al. (2020) demonstrate that the availability of a retail CBDC reduces the necessity for cash in the economy, resulting in lower cash deposits and withdrawals from banks for liquidity needs (Whited et al. (2022)).

However, there are contrasting views. Andolfatto (2021) suggests that the introduction of CBDCs could result in a higher monopoly deposit rates, which, while reducing commercial banks' profits, could expand deposit funding through increased financial inclusion and savings. Moreover, according to current theory and evidence, a well-designed CBDC is unlikely to threaten financial stability. Chiu et al. (2023) indicate that if banks possess market power

in the deposit market, a CBDC could enhance competition, raising deposit rates, expanding financial intermediation, and increasing output. Our insights into the behaviour of Alipay's digital cash may offer a valuable reference point for understanding the potential implications of CBDCs on the financial landscape.

2 Data and Institutional Background

2.1 Alipay e-wallet data

The use of e-wallets has witnessed remarkable growth, particularly in Asia. In 2021, e-wallets were used for 69% of e-commerce spending and 44% of point-of-sale transactions in the Asia-Pacific region. The extensive use can be attributed to several factors, including underdeveloped payment infrastructures, a significant portion of the population remaining unbanked, and rapidly expanding e-commerce markets. E-wallet 'super-apps' such as Alipay in China, Grab in Singapore, and Paytm in India have been at the forefront of this revolution. These platforms have successfully attracted a large user base, previously underserved by traditional banking systems. They have achieved this by utilizing mobile applications and QR codes to provide an array of comprehensive services encompassing payments, credit, and wealth management.

In China, e-wallets have become a cornerstone of household finance, playing a pivotal role in consumption, investment, and payment activities. Founded in 2004, Ant Group's Alipay has developed a multifaceted ecosystem encompassing a broad spectrum of services. The platform adeptly integrates financial transactions with daily activities such as online shopping and food delivery. It offers a seamless user experience by consolidating these services into a single 'super-app'. By 2021, e-wallets had emerged as the predominant payment method for e-commerce transactions, commanding an 83% market share. In this landscape, Alipay and WeChat Pay are the leading e-wallets in China, exemplifying the nation's rapid

adoption and reliance on digital payment solutions.

Individuals using Alipay's e-wallet have three primary options for managing their assets: E-wallet Yu'E Bao, E-wallet Ant Fund investments, and non-interest-bearing E-wallet balances. Table 1 summarizes the features of each option. The first option, E-wallet Yu'E Bao, uniquely functions as an interest-bearing digital currency. When users transfer money into E-wallet Yu'E Bao, it is essentially akin to purchasing a 'T+0' money market fund. This option offers an interest rate higher than traditional bank demand deposits. While the rate is typically similar to or lower than other wealth management products, it uniquely supports payment functionalities. In other words, the money invested in Yu'E Bao can be used for digital payments with no significant liquidity restrictions.

As a second option, users can choose to invest their money in E-wallet investments, also known as Ant Fund, which is a fund supermarket operated by the Ant Group. Ant Fund offers a diverse range of fund asset classes, providing users with various investment opportunities. In addition to risk-free money market funds (MMFs), there are six types of mutual funds available on the platform: bond, mixed, equity, index, QDII (Qualified Domestic Institutional Investor), and gold funds. However, it's important to note that direct payment using funds from E-wallet Ant Fund investments is not feasible. If individuals wish to use the money invested in Ant Fund as a means of payment, they must anticipate at least a one-day waiting period for redeeming the funds.

The third option available to users is the E-wallet balance. This serves as a digital payment medium and is non-interest bearing. The funds in the E-wallet balance are fully deposited with the People's Bank of China (PBC). This arrangement has been mandatory for all non-banking financial institutions since 2019, ensuring that their deposits are securely held with the central bank, or with qualified commercial banks since March 2021. This regulatory measure ensures the safety and liquidity of funds used for digital payments.

