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Consumer Financial Knowledge and the Use of Mobile Banking: Evidence from the 2018 U. S. National Financial Capability Study

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Authors' contributions

This work was carried out in collaboration between both authors. Author FC designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors FC and JX managed the analyses of the study. Author JX managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

As a widely used technology in recent years, the use of mobile banking has been addressed by a great deal of extant research, and a large and growing body of literature has investigated its determinants as well. Utilizing data from the 2018 U.S. National Financial Capability Study, this study aims at examining the association between financial knowledge and mobile banking by using the approach of ordered probit regression. Besides, this study conducts a comprehensive robustness check by replacing estimation methods and removing outliers by income. The results indicate that the relationship between financial knowledge and mobile banking is negative. Besides, financial knowledge negatively contributes to the adoption of mobile payment as well as mobile transfer. Also, consumers with more financial knowledge are more likely to use traditional financial ways. Thus, financial institutions are encouraged to focus on the reduction of risks perceived by consumers to promote the penetration of financial services via mobile devices.

Keywords: Mobile banking; financial knowledge; financial literacy; financial capability; ordered probit regression.

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1. INTRODUCTION

In recent years, the intention to provide new value-added services for consumers has benefited from the rapid development of information technology. In the banking sector, with innovations in telecommunications, it is possible to introduce new channels for accessing banking services. One of the most popular ways is mobile banking, which is defined as a channel whereby consumers interact with a bank through mobile devices [1].

Apart from Internet-based online banking, access to banking services virtually can be available at the time and place that consumers choose through mobile banking. The eye-catching value propositions of mobile banking services are their uninterrupted functionality and freedom of eliminating temporal and spatial constraints. Consumers can pay bills, transfer funds, perform transactions, and check account balance with support from mobile banking whenever and wherever possible. Additionally, banking services via mobile devices provide a lower cost for consumers living in remote areas, especially in some emerging markets. More importantly, mobile banking provides the possibility of creating an alternative option beyond bank branches and ATM networks, in which formal financial services will more easily reach large numbers of consumers, including those living in remote areas, further enhancing financial inclusion [2]. However, there are indeed some risks lying in the use of mobile banking. Risks involving several facets like financial risk, performance risk, privacy risk, psychological risk, and time risk may delay or even prevent the use of mobile banking services in the initial stage [3]. Purwanegara et al. [4] suggested that limited regulation, fraud claim procedure, and perceived risk are hindrances to form a positive attitude, and thereby discourage consumers from accepting mobile banking.

Meanwhile, as new products and financial services become more widely available, access to global financial markets for “small investors” is getting easier. In view of this, it is necessary and urgent to identify whether these investors are financially sophisticated enough to master complex financial products. And typical questions on related topics introduced in basic financial courses have always been used to measure financial knowledge which is considered as a proxy of financial literacy. For instance, Chen and Volpe [5] conducted a 36-question survey aiming at measuring the personal financial knowledge of college students. The questions are associated with common sense, savings, borrowing, insurance, and investments, and the result reveals that the average score of correct responses was nearly 53%, lower than a typical passing score. Besides, prior studies also utilize the abilities to calculate the annual percentage rate and understand risk diversification to measure specific financial knowledge [6-8]. In addition, Lusardi and Mitchell [9] captured consumers’ financial literacy through three concepts as follows: First, consumers' ability to calculate interest rates, such as compound interest, such as compound interest; second, understanding of inflation; and third, understanding of risk diversification. In a special module of the 2004 Health and Retirement Study (HRS), these three questions were first surveyed among a sample of Americans aged 50 and older. Although this group tends to be involved in many financial decisions during their lifetime, this age group underperforms, with only a third able to answer all three questions correctly [10]. Since then, the same questions have been used by several other surveys in the United States, involving the 2007-2008 National Longitudinal Survey of Youth (NLSY), which looked at young respondents (ages 23-28) [11]; the 2009 and 2012 National Financial Capability Study [12]. In these surveys, the findings highlight and expand on the results of HRS, with low levels of financial literacy among all age groups in the United States. Thus, increasingly complex concepts were added to the financial literacy test. For instance, the 2009 National Financial Capability Survey showed that only a small portion of Americans (21 percent) were aware of the inverse relationship between bond prices and interest rates [13]. The rapid spread of financial complex products has imposed greater responsibility on consumers to borrow, save, invest and sign tailored financial contracts. The poor performance of financial literacy in surveys mentioned above, nevertheless, raises concerns of scholars whether consumers are well-equipped to assume responsibilities to make financially complex decisions. To be more specific, financial crisis is often closely related to financial decisions of consumers.

Since credit card has been a vital part of consumer’s life and consumers need to be responsible for their retirement plans, misuse of credit card and wrong plan for retirement savings may bring problems to the society and the economy. Considering the facts, a large and

growing body of literature has investigated the relationships between financial knowledge and the likelihood of a retirement plan as well as the use of credit cards to identify whether consumers who are financially better equipped will perform well in using credit cards and planning retirement savings. Financial knowledge is hypothesized by Jacobs-Lawson and Hershey [14] together with future time perspective and risk tolerance to be factors influencing retirement saving behaviors. Accordingly, the result reveals that future time perspective and risk tolerance interactively affect retirement saving behaviors while financial knowledge has no significant influence on retirement saving behaviors. Moreover, using data from National Financial Capability Study, Lusardi and Mitchell [15] argued that consumers who score higher on the financial knowledge-related questions show a high inclination for retirement plans which is likely to leave them in a better position for retirement life. Specifically, Borden et al. [16] indicated that financial knowledge does not appreciably bear a positive relationship with effective or risky financial behaviors in the pre-test survey. In terms of a study conducted by Jones [17], no significant relationship is found between financial knowledge and college student credit card debt behavior. Furthermore, Robb and Sharpe [18] suggested that financial knowledge functions as a significant factor in an unexpected way influencing credit card decisions as the results show that students possessing higher levels of financial knowledge have significantly higher credit card balances than those with comparatively lower levels but the difference is not significant.

