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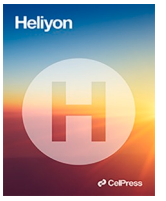

Research article

Investigating the associations of consumer financial knowledge and financial behaviors of credit card use

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ABSTRACT

The growing economic uncertainty makes consumers realize the importance of financial preparedness and management ability. Based on the U.S. National Financial Capability Study dataset from 2009, 2012, 2015, and 2018, this study explores the nexus between consumer financial knowledge and financial behaviors of credit card use. The results indicate that financial knowledge positively affects consumer credit card ownership and desirable financial behaviors of credit card use, and is negatively related to undesirable credit card behaviors. The results are robust to different regression methods and after removing income outliers. The heterogeneity test shows that financial knowledge cannot enhance desirable credit card behaviors because of the income limitations in the low-income group. Therefore, there are implications for policymakers, financial sectors, and consumers to improve consumers' usage of credit cards and cultivate proper consumption habits by enhancing consumer financial knowledge.

1. Introduction

As the speeding-up growth of financial innovation, new financial products, and financial services arise, financial markets throughout the world become easier for "small investors" to participate in [1]. One of the financial innovation products is the credit card. According to the U.S. Credit Card Statistics in 2021, 70.2% of consumers have at least one credit card, and 14% have at least ten. Moreover, the number of credit card accounts increased by 2.5% year-over-year, implying that credit cards have become a primary and vital payment method in modern societies. Economic prosperity brings the accessibility of financial services and the complexity of new financial products [2], making consumers participate directly and indirectly in the financial market and gain unprecedented control over their properties. However, the lessons from the global financial crisis make investors, researchers, and policymakers increasingly aware of the importance of financial knowledge among financial participants [3]. Therefore, this study explores the nexus between consumer financial knowledge and financial behaviors of credit card use, which is positive for consumers to establish proper consumption behaviors, and avoid excessive or impulsive consumption.

The definition of financial knowledge includes three aspects. The first refers to understanding financial concepts, measured by surveyed questions [4,5]. At the same time, the second considers the level of financial knowledge as the proxy for financial literacy [6,7]. Third, financial knowledge is also defined as understanding financial concepts, properly managing money for various uses, and coping with financial problems [8]. In this study, financial knowledge is measured in two ways: Objective financial knowledge,

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represented by six basic financial questions, and subjective financial capability, expressed as a self-assessment of the financial knowledge. Financial knowledge can help consumers better manage their pensions and savings or make wiser investment decisions [9, 10].

However, consumers' average level of financial knowledge is not high worldwide. Prior studies suggest a general lack of financial expertise among U.S. consumers of all ages [11,12]. Liao et al. [13] suggested that financial illiteracy in China prevails. Karakurum-Ozdemir et al. [14] argued that the lack of financial knowledge is severe in five specific middle-income countries, including Mexico, Lebanon, Uruguay, Colombia, and Turkey. Consumer financial decision-making reflects their financial knowledge, and inadequate financial knowledge will introduce irrational investments, inappropriate financial plans, impulsive consumptions, and the like. Low financial literacy negatively contributes to saving ability and retirement planning [15]. In addition, Howlett et al. [16] justified that financial knowledge can affect consumer saving plans and retirement investments, which will be most beneficial in the long run. Also, the COVID-19 crisis reflects that most consumers do not have proper management and planning of their savings, especially the consciousness of financial preparedness [17]. Hence, the significance of financial knowledge and financial education cannot be emphasized any more.

Due to the rapid development of financial innovation, consumer financial capability and knowledge requirements have increased dramatically. This study aims to empirically investigate the connections between financial knowledge and the use of credit cards and to make consumers realize the essential role of financial knowledge in establishing proper consumption behaviors. The data in this study comes from the National Financial Capability Study (NFCS) in 2009, 2012, 2015, and 2018, with 108,310 individuals in this study. Credit card use is comprehensively measured in four ways, including whether the consumer has credit cards, the number of credit cards, as well as the desirable and undesirable behaviors of holding credit cards. Since the dependent variable is a dummy variable or an ordered discrete variable, the methods of logit and ordered logit regression are utilized in this study. The approaches of two-stage least squares (2SLS) and instrumental variable (IV) are used to mitigate the estimation bias caused by endogeneity. The probit regression and dropping the outliers are concerned with improving the estimation results. Finally, the different stages of financial education and income levels are utilized as the sample separation criteria for the heterogeneity test. This study finds that financial knowledge positively contributes to the financial behaviors of credit card use. Additionally, the heterogeneity test shows that financial knowledge cannot enhance desirable credit card behaviors because of the income limitations in the low-income group.

The first contribution of this study is to comprehensively explore the nexus between consumer financial knowledge and financial behaviors of credit card use, which is positive to provide overall empirical evidence for the pivotal effects of financial knowledge on credit card use. Secondly, previous studies mainly focus on the relationships between financial knowledge and credit card use among college students [18]. Nevertheless, this research further investigates the connections between financial knowledge and the use of credit cards by a national survey instead of focusing on the specific object, which can provide more comprehensive results. Thirdly, in light of the empirical analysis, there are constructive implications for policymakers, financial institutions, and consumers to enhance the suitable usage of credit cards by improving consumer financial knowledge.

The remainder of this study is structured as follows. Section 2 reviews prior studies on the roles of consumer financial knowledge in the financial behaviors of credit card use, and the hypothesis is also developed. The data and methodology are introduced in Section 3. Section 4 carefully discusses empirical results and checks endogeneity and robustness. The heterogeneity is examined in Section 5. Section 6 concludes and puts forward the implications and limitations.

2. Literature review and hypothesis development

2.1. Previous research on financial knowledge

Previous studies have addressed the decisive effect of financial knowledge on consumer economic activities [19], such as consumers' investment decisions [12,20,21], the lending behaviors [22], asset investment decisions [23–25] and participation in financial markets [23-25]. The favorable impacts of financial knowledge are vividly demonstrated through preceding literature, indicating that high financial knowledge enables consumers to have better outcomes for saving, lending, investment choices, and financial behaviors. Thus, the hypothesis is put forward as follows:

H1. Given economic conditions and other control variables, financial knowledge positively affects consumers' credit card ownership. Namely, consumers with higher financial knowledge are more likely to have more credit cards.

2.2. Influencing factors of credit card use

Many factors can influence the usage of credit cards. For instance, married status is suggested to significantly affect having a credit card and credit card debt [26-28]. Income is one of the most critical factors affecting the use of credit cards [29]. Hancock et al. [30] indicated that work status positively correlates with the number of credit cards. Utilizing the 1983 and 1986 Survey of Consumer Finance data, Zhu and Meeks [31] revealed that age and employment status significantly affect the amount of credit outstanding. Characteristics and risk attitudes are justified to correlate significantly with credit card performance [28,32]. Emergency consumption while raising a child makes credit cards necessary for some families [33], and housing ownership can also influence the possession of credit cards [34].

