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DIGITAL FINANCE AND FINANCIAL LITERACY: AN EMPIRICAL INVESTIGATION OF CHINESE HOUSEHOLDS

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Abstract

Using the 2015 and 2017 waves of the China Household Finance Survey (CHFS), we measured financial literacy and study its relationship to households' demand for digital finance. We found that a majority of households in the People's Republic of China possess limited financial literacy. The low levels of financial sophistication are responsible for the low usage of digital finance among Chinese households. Further, the positive impact of financial literacy on digital finance is more pronounced for wealthy, high-income, and young households, women, and households in urban and coastal areas. Our results are robust to using a variety of specifications and controlling for endogeneity, peer effects, cognition, and voluntary self-exclusion.

Keywords: financial literacy, digital finance, household finance, CHFS, People's Republic of China

JEL classification: D10, G11, D91, D83

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1. INTRODUCTION

The digitization of financial services is transforming the way in which households participate in the financial markets as well as the way in which they live. Essentially, digital finance connects new financial products and financial services to a digital world to propel financial innovations. Digital finance facilitates payments via a mobile device and helps households to manage their personal assets and investments, providing more convenient access to finance and financial services at a lower cost and leading to greater financial inclusion.

Over the past decade, digital finance has developed rapidly as an alternative finance model in the People's Republic of China (PRC). Diverse digital financial products and services have become increasingly accessible to Chinese households.

First, the demand for mobile payments emerged due to the rise of e-commerce and online shipping, such as Taobao. Mobile payments in the PRC (e.g., Alipay and Wechat Pay) have gained popularity due to their convenience (wide coverage and no intermediary), better features (easy to use and low cost), and quality of service (fast and safe transactions). Mobile payments provide Chinese households with access to credit and financial services via digital interactions.

Second, online financial products in the PRC have grown rapidly. As one of the world's biggest money-market funds, the number of Yu'ebao users grew by more than 370 million in 5 years as a result of a combination of the usage of Alipay and easy access to an interest-bearing facility. Yu'ebao had a turnover of around $268 billion in March 2018. Given the limited alternative investment opportunities in the PRC, internet financial products are attractive due to the promise of higher returns and the flexibility of redemption. These may yield social benefits to create opportunities and improve equality.

Third, internet debts offer an alternative funding source for households and small businesses, improving the credit access for the underserved segments. In the PRC, inefficient bank credit and capital markets have led to rapid internet credit expansion. For example, the credit volume of P2P online lending in the PRC reached RMB3.9 trillion in 2017, which is equivalent to $700 billion (Nemoto, Storey, and Huang 2019). However, years of unregulated growth have led to numerous cases of fraud and the closure of thousands of P2P platforms.

The rapid growth of digital finance has created financial opportunities for Chinese households, who have limited access to sophisticated financial sectors or are deprived of financial services. According to the Global Findex Database 2017, the PRC has the largest unbanked population in the world, and about a fifth of all adults (equal to 255 million adults) do not have an account with a formal institution (accounting for 13% of the world's unbanked population). Digital finance may complement traditional financial intermediaries by increasing access to finance for the members of the population who are often underserved or ignored by inefficient Chinese formal institutions. Consequently, digital finance might create more opportunities to improve income equality and social welfare (Cocco, Gomes, and Maenhout 2005; Demir et al. 2020). Next, by competing with traditional finance business, digital finance may also enhance the resilience of a financial system and promote financial stability (Buchak et al. 2018). Therefore, the promotion of digital finance could be an essential development strategy to improve social welfare and inclusive growth in the context of the PRC.

Financial literacy is critical for households to make financial decisions and for household welfare (Cole, Sampson, and Zia 2011; van Rooij, Lusardi, and Alessie 2011, 2012; Lusardi and Mitchell 2014; Gaudecker 2015). The rapid growth of digital finance and its complexity require households to be well-equipped with financial literacy and knowledge. Prior research has found that the levels of financial literacy are low in the PRC and many other countries (Lusardi and Mitchell 2014; Yuan and Jin 2017). Given that there are profound implications for the welfare effects of households having greater access to financial markets (van Rooij, Lusardi, and Alessie 2012), the recognition of the economic importance of financial literacy has been a major priority for the PRC government to address issues of financial vulnerability and financial resilience.

In this study, we investigated whether Chinese households possess adequate financial literacy to make digital financial decisions and, if so, to what extent financial literacy affects the use of digital finance, that is, mobile payments, internet financial products, and online credit. What mechanism is behind financial knowledge facilitating the promotion of digital finance? To answer these research questions, we used the 2015 and 2017 waves of the China Household Finance Survey (CHFS) to construct households' financial literacy, which allowed us to test our hypothesis in a straightforward way. We documented that financial literacy helps to increase the usage of digital finance. However, a major challenge in the financial literacy literature concerns whether financial knowledge itself could be the result of endogenous choices. Thus, financial literacy may capture not just financial knowledge per se but also other demographic, socioeconomic, and geographic factors that may have an association with the possibilities of using digital finance. For example, households with greater financial knowledge may be more optimistic and hence have higher expectations of innovative digital finance. Alternatively, they may be more confident about embracing new technologies and hence have more trust in digital finance. To overcome the endogeneity concerns, first, we employed an instrumental variable (IV) approach and constructed an instrument for financial literacy. Specifically, using the education levels of the respondents' parents and the neighborhood's financial literacy as the instrumental variables for the level of financial literacy, we confirmed a causal and positive effect of financial literacy on the use of digital finance. Across the entire sample, a one standard deviation increase in financial literacy is associated with an increase in the use of digital finance of 8.8% standard deviations, all else being equal. To control for potential measurement errors, we used different alternative measures of financial literacy in the estimations. Our results are robust to accounting for the impact of peer effects, cognition, and voluntary self-exclusion. We also found that financial knowledge is associated with access to information and communications technology (ICT) and digital trust and tolerance to new technology, which are key mechanisms for promoting digital finance. Finally, we showed that the positive impact of financial literacy on digital finance is more pronounced for wealthy and high-income households, a younger age group, women, and households in urban and coastal areas.

Our paper contributes to the existing literature in several ways. First, this paper complements the literature by investigating the role of financial literacy (see, for example, van Rooji, Lusardi, and Alessie 2011; Lusardi and Mitchell 2014; Gaudecker 2015). Using a more recent dataset, our paper provides microeconomic evidence on the role of financial literacy in the usage of digital finance in an emerging market, namely the PRC.

Our paper also contributes to the welfare enhancement of emerging economies with a weak welfare system, such as the PRC. It proposes a number of policies aimed at enhancing financial sophistication and promoting digital finance as well as digital financial inclusion. Ensuring that the public possesses adequate financial literacy is important to promote digital finance. In addition, it identifies the key barrier that households face in their financial decision making, which is essential to provide high-impact policy advice to improve financial capabilities and meet the financial needs of particularly vulnerable segments of the population.

The remainder of the paper proceeds as follows. Section 2 summarizes the related literature. We develop the research hypothesis in Section 3. Section 4 introduces the dataset, along with our definitions of financial literacy and digital finance, and presents the summary statistics. In section 5, we discuss our main results and present a variety of robustness tests. In section 6, we provide several extensions. Section 7 concludes.

2. RELATED LITERATURE

Financial literacy, as a form of human capital, is the understanding of financial concepts and the knowledge necessary to make important financial decisions. The Organisation for Economic Co-operation and Development (OECD) defined financial literacy as "a combination of awareness, knowledge, skill, attitude and behavior necessary to make sound financial decisions and ultimately achieve individual financial wellbeing." The global policy agenda has prioritized the importance of financial literacy given its important role in the financial empowerment of individuals and the foundation of building financial stability at the household level. However, there are considerably low levels of financial knowledge across different countries. For example, the 2016 OECD/INFE Survey of Adult Financial Literacy Competencies (OECD 2016) reviewed 30 countries and economies, including 17 OECD countries, highlighting that only 56% of adults achieved a minimum target score for financial knowledge (a score of at least five out of seven).