This study was remotely conducted on the Ant Open Research Laboratory in an Ant

Group Environment. All data was sampled and desensitized, and was analyzed on the Ant Open Research Laboratory. The laboratory is a sandbox environment where the authors can only remotely conduct empirical analysis and individual observations are invisible. We have access to comprehensive Alipay data, including individual demographics, monthly investment activities, digital payment usage, and spending patterns, of a randomly selected sample of 100,000 individuals. This data spans from January 2018 to December 2021. The sample is drawn from the entire user base of the Ant community, focusing on investors who have at least 10 RMB (approximately 1.6 USD) in their Alipay e-wallets. Given Alipay's vast user base, which encompasses over 1.3 billion individuals, and considering that a significant majority of Alipay users participate in risk-free MMF investments through E-wallet Yu'E Bao, as noted by Buchak et al. (2021), our sample provides a representative cross-section of the broader Chinese population.

Table 2 presents demographic and asset allocation details for the 100,000 individuals in our sample. Among these individuals, 47% are female, with an average age of 31 years old. The average amount held in Alipay accounts is to 16,786 RMB (approximately 2,152 USD). Interestingly, about 71% of the funds, on average, are allocated to the E-wallet Yu'E Bao which is interest bearing and can be used for digital payments. The average amount held in E-wallet Ant Fund investments is 4,077 RMB (around 522 USD), accounting for 24% of the total assets in Alipay wallets. In contrast, the average amount held in the Alipay E-wallet non-interest-bearing account is considerably lower, at only 392 RMB (around 50 USD), representing a mere 2.3% of the total assets. The median age of the Alipay users in our sample is 29, while the median age for the general population of China is 38.5. This comparison highlights that the users of Alipay tend to be younger. The sample represents the group of people in China who are not fell into the digital divide and stands for the future trends of society.

2.2 Bank Data

Our bank dataset includes quarterly series data from 42 publicly listed commercial banks, obtained from WIND. This dataset provides comprehensive details of bank balance sheets and key financial metrics, such as a bank's net interest margin (NIM) and return on assets (ROA), both of which are crucial indicators of bank profitability. This extensive data allows for an in-depth analysis of the financial health and performance trends of these commercial banks.

Many banks in China are regional, primarily serving local customers. This regional focus provides an opportunity to correlate the banks' business activities with local FinTech developments. However, one potential complication is that regional banks may conduct business outside their primary region. To accurately capture the geographic distribution of each bank's business, we have collected location information for all branches of each institution. Additionally, we employ the Herfindahl-Hirschman Index (HHI) to assess market concentration and competition. The HHI is calculated as the sum of the squared market share based on the number of branches each bank has in a city, relative to the total number of bank branches in that city. This measure helps us to understand the competitive landscape and market dominance of banks within their respective regions.

2.3 Monetary Policy

In recent years, there has been increasing attention on China's monetary policy which has evolved from being predominantly quantity-based to more interest rate-based. This shift aims to maintain the stability of prices and the Renminbi, while also promoting and facilitating economic growth.

To measure China's monetary policy, we utilize a monetary policy indicator developed by Xu and Jia (2019). This indicator synthesizes information from a variety of interest rates and

is considered exogenous, effectively addressing potential endogeneity issues in the analysis. It reflects the People's Bank of China's (PBC) policy stance and serves as an analogue of the federal funds rate, as noted by Miranda-Agrippino et al. (2020). This approach allows for a more nuanced understanding of the impacts and implications of China's monetary policy decisions.

2.4 Digital Finance Development

To accurately represent the current state of digital finance development in China, we utilize the 'Peking University Digital Financial Inclusion Index of China (PKU-DFIIC)'. This dataset, developed by Guo et al. (2020) and launched by the Institute of Digital Finance of Peking University, is based on individual-level usage data of various financial services within Alipay. It has been increasingly employed in recent academic studies, including those by Ding et al. (2022) and Hong et al. (2020).

The PKU-DFIIC provides a comprehensive overview of digital finance development at the provincial, city, and county levels, spanning from 2011 to 2021. The aggregated indicator encompasses a wide array of metrics, including the usage of online payment services, enrolment in online insurance policies, access to internet loans, purchases of money market funds, engagement in online wealth management and investment, and credit evaluation practices. Beyond the aggregate index, the PKU-DFIIC also offers disaggregated indexes that measure various dimensions such as the breadth of coverage, depth of usage, level of digitization, and other specific subsector indexes. These detailed metrics enable a nuanced understanding of the evolution and current landscape of digital finance in China.