2.3. Previous research on financial knowledge and credit cards use

Financial knowledge is necessary for consumers to make desirable financial decisions; thus, knowing how to select the appropriate credit card and adequately use the card needs favorable financial knowledge [10]. Norvilitis et al. [35] surveyed 448 students from Midwestern, Northeastern, and Southern U.S. colleges, highlighting the need for comprehensive financial literacy education. Allgood and Walstad [11] showed that objective and perceived financial knowledge significantly correlate with credit card behaviors. They also illustrated that perceived financial knowledge substantially affects desirable credit card behaviors related to better financial management and less credit card delinquency. Limbu [36] employed the information-motivation-behavioral skills model and surveyed 427 participants, indicating that credit card knowledge has a direct negative relationship with credit card misuse. However, prior studies have not explored whether financial knowledge can affect a consumer's decision to have a credit card or the number of credit cards. This study will fill up this gap and make a comprehensive analysis of credit card use.

The lack of financial knowledge is more likely to cause unfavorable credit card behaviors. Soll et al. [37] performed a multinomial logit analysis and revealed that consumers' misunderstanding of credit card documents results in misusing credit cards and making mistakes on monthly payments. Norvilitis et al. [35] also suggested that credit card debt positively relates to insufficient financial knowledge. Van Rooij et al. [25] designed questions to measure basic financial knowledge and indicated that individuals with low financial literacy are less likely to participate in the stock market. Lusardi and Mitchell [12] showed that many households lack retirement plans because they are unfamiliar with basic financial concepts. Lusardi and Tufano [38] employed a national sample of Americans to examine the relationships between financial experiences, debt literacy, and indebtedness. The results suggest that consumers with low levels of debt literacy and financial experiences are more likely to encounter high-cost borrowing and debt problems. Sunderaraman et al. [39] revealed that numerical ability and financial literacy statistically correlate with delinquency and default.

As mentioned, this study carefully justifies the decisive impacts of financial knowledge on credit card use and other financial behaviors. Meanwhile, the outcomes of lacking financial knowledge are also addressed in detail. Thus, this study puts forward the following hypotheses:

H2. Given economic conditions and other control variables, financial knowledge is positively associated with desirable credit card behaviors, that is, the more financial knowledge consumers have, the more desirable credit card behaviors they will perform.

H3. Given economic conditions and other control variables, financial knowledge negatively contributes to undesirable credit card behaviors, that is, the more financial knowledge consumers have, the less possibility for them to behave undesirably.

3. Data and methodology

3.1. Data

The data in this study comes from the NFCS conducted by the FINRA Investor Education Foundation every three years, a large-scale, multi-year project investigating Americans' financial capability. The NFCS data are publicly available, and all respondents are voluntary. The NFCS was first performed in 2009 and then repeated every three years, covering demographic, behavioral, attitudinal, and financial literacy characteristics in the survey. In the data selection process, this study utilizes surveys conducted in 2009, 2012, 2015, and 2018, and year and state dummies are controlled in all estimates. The samples with answers of "don't know" or "prefer not to say" are excluded. Thus, the sample size used in this study is 108,310.

3.2. Model specifications and variable measurements

This study primarily investigates the impacts of financial knowledge on consumer financial behaviors of credit card use. Based on the hypotheses, the baseline regression model is specified as follows:

$$creditcard_i = \alpha_0 + \beta_1 * finknw_i + \sum_{k=1}^{M} \gamma_k * cv_{k,i} + \theta * y_t + \varphi * s_i + \varepsilon_{i,t} \quad (1)$$

In Eq. (1), the subscript i of the variables represents the sampling respondents, and the superscript M stands for the number of control variables. The $cv_{k,i}$ denotes the control variable k for consumer i. The y_t represents the year-fixed effect, and s_i stands for state dummies. Following the specifications of [40]; control variables incorporate age, ethnicity (Two categories: white and non-white), marital status (Two types: married and not married), the number of children, income, work status (0—unemployed, and 1—employed), risk attitude (From 1—not at all willing to take any risk to 10—very willing to take risks), financial education (0—no financial education, and 1—have financial education), perceived financial capability (From 1—very low to 7—very high), perceived math capability (From 1—strongly disagree that I am pretty good at math to 7—strongly agree that I am pretty good at math), owning house property (0—don't have a house, and 1—have a house), and credit rating (1—very bad, and 5—very good). Moreover, $finknw_i$ represents the financial knowledge a respondent has. Following prior studies [10,25,41,42], this study measures financial knowledge by six questions related to the interest rate, asset price, funds, and the like. This study gives each correct answer one point and then calculates the total points for each respondent. Therefore, the variable of $finknw_i$ ranges from 0 to 6. Besides, ε_i is the random disturbance term.

In detail, there are four measurements used to represent consumer financial behaviors of credit card use ($creditcard_i$), namely having credit cards ($havecard_i$), the number of credit cards ($numcrd_i$), desirable credit card behaviors ($desdb_i$), and undersirable credit card behaviors ($udsdb_i$), respectively. Thus, the further regression models are specified as follows:

$$havecard_i = \alpha_0 + \beta_1 * finknw_i + \sum_{k=1}^{M} \gamma_k * cv_{k,i} + \theta * y_t + \varphi * s_i + \varepsilon_{i,t} \tag{2}$$

$$numcrd_i = \alpha_0 + \beta_1 * finknw_i + \sum_{k=1}^{M} \gamma_k * cv_{k,i} + \theta * y_t + \varphi * s_i + \varepsilon_{i,t} \tag{3}$$

$$desdb_i = \alpha_0 + \beta_1 * finknw_i + \sum_{k=1}^{M} \gamma_k * cv_{k,i} + \theta * y_t + \varphi * s_i + \varepsilon_{i,t} \tag{4}$$

$$udsdb_i = \alpha_0 + \beta_1 * finknw_i + \sum_{k=1}^{M} \gamma_k * cv_{k,i} + \theta * y_t + \varphi * s_i + \varepsilon_{i,t} \tag{5}$$

In Eqs. (2)-(5), $havecard_i$ is a dummy variable, equaling 1 if consumers have credit cards and otherwise 0. Moreover, $numcrd_i$ represents the number of credit cards the respondents have, which ranges from 1 to 6. Moreover, $desdb_i$ is desirable credit card behaviors, including two kinds of behaviors, paying all the bills punctually and collecting information about different cards to make the comparison. Meanwhile, $udsdb_i$ stands for undesirable credit card behaviors, including carryover balance and charging interest, paying the minimum payment, charging a late fee for late payment, charging an over-the-limit fee for exceeding the credit line, and using the card for a cash advance. This study offers one point for each behavior, then takes the sum of all the points together. In the end, the range of $desdb_i$ is from 0 to 2, and that of $udsdb_i$ is from 0 to 5. The variable specification is presented in Table 1.

3.3. Estimation method

Since all dependent variables are not continuous in this study, *havecard* is a dummy variable, *numcrd*, *desdb*, and *udsdb* are ordered discrete variables, and the OLS regression may decrease the accuracy and generate misleading results [43]. Therefore, the benchmark methods in this study are logit and ordered logit regression, and the OLS is applied as the reference.