A growing body of literacy studies has found that financial literacy has implications for household behavior (van Rooij, Lusardi, and Alessie 2011, 2012; Lusardi and Mitchell 2014; Gaudecker 2015). Calvet, Campbell, and Sodini (2009) reported that financially unsophisticated households in Sweden are more likely to make financial mistakes, such as underdiversification and inertia in risk taking, and suffer from the disposition effect in direct stockholdings. The study by van Rooij, Lusardi, and Alessie (2011) suggested that a majority of households in the Netherlands possess limited financial literacy, which affects their likelihood of participating in stock markets. Disney and Gathergood (2013) examined survey data from a sample of UK households, showing that borrowers with poor financial literacy are more likely to make bad decisions in the consumer credit market. Specifically, they found that these borrowers, with a lack of understanding of financial concepts, hold more high-cost credit, such as home collected credit, mail order catalog debt, and payday loans.

A handful of papers has documented a link between financial literacy and retirement planning. Focusing on women's retirement planning, Lusardi and Mitchell (2008) found that financial illiteracy is responsible for their unsuccessful plans for retirement. van Rooij, Lusardi, and Alessie (2012) used detailed information about basic and more advanced financial literacy and found that financial literacy has a positive impact on retirement planning and the development of a savings plan, resulting in wealth accumulation. Similarly, by employing the instrumental variables (IV) approach, which relies on regional variation in the financial knowledge of peers, Bucher-Koenen and Lusardi (2011) identified a causal link showing that financial literacy increases retirement

planning. Lusardi and Mitchell (2017) enhanced the measurement of financial literacy based on the data from the Rand American Life Panel (ALP) and obtained a similar result indicating that households with high financial literacy are more likely to plan and save for retirement.

Another strand of research documents has suggested that financial literacy plays an important role in household welfare (Lusardi and Mitchell 2014). Households benefit from investment in financial literacy, which is associated with greater wealth (Jappelli and Padula 2013). Klapper, Lusardi, and Panos (2013) provided evidence that households with higher financial literacy were better at dealing with a negative income shock during 2009. Bucher-Koenen and Ziegelmeyer (2013) showed that financially illiterate households are more likely to sell assets that have lost value due to a financial shock, specifically in the 2008–2009 financial crisis. These illiterate households end up experiencing lower returns in the long run as they do not participate in markets' resurgence.

3. HYPOTHESIS DEVELOPMENT

The household finance landscape in emerging economies, such as the PRC, is facing a series of tough challenges for households due to financial market imperfection. For instance, because households in the PRC have limited access to formal financial markets, their saving rate exceeds 30%. The growth of digital finance offers a unique opportunity for the PRC to achieve inclusive financial development. Digital finance could provide financial services and products to the underserved group or vulnerable people who are systematically disadvantaged in access to financial services, for example women, the low-income group, households without financial knowledge, the elderly/young, and the disabled.

However, financial illiteracy could be a critical barrier to the demand for digital financial services/products. If households are not equipped with enough financial knowledge and not comfortable with new Fintech products, they might not demand them. In line with this argument, and focusing on the PRC, Chu et al. (2017), Zou and Deng (2019), and Jiang et al. (2020) showed that financial literacy could explain households' portfolio choice, financial market participation, and investment outcomes. Similarly, high levels of financial literacy could increase households' awareness of retirement planning and their demand for life insurance and retirement preparation (Zhang et al. 2015; Niu, Zhou, and Gan 2020). They argued that financial knowledge lowers the costs of acquiring information, helps in processing economic information, and enables households to make informed decisions about different financial services and products. Financial knowledge also reduces the psychological barriers to acquiring information and increases households' confidence/trust in new and complex financial products/services. Our study relates to this literature by focusing on the demand for digital finance, which is typically more complex and hence requires more financial knowledge. We thus propose our testable hypothesis:

H1: Ceteris paribus, financial literacy increases households' demand for digital finance.

4. DATA AND SUMMARY STATISTICS

4.1 Data

We used the 2015 and 2017 waves of the China Household Finance Survey (CHFS), which contain very detailed household- and individual-level household finance and

assets, including demographics, wealth, income, and other relevant information. The datasets are designed to be representative of the PRC through a multi-stage stratified random sampling process with probability proportionate to size (PPS).[1] The survey samples cover 29 provinces (municipalities and autonomous regions) and 83 cities, encompassing a total of 37,340 households in 2015 and 40,011 households in 2017. To alleviate the simultaneity issue, the dependent variables of digital finance come from the 2017 wave[2] and the rest of the control variables come from the 2015 wave, and the final sample contains 19,859 observations.

4.2 Measures of Digital Finance

To evaluate the use of digital finance, we asked the respondents whether they had used any digital finance, that is, mobile payments, internet financial products, and internet debts. Specifically, a mobile payment is a money payment processed through a portable electronic device (tablet or mobile phone), such as Alipay (Alibaba), Wechat Pay (Tencent), and Apple Pay (Apple). Internet financial products refer to internet-based wealth management products, such as Yu'ebao (Alibaba), Licaitong (Tencent), JD xiaojinku (JD.com), and Baifa (Baidu). Internet debts include online consumer finance (such as Huabei, JD IOU, etc.), borrowing from internet banks (Webank, Mybank, etc.), online cash lending (Ali microfinance, Ant Borrow, etc.), and P2P lending. *Digital_payments*, *Internet_FPs*, and *Internet_Debts* are binary variables that take the value of one if the respondent uses mobile payments, purchases internet financial products, and has internet debts, respectively, and zero otherwise. Collectively, we determined who uses digital finance with a binary variable (*Digital_Finance*), taking the value of one if the respondent uses any form of digital finance, that is, mobile payments, internet financial products, and internet debts, and zero otherwise.

4.3 Measures of Financial Literacy

To determine whether and to what extent financial literacy affects households' demand for digital finance, we asked three questions to assess the level of financial literacy of the respondents. These three questions covered topics related to the concepts of interest rates and interest compounding (*Quiz_Interest*), the effect of inflation (*Quiz_Inflation*), and the financial risk of stocks and bonds (*Quiz_Risk*), respectively.[3] These questions aimed to assess the basics of financial sophistication associated with households' financial decision making. Table 1 presents the responses to these three questions. There are three recorded answers to the three financial literacy questions: the respondents understood the question and answered the question correctly (*Correct*); the respondents understood the question but did not give the correct answer (*Incorrect*); the respondents did not understand the question and could not answer the question (*Do_not_Know*).

Table 1 reports some basic descriptive statistics about the responses to these three questions. The percentage of correct responses to the questions *Quiz_Interest*,

[1] The Survey and Research Center for China Household Finance, at the Southwestern University of Finance and Economics in the People's Republic of China, has conducted the China Household Finance Survey (CHFS) every two years since 2011. It conducts the survey in the form of face-to-face interviews in the respondents' home. The interviews follow the CAPI (computer-assisted personal interviewing) system and the corresponding survey management system.

[2] The variables of digital finance are only available from the 2017 wave.

[3] Appendix A contains the exact wording of the three questions measuring financial literacy.

Quiz_Inflation, and *Quiz_Risk* is 28.5%, 16.2%, and 51.4%, respectively. However, the percentage of respondents who did not understand the question and could not answer the question is 48.6% (*Quiz_Interest*), 45.9% (*Quiz_ Inflation*), and 39.0% (*Quiz_Risk*). These statistics suggest that the surveyed respondents possess limited financial/economic knowledge. There is widespread financial illiteracy in the PRC.