A great deal of previous research has explored the effect of financial knowledge on some financial behaviors including the use of credit cards, the likelihood of a retirement plan, and the like. However, few studies have investigated the relationship between financial knowledge and the use of mobile banking. Consumers can get in touch with the mainstream financial system through a bank account, which is the onset to effectively manage one's finances. But according to the data from the report of consumers and mobile financial services 2014, about 11% of Americans are disconnected from the mainstream financial system and cannot enjoy the services provided by the mainstream financial system. Lack of access to a bank account deprives them of ability to manage their finances effectively. Thus, access to financial services for unserved and underserved consumers need to be paid attention from relevant governments who focus on enhances social welfare. But the proliferation of mobile banking tools has enabled unserved or underserved consumers to access financial services and manage their finances effectively without having a bank account. Thus, the widespread use of mobile banking can help bridge the gap between those who have traditional financial services and those who don't. Therefore, it is necessary to identify the factors that influence the use of mobile banking by consumers because its spread use could improve the overall welfare of society and narrow the gap between different groups. The purpose of this study is to examine the role that financial knowledge may play in consumers' decision to adopt mobile banking, which has a managerial implication for retail financial services and banking. The dataset in this study comes from the State-by-State survey data of the National Financial Capability Study (NFCS) in 2018. The data from NFCS over different years has been used in studies to examine financial capabilities among some groups or detect the role of financial education in some financial behaviors [19-21]. Based on such surveys, consumers' financial capability and financial behaviors can be quantified through their answers to various questions. In this study, mobile banking refers to administer businesses through text messaging, mobile app, or Internet browser, or email on a mobile phone, and it is measured by the frequency of accessing checking and savings account by mobile banking. Moreover, financial knowledge is measured by some questions related to the compounded interest rate, inflation, relationship between bond price and the interest rate, time value of money, and risk diversification.

The remainder of this study is structured as follows. Section 2 reviews related literature on financial knowledge and mobile banking, and this section also develops the hypotheses concerning the role of financial knowledge in mobile banking. Section 3 describes the sample data, model specification, variable measurements, and statistical descriptions. Section 4 deals with empirical results. Section 5 provides conclusions and implications.

2. LITERATURE REVIEW

2.1 Financial Knowledge

Given the fact that increasing responsibilities consumers assume in the fields of retirement plan, the credit card and so on, issues

concerning whether consumers are financially well-equipped to deal with financial matters have been highlighted. Moreover, prior studies have been conducted to quantify financial knowledge of consumers to identify the level of consumers' ability to bear responsibilities of relevant finances. Financial knowledge has always been measured by some questions regarding basic financial concepts and simple calculations in much of the current literature. To be more specific, consumers with higher scores on these questions are regarded as those who possess more actual financial knowledge. For instance, Knoll and Houts [22] developed a psychometrically sound 20-item scale, including interest, inflation, and the time value of money, to measure financial knowledge. Furthermore, based on the data of the Understanding America Study Internet Panel, Houts and Knoll [23] constructed an improved financial knowledge scale and offered an appropriate way to measure financial knowledge quantitatively. These scales enable decision-makers and program evaluators to reckon the impact or success probability of interventions on financial decisions or behaviors through increasing financial knowledge.

Moreover, a large and growing body of literature has examined the current level of financial knowledge of different cohort groups and suggests that most respondents are not financially literate and fail to grasp essential financial concepts. Financial decision-making is associated with financial literacy. But most consumers both in the United States and other countries have a poor ability to perform financial-numerical operations and a poor understanding of basic financial concepts such as the compound interest, difference between nominal and real values, and risk diversification [24]. Lusardi et al. [11] examined young's financial literacy and indicated that their financial literacy is low. Specifically, less than one-third of young individuals possess basic financial knowledge of the interest rate, inflation, and risk diversification. Additionally, the result also indicates that demographic characteristics and family financial sophistication may largely account for financial literacy. Besides, Lusardi et al. [25] investigated the financial sophistication of Americans over 50 years old and suggested that many older respondents are not financially sophisticated, since they fail to understand the basics of risk diversification, asset valuation, portfolio selection, and investment fees.

Also, more recent attention has focused on identifying whether financial knowledge contributes to the improvement of financial behaviors. Von and Gaudecker [26] investigated the relationship between portfolio diversification and financial literacy and revealed that almost all households achieving high scores on financial literacy or those dependent on professionals or private contacts for suggestions receive better investment outcomes. To be more specific, those households who neither seek external help to make financial decisions nor have a good grasp of finance-related concepts and skills in performing essential financial calculations suffer the largest losses due to insufficient diversification. Hence, Von and Gaudecker [26] suggested that policies intending to reduce welfare losses from inferior investment strategies may be initiated by improving financial numeracy and increasing the absorption of financial advice from outside. Lusardi et al. [27] implied that the profile of optimal financial knowledge is hump-shaped over the life cycle. Besides, it varies with educational groups since different educational individuals' income paths may change. In detail, being financially illiterate to some extent will be an optimal choice for a portion of individuals as achieving greater financial sophistication is too expensive so that they hardly benefit from more financial knowledge, and these consumers may rationally have knowledge investment failure. Howlett et al. [28] claimed that financial knowledge and orientation toward the future affect the possibility of a retirement plan in a mutually affected way. Under the given constrained condition that consumers have essential financial knowledge, consumers with an orientation toward the future are more likely to participate in retirement plans while in absence of financial knowledge, the future-oriented character does not contribute to the likelihood of participation in retirement plans.

