Fuzzy Math and Red Ink: When the Opportunity Cost of Consumption is Not What it Seems*

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ABSTRACT

The economics of intertemporal choice has varied the specification of every key aspect of modeling but one: it generally assumes that consumers correctly perceive the opportunity costs of intertemporal consumption tradeoffs. We present some new evidence that, together with earlier work, suggests that consumers hold *biased* perceptions about intertemporal tradeoffs: they tend to systematically underestimate the costs of short-term borrowing and the returns to long-term saving. We develop a new theory of biased perceptions that fits this evidence and is based on a well-established microfoundation from cognitive psychology: the general tendency to underestimate exponential series. With a household-level measure of biased perceptions in hand, we test the following predictions: more biased consumers will save less and hold less wealth, hold more short-term installment debt and fewer stocks, and use and benefit from financial advice relatively intensively. The data bear out these predictions. In all, the evidence suggests that many consumers systematically misperceive the opportunity cost of intertemporal tradeoffs, that there is a clear cognitive microfoundation for such misperceptions, and that an easily measured metric of misperception explains substantial cross-sectional variation in household finance.

Keywords: household finance, intertemporal choice, portfolio choice, interest rates, exponential growth bias, behavioral economics, behavioral finance, bounded cognition, financial advice

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I. Introduction

The main parameters economists use to model household finance are *preferences* over risk and current vs. future consumption, *beliefs* over future income realizations, and *interest rates* measuring the costs and benefits of shifting consumption across time.

Because models using strict neoclassical specifications of these parameters can struggle to explain real-world financial behavior, a growing body of work develops alternative specifications of preferences and belief parameters. Related work focuses on whether and how well consumers solve problems, given parameter values.[1]

But economics and finance has largely ignored specification issues regarding the opportunity cost of consumption. Theoretical and empirical work continues to assume that consumers correctly perceive how much their future consumption will fall (rise) if they borrow (save) today. This suggests the lines of inquiry that we explore in this paper: 1) How do people actually perceive the costs of intertemporal tradeoffs? 2) If perceptions deviate from standard assumptions, what are the implications—both theoretical and empirical—for household finance?

Our work builds on some prior survey and lab evidence related to the first question. Prior studies suggest that consumers' perceptions of the opportunity cost of consumption are systematically *biased*. Eisenstein and Hoch (2005) find that subjects systematically underestimate compounded returns to saving.[2] Several studies based from the 1960s and 1970s find that consumers systematically underestimate the borrowing interest rates implied by other loan terms.[3] Anecdotal evidence suggests that the market recognizes these tendencies and responds accordingly. Eisenstein and Hoch discuss how investment firms seek to counteract consumers' tendency to underestimate compound returns, with product presentations that show future values in addition to annual rates of return. Our companion paper finds that lenders seek

[1] For "rule of thumb" alternatives to dynamic optimization see, e.g., Hurst (2006) and Lettau and Uhlig (1999). There is also a related literature on financial planning; see e.g., Ameriks, Caplin, and Leahy (2003) and Lusardi (2003). For alternative formulations of beliefs see, e.g., Brunnermeier and Parker (2005) and Puri and Robinson (forthcoming). For alternative formulations of preferences see, e.g., Angeletos, Laibson, Repetto, Tobacman, and Weinberg (2001), Barberis, Huang, and Santos (2001), and Gul and Pesendorfer (2004). DellaVigna (2007) provides a more comprehensive summary of field evidence on these three types of deviations from neoclassical assumptions.

[2] See also Lusardi and Mitchell (forthcoming), where responses to a question on the Health and Retirement Survey are consistent with the underestimation of compound returns.

[3] See, e.g., Juster and Shay (1964), National Commission on Consumer Finance (1972), Day and Brandt (1974), Parker and Shay (1974) and Kinsey and McAlister (1981).

to exacerbate the consumer tendency to underestimate borrowing costs, by "shrouding" interest rates (Stango and Zinman 2007).[4]

The existing evidence on how consumers perceive borrowing costs and returns to saving is suggestive but has three important limitations. First, it has not systematically established bias in nationally representative data, or measured how the severity of bias changes over different time horizons. Second, it is piecemeal: there is no unifying theory that both explains why consumers systematically underestimate both borrowing costs and returns to saving, and identifies the comparative statics of bias with respect to maturity on savings and debt. Without such a theory it is difficult to think clearly about how biased perceptions might affect the entire range of financial decisions. Third, there has been no work showing that misperceptions matter empirically for the key outcomes of interest in household finance: borrowing and saving rates, portfolio choice, and wealth accumulation. Our work addresses each of these limitations.