3 Empirical Evidence

3.1 Identification Strategy

To examine how E-wallets influence the deposits channel of monetary policy, we implement the following regression model:

$$\Delta EWallet_{it} = \alpha_i + \beta_1 \cdot MPI_t + X_{c(i)t} + \varepsilon_{it} \tag{1}$$

where i and t indicate individual and the specific year-month. The $\Delta EWallet_{it}$ stands for the log change in Alipay money balances (covering three types of account: the E-wallet Yu'E Bao, the E-wallet Ant Fund investment funds and in the non-interest-bearing E-wallet) of individual i from month t to t+1. MPI_t is the monetary policy index indicator, where positive values indicate a tightening monetary policy stance, and negative values indicate an easing stance. $X_{c(i)t}$ is the control variables of city c where individual i is located in month t, including the logarithm of GDP per capita and housing prices. α_i represents individual fixed effect and ε_{it} is the error term. Standard errors are clustered at the account level. Depending on the specification, an estimate of β_1 captures the sensitivity of the Alipay money balances to changes in monetary policy.

3.2 Baseline Results

Table 3 displays the estimated results for Equation (1), providing insight into how the development of E-wallet technology affects the retail deposit channel of monetary policy. The findings from Column (1) indicate that a one-standard-deviation increase in the monetary policy index corresponds to an increase of 1.1 per cent in asset inflows into Alipay E-wallets (0.112*0.100=0.011). This effect is primarily driven by inflows into E-wallet Yu'E Bao interest bearing deposits, which experience an increase of 2.8 per cent (0.112*0.246=0.028).

In contrast, for E-wallet Ant Fund investment funds and non-interest-bearing E-wallet balances, a one-standard-deviation increase in the monetary policy index results in a decline of inflows of 1.0 and 4.7 per cent, respectively.

This analysis reveals that the component in E-wallet Yu'E Bao, characterized by being interest-bearing, highly liquid, and supporting payments, plays a major role and exerts a significant impact on bank liabilities. When monetary policy is tightened, there is a notable increase in the total assets within E-wallets, predominantly in the form of interest-bearing deposits.

Conversely, investment funds and non-interest-bearing digital cash balances tend to decrease in a monetary policy tightening. This suggests that non-interest-bearing digital cash and less liquid but higher- risk investment products are not strong substitutes for bank deposits. Instead, E-wallet Yu'E Bao, with its liquidity and interest-bearing features, appears to be a primary alternative for households shifting money balances in response to changes in monetary policy.

There are several events that could potentially affect households' money demand decisions. Firstly, there were regulation changes on E-wallet Yu'E Bao accounts in May 2018. Secondly, from January 14, 2019, 100% of the Alipay reserve is deposited with the People's Bank of China (PBC). Lastly, the Covid-19 pandemic, which began in January 2020 could have influenced money demand. To address the potential impacts of these events, we conduct tests on the sample after these events and find that our results are robust to these events. In Table A3 in the annex, we add year fixed effects or city-year fixed effects to control for common factors on national level and city level and the results remain unchanged.

Next, we focus our analysis on the various subitems of E-wallet Ant Fund investment funds, which include hybrid funds, index funds, bond funds, equity funds, and other money market funds. The results presented in Table 4 suggest that when during periods of a loose monetary stance, individuals tend to be more inclined towards risk-taking and seek higher

yields, and vice versa. This trend is observable in the increased (decreased) allocations to riskier investment options like equity and hybrid funds during periods of looser (tighter) monetary policy. The data imply that individuals adjust their investment strategy in response to monetary conditions, shifting towards assets with potentially higher returns but also higher risk when the monetary stance is looser.

The coefficient estimates for the monetary policy indicator are statistically significant across the various investment categories. According to the results shown in Table 4, as the monetary policy (MP) index increases, indicating a tightening of policy, the growth in investments in hybrid, index, and equity funds is observed to decline. Specifically, for a one-standard-deviation rise in the MP index, the growth rates in hybrid, index, and equity funds decrease by 1.8, 0.5, and 0.6 per cent, respectively. This suggests that tighter monetary policy is associated with a stronger tendency among individuals to reduce purchases of riskier assets.