Nevertheless, the evidence of previous studies on the effect of financial knowledge on financial decisions and behaviors is mixed. For instance, Fernandes et al. [29] argued that interventions seeking to improve financial literacy only account for 0.1% of the difference in financial behaviors, with weaker impacts on low-income cohorts. They also indicated that financial education gradually decays over time, especially the part of interventions with much time of instruction playing in affecting on behavior become negligible 20 months or more from the initial interventions, and the marginal effects of financial literacy plummet when psychological traits are controlled. Tang and Baker [30] divided financial knowledge into objective and subjective

financial knowledge and suggested that a positive self-assessment contributes essentially to change individuals' financial behaviors while objective financial knowledge is important but not decisive enough to explain financial behaviors.

2.2 Mobile Banking

In addition to consumers' financial knowledge, which is highly concerned, mobile banking, which can provide consumers with better financial services, is also highly valued. Mobile banking can be defined as a channel whereby a consumer obtains banking services via mobile devices such as a mobile phone. One of the attention-grabbing traits of mobile banking services is that it is available "on the move". As an innovative technology, mobile banking is valuable for both financial institutions and individuals, especially those underserved. For consumers, this technology enables them to obtain banking services needed to perform financial businesses via mobile devices anytime and anywhere [31]. For financial institutions, this novel technology increases the potential for them to serve consumers within larger regions, particularly in places beyond the Internet and traditional branches [32].

Many studies have dedicated to examining factors playing vital roles in consumers' decisions to adopt mobile banking. It is crucial to identify those for both financial institutions and policymakers as this can help them expand the scope of usage and formulate relevant policies. A large and growing body of literature has attempted to examine how consumers shape their attitude, perception, and intention toward mobile banking. For instance, Zhou [31] claimed that structural assurance is the main factor affecting trust, and the result reveals that trust and perceived ease of use are the key drivers affecting flow experience and willingness to use, and thereby contributing to actual use. Lin [33] indicated that the main factors affecting consumers' perception toward mobile banking are ease of use and compatibility, and the result shows that both of them increase consumers' willingness to adopt services. Besides, the use of mobile banking is heterogeneous in different countries around the world, which may be put down to the diversity of the cultural landscape. Moreover, Bankole et al. [34] conducted a transnational survey consisting of students, and workers from varying employment fields, probing into the factors affecting the use of mobile banking in Nigeria. The result shows that culture is the most indispensable factor affecting the behaviors of users who adopt mobile banking in Nigeria.

The applicability of the technology acceptance model and theory of planned behavior has been extended to the mobile banking environment, in which perceived credibility, perceived self-efficacy, and perceived financial cost are added to the existing structure of the technology acceptance model [35]. Moreover, several studies have introduced other factors affecting the use of mobile banking. Koenig-Lewis et al. [36] provided insight into the potential impact of compatibility, and identified that this factor with perceived usefulness, perceived ease of use, perceived risk, trust, and credibility affects behavioral purposes together, in turn, causes consumers' decision to adopt mobile banking. Besides, the result shows that if the value of mobile banking perceived is consistent with consumers' existing beliefs, values, lifestyle, and experience, the new services are more likely to be used. Simultaneously, this study also indicates that young consumers are more likely to find mobile banking services easy to use, useful, and credible. Meanwhile, if they have a positive belief in the compatibility of this new technology, mobile banking will be free of security and privacy threats. Moreover, task technology fit also explains users' use of this technology besides consumers' perception toward mobile banking. Also, the task technology fit model, the unified theory of acceptance coupled with usage technology were integrated by Zhou et al. [37] into a framework to investigate the determinants of the use of mobile banking. The result reveals that performance expectancy, task technology fit, social influence, as well as facilitating conditions have significant effects on user adoption.

Additionally, the stage of pre-adoption from post-adoption in the process of consumers' actions and decisions to adopt innovations have been separated in prior studies. Looney et al. [38] offered an opinion that pre-adoption begins with consumers' awareness is followed by mental evaluation, which, in turn, may result in the use of new technologies. The post-adoption of innovations involves a trial that brings about the continued use of the innovation. Montazemi and Qahri-Saremi [39] showed that varying factors may be of different importance at disparate stages in the use of online banking. The findings imply that information quality, service quality,

system quality, trust in physical banks act as sufficient drivers for post-adoption of online banking, while in pre-adoption of which structural assurance, perceived ease of use, and social influence matter more.

2.3 Financial Knowledge and Consumer Mobile Banking

To achieve widespread use of mobile banking, identifying related factors which could influence the use of this tool need to be prioritized. Previous research suggests that high levels of financial numeracy and cognitive skills possessed by consumers with financial sophistication may motivate and enable individuals to process information, perform a business, acquire new knowledge, and search for what is available in the market [40]. These characteristics pave a path for using new services such as mobile banking. Besides, financially literate consumers are more likely to manage financial affairs without needing to accept help from counseling services. Mohammad G. and Katayon [41] claimed that financially literate consumers use retail banking services more effectively. Additionally, financially literate consumers are more likely to use online and mobile banking for diverse intentions and applications given that these technologies provide a channel to enjoy banking services at a low cost. Meanwhile, Servon and Kaestner [42] argued that it is beneficial for banks to educate consumers about related products and services which meet their need and then consumers may have a desire for new products and services. This can interpret why banks need to educate consumers with the advent of online banking. Without sufficient financial literacy education, e-banking will remain a field prepared only for financially educated and high-income customers. However, several studies have also indicated that there is a negative association between financial literacy and the use of mobile banking. Financial illiteracy and the lack of information are regarded as the major explanation for low access to formal financial services [43]. Besides, Ky et al. [44] offered the opinion that it is difficult for consumers with less education to understand the diverse financial services available, and they are more likely to lack confidence which holds them back from formal financial branches. Mobile money, therefore, being affordable and perceived easy to use may be adopted by a cohort with a comparatively low level of education. More importantly, there are plenty of risks in the use of mobile banking. The possibility of the product malfunctioning, not being able to operate as it is designed and advertised which leads to failure of providing expected benefits, personal information out of control, and financial losses coming from fraud stand on the way for consumers to embrace mobile banking [3].

