Numerical ability predicts mortgage default

Kristopher Gerardi[a], Lorenz Goette[b,1], and Stephan Meier[c]

[a]Research Department, Federal Reserve Bank of Atlanta, Atlanta, GA 30309; [b]Department of Economics, Faculty of Business and Economics, University of Lausanne, 1015 Lausanne-Dorigny, Switzerland; and [c]Graduate School of Business, Columbia University, New York, NY 10027

Edited by Jose A. Scheinkman, Princeton University, Princeton, NJ, and approved May 20, 2013 (received for review November 26, 2012)

Unprecedented levels of US subprime mortgage defaults precipitated a severe global financial crisis in late 2008, plunging much of the industrialized world into a deep recession. However, the fundamental reasons for why US mortgages defaulted at such spectacular rates remain largely unknown. This paper presents empirical evidence showing that the ability to perform basic mathematical calculations is negatively associated with the propensity to default on one's mortgage. We measure several aspects of financial literacy and cognitive ability in a survey of subprime mortgage borrowers who took out loans in 2006 and 2007, and match them to objective, detailed administrative data on mortgage characteristics and payment histories. The relationship between numerical ability and mortgage default is robust to controlling for a broad set of sociodemographic variables, and is not driven by other aspects of cognitive ability. We find no support for the hypothesis that numerical ability impacts mortgage outcomes through the choice of the mortgage contract. Rather, our results suggest that individuals with limited numerical ability default on their mortgage due to behavior unrelated to the initial choice of their mortgage.

foreclosure | consumer finance | subprime loans | limited rationality

In 2007, a dramatic rise in US subprime mortgage defaults set off a global financial crisis that dragged much of the industrialized world into the most severe recession since the Great Depression (1). As Fig. 1 shows, well over 50% of US subprime mortgages that originated in 2006 and 2007 ended up in default after 5 y, and many more had fallen behind on their payments. This was in contrast to subprime vintages in the early 2000s in which 5-y default rates reached less than 15%.

In the aftermath of the crisis, researchers and policymakers have focused on determining the sources of the explosion in mortgage defaults and appropriate policy responses to prevent such a costly crisis in the future. The vast majority of this literature has focused on the question of why mortgage lenders were willing to lend money to riskier and riskier borrowers. [For example, several influential papers have focused on the role of credit supply changes during the US housing boom, and in particular the potential role of relaxed underwriting standards in generating an expansion of mortgage credit (2–4) and inattentive actors in the financial market (5).] Much less attention has been given to the other side of the issue: Why were so many borrowers willing to take out mortgages that they could not repay? In particular, there has been very little analysis of the role of individuals' ability to make financial decisions and to handle the relatively complicated trade-offs involved in choosing various aspects of a mortgage contract (1, 6). Although recent research has shown that many individuals have problems answering simple questions about basic financial principals (7–10) and routinely make systematic financial mistakes, such as underestimating interest rates from payment streams (11), empirical evidence on the link between an individual's ability to make complicated financial decisions and the propensity to default on one's mortgage is still missing.

In this paper we focus on one particular aspect of financial decision making, numerical ability (NA), and examine the link between subprime mortgage borrowers' NA and the probability that they default on their mortgage payment obligations. We match individual measures of numerical and cognitive ability of subprime mortgage borrowers to administrative records that contain detailed information on their mortgage payment behavior (see *Materials and Methods* and *SI Appendix* for details). Limited cognitive and numerical abilities may impact the default risk of a mortgage borrower for several different reasons. First, limited cognitive abilities could impact an individual's choice of mortgage contract. Several studies have shown that better cognitive abilities are associated with improved ability to "think ahead" in a variety of decision-making problems (12, 13). Thus, individuals with better cognitive abilities may be better able to anticipate future contingencies and choose a mortgage with payment streams that better accommodate those contingencies. Indeed, optimal mortgage choice turns out to be a very complicated problem with often surprising implications (14). Furthermore, individuals are often confused about even basic mortgage terms (15). Higher cognitive abilities and financial literacy have also been shown to result in better bargaining outcomes (16) and to a lower likelihood of being susceptible to questionable practices (17). Thus, individuals with higher cognitive abilities may be more agile in negotiating with mortgages lenders to obtain better contract terms, such as lower interest rates and the absence of prepayment penalties. Similarly, individuals with low NA might have a harder time understanding the financial consequences of a particular type of financial product. An important example is the typical subprime adjustable-rate mortgage, which has a relatively low initial interest rate but adjusts (often upward) after a couple of years, at which point the corresponding increased mortgage payment may make it difficult to honor the debt obligation. Other examples include prepayment penalties that increase the cost of refinancing or the higher interest costs often associated with low documentation loans. Similarly, borrowers with limited NA might opt to borrow more money relative to the value of their home, which would make them more vulnerable to default when house prices decline.