First, we provide new evidence on misperceptions of borrowing costs, using data from the 1977 and 1983 Surveys of Consumer Finance. As in prior studies, we find that inference about the interest rate on a hypothetical loan is biased: nearly all consumers underestimate the interest rate implied by a stream of repayments on short-term installment debt, and do so by an economically large amount. We call this tendency *payment/interest bias*. We also find that consumers also underestimate the interest rates on *actual* loans they hold. Finally, we show that payment/interest bias is a function of loan maturity: it is much more severe for short-term loans than longer-term loans, and essentially zero on the modal 30-year mortgage.[5] The last finding is, to our knowledge, new in the literature on perceptions of borrowing costs.

Our second contribution is developing a theory that explains why consumers systematically underestimate borrowing costs and returns to saving; the theory also squares with our new evidence on bias and maturity. The theory relies on a single, more general, cognitive microfoundation: *exponential growth bias,* the tendency to underestimate the growth of exponential series. Exponential growth bias has been documented in a variety of problem-solving contexts in cognitive psychology (see Appendix A for a discussion and references). Its

[4] See Gabaix and Laibson (2006) for a model of a shrouding equilibrium.
[5] We have no new data that directly measures perceived returns to saving, but show below that biased perceptions of borrowing costs map predictably into biased perceptions of savings returns under general assumptions.

economic applications to-date have been limited to perceptions about savings (Eisenstein and Hoch 2005) and inflation (Keren 1983; Jones 1984; Kemp 1984). Relative to this other work, we show that exponential growth bias has both wider theoretical applicability and sharper empirical predictions regarding household finance. It causes a consumer to underestimate both installment borrowing costs and the future value of savings, when making inferences based on information commonly available in the market. The magnitude of underestimation varies with the maturity of debt and assets in asymmetric fashion: it is largest for short-term installment debt, and long-term investments.

The theory thus generates specific testable predictions on how the tendency to underestimate borrowing costs and returns to saving will affect saving decisions, portfolio choices, and wealth accumulation. More biased households should be more likely to hold short-term installment debt, but no more likely to hold longer-term installment debt. More biased households should be less likely to hold long-term, high-yielding assets like publicly-traded stocks, but no less likely to hold shorter-term, lower-yielding assets like certificates of deposit. As a consequence of these factors, more biased households should save less and accumulate less wealth overall. The nature of the bias implies that the relationships between bias, decisions, and outcomes should be weaker for households that have less direct control over their financial decisions, whether by constraint (credit rationing that prevents them from borrowing at desired levels) or by choice (the use of financial advice). If some consumers are aware of their bias we should see more biased consumers obtaining more financial advice, all else equal.

We test these predictions using the only dataset that measures both household-specific misperceptions about the opportunity cost of consumption, and rich information on financial decisions, outcomes, and other factors that might influence intertemporal choices: the 1983 Survey Consumer Finances (SCF).[6] The measure of misperceptions is payment/interest bias on a hypothetical short-term loan. Each empirical test correlates payment/interest bias with a financial outcome, conditional on a set of controls. The controls include demographic and life-

[6] Methodologically speaking, empirical work testing relationships between an individual- or household-specific measure of a potentially biased decision input and financial choices is rare. Aside from Puri and Robinson and related papers discussed therein on over-optimism, the empirical examples we know of focus on present-biased preferences. Ashraf, Karlan, and Yin (2006), Dohmen et al (2005), and Meier and Sprenger (2006) use survey questions to construct measures of time-inconsistent preferences and then examine relationships between preferences and saving or borrowing decisions..

cycle factors (age, gender, race, household size, marital status, health status), available resources (employment status, income, homeownership, occupation, industry, pension coverage, pension + Social Security wealth), measures of preferences (patience, risk aversion and attitudes toward borrowing), and other decision inputs (expectations about future income, loan shopping, education, and advice). Because the locus of control over financial decisions is critical, we also estimate models that split the sample by the use of financial advice or the existence of credit constraints.

The data are consistent with each of the theory's predictions. Bias is correlated with greater short-term installment debt, and with lower long-term asset holding (even conditional on total savings). More biased households save less and accumulate less wealth. Whether households retain control over financial decisions matters Bias is empirically inconsequential among households who rely on external advice for financial decisions, and has greater impact among households who do not face credit constraints. The overall economic impact of biased misperceptions of the opportunity cost of consumption is large; holding our covariates constant, moving from the quintile of households with the lowest bias to the quintile with the highest is correlated with twelve to twenty-eight percent reduction in total household wealth.

The paper proceeds as follows. Section II discusses prior work on misperceptions about borrowing costs and returns to saving, and presents new evidence documenting payment/interest bias on hypothetical and actual loans. Section III illustrates our theory that both borrowing and saving misperceptions can be explained by exponential growth bias (formal derivations are in Appendix B). Section IV describes the theory's empirical predictions on the relationship between bias and portfolio choices, savings rates, wealth holdings, and the degree of control over financial decisions, and details how we test them. Section V presents our test results. Section VI interprets the results, comparing our theory to alternative explanations. Section VII concludes by discussing implications for modeling, the "treatment" of biased perceptions, and future research.