Based on the previous studies, this study proposes a hypothesis as follows: although potential risks hiding in new financial products and more access to traditional financial services, consumers with financial knowledge are more likely to learn skills, grasp new information, and have the cognitive ability, and thereby benefit themselves to process information and embrace new things and even avoid risks. Also, financially sophisticated consumers tend to develop diverse applications of new technologies, and thus new devices and services may provide them with greater value. Therefore, the hypothesis is put forward as:

> H_1: The association between consumer financial knowledge and the use of mobile banking is positive.

3. METHODOLOGY AND DATA DESCRIPTION

3.1 Data

The dataset in this study comes from the State-by-State survey data of the National Financial Capability Study (NFCS) in 2018 which was commissioned by the Financial Industry Regulatory Authority Investor Education Foundation and was administered in consultation with the U.S. Treasury Department and the President's Advisory Council on Financial Literacy. In the survey, state figures are weighted to the representative of each state in terms of age, gender, ethnicity, and education. National figures are weighted to be representative of the national population in terms of age, ethnicity, education, and Census division. Moreover, the finding from the survey is weighted to be representative of Census distributions. The survey, a nationwide online survey of 25,000 American adults, has developed benchmarks of financial competence to evaluate how these changes with changes in underlying demographic, behavioral, attitude, and financial literacy characteristics. Additionally, this study also quantifies consumer financial capability and financial behaviors from different perspectives.

3.2 Model Specification and Variables

This study primarily investigates the role of financial knowledge in the use of mobile banking in the USA. Based on hypotheses, the baseline model is specified as follows:

$$mobank_i = \varphi_0 + \beta_i * fks + \alpha_i * finpart + \gamma_i * desfb + \sum_{K=1}^{M} \delta_k * PC_{k,i} + \varepsilon_i \quad (1)$$

In Equation (1), φ_0 is the constant term, the subscript i represents sampling consumer individual, M stands for the numbers of demographic characteristic variables, and ε is the random disturbance term.

In detail, $mobank$ is specified as the dependent variable and is measured by a 3-point scale according to "How often do you access your checking or savings account in the way of mobile banking?" Responses range from 1 to 3, where 1 point means never while 3 point means frequently. In this study, mobile banking refers to performing businesses in the way of text messaging, mobile app, or Internet browser, or email on a mobile phone. Independent variables consist of financial knowledge and other control variables. Besides, this study also investigates the effect of financial knowledge on mobile payment and mobile transfer. Specifically, $mobpay$ denotes mobile payment measured by a 3-point scale in terms of "How often do you use your mobile phone to pay for a product or service in person at a store, gas station, or restaurant?" Moreover, $mobtrs$ stands for mobile transfer, and it is measured by the question of "How often do you use your mobile phone to transfer money to another person?" Both responses of $mobpay$ and $mobtrs$ range from 1 to 3, where 1 point means never while 3 point means frequently as well. Meanwhile, this study tries to examine whether financial knowledge bears a positive relationship on traditional financial ways which is measured by question according to "How strongly do you agree or disagree with the following statement? I would feel comfortable going to a bank or credit union branch to ask a question about a product or service". The responses range from 1 to 7, where 1 point stands for strong disagreement, 7 point means strong agreement, and 4 point represents neither agreement nor disagreement.

To be more specific, fks stands for financial knowledge of consumers which is measured by the sum of correct responses to six financial knowledge questions related to the annual interest rate, the relation between price and interest rate, risk diversification, and inflation. The questions are elaborated on in Table 1. The more questions respondents answer correctly, the higher their score for financial knowledge. Besides, $finpart$ indicates whether respondents have participated in the financial market and invested in stocks, bonds, mutual funds, or other securities. Besides, $desfb$ is utilized to denote consumers' financial behaviors. The financial behaviors are regarding the condition of spending relative to income over the past year, the difficulty of covering expenses and paying all bills in a month, the stability of income in the past 12 months, the behaviors of setting aside rainy-day funds for emergencies, children's college education and the awareness of figuring out the amount to save for retirement. The concrete questions are also shown in Table 1. Also, PC_k denotes the control variable k of demographic characteristics. Six categorical variables for ages (Six categories as 18-24, 25-34, 35-44, 45-54, 55-64, and 65+), and three categorical variables for education (Three categories as high school or lower, some college to bachelor's degree, the postgraduate degree or higher) are included in PC_k. Marital status (1 represents married and 0 otherwise), gender (1 stands for male and 0 otherwise), number of financially dependent children, annual income (ranging from 1 to 8) are incorporated to measure demographics characteristics as well.

3.3 Estimation Method

In terms of the survey data, the variable of mobile banking is not continuous, but an ordered discrete variable (ranging from 1-never to 3-frequently). Therefore, the ordered probit regression is utilized to aim at resolving problems of accuracy and robustness that will occur with the traditional Ordinary Least Squares (OLS) method. In this study, the OLS regression method is conducted, and the ordered probit regression is applied to improve the estimated results.