Alternatively, individuals with limited NA may make choices after deciding on a specific mortgage contract that put them at higher risk of default. One possibility is that borrowers with low NA have trouble maintaining a budget in other areas of consumer spending and, as a result, experience more adverse financial scenarios. There is strong evidence from earlier studies showing that individuals with limited NA have lower savings and lower wealth, and that they are less likely to plan for retirement (7–9). Based on this evidence, it is reasonable to infer that individuals with limited NA are prone to financial planning mistakes that may result in situations of financial duress. Poor NA also correlates with a coarser understanding of financial decisions more generally (7, 9), such as suboptimal use of credit cards (18), and a lower participation rate in stock markets (19). This suggests that individuals with lower NA may make suboptimal choices in

Author contributions: K.G., L.G., and S.M. designed research, performed research, analyzed data, and wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

Freely available online through the PNAS open access option.

[1]To whom correspondence should be addressed. E-mail: lorenz.goette@unil.ch.

This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1220568110/-/DCSupplemental.

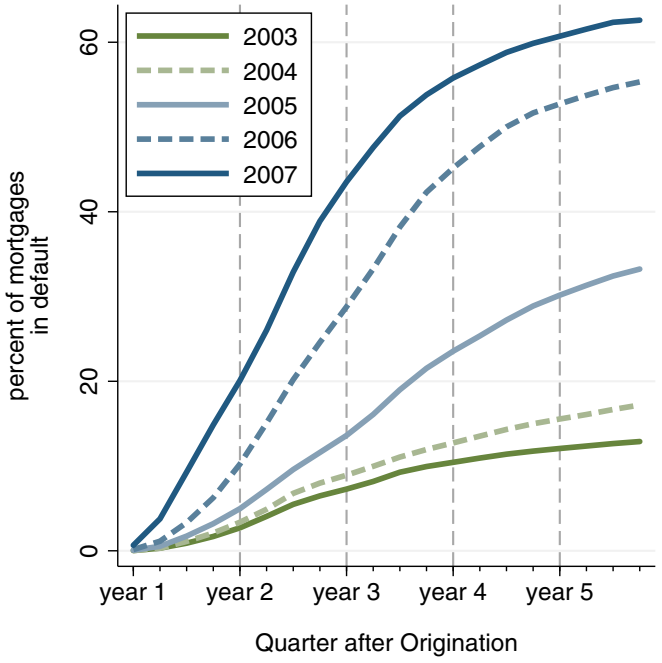

Fig. 1. The evolution of subprime mortgage defaults in the United States. The graphs show the cumulative default rates, measured by the issuance of a foreclosure petition, across different years on a quarterly basis. Source: own calculations using the Corelogic dataset.

other areas of financial planning, such as a lack of sufficient insurance or self-selection into unstable employment contracts. These may render a household more vulnerable to a given financial shock and could increase the propensity of mortgage default.