Let $creditcard^* = X'\beta + u$, and $creditcard^*$ is non-observable, $X' \in (finknw, cv)$ and $u \in (u_1, u_2, \ldots, u_n)$. Meanwhile, assume that all the ordered discrete dependent variables (*numcrd*, *desdb*, *udsdb*) follow the following rules,

$$numcrd_i = \begin{cases} = 1, if\ numcrd_i < u_1 \\ = 2, if\ u_1 < numcrd_i < u_2 \\ = 3, if\ u_2 < numcrd_i < u_3 \\ \vdots \\ = Q, if\ numcrd_i > u_n \end{cases} \tag{6}$$

Table 1
Variable specification.

Variables	Description
finknw	How many financial questions can be answered correctly? 0-No correct answer, and 6-All six answers are correct
havecard	"Do you have a credit card?" 0 = No, and 1 = Yes
numcrd	"How many credit cards do you have?" 1 = 1, 2 = 2–3, 3 = 4–9, 4 = 9–12, 5 = 13–20, and 6 = More than 20
desdb	A sum of two desirable credit card behaviors, 0-Have no desirable credit card behaviors, and 2-Have all the good behaviors
udsdb	A sum of five desirable credit card behaviors, 0-Have no desirable credit card behavior, and 5-Have all the desirable behaviors
age	All of the sampling respondents are older than 25 years, and it is divided into five categories: 18–24, 25–34, 35–44, 45–54, 55–64, and 65 or above
ethn	0 = White, and 1 = Non-white
marriage	0 = Not married, and 1 = Married
child	"How many children do you have who depend financially on you [or your spouse/partner]?" 0-No child, and 4-More than four children
income	"What is your [household's] approximate annual income" 1 = less than $15,000, 2 = $15,000 to $25,000, 3 = $25,000 to $35000, 4 = $35,000 to $50,000, 5 = $50,000 to $75,000, 6 = $75,000 to $100,000, 7 = $100,000 to $150,000, and 8 = More than $150,000
worksts	0-No job, and 1-Have a job
riskatt	"When thinking of your financial investments, how willing are you to take risks?" 1-Not at all willing, and 10-Very willing.
finedu	"Was financial education offered by a school or college you attended or a workplace where you were employed?" 1-Yes, and 0-No
pefcap	"How strongly do you agree or disagree with the following statements? - I am good at dealing with day-to-day financial matters, such as checking accounts, credit and debit cards, and tracking expenses." From 1-Strongly disagree to 7-Strongly agree
pemath	"How strongly do you agree or disagree with the following statements? –I am pretty good at math" From 1-Strongly disagree to 7-strongly agree
havhome	"Do you [or your spouse/partner] currently own your home?" 1-Yes, and 0-No
crerating	"How would you rate your current credit record?" From 1-Very bad to 5-Very good.

Note: All the binary variables are appropriately encoded from the original dataset.

$$desdb_i = \begin{cases} = 1, if\ dscdb_i < u_1 \\ = 2, if u_1 < dscdb_i < u_2 \end{cases} \tag{7}$$

$$udsdb_i = \begin{cases} = 1, if\ udscdb_i < u_1 \\ = 2, if u_1 < udscdb_i < u_2 \\ = 3, if u_2 < udscdb_i < u_3 \\ \vdots \\ = Q, if\ udscdb_i > u_n \end{cases} \tag{8}$$

In Eqs. (6)-(8)), $u_1 < u_2 < u_3 \ldots < u_n$ are parameters to be estimated, which are also designated as the cutoff points. Besides, Q is the maximum number of points of each specific variable. The primary function of logit regression is as follows:

$$P(creditcard^*|X) = \Lambda\left(X_i'\beta\right) \equiv \frac{exp\left(X_i'\beta\right)}{1 + exp\left(X_i'\beta\right)} \tag{9}$$

In Eq. (9), the values of the dependent variable of *creditcard* are 0 and 1. Furthermore, the primary function of ordered logit regression is:

$$\begin{cases} P(Y_i = 1|X) = \varnothing\left(u_2 - X_i'\beta\right) - \varnothing\left(u_1 - X_i'\beta\right) \\ P(Y_i = 2|X) = \varnothing\left(u_3 - X_i'\beta\right) - \varnothing\left(u_3 - X_i'\beta\right) \\ \vdots \\ P(Y_i = n|X) = 1 - \varnothing\left(u_{n-1} - X_i'\beta\right) \end{cases} \tag{10}$$

In Eq. (10), the dependent variables are *numcrd*, *desdb*, and *udsdb*, which are ordered and non-continuous. By utilizing the logit and ordered logit regression, the probability distribution function is more identical to the characteristics of discontinuous and ordered dependent variables, ensuring the empirical results' robustness and accuracy. Besides, the ordered logit regression is utilized to solve the likelihood function, and the MLE estimator can be obtained, further improving the accuracy of empirical results. Additionally, this study replaces the logit and ordered logit regressions with the probit and ordered probit regressions. Unlike the logit regression, which is based on the logistic distribution, the probit regression depends on the normal distribution. The method of 2SLS is utilized to eliminate estimation bias caused by endogenous problems.

3.4. Descriptive statistics

Table 2 presents the results of the descriptive statistics. For the dependent variables, consumers with credit cards account for 76.7% of the total sample, implying that credit cards are popular in modern society. The mean value of the number of credit cards is 1.73, reflecting that most consumers have more than one credit card. The mean score of the variable to measure the desirable credit card behaviors is 0.647 out of 2, indicating that less than one-third of consumers pay all the bills punctually or collect information about different cards to make comparisons before they want to get one credit card. However, the mean value of the variable to measure

Table 2
Descriptive statistics.

Variables	Obs.	Mean	Min	Max
havecard	108,310	0.767	0	1
numcrd	108,310	1.730	0	6
desdb	108,310	0.647	0	2
udsdb	108,310	0.932	0	5
finknw	108,310	3.134	0	6
age25_34	108,310	0.175	0	1
age35_44	108,310	0.174	0	1
age45_54	108,310	0.192	0	1
age55_64	108,310	0.176	0	1
*age65_*	108,310	0.175	0	1
ethn	108,310	0.262	0	1
marriage	108,310	0.551	0	1
child	108,310	0.708	0	4
income	108,310	4.348	1	8
worksts	108,310	0.555	0	1
riskatt	108,310	4.654	0	10
finedu	108,310	0.156	0	1
pefcap	108,310	5.665	0	7
pemath	108,310	5.569	0	7
havhome	108,310	0.615	0	1
crerating	108,310	1.875	0	5

Note: The content is arranged by the authors.

undesirable credit card behaviors is 0.932 out of 5, implying a low possibility of unwanted credit card behaviors. For the primary independent variable, the mean score of financial knowledge is 3.134 out of 6, suggesting that most consumers are well-equipped with financial knowledge.