3.4 Statistical Description

Table 2 presents the results of descriptive statistics involving mean, standard deviation, the maximum and minimum values of each variable. In addition, the number of observations for each variable is 23381. For the dependent variable, the mean of mobile banking is 2.093 on the 3-point scale, which implies most of the consumers prefer to sometimes access checking or savings accounts with mobile banking. The average

Table 1. Variable specification

Variable	Attribute
Mobile banking	"How often do you access your checking or savings account in the way of mobile banking?" 1-never, 3-frequently
Mobile payment	"How often do you use your mobile phone to pay for a product or service in person at a store, gas station, or restaurant?" 1-never, 3-frequently
Mobile transfer	"How often do you use your mobile phone to transfer money to another person?" 1-never, 3-frequently
Traditional financial ways	"How strongly do you agree or disagree with the following statement? I would feel comfortable going to a bank or credit union branch to ask a question about a product or service." 1-strongly disagree, 7-strongly agree," and 4-neither agree nor disagree"
Financial knowledge (The sum of correct responses to six financial knowledge test questions)	"Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow? " 0-false answer, 1-true answer
	"Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?" 0-false answer, 1-true answer
	"If interest rates rise, what will typically happen to bond prices?" 0-false answer, 1-true answer
	"Suppose you owe $1,000 on a loan and the interest rate you are charged is 20% per year compounded annually. If you didn't pay anything off, at this interest rate, how many years would it take for the amount you owe to double?" 0-false answer, 1-true answer
	"A 15-year mortgage typically requires higher monthly payments than a 30-year mortgage, but the total interest paid over the life of the loan will be less." 0-false answer, 1-true answer
	"Buying a single company's stock usually provides a safer return than a stock mutual fund." 0-false answer, 1-true answer
Age	1 = 18 to 24, 2 = 25-34, 3 = 35 to 44, 4 = 45 to 54, 5 = 55 to 64, 6 = greater than 65
Gender	1 = male, 0 = female
High school or lower	1-yes, 0=no
Some college to a bachelor's degree	1-yes, 0=no
Postgraduate degree or higher	1-yes, 0=no
Marital status	1=being married, 0=not married
Children	The number of children financially dependent on their parents.
Annul income	1 =< $15,000, 2 = $15,000-$25,000, 3 = $25,000-$35,000, 4 = $35,000-$50,000, 5 = $50,000-$75,000, 6 = $75,000-$100,000, 7 = $10,000-$150,000, 8 => $15,0000
Participating degree in the financial market	"Do you have any investments in stocks, bonds, mutual funds, or other securities?" 0-no, 1-yes

Variable	Attribute
Desirable financial behaviors (The sum of responses to six financial behaviors test questions)	"Over the past year, would you say your household's spending was less than, more than, or about equal to your income?" 0-more than income, 1-less than or equal to income
	"In a typical month, how difficult is it for you to cover your expenses and pay all your bills?" 0-very difficult or somewhat difficult, 1-not at all difficult
	"Have you set aside emergency or rainy day funds that would cover your expenses for 3 months, in case of sickness, job loss, economic downturn, or other emergencies?" 0-no, 1-yes
	"Are you setting aside any money for your children's college education?" 0-no, 1-yes
	"Have you ever tried to figure out how much you need to save for retirement?" 0-no, 1-yes
	"In the past 12 months, which one of the following best describes your income?" 0-varies quite often, 1-roughly the same or occasionally varies

Note: The content is arranged by the authors

Table 2. Descriptive statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Mobile banking	23,381	2.093	0.875	1	3
Mobile payment	23,381	1.447	0.681	1	3
Mobile transfer	23,381	1.479	0.674	1	3
Financial knowledge	23,381	3.300	1.628	0	6
Gender	23,381	0.447	0.497	0	1
Age 18 to 24	23,381	0.094	0.291	0	1
Age 25 to 34	23,381	0.168	0.374	0	1
Age 35 to 44	23,381	0.164	0.371	0	1
Age 45 to 54	23,381	0.172	0.377	0	1
Age 55 to 64	23,381	0.188	0.391	0	1
Age 65 or older	23,381	0.215	0.411	0	1
High school or lower	23,381	0.246	0.431	0	1
Some college to Bachelor's degree	23,381	0.611	0.488	0	1
Post graduate degree or higher	23,381	0.143	0.350	0	1
Marital status	23,381	0.556	0.497	0	1
Children	23,381	0.650	1.046	0	4
Annual income	23,381	4.681	2.008	1	8
Participating in the financial markets	23,381	0.365	0.482	0	1
Desirable financial behaviors	23,381	3.267	1.368	0	6

Note: The results are arranged by the authors

value of the mobile payment and mobile transfer is 1.447 and 1.479, respectively. It implies that fewer sampled consumers utilize a mobile phone to purchase products or services and transfer money than those checking accounts with mobile banking. The mean of financial knowledge is 3.300, which indicates a relatively poor grasp of financial knowledge measured by six questions in this study. The average value of participating in the financial markets is 0.365, which shows a relatively low degree of participation in stocks, bonds, mutual funds, and other securities. Besides, the mean value of desirable financial behaviors is 3.267, which implies that half of the sampled consumers have been involved in the financial behaviors elaborated above.