Interestingly, despite a marginal increase in the growth rate of other money market funds by 0.2 per cent, this rate is still considerably lower compared to E-wallet Yu'E Bao balances, which offer better liquidity. This can be attributed to the operational differences between the two wallets: E-wallet Yu'E Bao operates on a 'T+0' day trading system, which allows for immediate transactions, whereas other money market funds typically follow a 'T+1' trading system. Although these other money market funds might offer higher interest rates compared to Alipay wallet deposits, the larger inflows into Alipay wallet deposits indicate a preference for liquidity and immediate access to funds in times of tighter monetary policy.

3.3 Market competition

In this section, we delve deeper into how the degree of competition influences the impact of monetary policy on E-wallet money balances. Drechsler et al. (2017) find that an increase in the Fed Funds Rate leads to larger deposit outflows at branches with low market concentra-

tion compared to those with high concentration within the same banks, indicating stronger market power in the latter. Drawing on this insight, we incorporate a proxy for the level of bank competition and its interaction with the monetary policy index into our estimation model. The model is formulated as follows:

$$\Delta EWallet_{it} = \alpha_i + \beta_1 \cdot MPI_t + \beta_2 \cdot HHI_{c(i)t} + \beta_3 \cdot HHI_{c(i)t} \cdot MPI_t + \varepsilon_{it} \tag{2}$$

Here, $HHI_{c(i)t}$ is the Herfindahl Index of city c where individual i is located in month t. The lower the index, the more intense the competition. We also use $CR4$ and $CR5$ for robustness checks, where CRn represents the total number of branches of the top n banks as a share of the total number of bank branches in any city. The coefficient β_3 captures the interaction between the degree of bank competition and the monetary policy index. The other variables are defined as in equation (1).

Table 5 reports the results of our analysis. As anticipated, the coefficient β_3 in column (1) is positive and statistically significant. This indicates that the effect of monetary policy tightening on E-wallet Yu'E Bao balances diminishes as competition among banks intensifies. The underlying rationale is that E-wallet Yu'E Bao balances become less appealing and less of a substitute for bank deposits in a more competitive banking environment. This effect is also observable for total assets, financial products, and investments within E-wallets. However, the effect is not significant for the non-interest-bearing balances in E-wallets.

To sum up, with the increasing advancement of digitization, we observe that individuals are more inclined to transfer their funds to E-wallet Yu'E Bao in response to a tightening of monetary policy. This behaviour is particularly pronounced in regions where bank competition is more limited. Our research indicates that E-wallets significantly influence the behaviour of households' money demand. Notably, E-wallet Yu'E Bao balances, which offer payment functionalities and higher liquidity, play a crucial role in this dynamic. This

contrasts with E-wallet Ant Fund investment balances that, despite offering higher yields, provide lower liquidity. Thus, it becomes evident that in the context of monetary policy shifts, the features of liquidity and payment functionality inherent in E-wallet Yu'E Bao balances are highly valued by users, overshadowing the appeal of higher-yielding, less liquid investment options.

3.4 The impact on bank deposit

Furthermore, we explore how digital finance affects the bank deposits channel of monetary policy. To do this, we calculate the Digital Financial Inclusion Index (DF) at the bank level, weighted by the number of bank branches:

$$DF_{jt} = \sum_{c} \omega_{c(j)t} \cdot DF_{ct}$$

where

$$\omega_{c(j)t} = b_{c(j)t}/b_{jt}$$

In this formula, DF_{jt} is the weighted average of a Digital Financial Inclusion Index for prefecture-level cities by the number of bank branches. $b_{c(j)t}$ is the number of branches of bank j in a particular city c and b_{jt} is the total number of branches of bank j. Hence, $\omega_{c(j)t}$ is bank j's branches located in city c as a proportion of all branches of banks j in quarter t. DF_{ct} is the Digital Financial Inclusion Index for city c in quarter t.