To be more specific, the mean value of financial education is just 0.156, indicating a small number of schools or colleges that offer financial knowledge education. The average value of the perceived financial capability and math ability is 5.665 and 5.569 out of 7, respectively, revealing that many consumers confidently believe that they are good at dealing with financial matters and they are pretty good at math. However, the mean value of self-assess of credit card rating is only 1.875 out of 5, indicating that consumers think their rating is low because of their undesirable credit card behaviors.

4. Empirical results

In this study, credit card use is measured by the ownership of credit cards and credit card use behaviors. The approaches of logit and ordered logit regression are utilized to perform baseline estimations.

4.1. Financial knowledge and the ownership of credit cards

Table 3 presents the estimation results of the regressions of financial knowledge on the ownership of credit cards. In Columns (1),

Table 3
Results of regressions of financial knowledge on the consumer having a credit card.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	Logit	OLS	Logit	OLS	Ordered logit	OLS	Ordered logit
	havecard	havecard	havecard	havecard	numcrd	numcrd	numcrd	numcrd
finknw			0.021***	0.174***			0.065***	0.125***
			(0.001)	(0.006)			(0.002)	(0.004)
age25_34	0.049***	0.233***	0.047***	0.219***	0.223***	0.375***	0.217***	0.364***
	(0.004)	(0.030)	(0.004)	(0.030)	(0.013)	(0.023)	(0.013)	(0.023)
age35_44	0.014***	0.011	0.007	−0.036	0.166***	0.286***	0.144***	0.245***
	(0.005)	(0.032)	(0.005)	(0.032)	(0.013)	(0.024)	(0.013)	(0.024)
age45_54	−0.002	−0.086***	−0.012***	−0.157***	0.155***	0.277***	0.124***	0.217***
	(0.004)	(0.030)	(0.004)	(0.031)	(0.013)	(0.023)	(0.013)	(0.023)
age55_64	0.033***	0.164***	0.019***	0.067**	0.269***	0.485***	0.228***	0.407***
	(0.005)	(0.032)	(0.005)	(0.033)	(0.014)	(0.024)	(0.014)	(0.024)
*age65_*	0.107***	0.792***	0.091***	0.687***	0.521***	0.924***	0.471***	0.833***
	(0.005)	(0.037)	(0.005)	(0.037)	(0.014)	(0.025)	(0.014)	(0.025)
ethn	−0.004	−0.054***	0.001	−0.014	−0.020**	−0.039***	−0.004	−0.008
	(0.003)	(0.021)	(0.003)	(0.021)	(0.008)	(0.014)	(0.008)	(0.014)
marriage	0.007***	0.071***	0.008***	0.076***	−0.015*	−0.020	−0.013*	−0.017
	(0.003)	(0.020)	(0.003)	(0.020)	(0.008)	(0.014)	(0.008)	(0.014)
child	−0.013***	−0.106***	−0.012***	−0.096***	−0.011***	−0.025***	−0.007**	−0.017***
	(0.001)	(0.009)	(0.001)	(0.009)	(0.003)	(0.006)	(0.003)	(0.006)
income	0.041***	0.316***	0.038***	0.295***	0.155***	0.266***	0.145***	0.248***
	(0.001)	(0.006)	(0.001)	(0.006)	(0.002)	(0.004)	(0.002)	(0.004)
worksts	0.068***	0.380***	0.067***	0.363***	0.168***	0.301***	0.162***	0.292***
	(0.003)	(0.019)	(0.003)	(0.019)	(0.007)	(0.013)	(0.007)	(0.013)
riskatt	0.009***	0.076***	0.008***	0.067***	0.029***	0.046***	0.025***	0.039***
	(0.000)	(0.003)	(0.000)	(0.003)	(0.001)	(0.002)	(0.001)	(0.002)
finedu	0.027***	0.276***	0.019***	0.200***	0.106***	0.173***	0.082***	0.128***
	(0.003)	(0.027)	(0.003)	(0.027)	(0.009)	(0.016)	(0.009)	(0.016)
pefcap	0.022***	0.128***	0.021***	0.122***	0.047***	0.091***	0.045***	0.087***
	(0.001)	(0.006)	(0.001)	(0.006)	(0.002)	(0.004)	(0.002)	(0.004)
pemath	−0.001	−0.001	−0.005***	−0.033***	0.004	0.009**	−0.009***	−0.015***
	(0.001)	(0.005)	(0.001)	(0.006)	(0.002)	(0.004)	(0.002)	(0.004)
havhome	0.115***	0.717***	0.113***	0.702***	0.329***	0.549***	0.323***	0.541***
	(0.003)	(0.020)	(0.003)	(0.020)	(0.008)	(0.014)	(0.008)	(0.014)
crerating	0.079***	0.601***	0.077***	0.591***	0.171***	0.318***	0.164***	0.305***
	(0.001)	(0.009)	(0.001)	(0.009)	(0.003)	(0.006)	(0.003)	(0.006)
Constant	0.347***		0.329***		0.385***		0.329***	
	(-0.01)		(-0.01)		(-0.031)		(-0.031)	
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	108,310	108,310	108,310	108,310	108,310	108,310	108,310	108,310
Adjusted R^2	0.258		0.262		0.269		0.274	
Pseudo R^2		0.265		0.272		0.105		0.108

Notes: The reference categories are the year 2009, and aged 18 to 24. Moreover, ***, **, and * represent 1%, 5%, and 10% significance levels, respectively, and the data in parentheses are standard errors.

(2), (5), and (6), only control variables are entered. In Columns (3), (4), (7), and (8), the level of financial knowledge is incorporated. Additionally, Columns (1), (3), (5), and (7) show the results of the OLS regression, and Columns (2) and (4) present the results of logit regression for whether the consumer has a credit card. Columns (6) and (8) show the results of ordered logit regression for the number of credit cards a consumer holds. The year and state dummies are controlled in all estimates. Standard errors are reported in parentheses.

In Columns (1), (2), (5), and (6), most of the control variables are statistically significant, as expected. More specifically, consumers who received financial education in school or college and have higher self-assess of financial capability tend to have more credit cards, corresponding to the findings of [41]. The coefficient of self-assess of math capability shows a significant effect on credit card holding without considering financial knowledge in Columns (6), implying that individuals who are good at math are more likely to have credit cards.

In Columns (3), (4), (7), and (8), the coefficients of financial knowledge are 0.021, 0.174, 0.065, and 0.125, respectively, and they are all significant at the 1% level. Therefore, financial knowledge is positively significant regardless of the OLS, logit, and ordered logit regression, indicating that consumers having more financial knowledge tend to have a credit card or more credit cards. The results are aligned with H1, illustrating the positive effect of financial knowledge on credit card ownership.