The results of descriptive statistics also show that 44.7% of sampling consumers are male. In terms of age, consumers over 65 years old account for the largest proportion (21.5%), followed by consumers whose age range between 55-64 (18.8%) and 45-54, (17.2%). While consumers aged 35-44, (16.4%) and aged 25-34, (16.8%) indicate nearly closer share, those whose age range between 18 and 24 account for a small share (9.40%). Regarding the educational attainment, sampling consumers who attended a high school or lower account for 24.60%, while 61.1% have some college to bachelor's degree as well as 14.3% acquire a postgraduate degree or higher. In terms of marital status, 55.6% of the sampled consumers are married. The average value of annual income is 4.681, which lies in the span of $35,000 to $50,000. Furthermore, the average value of the number of financially dependent children is 0.650, which indicates the families of sampling consumers bear fewer children who need financial support.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1 Results of Correlation Analysis

Table 3 reports the correlations among mobile banking, mobile payment, mobile transfer, financial knowledge, annual income, participating in financial markets, and desirable financial behaviors. Most correlations are as expected. The correlation coefficient between financial knowledge and mobile banking at a significance of 1% is -0.108, showing that a negative relationship exists between financial knowledge and mobile banking. Moreover, the coefficient between financial knowledge and mobile payment is -0.131, implying a bit stronger negative association between financial knowledge and mobile payment. Moreover, there is a negative relationship at a significance of 1% between financial knowledge and mobile transfer, as the same as the negative relevance between financial knowledge and mobile banking or mobile payment. Besides, the relationships between the variable of annual income and the

variable of mobile banking, mobile payment coupled with a mobile transfer are all statistically positive. Meanwhile, the correlations between consumer financial knowledge and participating in the financial market as well as desirable financial behaviors are both positive at a significance of 1% as well. Additionally, the results suggest that consumers who participate in the financial market or have desirable financial behaviors are more likely to perform mobile payment as well as mobile transfer.

4.2 Financial Knowledge and Mobile Banking

Table 4 presents the results of the regressions of financial knowledge on mobile banking, mobile payments, mobile transfer as well as traditional financial ways. In Column (1), only the control variables are entered. In Columns (2) to (6), financial knowledge is added. Columns (1) and (2) show the results of OLS regression. In Columns (3) to (6), to produce more accurate estimates, ordered probit regressions are conducted. To eliminate the influence of the U.S. state-related heterogeneity on estimation results, the dummy variables of all the U.S. states are controlled in all the estimations.

In Column (1), most of the control variables are statistically significant. Accordingly, the negative coefficient for gender indicates that, on average, female consumers have more usage frequency of mobile banking than the male. Moreover, the relationships between different age groups and the use of mobile banking are inconsistent. The coefficient of the 25-34 age group is the largest, followed by the 35-44 age group, and the 45-54 age group is the third. Also, the transitional group of age changing from tapering off to negative coefficient is 45-54. The coefficients of the first three groups are positive, while the coefficient of the 55-65 age group is negative. The results imply that there is a nonlinear relationship between age and the use of mobile banking. The younger the people are, the more likely they are to use mobile banking. The elder, especially those over 55, are less likely to use mobile banking. The reasons for the results may be that the younger use mobile phones more frequently and they have a greater ability to embrace and learn new things. Also, they may feel easier to use mobile banking. Concerning education, since the coefficient for the postgraduate degree or higher is negative while the college to bachelor's degree's coefficient turns out to be positive, the use of mobile banking tends to decline as consumers are more educated. The reason is that consumers with less education are more likely to feel the ease of use of mobile banking services and use the technology more, while consumers with more education are more concerned about the risks of mobile banking and are less likely to use such systems. Meanwhile, the negative coefficient of the variable specific to marital status shows married consumers are less likely to use mobile banking while both the number of children and annual income have a positive impact on mobile banking usage. Additionally, consumers participating in the financial markets or consumers with desirable financial behaviors are less likely to use mobile banking indicated by the negative coefficient shown in Table 4. Consumers with frequent participation in financial markets or those with desirable financial behaviors have already convenient and seamless financial services and the new services offered by mobile banking are not attractive enough.

Table 3. The results of correlations

Variables	Mobile banking	Mobile payment	Mobile transfer	Financial knowledge	Annual income	Participating in financial markets	Desirable financial behaviors
Mobile banking	1.000						
Mobile payment	0.377***	1.000					
Mobile transfer	0.484***	0.478***	1.000				
Financial knowledge	-0.108***	-0.131***	-0.121***	1.000			
Annual income	0.040***	0.060***	0.066***	0.314***	1.000		
Participating in financial markets	-0.054***	0.058***	0.032***	0.286***	0.349***	1.000	
Desirable financial behaviors	-0.054***	0.047***	0.022***	0.277***	0.467***	0.379***	1.000

*Notes: The sample size is 23381. Besides, ***, ** and * denote statistical significance at 1%, 5%, and 10% levels, respectively*