II. Biased Interest Rate Perceptions: Evidence

This section first reviews prior work related to the underestimation of borrowing costs and returns to savings. We then present new evidence from two data sources that have not been used in prior studies: the 1977 and 1983 Surveys of Consumer Finances (SCFs). As in prior studies, we find consumers underestimate the interest rate implied by a loan amount and repayment stream when asked hypothetical questions about short-term loans. We call this *payment/interest bias*. We also find that consumers display substantial payment/interest bias on their *actual* short-term loans. Further examination of the data reveals a new stylized fact: payment/interest bias falls with maturity, and disappears at the longest maturities.

A. Prior Work on the Underestimation of Returns to Saving

Eisenstein and Hoch ("EH") deal most directly with the question of whether individuals underestimate returns to saving when making hypothetical financial decisions. EH present Internet survey participants with a brief definition and description of compound interest. They follow with several questions asking subjects to estimate a future value given a present value, time horizon, and interest rate. (Subjects were instructed to give their best estimate, and not to use calculators or pencil-and-paper.) EH find significant underestimation of future values; underestimation is prevalent (over 90% of respondents err on the low side), large on average, and increasing in the time horizon.[7] EH note that respondents display a strong tendency to anchor on a linear forecast of savings growth, and to ignore the gains provided by compounding.

B. Prior Work on the Underestimation of Borrowing Costs

Several previous studies contain evidence that consumers systematically underestimate borrowing costs.[8] Most studies establish this by asking respondents to estimate the interest rate implied by a given loan principal, maturity, and repayment stream. In some cases the questions

[7] Lusardi and Mitchell (forthcoming) show that responses to a question on savings yields in the Health and Retirement Study (HRS) are consistent with the underestimation of compound yields. We note however that the HRS question does not necessarily capture a *bias* per se: its multiple choice format provides respondents with options that underestimate the yield implied by the question, but *not* with options that *overestimate* the yield.

[8] This work includes Juster and Shay (1964), National Commission on Consumer Finance (1972), Day and Brandt (1974), Parker and Shay (1974) and Kinsey and McAlister (1981).

are hypothetical, in others they pertain to actual loans. The focus on asking consumers to infer rates from other loan terms was motivated by loan marketing at the time, which often emphasized payments and obscured or omitted interest rates (National Commission on Consumer Finance 1972). Policymakers view accurate and unbiased perceptions of interest rates as critical because rates potentially provide a standard unit of comparison for loans with different maturities, and for loans to savings instruments with returns stated as interest rates.

Emphasis in prior studies is most often on measuring awareness-- whether a respondent knows the ("market") rate or not--, or mistakes (whether inference about rates is correct or incorrect). Nonetheless, most of the studies find that consumers systematically underestimate rates.[9] The earliest studies played a big part in shaping the United States' first Truth in Lending Act (enacted 1968) and its focus on APR disclosure (National Commission on Consumer Finance 1972). More recently, Bernheim (1995; 1998) and Moore (2003) find evidence consistent with limited understanding of loan terms, including interest rates.

C. New Evidence on the Underestimation of Borrowing Costs from Hypotheticals

We build on this prior work in several ways. We start by presenting evidence on the underestimation of borrowing costs from two previously unused sources: the 1983 and 1977 Surveys of Consumer Finances (SCFs).[10] The 1983 data is of primary interest for our empirical strategy, since only the 1983 survey contains the additional, rich data on financial outcomes and controls that we use for our empirical tests (see Section IV). The advantage of the 1977 data, on the other hand, is that it asks borrowers to self-report interest rates on actual rather than hypothetical loans; this allows us to present some new stylized facts regarding the relationship

[9] Because those studies tended to focus on measuring mistakes rather than bias, identifying payment/interest bias from those papers requires inference based on summary data in the papers. Based on those data it appears that respondents underestimate interest rates. Some do make more direct statements about bias; Parker and Shay (1974), for example, note that consumers display "a strong tendency to underestimate annual percentage rates of charge by about one-half or more…"

[10] Both the 1977 and 1983 SCFs are nationally representative. The 1983 SCF has more content overlap with the modern, triennial version of the SCF that started asking a very consistent set of questions in 1989 (unfortunately dropping questions about borrowing cost perceptions). We use data on the 4,103 1983 SCF households with relatively complete data, dropping the 159 "area probability sample excluded observations" (variable b3001). See Avery, Canner, Elliehausen and Gustafson (1984) for additional information on the survey. The 1977 SCF focused more on consumer credit issues, and has a substantially less complete accounting of the household balance sheet and decision inputs. We use data on all 2,563 households to construct the measures of borrowing cost perceptions in Tables 1 and 2. The codebook (available on the ICPSR website) provides details on the motivation and survey methodology.

between bias and loan maturity, and also allows us to link bias on hypothetical loans to bias on actual loans.[11] The latter fact is important given that our measure of bias in 1983 is based on hypothetical questions.