Table 1: Response to Three Questions about Financial Literacy

	Quiz_Interest		Quiz_Inflation		Quiz_Risk	
	Number	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**
Correct	10,412	28.5%	5,901	16.2%	17,911	51.4%
Incorrect	8,358	22.9%	13,806	37.9%	3,364	9.7%
Do_not_Know	17,726	48.6%	16,728	45.9%	13,589	39.0%
Aggregate	36,496	100.0%	36,435	100.0%	34,864	100.0%

Note: This table reports the number of respondents and the weighted percentage of households providing correct, incorrect, and ''Do_not_know'' answers to each of the financial literacy questions. The data are from the 2015 wave of the China Household Finance Survey (CHFS). The three questions concern the following concepts: numeracy and the capacity to perform calculations relating to interest rates, such as compound interest (*Quiz_Interest*); understanding of inflation (*Quiz_Inflation*); and understanding of financial risk (*Quiz_Risk*). We used sampling weights to ensure that our statistics are representative of the population. Appendix A provides the detailed definitions of all the variables.

To take into account the difference between "incorrect" answers and "do not know" answers, following van Rooij, Lusardi, and Alessie (2011), we constructed two dummy variables for each question based on the respondents' answers. First, if a respondent understood the question and gave an answer (regardless of whether it was correct or incorrect), the dummy variable (*Q_Understand*) is equal to one; otherwise, it is equal to zero. Second, the dummy variable (*Q_Correct*) is equal to one if the respondent also gave the correct answer to the question and zero otherwise. Using the six indicators associated with the three financial literacy questions, we constructed the financial literacy scores for each respondent. Specifically, using factor analysis, we determined one factor based on the statistical identification of eigenvalues in which only one factor has eigenvalues above one. Next, we conducted the iterated principal factor analysis to compute our composite index of financial literacy (*Literacy_Index*).[4]

Alternatively, we used rating scales (*Literacy_Score1* and *Literacy_Score2*) to measure the degree of financial knowledge of the respondents. *Literacy_Score1* is a variable with a three-point scale. Specifically, if a respondent answered the question correctly, she/he would receive one point for the score and zero otherwise. Given the three financial literacy questions asked, *Literacy_Score1* has a range from zero to three. Zero equals the lowest level of financial literacy, and three equals the highest level of financial literacy. Likewise, *Literacy_Score2* is a variable with a six-point scale. Specifically, if a respondent answered the question correctly, she/he would receive two points for the score. If the respondent understood the question but gave the incorrect answer to the question, she/he would have one point for the score. If the respondent did not understand the question ("*Do_not_Know*"), she/he would have zero points for the score. *Literacy_Score2* has a range from zero to six. Zero equals the lowest level of financial literacy, and six equals the highest level of financial literacy.

4.4 Demographic, Socioeconomic, and Geographic Factors

Apart from the financial literacy index, our empirical specification recognized that there are many determinants of the demand for digital finance, which the literature has

[4] The Appendix provides details about the factor analysis.

widely used (Haliassos and Bertaut 1995; van Rooij, Lusardi, and Alessie 2011, 2012; Lusardi and Mitchell 2014; Gaudecker 2015). Specifically, we included demographic factors—age, gender, marital/health status, and household size; socio-economic factors—financial situation, personal income, home ownership and occupation (employment/entrepreneurship), and political status (a communist party member); and geographic factors—rural or urban location and GDP per capita. Specifically, we included the age of the households' head (*Age*) and its square term (Age^2), controlling for the life cycle factors; the education level (*Education*), marital status (*Married*), health status (*Unhealth*), and political status (*Party*), controlling for the impact of the individual/household background on the use of digital finance; the family size (*Size_household*), home ownership (*Homeowner*), and employment status (*Employed* and *Entrepreneurship*), controlling for family burden factors; and net wealth (*Wealth*) and total income (*Income*), controlling for the household financial situation. We included a dummy variable for rural areas (*Rural*), the number of bank branches in the community where the household resides (*Number of branches*), and the logarithm of the county-level GDP per capita (*GRP_per_capita*), controlling for the potential impact of local economic and financial development on the usage of digital finance. To control for uneven development across different provinces, we also included province dummies. As Table 2 shows, the summary statistics for these variables are roughly in line with the summary statistics in Zhang et al.'s (2015) study. See Appendix A for the detailed definitions of all the variables.

Table 2: Summary Statistics of the Key Variables

		N	Mean	S.D.	Min.	Max.
	Digital Finance	19,859	0.288	0.453	0	1
Dependent Variables	Digital_Payment	19,859	0.279	0.448	0	1
	Internet_FP	19,859	0.066	0.248	0	1
	Internet_Debts	19,859	0.039	0.194	0	1
Independent Variables	Literacy_Index	19,859	–0.003	0.943	–1.49	1.15
	Literacy_Score1	19,859	0.965	0.904	0	3
	Literacy_Score2	19,859	2.67	1.95	0	6
	Financial_Class	19,859	0.057	0.232	0	1
Control Variables	Wealth	19,859	792,398	1,123,137	1,136	6,673,773
	Income	19,859	74,048	79,106	2,000	653,219
	Age	19,859	55.45	12.87	25	87
	Age^2	19,859	32.40	14.50	6.25	75.69
	Male	19,859	0.803	0.397	0	1
	Education	19,859	9.04	3.87	0	19
	Married	19,859	0.835	0.371	0	1
	Size_household	19,859	4.10	1.75	2	10
	Unhealthy	19,859	0.115	0.214	0	1
	Employed	19,859	0.419	0.493	0	1
	Homeowner	19,859	0.888	0.316	0	1
	Entrepreneurship	19,859	0.140	0.347	0	1
	Party	19,859	0.167	0.373	0	1
	No_branches	19,859	1.11	1.88	0	25
	Rural	19,859	0.371	0.483	0	1
	GRP_per_capita	19,859	55,405	21,531	26,165	107,960

Note: This table reports the summary statistics of the key variables. Appendix A provides the detailed definitions of all the variables.

4.5 Summary Statistics

Examining the extent to which Chinese households possess financial literacy across demographic groups, Table 3 presents the descriptive statistics. It reveals that there

is a significant difference in the financial literacy of households across different regions. For example, urban households' financial literacy index (*Literacy_Index*) is 0.183, which is significantly larger than that of rural households (-0.457). The financial literacy of households living in eastern regions (0.029) is significantly higher than that of households living in western (–0.156) and central (–0.136) regions. Next, women are more likely to possess financial knowledge than men, as are younger age groups and unmarried people more than mature age groups and married people. These results contradict the findings of Atkinson and Messy (2012), who reported that overall female respondents have lower scores for financial knowledge than male respondents based on 13 countries across 4 continents. Lusardi and Mitchell (2007) and Agarwal et al. (2009) pointed out that the young and the elderly in the United States and other countries are the groups that display lower financial knowledge. In the PRC, it might be the case that the elderly possess low levels of financial knowledge as they have long experience of the centrally planned economy. There is also an apparent relationship between education/wealth/income and the levels of financial literacy. Those with better education and more wealth/higher incomes are more likely to possess financial literacy than those with lower levels of education and personal wealth/income.