Our data allow us to determine whether the impact of NA on default occurs through the choice of a particular type of mortgage product or through behavior that occurs after the time of contracting. We combine administrative data on individual mortgages with measures of NA obtained through a telephone survey. Our mortgage data, a proprietary dataset for New England, contains detailed information on the characteristics of the mortgage contracts chosen by subprime borrowers as well as the entire payment history of each mortgage. (The dataset was purchased by the Federal Reserve Bank of Boston from the data vending firm Corelogic.) We supplement this information with measures of numerical and general cognitive ability through telephone interviews with these same homeowners. Using these data, we test whether variation in the choice of mortgage contracts can explain the results, by consecutively controlling for numerous mortgage attributes and determining to what extent these choices can explain the negative correlation that we find between NA and default. A serious concern in studies that use telephone surveys is response selectivity: individuals who respond to the survey may be different from those who refuse to participate, and these differences may be present in the characteristics that we are interested in as researchers. Our data allow us to examine this issue by examining whether participants in the survey had different mortgages and default rates from nonparticipants in the administrative dataset. We find no evidence of response selectivity with respect to mortgage characteristics (*SI Appendix*, Table S1).

Section 1: Results

Our empirical analysis relates mortgage delinquency to cognitive and NA while at the same time holding constant a range of control variables. We use two measures of mortgage delinquency: the fraction of months that a borrower is behind by at least one mortgage payment, which we refer to as the percentage of time delinquent; and an indicator for whether the lender initiates the foreclosure process. Based on the strong results from the previous literature, we initially focus on NA. Our NA measure is an index originally constructed by Banks and Oldfield (8) that determines the proficiency of a borrower for solving basic mathematical calculations (see *SI Appendix* for details). Fig. 2 displays the relationship between the NA index and the two measures of delinquency (with and without control variables). The solid line (without control variables) presents the raw probability of delinquency (Fig. 2*A*) and incidence of foreclosure (Fig. 2*B*). Fig. 2*A* shows that there is a monotonically decreasing relationship between the percentage of time spent behind on mortgage payments and NA. Borrowers in the lowest NA group on average spend almost 25% of the time in delinquency, whereas those in the highest group spend on average only 12% of the time in delinquency. A linear regression shows that the NA index is significantly correlated with delinquency ($p < 0.001$; *SI Appendix*, Tables S6 and S7). In Fig. 2*B*, a similar relationship holds between the incidence of foreclosure and NA. Although there is only a small difference in the incidence of foreclosure between the first and second NA group, the third group is characterized by a lower incidence of foreclosure compared with the first two groups (15% vs. more than 20%), whereas the fourth and highest group is characterized by a substantially lower incidence of foreclosure compared with the third group (7% vs. 15%). In a linear regression the correlation between the NA index and the incidence of foreclosure is significant ($p < 0.05$; *SI Appendix*, Tables S6 and S7).

To verify that this primary result is not driven by omitted socioeconomic characteristics that are correlated with NA, we reestimate the relationship adding critical independent variables: age, sex, ethnicity, education, marital status, the size of the household, time and risk preference parameters, labor market status over the previous 5 y, the household's income, a subjective measure of income volatility, FICO score, and dummy variables for whether the borrower is an investor (owner occupant as the reference group), as well as whether the mortgage is for a home purchase. This result is presented as regression-adjusted coefficients in Fig. 2 (dashed line) and is consistent with the analysis above: the implied default rates shown in the figure are unaffected and follow the same pattern, and remain statistically significant in both panels (*SI Appendix*, Table S7). The inclusion of these controls also significantly increases the R^2 of the regression from around 2% to ~25%. The FICO score, in particular, is an important determinant of delinquency and foreclosure. The fact that the correlation between NA and delinquency does not change when the FICO score at origination is included is an important finding. It implies that the measure of NA is not just capturing the fact that borrowers who have defaulted on previous debts are more likely to default on their mortgage compared with borrowers with good credit histories. Therefore, initial creditworthiness, e.g., the initial ability to borrow to smooth out shocks, does not drive the effect of NA (for the full regression, see *SI Appendix*, Table S7). Additional robustness checks indicate that our result is also not driven by borrowers' experience as homeowners (*SI Appendix*, Table S8) and specific aspects of the geographic area or lender characteristics (*SI Appendix*, Table S9).

