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Working Paper

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Jena Economic Research Papers, No. 2023-007

Provided in Cooperation with:
Friedrich Schiller University Jena, Faculty of Economics and Business Administration

Suggested Citation: Tran Huynh (2023) : Financial literacy and mortgage payment delinquency?, Jena Economic Research Papers, No. 2023-007, Friedrich Schiller University Jena, Faculty of Economics and Business Administration, Jena

This Version is available at:
https://hdl.handle.net/10419/283178

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JENA ECONOMICS RESEARCH PAPERS · # 2023-007

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is a publication of the Friedrich Schiller University Jena, Germany (www.jenecon.de).

Jena Economics Research Papers # 2023 - 007

Financial Literacy and Mortgage Payment Delinquency*

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June 30, 2023

Abstract

This study investigates the causal effect of financial literacy on mortgage payment delinquency. Using an Instrumental-Variable (IV) approach, we find that increased financial literacy significantly reduces the probability of mortgage delinquency. The identified causal effect is robust to different specifications of the IV and cannot be explained by formal education, income, and many other individual characteristics. Our study also examines the heterogeneity of the impact across various demographic groups. We find that the effect of financial literacy on delinquency likelihood is negative and significantly different from zero for any age, gender, income, or education level. However, the magnitude of the effect decreases with age and is higher in states where the population's financial literacy is low, as compared with high-literate states.

JEL classification: G51, G53

Keywords: financial literacy, mortgage delinquency, NFCS surveys, instrumental variables.

*Special thanks to Silke Uebelmesser for helpful comments and suggestions. The funding by the Free State of Thuringia through the Graduate Programme 'The Economic Impact of Digital Transformation' is gratefully acknowledged .

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I Introduction

Some of the most important economic decisions people make are those concerning their personal finances. Rapid developments in global financial markets have made financial products increasingly accessible to households. With more choices, individuals also face greater responsibility when it comes to their own financial well-being, which is being shifted to them from governments and employers (Lusardi and Mitchell 2014). It is thus of crucial importance for individuals to be financially literate. At the same time, the rapid growth of the mortgage market and its link to the Great Recession have made the relationship between households' financial literacy and their mortgage-related decisions a legitimate concern for policymakers and financial practitioners around the world (Stango and Zinman 2009; Lusardi and Tufano 2015).

In this study, we assess the causal effect of financial literacy on mortgage payment delinquency. While some suggestive results exist on the correlation between financial literacy and mortgage delinquency (Kim et al. 2020), evidence of a causal relationship between the two remains absent to the best of our knowledge. To analyze how financial literacy affects mortgage repayment behavior, we employ the data from the National Financial Capability Study (NFCS), which has provided rich information on individual-level financial knowledge, perceptions, attitudes, experiences, capabilities, and behaviors for a large and representative sample of the US population since 2009. Following the literature, we measure financial literacy based on respondents' answers to a standardized set of questions on general financial knowledge, covering fundamental concepts in household finance such as interest compounding, inflation, risk diversification, and bond pricing. In doing so, we refer to financial literacy as an individual's ability "to process economic information and make informed decisions about financial planning, wealth accumulation, debt, and pensions" (Lusardi and Mitchell 2014).

Similar to other studies investigating the causal effect of financial literacy on economic and financial outcomes, reverse causality, unobserved heterogeneity, and measurement error in financial literacy are our major challenges (Rooij et al. 2011). To address these concerns, we perform several robustness exercises, and most importantly, we employ four different Instrumental-Variable (IV) strategies for identification.

Specifically, since individuals might learn and improve their financial knowledge after experiencing the delinquency event, our explanatory variable of interest - financial literacy - is

potentially endogenous. Hence, in the first IV strategy, we use the financial literacy of a matched person from the previous survey wave as an instrument for the respondent's financial literacy. The matched pairs are identified by the propensity score matching technique based on respondents' demographic and individual characteristics such as age, gender, ethnicity, education, income, risk attitude, state of residency, etc. We conjecture that those with similar individual-level characteristics have correlated levels of financial literacy. This approach is inspired, though it remains unique to our study, by a number of previous studies that use the financial knowledge of peers or family members as an instrument for respondents' financial literacy (Alessie et al. 2011; Rooij et al. 2011; Deuflhard et al. 2019). The second IV strategy applies the same logic and method as the first one, with the only difference being that the matched pairs are drawn from the same survey wave. With this, we aim to address the concern that the relationship between individual characteristics and financial knowledge might vary over time.

Nevertheless, since the instruments of the first two IV strategies (i.e., the financial literacy of matched individuals) arise from the primary NFCS data, the IV estimates may still be confounded by the effects of unobserved factors that affect both financial literacy and financial decisions and that are not covered by the NFCS surveys. Such factors can be: specific bank information policies (Fort et al. 2016); professional financial advice (Calcagno and Monticone 2015; Gaudecker 2015); strategic default incentives (Burke 2012); discount factors (Meier and Sprenger 2013); or IQ (Grinblatt et al. 2011). To tackle this issue, we implement two additional IV strategies whose instruments are constructed using external data. One strategy employs state-level data on the percentage of the population using the Internet (from the National Telecommunications and Information Administration - NTIA) and the number of degree-granting postsecondary institutions (from the National Center for Education Statistics - NCES) as instruments for financial literacy. The other setting's instruments are based on individual-level data on internet usage and occupation (financial vs. non-financial) from the merged sample between our primary NFCS dataset and the NTIA microdata.

We find that increased financial literacy significantly reduces mortgage payment delinquency. In particular, one standard deviation increase in financial literacy (about one additional correct answer to the financial literacy questions) reduces mortgage delinquency likelihood by nearly 3 percentage points on average. This corresponds to a 17% decrease in the average mortgage delinquency rate of the whole sample during the period. The true effect is likely greater since

our IV estimates are larger than standard probit estimates, which aligns with previous findings in the literature. Importantly, the effect cannot be explained by formal education, income, and many other individual characteristics (e.g., age, gender, marital status, etc.). Besides, our study also investigates the heterogeneity of the impact across various demographic groups. We find that the effect of financial literacy on delinquency likelihood is negative and significantly different from zero for any age, gender, income, or education level, suggesting the impact of financial literacy is widespread. Yet, the effect is shown to decrease with age and is lower in states where the population's financial literacy is high, as compared with low-literate states.

Our study makes several contributions to the literature on the economic importance of financial literacy. First and most importantly, we establish the first explicit causal evidence on the relationship between financial literacy and mortgage payment delinquency. So far, only suggestive correlations have been provided. Second, we add to the literature that uses survey data to study the link between financial literacy and financial behaviors/outcomes using survey data. Lusardi and Mitchell (2008) and Bucher-Koenen and Lusardi (2011) find that more financially literate individuals are more likely to plan for retirement. Rooij et al. (2011) show that individuals with low financial literacy are much less likely to invest in stocks. Studying the fundamental and common asset of households - saving accounts, Deuflhard et al. (2019) find that higher-literacy households are more likely to earn higher returns on their saving accounts. Third, our results are highly relevant for the policy discussions concerning financial literacy and financial education (Kaiser et al. 2022). Delinquency on mortgage payments exposes borrowers not only to the incurred late fees but also to default and foreclosure risks, as well as potential rejections on future loan applications since the credit score is negatively affected.[1] Hence, reducing delinquency rates among mortgage holders by increasing the population's financial literacy helps to preempt significant welfare losses. Furthermore, our results suggest that the earlier in life one invests in enhancing financial literacy, the greater the benefits one can reap. And the relevance of the issue is even higher in states where the population's financial literacy is low.

The rest of the paper is organized as follows. Section II reviews the related literature. Section III describes the data and descriptive statistics. Section IV presents the empirical strategy. Section V analyzes the results. Section VI discusses the policy implications and concludes the paper.

[1]Typically, a loan is declared in default if the borrower fails to make any payments on the loan for 270 days.

II Related Literature

A Financial Literacy and Household Finance

The literature investigating the link between financial literacy and household finance behaviors has grown significantly over the past two decades. Regarding the fundamental investment decision - saving, Bernheim (1995) observed that most U.S households lacked basic financial knowledge and their saving behaviors mainly relied on crude rules of thumb. Deuflhard et al. (2019) show that higher financial literacy levels are associated with higher returns on households' saving accounts.

Financial literacy also plays a vital role in stock market participation. Rooij et al. (2011) finds that individuals with low literacy are much less likely to invest in stocks. Almenberg and Dreber (2015) look at the gender gap in stock market participation and argue that women are less likely to engage in stock investments mainly due to their lower financial literacy compared to their male counterparts. Bucher-Koenen et al. (2021) study the same gender gap issue and find that part of the financial literacy gap between men and women is due to women's lack of confidence.

Another group of studies examines the role of financial literacy in retirement planning. Deciding on how much to save for retirement is not easy as it requires the understanding of several factors such as national pension programs, interest rates, inflation, mortality risks, etc. Several studies have shown that more financially knowledgeable individuals are more likely to plan or to earn more on investments for their retirements (Lusardi and Mitchell 2008; Bucher-Koenen and Lusardi 2011; Anderson et al. 2017).

In addition, a growing literature sheds light on the role of financial literacy in wealth accumulation and distribution - a topical policy issue in recent years (Behrman et al. 2012). Bianchi (2018) find that more financially literate households are better at managing asset portfolios and are more likely to earn higher returns than low-literate households. Fort et al. (2016) show that increased financial knowledge positively affects household financial assets. Gaudecker (2015) suggests that individuals who neither seek external financial advice nor possess basic skills in financial-numerical operations and concepts are exposed to greater investment losses due to under-diversification. Building a stochastic life cycle model in which households

invest not only in financial assets but also in financial knowledge acquisition, Lusardi et al. (2017) estimate that 30-40 percent of wealth inequality is attributed to financial knowledge. Overall, the literature shows that more financially literate individuals are more likely to save, make investments, and acquire financial assets. In short, they tend to be wealthier.

B Financial Literacy and Debt-related Behaviors

Financial literacy might affect the liability side of the household balance sheet as well (Stango and Zinman 2009). For instance, Campbell (2006) emphasizes the failure of less educated borrowers to exploit periods of falling interest rates by refinancing their mortgages. Likewise, Lusardi and Tufano (2015) use a set of survey questions to measure debt literacy and find that individuals with low literacy levels are more susceptible to high-cost borrowing.

Regarding debt repayment behaviors, Gerardi et al. (2013) find that subprime borrowers with limited numerical abilities were significantly more likely to default on their mortgages during the global financial crisis of 2007/2008. Their study suggests the causes of default are these individuals' sub-optimal spending and saving patterns rather than the choice of mortgages at origination. Agarwal et al. (2017) demonstrate that financial professionals are less likely to be delinquent on their mortgage loans than non-financial professionals. More recently, Kim et al. (2020) provide evidence of a significant negative correlation between financial literacy and mortgage delinquency likelihood. The authors further conclude that overconfidence in one's own financial knowledge is positively associated with the tendency to make late payments.

While those studies have shown correlations, our study adds to this literature by investigating the causal effect of financial literacy on mortgage payment delinquency. To test our primary hypothesis that increased levels of financial literacy reduce mortgage delinquency, we employ various instrumental variable strategies for identification. Furthermore, we examine the heterogeneity of the impact across different demographic groups (e.g. based on income, education, age, gender, and race), which is highly relevant in the context of policy discussions concerning financial literacy and financial education.