Table 3: **Financial Literacy across Demographics**

	Literacy_Index	Literacy_Score1	Literacy_Score2
Nation	–0.003	0.965	2.67
Urban	0.183	1.117	3.034
Rural	–0.457	0.568	1.663
Eastern	0.029	0.994	2.700
Central	–0.136	0.837	2.367
Western	–0.156	0.819	2.286
Female	0.094	1.011	2.755
Male	–0.101	0.882	2.449
Age_16_30	0.468	1.453	3.777
Age_31_40	0.320	1.299	3.460
Age_41_50	0.087	1.038	2.853
Age_51_60	–0.060	0.894	2.508
Age_61_70	–0.237	0.736	2.081
Age_71_max	–0.329	0.677	1.897
Unmarried	0.079	1.034	2.780
Married	–0.044	0.930	2.569
Marriage_Others	–0.206	0.729	2.050
No schooling	–0.641	0.366	1.081
Primary_education	–0.204	0.752	2.138
Secondary_education	0.251	1.179	3.235
Higher_education	0.576	1.635	4.233
Income_Grp1	–0.365	0.656	1.892
Income_Grp2	0.031	0.952	2.678
Income_Grp3	0.324	1.288	3.452
Wealth_Grp1	–0.355	0.654	1.905
Wealth_Grp2	–0.002	0.931	2.616
Wealth_Grp3	0.348	1.311	3.502

Note: This table reports the mean of the literacy measures across demographics. For the education groups, *No_schooling, Primary_education, Secondary_education*, and *Higher_education* are 0, up to 9, 9–12, and more than 12 years of education, respectively. For income/wealth groups, we grouped the corresponding variables based on the tertiles of the distribution of the values. Appendix A provides the detailed definitions of all the variables.

Table 4 reports basic information about the usage of digital finance across demographic groups. On average, 28.8% of households in our sample use digital finance. This figure includes 27.9% for the usage of mobile payments, 6.6% for the usage of internet financial

products, and 3.9% for the usage of internet debts. The usage of mobile payments varies across different regions. Specifically, the percentage of people using mobile payments is 35.3% in eastern regions, which is much higher than that in central (24.1%) and western regions (24.8%). A rural–urban disparity exists: 38.8% in urban areas vs. 11.6% in rural areas. Additionally, younger, unmarried, and female householders are more likely to use digital finance than their mature, married, and male counterparts. The usage of mobile payments increases with the wealth, income, and education levels. Most importantly, the percentage of people using digital finance increases with the financial literacy index, which is in line with our main hypothesis, according to which households that are more financially knowledgeable—that is, more familiar with digital financial products—are more likely to use digital finance.

Table 4: Digital Finance Usage across Subgroups

	Digital_Finance	Mobile_Payments	Internet_FPs	Internet_Debts
Nation	28.8%	27.9%	6.6%	3.9%
Urban	38.8%	37.7%	10.5%	6.9%
Rural	11.6%	11.2%	1.8%	1.1%
Eastern	35.3%	34.2%	10.3%	6.2%
Central	24.1%	23.5%	5.0%	3.6%
Western	24.8%	24.1%	4.9%	4.3%
Female	35.2%	34.0%	9.6%	6.0%
Male	28.7%	27.9%	7.2%	4.8%
Age_16_30	79.4%	77.6%	32.8%	27.0%
Age_31_40	63.7%	61.9%	19.3%	13.7%
Age_41_50	42.4%	41.3%	9.2%	5.5%
Age_51_60	25.1%	24.2%	5.4%	3.0%
Age_61_70	13.2%	12.7%	2.5%	1.2%
Age_71_max	8.0%	7.6%	1.6%	0.7%
Unmarried	60.4%	58.7%	26.2%	23.6%
Married	30.5%	29.6%	7.5%	4.7%
Marriage_Other	18.6%	18.1%	4.0%	2.5%
Edu_Grp0	7.4%	7.2%	1.4%	0.9%
Edu_Grp1	20.3%	19.7%	3.6%	2.4%
Edu_Grp2	38.5%	37.4%	8.8%	6.3%
Edu_Grp3	66.5%	64.5%	24.2%	15.2%
Wealth_Grp1	9.8%	9.5%	1.4%	1.1%
Wealth_Grp2	26.8%	25.9%	4.8%	3.5%
Wealth_Grp3	49.7%	48.2%	13.7%	7.1%
Income_Grp1	10.3%	9.9%	1.3%	1.1%
Income_Grp2	25.1%	24.4%	4.1%	2.8%
Income_Grp3	50.9%	49.3%	14.3%	7.8%
literacy_Grp1	10.3%	9.9%	1.5%	0.9%
literacy_Grp2	39.0%	38.0%	11.2%	6.1%
literacy_Grp3	48.7%	47.1%	12.6%	7.3%

Note: This table reports the mean of the literacy measures across demographics. For education groups, *No_schooling, Primary_education, Secondary_education*, and *Higher_education* are 0, up to 9, 9–12, and more than 12 years of education, respectively. For income/wealth/literacy groups, we grouped corresponding variables based on the tertiles of the distribution of the values. Appendix A provides the detailed definitions of all the variables.

5. FINANCIAL LITERACY AND DIGITAL FINANCE

5.1 Baseline Results

Table 5 reports the results of the probit estimation to determine whether the financial literacy index plays an important role in the usage of digital finance when controlling for other variables.

Table 5: Main Results of the Probit Marginal Effects

	(1)	(2)	(3)	(4)
	Digital_Finance	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Literacy_Index	0.042***	0.042***	0.014***	0.012***
	(0.003)	(0.003)	(0.002)	(0.002)
Ln(Wealth)	0.047***	0.046***	0.015***	0.005***
	(0.002)	(0.002)	(0.002)	(0.001)
Ln(Income)	0.053***	0.051***	0.024***	0.012***
	(0.003)	(0.003)	(0.002)	(0.002)
Age	–0.012***	–0.011***	–0.003***	–0.004***
	(0.002)	(0.002)	(0.001)	(0.001)
Age^2	0.004***	0.004**	0.001	0.002***
	(0.002)	(0.002)	(0.001)	(0.001)
Male	–0.038***	–0.038***	–0.009**	–0.000
	(0.007)	(0.007)	(0.004)	(0.003)
Education	0.007***	0.007***	0.003***	0.001***
	(0.001)	(0.001)	(0.001)	(0.000)
Marriage	–0.018**	–0.019***	–0.002	–0.002
	(0.007)	(0.007)	(0.004)	(0.003)
Size_household	0.010***	0.010***	0.001	0.002**
	(0.002)	(0.002)	(0.001)	(0.001)
Unhealth	–0.085***	–0.089***	–0.032***	–0.022**
	(0.016)	(0.016)	(0.012)	(0.010)
Employed	0.027***	0.028***	0.003	0.009***
	(0.006)	(0.006)	(0.004)	(0.003)
Homeowner	–0.077***	–0.073***	–0.021***	–0.021***
	(0.009)	(0.009)	(0.005)	(0.004)
Entrepreneurship	0.064***	0.061***	0.008**	0.013***
	(0.007)	(0.007)	(0.004)	(0.003)
Party	–0.023***	–0.018**	–0.010**	–0.020***
	(0.007)	(0.007)	(0.004)	(0.004)
Rural	–0.076***	–0.073***	–0.021***	–0.018***
	(0.007)	(0.007)	(0.005)	(0.004)
No_branches	0.003**	0.002	0.002**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Ln(GRP_pc)	–0.014	–0.014	0.014	–0.012
	(0.024)	(0.024)	(0.017)	(0.012)
Province fixed effects	Yes	Yes	Yes	Yes
N	19,859	19,859	19,859	19,859
pseudo R^2	0.271	0.280	0.206	0.176

Notes: The table reports the marginal probability coefficients and standard errors (in parentheses). We estimated all the specifications using the probit estimator. The test statistics and standard errors (in parentheses) of all the variables in the regressions are asymptotically robust to heteroscedasticity. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Commencing with who is more likely to use digital finance in the PRC, column 1 shows that financial literacy significantly increases the probability of using digital finance at the 1% level. Specifically, the marginal effect associated with the financial literacy index is 4.2%. Bearing in mind that the standard deviations of the financial literacy index and digital finance are, respectively, 0.94 and 0.45, a one-standard deviation increase in financial literacy is associated with an increase in the use of digital finance of 8.8% (4.2%*0.94/0.45) standard deviations or 3.9 percentage points (4.2%*0.94), which is economically significant. This effect (4.2%) is also sizeable compared with the marginal effects associated with household wealth and income, which are 4.7% and 5.3%, respectively. We observed the significant and positive marginal effects associated with household wealth and income, suggesting that wealthier and higher-income households are more likely to use digital finance. There are fixed costs for families to use digital finance, which are, however, insufficient to deter them from using it. Education might overcome the barrier to the usage of digital finance due to ignorance and misperceptions (Haliassos and Bertaut 1995). We found that the use of digital finance increases significantly with household education. Education has a positive impact on the use of digital finance, while it does not necessarily reflect financial knowledge or cognitive ability.