A concern is that other cognitive abilities related to NA may impact the propensity to default, so it is important to verify that the correlation is associated with NA specifically. Our study allows us to address the question of whether it is the specific ability to perform numerical calculations that affects default or a more general aspect of cognitive ability. We obtain a measure of verbal intelligence quotient (IQ) to proxy for general cognitive ability (20). Included in the survey are also several questions on economic literacy in general, i.e., knowledge about inflation, and the basic mechanics of interest rates. Finally, we also use the reaction times of the survey participants to the numeracy

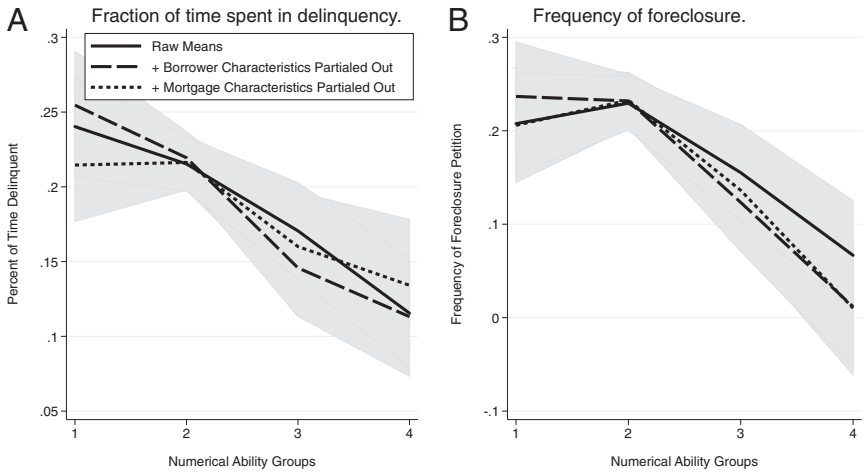

Fig. 2. Numerical ability (NA) and mortgage default. Simple relationship (solid line) along with two regression-adjusted relationships between the NA index (1 is bottom and 4 top group in terms of NA) and measure of mortgage default is shown. The dashed line shows the regression-adjusted relationship controlling for borrower characteristics [age, sex, ethnicity, education, marital status, the size of the household, time and risk preference parameters, labor market status over the previous 5 y, the household's income, the subjective measure of income volatility, FICO score, and dummy variables for whether the borrower is an investor (owner occupant as the reference group), as well as whether the mortgage is for a home purchase]. The dotted line shows the regression-adjusted relationship controlling for borrower characteristics and mortgage characteristics (fixed-rate mortgage vs. adjustable-rate mortgage, mortgage amount, presence of prepayment penalties, documentation status, initial interest rate, loan-to-value ratio, debt-to-income ratio). SEs (gray) overlap for the three models. *A* shows the probability of delinquency, and *B* shows the incidence of foreclosure. Source: own calculations.

questions as a proxy for general cognitive ability. All of these different measures of cognitive ability are strongly correlated, and exhibit one common factor (for details, see *Materials and Methods* and *SI Appendix*, Table S3). The results are displayed in Table 1 for both measures of cognitive ability. Turning to the first specification in the two columns under "Fraction of time in delinquency," which uses the fraction of time an individual is behind as the dependent variable, we see that the addition of the verbal IQ measure does not explain the association between NA and mortgage delinquency. NA remains statistically significant, whereas the addition of the verbal IQ measure to the covariate set adds little explanatory power to the regression. Adding variables that measure economic literacy and the reaction times to the NA and verbal IQ questions also has little impact on the estimation results. Thus, mortgage delinquency seems specifically associated with NA, not with general IQ levels or economic literacy. The two columns under "Foreclosure initiated (=1)" in Table 1 report the results for the initiation of foreclosure. Interestingly, although the inclusion of IQ does not diminish the coefficient associated with NA, it does display a statistically significant, negative correlation with the incidence of foreclosure. This suggests that, holding NA constant, higher IQ does not prevent households from falling behind on payments, but it does help them to avert foreclosure, perhaps because borrowers with higher IQ have better strategic skills, as indicated by earlier studies (12, 13).

