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## The Effects of Financial Literacy Overconfidence on the Mortgage Delinquency of US Households

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This study investigated the effect of objective and subjective financial literacy on mortgage payment delinquency using the 2015 National Financial Capability Study dataset. A hierarchical model showed a substantial negative effect of objective literacy on delinquency, but subjective literacy did not have a significant effect. The predicted likelihood of delinquency at the 10th percentile of objective literacy was over three times as high as the likelihood at the 90th percentile. In a model with combinations of high or low objective and subjective financial literacy, those who were overconfident had a delinquency likelihood three times as high as those who had high objective and subjective literacy. Subjective literacy had substantial effects on delinquency both for high- and low-objective literacy levels. In financial education, attention should be focused not only on objective learning but also making sure consumers are aware of the limitations of their understanding.

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While the subject of financial literacy has been a salient issue to financial practitioners and consumer advocates (Gerardi, Goette, and Meier 2010), the subject gained more attention after the Great Recession (USA Today 2013). Many studies have found that consumers have low financial literacy (e.g., Atkinson and Messy 2012; Lusardi and Mitchell 2017; Lusardi and Tufano 2015).

Low financial literacy might lead consumers to make bad decisions (Van Rooij 2008). For example, Lusardi (2008) found that financially illiterate individuals are less likely to achieve adequate retirement. Being financially illiterate has been found to be linked to financial mistakes (Stango and Zinman 2009). Bernanke (2006) argued that with the increasing complexity of financial markets, consumer financial literacy has become an increasingly critical issue as a larger segment of the population now has to make important and complicated financial decisions. Previous studies have found that

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The Journal of Consumer Affairs, Summer 2020: 517–540

DOI: 10.1111/joca.12287

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lower levels of debt literacy are positively related to debt accumulation (Stango and Zinman 2009), high-cost borrowing (Lusardi and de Bassa Scheresberg 2013; Lusardi and Tufano 2015; Robb et al. 2015), and mortgage delinquency (Gerardi, Goette, and Meier 2010). Some recent studies have analyzed the effects of financial literacy overconfidence on household financial decisions, with overconfidence measured by a divergence between objective and subjective financial literacy. Households with financial literacy overconfidence were more likely to hold only stocks in their portfolios (Chu et al. 2017; Xia, Wang, and Li 2014) and more likely to utilize alternative financial services (Robb et al. 2015).

We used the 2015 National Financial Capability Study (NFCS) dataset to investigate the effect of financial literacy on mortgage payment delinquency, controlling for household characteristics and state fixed effects. We attempted to identify the effects of objective and subjective financial literacy measures on mortgage payment delinquency, and the explanatory power of financial literacy variables was tested by constructing a hierarchical model. Specifically, we focused on the relationship between financial literacy overconfidence and delinquency, among households with a home mortgage. In order to analyze the relationship, we used logistic regression models with different measures of overconfidence. Further, we conducted a propensity score matching (PSM) analysis, which mitigates a possible selection bias of overconfidence, as well as produces less biased estimates of the relation between overconfidence and mortgage loan delinquency.

Even though there are differing opinions about whether financial literacy can be measured by financial knowledge scores (e.g., Huston 2010), for convenience we use the term “financial literacy” to refer to the financial knowledge objective score and self-assessment measure. The results of this study provide insights into the role of financial literacy and financial literacy overconfidence on the mortgage delinquency of US households and have implications for financial education and research.

## LITERATURE REVIEW

### Theoretical Background

Neoclassical economic theory assumes that people make decisions in order to maximize their utility subject to constraints (Boatman, Evans, and Soliz 2014; Robb et al. 2015). Under this model, individuals have full information with regard to costs, benefits or alternatives when making decisions. There is considerable evidence of human behavior that is inconsistent with the neoclassical model, and people are subject to bounded rationality (Robb et al. 2015). People do not always make decisions pursuing consistent goals

with consideration of relevant external factors. Rather, people often make decisions based on their limited knowledge and ability (Simon 2000). For example, when faced with a decision that requires complex calculations and predictions about the future, many people tend to depend on signals such as default options (Boatman, Evans, and Soliz 2014).

Rational borrowers should consider the costs and benefits of repaying the debt when deciding whether to keep making debt payments. Some borrowers may fall behind due to the inability to repay their loans because of an adverse change in their financial condition. Many consumers fall behind, then become current again, only for the cycle to repeat itself again (Foote et al. 2010). Other borrowers may engage in strategic default, which is typically defined as default by borrowers who have sufficient resources to make the mortgage payment. Foote et al. (2010) concluded that few borrowers show an abrupt stoppage of payments that would be indicative of strategic default. Also, it is hard to identify strategic behavior because strategic defaults are unobserved, and borrowers are incentivized to mask their behavior as an inability to repay their mortgages (Guiso, Sapienza, and Zingales (2013). Therefore, our study does not assume strategic default is important. The debt payment decision is part of a complex household debt management problem. A household might skip a debt payment when the expected utility of doing so is larger than the expected utility from making the payment on time. Poor debt payment, however, can cause long-term problems such as decreased credit scores and loss of assets. Missing loan payments can also be a precursor to bankruptcy (McCloud and Dwyer 2011; Moorman and Garasky 2008).

Dominy and Kempson (2003) suggested that a majority of borrowers who are delinquent on their debt payments have every intention to pay in a timely manner, but simply lack the ability to do so. Examples of defaulting borrowers include low-income earners who experience unexpected and immediate financial expenses; borrowers who have experienced a sudden substantial income drop leaving them unable to meet all their debt obligations; and people with cognitive disabilities that impair their ability to manage their finances on their own. Van Zandt and Rohe (2011) found that many low-income homeowners were struggling with their mortgage payments, with about half facing unexpected costs and about a third experienced unaffordable home repairs within two years of homeownership. Lee and Hanna (2012) found that income decreases and poor health status increased the likelihood of debt delinquency. A few studies have investigated the effects of financial literacy, for instance, Gerardi, Goette, and Meier (2010) found negative effects of a component of financial literacy, numerical ability, on mortgage delinquency. The relationship between

financial literacy and debt payment behavior might be due to poor decisions by consumers in obtaining credit in terms of choosing high-cost credit, or in taking on too much credit, or financial literacy might be related to unobserved characteristics of consumers that make it more likely they will be delinquent.