Focusing on the other regressors, we found that employment and entrepreneurship have a positive impact on the use of digital finance. However, households with home ownership are less likely to use digital finance, which might suggest that they prefer investing in property to investing in financial assets. We found that the likelihood of using digital finance is significantly lower among men than among women, among married people than among single people, among those living with more unhealthy/communist party members and in the small family size than those with more healthy/no party members and in the large family size. In addition, age is negatively and significantly related to the use of digital finance, whilst the square of age is significantly positively related to it. This suggests a U-shaped relationship between age and the use of digital finance. However, based on the magnitudes of the single term and the squared term, we find that the turning points of the U relationship between age and using digital finance (i.e., the quadratic graph goes from having a downward slope to an upward slope) are all greater than 100.[5] Therefore, age in fact has a negative impact on using digital finance. The findings on regional differences in the propensity to use digital finance, meanwhile, show that its prevalence is higher in urban areas and regions with more financial development than in rural areas and regions with lower levels of financial development.

Columns 2–4 of Table 5 focus on the use of mobile payments, internet financial products, and internet debts, respectively. Consistent with our hypothesis, financial literacy has a significantly positive impact on the use of digital finance through the use of mobile payments, the purchasing of internet financial products, and internet debts, even after accounting for different demographic, socio-economic, and geographic factors. The marginal effects across different types of digital finance reveal that the impact of financial literacy is greater for mobile payments (4.2%, column 2) and then internet financial products (1.4%, column 3) and internet debts (1.2%, column 4). For example, bearing in mind that the standard deviations of mobile payments and the financial literacy index are, respectively, 0.45 and 0.94, a one standard deviation increase in financial literacy is associated with an increase in mobile payments of 8.8% (0.042*0.94/0.45) standard

[5] For example, in column 1, given that the magnitudes of the marginal effects of the single term (Age) and the squared term ($Age^2/100$) are -0.012 and 0.004, the turning point of age for the quadratic graph is 150=0.012/(2*0.004/100).

deviations, which is economically significant. Furthermore, the signs and significance of the other control variables are generally similar in our baseline models (column 1).

5.2 Robustness Tests

We conducted a series of robustness tests to check the validity of our results. Section 5.2.1 reports our check indicating whether our main findings are robust to using different measures of financial literacy. Section 5.2.2 presents the instrumental variable (IV) approach that we used to control for the possible endogeneity of our right-hand side variables. Sections 5.2.3, 5.2.4, and 5.2.5 report the verification of our results when taking peer effects, cognitive ability, and voluntary self-exclusion into account.

5.2.1 Using Different Measures of Financial Literacy

We first verified whether our results are robust to using different proxies for financial literacy. Table 6 presents the estimates based on each of these alternative financial literacy indexes in turn. Panel A corresponds to *Literacy_Score1*, and Panel B corresponds to *Literacy_Score2*. Regardless of the financial literacy index used, the estimates suggest that the marginal effects associated with the financial literacy indexes are statistically significant and positive at the 1% level. Panel C further measures financial knowledge based on whether the respondents have taken any finance-related classes. Specifically, *Financial_Class* is a dummy variable that is equal to one if the respondents attended economics and/or finance classes in the past and zero otherwise. The findings using *Financial_Class* as a proxy for financial literacy confirm that financial literacy generally increases the use of digital finance. As for the other explanatory variables, the estimates are qualitatively similar to those reported in Table 5, but, for brevity, we do not report them. In summary, these results suggest that our main findings are robust to the use of different financial literacy indicators.

Table 6: Probit Model Regressions: Alternative Measures of Financial Literacy

	(1)	(2)	(3)	(4)
Panel A	**Digital_Finance**	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Literacy_Score1	0.042***	0.041***	0.020***	0.011***
	(0.003)	(0.003)	(0.002)	(0.001)
Other Control Variables	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes
N	19,859	19,859	19,859	19,859
Pseudo R2	0.290	0.282	0.229	0.184
Panel B	**Digital_Finance**	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Literacy_Score2	0.026***	0.025***	0.011***	0.006***
	(0.002)	(0.002)	(0.001)	(0.001)
Other Control Variables	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes
N	19,859	19,859	19,859	19,859
Pseudo R2	0.294	0.287	0.229	0.185
Panel C	**Digital_Finance**	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Financial_Class	0.188***	0.175***	0.075***	0.021*
	(0.036)	(0.035)	(0.015)	(0.012)
Other Control Variables	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes
N	19,859	19,859	19,859	19,859
Pseudo R2	0.341	0.336	0.262	0.254

Notes: The table reports the marginal probability coefficients and standard errors (in parentheses). We estimated all the specifications using the probit estimator. The test statistics and standard errors (in parentheses) of all the variables in the regressions are asymptotically robust to heteroscedasticity. See Appendix A for the detailed definitions of all the variables. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

5.2.2 IV Methods

Prior research has often considered financial literacy to be endogenous (van Rooij, Lusardi, and Alessie 2011). Although our baseline specification controls for different demographic, socio-economic, and geographic factors, there might still be unobservable factors that affect the respondents' financial literacy and their use of digital finance. Additionally, financial behavior could influence financial literacy. For example, individuals who use digital finance might be more likely to search for relevant financial information or learn from experience. This may result in a spurious relationship between financial literacy and the use of digital finance. To overcome this endogeneity issue, we employed an instrumental variable (IV) approach. Specifically, following van Rooij, Lusardi, and Alessie (2011), we first used the education levels of the respondents' parents as an instrument for their financial literacy. The intuition is that the education levels of the respondents' parents are unlikely to change as a result of the financial behavior of their children but are likely to be correlated with the financial knowledge of their children. In addition, inspired by Bucher-Koenen and Lusardi (2011), we used the neighborhood's financial literacy as another instrument as the financial knowledge of households belonging to the same community/neighborhood is likely to have a close link but is unlikely to experience an effect from individuals' decisions on digital finance.