As discussed above, one particular channel through which NA could impact mortgage delinquency is in leading individuals to obtain mortgages with unfavorable terms given their specific financial situations. Limited NA could cause individuals to overly extend their leverage by borrowing too much, or to agree to mortgage terms for which they do not fully understand the risks

Table 1. Controlling for general cognitive skills and economic literacy

Variables	Fraction of time in delinquency		Foreclosure initiated (=1)	
NA index	−0.047**	−0.051***	−0.065**	−0.061**
	(0.019)	(0.019)	(0.027)	(0.028)
Verbal IQ measure	−0.001	−0.002	−0.006**	−0.006**
	(0.002)	(0.002)	(0.003)	(0.003)
Savings scenario correct (DV)		0.002		−0.051
		(0.036)		(0.058)
Inflation scenario correct (DV)		0.006		−0.016
		(0.033)		(0.047)
Reaction time in NA questions		−0.003		−0.001
		(0.002)		(0.003)
Control variables?	Yes	Yes	Yes	Yes
R^2	0.262	0.268		
F test of H_0: All coefficients are equal to zero	$P < 0.01$	$P < 0.01$	$P < 0.01$	$P < 0.01$
N	322	322	318	318

Regression coefficients are reported in the two columns under "Fraction of time in delinquency." Marginal effects from probit models are reported in the two columns under "Foreclosure initiated (=1)." Robust SEs are shown in parentheses in these columns. All specifications contain the full set of control variables as in Fig. 2. "DV" indicates variables that are dichotomous. Level of significance: *$P < 0.1$, **$P < 0.05$, ***$P < 0.01$.

involved. This channel has received a lot of attention in policy discussions despite little hard evidence. Examples include mortgages with interest rates that are fixed for an initial period and then reset to higher adjustable rates, high prepayment penalties, or loan-to-value ratios close to 100%, which put borrowers in vulnerable positions in the event of house price declines and make it difficult to refinance. By making use of the detailed information on mortgage and borrower characteristics in the administrative dataset, it is possible to directly examine this possibility. Table 2 presents correlations between the NA index and various aspects of an individual's mortgage choice. The "Unconditional" column presents the estimated unconditional correlation between the NA index and various mortgage contract terms. The "Conditional" column shows how the correlation estimates change when the control variables included in Fig. 2 are added to the regressions. The NA index is unconditionally correlated with many of the mortgage and borrower attributes, but when the set of control variables is added, most of the correlations disappear. The lone exception is the initial interest rate, which is negatively correlated with NA (individuals with higher ability have mortgages with lower interest rates on average).

To test whether the inclusion of the mortgage terms affects the association between NA and mortgage default, we add them to the regressions underlying Fig. 2 with all of the control variables included. The results are displayed in the dotted line in Fig. 2. They show that the inclusion of the mortgage terms does not change the qualitative pattern in the relationship between NA and mortgage default, even though some of the variables, such as the mortgage amount and initial interest rate, are strong predictors of default (*SI Appendix*, Table S11). These findings suggest that the negative correlation between NA and mortgage default cannot be explained through different choices of mortgage terms. Taken together with the previous result on the inclusion of the FICO score, they imply that NA must influence mortgage default through behavior that occurs after the choice of the mortgage contract.

Section 2: Discussion

Our analysis raises the possibility that limitations in NA may have significantly contributed to the massive amount of defaults on subprime mortgages in the recent financial crisis. To get a sense of the magnitude of the effects, we can compare the default rates across vintages in Fig. 1. In making such a comparison, it is important to hold constant the age of the mortgages, as it is well known in the literature that default rates have a hump-shaped pattern with age. Thus, we compare default rates for mortgages that are approximately 2 y old. Default rates at the 2-y mark increased from 2% for the 2003 subprime vintage to 21% for the 2007 vintage. This difference proved to be large enough to cause mortgage-backed securities and their associated derivatives (for example, collateralized debt obligations) that were based on the cash flows from these mortgages to lose a significant fraction of their value. We see the same order of magnitude in passing from the highest NA group to the lowest. Thus, the differences in default rates predicted by NA are quantitatively important.