Table 4
Results of regressions of financial knowledge on the behavior of credit card use.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	Ordered logit	OLS	Ordered logit	OLS	Ordered logit	OLS	Ordered logit
	desdb	desdb	desdb	desdb	udsdb	udsdb	udsdb	udsdb
finknw			0.037***	0.123***			−0.027***	−0.030***
			(0.001)	(0.005)			(0.003)	(0.004)
age25_34	−0.035***	−0.124***	−0.038***	−0.141***	0.298***	0.485***	0.301***	0.488***
	(0.008)	(0.026)	(0.008)	(0.026)	(0.015)	(0.024)	(0.015)	(0.025)
age35_44	−0.160***	−0.540***	−0.172***	−0.591***	0.200***	0.365***	0.209***	0.376***
	(0.008)	(0.027)	(0.008)	(0.027)	(0.016)	(0.025)	(0.016)	(0.025)
age45_54	−0.211***	−0.710***	−0.229***	−0.781***	0.135***	0.290***	0.148***	0.305***
	(0.008)	(0.026)	(0.008)	(0.027)	(0.015)	(0.025)	(0.016)	(0.025)
age55_64	−0.152***	−0.507***	−0.176***	−0.595***	0.046***	0.170***	0.063***	0.189***
	(0.008)	(0.027)	(0.008)	(0.027)	(0.016)	(0.026)	(0.016)	(0.026)
*age65_*	−0.049***	−0.181***	−0.078***	−0.284***	−0.019	0.044	0.001	0.067**
	(0.008)	(0.028)	(0.008)	(0.028)	(0.017)	(0.027)	(0.017)	(0.027)
ethn	−0.003	−0.001	0.007	0.030*	0.126***	0.168***	0.119***	0.161***
	(0.005)	(0.016)	(0.005)	(0.016)	(0.010)	(0.015)	(0.010)	(0.015)
marriage	0.001	−0.001	0.002	0.001	−0.001	0.013	−0.001	0.013
	(0.005)	(0.015)	(0.005)	(0.015)	(0.009)	(0.014)	(0.009)	(0.014)
child	−0.035***	−0.113***	−0.033***	−0.105***	0.094***	0.126***	0.092***	0.124***
	(0.002)	(0.007)	(0.002)	(0.007)	(0.004)	(0.006)	(0.004)	(0.006)
income	0.055***	0.174***	0.049***	0.156***	−0.006**	0.003	−0.002	0.007*
	(0.001)	(0.004)	(0.001)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)
worksts	0.020***	0.102***	0.016***	0.092***	0.257***	0.444***	0.259***	0.447***
	(0.004)	(0.015)	(0.004)	(0.015)	(0.009)	(0.014)	(0.009)	(0.014)
riskatt	0.036***	0.113***	0.034***	0.107***	0.015***	0.012***	0.017***	0.013***
	(0.001)	(0.003)	(0.001)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
finedu	0.109***	0.331***	0.095***	0.287***	0.106***	0.148***	0.116***	0.159***
	(0.006)	(0.018)	(0.006)	(0.018)	(0.011)	(0.017)	(0.011)	(0.017)
pefcap	0.046***	0.172***	0.045***	0.169***	−0.046***	−0.043***	−0.045***	−0.042***
	(0.001)	(0.005)	(0.001)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)
pemath	0.002	0.006	−0.005***	−0.018***	0.017***	0.020***	0.022***	0.025***
	(0.001)	(0.005)	(0.001)	(0.005)	(0.003)	(0.004)	(0.003)	(0.004)
havhome	0.158***	0.543***	0.155***	0.536***	0.129***	0.206***	0.131***	0.209***
	(0.005)	(0.016)	(0.005)	(0.016)	(0.010)	(0.015)	(0.010)	(0.015)
crerating	0.122***	0.461***	0.118***	0.449***	−0.074***	−0.078***	−0.071***	−0.075***
	(0.002)	(0.008)	(0.002)	(0.008)	(0.004)	(0.006)	(0.004)	(0.006)
Constant	0.044**		0.012		0.730***		0.753***	
	(0.018)		(0.018)		(0.036)		(0.036)	
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	108,310	108,310	108,310	108,310	108,310	108,310	108,310	108,310
Adjusted R^2	0.219		0.224		0.061		0.062	
Pseudo R^2		0.132		0.136		0.021		0.021

Notes: The reference categories are the year 2009, and aged 18 to 24. In addition, ***, **, and * represent 1%, 5%, and 10% significance levels, respectively, and the data in parentheses are standard errors. For the OLS regression utilized in Columns (1), (3), (5), and (7), the statistics of adjusted R^2 are reported. Additionally, for logistic regression, the statistics of pseudo R^2 are reported.

4.2. Financial knowledge and financial behaviors of credit card use

Table 4 presents the empirical results of regressions of financial knowledge on consumer financial behaviors of credit card use. In Columns (1), (2), (5), and (6), only control variables are included. In Columns (3), (4), (7), and (8), the level of financial knowledge is considered. Columns (1), (3), (5), and (7) display the results of the OLS regression, and Columns (2), (4), (6), and (8) present the results of ordered logit regression. The year and state dummies are also controlled in these regressions.

In Columns (3) and (4), the coefficients of financial knowledge are 0.037 and 0.123, respectively, which are significantly positive, implying that consumers with more financial knowledge behave desirably in using credit cards. Disney and Gathergood [22] suggested that financial literacy positively increases the possibility of engaging in behaviors that may help improve consumers' awareness of the credit market. The results indicate that financial knowledge positively affects the financial behaviors of credit card use. In Columns (7) and (8), undesirable credit card behaviors tend to be decreased by enhancing financial knowledge with statistically significant coefficients of −0.027 and −0.030, respectively. Thus, consumers with more financial knowledge are more likely to understand the financial risks caused by credit problems, which helps them avoid credit card misuse and enhance their financial security. Thus, the results endorse H2 and H3.

Based on the analysis above, it can conclude that financial knowledge plays a vital role in credit card use. A higher level of financial knowledge can increase the possibility of consumers' decision to have a credit card and make consumers hold more credit cards. Consumers with more financial knowledge tend to have more desirable behaviors in using credit cards, for example, making comparisons before choosing one credit card and paying the bill punctually. Consumers equipped with more financial knowledge are less likely to behave undesirably. The findings highlight that financial knowledge can improve credit card use and help consumers cultivate proper consumption habits and behaviors, aligning with several extant studies [44,45].

Table 5
Endogeneity check.