We define *payment/interest bias* as the degree to which an individual underestimates the annual percentage rate (APR) associated with a loan principal and repayment stream. Our first measure of payment/interest bias comes from two hypothetical questions in the 1977 and 1983 SCFs:[12]

> *"Suppose you were buying a room of furniture for a list price of $1,000 and you were to repay the amount to the dealer in 12 monthly installments. How much do you think it would cost in total, for the furniture after one year -- including all finance and carrying charges?"*

The response to this first question is a lump sum *repayment total* (e.g., $1200). Given the predefined maturity and principal amount, the repayment total yields i^*, the *actual APR* implied by the respondent's self-supplied repayment total (we give more detail on the calculation underlying this result below).[13] Figure 1a shows the distribution of the actual APR in the 1983 SCF across all households. The mean is 57 percent, which corresponds to a stream of payments over the year totaling roughly $1350. The modal actual APR is 35% ($1200), with other frequent rates corresponding to round repayment totals ($1300, $1400, $1100, etc.). The twenty-fifth percentile is 35% and the seventy-fifth is 81% ($1500).

The next question in the survey is:

> *"What percent rate of interest do those payments imply?"*

This response is i', the *stated* or *perceived APR*.[14] Figure 1b shows the distribution of perceived APRs. While perceived rates also vary, the perceived rate distribution has both a lower mean and a lower variance than the distribution of actual rates.

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[11] The 1983 SCF asks respondents for loan payments, maturity and principal. It then uses these data to calculate the loan rate, avoiding the need to ask respondents to supply it (but preventing us from comparing actual to perceived rates).

[12] The survey respondent is whomever was determined to be the "most knowledgeable about family finances." We use the terms "household," "individual", "consumer" and "borrower" interchangeably.

[13] We assume that the monthly installment payments are equal when calculating the actual APR. Different assumptions about payment arrangements do not change the qualitative results that respondents generally underestimate interest rates (even if we assume that the first eleven payments are zero, and the last completely repays the loan). More important, while such transformations change the level measure of misperception they do not alter the cross-sectional ranking in misperception. It is that ranking that provides identification in our empirical tests below.

[14] Although the SCF question does not specify a particular definition of "rate of interest", we use the APR as our benchmark because: a) it has been the standard unit of comparison for borrowing costs in the U.S.

The difference between the perceived and actual rates is what we call payment/interest bias. Figure 2a presents a histogram of the difference between actual and perceived APRs in the 1983 SCF. Both the prevalence of bias and its size are striking. Over 98% of respondents underestimate the actual rate. The median bias is -25 percentage points (-2500 basis points), and the mean bias is -38 percentage points.[15] Roughly twenty percent of respondents give the "simple" or "add-on" rate (i.e., a repayment total of $1200 yields a perceived APR of 20%). But responses are biased even relative to this rate; those who supply something other than the add-on rate tend to underestimate relative to the add-on (Figure 2b).

Table 1 shows tabular data on payment/interest bias in both the 1983 and 1977 SCFs. We stratify bias into quintiles that we use in the empirical work below. The data show that bias is similar in both surveys, although it is slightly smaller in the 1977 data.[16]

D. New Evidence on the Underestimation of Borrowing Costs from Actual Loans

Both the 1983 and 1977 SCFs also contain self-reported interest rates on *actual* loans: on all installment loans in the 1977 SCF, and on mortgages in the 1983 SCF. This is useful because with self-reported data on principal, maturity and payments, we can calculate the actual APR on each loan. This allows us to ask whether consumers also display payment/interest bias on actual loans, and moreover whether payment/interest bias varies with loan maturity.

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since the enactment of Truth in Lending law in 1968; b) it is the rate respondents supply when asked about the most prevalent type of loan, home mortgages (more on this in Section II-D). Using alternative benchmarks such as the Effective Annual Rate (which tends to be higher than the APR) or the "simple" or "add-on" rate (which does not account for declining principal balances on installment debt and hence is dominated by the APR as a measure of the shadow cost of foregone future consumption) does not change our results. This is not surprising because, as Section III details, we identify off cross-sectional variation in the degree of bias rather than its level. Our empirical tests also allow for the possibility that respondents who supply the add-on rate are correct in a sense, by allowing add-on respondents to have their own intercept (see equation (6)). Below we shows that consumers' responses are biased downward even relative to the add-on rate and explore the related questions of what problem respondents are trying to solve, and how to interpret our measure of payment/interest bias.