Table 2. Correlation between NA and mortgage attributes

Variables	Unconditional	Conditional
Fixed-rate mortgage (DV)	0.018	0.029
	(0.029)	(0.038)
Initial interest rate	−0.119*	−0.148**
	(0.068)	(0.074)
Low-doc loan (DV)	−0.065**	−0.058
	(0.029)	(0.036)
Prepayment penalty (DV)	0.017	−0.001
	(0.031)	(0.040)
Log (origination amount)	0.069**	−0.037
	(0.029)	(0.031)
Loan-to-value ratio	0.003	−0.013
	(0.011)	(0.012)
Debt-to-income ratio	−0.874*	−0.342
	(0.514)	(0.676)

The table displays the estimated correlation between the NA index and various mortgage attributes from regressions in which the mortgage attribute is the dependent variable. The "Unconditional" column reports the regression coefficient without control variables. The "Conditional" column reports the regression coefficient with all of the controls from Fig. 2 included. "DV" indicates variables that are dichotomous. OLS estimates are reported. The single asterisk (*), double asterisk (**), and triple asterisk (***) indicate significance at the 10%, 5%, and 1% levels, respectively.

It is crucial in this context to determine whether this association should be interpreted as causal. There are two obstacles to such an interpretation: reverse causality and omitted variable bias. Reverse causality can be ignored in our context, as it is implausible to argue that falling behind on one's mortgage could impair one's ability to perform simple mathematical calculations. Omitted variable bias is a more serious problem, but the design of our study allows us to narrow down the possible interpretations for the association that we find between NA and mortgage defaults. First, we can rule out omitted socioeconomic characteristics, as we include a host of variables that measure such characteristics as controls. Second, we can rule out the idea that other, more general forms of cognitive ability such as general IQ or economic literacy drive the results. Finally, we have shown that the association is not caused by different choices of mortgage attributes that may be correlated with NA and mortgage default at the same time. This suggests that the negative correlation between NA and mortgage default is likely driven by some aspect of individual behavior that occurs after the mortgage is originated. Possibilities include spending and savings patterns or suboptimal investments made with respect to other financial contracts that impact borrowers' ability to repay their mortgages. Links between these behaviors and cognitive abilities, including NA, have been previously documented (7–9).

Two policy implications emerge from our study. An important goal of policy is to avoid elevated levels of mortgage defaults and foreclosures because dislocation can be costly at many levels. It has often been argued that complicated mortgage products like hybrid-adjustable rate mortgages are an important culprit in causing mortgage defaults. Indeed, such mortgages have been shown to have higher default rates in other studies (21, 22). Our results suggest that they are not the only important factor for the elevated default rates associated with subprime mortgages. We find that differences in NA play just as important a role quantitatively in terms of predicting the incidence of mortgage default and that this effect is also present for individuals who hold fixed-rate mortgages. Thus, imposing restrictions on the set of available mortgage products that could be offered to borrowers would likely not solve the problem of elevated mortgage defaults during periods of declining house prices such as the one we recently experienced.

Second, our results indicate possibly large benefits from increased financial education of homeowners. Recent studies have found that changes in financial education curricula in high schools have important effects on financial decisions later in life (23, 24), that foreclosure counseling can reduce incidences of foreclosure (25), and that mathematical skills in general may be more malleable and less genetically driven than previously thought (26). If financial education can reduce suboptimal financial decision making, this could have profound effects on household behavior, as suggested by our results. Our study is correlational and puts this hypothesis in play. Future research should address it by running a randomized study, offering financial education to some homeowners, but not to others, and subsequently tracking their performance.