III Data and Descriptive Statistics

A Data Source and Sample Selection

The primary data used in this study is obtained from the National Financial Capability Study (NFCS) conducted by Investor Education Foundation, established by the US Financial Industry Regulatory Authority (FINRA) in 2003. The NFCS surveys have a rich set of questions that allow comprehensive analyses of financial knowledge, perceptions, attitudes, experiences, capabilities, and behaviors among US adults. For our study purposes, we focus on questions concerning mortgage payment delinquency; financial knowledge (both objective and subjective); as well as several demographic and individual characteristics such as age, gender, race, marital status, education, income, risk attitude, math skill, etc.[2] We employ all five waves of the data available to date since 2009, with each wave released every three years - 2009, 2012, 2015, 2018, and 2021. Hence, we are able to cover a large, diverse, and representative sample of the US population with a total sample size of 73,977 observations, of which 44,347 are mortgage holders. Table A1 presents the descriptive statistics of all variables later used in our analyses. Though we are interested in the mortgage-holder group, we provide the summary statistics of the non-mortgage holders in our sample for comparison purposes.

Table A1 shows that compared to the non-mortgage-holder group, mortgage holders tend to be younger, have higher incomes, and are more able to tolerate risks. Most of them are educated, employed, and married. At the same time, the proportion of mortgage holders who face financial hardships and thus might need financial support through borrowing is also higher than in the other group. From another perspective, mortgage holders seem more financially literate (e.g., they are more likely to use, or be familiar with, other financial products such as other loan products and health insurance).

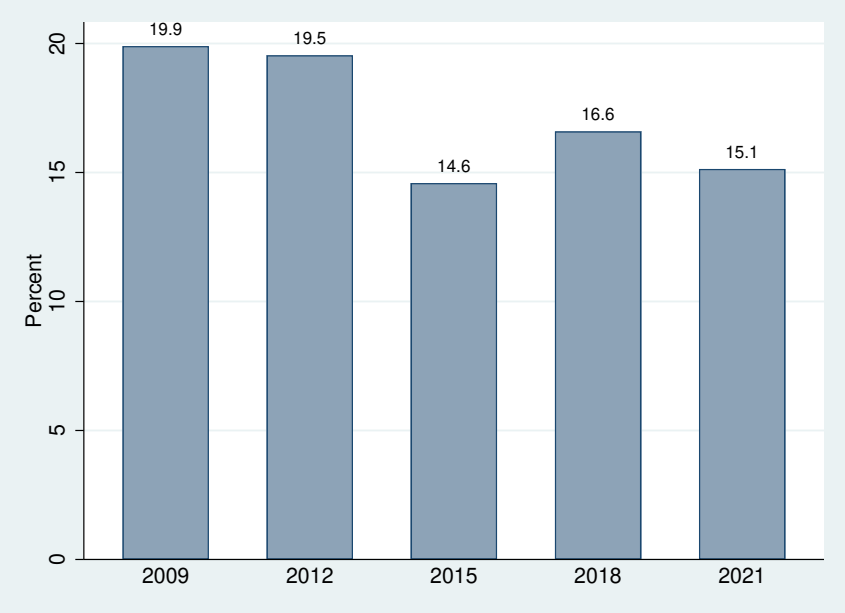
B Mortgage Payment Delinquency

Around 8% and 11% of mortgage holders report having been late with their mortgage payments once and more than once in the past 12 months, respectively (see Table A1). In total, it means almost 19% of US mortgage holders report being delinquent with their mortgage payments at

[2]We drop observations where the respondents answered "Prefer not to say" or "Do not know" to questions on mortgage payment delinquency and subjective financial literacy, and where the respondent answered "Prefer not to say" to questions measuring objective financial literacy.

least once in the last 12 months. Figure 1 shows the same statistics separately for each wave of the survey. Overall, there is a declining trend in delinquency among mortgage holders from nearly 20% in the post-crisis period 2009-2012 to around 15% in recent years. Figure B1 further illustrates the quartile distribution of delinquency rates across US states.

Figure 1: Delinquency Likelihood among Mortgage Holders



Notes: Own calculations using NFCS data.

C Objective and Subjective Financial Literacy

Objective Financial Literacy

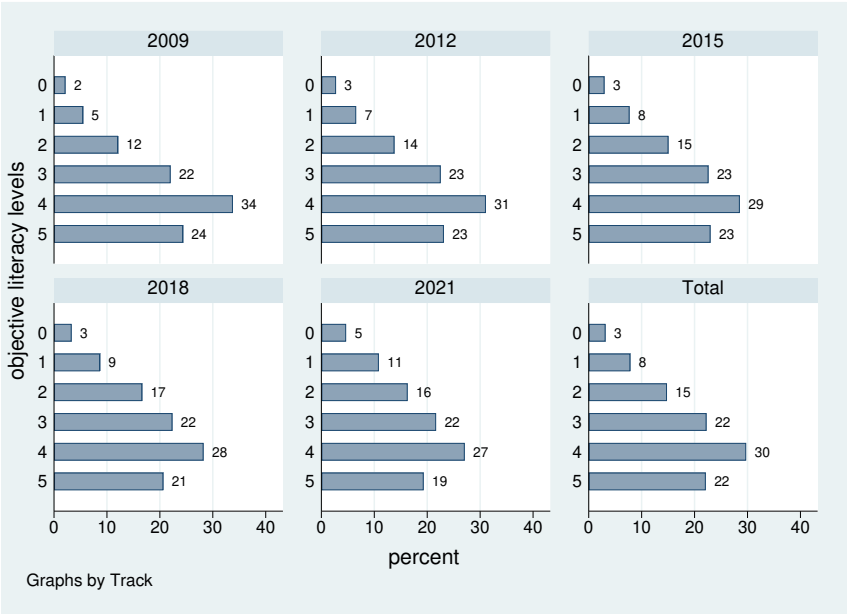
Following the pioneering work of Lusardi and Mitchell (2008), the literature on financial literacy makes use of a small set of questions that can proxy individuals' overall financial knowledge, covering fundamental concepts in household finance such as interest compounding, inflation, risk diversification, and bond pricing. The inclusion of such questions in the NFCS surveys enables us to establish the objective literacy score for each respondent in our sample. Table A2 reports the exact wording of the financial literacy questions and the proportions of respondents giving correct, incorrect, and "don't know" answers to these questions.

The first five (three) financial literacy questions in Table A2 are referred to as the "Big 5" ("Big 3"), according to Hastings et al. (2013). Following the literature, we define objective financial literacy as the number of correct answers to these questions. Since 2015, the NFCS has added one more question regarding loan interest to its survey. To consistently measure literacy

across years, we employ only the first five questions in our main analyses and use all six questions in a robustness check. With respect to the "Big 5" questions, most people are able to do a simple calculation related to interest compounding in saving accounts. A majority correctly understand the effects of inflation and the difference in the total interest paid between two mortgages with different loan terms. However, many US adults fail to understand risk diversification in the stock market and the relationship between interest rates and bond prices.

Figure 2 provides the objective financial literacy of the mortgage-holder group for each wave separately and as a total across all waves.[3] Overall, we observe the same distribution of objective literacy scores across all five NFCS waves, with only around 50% of US adults having more than 3 correct answers and a modest 20% having all 5 answers correct. Our results align with the literature (Lusardi and Mitchell 2008; Rooij et al. 2011), which highlights that although many respondents demonstrate familiarity with certain financial concepts, fundamental financial literacy is not widespread.

Figure 2: Summary Statistics of Objective Financial Literacy (Mortgage Holders)



Notes: Own calculations using NFCS data. We define objective financial literacy as the number of correct answers to the "Big 5" financial literacy questions. See also Table 2 for the details of these questions.

Figure B2 shows the quartile distribution of the per-state percentage of respondents having more than 3 correct answers to the Big 5 financial literacy questions. In general, we see that the

[3]Though not reported, we obtained very similar figures with only minor differences for the full sample and the non-mortgage group. The same applies to Figure 3, which is mentioned in the following.

northern and northeast states perform relatively better than the southern states. Figure B3(a-e) further presents the distribution of the objective literacy scores by different demographic groups. Without any implications of causation, we observe that financial literacy increases in age, income, and education level. In terms of gender, male respondents give more correct answers than their female counterparts on average. Also, the statistics show us that white Americans are generally more financially literate than non-white citizens.

Subjective Financial Literacy

Besides quiz questions that measure objective financial literacy, the NFCS surveys also provide individuals' self-perceptions of their financial knowledge by asking the following question: "On a scale from 1 to 7, where 1 means very low and 7 means very high, how would you rate your overall financial knowledge?". We use the answers to this question as our measure of respondents' subjective financial literacy, whose summary statistics are reported in Figure 3. Again, we observe the same pattern in the responses across all waves. Despite moderate average scores on objective literacy (3.3 and 3.2 for the mortgage and non-mortgage groups, respectively, see Table A1), most US adults are rather confident with their overall financial knowledge, with more than 80% giving themselves at least 5 on a 7-point scale. However, among those who give themselves the highest rating, only 52% have more than 3 correct answers to the "Big 5" financial literacy questions (see Figure B3(f)).

IV Econometric Strategy

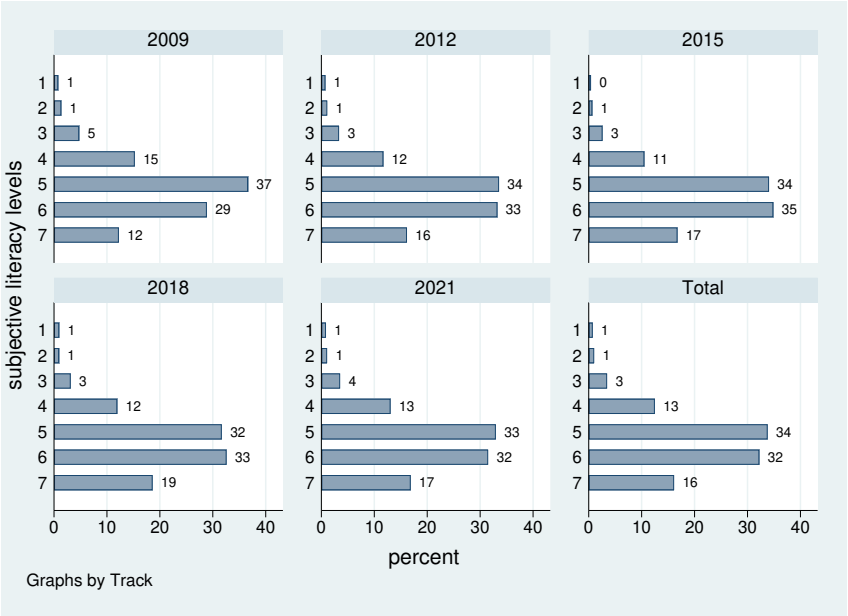
A Probit Regression

We estimate the following probit regression to examine the relationship between financial literacy and mortgage payment delinquency:

$$Pr(MPD_{\mathrm{i}} = 1) = 1 - 1/[1 + exp(\alpha + \beta FinLit_{\mathrm{i}} + X_{\mathrm{i}}{}'\gamma + \delta_{\mathrm{s}} + \lambda_{\mathrm{t}})] \tag{1}$$

where MPD_{i} is a dummy that equals one if the individual has been late with their mortgage payments at least once in the past 12 months; $FinLit_{\mathrm{i}}$ denotes the individual's financial literacy; X_{i} is the vector of individual-level observable characteristics that are potentially correlated with mortgage payment behavior such as age, gender, marital status, education, income, etc. (see Table A1 for the full list of these variables); δ_{s} and λ_{t} are the state and year/wave fixed-effects,

Figure 3: Summary Statistics of Subjective Financial Literacy (Mortgage Holders)



Notes: Own calculations using NFCS data. We measure subjective financial literacy by using respondents' self-assessments of general financial knowledge on a 1-to-7-point scale.

respectively. For our empirical analyses, we run the above probit regression with four model specifications: (1) without financial literacy variables; (2) with objective literacy variable only; (3) with subjective literacy variable only; (4) with both objective and subjective literacy variables. All results are weighted by the NFCS population weight.