Then we match the banks' exposure to digital finance level data with their balance sheet information to estimate the following regression:

$$Deposit_{jt} = \alpha_j + \gamma_1 \cdot DF_{jt} + \gamma_2 \cdot DF_{jt} \cdot MPI_t + \lambda_j + \tau_t + \varepsilon_{it} \tag{3}$$

In equation (3), $Deposit_{jt}$ refers to the total deposit ratio. λ_j denotes bank fixed ef-

fects and τ_t is year-quarter time fixed effects. For this analysis, we focus solely on local banks, excluding all national banks from the sample. The coefficient γ_2 is of particular interest; if monetary policy tightening results in a more significant reduction of bank deposits in geographical areas where the digital finance index is higher, we would expect γ_2 to be significantly negative.

Furthermore, for robustness checks, we also utilize the Digital Financial Inclusion Index of the provinces and cities where the banks are headquartered. This additional analysis helps our understanding of how digital finance influences the relationship between monetary policy and bank deposits at a regional level.

The effect on the full sample is reported in Table 6 column (1); the heterogeneous effects of digital finance on large banks and small banks are reported in columns (2) and (3). In addition to the aggregate index, column (4) to (6) shows the results of disaggregated indexes, including coverage breadth, usage depth and the digitization level. [2]

According to the results in Table 6, the coefficient of the interaction terms, γ_2, are all significantly negative in the full sample regression. That is, tight monetary policy leads to more outflows of bank deposits where digital finance is more developed. Meanwhile, there is also a marked difference between large and small banks. The impact is more pronounced for small banks, and is limited for large banks, since the coefficient for small banks is -0.52 but not significant for large banks.

Since deposits are typically a stable source of funding for banks, the deposits channel impacts the capacity of banks to fund their lending, and therefore their overall profitability. For this reason, in the next step of the analysis we analyse the impact on banks' profitability

[2]The coverage breadth index is primarily based on account coverage rate, such as the number of Alipay accounts per ten thousand people. Usage depth is mainly based on the average usage per user, such as the number of transactions and the amount of money used per capita through Alipay. The degree of digital level is primarily based on the cost and convenience of financial services, and measured, for example, by the average loan interest rate.

using the following regression:

$$Profit_{jt} = \alpha_j + \delta_1 \cdot DF_{jt} + \delta_2 \cdot DF_{jt} \cdot MPI_t + \lambda_j + \tau_t + \varepsilon_{it} \tag{4}$$

where $Profit_{jt}$ is the profitability of bank j in quarter t, measured by the net interest margin (NIM) and return on assets (ROA). DF_{jt} is the bank-level Digital Financial Inclusion Index weighted by bank branches, as defined above. The sample is restricted to local banks. If digital finance squeezes the volume of bank deposits, which in turn affects lending operations and earning capacity, then δ_2 is expected to be negative.

In all columns in Table 7, the interaction terms between the monetary policy indicator and digital finance index, are all negative and statistically significant. Similarly, the effects of the digital level index are the largest compared with its counterparts.

To summarize, our findings indicates that there is an outflow of deposits from the banking system in response to monetary tightening. Furthermore, we observe that the sensitivity of bank deposits to monetary policy is heightened in regions where digital finance is more developed. Areas with more developed digital finance experience a decline in both Net Interest Margin (NIM) and Return on Assets (ROA) when monetary policy is tightened. While tighter monetary policy generally tends to improve the profitability of banks, our research indicates that this benefit is offset by increased competition for liabilities.

4 Conclusions

The increasing use of digital wallets by households has substantial implications for monetary policy and traditional banking practices. Digital wallets have significantly enhanced payment convenience and reduced reliance on physical cash. Moreover, the variety of assets available through these wallets has intensified competition in the bank funding market. This shift has given households greater flexibility in managing their money balances, potentially leading to

a more pronounced reaction of household asset portfolio composition in response to changes in monetary policy. Interestingly, the characteristics of certain digital wallets closely resemble those proposed for CBDCs. Therefore, understanding the behaviour of digital money demand in E-wallets is relevant in estimating the impact of the introduction of retail CBDCs on the banking system.