Variables	(1)	(2)	(3)	(4)
	havecard	numcrd	desdb	udsdb
finknw	0.927***	0.410***	1.701***	−0.125**
	(0.076)	(0.048)	(0.052)	(0.049)
age25_34	0.147***	0.338***	−0.279***	0.473***
	(0.031)	(0.023)	(0.026)	(0.025)
age35_44	−0.294***	0.151***	−1.100***	0.325***
	(0.040)	(0.028)	(0.032)	(0.030)
age45_54	−0.533***	0.078**	−1.537***	0.230***
	(0.048)	(0.033)	(0.037)	(0.034)
age55_64	−0.421***	0.224***	−1.592***	0.091**
	(0.058)	(0.039)	(0.043)	(0.041)
*age65_*	0.070	0.608***	−1.494***	−0.053
	(0.070)	(0.044)	(0.049)	(0.047)
ethn	0.173***	0.062***	0.421***	0.199***
	(0.028)	(0.019)	(0.021)	(0.019)
marriage	0.089***	−0.012	0.031**	0.016
	(0.020)	(0.014)	(0.015)	(0.014)
child	−0.044***	0.002	−0.001	0.134***
	(0.010)	(0.007)	(0.008)	(0.007)
income	0.177***	0.204***	−0.083***	−0.016*
	(0.013)	(0.008)	(0.009)	(0.008)
worksts	0.319***	0.262***	−0.069***	0.433***
	(0.019)	(0.014)	(0.016)	(0.015)
riskatt	0.024***	0.023***	0.019***	0.005
	(0.005)	(0.003)	(0.004)	(0.004)
finedu	−0.067*	0.022	−0.294***	0.102***
	(0.039)	(0.024)	(0.026)	(0.025)
pefcap	0.096***	0.076***	0.110***	−0.047***
	(0.006)	(0.005)	(0.005)	(0.005)
pemath	−0.177***	−0.069***	−0.318***	−0.004
	(0.015)	(0.010)	(0.011)	(0.010)
havhome	0.638***	0.513***	0.397***	0.196***
	(0.021)	(0.015)	(0.017)	(0.015)
crerating	0.500***	0.273***	0.276***	−0.092***
	(0.012)	(0.008)	(0.009)	(0.008)
State fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	108,310	108,310	108,310	108,310
Pseudo R^2	0.267	0.105	0.137	0.021

Notes: The reference categories are the year 2009, and aged 18 to 24. The data in parentheses are standard errors. In addition, ***, **, and * represent 1%, 5%, and 10% significance levels, respectively. The variable of savings for retirement is treated as the IV, and 2SLS estimation is utilized to eliminate the endogeneity.

4.3. Endogeneity check

In this study, financial knowledge may also be an endogenous regressor since consumers who have a credit card or behave desirably tend to learn more financial knowledge. The coefficients cannot determine the causality between financial knowledge and consumer financial behaviors of credit card use, which will cause estimation bias and inconsistency. Additionally, although comprehensive control variables are considered in this study, as well as the year and state dummies, there may still exist unobservable variables causing omitted variable bias. Therefore, IV is necessary for coping with the potential endogeneity problem of financial knowledge.

In this study, the variable of savings for retirement is selected as an IV for financial knowledge, which is associated with consumer financial knowledge but uncorrelated to the dependent variable of credit card use. In the NFCS, the respondents were asked, "Have you ever tried to figure out how much you need to save for retirement?" Responses are encoded as a binary variable, with 1 as having performed the activity and 0 otherwise. According to Clark et al. [46]; retirement savings are associated with consumer financial knowledge, while retirement savings are almost exogenous to credit card use. Thus, the variable of savings for retirement can be considered an appropriate IV.

The approach of 2SLS is utilized to perform the endogeneity check. The first regression stage is between consumer financial knowledge and savings for retirement. According to the result of the first regression stage, the coefficients of retirement savings are positively significant, and the F statistic is 595.55, far beyond the critical values, implying the problem of weak IV can be negligible. Table 5 displays the results of the endogeneity check.

Accordingly, the coefficients of the instrumented consumer financial knowledge are positive and significant in Columns (1), (2), and (3). To be more specific, the coefficients are 0.927, 0.410, and 1.701 at a significance of 1%, respectively. In contrast, it has a negatively significant coefficient in Column (4). In detail, the coefficient is 0.125 at a significance of 1%. Besides, the signs of other control variables almost remain unchanged. More specifically, the coefficients of instrumented financial knowledge are greater,

Table 6
Robustness check.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Probit	Ordered probit	Ordered probit	Ordered probit	Logit	Ordered logit	Ordered logit	Ordered logit
	havecard	numcrd	desdb	udsdb	havecard	numcrd	desdb	udsdb
finknw	0.102***	0.068***	0.077***	−0.020***	0.184***	0.129***	0.126***	−0.022***
	(0.004)	(0.002)	(0.003)	(0.003)	(0.007)	(0.005)	(0.005)	(0.005)
age25_34	0.134***	0.221***	−0.106***	0.274***	0.290***	0.399***	−0.157***	0.381***
	(0.018)	(0.013)	(0.015)	(0.014)	(0.036)	(0.027)	(0.030)	(0.028)
age35_44	−0.020	0.146***	−0.375***	0.203***	0.005	0.297***	−0.624***	0.280***
	(0.018)	(0.014)	(0.016)	(0.015)	(0.038)	(0.028)	(0.031)	(0.029)
age45_54	−0.086***	0.126***	−0.487***	0.160***	−0.118***	0.253***	−0.812***	0.200***
	(0.018)	(0.014)	(0.015)	(0.014)	(0.037)	(0.027)	(0.031)	(0.029)
age55_64	0.041**	0.233***	−0.384***	0.084***	0.116***	0.437***	−0.620***	0.052*
	(0.019)	(0.014)	(0.016)	(0.015)	(0.039)	(0.028)	(0.031)	(0.029)
*age65_*	0.384***	0.472***	−0.200***	0.003	0.766***	0.867***	−0.303***	−0.128***
	(0.021)	(0.015)	(0.016)	(0.016)	(0.044)	(0.029)	(0.032)	(0.031)
ethn	−0.006	0.001	0.025***	0.107***	0.008	−0.001	0.052***	0.167***
	(0.012)	(0.008)	(0.009)	(0.009)	(0.024)	(0.016)	(0.018)	(0.016)
marriage	0.044***	−0.018**	0.002	0.002	0.069***	−0.039***	−0.007	0.013
	(0.012)	(0.008)	(0.009)	(0.008)	(0.022)	(0.015)	(0.016)	(0.015)
child	−0.053***	−0.005	−0.059***	0.076***	−0.094***	−0.019***	−0.102***	0.123***
	(0.005)	(0.003)	(0.004)	(0.004)	(0.010)	(0.007)	(0.007)	(0.007)
income	0.166***	0.143***	0.091***	0.002	0.304***	0.246***	0.152***	−0.007
	(0.003)	(0.002)	(0.002)	(0.002)	(0.007)	(0.005)	(0.005)	(0.005)
worksts	0.210***	0.171***	0.054***	0.259***	0.386***	0.276***	0.079***	0.407***
	(0.011)	(0.008)	(0.009)	(0.008)	(0.021)	(0.014)	(0.016)	(0.015)
riskatt	0.039***	0.025***	0.065***	0.013***	0.071***	0.041***	0.114***	0.016***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)	(0.003)	(0.003)
pefcap	0.072***	0.048***	0.099***	−0.030***	0.137***	0.094***	0.175***	−0.054***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.007)	(0.005)	(0.006)	(0.005)
pemath	−0.019***	−0.009***	−0.010***	0.018***	−0.038***	−0.017***	−0.019***	0.027***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.007)	(0.005)	(0.005)	(0.005)
havhome	0.401***	0.318***	0.313***	0.120***	0.714***	0.530***	0.527***	0.198***
	(0.011)	(0.008)	(0.009)	(0.009)	(0.022)	(0.015)	(0.017)	(0.016)
crerating	0.327***	0.176***	0.250***	−0.052***	0.606***	0.299***	0.455***	−0.126***
	(0.005)	(0.004)	(0.004)	(0.004)	(0.011)	(0.007)	(0.009)	(0.007)
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	108,310	108,310	108,310	108,310	88,330	88,330	88,330	88,330
Pseudo R^2	0.271	0.104	0.132	0.023	0.231	0.080	0.116	0.022

Notes: The reference categories are the year 2009, and aged 18 to 24. The data in parentheses are standard errors. Moreover, ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

implying that the endogeneity problem exists. Therefore, the IV eliminates the impacts of endogeneity and makes the estimation results more accurate.