[15] It is difficult to compare the size of payment/interest bias here to that in the earlier studies, because those studies typically only measure the share of consumers underestimating the actual rate. The one study that does allow us to infer average payment/interest bias (Juster and Shay 1964) uses a sample of consumers that is nonrepresentative, and in all likelihood better informed about rates than average. Juster and Shay find bias that is substantial (1500 bp) but smaller on average than what we document here.

[16] We also have one bit of contemporary evidence on payment/interest bias: following an internal presentation of this paper, a skeptical colleague gave a version of the SCF questions to students in a finance class that had recently covered discounting. Of thirty-seven students, all underestimated the APR: one gave a rate above the add-on rate, twelve gave the add-on rate, and the remainder underestimated relative to both the APR and the add-on rate.

Table 2 presents summary data on payment/interest bias on all actual non-mortgage installment loans in the 1977 SCF, and all actual mortgages in the 1983 SCF.[17] The data reveal substantial payment/interest bias on short-term loans; for the shortest-maturity loans actual rates average 30 percent while perceived rates average 13 percent. Bias falls with maturity, and is close to zero for the longest-maturity installment loans and mortgage loans (which themselves tend to have 15-30 year maturities). Payment interest bias on hypothetical loans is positively correlated with payment/interest bias on actual loans. In the bottom two panels of the table we separate consumers into "low bias" and "high bias" groups by their hypothetical loan answers, and find that bias on actual loans is generally lower for the low bias group.

E. Summary of the Descriptive Evidence

In all, our new evidence (along with prior evidence) suggests two stylized facts regarding how consumers perceive the costs and benefits of intertemporal tradeoffs. First, when asked to make intuitive calculations consumers systematically underestimate future values on savings, and underestimate interest rates on installment loans. Solving for an APR or future value is of course complex (as detailed in the next section), so we should not be surprised that large *mistakes* are common. The striking fact is that consumers are *biased*: they make mistakes *in a particular direction*, underestimating borrowing costs and compounded returns to saving. The size of the underestimations are economically large on both hypothetical and actual questions. Second, the severity of these biases depends on the time horizon. Eisenstein and Hoch find that underestimation of returns to saving increases with the investment horizon, and we find that underestimation of installment debt interest rates decreases with the borrowing horizon.

III. Perceptions of Intertemporal Consumption Tradeoffs and Exponential Growth Bias

Here we develop a theory of how consumers perceive the opportunity cost of consumption that fits the empirical regularities described in the previous section. The theory is based on a

[17] We discard installment loan responses from 1977 that imply negative interest rates; in all likelihood these are loans with balloon payments, which we do not observe. We also discard mortgages from 1977, because that survey does not identify the size of escrow payments for taxes and insurance in each household's mortgage payment, making calculation of the actual APR impossible. Mortgage payments in 1983 are measured net of escrow.

microfoundation from cognitive psychology: *exponential growth bias*, the tendency to underestimate exponential series. Our reasons for developing the theory are twofold. First, it clarifies the assumptions under which a consumer who underestimates the interest rate implied by other loan terms on short-term installment debt will also underestimate the future value implied by an average annual return. This link is particularly important given our data limitations, since we have direct evidence only on perceptions of borrowing interest rates, and not on perceptions of returns to saving. A second reason for drawing the link is that it enables us to clarify the testable predictions regarding how our measure of payment/interest (exponential growth) bias should correlate with actual financial decisions: short-term and long-term borrowing, the allocation of savings, savings rates and wealth accumulation.

A. Exponential Growth Bias: a Cognitive Microfoundation for Biased Perceptions

Exponential growth bias was first identified in a series of papers in cognitive psychology in the mid-1970s. To save space we refer the interested reader to Appendix A, which discusses that and subsequent work in some detail. But the nature of exponential growth bias is easy to grasp: when asked to extrapolate or forecast an exponentially growing series, individuals systematically underestimate its growth. Prior work shows that the bias is large and general; it has been documented in contexts ranging from pollution to inflation. Since exponential series play important roles in the mathematics of borrowing and saving decisions, we now explore how biased perceptions of exponential growth will influence these decisions.

Expositionally, it is easiest to begin by describing exponential growth bias in the context of savings. Consider the following saving problem faced by a consumer deciding whether to invest a present value PV at a periodic interest rate i over time horizon t, with periodic compounding. Holding constant preferences over consumption now vs. the future, the consumer needs to solve:

$$FV = PV(1+i)^t \tag{1}$$

Exponential growth bias implies that consumers will systematically underestimate the future value (Appendix B, Part C shows this formally). On the margin, this will make saving less attractive given a choice between current and future consumption. Estimating the size of exponential growth bias in this setting is the focus of Eisenstein and Hoch (2005).