Table 4. The results of regressions of financial knowledge on mobile banking

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Mobile banking**	**Mobile banking**	**Mobile banking**	**Mobile payments**	**Mobile transfer**	**Traditional financial ways**
Financial knowledge		-0.026***	-0.035***	-0.108***	-0.085***	0.061***
		(0.004)	(0.005)	(0.006)	(0.006)	(0.005)
Constant	1.973***	2.013***				
	(0.046)	(0.046)				
Male	-0.023**	-0.009	-0.018	0.221***	0.083***	0.004
	(0.011)	(0.011)	(0.016)	(0.017)	(0.017)	(0.015)
Age 25 to 34	0.604***	0.586***	0.833***	0.611***	0.741***	-0.238***
	(0.016)	(0.016)	(0.025)	(0.026)	(0.025)	(0.023)
Age 35 to 44	0.419***	0.408***	0.561***	0.354***	0.332***	-0.187***
	(0.018)	(0.018)	(0.026)	(0.027)	(0.026)	(0.025)
Age 45 to 54	0.203***	0.200***	0.267***	0.171***	0.040	-0.109***
	(0.017)	(0.017)	(0.024)	(0.026)	(0.026)	(0.023)
Age 55 to 64	-0.056***	-0.054***	-0.074***	-0.107***	-0.257***	0.004
	(0.016)	(0.016)	(0.023)	(0.027)	(0.026)	(0.022)
Some college to Bachelor's degree	0.078***	0.094***	0.136***	0.054**	0.174***	0.015
	(0.013)	(0.014)	(0.020)	(0.021)	(0.021)	(0.018)
Post graduate degree or higher	-0.020	0.005	0.004	-0.005	0.089***	0.047*
	(0.019)	(0.019)	(0.028)	(0.030)	(0.030)	(0.027)
Being married	-0.189***	-0.185***	-0.266***	-0.208***	-0.304***	0.097***
	(0.012)	(0.012)	(0.018)	(0.019)	(0.019)	(0.017)
Number of children	0.090***	0.087***	0.127***	0.137***	0.125***	-0.041***
	(0.006)	(0.006)	(0.009)	(0.008)	(0.008)	(0.008)
Annual income	0.049***	0.052***	0.075***	0.048***	0.075***	0.030***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.005)
Participating in the financial markets	-0.039***	-0.029**	-0.045**	0.191***	0.108***	0.208***
	(0.012)	(0.012)	(0.018)	(0.019)	(0.019)	(0.018)
Desirable financial behaviors	-0.043***	-0.040***	-0.060***	0.024***	-0.000	0.181***
	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.006)
State fixed	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23381	23381	23381	23381	23381	23381
Adjusted R^2	0.140	0.141				
Pseudo R^2			0.071	0.070	0.089	0.047

*Notes: ***, ** and * denote statistical significance at 1%, 5%, and 10% levels, respectively. The numbers in parentheses are standard errors. In Columns (1) and (2), the constant item and adjusted R^2 are reported for the OLS regression method utilized. Besides, only the pseudo R^2 is reported in Columns (3) to (6), since the approach of ordered probit regression is utilized*

In Columns (2) and (3), consumers with financial knowledge are less likely to use mobile banking since the coefficients of financial knowledge are all statistically positive at a significance of 1%. Furthermore, the impacts of financial knowledge on mobile payment as well as mobile transfer are also statistically negative as shown in Columns (4) and (5). The results indicate that the more financial knowledge consumers have, the less likely they are to use mobile payment and mobile transfer, which rejects H_1. One possible explanation is that the negative relationships between financial knowledge and mobile banking, mobile payments as well as the mobile transfer may be explained by the fact that consumers with financial knowledge could better understand and identify the risks hiding in the use of the financial services via mobile devices. Perceived risks are great hindrances to embracing mobile banking, mobile payment, and mobile transfers. Also, consumers may access traditional financial ways better compared with those with a low level of financial knowledge and have less need to use financial services via mobile devices, such as mobile banking, mobile payment, and mobile transfer. Moreover, consumers with less financial education are less likely to obtain services from formal financial branches, and mobile bank provides services with relatively low threshold for this group to obtain financial services.

Such a positive relationship does hold between financial knowledge and traditional financial ways which imply obtaining services in physical outlets for related business is favored by consumers with financial knowledge. The reason is that compared with mobile banking, the legal framework of the traditional financial mode is more perfect. Also, the traditional financial business is often under strong supervision, which can reduce the potential risks. Moreover, the development of the traditional financial business enables it to provide consumers with more perfect and adequate after-sales service. Besides, there is also a nonlinear relationship between age and traditional financial ways, the same as the relationship between age and mobile banking. However, it's worth noting that the relationship between age and traditional financial ways is U-shaped rather than inverted U-shaped which means the older people are, more likely to use traditional financial ways. The causes of the results are that traditional financial ways do not possess risks perceived in mobile banking and are relatively mature in structural assurance and after-sales service so that consumers with financial knowledge more believe in traditional business ways. Specifically, the elder is more familiar with traditional business ways, and they prefer to use these familiar channels due to their comparatively weak ability to embrace new technologies.

Table 5. Results of robustness check

Variables	(1) Mobile banking	(2) Mobile payments	(3) Mobile transfer	(4) Mobile banking	(5) Mobile payments	(6) Mobile transfer
Financial knowledge	-0.056***	-0.186***	-0.141***	-0.066***	-0.196***	-0.153***
	(0.009)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)
Male	-0.034	0.392***	0.146***	-0.041	0.407***	0.142***
	(0.027)	(0.030)	(0.029)	(0.029)	(0.033)	(0.032)
Age 25 to 34	1.343***	1.043***	1.287***	1.484***	1.129***	1.422***
	(0.041)	(0.044)	(0.044)	(0.045)	(0.048)	(0.048)
Age 35 to 44	0.910***	0.606***	0.594***	1.031***	0.670***	0.700***
	(0.042)	(0.046)	(0.045)	(0.047)	(0.051)	(0.050)
Age 45 to 54	0.436***	0.296***	0.097**	0.536***	0.363***	0.187***
	(0.039)	(0.045)	(0.044)	(0.043)	(0.050)	(0.049)
Age 55 to 64	-0.119***	-0.205***	-0.428***	-0.025	-0.138***	-0.322***
	(0.038)	(0.047)	(0.046)	(0.042)	(0.052)	(0.051)
Some college to Bachelor's degree	0.224***	0.097***	0.307***	0.224***	0.118***	0.328***
	(0.033)	(0.036)	(0.037)	(0.036)	(0.040)	(0.040)
Post graduate degree or higher	0.008	0.012	0.167***	0.007	-0.004	0.160***
	(0.045)	(0.051)	(0.051)	(0.050)	(0.056)	(0.056)
Being married	-0.440***	-0.363***	-0.516***	-0.452***	-0.384***	-0.533***
	(0.030)	(0.033)	(0.032)	(0.032)	(0.036)	(0.035)
Number of children	0.209***	0.236***	0.212***	0.194***	0.223***	0.193***
	(0.014)	(0.014)	(0.014)	(0.016)	(0.016)	(0.016)
Annual income	0.124***	0.084***	0.131***	0.151***	0.112***	0.170***
	(0.009)	(0.009)	(0.010)	(0.011)	(0.012)	(0.012)
Participating in the financial markets	-0.080***	0.331***	0.186***	-0.106***	0.338***	0.176***
	(0.030)	(0.033)	(0.032)	(0.032)	(0.036)	(0.035)
Desirable financial behaviors	-0.099***	0.043***	0.000	-0.104***	0.035***	-0.008
	(0.011)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
Observations	23381	23381	23381	19654	19654	19654
Pseudo R^2	0.070	0.071	0.090	0.081	0.077	0.100