4.4. Robustness check

To further examine the robustness of the estimates, this study firstly replaces the estimation approach of logit and ordered logistic regression with probit and ordered probit regression. Secondly, this study drops the samples whose annual income is less than $15,000 or more than $150,000 to mitigate the estimation bias caused by annual income outliers. Table 6 presents the results of the robustness check.

In Columns (1) and (3), the coefficients of financial knowledge remain significantly positive, and that of financial knowledge in Column (4) is still statistically negative. Accordingly, the coefficients are 0.102, 0.068, 0.077, and −0.020, respectively, and are all at a significance of 1%. After removing the outliers of annual income, the coefficients are still unchanged. In Columns (5) to (8), the coefficients of financial knowledge are 0.184, 0.129, 0.126, and −0.022, respectively, and are all statistically significant at 1%. Finally, the results suggest that there is still a robust relationship between consumer financial knowledge and financial behaviors of credit card use.

5. Heterogeneity check

Considering that the vital roles of financial knowledge may vary with different conditions, the samples are divided into two groups to perform a heterogeneity check, namely various stages of financial education and income levels, respectively.

Table 7
Heterogeneity Test I: Different stages of financial education.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	havecard	numcrd	desdb	udsdb	havecard	numcrd	desdb	udsdb
finknw	0.107***	0.063***	0.036***	−0.181***	0.182***	0.063***	−0.014	−0.241***
	(0.021)	(0.012)	(0.013)	(0.013)	(0.037)	(0.018)	(0.019)	(0.019)
age25_34	0.422***	0.648***	−0.090	0.887***	−0.080	0.276**	−0.216*	0.635***
	(0.091)	(0.059)	(0.064)	(0.063)	(0.206)	(0.114)	(0.121)	(0.115)
age35_44	0.122	0.527***	−0.625***	0.693***	−0.540**	0.052	−0.811***	0.236**
	(0.098)	(0.064)	(0.070)	(0.068)	(0.211)	(0.118)	(0.126)	(0.119)
age45_54	0.061	0.505***	−0.867***	0.461***	−0.733***	0.038	−1.220***	0.126
	(0.095)	(0.063)	(0.069)	(0.067)	(0.205)	(0.117)	(0.125)	(0.119)
age55_64	0.104	0.556***	−0.694***	0.301***	−0.502**	0.039	−0.986***	−0.078
	(0.103)	(0.066)	(0.072)	(0.072)	(0.212)	(0.119)	(0.126)	(0.122)
*age65_*	0.681***	1.016***	−0.467***	0.251***	0.017	0.544***	−0.787***	−0.201
	(0.122)	(0.070)	(0.075)	(0.078)	(0.233)	(0.123)	(0.131)	(0.128)
ethn	−0.005	0.014	0.134***	0.286***	−0.212*	−0.103*	−0.002	0.311***
	(0.067)	(0.041)	(0.044)	(0.042)	(0.114)	(0.057)	(0.060)	(0.058)
marriage	0.168**	−0.003	−0.036	−0.022	−0.073	−0.106*	−0.032	−0.152***
	(0.070)	(0.041)	(0.043)	(0.043)	(0.114)	(0.056)	(0.059)	(0.058)
child	−0.038	0.056***	−0.026	0.156***	0.017	0.090***	−0.054**	0.195***
	(0.030)	(0.018)	(0.019)	(0.018)	(0.049)	(0.025)	(0.026)	(0.025)
income	0.293***	0.231***	0.140***	−0.020*	0.346***	0.233***	0.143***	−0.074***
	(0.018)	(0.011)	(0.012)	(0.011)	(0.032)	(0.016)	(0.017)	(0.017)
worksts	0.414***	0.285***	0.155***	0.401***	0.209*	0.083	0.013	0.347***
	(0.062)	(0.039)	(0.042)	(0.042)	(0.113)	(0.058)	(0.061)	(0.062)
riskatt	0.095***	0.061***	0.146***	0.070***	0.114***	0.069***	0.153***	0.090***
	(0.011)	(0.007)	(0.007)	(0.007)	(0.019)	(0.010)	(0.010)	(0.010)
pefcap	0.081***	0.042***	0.120***	−0.076***	0.109***	0.097***	0.096***	−0.057**
	(0.021)	(0.014)	(0.016)	(0.015)	(0.040)	(0.023)	(0.024)	(0.023)
pemath	−0.044**	−0.031**	0.003	0.033**	−0.157***	−0.115***	0.007	0.004
	(0.020)	(0.014)	(0.015)	(0.014)	(0.040)	(0.021)	(0.022)	(0.021)
havhome	0.687***	0.449***	0.507***	0.259***	0.894***	0.573***	0.613***	0.414***
	(0.066)	(0.043)	(0.045)	(0.044)	(0.110)	(0.063)	(0.066)	(0.065)
crerating	0.638***	0.363***	0.497***	−0.080***	0.619***	0.254***	0.435***	−0.243***
	(0.024)	(0.016)	(0.018)	(0.016)	(0.051)	(0.028)	(0.031)	(0.029)
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,633	12,633	12,633	12,633	6562	6562	6562	6562
Pseudo R^2	0.325	0.116	0.138	0.047	0.276	0.065	0.108	0.080

Notes: The reference categories are the year 2009, and aged 18 to 24. Moreover, the data in parentheses are standard errors. In addition, ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

5.1. Heterogeneity of different stages of financial education

In light of Kim and Xiao [47]; financial education positively contributes to consumer financial capability. Therefore, consumers who receive financial courses in school or college tend to have the higher financial capability. To be more specific, this study divides the samples into two groups to examine the roles of financial education. One group received financial education during their school periods, and the other got financial education from their workplaces. The results of the estimation are shown in Table 7.

Accordingly, the coefficients of consumer financial knowledge remain significantly positive in the subsample of receiving financial education in school periods [see Columns (1) to (4)]. As for consumers receiving financial education from the workplace, financial knowledge is still significantly and positively associated with credit card ownership in Columns (5) and (6) and negatively contributes to undesirable credit card behaviors in Column (8). Nevertheless, the coefficient in Column (7) becomes negative, with other coefficients remaining unchanged. However, the changed coefficient is not significant. Thus, the overall results are still consistent.