Exponential growth bias also implies payment/interest bias. Consider a consumer attempting to infer a loan interest rate when confronted with a periodic payment, principal and maturity.[18] Given a loan amount L, maturity t, and monthly payment p the consumer must solve:[19]

$$p = Li^* + \frac{Li^*}{(1+i^*)^t - 1} \tag{2}$$

There is no closed form solution for the APR, but it is defined implicitly.

A consumer with exponential growth bias but otherwise correct inference will underestimate the exponential term in the denominator. The question is whether that specific form of misperception—a feature of mathematical cognition with extensive prior documentation—is sufficient to generate payment/interest bias. I.e., will a consumer who underestimates the exponential term in the denominator underestimate the true interest rate on the loan, holding all else constant? Appendix B, part D shows that the answer is yes, under general assumptions. Exponential growth bias also implies that payment/interest bias is more severe on short-term loans, as we illustrate below and prove in Appendix B, Part E.

A specific numerical example illustrates the links between exponential growth bias and biased perceptions about borrowing costs and returns to saving. Consider a consumer who, rather than using the correct value for the exponential term $f(i,t) = (1+i)^t$, displays exponential growth bias of the following form (which fits the mean responses on the hypothetical loan questions in the 1983 SCF):[20]

$$f(i,t) = 1.01 \cdot (1+i)^{0.7t} \tag{3}$$

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[18] As discussed by Stango and Zinman (2007), this "payments marketing" of loan offers is quite common. If a consumer views a rate along with the information listed above, misperception is of course impossible and exponential growth bias will have no empirical effects on real-world decisions; this is what we test below.

[19] This formula (implicitly) yields the periodic interest rate. For an installment loan with monthly payments, the APR is twelve times the monthly (periodic) rate.

[20] With this parameterization, on the mean loan APR of 56% (the actual rate implied by the mean of the respondent-supplied repayment totals), the perceived rate is 17%, which matches the mean perceived rate in the data. This parameterization should be thought of as representative of the mean rather than fitting the entire range of data, because there is substantial cross-sectional variation in the degree of payment/interest bias (indeed, it is that variation that provides identification in our data).

The multiplicative term in front of the exponential term (1.01) is an adjustment factor ensuring that a consumer with this bias does not infer a negative interest rate on a very short-term loan. There is experimental support for such adjustment factors; in an early paper Wagenaar and Sagaria (1975) describe this as reflecting "linear compensation." See Appendix A for more detailed discussion.

Given the other loan terms $[L, p, t]$ this consumer perceives an interest rate that solves this problem:

$$p = Li^p + \frac{Li^p}{1.01(1+i^p)^{0.7t} - 1} \tag{4}$$

Figure 3 shows how such a consumer will perceive interest rates on loans with different maturity. It plots the actual and perceived APR for a loan with a simple (add-on) interest rate of 30%. The add-on rate is constant across maturities, so each point on the curve represents a loan with two identical characteristics: the $1,000 principal, and a 30% add-on rate.[21] The APR is much higher than the add-on rate at short maturities (in the figure, the add-on is just a horizontal line at 30%), but approaches the add-on as maturity goes to infinity.

The first insight from Figure 3 is that exponential growth produces payment/interest bias. It also fits the other stylized fact: payment/interest bias declines, and ultimately disappears, as maturity increases. As maturity increases the actual and perceived rates converge; mathematically what drives this is that as maturity increases $(t \to \infty)$, the exponential growth term in the denominator gets very large and drives the fraction to zero. This produces the correct and intuitive result that an infinite-maturity ("interest-only") loan has a periodic payment of $p=Li$, and contains no exponential growth term.[22]

Figure 4 shows the more self-evident result that exponential growth bias implies underestimation of the return to savings. Here we plot the actual and perceived future values for a consumer who perceives future values using the same form of exponential growth bias as above in Figure 3:

$$FV^p = 1.01PV(1+i)^{0.7t} \tag{5}$$

[21] A 30% add-on rate means charging $30 of interest per $100 of original principal, per year of the loan. This does not account for declining principal balances (i.e., for the fact that installment loan repayments include principal as well as interest), and therefore understates the APR. The add-on rate was the prevailing way of quoting loan terms before the enactment of the Truth-in-Lending Act (National Commission on Consumer Finance 1972).

[22] Note there will be a similar but not identical pattern if we parameterize exponential growth bias as simple linear bias; i.e., if consumers perceive add-on rates rather than trying to adjust for declining balances as in (3). One could see this in Figure 3 by adding a horizontal line for "perceived APR under linear bias" at 30%. Linear bias provides a better approximation to the APR than our parameterization in (3) at short maturities, does worse at medium maturities, slightly worse at long maturities, and equally well at infinite (interest-only) maturity.

The saver faces an annual percentage return of 7% (the long-run real return on stocks), and has a present value of $1,000 to invest. Underestimation of the return to saving (the vertical distance between the actual and perceived future values) increases at longer time horizons, which fits with the results found by Eisenstein and Hoch (2005). Not shown but equally intuitive is the fact that the level effect of underestimation increases in the annual rate of return, all else equal.