B Endogeneity Concern and Identification

A common empirical challenge in the literature that investigates the effect of financial literacy on economic outcomes is the potential endogeneity of financial literacy. Specifically, there are three main sources that could introduce biases to our probit estimates of β in Equation (1): (i) unobserved factors that correlate with both mortgage delinquency and financial literacy; (ii) measurement error in objective financial literacy; and (iii) reverse causality.

(a) Omitted-variable Bias

Regarding the first concern of omitted variables, despite a rich set of control variables, our model cannot capture all the factors that might confound the effect of interest (e.g., unobserved individual characteristics). To address this concern, we perform two robustness checks. One test employs a multinomial probit model to take into account the difference between being late once and being late more than once with mortgage payments in the last 12 months. The rationale

behind doing so is that there might be cases where people are occasionally absent-minded and thus forget to make their mortgage payments on time. Such cases are likely those who end up being late once. The other test considers whether having had other outstanding loans in the past 12 months (e.g., home equity loans, auto loans, student loans, or loans from retirement accounts) affects the likelihood of being delinquent.[4]

(b) Measurement Error

Concerning the measurement error in objective financial literacy, answers to a set of financial literacy questions might not be a perfect measure of the concept. For instance, the possibility of guessing and random answers might impose a downward bias on the probit estimates (Rooij et al. 2011). To tackle this problem, we perform three additional robustness checks that create variations in the measure of objective financial literacy. In one test, we count the number of "Don't know" answers by each respondent and use it as an additional control. In the other two tests, we use two modified sets of financial literacy questions - one using only the three easiest questions (i.e., those with the highest percentage of correct answers) and one including all 6 questions on financial knowledge available since NFCS 2015.

(c) Reverse Causality

The third and major source of endogeneity in our model comes from the threat of reverse causality or simultaneity. Specifically, since our dependent variable measures delinquency likelihood in the past 12 months, it is plausible that one might update their knowledge (objective literacy) and/or perception (subjective literacy) after experiencing the event of delinquency. One ideal solution to this issue is using individuals' past measures of financial literacy. However, we do not have such information since the NFCS datasets are not constructed as a panel. Therefore, we pursue an instrumental variable (IV) approach to assess the causal effect of financial literacy on mortgage delinquency. The principal idea is to find a variable (*the instrument*) that is, in the first stage, correlated with the endogenous causal variable of interest (*financial literacy*) but has no effect on the outcome of interest (*mortgage payment delinquency*) other than through the first-stage channel. The latter condition is termed *exclusion restriction* as the instrument can be excluded from the causal model of interest (Angrist and Pischke 2009). In the following, we provide the

[4]For this test, we drop observations whose answers to the questions dealing with these different types of loans are "Don't know" or "Prefer not to say".

details of our four IV strategies built upon this idea. It should be noted that these strategies can only assess the causal effect of objective financial literacy on mortgage delinquency. Though we are also interested in the causal effect of subjective literacy, finding a valid instrument for it is challenging as perceptions are unique to each individual and thus rather complex to model. We leave this issue for future investigations.

(i) IV strategy using propensity score matching across NFCS data waves

Facing the same endogeneity issue, many previous studies use the financial knowledge of peers or family members as an instrument for respondents' financial literacy (Alessie et al. 2011; Rooij et al. 2011; Deuflhard et al. 2019). Such identification strategy assumes that peers or family can significantly influence one's financial knowledge but cannot directly affect one's experience through other channels. Inspired by those studies, we propose a new IV strategy in which the objective financial literacy of respondents is instrumented using the objective literacy of the closest matched individuals from the previous wave. Specifically, we find for each respondent in an NFCS wave (e.g. the 2021 wave) a person in the previous wave (e.g. the 2018 wave) who has the most similar demographic and individual characteristics (such as state of residence, age, gender, income, ethnicity, education, etc.) using the propensity score matching technique. All controlled variables in our model are used to compute the propensity score, and the caliper is set at 0.05. We conjecture that matched individuals would have close levels of financial knowledge while they clearly cannot influence the mortgage payment behavior of each other.

(ii) IV strategy using propensity score matching within NFCS data waves

This IV strategy applies the same logic and method described above, with the only difference being that the matched pairs are drawn from the same survey wave. We repeat the estimation procedure for all five NFCS waves. We provide this IV estimation to address the concern that the relationships between individual characteristics and financial knowledge might vary over time.

(iii) IV strategy using state-level data on internet usage and education

Another IV strategy employed by the related literature exploits exogenous variation in financial knowledge induced by regional heterogeneity in socio-economic developments. For instance, Bucher-Koenen and Lusardi (2011) use regional-level political attitudes (in particular, voting shares for competing political parties) as an instrument for financial literacy to assess

its effect on retirement planning in Germany. Investigating the relationship between financial literacy and several financial market outcomes during the financial crisis in Russia, Klapper et al. (2013) use the number of newspapers in circulation and the number of universities at the regional level as instruments for financial literacy. In the same spirit as these studies, we introduce two alternative instruments for our IV estimation: (i) the state-level percentage of the population using the Internet; and (ii) the state-level number of degree-granting postsecondary institutions.[5] Data of the two variables are collected from NTIA (National Telecommunications and Information Administration) and NCES (National Center for Education Statistics), respectively. For both, we use the data that are reported two years prior to each wave of the NFCS surveys. Table A3 provides the descriptive statistics of the data.

These two variables satisfy two aforementioned conditions of a valid instrument. On the one hand, it is expected that the above two variables are correlated with financial literacy as they can, to some extent, reflect not only the respondent's exposure to economic and financial knowledge but also that of their communities within the state.[6] A number of studies show that individuals learn about financial markets from their peers, neighbors, or colleagues in the form of "word-of-mouth" communication (Brown et al. 2008; Hong et al. 2004; Guiso et al. 2004; Duflo and Saez 2002). On the other hand, although others can influence an individual's financial literacy via community effects, they cannot directly affect his/her mortgage payment decisions as such decisions are outside their control. Figures B4 and B5 illustrate the correlations between state-level financial literacy and internet usage/degree-granting institutions, respectively.

(iv) IV strategy using NTIA microdata on internet usage and occupation

To rigorously assess the causal effect of objective financial literacy on mortgage delinquency, we further propose an IV strategy that exploits the exogenous variations in financial knowledge at the individual level (instead of the state level as above). Specifically, we use individuals' data on internet usage and occupations as instruments for financial literacy. Internet usage and occupation information are obtained from the NTIA microdata, as the NFCS surveys do not provide such information. We exploit the overlapping variables on demographic characteristics

[5] A degree-granting postsecondary institution is an educational institution that awards degrees or certifications at the associate's, bachelor's, master's, doctoral, or first-professional degree level (e.g., 2-year or 4-year colleges, universities).

[6] Note that economic and financial subjects are usually taught in higher levels of education.

between our primary dataset with the NTIA microdata to construct a merged dataset. These variables include age, gender, marital status, ethnicity, education, employment status, income level, and state of residence. Of the 73,977 observations in our primary dataset, 36,669 are uniquely matched with an NTIA record, of which 17,203 are mortgage holders.[7] From our merged sample, we create two dummy variables - one indicates whether the individual uses the internet at home, workplace, or school, and the other specifies whether the individual has a financial occupation. Table A4 provides the descriptive statistics of the merged sample.

The two new variables are potentially good instruments in our setting for two reasons. First, as previously discussed, the variable on internet usage represents variations in individuals' exposure to economic and financial content. Meanwhile, working in the financial sector would likely equip individuals with more knowledge about the financial markets and thus increase their financial literacy. Second, regarding the "exclusion restriction" condition, since these variables represent the channels through which one might improve their financial knowledge, they cannot directly affect the outcome variable of interest but only indirectly through the literacy variable.

V Empirical Analyses

A Financial Literacy and Mortgage Payment Delinquency

Table 1 presents the probit estimates. Average marginal effects and robust standard errors are reported. Model 1 excludes the measures of financial literacy and regresses mortgage payment delinquency on the set of control variables only. Objective and subjective financial literacy are added in Models 2 and 3, respectively. Model 4 includes both financial literacy measures.

Regarding first the control variables, our results suggest that individuals who are older, more educated, and white are less likely to be delinquent with their mortgage payments. There is no significant difference in delinquency likelihood between men and women. Interestingly, except for households with very high levels of income (above $150,000), higher income does not always correspond to a lower delinquency likelihood. Besides, our results show that respondents who are more willing to take risks and those who have dependent children or financial hardships are more likely to make late payments.

[7] There are in total 211,521 observations in the initial NTIA dataset for the 5 studied years - 2009, 2012, 2015, 2018, and 2021. To avoid ambiguous cases, we drop observations that have more than one matched record from the NTIA dataset while doing the merging.

Table 1: Probit Regression of Financial Literacy on Mortgage Delinquency Likelihood (Marginal Effects)

Dependent variable: Mortgage Payment Delinquency	Model 1	Model 2	Model 3	Model 4
Objective financial literacy	-	-0.0286***	-	-0.0286***
		(0.0016)		(0.0016)
Subjective financial literacy	-	-	0.0027	0.0027
			(0.0019)	(0.0019)
Age (ref: Age 18-24)				
Age 25-34	-0.0758***	-0.0673***	-0.0756***	-0.0672***
	(0.0143)	(0.0137)	(0.0143)	(0.0137)
Age 35-44	-0.1145***	-0.0958***	-0.1142***	-0.0954***
	(0.0143)	(0.0137)	(0.0143)	(0.0137)
Age 45-54	-0.1388***	-0.1126***	-0.1384***	-0.1122***
	(0.0142)	(0.0138)	(0.0142)	(0.0138)
Age 55-64	-0.1508***	-0.1234***	-0.1506***	-0.1233***
	(0.0148)	(0.0143)	(0.0147)	(0.0143)
Age 65+	-0.1782***	-0.1485***	-0.1783***	-0.1485***
	(0.0159)	(0.0156)	(0.0158)	(0.0156)
Gender (ref: Female)				
Male	-0.0040	0.0076	0. 0040	0.0076
	(0.0043)	(0.0043)	(0.0043)	(0.0043)
Education (ref: Less than high school)				
High school diploma	-0.0342	-0.0258	-0.0342	-0.0258
	(0.0181)	(0.0168)	(0.0180)	(0.0167)
Some college	-0.0513**	-0.0319	-0.0513**	-0.0319
	(0.0181)	(0.0168)	(0.0180)	(0.0168)
Bachelor degree	-0.0772***	-0.0516**	-0.0773***	-0.0517**
	(0.0185)	(0.0173)	(0.0185)	(0.0173)
Post-bachelor degree	-0.0648***	-0.0411*	-0.0650***	-0.0412*
	(0.0193)	(0.0181)	(0.0193)	(0.0181)
Marital status (ref: Married)				
Single	0.0047	0.0029	0.0047	0.0029
	(0.0062)	(0.0061)	(0.0062)	(0.0061)
Separated/divorced/widow	0.0092	0.0113	0.0092	0.0112
	(0.0066)	(0.0066)	(0.0066)	(0.0066)
Ethnicity (ref: White)				
Non-white	0.0498***	0.0446***	0.0497***	0.0445***
	(0.0052)	(0.0051)	(0.0052)	(0.0051)
Employment status (ref: Full-time workers)				
Self employed	-0.0050	0.0000	-0.0054	-0.0004
	(0.0077)	(0.0078)	(0.0078)	(0.0078)
Part-time worker	-0.0144	-0.0149	-0.0144	-0.0148
	(0.0078)	(0.0077)	(0.0078)	(0.0077)
Homemaker	-0.0352***	-0.0360***	-0.0351***	-0.0360***
	(0.0072)	(0.0071)	(0.0072)	(0.0071)
Student	-0.0286	-0.0280	-0.0283	-0.0277
	(0.0160)	(0.0157)	(0.0160)	(0.0158)
Disable	-0.0010	-0.0025	-0.0011	-0.0026
	(0.0118)	(0.0116)	(0.0118)	(0.0116)
Unemployed	-0.0377***	-0.0338***	-0.0378***	-0.0339***
	(0.0094)	(0.0094)	(0.0094)	(0.0094)
Retired	-0.0506***	-0.0521***	-0.0509***	-0.0525***
	(0.0080)	(0.0080)	(0.0080)	(0.0080)
Household income (ref: <$15,000)				
$15,000 - $25,000	0.0182	0.0169	0.0178	0.0165
	(0.0152)	(0.0145)	(0.0152)	(0.0145)
$25,000 - $35,000	0.0117	0.0132	0.0110	0.0125
	(0.0143)	(0.0136)	(0.0142)	(0.0136)