Table 7: Robustness Check: Using an Instrumental Variables Probit Approach

	(1)	(2)	(3)	(4)	(5)
Panel A	**First Stage**	**Digital_Finance**	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Literacy_Index		0.283*** (0.010)	0.285*** (0.009)	0.196*** (0.052)	0.210*** (0.053)
Parents' Education	0.011*** (0.002)				
Other Control Variables	Yes	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes	Yes
P-value Exogeneity Test		0.000***	0.000***	0.000***	0.001***
First-Stage F-stat	48.14				
N	16,572	16,572	16,572	16,572	16,572
Panel B	**First Stage**	**Digital_Finance**	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Literacy_Index		0.183*** (0.018)	0.188*** (0.018)	0.032* (0.019)	0.041** (0.021)
Neighborhood's Financial Literacy	0.954*** (0.048)				
Other Control Variables	Yes	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes	Yes
P-value Exogeneity Test		0.000***	0.000***	0.09*	0.027**
First-Stage F-stat	394.19				
N	19,859	19,859	19,859	19,859	19,859

Notes: We estimated all the specifications using the instrumental variable (IV) probit estimator. The test statistics and standard errors (in parentheses) of all the variables in the regressions are asymptotically robust to heteroscedasticity. The p-value exogeneity tests are the Wald tests of exogeneity of the instruments. See Appendix A for the detailed definitions of all the variables. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 7 presents the IV probit estimates. We included all the control variables from the baseline specification. We instrumented the financial literacy index using the education levels of the respondents' parents and the neighborhood's financial literacy in Panels A and B, respectively. Column 1 of Panels A and B reports the marginal effects from our

first-stage regression of financial literacy on the financial literacy of the respondents' parents and neighborhoods, respectively. The marginal effects of both instrumental variables are significantly positive at the 1% level, which satisfies the relevance condition. If parents have a higher level of education, their children have more financial knowledge. Additionally, respondents' understanding of financial matters has a positive association with their neighborhood. These results suggest a potential learning mechanism for financial knowledge. Respondents whose parents have high levels of education or who reside in the same community with high levels of financial knowledge are more likely to have high financial literacy. The statistical first-stage F-values are respectively equal to 48.1 and 394.2, which are greater than the rule of thumb of 10. The large F statistics suggest that our instruments have high explanatory power, so the instruments are valid and justify inference from the results (Stock and Yogo 2005).

Columns 2 to 5 of Panels A and B present the results of the second-stage regression. As expected, the results show a positive and statistically significant estimate of financial literacy, suggesting that individuals with high financial literacy have a higher likelihood of using digital finance, that is, mobile payments, internet financial products, and internet debts. In particular, a 10% increase in financial literacy is associated with an increase in the probability of the use of digital finance ranging from 1.83% to 2.83% (in column 2). In unreported results, we re-estimated the empirical models using the two-stage least square instrumental variable (2SLS) approach. We found similar results to those of our IV probit estimates, indicating that the coefficients for *Literacy_Index* are still significant and positive across different forms of digital finance, that is, mobile payments, internet financial products, and internet debts. In particular, we found that a 10% increase in financial literacy is associated with an increase in the probability of the use of digital finance ranging from 2.52% to 7.03%. For the tests of instrument validity, both the Kleibergen–Paap rk LM and the Anderson test have significant p-values (i.e., a p-value smaller than 0.05), rejecting the null hypothesis that the equation is under-identified. The tests suggest that our instruments are adequate for identifying the equation. In short, our main results are robust to accounting for the potential endogeneity of financial literacy: those who have high financial literacy are more likely to use digital finance.

5.2.3 Peer Effects

Prior research has shown that the experiences of peers can influence respondents' portfolio choices (Hong, Kubik, and Stein 2004; Brown et al. 2008). Our instrumental variable results also show that there is a potential channel of learning about financial knowledge: a direct effect on the acquisition of financial matters of the interaction with individuals who have close links. If this is the case, information about the use of digital finance could spread through peer groups via word of mouth. This subsection investigates whether our estimates hold after controlling for the peer effects of the use of digital finance. To this end, in Panel A of Table 8, we constructed the financial literacy index by subtracting peers' financial literacy from respondents' financial literacy index. Specifically, the financial literacy of peers is the average level of financial literacy, which is constructed as 24 subgroups on the basis of age (6 groups) interacted with education (4 groups), as in Table 2. For brevity, we only report the probit estimates of the new measure of financial literacy. We found that the marginal effects of financial literacy remain significantly positive after taking peer group effects into consideration.

Table 8: Probit Model Regressions: Taking Cognitive Ability and Peer Effects into Consideration

	(1)	(2)	(3)	(4)
Panel A	**Digital_Finance**	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Literacy_Index	0.040***	0.040***	0.013***	0.012***
	(0.003)	(0.003)	(0.002)	(0.002)
Other Control Variables	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes
N	19,859	19,859	19,859	19,859
R2	0.286	0.278	0.209	0.178
Panel B	**Digital_Finance**	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Literacy_Index	0.037***	0.037***	0.012***	0.011***
	(0.003)	(0.003)	(0.002)	(0.002)
Ability_high1	0.026***	0.024***	0.011***	0.007*
	(0.007)	(0.007)	(0.004)	(0.003)
Ability_high2	0.039***	0.038***	0.009*	0.005
	(0.007)	(0.007)	(0.004)	(0.004)
Other Control Variables	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes
N	19,859	19,859	19,859	19,859
R2	0.280	0.272	0.226	0.174

Notes: The table reports the marginal probability coefficients and standard errors (in parentheses). We estimated all the specifications using the probit estimator. The test statistics and standard errors (in parentheses) of all the variables in the regressions are asymptotically robust to heteroscedasticity. See Appendix A for the detailed definitions of all the variables. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

5.2.4 Knowledge or Cognitive Ability

We argue that our financial literacy index is a good measure of financial knowledge. However, it could reflect cognition and ability, which are surrogates for personality traits. To take this into account, we introduced additional controls (*Ability_high1* and *Ability_high2*) for cognitive ability. Specifically, *Ability_high1* is a dummy variable that is equal to one if the respondents relied less on the interpretation of the interviewer when they answered the questions in the survey and zero otherwise. *Ability_High2* is another dummy variable, which is equal to one if overall the respondents were capable of understanding the questions and zero otherwise. It is plausible that the respondents who relied less on help to answer the questions or spent less time understanding the questions have high cognitive abilities. Therefore, we expected that, if our financial literacy index only captured cognitive ability, we would no longer see any effect of the financial literacy index on the use of digital finance in our regressions. Accounting for cognitive ability, the results in Panel B of Table 8 are similar to our baseline findings, showing the significantly positive marginal effects of the financial literacy index on the use of digital finance. In addition, the proxies for cognitive ability tend to be significant and have the expected signs—suggesting that high levels of cognition and ability have a positive effect on the use of digital finance.

5.2.5 Voluntary Self-exclusion

The empirical analysis so far has assumed that respondents' exclusion from digital finance is involuntarily, resulting from a lack of financial knowledge. However, some households may have access to digital finance service but choose not to use it as they do not need it and therefore voluntarily exclude themselves from digital finance. To take this into account, we further dropped households that voluntarily exclude

themselves from digital finance to alleviate self-selection bias. Specifically, we dropped respondents if they answered “no need” to a follow-up question “why don’t you have digital finance?” We found that the results remained qualitatively unchanged: financial literacy has a positive impact on households’ use of digital finance if they are voluntary non-users of digital finance.

6. FURTHER TESTS

6.1 Exploring the Mechanism through Financial Literacy

Access to information and communications technology (ICT) and lack of trust in new technology could be key barriers to the use of digital financial (OECD 2018). In this section, we conducted mechanism tests and examined various channels through which financial literacy can promote the use of digital finance. Specifically, first, we tested whether financial literacy bridge the digital divide. The digital divide is a term refers to the gaps in access to ICT, for example, the use of internet connection devices and access to financial information online and hence increases their use of digital finance (OECD 2018). Second, we tested whether financial literacy can increase households’ trust in the use of new technology and increase their risk tolerance, which might also lead to an increase in their use of digital finance.