Our research uses unique datasets that capture detailed household financial behaviour and bank-level responses, providing insights into the relationship between digital wallet balances and monetary policy. We find a strong household preference for E-wallet Yu'E Bao, which offer higher liquidity despite lower returns than E-wallet investment funds. There is minimal allocation to E-wallet investment funds, which offer higher returns but lower flexibility for payments, and to non-interest-bearing E-wallet balances, which provide liquidity without yield—akin to the expected nature of CBDCs. Notably, we observe significant fund inflows into E-wallets in response to monetary tightening, with a preference for E-wallet Yu'E Bao balances that offer liquidity and are interest-bearing. This results in an increased sensitivity of bank deposits to monetary policy tightening, with an increase in the effectiveness of the deposit channel of monetary policy.

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Table 1: Features of the payment options

	Payment function	Interest-bearing	Risk
Cash	Yes	No	No
E-wallet balance	Yes	No	Negligible
E-wallet deposits	Yes	Low	Low
E-wallet investment	No	High	High
Bank deposit	Yes	Very low	Very low
CBDC	Yes	Likely no	No

Table 2: Summary Statistics

	Obs.	**Mean**	**Std**	**Min**	**P25**	**Median**	**P75**	**Max**
Panel A: Individuals								
E-wallet assets	3284516	16786.23	65955.90	10	204.89	1701.07	11002.57	8136171
E-wallet Yu'E Bao	3284516	11966.57	43703.35	0	100.02	1003.28	7759.48	6022260
E-wallet investments	3284516	4076.94	40896.75	0	0	0	9.3	7931242
E-wallet balance	3284516	392.47	5509.57	0	0	0	0.57	2190261
Hybrid Fund	3284516	1682.62	22502.99	0	0	0	0	6646579
Index Fund	3284516	800.78	14678.40	0	0	0	0	3116111
Bond Fund	3284516	595.33	12169.75	0	0	0	0	3268226
Equity Fund	3284516	372.29	6370.21	0	0	0	0	2163345
Other MMFs	3284516	557.24	16751.45	0	0	0	0	5849853
Age	3284516	30.97	9.00	18	24	29	36	70
Gender	3284516	0.47	0.50	0	0	0	1	1
Panel B: Banks								
Deposits ratio	550	0.64	0.08	0.43	0.57	0.63	0.71	0.92
NIM (%)	528	2.20	0.47	0.90	1.88	2.14	2.40	4.21
ROA (%)	543	0.55	0.25	0.14	0.32	0.53	0.75	1.13
Panel C: Index								
MPI	3284516	-0.062	0.112	-0.290	-0.144	-0.138	0.044	0.095
HHI	2810910	0.092	0.030	0.052	0.069	0.087	0.105	0.260
log index_aggregate	540	5.64	0.10	5.43	5.57	5.64	5.72	5.86
log coverage_breadth	540	5.63	0.13	5.34	5.53	5.62	5.72	5.89
log usage_depth	540	5.63	0.10	5.39	5.57	5.63	5.70	5.85
log digitization_level	540	5.70	0.08	5.53	5.65	5.72	5.76	5.81
log alipay_user	440	-9.16	0.51	-10.12	-9.38	-9.09	-8.85	-8.39
Panel D: Controls								
log perGDP	3284516	11.60	0.38	10.29	11.33	11.68	11.92	12.29
Housing price	3284516	19918.01	14391.03	4352	10318	13272	23923	54739

Notes: "log" is applied to the original value adding 1.

Table 3: Impact of MP on E-wallet

	E-wallet assets	E-wallet Yu'E Bao	E-wallet investments	E-wallet balance
	(1)	(2)	(3)	(4)
Panel A: All time periods				
MPI	0.100***	0.246***	-0.085***	-0.417***
	(7.16)	(14.65)	(-9.60)	(-24.36)
Controls	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Obs.	3193286	3193286	3193286	3193286
R-squared	0.02	0.02	0.02	0.03
Panel B: After 2018.05				
MPI	0.105***	0.266***	-0.105***	-0.415***
	(7.03)	(14.71)	(-11.06)	(-23.54)
Controls	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Obs.	2894235	2894235	2894235	2894235
R-squared	0.03	0.03	0.02	0.03
Panel C: After 2019.01.14				
MPI	0.120***	0.230***	-0.085***	-0.277***
	(7.47)	(11.84)	(-8.35)	(-15.17)
Controls	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Obs.	2508110	2508110	2508110	2508110
R-squared	0.03	0.03	0.02	0.03
Panel D: After Covid (2020.01)				
MPI	0.270***	0.286***	0.191***	-0.259***
	(11.98)	(10.27)	(12.47)	(-10.32)
Controls	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Obs.	1825640	1825640	1825640	1825640
R-squared	0.03	0.04	0.03	0.04

Notes: Values in brackets in the second row of each indicator are the t values of the regression coefficients, similarly hereinafter. *, ** and *** denote 10%, 5% and 1% levels of significance respectively, similarly hereinafter.