Table 1 (continued)

Dependent variable: Mortgage Payment Delinquency	Model 1	Model 2	Model 3	Model 4
$35,000 - $50,000	0.0085	0.0147	0.0080	0.0142
	(0.0136)	(0.0131)	(0.0136)	(0.0131)
$50,000 - $75,000	-0.0086	0.0013	0.0092	0.0007
	(0.0134)	(0.0129)	(0.0134)	(0.0129)
$75,000 - $100,000	-0.0119	-0.0018	-0.0125	-0.0024
	(0.0138)	(0.0133)	(0.0138)	(0.0133)
$100,000 - $150,000	-0.0317*	-0.0166	-0.0324*	-0.0173
	(0.0142)	(0.0137)	(0.0142)	(0.0137)
>$150,000	-0.0469**	-0.0302*	-0.0477**	-0.0310*
	(0.0150)	(0.0147)	(0.0150)	(0.0147)
Risk loving (scale 1-7)	0.0123***	0.0122***	0.0120***	0.0119***
	(0.0008)	(0.0008)	(0.0009)	(0.0008)
Self-assessed math skill (scale 1-7)	-0.0025	0.0013	-0.0032*	0.0071***
	(0.0013)	(0.0013)	(0.0014)	(0.0016)
Self-assessed basic financial skills (scale 1-7)	-0.0143***	-0.0144***	-0.0164***	-0.0164***
	(0.0016)	(0.0016)	(0.0017)	(0.0016)
Have dependent child (ref: No)	0.0551***	0.0512***	0.0550***	0.0511***
	(0.0046)	(0.0045)	(0.0046)	(0.0046)
Financial hardship (ref: No)				
Very difficult	0.2761***	0.2611***	0.2764***	0.2614***
	(0.0095)	(0.0094)	(0.0095)	(0.0094)
Somewhat difficult	0.1222***	0.1192***	0.1226***	0.1195***
	(0.0048)	(0.0048)	(0.0048)	(0.0048)
Had unexpected and large drop in income in the past 12 months (ref: No)	0.1156***	0.1089***	0.1153***	0.1086***
	(0.0053)	(0.0052)	(0.0053)	(0.0052)
Have precautionary saving(s) (ref: No)	-0.0555***	-0.0576***	-0.0565***	-0.0585***
	(0.0045)	(0.0044)	(0.0045)	(0.0045)
Covered by health insurance (ref: No)	-0.0509***	-0.0485***	-0.0509***	-0.0485***
	(0.0079)	(0.0078)	(0.0079)	(0.0078)
Observations	44347	44347	44347	44347
Wald/LR χ^2	5703.15***	5869.64***	5718.33***	5886.30***
Pseudo R^2	0.2516	0.2624	0.2516	0.2624
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Notes: * p<.05; ** p<.01; *** p<.001. Weighted results. Robust standard errors in parentheses.

With respect to our focal explanatory variables, objective financial literacy is significantly and negatively correlated with mortgage payment delinquency while subjective literacy seems to play no role in the delinquency likelihood. The inclusion of the literacy variables does not affect the estimates of education (at the bachelor level and higher) and of basic financial skills (such as checking accounts, tracking expenses, etc.).[8] This implies that the potential effect of financial knowledge on mortgage payment behavior cannot be explained by formal education or fundamental financial skills. Our results are in line with previous findings in the literature, where it is suggested that the impact of financial knowledge on financial market participation is

[8]Assume that respondents' self-assessments of their basic financial skills correctly reflect their true skills to some extent.

beyond the influence of general schooling (Klapper et al. 2013).

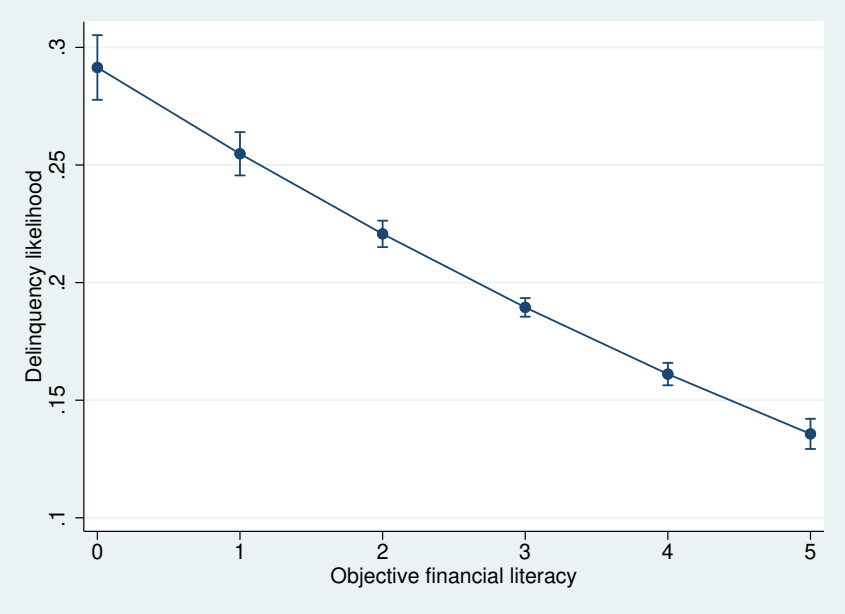
Table 2: Mortgage Delinquency Likelihood by Levels of Objective Financial Literacy

	Margin	Std. Err.	t	P >t	[95% CI]	
Objective financial literacy level						
0	0.291	0.007	41.550	0.000	0.278	0.305
1	0.255	0.005	54.270	0.000	0.246	0.264
2	0.221	0.003	77.000	0.000	0.215	0.226
3	0.189	0.002	94.020	0.000	0.186	0.193
4	0.161	0.002	66.150	0.000	0.156	0.166
5	0.136	0.003	41.500	0.000	0.129	0.142

Notes: Predictive margins at representative values of objective financial literacy are reported.

Furthermore, the marginal effect of objective literacy is sizeable, with an average impact of 2.8 percentage points. Table 2 provides the delinquency probability calculated for each literacy level, and Figure 4 visualizes the results. One additional correct answer to the financial knowledge questions would raise the literacy level by 1 unit. We see that respondents with very low literacy (levels 0 and 1) have a delinquency likelihood almost twice as high as that of the high-literacy respondents (levels 4 and 5).

Figure 4: Mortgage Delinquency Likelihood: By Levels of Objective Financial Literacy



Notes: Own calculations using NFCS data.

B Robustness Checks

Table 3 reports the results of several robustness checks in which we address concerns about relevant omitted factors in our model and the measurement error in financial literacy. In all cases, the estimates of objective literacy remain negative and statistically significant at the 0.1% level. In the first robustness check, we run a multinomial probit model to examine the difference between being late once and more than once, as there might be cases where individuals are occasionally forgetful and fail to make their payments on time. The obtained result suggests that even in cases of being late once, a higher financial literacy level still corresponds to a lower delinquency likelihood, though its impact is smaller than in cases of being late more often. The second test investigates whether having other debt payment obligations would play a role in mortgage delinquency. We find that having other outstanding loans is indeed related to higher delinquency likelihood. Yet, financial literacy seems to be even more important as its marginal effect is larger in this test than in the benchmark case.

Robustness Checks 3-5 introduce several variations to the measure of objective financial literacy. Specifically, we explicitly control for respondents' "Don't know" answers in one test and employ two different sets of literacy questions in the other two tests (with 3 and 6 quizzes, respectively, instead of 5 as in the benchmark case). Our results show that measurement error in financial literacy could only bias the variable's estimates but cannot eliminate its significant effect on mortgage delinquency. In particular, the presence of guessing and random responses to literacy questions biases the probit estimates downward. Hence, once that possibility is controlled for, we obtain a larger effect of financial literacy on delinquency likelihood (Robustness Check 3). At the same time, the probit estimates in the benchmark case could also be biased upward or downward if the set of literacy questions over- or under-estimated respondents' financial knowledge, as suggested by the results of Robustness Checks 4 and 5.

Besides, Robustness Check 3 also suggests that individuals who give more "Don't know" answers to literacy questions tend to have a lower delinquency likelihood. Our result might relate to the study of Bucher-Koenen et al. (2021), in which the authors find that women are on average less confident than men and thus tend to respond "do not know" to financial knowledge questions more often than their male counterparts. Though, it turns out that women often choose the correct answers in the absence of the "do not know" option.

Table 3: Robustness Checks: Probit Regression of Financial Literacy on Mortgage Payment Delinquency (Marginal Effects)

	Benchmark Model	Robustness Check 1		Robustness Check 2	Robustness Check 3	Robustness Check 4	Robustness Check 5
Dependent variables: Mortgage Payment Delinquency	Binomial probit model - Using the "Big 5" financial literacy questions	Multinomial probit model - (base outcome: Never been late)		Binomial probit model - Controlling for other outstanding loan(s)	Binomial probit model - Controlling for "Don't know" answers	Binomial probit model - Using 3 easiest financial literacy questions	Binomial probit model - Using all 6 financial literacy questions
		Have been late once	Have been late more than once				
Objective financial literacy	-0.0286***	-0.0116***	-0.0174***	-0.0315***	-0.0504***	-0.0412***	-0.0245***
	(0.0016)	(0.0012)	(0.0013)	(0.0017)	(0.0020)	(0.0023)	(0.0017)
Subjective financial literacy	0.0027	0.0040**	-0.0010	0.0036	-0.0025	0.0016	0.0046
	(0.0019)	(0.0014)	(0.0015)	(0.0021)	(0.0019)	(0.0019)	(0.0023)
Have other outstanding loan(s)	-	-	-	0.0695***	-	-	-
				(0.0071)			
Number of "Don't know" answers	-	-	-	-	-0.0376***	-	-
					(0.0023)		
Observations	44347	44347	44347	33733	44347	44347	25353
Pseudo R^2	0.2624	0.2208	0.2208	0.2978	0.2718	0.2622	0.3261
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * p<.05; ** p<.01; *** p<.001. Weighted results. Robust standard errors in parentheses. Control variables are the same as in Table 1. The benchmark model is Model 4 in Table 1. Robustness Check 1 runs a multinomial probit regression, taking into account the difference between being late once and being late more than once with mortgage payments. In Robustness Check 2, we further control whether the respondents have had other outstanding loans (e.g., home equity loans, auto loans, student loans, or loans from their retirement accounts) in the past 12 months. For all model specifications except Robustness Check 3, "Don't know" answers to financial literacy questions are counted as wrong. In Robustness Check 3, we count the number of "Don't know" answers by each respondent separately and use it as an additional control variable. With Robustness Check 4, the two most difficult questions in the "Big 5" questions (i.e., two questions with the least percentage of correct answers, see Table A2) are dropped in measuring objective financial literacy. Robustness Check 5 employs all six financial literacy questions that have been available since the NFCS 2015. Running the benchmark model for the reduced sample as in Robustness Check 5 (NFCS 2015-2021), we obtain the marginal effect estimate of objective literacy of -0.0301, being significant at the 0.1% level. Full results of controlled variables are available upon request.