### Financial Literacy and Debt Behaviors

Many studies have provided evidence that higher financial literacy is related to a greater likelihood of making rational financial decisions. For example, Moore (2003) assessed financial literacy among residents of the state of Washington, and found that people were uninformed about financial instruments, and a large number of the respondents did not understand financial concepts related to bonds, stocks, mutual funds, and the compound interest. Moore also found that those with lower levels of financial literacy were more likely to take out high-cost mortgages. Campbell (2006) examined whether mortgage borrowers understood the terms of their mortgages, using the American Housing Survey. He found that some respondents reported implausibly low fixed-rate mortgage rates, and that less-educated individuals were less likely to refinance their mortgages when interest rates were falling. Lusardi and Tufano (2015) analyzed a national sample of Americans regarding individuals' debt literacy and their financial experiences and found that individuals with lower levels of debt literacy were more likely to have financial transactions with higher fees, and to use high-cost borrowing. Lack of financial literacy is one of the factors that have contributed to poor financial decisions. For example, the lack of financial literacy has been found to be related to reduced access to financial markets (Clark and D'Ambrosio 2008; Lusardi and Mitchell 2007a) and to low levels of portfolio diversification (Mouna and Jarboui 2015).

Only a few empirical studies have looked at the psychological effect of overconfidence on household financial decisions. For example, Odean (1999) and Barber and Odean (2000) related the deviation from rational behavior to overconfidence bias and concluded that overconfidence leads to excessive trading, excessive risk taking, and under diversification. Overconfidence bias was described as miscalibration or overprecision, which refers to a systematic overweighting of the accuracy of one's own literacy (e.g., Chu et al. 2017; Robb et al. 2015; Xia, Wang, and Li 2014). Overconfidence bias was measured by comparisons of respondents' subjective financial literacy to their objective financial literacy. Irrationally high levels of overconfidence were associated with under-diversification (e.g. only stocks in their portfolios) (Chu et al. 2017; Xia, Wang, and Li 2014) and

high-cost borrowing behavior such as alternative financial services (Kim and Lee 2018; Robb et al. 2015).

These previous studies offer an important starting point. However, unlike the previous studies, our study investigated the role of financial literacy, overconfidence and demographic factors on debt payment delinquency. We estimated the effects of objective and subjective financial literacy measures on the likelihood of mortgage payment delinquency. In addition, we tested the effect of having appropriate high confidence and low confidence, being overconfident, and being underconfident on the likelihood of mortgage payment delinquency. In order to produce less biased estimates of the relation between overconfidence and mortgage loan delinquency, we also conducted a PSM analysis (Li 2013; Rosenbaum and Rubin 1983; Rubin 2001), which mitigates the effects of selection bias.

## METHODS

### Dataset and Sample Selection

This study used the restricted dataset from the 2015 state-by-state version of the NFCS commissioned by the Financial Industry Regulatory Authority (FINRA) Investor Education Foundation. The state-by-state survey contains information collected from approximately 500 respondents per state, and the total sample size is 27,564. The NFCS provides detailed measures of financial literacy, as well as socio-demographic, behavioral, and attitudinal traits of US households. For our analyses, we dropped households where the respondent chose “prefer not to say” as their answer to the questions dealing with objective financial literacy and/or where the respondent answered “prefer not to say” or “do not know” as their answer to the mortgage payment delinquency and subjective literacy question, which resulted in a sample size of 26,385 and the final analytic sample included 9,644 mortgage holders. In order to be representative of the general US population, results were weighted by the NFCS population weight.

### Dependent Variable

#### *Mortgage Payment Delinquency*

This study defined mortgage delinquency as being behind in making mortgage payments, which reflects a serious delinquency risk (Getter 2003; Lee and Hanna 2012). We created a binary dependent variable of mortgage payment delinquency coded as 1 if the respondent reported, over the last 12 months, the household was behind in the mortgage payments once or more, and coded as 0 otherwise. In this study, self-reported delinquency was used to measure the debt payment behavior of respondents. How

accurate are self-reported measures of debt payment behavior? Brown et al. (2011) compared self-reported data in the US Survey of Consumer Finances and credit bureau-reported data in the Federal Reserve Bank of New York Consumer Credit Panel and concluded self-reported payment patterns of borrowers and credit lender reported data are similar for nearly all forms of debt.

This study provides several tests on the effects of financial literacy and of financial literacy overconfidence on mortgage delinquency. State fixed effects are controlled, which provides an advantage over some previous studies on delinquency that could not control for location (e.g., Lee and Hanna 2012). We found substantial effects of financial literacy overconfidence on the likelihood of mortgage delinquency.

### Focal Independent Variables

#### *Objective and Subjective Financial Literacy*

The NFCS questionnaire is explicitly designed to understand both self-perceptions of financial knowledge and an objective assessment of individuals' financial literacy (Angrisani, Kapteyn, and Lusardi 2016). The NFCS includes five questions related to personal finance (see Appendix 1) and these can be used to create an objective financial literacy score. The first part of this questionnaire includes three questions asking simple calculations of interest in a savings account and inflation, and the relationship between interest rate and bond prices. An additional two questions ask individuals' knowledge of the relationship between the length of a mortgage and the total interest paid over the loan, and the concept of risk diversification. The rates of accurate answers to each question were consistent with other studies (e.g. Lusardi 2009; Lusardi and Mitchell 2011) and show the lack of financial literacy among Americans. To indicate the correct answer for each of the quiz questions, we created binary indicators whether a respondent reported a correct answer. Then, the objective literacy index was created, i.e., the sum of correct answers to the financial literacy questions, ranging from 0 to 5. The NFCS also includes a self-assessment measure of financial literacy, based on the following question: "On a scale from 1 to 7, where 1 means very low and 7 means very high, how would you assess your overall financial knowledge?" We refer to this variable as subjective financial literacy.

#### *Overconfidence*

To examine financial literacy overconfidence, following Robb et al. (2015) and Xia, Wang, and Li (2014), we defined high objective and high

subjective financial literacy based on whether the respondent had a value higher than the sample median for each variable. We used a divergence between objective and subjective financial literacy, creating four mutually exclusive variables. Based on combinations of high/low objective and high/low subjective categories, four dichotomous variables were created: (1) appropriate high confidence (high objective and high subjective literacy), (2) underconfidence (high objective and low subjective literacy), (3) overconfidence (low objective and high subjective literacy), and (4) appropriate low confidence (low objective and low subjective literacy). In order to check the robustness of our multivariate tests of the effects of these dichotomous variables on mortgage delinquency, we also tested the effects of two additional measures of overconfidence: (1) the continuous measure of divergence between objective and subjective financial literacy and (2) the residual from a least squares regression of objective literacy on subjective literacy. The residual measure of overconfidence indicates whether subjective financial literacy was higher or lower than the average individual with the same level of objective literacy.