Taken together, these results help formalize the proposition that a common cognitive microfoundation can lead consumers to underestimate both borrowing costs and returns to saving. This will distort perceptions of the opportunity cost of consumption. Bias makes saving less attractive, by depressing the perceived dollar returns one gets in the future from forgoing consumption now. On the other side of the ledger, bias makes borrowing more attractive by depressing its perceived opportunity cost. The latter result is true if the reference opportunity cost is an interest rate, such as that on savings. The intuition also holds if consumers instead consider that they could save the stream of payments and consume a lump sum still later. Exponential growth bias depresses the perceived return to saving those monthly payments, and hence makes taking the loan (weakly) more attractive.

In all, exponential growth bias provides a unifying explanation for the stylized facts on perceptions of borrowing costs and returns to saving found in our data and related studies. The existence of these biases does not prove their empirical relevance, of course. The discussion above presumes that consumers must infer interest rates defined by loan repayment streams, or future values defined by asset returns. The existence of payment/interest bias on *actual* loans fits with this view. But is possible that consumers receive (and understand) additional information that renders such inferences unnecessary for decision-making. Moreover even if consumers do rely on inference and thereby tend to misperceive the opportunity cost of consumption, demand- or supply-side factors might render bias irrelevant in the market. Establishing the real-world relevance of biases therefore requires developing a clear set of empirical predictions and testing those predictions.

IV. Testing the Predictions: Empirical Strategy

A. Overview

We test the predictions detailed below using a series of empirical models of the form:

$$Outcome_h = f(Bias_h, Addon_h, X_h) \quad (6)$$

In each model *Outcome* is a behavior or measure of financial condition suggested by one of the predictions, *Bias* is a vector of indicators for payment/interest bias quintile (including a category "no quiz response."). *Add-on* is a binary variable capturing whether the household's a perceived rate equals the add-on rate, and X is a vector of variables that control for other factors that might affect financial decisions (recall that the theory implicitly conditions on these factors)..All variables are constructed from the 1983 Survey of Consumer Finances (SCF) and measured at the household level (h). We use a single cross-section because, as noted above, only the 1983 SCF has rich data on all components of our empirical model. Appendix C contains a complete description of each variable.

Ideally, the empirical model would include a household-level measure of exponential growth bias; that would provide the most direct test of our theory. However, the 1983 SCF only measures payment/interest bias on short-term loans (as detailed in Section II). This means that the interpretation of our empirical model depends on the outcome. In some cases the outcome is one that should be directly affected by payment/interest bias: installment borrowing is an example. In other cases the outcome is one should not be affected by payment/interest bias *per se*; asset allocation is an example. In the latter instance the empirical model tests whether payment/interest bias has the broader impact one would expect to find if it reflects exponential growth bias that also depresses perceived returns to long-run savings. Finally, for some of our outcomes (such as overall wealth), an empirical relationship might reflect either a direct effect of payment/interest bias, underestimation of returns to saving or a combination of both.

B. Outcomes and Testable Predictions

Here we map our theory into testable predictions about specific financial outcome variables. Table 3 shows summary statistics for each of these outcome variables, by quintile of payment/interest bias. These are *unconditional* relationships between outcomes and bias and

hence do not speak to the validity of our theory's predictions. These statistics are merely intended to help describe the variables we use to implement our tests.

The theory's predictions are:

Prediction #1a: Holdings of short-maturity installment debt will increase with payment/interest bias on short-maturity loans (this prediction is illustrated in Figure 3, and derived in Appendix B, Part E). We measure short-term installment debt in two ways. The first is "financed a large recent purchase." For those households making a large (¿$500) recent purchase, this dummy variable equals one if the household financed the purchase via short-term installment debt (the median original maturity on these loans is 36 months, and 99% of them are 60 months or less). The second measure is a ratio: (total non-mortgage installment debt owed)/(wage income). The median original maturity on non-mortgage installment loans is again 36 months; 86% have maturities of 60 months or less, and 95% have maturities of 120 months or less.

Prediction #1b: Holdings of long-maturity debt will not vary with payment/interest bias on short-maturity loans, since perceptions of long-term borrowing interest rates are unbiased on average and do not vary with bias on short-maturity loans. Our measure of long-term debt includes both mortgage debt (median maturity of 300 months) and revolving debt (which requires little if any principal payments, and hence approaches infinite maturity. As with short-term installment debt, we measure long-term debt using its ratio to labor income.