To test these potential channels, in Panel A of Table 9, we regressed financial literacy on *Internet_connection_device*, *Financial_information_online*, *Trust*, and *Risk_averter*, including all demographic, socio-economic and geographic factors. See Appendix C for a detailed definition of these variables. As we expected, the coefficients on the first three variables are significantly positive, while the coefficient on *Risk_averter* is significantly negative. These results suggest that households with greater financial literacy tend to have more access to ICT, have more confidence (trust) in embracing new technologies and are less risk-averse. Financial knowledge is an important determinant of the digital divide and the extent of acquiring new technology.

Furthermore, we included these four variables in our baseline regressions. Panel B of Table 9 presents the results. We found that the marginal effects of *Internet_connection_device*, *Financial_information_online*, *Trust*, and *Risk_averter* are significant and positive, suggesting that bridging the digital divide through promoting the use of internet connection devices and access to financial information online increase the use of digital finance. Moreover, an increase in trust in strangers (new technology) and risk tolerance is positively associated with the use of digital finance. We also found that after accounting for these four variables in our regressions, the marginal effect of financial literacy remains significantly positive, but the magnitude reduces. For example, the marginal effect of financial literacy in column 1 dropped by around 50%, that is, from 4.2% (in Table 5) to 2.1%. These results suggest that *Internet_connection_device*, *Financial_information_online*, *Trust*, and *Risk_averter* partially mediate the effect of financial literacy on the use of digital finance. There are important roles for financial literacy to promote the use of digital finance, which are associated with access to information and communications technology (ICT) and digital trust and tolerance to new technology.

Table 9: Further Mechanism Test

	(1)	(2)	(3)	(4)
Panel A	**Internet_device**	**Watch_Fin_online**	**Trust**	**Risk_averter**
Literacy_Index	0.055***	0.026***	0.013***	–0.056***
	(0.003)	(0.003)	(0.003)	(0.004)
Other Control Variables	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes
N	19,859	19,859	19,859	19,859
Pseudo R2	0.286	0.174	0.025	0.073
Panel B	**Digital_Finance**	**Mobile_Payments**	**Internet_FPs**	**Internet_Debts**
Literacy_Index	0.021***	0.021***	0.007***	0.007***
	(0.003)	(0.003)	(0.002)	(0.002)
Internet_ device	0.193***	0.193***	0.063***	0.052***
	(0.005)	(0.005)	(0.005)	(0.005)
Watch_Fin_online	0.096***	0.093***	0.044***	0.025***
	(0.006)	(0.006)	(0.004)	(0.003)
Trust	0.022***	0.017***	0.014***	0.007**
	(0.006)	(0.006)	(0.004)	(0.003)
Risk_averter	–0.037***	–0.034***	–0.018***	–0.011***
	(0.005)	(0.005)	(0.003)	(0.003)
Other Control Variables	Yes	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes
N	19,859	19,859	19,859	19,859
Pseudo R^2	0.385	0.354	0.801	0.265

Notes: The table reports the marginal probability coefficients and standard errors (in parentheses). We estimated all the specifications using the probit estimator. The test statistics and standard errors (in parentheses) of all the variables in the regressions are asymptotically robust to heteroscedasticity. See Appendix A for the detailed definitions of all the variables. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

6.2 Exploring the Interaction Effects of Financial Literacy and Demographic and Socioeconomic Factors

We have shown that demographic and socioeconomic factors, for example household wealth/income, play an important role in determining the use of digital finance. We then investigated the extent of the effect of financial literacy on the use of digital finance for households with different levels of wealth/income. Accordingly, we classified households into three groups (*High_group*, *Medium_group*, and *Low_group*) based on their net wealth/total income. Specifically, in column 1(3) of Panel A of Table 10, we considered a household to have a high (low) level of wealth and income if its net wealth/total income lies in the top (bottom) third of the distribution of the variable in the data sample. The remaining households form the group with medium levels of wealth. We found that the use of digital finance is more sensitive to the level of financial knowledge for families with high levels of wealth (5.6%) and income (5.3%) than for households with the lowest levels of wealth (2.1%) and income (2.5%). We can explain our findings considering that households with high literacy are more likely to use digital finance to manage their wealth/income. High-wealth/income households are more likely to demand digital finance than low-wealth/income households. Therefore, the impact of financial literacy on the demand for digital finance is stronger for high-wealth/income families. Low-wealth/income households might not have finance capacities and might have less exposure to digital finance. Therefore, the role of financial knowledge in the use of digital finance is weaker for this group of families. Alternatively, wealth/income

levels are a key barrier to access to information and communications technology (ICT), which we found is one of the important building blocks for digital finance. The different marginal effects of financial literacy associated with the use of digital finance between high- and low- wealth/income families could be the result of the digital divide between different wealth/income levels.

Table 10: Probit Model Regressions: Taking Demographic and Socio-economic, into Consideration

	(1)	(2)	(3)
Panel A	**Low_Wealth**	**Mid_Wealth**	**High_Wealth**
Literacy_Index	0.021***	0.047***	0.056***
	(0.003)	(0.005)	(0.007)
Other Control Variables	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes
N	6,620	6,620	6,619
Pseudo R^2	0.220	0.317	0.346
Panel B	**Low_Income**	**Mid_Income**	**High_Income**
Literacy_Index	0.025***	0.046***	0.053***
	(0.003)	(0.006)	(0.007)
Other Control Variables	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes
N	6,620	6,620	6,619
Pseudo R^2	0.184	0.123	0.102
Panel C	**Young_Age**	**Middle_Age**	**Old_Age**
Literacy_Index	0.058***	0.046***	0.035***
	(0.008)	(0.005)	(0.004)
Other Control Variables	Yes	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes
N	4,083	8,038	7,738
Pseudo R^2	0.270	0.204	0.194
Panel D	**Male**	**Female**	
Literacy_Index	0.038***	0.057***	
	(0.003)	(0.008)	
Other Control Variables	Yes	Yes	
Province Fixed Effects	Yes	Yes	
N	15,954	3,905	
Pseudo R^2	0.295	0.283	

Notes: The table reports the marginal probability coefficients and standard errors (in parentheses). We estimated all the specifications using the probit estimator. The test statistics and standard errors (in parentheses) of all the variables in the regressions are asymptotically robust to heteroscedasticity. See Appendix A for the detailed definitions of all the variables. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panels C and D further explore whether the impact of financial knowledge on the use of digital finance varies across different age groups and between men and women, respectively. Focusing on the impact of financial literacy on the use of digital finance in panel C, we split the sample into three groups by age: young adults (18–44 years old), middle-aged adults (45–59 years old), and older adults (older than 59 years). We found that young adults exhibit the highest sensitivities of financial literacy to the use of digital finance, followed by middle-aged adults and older adults. In Panel D, the impact of financial literacy on the use of digital finance is more pronounced for women than for men. All in all, the estimates in Panels C and D above indicate that financial knowledge

plays a more important role in the use of digital finance for the young age group and for women.

6.3 Exploring the Interaction Effects of Financial Literacy with Regional Differences

The PRC is a vast nation with significant rural and urban disparity in wellbeing (Huang, Zhang, and Rozelle 2008). As Table 4 shows, urban families use significantly more digital finance than rural families. This sub-section takes a closer look at the possible rural–urban differences in the relationship between financial literacy and the use of digital finance. To this end, we split the sample into rural and urban regions. Panel A of Table 11 presents the results. It shows that the marginal effect for urban families' financial knowledge is 5.4%, which is significantly higher than that for rural families (2.4%). We could attribute this finding to the rural and urban disparity in the development of digital finance (the digital divide). Based on the 2019 China Household Fintech Survey, the percentages of internet access (62.26%) and the use of smartphones (77.20%) in urban areas are much higher than those in rural areas for internet access (26.87%) and for smartphone users (48.17%). Rural households (even those that have financial knowledge), due to their lack of access to the internet and smartphones, are likely to face exclusion from digital finance. Thus, financial literacy would be more beneficial if there was a superior environment for the development of digital finance. In Panel A, we split the sample into three groups by households' locations: coastal regions, central regions, and western regions. We found that in all specifications, the marginal effects associated with financial literacy are always positive and significant. The magnitude is higher in coastal regions (4.8%, column 3) than in western regions (4.1%, column 1) and in central regions (3.2%, column 2). These differences could be the result of digital divides among regions, which are associated with economic development. The coastal regions in the PRC has enjoyed the fastest economic growth.