### Control Variables

This study included independent variables on the basis of the literature on loan delinquency with the consideration of wealth effects and life cycle effects on the probability of loan delinquency discussed by Lee and Hanna (2012). The set of control variables included age of respondent, gender (male, female), education (less than high school, high school diploma, some college, bachelor degree, post-bachelor degree), marital status (married, single, separated/divorce/widow), racial/ethnic status (White, Black, Hispanic, Asian/others), presence of a dependent child (yes/no), employment status (full-time worker, self-employed, part-time worker, homemaker, student, disabled, unemployed, retired), household income, having an unexpected large drop in income (yes/no), and covered by health insurance (yes/no).<sup>1</sup> Lastly, we also controlled for region, using the state of residence variable, to account for the variation in financial behaviors due

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1. An anonymous reviewer suggested controlling for other variables that are indicators of financial hardship, NFCS variables J4 (how difficult to pay bills) and J5 (have emergency fund), but adding them to the models did not substantially change the effects of overconfidence in our models. The reviewer also suggested controlling for E20 (having negative home equity), as an indicator of possibly rational delinquency, but adding that indicator also did not substantially change the effects of overconfidence on delinquency, except in Model 3b, where the residual measure of overconfidence became insignificant. We judged that all of these additional control variables are plausibly endogenous, so we present estimates without them.



to the unobserved regional attitudes toward various financial behaviors or differences in state-level policies. We used the state of Nebraska as a reference state because it had the lowest average rate of mortgage delinquency (5.33%) among states.

### Analysis

#### *Logistic Regression Models on Mortgage Delinquency*

This study utilized logistic regression models to analyze the relationship between financial literacy overconfidence and mortgage payment delinquency, controlling for various household characteristics. We expected that the inclusion of financial literacy variables would increase the explanatory power for household mortgage delinquency beyond that of basic household characteristics. In order to test the explanatory power that financial literacy variables provided, we constructed a hierarchical model (Table 3) as follows: Model 1a, baseline model; Model 1b, adding objective financial literacy; Model 1c, adding objective and subjective financial literacy. We performed Wald-tests, with the null hypothesis that the regression coefficients of the financial literacy variables would be not improve the fit. We also tested alternate models to more explicitly estimate the effect of overconfidence on loan delinquency. Model 2 (Table 4) tested the effects of indicator variables for overconfidence, underconfidence, and appropriately high confidence, compared to appropriately low confidence. As a robustness check, we tested the effects of two continuous measures of overconfidence, as discussed above.

As Lusardi and Mitchell (2014) discussed, it is plausible that financial literacy is endogenous. They reviewed 11 empirical studies and concluded that analyses of the effects of financial literacy that ignore the endogeneity of financial literacy may underestimate its effects. For some types of financial behavior, the mechanism for behavior possibly affecting literacy is obvious, for instance, a consumer who owns stocks will be more motivated to obtain more knowledge about the stock market. Similar mechanisms are plausible for the process of obtaining credit, but not as clear for payment behavior after credit has been obtained. We did not attempt to directly model the endogeneity of financial literacy, but based on the Lusardi and Mitchell's (2014) review of studies, it is plausible that our results might underestimate the effects of financial literacy on loan delinquency. Furthermore, all of the studies cited used instruments for financial literacy, not for overconfidence. Given that overconfidence is defined based on the divergence between objective and subjective measures of financial literacy, modeling an instrument for overconfidence would be challenging.



*Propensity Score Matching Analysis*

In order to mitigate a possible selection bias of overconfidence, we also conducted a PSM analysis (Li 2013; Rosenbaum and Rubin 1983; Rubin 2001), which produces less biased estimates of the relation between overconfidence and mortgage loan delinquency. Selection bias could have occurred due to observables (i.e., controlled difference) as well as unobservables (i.e., uncontrolled difference) and the PSM can address and mitigate the potential selection bias due to observables (Tucker 2010). To construct our analytic sample, each individual who was overconfident (low objective and high subjective literacy) was matched with a non-overconfident respondent who had similar characteristics as those in the treatment (overconfidence) group. In the process of the PSM, the same set of variables was included as in our logistic regressions. In addition, a one-to-one matching method without replacement was used as the matching algorithm.

## RESULTS

### Descriptive Results

Table 1 presents the descriptive results of both mortgage holders and full sample. About 16% of households with mortgages had been late with their mortgage payments in the 12 months prior to the survey. As mentioned above, we created two measures of financial literacy, with the first measure based on a set of questions assessing objective financial literacy and the second measure based on a question measuring subjective financial literacy. The objective financial literacy score, calculated based on using the number of correct responses to a subset of five questions drawn from the areas of personal finance, had a mean of 2.9 for all households and 3.2 for mortgage holders. The subjective financial literacy measure was based on respondent assessments of their overall financial literacy, and the mean was 5.2 for all households and 5.4 for mortgage holders, out of 7 (see Appendix 1).

For testing the effects of financial literacy overconfidence in Model 2, we created four mutually exclusive variables incorporating objective and subjective financial literacy and found that about 23% of all respondents had overconfidence (low objective and high subjective literacy) as shown in Table 1. The largest category was appropriate low confidence (low objective and low subjective financial literacy), with about 39% of all respondents, while the smallest category was underconfidence (high objective and low subjective financial literacy), with 18% of all respondents. Table 1 also shows demographic characteristics of mortgage holders and the full