5.2. Heterogeneity of different levels of income

Kim et al. [48] suggested that a higher income in the future is expected to increase the likelihood of being a credit card user and paying the amount of the outstanding punctually. Singh et al. [49] indicated that a low-income level is related to undesirable credit card behaviors. In detail, following the approach of Chen et al. [50]; this study divides the samples in light of the mean value of income level into high- and low-income subsamples. Table 8 shows the results.

According to the estimation results, except for Column (4), which shows a statistically positive coefficient, the results keep unchanged. The reason for the coefficient change is that, in terms of the low-income subsamples, it is still possible for them to perform undesirable credit card behaviors due to their income limitations. Thus, this study can still get consistent results on the roles of financial knowledge in credit card behaviors.

Table 8
Heterogeneity Test II: Different levels of income.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	havecard	numcrd	desdb	udsdb	havecard	numcrd	desdb	udsdb
finknw	0.155***	0.134***	0.144***	0.049***	0.212***	0.119***	0.120***	−0.097***
	(0.007)	(0.006)	(0.007)	(0.006)	(0.012)	(0.006)	(0.006)	(0.006)
age25_34	0.096***	0.219***	−0.226***	0.303***	0.677***	0.796***	−0.092**	0.564***
	(0.034)	(0.028)	(0.033)	(0.030)	(0.066)	(0.042)	(0.046)	(0.046)
age35_44	−0.163***	0.048	−0.637***	0.212***	0.369***	0.725***	−0.606***	0.439***
	(0.037)	(0.031)	(0.037)	(0.033)	(0.066)	(0.043)	(0.047)	(0.046)
age45_54	−0.314***	−0.051*	−0.803***	0.139***	0.302***	0.768***	−0.797***	0.396***
	(0.035)	(0.029)	(0.035)	(0.032)	(0.065)	(0.043)	(0.046)	(0.046)
age55_64	−0.073**	0.179***	−0.633***	0.117***	0.486***	0.920***	−0.621***	0.189***
	(0.037)	(0.030)	(0.035)	(0.033)	(0.070)	(0.043)	(0.047)	(0.047)
*age65_*	0.517***	0.618***	−0.301***	0.064*	1.158***	1.268***	−0.363***	−0.113**
	(0.042)	(0.032)	(0.037)	(0.035)	(0.081)	(0.045)	(0.048)	(0.049)
ethn	0.012	−0.007	0.026	0.181***	−0.048	0.007	0.064***	0.146***
	(0.024)	(0.020)	(0.023)	(0.021)	(0.039)	(0.021)	(0.022)	(0.022)
marriage	−0.042*	−0.092***	0.009	−0.051**	0.252***	0.034*	0.006	0.094***
	(0.024)	(0.019)	(0.022)	(0.020)	(0.039)	(0.020)	(0.021)	(0.021)
child	−0.121***	−0.067***	−0.132***	0.056***	−0.055***	0.021**	−0.083***	0.175***
	(0.011)	(0.009)	(0.011)	(0.009)	(0.015)	(0.008)	(0.009)	(0.008)
income	0.331***	0.304***	0.161***	0.186***	0.224***	0.184***	0.153***	−0.188***
	(0.010)	(0.008)	(0.009)	(0.009)	(0.018)	(0.008)	(0.008)	(0.009)
worksts	0.299***	0.278***	0.161***	0.342***	0.419***	0.219***	0.004	0.446***
	(0.022)	(0.018)	(0.021)	(0.019)	(0.036)	(0.019)	(0.021)	(0.021)
riskatt	0.054***	0.038***	0.094***	0.020***	0.098***	0.045***	0.125***	0.020***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.006)	(0.003)	(0.004)	(0.003)
pefcap	0.108***	0.090***	0.153***	−0.006	0.163***	0.080***	0.186***	−0.110***
	(0.007)	(0.006)	(0.007)	(0.006)	(0.011)	(0.007)	(0.007)	(0.007)
pemath	−0.031***	−0.020***	−0.022***	0.010*	−0.041***	−0.005	−0.011	0.051***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.011)	(0.006)	(0.007)	(0.007)
havhome	0.651***	0.550***	0.564***	0.207***	0.778***	0.469***	0.469***	0.128***
	(0.023)	(0.019)	(0.022)	(0.020)	(0.037)	(0.023)	(0.024)	(0.023)
crerating	0.589***	0.400***	0.476***	0.049***	0.592***	0.233***	0.460***	−0.299***
	(0.011)	(0.008)	(0.011)	(0.009)	(0.017)	(0.010)	(0.012)	(0.011)
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	53,856	53,856	53,856	53,856	54,454	54,454	54,454	54,454
Pseudo R^2	0.186	0.090	0.115	0.020	0.195	0.043	0.089	0.048

Notes: The reference categories are the year 2009, and aged 18 to 24. In addition, ***, **, and * represent 1%, 5%, and 10% significance levels, respectively, and the data in parentheses are standard errors.

6. Conclusions, implications, and limitations

Substantial financial products and services have emerged rapidly in the continuous development of the financial market and financial innovation. As a payment and settlement tool, the credit card has greatly changed the way of consumption and promoted economic growth. At the same time, the lessons from the global financial crisis make consumers realize the importance of establishing a correct consumption notion and properly using credit cards. This study explores the effects of consumer financial knowledge on financial behaviors of credit card use by using national-level data from the NFCS. The results indicate that consumers with higher financial knowledge are more likely to hold credit cards. In addition, the more financial knowledge consumers have, the more credit cards they will hold. Besides, in terms of credit card behaviors, financial knowledge is positively associated with desirable credit card behaviors, including making comparisons before choosing one credit card and paying the bill punctually. Additionally, higher financial knowledge can decrease undesirable credit card behaviors, such as carryover balance and charging interest, only paying the minimum payment, charging a late fee, and charging an over-the-limit fee.

The findings of this study provide a better understanding of the relationships between consumer financial knowledge and financial behaviors of credit card use, which is essential for consumers to enhance the suitable usage of credit cards. Therefore, policymakers are encouraged to offer more financial education programs at the university to facilitate students' financial knowledge. According to the descriptive statistics, consumers with credit cards account for 76.7% of total samples, while the mean score of consumer financial knowledge is 3.134 out of 6, and the mean value of financial education is 0.156. Therefore, financial education is inadequate, and financial education programs need to be increased. Moreover, financial sectors are recommended to raise awareness of risk management and screen target consumer groups by formulating financial literacy standards for holding credit cards to improve the quality of customer groups, particularly the low-income group. Additionally, consumers should increase their enthusiasm for learning financial knowledge, cultivate self-control on impulsive consumption, and make proper consumption decisions.

This study conducts a comprehensive empirical analysis of the nexus between consumer financial knowledge and financial behaviors of credit card use. The results are informative for policymakers to formulate measures for different consumer groups. However, there are still some limitations. First, some vacant answers must be filtered out, which may bring estimation bias. However, the potential problems caused by these vacant answers are unavoidable. Second, some self-assessment questions are numerically quantified and cannot accurately measure the subtle differences in subjective evaluations.

Declaration of competing interest

We declare that we have no conflict of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.heliyon.2022.e12713.

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