C IV Results

Studying the effect of financial literacy on mortgage payment delinquency, we are aware of the possibility of reverse causality - for example, individuals may learn and improve their financial literacy based on their experience in the mortgage market. To address this concern, we employ four IV strategies to assess the causal effect of interest. Tables 4 and 5 present the IV probit estimates of the first two strategies, in which we use the financial literacy of the matched person as an instrument for the respondent's financial literacy. The matched pairs in these two IV strategies are identified by the propensity score matching across or within NFCS data waves.

The first-stage regressions reported in Tables 4 and 5 show a significant positive correlation between the instrument and the endogenous variable, confirming our hypothesis that individuals who have similar demographic and individual characteristics would have close levels of financial literacy. The F-tests on excluded instruments from the first stage are all much larger than 10, implying the used instrument is not weak.[9]

The second-stage results reported in Tables 4 and 5 show that the IV estimates of the causal effect of financial literacy on mortgage delinquency are larger than the probit estimates. Yet, insignificant results are obtained in the two IV settings when the 2009 sample is involved. We suspect that such results might be due to the global financial crisis of 2007/2008 that caused severe damage to the US mortgage market and affected most mortgage holders.[10] The larger IV estimates might reflect the measurement errors in objective financial literacy that caused the downward bias in the probit estimates and that is now captured in the error terms of the first-stage regressions. On average, a one standard deviation increase in financial literacy (about one additional correct answer) reduces the delinquency probability by 3 to 5 percentage points.[11]

[9] As a rule-of-thumb, the F-statistics result should be greater than 10 to avoid the weak instrument problem (Staiger and Stock 1997).

[10] During the subprime mortgage crisis of 2007-2010, the delinquency rate on single-family residential mortgages in the US soared and reached its peak at 11.48% in 2010 (Federal Reserve System (US) 2023).

[11] One standard deviation of objective financial literacy in our sample is about 1.3, which is equivalent to more than one additional correct answer.

Table 4: Instrumental Variable Analysis using Propensity Score Matching across NFCS Data Waves

	2009-2012		2012-2015		2015-2018		2018-2021	
	1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage
Dependent variable:	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency
Objective financial literacy (matched person)	0.2555***	-	0.3348***	-	0.3020***	-	0.3588***	-
	(0.0104)		(0.0101)		(0.0099)		(0.0110)	
Objective financial literacy (respondent)	-	0.0002	-	-0.0404***	-	-0.0369***	-	-0.0230**
		(0.0151)		(0.0089)		(0.0098)		(0.0083)
Observations	7459	7459	7819	7819	7032	7032	6257	6257
Wald test of exogeneity	-	1.97	-	2.53	-	1.03	-	2.27
Test of excluded instruments (F-test)	36.48***	-	45.72***	-	45.97***	-	40.84***	-
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * p<.05; ** p<.01; *** p<.001. Weighted results. Robust standard errors in parentheses. Control variables are the same as in Table 1. In this IV setting, the objective financial literacy of respondents is instrumented using the objective financial literacy of the most matched individuals in the closest past survey. For instance, the 2021 sample is matched with the 2018 sample, and so on. One-to-one nearest matching without replacement is employed, and all controlled characteristics are used to calculate the propensity scores. The matching procedure uses a caliper of 0.05. Marginal effects are reported in the second stage of the IV estimation. Full results of controlled variables are available upon request.

Table 5: Instrumental Variable Analysis using Propensity Score Matching within NFCS Data Waves

	2009		2012		2015		2018		2021	
	1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage
Dependent variable:	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency
Objective financial literacy (matched person)	0.2588***	-	0.2418***	-	0.3224***	-	0.3186***	-	0.3534***	-
	(0.0144)		(0.0134)		(0.0140)		(0.0142)		(0.0154)	
Objective financial literacy (respondent)	-	-0.0039	-	-0.0526**	-	-0.0386**	-	-0.0322*	-	-0.0311**
		(0.0208)		(0.0198)		(0.0128)		(0.0132)		(0.0119)
Observations	3662	3662	4568	4568	3804	3804	3496	3496	2997	2997
Wald test of exogeneity	-	0.18	-	5.18*	-	1.44	-	1.06	-	1.02
Test of excluded instruments (F-test)	18.24***	-	21.52***	-	22.35***	-	24.75***	-	21.91***	-
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * p<.05; ** p<.01; *** p<.001. Weighted results. Robust standard errors in parentheses. Control variables are the same as in Table 1. In this IV setting, the objective financial literacy of respondents is instrumented using the objective financial literacy of the most matched individuals in the same survey. One-to-one nearest matching without replacement is employed, and all controlled characteristics are used to calculate the propensity scores. The matching procedure uses a caliper of 0.05. Marginal effects are reported in the second stage of the IV estimation. Full results of controlled variables are available upon request.

Table 6: Instrumental Variable Analyses using External Data

Panel A: IV Analyses using State-level NTIA and NCES Data

	Benchmark Model	IV Model with Internet Usage Data		IV Model with Education Data	
		1st Stage	2nd Stage	1st Stage	2nd Stage
Dependent variable	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency
Percentage of state population using the Internet	-	0.0383***	-	-	-
		(0.0114)			
Number of degree-granting postsecondary institutions	-	-	-	0.0042**	-
				0.0016	
Objective financial literacy	-0.0286***	-	-0.2511***	-	-0.2126***
	(0.0016)		(0.0326)		(0.0485)
Observations	44347	44347	44347	44347	44347
Wald test of exogeneity	-	-	4.73*	-	4.10*
Test of excluded instruments (F-test)	-	41.55***	-	39.32***	-
Control variables	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Panel B: IV Analyses using NTIA Microdata

	Benchmark Model	IV Model with Internet Usage Data		IV Model with Occupation Data	
		1st Stage	2nd Stage	1st Stage	2nd Stage
Dependent variable	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency	Objective Financial Literacy	Mortgage Payment Delinquency
Use internet at home/work/school	-	0.0997*	-	-	-
		(0.0418)			
Have financial occupation(s)	-	-	-	0.1179***	-
				(0.0321)	
Objective financial literacy	-0.0232***	-	-0.1661*	-	-0.1237*
	(0.0025)		(0.0665)		(0.0580)
Observations	17203	17203	17203	17203	17203
Wald test of exogeneity	-	-	4.03*	-	4.49*
Test of excluded instruments (F-test)	-	71.60***	-	71.72***	-
Control variables	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Notes: * p<.05; ** p<.01; *** p<.001. Weighted results. Robust standard errors in parentheses. Control variables are the same as in Table 1. The benchmark model is Model 4 in Table 1. Marginal effects are reported in the second stage of the IV estimations. Full results of controlled variables are available upon request.

To carefully examine the causal relationship of interest, we implement two additional IV strategies that exploit exogenous variation in financial literacy driven by heterogeneity in regional and individual characteristics, respectively. Table 6 reports the corresponding results.

The first-stage results in Table 6 confirm the validity of our instruments. In both IV strategies, the employed instruments are significantly and positively correlated with the endogenous regressor - objective financial literacy. The F-test results reject the possibility of weak instruments. In the second stage, the effect of financial literacy on mortgage payment delinquency remains negative, statistically significant, and is much larger (in absolute value) than in the benchmark case. As previously discussed, the standard probit estimates tend to underestimate the true effect of financial literacy due to measurement errors in the variable itself and the unobservables that could affect both financial literacy and mortgage delinquency. Lusardi and Mitchell (2014) provides an extensive literature overview showing that IV estimates of financial literacy are always larger than the OLS or probit estimates. In a nutshell, our results speak that a higher level of financial literacy significantly reduces mortgage payment delinquency.

D Heterogeneity

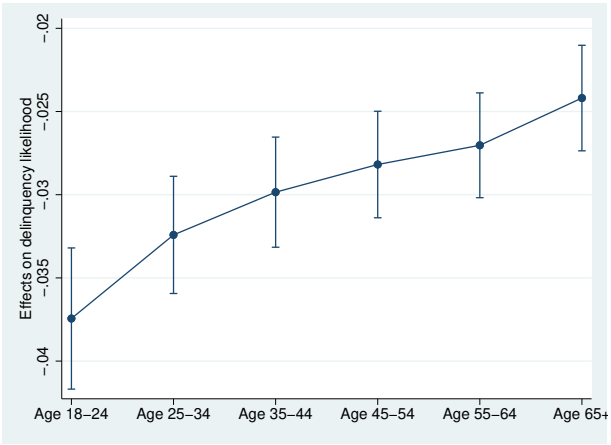
In this paper, we are also interested in the heterogeneity of the effect of financial literacy on mortgage delinquency among different demographic groups. Specifically, we analyze the effect on individuals of different ages, genders, income, and education levels. Figure 5 presents the results for the benchmark case.

In general, we see that the effect of financial literacy on delinquency likelihood is negative and significantly different from zero for any age, gender, income, or education level, suggesting increasing financial literacy benefits everyone. Nevertheless, the younger the individual, the greater the benefit since the effect decreases monotonically with age. For instance, while one standard deviation increase in objective financial literacy would reduce delinquency likelihood by nearly 3.7 percentage points for those in their early adulthood (18-24 years old), such effect is only -2.8 and -2.5 percentage points for people over 45 and 65 years old, respectively. Perhaps, as people get older, they are more experienced in financial management and thus less likely to make mistakes. On the contrary, there is no significant difference in the effect between males and females or among different income and education levels (considering the 95% confidence intervals around the point estimates). Yet, the effect seems slightly stronger for individuals with lower

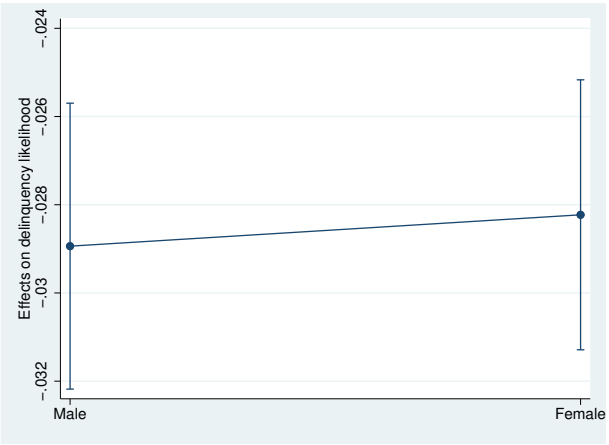
income or education levels. Complementary to these results, Figure B6 shows that the likelihood of mortgage delinquency decreases substantially with age and is significantly higher among non-white citizens than white citizens. Also, the gender difference in mortgage delinquency is negligible regardless of age and ethnicity.

Figure 5: Average Marginal Effects of Objective Financial Literacy on Mortgage Delinquency Likelihood By Demographic Groups

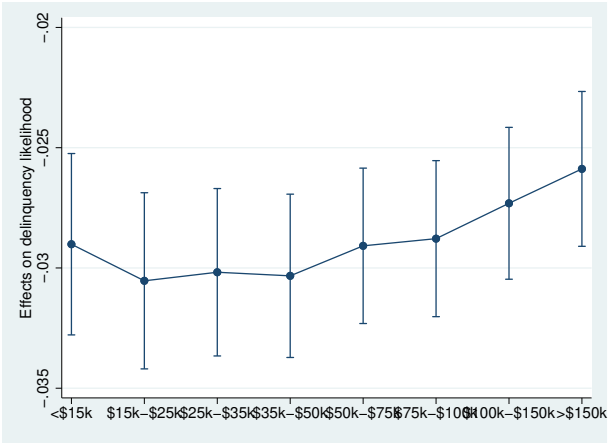
(a) By Age



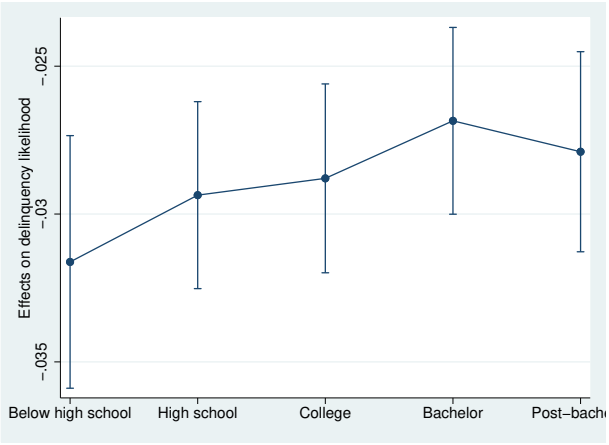
(b) By Gender



(c) By Income



(d) By Education



Notes: Own calculations using NFCS data. Point estimates with a 95% confidence interval are reported.