TABLE 1  
*Descriptive Statistics of All Households and Mortgage Holders, 2015 NFCS*

|                              | Variables   | All Households<br>(N = 26,385) | Mortgage Holders<br>(N = 9,644) |
|------------------------------|---|--------------------------------|---------------------------------|
| Dependent variables          | Mortgage delinquency, (%)                                     | 5.53                           | 16.03                           |
| Financial literacy variables | Objective financial literacy, mean (median)                   | 2.90 (3.00)                    | 3.23 (3.00)                     |
|                              | Subjective financial literacy, mean (median)                  | 5.23 (5.00)                    | 5.42 (5.00)                     |
|                              | Financial literacy over-confidence category, (%)              |                                |                                 |
|                              | Appropriate high confidence (high objective, high subjective) | 20.07                          | 24.92                           |
|                              | Underconfidence (high objective, low subjective)              | 18.21                          | 21.83                           |
|                              | Overconfidence (low objective, high subjective)               | 22.87                          | 23.57                           |
|                              | Appropriate low confidence (low objective, low subjective)    | 38.84                          | 29.68                           |
|                              |   |                                |                                 |
| Control variables            | Age of a respondent, mean (median)                            | 46.2 (47.0)                    | 47.8 (48.0)                     |
|                              | Gender, (%)   |                                |                                 |
|                              | Male  | 48.93                          | 48.48                           |
|                              | Female  | 51.07                          | 51.52                           |
|                              | Education, (%)  |                                |                                 |
|                              | Less than high school   | 2.47                           | 1.31                            |
|                              | High school diploma   | 25.96                          | 20.51                           |
|                              | Some college  | 43.67                          | 43.02                           |
|                              | Bachelor degree   | 17.25                          | 20.88                           |
|                              | Post-bachelor degree  | 10.65                          | 14.28                           |
|                              | Marital status, (%)   |                                |                                 |
|                              | Married   | 52.27                          | 71.70                           |
|                              | Single  | 31.49                          | 15.80                           |
|                              | Separated/divorce/widow                                       | 16.24                          | 12.50                           |
|                              | Racial/ethnic status, (%)                                     |                                |                                 |
|                              | White   | 65.51                          | 70.85                           |
|                              | Black   | 11.61                          | 8.44                            |
|                              | Hispanic  | 15.17                          | 13.70                           |
|                              | Asian/others  | 7.71                           | 7.01                            |
|                              | Presence of a dependent child, (%)                            | 36.04                          | 48.43                           |
|                              | Employment status, (%)  |                                |                                 |
|                              | Full-time worker  | 38.00                          | 50.81                           |
|                              | Self-employed   | 7.12                           | 7.51                            |
|                              | Part-time worker  | 9.79                           | 7.65                            |
|                              | Homemaker   | 8.59                           | 9.25                            |
|                              | Student   | 5.48                           | 1.89                            |
|                              | Disabled  | 4.62                           | 2.49                            |
|                              | Unemployed  | 6.35                           | 2.95                            |
|                              | Retired   | 20.06                          | 17.43                           |

TABLE 1  
*Continued*

| Variables   | All Households<br>( <i>N</i> = 26,385) | Mortgage Holders<br>( <i>N</i> = 9,644) |
|---|--|---|
| Household income, (%)   |  |   |
| Less than \$15,000  | 12.57                                  | 2.65                                    |
| At least \$15,000 but less than \$25,000                      | 11.52                                  | 4.85                                    |
| At least \$25,000 but less than \$35,000                      | 11.17                                  | 7.23                                    |
| At least \$35,000 but less than \$50,000                      | 15.10                                  | 13.65                                   |
| At least \$50,000 but less than \$75,000                      | 20.12                                  | 24.13                                   |
| At least \$75,000 but less than \$100,000                     | 12.66                                  | 18.60                                   |
| At least \$100,000 but less than \$150,000                    | 11.54                                  | 20.12                                   |
| \$150,000 or more   | 5.33                                   | 8.77                                    |
| Had unexpected large drop in income in past<br>12 months, (%) | 22.36                                  | 22.24                                   |
| Covered by health insurance, (%)                              | 87.90                                  | 94.25                                   |

*Note:* Weighted proportion. The analytic sample included 9,644 mortgage holders, excluding respondents who chose “prefer not to say” as their answer to the questions dealing with objective financial literacy and/or where the respondent answered “prefer not to say” or “don’t know” as their answer to the mortgage delinquency and subjective financial literacy question.

sample. Mortgage holders were more likely than the general population to have a college degree, be married, have a dependent child, have high income, and be full-time workers.

Table 2 presents the distributions of objective and subjective financial literacy of mortgage holders. A low proportion (15.6%) of the respondents got all five questions correct, and 11.4% got one or zero questions correct. The median score was three out of five questions correct. Some respondents (15.6%) gave themselves the highest rating on their assessment of their overall financial literacy, 7, and only 4.4% of respondents gave themselves a rating below 4 on the 7 point scale. The median self-assessment of financial literacy was 5. Table 2 also has the distributions of both overconfidence indexes. The divergence overconfidence index (subjective score minus objective score) ranged from –1 to 6, with a median of 2. The residual overconfidence index ranged from –3.4 to 2.4, with a median of –0.2.

Multivariate Results

Table 3 shows the results of logistic regressions on mortgage holders for hierarchical models. In Model 1a, the effects of household characteristics such as age on the likelihood of delinquency were estimated, but without controlling for objective or subjective financial literacy. In Model 1b, the objective financial literacy score was added, and it had a significant

TABLE 2

*Distribution of Objective and Subjective Financial Literacy and Overconfidence, 2015 NFCS*

| Percentile | Objective<br>Financial<br>Literacy | Subjective<br>Financial<br>Literacy | Overconfidence<br>Index 1 <sup>a</sup> | Overconfidence<br>Index 2 <sup>b</sup> |
|------------|------------------------------------|-------------------------------------|--|--|
| 99th       | 5                                  | 7                                   | 6                                      | 2.4340                                 |
| 95th       | 5                                  | 7                                   | 5                                      | 1.8950                                 |
| 90th       | 5                                  | 7                                   | 4                                      | 1.5191                                 |
| 75th       | 4                                  | 6                                   | 3                                      | 0.6794                                 |
| 50th       | 3                                  | 5                                   | 2                                      | -0.1743                                |
| 25th       | 2                                  | 5                                   | 1                                      | -0.5571                                |
| 10th       | 1                                  | 4                                   | 0                                      | -1.4567                                |
| 5th        | 1                                  | 4                                   | 0                                      | -1.9283                                |
| 1st        | 0                                  | 2                                   | -1                                     | -3.4391                                |

*Note:* Weighted results. Analytic sample includes 9,644 households holding a mortgage balance.

<sup>a</sup>Discrepancy between subjective and objective financial literacy.