Materials and Methods

Subjects and Sampling. The sample is composed of borrowers that took out subprime mortgages in 2006 and 2007. We attempted to contact borrowers by both phone and mail. Conditional on reaching a borrower and receiving an agreement to participate, the survey was conducted via telephone. Because we have mortgage information for all borrowers in the administrative data, we can show that responders are not different from nonresponders in terms of mortgage terms and outcomes (including the probability of being in default). See *SI Appendix* for further details of our sampling design and for summary statistics.

Measure of Numerical and Cognitive Ability. The core part of the survey asks five questions that test individuals' NA (8). Following ref. 8, we divide people into four groups in terms of their ability (i.e., the NA index goes from 1 indicating the bottom group to 4 indicating the top group). To measure general cognitive ability, we use a verbal fluency test that is highly correlated with IQ (20, 27). Additionally, we ask two financial literacy questions (7) and measure individuals' response time to the NA questions. *SI Appendix* provides details and reports correlations of the different measures in *SI Appendix*, Table S3. Additionally, the survey allows us to obtain information about individuals' time and risk preferences, homeownership experience, and other sociodemographic information.

Mortgage Data. The administrative dataset contains objective information about mortgage and borrower characteristics and payment behavior. For the main analysis, we analyze two measures that incorporate delinquency from the origination of the mortgage until March 2009: The first measure of delinquency measures the fraction of time a borrower is behind by at least one mortgage payment. This measure captures the amount of time during which a household is unable or unwilling to meet the promised mortgage payments. The second measure is a dichotomous variable that takes a value of 1 if foreclosure proceedings have been initiated by the lender. *SI Appendix* also shows analysis for a third outcome variable. The dataset also has extensive loan-level information on mortgage characteristics, including interest rates (initial levels and changes over time), documentation levels, payment histories, loan-to-value ratios, and various other lending terms. In addition, it contains some information regarding borrower characteristics, such as the borrower's credit score and debt-to-income ratio at origination (borrower's monthly debt payment divided by his or her monthly income).

Statistical Methods. The primary empirical specification in the analysis takes the following form:

$$D_i = \gamma \mathrm{NA}_i + \mathbf{x_i}'\beta + \epsilon_i,$$

where D_i corresponds to either a measure of delinquency (as in the underlying regressions of Fig. 1) or specific details of the mortgage (as in Table 1), for household i. The term NA_i represents the NA group of household i, $\mathbf{x_i}$ represents a vector of control variables, and ϵ_i is the residual. The equation is estimated by ordinary least squares (OLS) for continuous variables and by probit for dichotomous variables. Potential heteroskedasticity in the SEs is taken into account by estimating robust SEs.

ACKNOWLEDGMENTS. Preliminary data collection was done while the authors were employed at the the Federal Reserve Bank of Boston. Views expressed herein do not necessarily reflect the views of the Federal Reserve Bank of Boston or the Federal Reserve System.