Besides, we examine whether the causal effect of interest differs among high- and low-literate states. In doing so, we define low-literate states as those whose percentage of respondents having more than 3 correct answers to the Big 5 financial literacy questions is lower than the sample's median value and vice versa. We adjust the classifying criteria to "having more than 2 correct answers" in a robustness check. Table 7 reports the results. In low-literate states, the effect of objective financial literacy is larger than in high-literate states. This result is represented by the

negative coefficient of the interaction term between objective financial literacy and low-literate state.[12] Put differently, our results suggest that in states with low financial literacy, the impact of increased financial literacy on reducing mortgage delinquency is larger compared to states with high literacy rates.

Table 7: Further Cross-sectional Analyses

Dependent variable: Mortgage Payment Delinquency	Model 5		Model 6	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Objective financial literacy	-0.1169***	-0.0283***	-0.1155***	-0.0282***
	(0.0112)	(0.0016)	(0.0112)	(0.0016)
Low-literate state (ref: High literate state)	0.2114***	0.0125*	0.2031***	0.0090
	(0.0547)	(0.0063)	(0.0565)	(0.0068)
Objective financial literacy x Low-literate state	-0.0507***	-	-0.0539***	-
(ref: Objective financial literacy x High-literate state)	(0.0148)		(0.0148)	
Subjective financial literacy	0.0130	0.0026	0.0127	0.0025
	(0.0095)	(0.0019)	(0.0095)	(0.0019)
Constant	-0.6433***	-	-0.6409***	-
	(0.1352)		(0.1350)	
Observations	44347		44347	
Pseudo R^2	0.2630		0.2630	
Control variables	Yes		Yes	
State FE	Yes		Yes	
Year FE	Yes		Yes	

Notes: * p<.05; ** p<.01; *** p<.001. Weighted results. Robust standard errors in parentheses. Control variables are the same as in Table 1. Full results of controlled variables are available upon request. Low-literate states are states that have a percentage of respondents having more than 3 correct answers to the Big 5 financial literacy questions lower than the sample's median value, and vice versa. Model 6 is similar to Model 5 except that we adjust the criteria of classifying low- versus high-literate states from having more than 3 correct answers to having more than 2 correct answers to 5 financial literacy questions.

VI Policy Implication and Conclusion

Mortgage delinquency was a salient issue during the major financial crisis in the late 2000s. Even though the mortgage delinquency rate has significantly decreased in recent years from its peak, it is still considerably higher than the levels observed in the two decades preceding the crisis (Federal Reserve System (US) 2023). Since mortgage delinquency negatively affects the financial prospects of delinquent borrowers and consequently harms the economy, reducing mortgage delinquencies ought to be among the top priorities for policymakers and financial regulators around the world.

In this paper, we provide an empirical examination of the causal relationship between individual financial literacy and mortgage delinquency. A large and growing literature has elicited the importance of financial literacy on many economic and financial outcomes, such as

[12]Note that only the coefficient of the interaction term is reported as the marginal effect of interaction terms in non-linear models does not exist (Williams 2012).

precautionary savings, stock market participation, retirement planning, portfolio diversification, wealth accumulation, etc. (Lusardi and Mitchell 2008; Rooij et al. 2011; Bianchi 2018; Lusardi et al. 2017). In a similar vein, we ask whether financial literacy has a causal effect on mortgage payment delinquency. To answer this question, we use the well-established National Financial Capability Study (NFCS) survey data on the US adult population and exploit various Instrumental-Variable (IV) strategies for identification.

While no correlation is found between mortgage delinquency and subjective financial literacy, measured by individuals' self-perception about their general financial knowledge, we find that objective financial literacy, measured by individuals' responses to a set of financial literacy questions, has a significant and negative effect on mortgage delinquency. Specifically, a one-standard-deviation increase in objective financial literacy (about one additional correct answer) can reduce delinquency likelihood by at least 3 percentage points, corresponding to a nearly 17% decrease in the average mortgage delinquency rate during the studied period 2009-2021. Our IV estimates of the causal effect, which address the major concern of reverse causality, are much larger than the standard probit estimates (around 5-8 times), suggesting the crucial role of financial literacy in mitigating mortgage delinquency.

Furthermore, we assess the heterogeneity of the impact across different demographic groups. We find that the magnitude of the effect of financial literacy on mortgage delinquency decreases with age, implying young individuals would likely benefit the most from enhancing financial literacy. At the same time, there is no significant difference in the effect with respect to gender, formal education, and income levels. In line with the literature, our results suggest that financial literacy cannot be fully obtained in school but rather from hands-on experience in the financial markets or through the intervention of complementary financial education programs. Our study thus also relates to the growing body of the literature that documents the impact of financial education on financial literacy and downstream financial behaviors (see Kaiser et al. 2022 and the references therein). In addition, we show that the causal effect of interest would be of higher relevance in states where the financial literacy of the population is low. Altogether, we interpret these findings as pieces of evidence advocating for financial education interventions in low-literate states, especially for young individuals of all social backgrounds. To what extent the benefits from such interventions would outweigh the costs from a welfare point of view is an issue that we leave for future research.

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Appendix A - Tables

Table A1: Descriptive Statistics - NFCS Data

	Full sample	Mortgage holders	Non-mortgage holders	T-test/ Chi-squared test (p-value)
Observations	73,977	44,347	29,630	
Dependent variable				
Mortgage delinquency in the past 12 months (%)				
Never been late	88.8	81.0	-	
Have been late once	4.7	8.1	-	
Have been late more than once	6.5	10.9	-	
Financial literacy variables				
Objective financial literacy (mean, scale 1-5)	3.2	3.3	3.2	0.00
Subjective financial literacy (mean, scale 1-7)	5.4	5.3	5.4	0.00
Control variables				
Age (%)				
Age 18-24	4.5	4.3	4.8	0.00
Age 25-34	12.2	16.4	8.6	0.00
Age 35-44	16.4	21.3	9.6	0.00
Age 45-54	19.7	22.9	15.0	0.00
Age 55-64	21.6	19.3	24.8	0.00
Age 65+	24.6	15.8	37.2	0.00
Gender (%)				
Male	50.9	51.7	49.7	0.24
Female	49.1	48.3	50.3	0.24
Education (%)				
Less than high school	2.0	1.6	2.6	0.00
High school diploma	32.3	30.7	34.6	0.00
Some college	40.7	42.5	38.0	0.00
Bachelor degree	16.3	16.7	15.8	0.00
Post-bachelor degree	8.7	8.5	9.0	0.00
Marital status (%)				
Married	67.8	71.7	62.1	0.00
Single	17.0	15.4	19.4	0.00
Separated/divorced/widow	15.2	12.9	18.5	0.00
Ethnicity (%)				
White	73.9	71.1	77.9	0.00
Non-white	26.1	28.9	22.1	0.00
Employment status (%)				
Self employed	8.2	8.0	8.5	0.00
Full-time worker	41.2	60.0	27.1	0.00
Part-time worker	7.4	7.2	7.8	0.00
Homemaker	7.9	8.4	7.2	0.00
Student	1.7	1.6	1.8	0.00
Disable	3.1	2.6	3.7	0.00
Unemployed	3.9	3.8	4.1	0.00
Retired	26.6	17.3	39.8	0.00
Household income (%)				
<$15,000	4.5	2.6	7.3	0.00
$15,000 - $25,000	6.9	4.8	9.7	0.00
$25,000 - $35,000	8.9	7.2	11.3	0.00
$35,000 - $50,000	14.3	13.4	15.6	0.00
$50,000 - $75,000	22.5	24.2	21.4	0.00

Table A1 (continued)

	Full sample	Mortgage holders	Non-mortgage holders	T-test/ Chi-squared test (p-value)
$75,000 - $100,000	16.8	19.0	13.8	0.00
$100,000 - $150,000	16.7	19.4	12.8	0.00
>$150,000	9.4	10.4	8.1	0.00
Risk loving (mean, scale from 1-7)	5.1	5.3	4.8	0.00
Self-assessed math skill (mean, scale 1-7)	5.8	5.8	5.8	0.06
Self-assessed basic financial skills (mean, scale 1-7)	6.0	5.9	6.1	0.00
Have dependent child (%)	38.6	47.8	25.6	0.00
Financial hardship (%)				
Very difficult	9.3	11.0	6.8	0.00
Somewhat difficult	33.1	37.0	27.6	0.00
Not at all difficult	57.6	52.0	65.6	0.00
Had unexpected large drop in income in the past 12 months (%)	23.7	27.2	18.7	0.00
Have precautionary saving(s) (%)	60.3	54.4	68.8	0.00
Covered by health insurance (%)	91.3	92.5	89.5	0.00

Notes: The T-tests and Chi-square tests evaluate the differences in mean and proportion of variables, respectively, between mortgage and non-mortgage groups. Self-assessed basic financial skills are the self-assessment on dealing with day-to-day financial matters (such as checking accounts, credit and debit cards, and tracking expenses). See Table A2 for the definitions of financial literacy variables.

Table A2: Summary of Key Variables, 2009-2021 NFCS Surveys

Variable	Description	Correct (%)	Incorrect (%)	Don't Know (%)
Dependent variable				
Mortgage payment delinquency	Dummy variable that takes the value of 1 if the respondent reports having been late at least once, and 0 if never been late, to the following question: "How many times have you been late with your mortgage payments in the past 12 months?" (i) Never; (ii) Once; (iii) More than once; (iv) Don't know; (v) Prefer not to say.			
Financial literacy questions				
1. Compounding	"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?" (i) More than $102; (ii) Exactly $102; (iii) Less than $102; (iv) Don't know; (v) Prefer not to say.	79.9	12.1	8.0
2. Inflation	"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?" (i) More than today; (ii) Exactly the same; (iii) Less than today; (iv) Don't know; (v) Prefer not to say.	67.0	19.3	13.7
3. Diversification	"Buying a single company's stock usually provides a safer return than a stock mutual fund." (i) True; (ii) False; (iii) Don't know; (iv) Prefer not to say.	53.5	11.4	35.1
4. Bond pricing	"If interest rates rise, what will typically happen to bond prices?" (i) They will rise; (ii) They will fall; (iii) They will stay the same; (iv) There is no relationship between bond prices and the interest rates; (v) Don't know; (vi) Prefer not to say.	33.1	35.4	31.5
5. Mortgage	"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." (i) True; (ii) False; (iii) Don't know; (iv) Prefer not to say.	83.7	7.0	9.3
6. Loan interest	"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?" (i) Less than 2 years; (ii) At least 2 years but less than 5 years; (iii) At least 5 years but less than 10 years; (iv) At least 10 years; (v) Don't know; (vi) Prefer not to say.	35.0	44.8	20.2
Financial literacy variables				
Objective financial literacy	The number of correct answers to the first five financial literacy questions listed above.			
Subjective financial literacy	The answer to the following question: "On a scale from 1 to 7, where 1 means very low and 7 means very high, how would you rate your overall financial knowledge?"			