<sup>b</sup>We regress subjective financial literacy on the objective literacy and take the residual as an overconfidence measure.

negative effect on the likelihood of delinquency. In Model 1c, the subjective financial literacy measure was not significant, while the effect of objective financial literacy was not changed by much from Model 1b. The effects of the control variables were generally consistent with previous studies of delinquency (e.g., Lee and Hanna 2012), with weaker effects of having bachelor and post-bachelor degrees in Model 1b compared to Model 1a, suggesting that without the objective financial literacy score, to some extent the effects of the education variables reflected financial literacy. We performed a Wald-test for Model 1b compared to Model 1a, with the null hypothesis that the regression coefficient for objective financial literacy did not improve model fit. For Model 1b, we could reject the null hypothesis, which indicates that adding objective financial literacy increased fit of the independent variables. However, for the Wald Test comparing Model 1c to Model 1b, we could not reject the null hypothesis that the regression coefficient for subjective financial literacy improved the fit, which indicates that adding subjective financial literacy did not increase the model fit. Overall, the results implied that the explanatory power of objective financial literacy was significant, but that the subjective measure did not have a significant effect on delinquency, given the level of objective literacy.

In order to illustrate the magnitude of effects of objective financial literacy on the likelihood of delinquency, we estimated the effect of going from the 10th percentile to the 90th percentile of objective literacy, based on the coefficients in Model 1c shown in Table 3, at mean values of

TABLE 3  
*Logistic Regression on Mortgage Payment Delinquency, a Hierarchical Model, Mortgage Holders, 2015 NFCS*

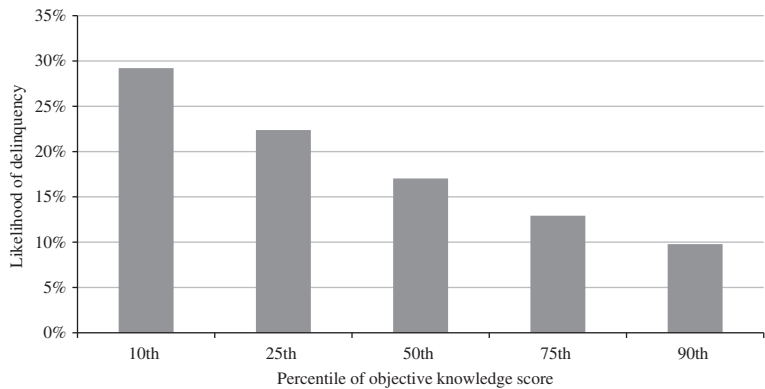
| Variables                                 | Model 1a    |                | Model 1b    |                | Model 1c    |                |
|---|-------------|----------------|-------------|----------------|-------------|----------------|
|   | Coefficient | Standard Error | Coefficient | Standard Error | Coefficient | Standard Error |
| Financial literacy variables              |             |                |             |                |             |                |
| Objective financial literacy              | —           | —              | −0.2517***  | 0.0265         | −0.2520***  | 0.0265         |
| Subjective financial literacy             | —           | —              | —           | —              | 0.0188      | 0.029          |
| Age of respondent                         | −0.0333***  | 0.0033         | −0.0276***  | 0.0034         | −0.0275***  | 0.0034         |
| Male (ref: female)                        | 0.0400      | 0.0704         | 0.1321      | 0.0716         | 0.1297      | 0.0717         |
| Education (ref: less than high school)    |             |                |             |                |             |                |
| High school diploma                       | −0.3364     | 0.2573         | −0.2885     | 0.2591         | −0.2932     | 0.2589         |
| Some college                              | −0.4288     | 0.2545         | −0.2833     | 0.2568         | −0.2903     | 0.2568         |
| Bachelor degree                           | −0.6627*    | 0.2636         | −0.4633     | 0.2665         | −0.4734     | 0.2667         |
| Post-bachelor degree                      | −0.7543**   | 0.2732         | −0.5504*    | 0.2763         | −0.5605*    | 0.2765         |
| Marital status (ref: married)             |             |                |             |                |             |                |
| Single                                    | −0.1378     | 0.1030         | −0.1615     | 0.1037         | −0.1633     | 0.1038         |
| Separated/divorce/widow                   | −0.0445     | 0.1144         | −0.0264     | 0.1147         | −0.0270     | 0.1147         |
| Racial/ethnic status (ref: White)         |             |                |             |                |             |                |
| Black                                     | 0.7768***   | 0.1067         | 0.6881***   | 0.1076         | 0.6846***   | 0.1078         |
| Hispanic                                  | 0.0351      | 0.0989         | 0.0259      | 0.0994         | 0.0272      | 0.0995         |
| Asian/others                              | 0.2992*     | 0.1314         | 0.2524      | 0.1335         | 0.2503      | 0.1336         |
| Presence of a dependent child (ref: No)   | 0.6810***   | 0.0786         | 0.6468***   | 0.0791         | 0.6448***   | 0.0792         |
| Employment status (ref: full-time worker) |             |                |             |                |             |                |
| Self-employed                             | 0.0102      | 0.1203         | 0.0842      | 0.1215         | 0.0811      | 0.1217         |
| Part-time worker                          | −0.3866**   | 0.1249         | −0.3698**   | 0.1254         | −0.3703**   | 0.1255         |
| Homemaker                                 | −0.5911***  | 0.1240         | −0.5979***  | 0.1242         | −0.5916***  | 0.1245         |
| Student                                   | −0.4167*    | 0.2098         | −0.4086     | 0.2115         | −0.4066     | 0.2118         |
| Disabled                                  | −0.1779     | 0.2118         | −0.2271     | 0.2119         | −0.2230     | 0.2118         |
| Unemployed                                | −0.1964     | 0.1700         | −0.1554     | 0.1707         | −0.1500     | 0.1708         |
| Retired                                   | −0.7519***  | 0.1550         | −0.8131***  | 0.1559         | −0.8167***  | 0.1560         |