1. Akerlof G, Shiller R (2009) *Animal Spirits: How Human Psychology Drives the Economy, and Why It Matters for Global Capitalism* (Princeton Univ Press, Princeton).
2. Foote CL, Gerardi KS, Willen PS (2012) *Rethinking Financial Crisis*, eds Blinder AS, Lo AW, Solow RM (Russell Sage Foundation, New York), pp 136–186.
3. Mian A, Sufi A (2009) The consequences of mortgage credit expansion: Evidence from the U.S. mortgage default crisis. *Q J Econ* 124(4):1449–1496.
4. Coval J, Jurek J, Stafford E (2009) The economics of structured finance. *J Econ Perspect* 23(1):3–25.
5. Gennaioli N, Shleifer A, Vishny R (2012) Neglected risks, financial innovation, and financial fragility. *J Financ Econ* 104(3):452–468.
6. Boeri T, Guiso L (2007) Subprime crisis: Greenspan's legacy. *VOX: Research-Based Policy Analysis and Commentary from Leading Economists.* August 23, 2007. Available at VoxEU.org. Accessed June 2, 2013.
7. Lusardi A, Mitchell O (2009) How ordinary consumers make complex economic decisions: Financial literacy and retirement readiness. *NBER Working Paper* (National Bureau of Economic Research, Cambridge, MA), No. 15350.
8. Banks J, Oldfield Z (2007) Understanding pensions: Cognitive function, numerical ability and retirement saving. *Fiscal Studies* 28(2):143–170.
9. Lusardi A, Tufano P (2008) Debt literacy, financial experience, and overindebtedness. *NBER Working Paper* (National Bureau of Economic Research, Cambridge, MA), No. 14808.
10. McArdle JJ, Smith JP, Willis R (2010) Cognition and economic outcomes in the health and retirement survey. *NBER Working Paper* (National Bureau of Economic Research, Cambridge, MA), No. 15266.
11. Stango V, Zinman J (2009) Exponential growth bias and household finance. *J Finance* 64(6):2807–2849.
12. Burks SV, Carpenter JP, Goette L, Rustichini A (2009) Cognitive skills affect economic preferences, strategic behavior, and job attachment. *Proc Natl Acad Sci USA* 106(19): 7745–7750.
13. Oechssler J, Roider A, Schmitz PW (2009) Cognitive abilities and behavioral biases. *J Econ Behav Organ* 72(1):147–152.
14. Campbell JY, Cocco JF (2003) Household risk management and optimal mortgage choice. *Q J Econ* 118(4):1449–1494.
15. Bucks B, Pence K (2008) Do borrowers know their mortgage terms? *J Urban Econ* 64(2):218–233.
16. Barry B, Friedman RA (1998) Bargainer characteristics in distributive and integrative negotiation. *J Pers Soc Psychol* 74(2):345–359.
17. Moore DL (2003) Survey of financial literacy in Washington State: Knowledge, behavior, attitudes, and experiences. *Washington State University Social and Economic Sciences Research Center Technical Report* (Washington State University, Pullman, WA), No. 03-39.
18. Agarwal S, Mazumder B (2013) Cognitive abilities and household financial decision making. *Am Econ J Appl Econ* 5(1):193–207.
19. Brown M, Graf R (2012) Financial literacy, household investment and household debt: Evidence from Switzerland. *Working Paper* (University of St. Gallen, St Gallen, Switzerland).
20. Dohmen T, Falk A, Huffman D, Sunde U (2010) Are risk aversion and impatience related to cognitive ability? *Am Econ Rev* 100(3):1238–1260.
21. Foote CL, Gerardi K, Goette L, Willen PS (2008) Just the facts: An initital analysis of the subprime crisis. *J Hous Econ* 17(4):1–24.
22. Foote C, Gerardi K, Goette L, Willen PS (2009) Reducing foreclosures: No easy answers. *NBER Working Paper* (National Bureau of Economic Research, Cambridge, MA), No. 15063.
23. Bernheim DB, Garrett DM, Maki DM (2001) Education and saving: The long-term effect of high school financial curriculum mandates. *J Public Econ* 80(3):435–465.
24. Bernheim BD, Garrett DM (2003) The effects of financial education in the workplace: Evidence from a survey of households. *J Public Econ* 87(7–8):1487–1519.
25. Collins JM, Schmeiser MD (2013) The effects of foreclosure counseling for distressed homeowners. *J Policy Anal Manage* 32(1):83–106.
26. Hyde JS, Mertz JE (2009) Gender, culture, and mathematics performance. *Proc Natl Acad Sci USA* 106(22):8801–8807.
27. Lang FR, Hahne D, Gymbel S, Schroepper S, Lutsch K (2005) *Erfassung des Kognitiven Leisungspotenzials und der "Big Five" mit Computer-Assisted-Personal-Interviewing (CAPI): Zur Reliabilitaet und Validitaet Zweier Ultrakurzer Tests und des BFI-S* (DIW Research Notes, Berlin).