Notes: We account for the difference between having been late with mortgage payments once and more than once in a robustness check. The first five (three) financial literacy questions are referred to as the "Big 5" ("Big 3"), according to Hastings et al. (2013). The 6^{th} financial literacy question is not included in the 2009 and 2012 NFCS surveys. For the sake of consistency, we use only the first five questions to calculate the objective financial literacy scores for the benchmark model. Nevertheless, we use all six financial literacy questions in a robustness check.

Table A3: Descriptive Statistics - State-level Internet Usage and Education Data

Variable	Description	Source	Obs	Mean	Std. Dev.	Min	Max
Percentage of state population using the Internet	Per state percentage of population using the Internet (Age 3+ Civilian Persons)	NTIA	255	.76	.06	.55	.89
Number of degree-granting postsecondary institutions	Per state number of degree-granting postsecondary institutions per 100,000 students	NCES	255	19.67	6.92	6.12	43.54

Notes: We collect state-level data from NTIA and NCES that are reported two years prior to each wave of the NFCS surveys. The 255 observations correspond to the data of 51 US states for 5 studied years. According to NCES definition, a degree-granting postsecondary institution is an educational institution that awards degrees or certifications at the associate's, bachelor's, master's, doctoral, or first-professional degree level (e.g. 2-year or 4-year colleges, universities).

Table A4: Descriptive Statistics - Merged Sample of NFCS and NTIA Data

	Full sample	Mortgage holders	Non-mortgage holders	T-test/ Chi-squared test (p-value)
Observations	36,669	17,203	19,466	
Dependent variable				
Mortgage delinquency in the past 12 months (%)				
Never been late	94.4	87.7	-	
Have been late once	2.3	5.1	-	
Have been late more than once	3.3	7.2	-	
NTIA only variables				
Use internet at home/work/school (%)	92.9	92.3	93.4	0.00
Have financial occupation(s) (%)	5.6	7.4	4.1	0.00
Financial literacy variables				
Objective financial literacy (mean, scale 1-5)	3.3	3.3	3.2	0.00
Subjective financial literacy (mean, scale 1-7)	5.4	5.3	5.5	0.00
Control variables				
Age (%)				
Age 18-24	2.1	2.2	1.9	0.00
Age 25-34	5.1	7.5	3.1	0.00
Age 35-44	7.0	11.4	3.2	0.00
Age 45-54	10.6	16.3	5.8	0.00
Age 55-64	19.0	20.1	18.2	0.00
Age 65+	56.2	42.5	67.8	0.00
Gender (%)				
Male	40.2	38.6	41.5	0.00
Female	59.8	61.4	58.5	0.00
Education (%)				
Less than high school	2.0	2.0	2.0	0.18
High school diploma	34.9	33.0	36.5	0.00
Some college	40.9	43.9	38.4	0.00
Bachelor degree	13.9	13.8	14.0	0.00
Post-bachelor degree	8.3	7.3	9.1	0.00
Marital status (%)				
Married	73.8	78.0	70.3	0.00
Single	6.0	6.2	5.8	0.00
Separated/divorced/widow	20.2	15.8	23.9	0.00
Ethnicity (%)				
White	90.8	88.9	92.4	0.00
Non-white	9.2	11.1	7.6	0.00
Employment status (%)				
Self employed	4.9	5.2	3.8	0.00
Full-time worker	30.8	31.5	15.3	0.00
Part-time worker	20.0	11.8	4.6	0.00
Homemaker	5.6	6.3	20.9	0.00
Student	1.0	1.2	0.9	0.00
Disable	1.6	1.6	1.7	0.00
Unemployed	1.7	2.2	1.3	0.00
Retired	34.4	40.2	51.5	0.00
Household income (%)				
<$15,000	3.9	2.6	4.9	0.00
$15,000 - $25,000	6.3	4.3	7.9	0.00
$25,000 - $35,000	9.9	7.0	12.3	0.00
$35,000 - $50,000	16.4	15.5	17.2	0.00
$50,000 - $75,000	27.8	29.6	26.3	0.00

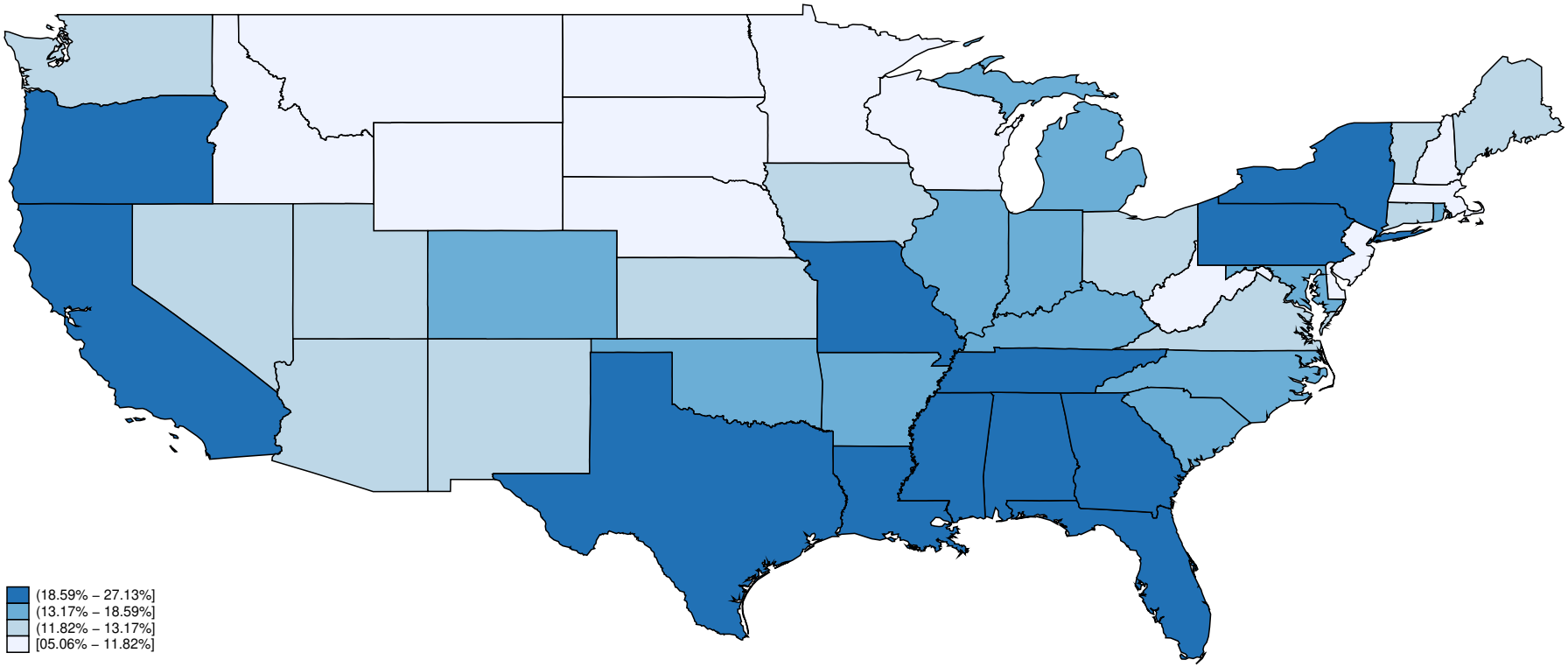
Table A4 (continued)

	Full sample	Mortgage holders	Non-mortgage holders	T-test/ Chi-squared test (p-value)
$75,000 - $100,000	15.3	18.2	12.9	0.00
$100,000 - $150,000	13.3	15.5	11.5	0.00
>$150,000	7.1	7.3	7.0	0.00
Risk loving (mean, scale from 1-7)	4.1	4.3	3.9	0.00
Self-assessed math skill (mean, scale 1-7)	5.8	5.7	5.9	0.00
Self-assessed basic financial skills (mean, scale 1-7)	6.2	6.1	6.3	0.00
Have dependent child (%)	24.1	35.7	14.3	0.00
Financial hardship (%)				
Very difficult	5.9	8.4	3.9	0.00
Somewhat difficult	28.6	36.6	22.0	0.00
Not at all difficult	65.5	55.1	74.1	0.00
Had unexpected large drop in income in the past 12 months (%)	17.7	23.0	13.2	0.00
Have precautionary saving(s) (%)	67.7	56.2	77.3	0.00
Covered by health insurance (%)	95.1	94.4	95.8	0.00

Notes: The T-tests and Chi-square tests evaluate the differences in mean and proportion of variables, respectively, between mortgage and non-mortgage groups. Self-assessed basic financial skills are the self-assessment on dealing with day-to-day financial matters (such as checking accounts, credit and debit cards, and tracking expenses). See Table A2 for the definitions of financial literacy variables.

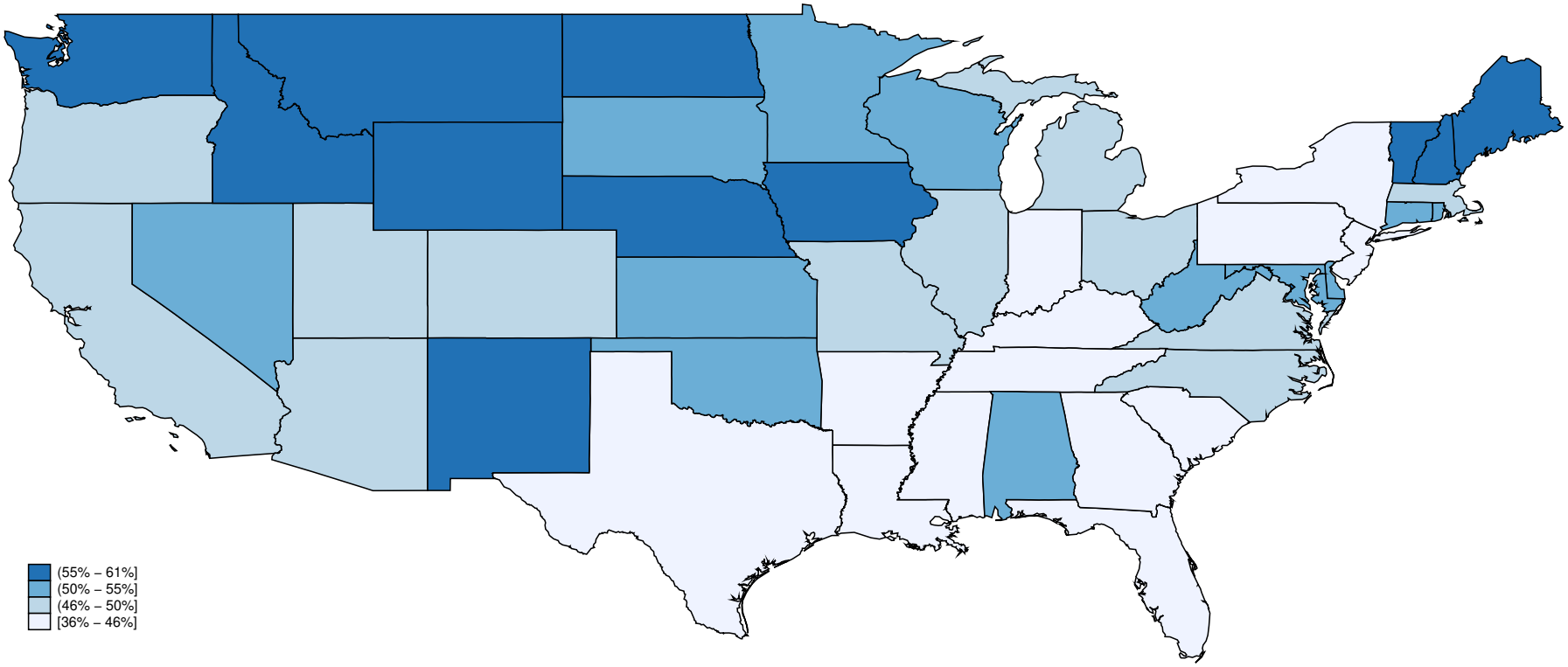
Appendix B - Figures

Figure B1: Quartile Distribution of Per State Percentage of Respondents Having Been Late with Mortgage Payments in the Past 12 Months