Table 4: Impact of MP on subitems

	Hybrid Fund	Index Fund	Bond Fund	Equity Fund	Other MMFs
	(1)	(2)	(3)	(4)	(5)
Panel A: All time periods					
MPI	-0.157***	-0.047***	0.079***	-0.058***	0.006
	(-22.45)	(-7.49)	(15.53)	(-12.18)	(1.28)
Controls	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes
Obs.	3193286	3193286	3193286	3193286	3193286
R-squared	0.02	0.02	0.02	0.02	0.02
Panel B: After 2018.05					
MPI	-0.195***	-0.068***	0.094***	-0.063***	0.020***
	(-24.97)	(-9.66)	(16.45)	(-11.85)	(4.62)
Controls	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes
Obs.	2894235	2894235	2894235	2894235	2894235
R-squared	0.02	0.03	0.03	0.02	0.02
Panel C: After 2019.01.14					
MPI	-0.193***	-0.055***	0.115***	-0.056***	0.014***
	(-22.67)	(-7.09)	(18.32)	(-9.65)	(3.20)
Controls	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes
Obs.	2508110	2508110	2508110	2508110	2508110
R-squared	0.02	0.03	0.03	0.03	0.02
Panel D: After Covid (2020.01)					
MPI	-0.018	0.045***	0.267***	0.020**	0.020***
	(-1.38)	(3.74)	(26.81)	(2.22)	(3.36)
Controls	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes
Obs.	1825640	1825640	1825640	1825640	1825640
R-squared	0.03	0.04	0.04	0.04	0.03

Notes: The result use samples from all periods.

Table 5: Bank competition level's effect on the relationship between MP and E-wallet

	E-wallet assets (1)	E-wallet Yu'E Bao (2)	E-wallet investments (3)	E-wallet balance (4)
MPI · HHI	0.326***	0.407***	0.329***	-0.146
	(2.32)	(2.58)	(3.07)	(-1.12)
MPI	0.112***	0.167***	0.048***	-0.251***
	(8.62)	(11.13)	(4.62)	(-20.15)
HHI	-1.759***	-2.620***	-1.577	4.543***
	(-3.42)	(-4.47)	(-3.93)	(8.97)
Individual FE	Yes	Yes	Yes	Yes
Obs.	2777195	2777195	2777195	2777195
R-squared	0.02	0.02	0.02	0.02

Notes: The Herfindahl-Hirschman Index (HHI).

Table 6: Digital Finance heterogeneity and the relationship between MP and bank deposits

	Total ratio					
	All	Large	Small	All	All	All
	(1)	(2)	(3)	(4)	(5)	(6)
MPI · log index_aggregate	-0.4690***	0.0258	-0.5211***			
	(-6.89)	(0.16)	(-6.02)			
MPI · log coverage_breadth				-0.3911***		
				(-5.38)		
MPI · log usage_depth					-0.2519***	
					(-5.34)	
MPI · log digitization_level						-0.8472***
						(-6.35)
log index_aggregate	-0.0836	1.9683***	-0.2784			
	(-0.32)	(3.06)	(-0.94)			
log coverage_breadth				-0.6313***		
				(-4.06)		
log usage_depth					0.2322*	
					(1.89)	
log digitization_level						0.3696***
						(4.48)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	530	134	396	530	530	530
R-squared	0.917	0.83	0.91	0.922	0.916	0.919

Notes: "Time FE" denotes year-quarter time fixed effects, similarly hereinafter. The result only contains sample of local banks and excludes national banks. "log index_aggregate" refers to logarithm of the aggregate PKU-DFIIC index, and "log coverage_breadth"" log usage_depth"" log digitization_level" refers to logarithm of the coverage breadth, usage depth and digitization level disaggregated indexes respectively.