*Notes: ***, ** and * stand for the significance level of 1%, 5%, and 10%, respectively. The numbers in parentheses are standard errors. In Columns (1) to (6), ordered logit regression is utilized and no coefficient about the constant item is reported. Outliers (i.e., less than $15,000 or more than $150,000) in the annual income variable are excluded for better estimates in Columns (4) to (6)*

4.3 Robustness Check

To examine the robustness of the estimates, this study firstly replaces the estimation approach of OLS regression and ordered probit regression by ordered logistic regression. Second, to decrease the impacts from outliers by income, this study drops the samples where the annual income is less than $15,000 or more than $150,000. Table 5 presents the results of the robustness check.

In Columns (1) to (3), the relationships of financial knowledge specific to mobile banking, mobile payment, and mobile transfer remain significantly negative. To be more specific, the negative coefficients of financial knowledge for mobile payment and mobile transfer are greater than these of mobile banking.

In Columns (4) to (6), after dropping outliers by income, the results of the associations between financial knowledge and mobile banking, mobile payment as well as mobile transfer vary little from those in ordered logit regression. According to the results of the robustness check, there are negative effects of financial knowledge on mobile banking, mobile payment, and mobile transfer, which is hypothesized in H_2.

5. CONCLUSIONS AND IMPLICATIONS

Previous research on financial knowledge usually focuses on its potential effects on financial behaviors such as the use of credit cards and the management of pensions but neglect its influence on the use of mobile banking which is an important financial behavior as well. Besides, extant studies trying to identify factors affecting the use of mobile banking pay attention to perceived ease of use, perceived risk, perceived usefulness, and the like. Yet little attention has been directed to how consumer financial knowledge affects consumers' decision to adopt mobile banking. Since mobile banking has been made possible by consumers' widespread use of smartphones and has become an increasingly penetrated technology, it is crucial to identify the relationship between financial knowledge and the use of mobile banking.

This study aims at investigating how financial knowledge influences consumer's use of mobile banking based on the data from the 2018 U.S. NFCS. In this study, the approach of ordered probit regression is employed to eliminate the estimation bias. To verify the robustness, comprehensive checks incorporating different estimation methods and removing outliers by income have been conducted as well.

The results show that financial knowledge is negative associated with the use of mobile banking. The more financial knowledge a consumer has, the less use of mobile banking, mobile payment, and mobile transfer. The reason for the results may be while financially sophisticated consumers tend to develop diverse applications of new technologies, some risks still exist in the providing of financial services via mobile devices. Although given that financially literate consumers possess strong numeric and cognitive skills which are essential for using new services [40], they can also recognize potential risks in innovative technologies and then have a low tendency to adopt the emerging things and consciously avoid the risks. Consumers with more financial knowledge are concerned about the loss of funds, divulgence of personal data, the shortage of structural assurance, and the like. On the contrary, they believe traditional financial ways are safer than mobile banking. The reason is the same for the negative relationship between financial knowledge and mobile transfer.

Moreover, this study provides novel findings on relationship between financial literacy and the use of mobile banking. Future research could further extend these findings to other emerging fields. Besides, future research could refine the findings of this study through identifying the mechanisms by which financial knowledge influences consumers' use of mobile banking. Finally, this paper studies consumers in America. It would be intriguing to repeat this study with samples from other countries and compare findings across varying cultures.

This study has some limitations. The first is that there is no panel data related to this topic so that cross-sectional data are utilized in this study. Therefore, this study fails to discover dynamic changes in relationships between financial knowledge and the use of mobile banking. The second limitation is that some more sophisticated methods may be utilized such as panel ordered probit regression when the related dataset is available.

The results of this study are of rich implications for financial institutions that aim at promoting the

use of mobile banking. As a more accessible financial product, the spread use of mobile banking can help to narrow the gap between consumers who are financially well-served and those who are not. And the factors driving consumers to use this novel tool need to be identified. But the result of this study shows a negative relationship between financial knowledge and the use of mobile banking, which may be because consumers with rich financial knowledge will be aware of the potential risks involved, and this group can better enjoy traditional financial services. Therefore, simply improving financial knowledge of consumers without preventing hidden risks may be hardly an effective way for relevant departments to expand the use of mobile banking. In order to promote the use of mobile banking, reducing potential risks hiding in use, the protection of private information, the perfection of structural assurance together with the further improvement of technology can't be ignored. Besides, policymakers are suggested to strengthen the investigation and improve the legal framework for mobile banking due to potential risks brought by the increasingly widespread use of mobile banking with a shortage of effective legal systems.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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