Table 11: Probit Model Regressions: Taking Geographic Factors into Consideration

	(1)	(2)	(3)
Panel A	**Rural**	**Urban**	
Literacy_Index	0.024***	0.054***	
	(0.004)	(0.005)	
Other Control Variables	Yes	Yes	
Province Fixed Effects	Yes	Yes	
N	7,363	12,496	
Pseudo R^2	0.263	0.207	
Panel B	**Western**	**Central**	**Coastal**
Literacy_Index	0.041***	0.032***	0.048***
	(0.006)	(0.005)	(0.005)
Other control variables	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes
N	4,363	6,171	9,325
Pseudo R^2	0.312	0.299	0.301

Notes: The table reports the marginal probability coefficients and standard errors (in parentheses). We estimated all the specifications using the probit estimator. The test statistics and standard errors (in parentheses) of all the variables in the regressions are asymptotically robust to heteroscedasticity. See Appendix A for the detailed definitions of all the variables. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

7. CONCLUSIONS

In this paper, we provided evidence of a significantly positive and causal effect of financial literacy on the use of digital finance. In particular, financial literacy plays a more important role for households with more wealth and a higher income, young adults, women, and families in urban and coastal areas, suggested by that the marginal effects of financial literacy associated with the use of digital finance are more pronounced for these families. In addition, we addressed the endogeneity concerns by employing an instrumental variable (IV) approach and including a set of demographic, socioeconomic, and geographic variables. Furthermore, we explored different mechanism channels through which financial literacy promotes the use of digital finance. The mechanism analysis found that the level of financial knowledge may promote digital finance through increasing access to information and communications technology (ICT) and digital trust and tolerance to new technology.

Digital finance in emerging markets can address the needs of underserved customer segments, including entrepreneurs, by providing them with solutions for key areas of their lives and business, such as banking and payments. Our findings have important policy implications, revealing that financial literacy plays an important role in bridging the digital divide and promoting digital trust, which leads to a rise in digital finance. Considering that financial illiteracy is prevalent in emerging markets, for example the PRC, it is necessary to use policy measures, such as education and awareness campaigns, to increase households' financial knowledge. Policies associated with promoting financial literacy should prioritize the needs of vulnerable populations, for example illiterate households with low levels of wealth and income and in rural or undeveloped areas.

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APPENDIX A

A1. Questions in the CHFS related to Financial Literacy

The answers to the following three questions relate to the calculation of our composite index of financial literacy (*Literacy_Index*). The three questions concern the following concepts: numeracy and the capacity to perform calculations related to interest rates, such as compound interest (Quiz_Interest); understanding of inflation (Quiz_Inflation); and understanding of financial risk (Quiz_Risk).

Quiz_Interest (H3105): Suppose that you had 100 yuan and the interest rate of a bank was 4% per year. If you deposited this money in the bank for 1 year, how much (the principal and interest earned) would you have in 1 year's time?

1. Less than 104 yuan
2. Equal to 104 yuan
3. More than 104 yuan
4. Do not know

Quiz_Inflation (H3106): Suppose that the annual interest rate of your bank was 5% and the inflation rate was 3%. If you deposited 100 yuan in the bank, after 1 year, how much would you be able to buy with the money:

1. More than you could buy a year ago
2. The same as you could buy a year ago
3. Less than you could buy a year ago
4. Do not know

Quiz_Risk (H3111): Which investment do you think is riskier in general when you buy a stock or equity funds?

1. Stocks
2. Equity funds
3. Never heard of "stocks"
4. Never heard of "equity funds"
5. Never heard of either

APPENDIX B: CONSTRUCTING THE FINANCIAL LITERACY INDEX USING FACTOR ANALYSIS

We constructed the *financial literacy index* using a factor analysis of six components of the answers to the three questions regarding the respondents' financial sophistication. Specifically, if the respondents understood the question and gave an answer, *Quiz_understand* is equal to one; otherwise, it is equal to zero. If the respondents gave the correct answer to the questions, *Quiz_ correct* is equal to one; otherwise, it is equal to zero.

For the factor analysis, one component has eigenvalues above one, suggesting that the study should use one factor. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy takes values between zero and one, with small values indicating that overall the variables have little in common to warrant a factor analysis and values above 0.5 are satisfactory for a factor analysis. The higher the KMO index, the more efficient the factorization. We observed that all the KMO values in our table are above 0.6, which satisfies the minimum requirement for sample adequacy (0.5).

Table A2: Constructing a Financial Literacy Index Using Factor Analysis

Variables	Loading	KMO Test	*Eigenvalue*	*Proportion*	*Cumulative*
Quiz_interest_understand	0.167	0.745	2.786	0.671	0.671
Quiz_interest_correct	0.262	0.711	0.892	0.215	0.886
Quiz_inflation_understand	0.073	0.756	0.342	0.082	0.968
Quiz_inflation_correct	0.261	0.749	0.132	0.032	1.000
Quiz_risk_understand	0.879	0.641	0.001	0.000	1.000
Quiz_risk_correct	0.881	0.647	0.000	0.000	1.000
Aggregate		0.701	0.6967		

APPENDIX C: DEFINITIONS OF ALL THE VARIABLES

Variable Name	Definition
Ln(Wealth)	Natural logarithm of total household net wealth
Ln(Income)	Natural logarithm of total household incomes
Age	Age of the householder
Age^2	Squares of the age of the householder divided by 100
Male	Gender of the householder (one for male, zero for female)
Education	Years of education of the householder
Married	Marital status of the householder (one for married/cohabiting, zero otherwise)
Size_household	Number of household members
Unhealth	Ratio of the number of unhealthy members to the household size
Employed	Dummy variable equal to one if the householder is employed and zero otherwise
Homeowner	Dummy variable equal to one if the household owns a house (the household head is a homeowner) and zero otherwise
Entrepreneurship	Dummy variable equal to one if the household has its own business and zero otherwise
Party	Dummy variable equal to one if the householder is a communist party member and zero otherwise
Trust	Dummy variable equal to one if the respondent trusts strangers and zero otherwise
Watch_Fin_online	Dummy variable equal to one if the respondent watches business/finance news online and zero otherwise
Internet_devices	Dummy variable equal to one if the respondent has internet connection devices and zero otherwise
Risk_averter	Dummy variable equal to one if the respondent is risk averse and zero otherwise
Ability_high1	Dummy variable equal to one if the respondents relied less on the interpretation of the interviewer when they answered the questions in the survey and zero otherwise
Ability_high2	Dummy variable equal to one if the respondents are capable of understanding the questions in the survey and zero otherwise
Financial_Class	Dummy variable equal to one if the respondent has ever attended economics/finance classes and zero otherwise
No_branches	Number of bank branches in the community
Rural	Dummy variable equal to one if the household is a rural resident and zero otherwise
Region	Coastal regions: Liaoning, Tianjin, Beijing, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Hainan Central regions: Heilongjiang, Jilin, Shanxi, Henan, Anhui, Hubei, Jiangxi, Hunan Western regions: Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet Autonomous Region, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang
Ln(GRP _capita)	Logarithm of the county-level GDP per capita