TABLE 3  
Continued

| Variables   | Model 1a    |                | Model 1b    |                | Model 1c    |                |
|---|-------------|----------------|-------------|----------------|-------------|----------------|
|   | Coefficient | Standard Error | Coefficient | Standard Error | Coefficient | Standard Error |
| Household income (ref: less than \$15,000)                      |             |                |             |                |             |                |
| At least \$15,000 but less than \$25,000                        | 0.3895      | 0.2118         | 0.3254      | 0.2123         | 0.3222      | 0.2124         |
| At least \$25,000 but less than \$35,000                        | 0.0120      | 0.2040         | -0.0478     | 0.2044         | -0.0552     | 0.2048         |
| At least \$35,000 but less than \$50,000                        | -0.1234     | 0.1952         | -0.1231     | 0.1955         | -0.1268     | 0.1955         |
| At least \$50,000 but less than \$75,000                        | -0.3115     | 0.1926         | -0.3056     | 0.1930         | -0.3123     | 0.1933         |
| At least \$75,000 but less than \$100,000                       | -0.4715*    | 0.2021         | -0.4796*    | 0.2028         | -0.4875*    | 0.2032         |
| At least \$100,000 but less than \$150,000                      | -0.9741***  | 0.2097         | -0.8775***  | 0.2105         | -0.8851***  | 0.2109         |
| \$150,000 or more   | -1.4343***  | 0.2510         | -1.2732***  | 0.2522         | -1.2819***  | 0.2526         |
| Had unexpected large drop in income in past 12 months (ref: No) | 1.4042***   | 0.0680         | 1.3456***   | 0.0688         | 1.3431***   | 0.0689         |
| Covered by health insurance (ref: No)                           | -0.5827***  | 0.1137         | -0.5335***  | 0.1145         | -0.5364***  | 0.1146         |
| Constant  | 0.3895      | 0.2118         | 0.3254      | 0.2123         | 0.3222      | 0.2124         |
| Regional fixed effect (state of residence)                      | Yes         | —              | Yes         | —              | Yes         | —              |
| Pseudo R-squared  | 0.2093      | —              | 0.2206      | —              | 0.2207      | —              |
| Wald-test for financial literacy variable(s)                    | —           | —              | 90.09       | $p = <.0001$   | 0.42        | $p = .5170$    |

Note: Weighted results.  
\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

FIGURE 1  
*Likelihood of Delinquency by Percentile of Objective Financial Literacy Score*



*Note:* Based on the coefficients in Model 1c shown in Table 3, at mean values of control variables. Weighted results.

other variables.<sup>2</sup> As shown in Figure 1, the likelihood of delinquency ranged from 29% (10th percentile of objective literacy) to about 10% (90th percentile of objective literacy), which indicates that all other things equal, having low objective literacy could almost triple the likelihood of delinquency.

The models in Table 3 provide limited evidence of the interaction between objective and subjective financial literacy, because of the implicit assumption in Model 1c of an additive effect of the two measures, so we conducted an additional logistic regression (Model 2) with four categories of financial literacy confidence based on the objective and subjective financial literacy measures (Table 4). Compared with respondents reporting appropriately low confidence (low objective-low subjective literacy), those with appropriately high confidence (high objective-high subjective literacy) were much less likely to be delinquent and those with overconfidence (low objective-high subjective literacy) were much more likely to be delinquent. Those with underconfidence (high objective-low subjective literacy) did not have a likelihood of delinquency significantly different

2. The odds ratios do not directly provide differences in probabilities, so we calculated likelihoods for Figure 1. The logit function (log odds) is  $L = \sum BX$ , so to calculate the likelihood (probability) for a particular combination of values of the independent variables, we used  $P = \text{EXP}(L)/(1 + \text{EXP}(L))$ , with  $L$  calculated at the mean value of each independent variable, plus an adjustment factor to make  $P$  equal to the analytic sample mean for delinquency. Then, for Figure 1, we calculated levels of  $p$  at mean values of all independent variables except for the objective literacy score, with the score ranging from 1 (10th percentile) to 5 (90th percentile).



TABLE 4

*Logistic Regression on Mortgage Payment Delinquency, Mortgage Holders, 2015 NFCS*

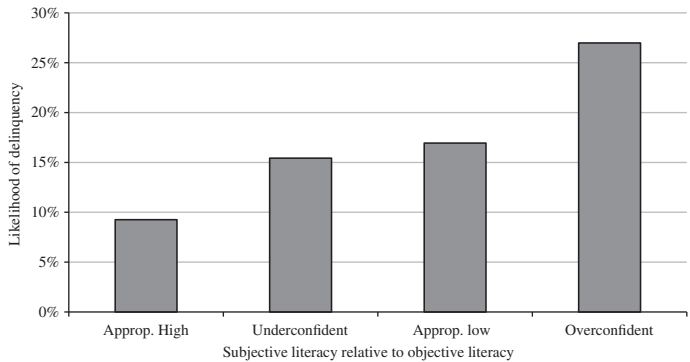
| Variables   | Coefficient | Standard Error | p-Value | Odds Ratio |
|---|-------------|----------------|---------|------------|
| Financial literacy overconfidence category (ref: Appropriate low confidence, low objective, low subjective) |             |                |         |            |
| Appropriate high confidence (high objective, high subjective)   | -0.5508     | 0.1128         | <.0001  | 0.5765     |
| Underconfidence (high objective, low subjective)  | -0.0855     | 0.0979         | .3826   | 0.9181     |
| Overconfidence (low objective, high subjective)   | 0.4330      | 0.0811         | <.0001  | 1.5419     |
| Age of respondent   | -0.0284     | 0.0034         | <.0001  | 0.9720     |
| Male (ref: female)  | 0.0698      | 0.0716         | .3295   | 1.0723     |
| Education (ref: less than high school)  |             |                |         |            |
| High school diploma   | -0.3039     | 0.2575         | .2379   | 0.7379     |
| Some college  | -0.3598     | 0.2550         | .1583   | 0.6978     |
| Bachelor degree   | -0.5510     | 0.2648         | .0375   | 0.5764     |
| Post-bachelor degree  | -0.6169     | 0.2747         | .0247   | 0.5396     |
| Marital status (ref: married)   |             |                |         |            |
| Single  | -0.1463     | 0.1037         | .1584   | 0.8639     |
| Separated/divorce/widow   | -0.0548     | 0.1151         | .6337   | 0.9467     |
| Racial/ethnic status (ref: White)   |             |                |         |            |
| Black   | 0.7123      | 0.1081         | <.0001  | 2.0387     |
| Hispanic  | 0.0304      | 0.0995         | .7598   | 1.0309     |
| Asian/others  | 0.2811      | 0.1332         | .0349   | 1.3246     |
| Presence of a dependent child (ref: No)   | 0.6486      | 0.0790         | <.0001  | 1.9129     |
| Employment status (ref: full-time worker)   |             |                |         |            |
| Self-employed   | 0.0462      | 0.1219         | .7046   | 1.0473     |
| Part-time worker  | -0.3738     | 0.1257         | .0029   | 0.6881     |
| Homemaker   | -0.5565     | 0.1240         | <.0001  | 0.5732     |
| Student   | -0.3638     | 0.2120         | .0862   | 0.6950     |
| Disabled  | -0.1760     | 0.2104         | .4028   | 0.8386     |
| Unemployed  | -0.1053     | 0.1699         | .5351   | 0.9001     |
| Retired   | -0.8145     | 0.1560         | <.0001  | 0.4429     |
| Household income (ref: less than \$15,000)  |             |                |         |            |
| At least \$15,000 but less than \$25,000  | 0.3642      | 0.2116         | .0853   | 1.4394     |
| At least \$25,000 but less than \$35,000  | -0.0270     | 0.2040         | .8948   | 0.9734     |
| At least \$35,000 but less than \$50,000  | -0.1150     | 0.1949         | .5551   | 0.8914     |
| At least \$50,000 but less than \$75,000  | -0.3176     | 0.1927         | .0994   | 0.7279     |
| At least \$75,000 but less than \$100,000   | -0.4778     | 0.2026         | .0183   | 0.6201     |
| At least \$100,000 but less than \$150,000  | -0.8974     | 0.2102         | <.0001  | 0.4076     |
| \$150,000 or more   | -1.2967     | 0.2525         | <.0001  | 0.2734     |