Table 7: Digital Finance heterogeneity and the relationship between MP and bank profitability

Panel A: NIM				
	(1)	(2)	(3)	(4)
MPI · log index_aggregate	-2.934***			
	(-3.45)			
MPI · log coverage_breadth		-1.893**		
		(-2.03)		
MPI · log usage_depth			-1.392**	
			(-2.39)	
MPI · log digitization_level				-6.088***
				(-4.23)
log index_aggregate	9.5977***			
	(3.54)			
log coverage_breadth		2.911		
		(1.42)		
log usage_depth			1.387	
			(1.06)	
log digitization_level				2.645***
				(2.85)
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Obs.	508	508	508	508
R-squared	0.629	0.62	0.623	0.632
Panel B: ROA				
	(1)	(2)	(3)	(4)
MPI · log index_aggregate	-0.927***			
	(-3.57)			
MPI · log coverage_breadth		-0.638***		
		(-2.93)		
MPI · log usage_depth			-0.705***	
			(-4.21)	
MPI · log digitization_level				-1.880***
				(-4.07)
log index_aggregate	-0.7015			
	(-0.95)			
log coverage_breadth		-1.230***		
		(-3.03)		
log usage_depth			0.044	
			(0.13)	
log digitization_level				0.689***
				(2.76)
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Obs.	523	523	523	523
R-squared	0.934	0.934	0.934	0.934

Notes: NIM equals to net interest income/average size of interest-earning assets. ROA equals to net profit/average total assets.

Appendix

Table 1: Impact of MP on E-wallet

	E-wallet assets (1)	E-wallet Yu'E Bao (2)	E-wallet investments (3)	E-wallet balance (4)
MPI	0.043***	0.120***	-0.015***	-0.165***
	(5.43)	(12.52)	(-2.97)	(-16.69)
Age	-0.001***	-0.0002**	-0.001***	-0.00002
	(-6.09)	(-2.09)	(-11.18)	(-0.20)
Gender	-0.006***	-0.007***	-0.004***	-0.0003
	(-3.44)	(-3.08)	(-3.10)	(-0.144)
Controls	Yes	Yes	Yes	Yes
Individual FE	No	No	No	No
Year FE	No	No	No	No
City-year FE	No	No	No	No
Obs.	3193286	3193286	3193286	3193286
R-squared	0.000	0.000	0.001	0.000

Table 2: Alipay adoption heterogeneity and the relationship between MP and bank indicators

	Deposits ratio (1)	NIM (2)	ROA (3)
MPI · log alipay_user	-0.057***	-0.279***	-0.066**
	(-7.95)	(-3.33)	(-2.51)
Bank FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Obs.	430	408	423
R-squared	0.917	0.443	0.919

Notes: log alipay_user is the number of alipay users divided by the local resident population and then take the logarithm.

Table 3: Robustness Test: Impact of MP on E-wallet

	E-wallet assets		E-wallet Yu'E Bao		E-wallet investments		E-wallet balance	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
MPI	0.298***	0.266***	0.506***	0.557***	0.037**	-0.042***	-0.596***	-0.757***
	(12.60)	(10.63)	(17.81)	(18.52)	(2.35)	(-2.60)	(-22.41)	(-26.65)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No	Yes	No
City-year FE	No	Yes	No	Yes	No	Yes	No	Yes
Obs.	3193286	3193286	3193286	3193286	3193286	3193286	3193286	3193286
R-squared	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03

Table 4: Robustness Test: Impact of MP on subitems

	Hybrid Fund		Index Fund		Bond Fund		Equity Fund		Other MMFs	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
MPI	-0.155***	-0.238***	-0.020*	-0.059***	0.210***	0.214***	-0.036***	-0.072***	0.011*	0.011
	(-11.84)	(-17.62)	(-1.69)	(-4.77)	(22.81)	(21.92)	(-4.05)	(-7.84)	(1.75)	(1.61)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
City-year FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Obs.	3193286	3193286	3193286	3193286	3193286	3193286	3193286	3193286	3193286	3193286
R-squared	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02