Notes: Own calculations using NFCS data. Alaska and Hawaii belong to the bottom quartile of the distribution. Our results are consistent with the statistics of the Consumer Financial Protection Bureau (CFPB) on the 30-89 mortgage delinquency rate across US states. See more at https://www.consumerfinance.gov/data-research/mortgage-performance-trends/mortgages-30-89-days-delinquent/

Figure B2: Quartile Distribution of Per State Percentage of Respondents Having more than Three Correct Answers to the Big 5 Financial Literacy Questions

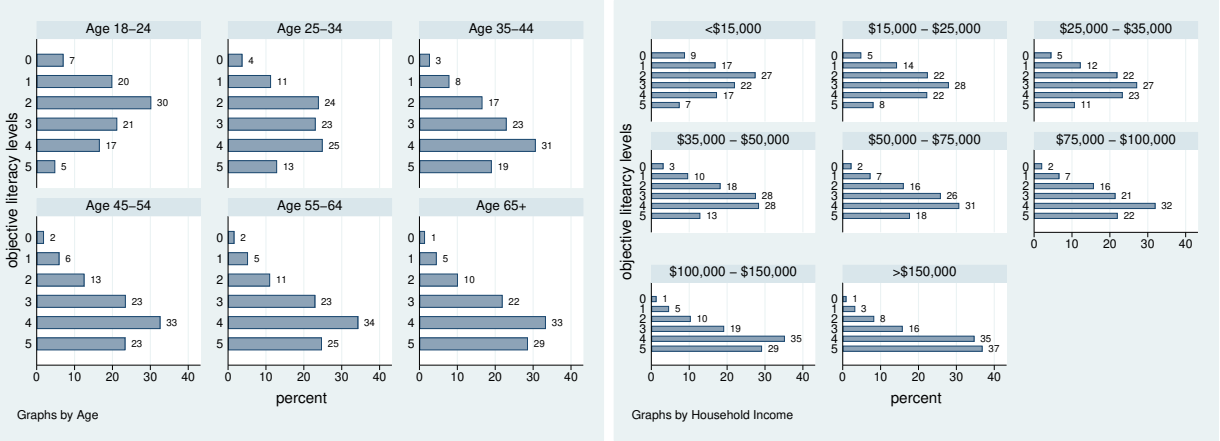


Notes: Own calculations using NFCS data. Alaska and Hawaii belong to the top quartile of the distribution.

Figure B3: Summary Statistics of Objective Financial Literacy by Demographic Groups

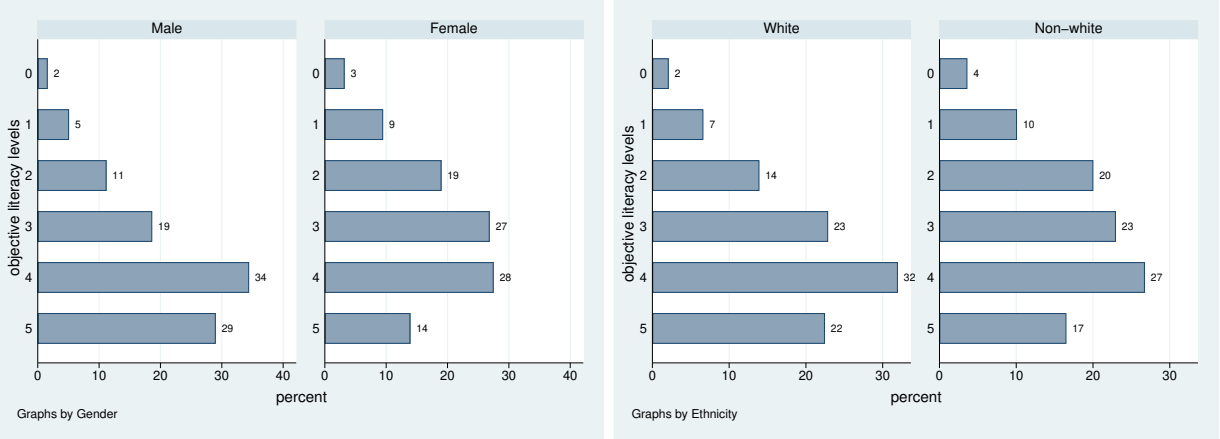
(a) By Age

(b) By Income



(c) By Gender

(d) By Ethnicity

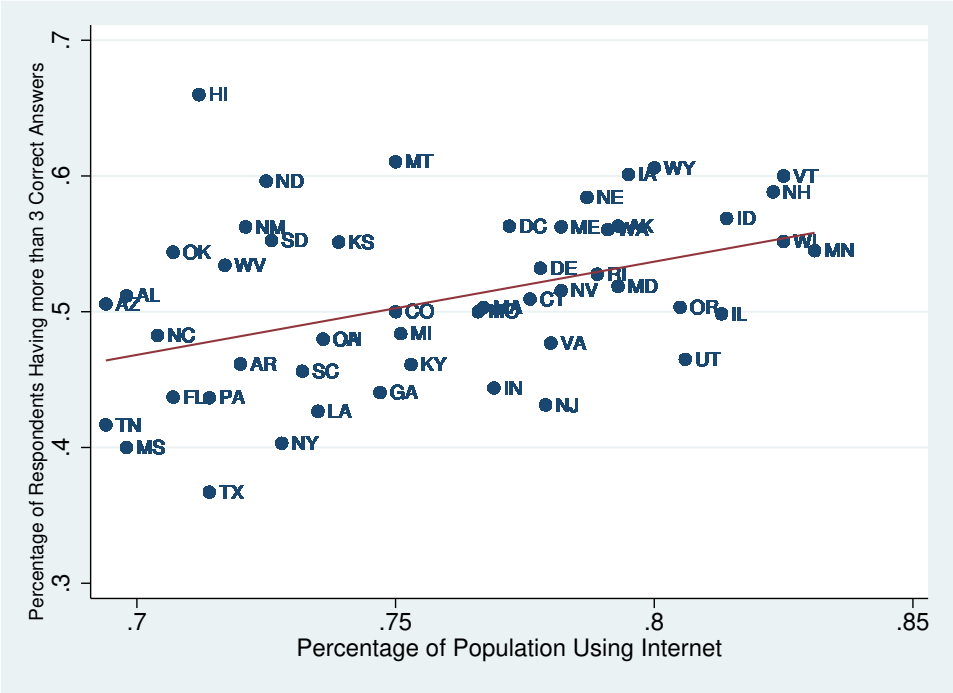


(e) By Education

(f) By Subjective Financial Literacy

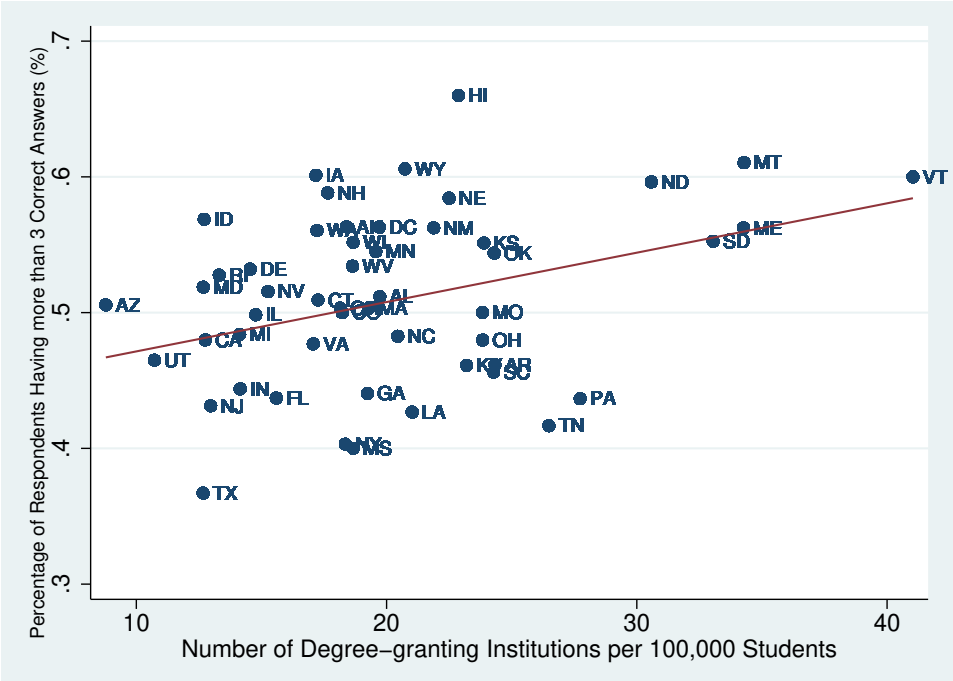
Notes: Own calculations using NFCS data. See Table 2 for the definition of objective financial literacy.

Figure B4: Financial Literacy Versus Internet Usage



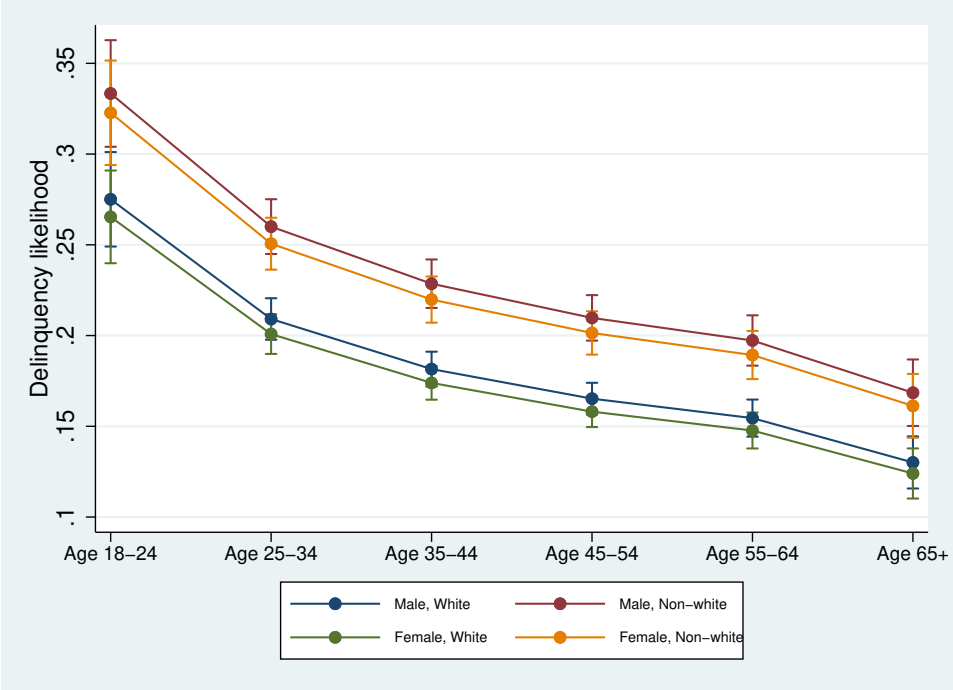
Notes: Own calculations using NFCS and NTIA data.

Figure B5: Financial Literacy Versus Degree-granting Institutions



Notes: Own calculations using NFCS and NCES data.

Figure B6: Mortgage Delinquency Likelihood: By Age, Gender, and Ethnicity



Notes: Own calculations using NFCS data.

IMPRESSUM
Jena Economics Research Papers
ISSN 1864-7057
Friedrich Schiller University Jena
Faculty of Economics and Business Administration
Carl-Zeiss-Str. 3
D-07743 Jena, Germany

Email: office.jerp@uni-jena.de
Editor: Silke Übelmesser
Website: www.wiwi.uni-jena.de/en/jerp