TABLE 4  
*Continued*

| Variables   | Coefficient | Standard Error | <i>p</i> -Value | Odds Ratio |
|---|-------------|----------------|-----------------|------------|
| Had unexpected large drop in income in past 12 months (ref: No) | 1.3265      | 0.0689         | <.0001          | 3.7678     |
| Covered by health insurance (ref: No)                           | −0.5944     | 0.1143         | <.0001          | 0.5519     |
| Constant  | −0.7880     | 0.6041         | .1921           |            |
| Regional fixed effect (state of residence)                      | Yes         |                |                 |            |
| Pseudo <i>R</i> -squared  | 0.2205      |                |                 |            |

*Note:* Weighted results.

FIGURE 2  
*Likelihood of Delinquency by Subjective Literacy Relative to Objective Literacy .*



*Note:* Based on coefficients in Table 4, at mean values of control variables. Weighted results

from those with low objective and subjective scores, implying that objective literacy alone did not affect delinquency among those with low subjective literacy.

In order to illustrate the interaction of objective and subjective financial literacy on the likelihood of delinquency, we estimated the likelihoods across four categories of financial literacy confidence at the mean values of other variables, as shown in Figure 2. Households with overconfidence had 2.9 times the likelihood of delinquency as those with appropriately high subjective literacy. Further, those with underconfidence had a delinquency likelihood 1.7 times as high as those with appropriately high literacy, indicating a substantial effect among those with high objective literacy based only on the difference in subjective literacy.

The effects of the control variables in Table 4 were similar to the effects shown in Table 3. Age had a strong negative relationship with the likelihood of being delinquent. Households with a college degree were less likely to be delinquent than those without a high school degree. Households with Black respondents and those with Asian/others respondents were more likely to be delinquent than households with Whites respondent. Households with a dependent child were much more likely to be delinquent than those without one. Households with full-time workers were more likely to be delinquent than those with part-time workers, homemakers and retired respondents. Households with income of \$75,000 or higher were less likely to be delinquent than those in the lowest income category. Respondents experiencing an unexpected large drop in income had a much higher likelihood of being delinquent than those without a negative income shock. Those covered by health insurance were less likely to be delinquent than those without health insurance.

#### Results of Propensity Score Matching Analysis

Table 5 reports the results from the PSM analysis to address a possible selection bias of overconfidence. To construct a treatment-control group set, we performed one-to-one nearest matching without replacement. Among the total sample of 9,644 mortgage holders, overconfident respondents were matched with non-overconfident respondents, which led to 1,963 pairs of units (total of 3,926 units) under the matching algorithm. Results from Panel A indicate that overconfident households had a 9.29% higher rate of payment delinquency than those without overconfidence. Further, logistic regression results from the matched sample showed that overconfidence increased the odds of being delinquent by 81.8%.

#### Robustness Check

In Table 4, we estimated the effects of overconfidence based on simple comparisons between the objective and subjective measures, for instance, overconfident meant having an objective score at the median or below, and having a subjective score above the median. Table 6 has the two logistic regressions (Models 3a and 3b) to check the robustness of our results for Models 1 and 2, using two continuous measures of overconfidence, as described in Methods section. Index 1 in Model 3a is based on a simple difference between the subjective score and the objective score. Index 2 in Model 3b is based on the residual from a least-squares regression of objective literacy on subjective literacy.

TABLE 5  
*Propensity Score Matching Analysis of Mortgage Payment Delinquency, 2015 NFCS*

| Panel A: Overconfidence vs. Non-Overconfidence Households |             |        |            |              |
|---|-------------|--------|------------|--------------|
| Variables   | Sample Size | Mean   | Difference | t-Statistics |
| Mortgage payment delinquency (overconfidence group)       | 1,963       | 0.2516 | 0.0929***  | 7.59         |
| Mortgage payment delinquency (non-overconfidence group)   | 1,963       | 0.1587 | —          | —            |

| Panel B: Logit Results on Mortgage Payment Delinquency, Matched Sample, 2015 NFCS |             |                |         |            |
|---|-------------|----------------|---------|------------|
| Variables   | Coefficient | Standard Error | p-Value | Odds Ratio |
| Overconfidence  | 0.5978      | 0.0946         | <.0001  | 1.8181     |
| Control variables <sup>a</sup>  | Yes         |                |         |            |
| Regional fixed effect (state of residence)  | Yes         |                |         |            |
| Pseudo R-squared  | 0.2238      |                |         |            |

*Note:* Panel A: Weighted results. The size of matched sample is 3,926. Panel B: The propensity score matching is based on the one-to-one matching without replacement. The differences of propensity scores between matched peers do not exceed 0.001 in absolute value. In the process of the matching analysis, 130 observations were dropped.

<sup>a</sup>Control variables are the same as Table 4. Full results are available from the authors upon request.  
\**p* < .05, \*\**p* < .01, \*\*\**p* < .001.

In order to illustrate the magnitude of effects of two overconfidence indexes on the likelihood of delinquency, we estimated the effect of going from the 10th percentile to the 90th percentile of overconfidence, at mean values of other variables. As shown in Figure 3, the likelihood of delinquency ranged from 11% (10th percentile of index 1) to 21.4% (90th percentile of index 1), which indicates that all other things equal, having too much overconfidence could almost double the likelihood of delinquency. Similarly, the likelihood of delinquency ranged from 14.7% (10th percentile of index 2) to 17.4% (90th percentile of index 2), but the range of effect was smaller than for index 1.

DISCUSSION AND IMPLICATIONS

This study examined the relation between financial literacy and mortgage payment delinquency using the 2015 NFCS dataset with a representative sample of US households with mortgages. In Model 1 (Table 3), objective financial literacy was negatively related to the likelihood of delinquency while subjective financial literacy was not related to the likelihood of being delinquent. In Model 2 (Table 4), when we incorporated both objective and subjective measures as interactions to create

TABLE 6

*Robustness Check, Logistic Regression on Mortgage Payment Delinquency, Mortgage Holders, Effects of Two Indexes of Overconfidence, 2015 NFCS*

| Variables  | Model 3a with Index 1 |                | Model 3b with Index 2 |                |
|--|-----------------------|----------------|-----------------------|----------------|
|  | Coefficient           | Standard Error | Coefficient           | Standard Error |
| Overconfidence variable                          |                       |                |                       |                |
| Overconfidence index 1, discrepancy <sup>a</sup> | 0.1475***             | 0.0199         | —                     | —              |
| Overconfidence index 2, residual <sup>b</sup>    | —                     | —              | 0.0512*               | 0.0255         |
| Control variables <sup>c</sup>                   | Yes                   |                | Yes                   |                |
| Regional fixed effect (state of residence)       | Yes                   |                | Yes                   |                |
| Constant   | −0.9509               | 0.6032         | 1.0480                | 0.3870         |
| Pseudo R-squared                                 | 0.2162                |                | 0.2074                |                |

Note: Weighted results.

<sup>a</sup>Discrepancy between subjective and objective financial literacy.

<sup>b</sup>We regress subjective financial literacy on the objective literacy and take the residual as an overconfidence measure.

<sup>c</sup>Control variables are from the same as Table 4.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

FIGURE 3

*Likelihood of Delinquency by Percentile of Financial Literacy Overconfidence Index .*



Note: Weighted results

indicators of confidence, those who were appropriately confident (with high objective-high subjective literacy) had lower likelihoods of delinquency, and those with overconfidence (low objective-high subjective literacy) had higher likelihoods of delinquency, compared to those with both low objective and low subjective financial literacy. Our findings from Model 2 imply that having appropriate confidence is important in reducing

the likelihood of delinquency, and that overconfidence may play an important role in payment delinquency. Further, the results from Models 3a and 3b suggest that overconfidence has a positive effect on mortgage delinquency in alternative specifications.

In light of our empirical evidence on the negative financial consequences of overconfidence, borrowers may benefit not only from greater financial literacy, but also from having realistic assessments of their financial literacy level. Overconfidence about one's financial literacy may also be a deterrent to finding professional advice, widening the literacy gap (Lusardi and Mitchell 2007b). Therefore, financial education programs need to be personalized (e.g., self-assessment tools), and designed to help people reduce the prevalence of overconfidence, thereby enabling them to make informed decisions. If overconfidence depends on the consequence of overly optimistic beliefs about own abilities, it is not enough to just educate people about financial concepts and expect positive financial consequences to happen. For example, providing feedback to assess their current state of financial literacy rather than just disseminating financial information can be helpful.

One implication from this research applies to future research on the effects of financial literacy. Relying only on a financial literacy test score might not accurately reflect the full effects of financial literacy on financial behaviors. The delinquency difference between the 25th and 75th percentiles in Figure 1 is comparable to the difference between the delinquency difference between having overconfidence and having appropriately high confidence in Figure 2, suggesting that adding subjective financial literacy to objective financial literacy greatly increases the effect of literacy on mortgage delinquency. It would be useful to explore similar effects for other financial behaviors, as Robb et al. (2015) did for the use of an alternate financial services. Future research should consider both objective and subjective measures of financial literacy, and the possible effects of financial literacy overconfidence.

It is possible that there are reverse causal mechanisms, in that delinquency may affect one's perceptions of subjective literacy. For example, the experience of delinquency could lead to a lower subjective assessment, or, the experience could lead to a higher assessment, assuming respondents who were opportunistic defaulters.<sup>3</sup> Our empirical results do not support the scenario of delinquency reducing confidence, but are consistent with the scenario of opportunistic defaulters thinking more highly of their abilities. Qualitative research might be needed to assess this scenario. Lusardi and

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3. Thanks to an anonymous reviewer for suggesting these two scenarios.

Mitchell (2014) concluded that establishing a causal link between financial literacy and economic behavior is very challenging and they suggested the use of instrumental variables and experimental approaches. Given that overconfidence is defined based on the discrepancy between objective and subjective measures of financial literacy, however, modeling an instrument for overconfidence would be even more challenging. Future research using a panel dataset, with measurements of objective and subjective financial literacy and later loan payment behavior, could examine whether delinquency has important effects on overconfidence, and provide additional insights into the causal relationships between behavior and perceptions of financial literacy.

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## APPENDIX 1

### Description of Key Variables in the 2015 NFCS

| Variable                      | Description   |
|-------------------------------|---|
| Dependent variable            |   |
| Mortgage delinquency          | How many times have you been late with your mortgage payments in the past 12 months? (If you have more than one mortgage on your home(s), please consider them all.)                    |
| Focal Independent variables   |   |
| Objective financial literacy  | Sum of correct answers to the financial literacy questions listed below (i.e., scaled from 0 to 5)  |
| Interest                      | “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?”   |
| 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?” |
| Bond price                    | “If interest rates rise, what will typically happen to bond prices?”  |
| 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.”                            |
| Portfolio                     | “Buying a single company’s stock usually provides a safer return than a stock mutual fund.”   |
| Subjective financial literacy | “On a scale from 1 to 7, where 1 means very low and 7 means very high, how would you assess your overall financial knowledge?”  |

*Note:* The mortgage delinquency variable in the NFCS was changed in terms of time frame of question, from 2 years in the 2012 NFCS to 12 months in the 2015 NFCS.