Prediction #2: Holdings of long-term and high-yielding assets will decrease with payment/interest bias, if payment/interest bias is correlated with underestimation of returns to long-term saving (this prediction is illustrated in Figure 4, and derived in Appendix B, Part C). We test this by classifying assets as either short-term/low-yield or long-term/high-yield. Conditional on our controls (including a highly predictive measure of risk aversion), more biased households should find long-term/high-yield assets less attractive on the margin. Our long-term, high-yield asset variables capture ownership of publicly-traded equities and/or non-money market mutual funds ("stockholding").[23] One measure creates a dummy variable equal to one if

[23] Only 8% of the sample held any non-money market mutual funds, and we count these households as owning stocks.

the household holds any stocks. Our two other measures use the stock share of total or financial assets. The short-term, low-yield variables measure ownership of certificates of deposit (CDs), which offer relatively low real rates of return over explicitly short horizons.

Prediction #3: Savings rates and wealth holdings will decrease with payment/interest bias, either as a direct consequence of how bias affects the perceived cost of debt, and/or if payment/interest bias is correlated with underestimation of returns to saving. We measure the savings rate based on the question: "considering all of your savings and reserve funds, overall, did you put more money in or take more money out in 1982?" Answers take one of three values: "saved," "even" and "dissaved." We measure wealth using a standard measure of net worth (that excludes defined-benefit retirement wealth, which we use as a control variable as detailed below). Because wealth is highly skewed and the functional form of the relationship between bias and wealth is unclear, we estimate the relationship using several different estimators and functional forms, as detailed in Section V-D.

Prediction #4: The relationship between bias and financial decisions (as measured by test results on predictions #1-#3) will be weaker for biased households that have less control over their financial decisions. This will be true whether the locus of control is a matter of choice (e.g., delegating decision-making to a less-biased expert) or constraint (e.g., being rationed in the credit market). Specifically:

Prediction #4a: The relationships between payment/interest bias and financial decisions/outcomes will be weaker for households that face relatively severe credit constraints and hence can not borrow as much as they would like. To conserve space we test this by estimating our borrowing, saving, and wealth models on sub-samples of households that face relatively *lax* credit constraints; i.e., by dropping relatively constrained households from our main sample. We use two standard measures of credit constraints: being turned down/rationed/discouraged from borrowing in the "past few years", and lacking a credit card.

Prediction #4b: The relationships between payment/interest bias and financial decisions/outcomes will be weaker for households that use advice, presuming that advisors are

less biased than advisees. We test this by estimating our wealth models on sub-samples of households that do and do not use external advice, as measured by several questions that ask whether the respondent "sought advice concerning savings and investment decisions" from different sources.

Prediction #5: The use of financial advice will increase with payment/interest bias. This will be true on average if bias does indeed affect actual decisions, (as our tests of predictions #1-#3 will suggest), if advice helps mitigate the effects of bias (as our tests of prediction #4b will suggest), and if some consumers are aware of their tendency toward bias. We test this using advice as the outcome.

No alternative model we know of predicts this particular pattern of results. We postpone detailed discussion of alternative explanations until Section VI, after we detail the right-hand-side variables used in our empirical tests and then present our empirical results in Section V.

C. Measuring Biased Interest Rate Perceptions

To review, our measure of perceptions related to the opportunity cost of consumption is based on *payment/interest bias* as measured by responses to the hypothetical questions described in Section II-C (recall that the 1983 SCF provides self-reported interest on actual loans only for mortgages, and that perceptions of these rates are unbiased, as predicted by the theory).[24] We preserve functional form flexibility by taking the continuous measure of payment/interest bias (which is plotted in Figure 2a) and dividing it into quintiles. We include a separate category for consumers who do not respond to one or both of the questions we use to construct our measure of bias. We also have an additional category for respondents that provide the add-on rate: this allows for the possibility that they may behave differently than those with identical bias who do not give the add-on rate. Table 1 shows the proportion of respondents supplying the add-on rate in each bias quintile.

[24] As detailed in Section II-D, the 1983 survey does not have any questions that can be used to assess interest rate perceptions on actual loans other than mortgages, nor does it have any questions that directly elicit perceptions on returns to saving.

This approach to functional form maps well into our data and theory in the sense that it provides *relative* tests of differing *degrees* of bias. It does not require anyone to have "correct" perceptions, which makes sense given the finding that 98% of 1983 SCF households exhibit at some payment/interest bias.

D. Control Variables

Recall that our theory generates predictions on the relationship between biased perceptions of intertemporal tradeoffs and financial decisions, *conditional on other factors that might influence choices*. We seek to control for all factors that might be correlated with both outcomes and our measure of payment/interest bias, hence erring on the side of "over-controlling."[25] Because specification error is a concern, we impose minimal functional form restrictions. Our controls include measures of preferences, expectations, available resources (including income, defined-benefit retirement wealth and credit constraints), claims on resources (including life-cycle factors), and problem-solving approaches (and financial sophistication more generally). We group them below for expositional purposes but emphasize that each of our empirical tests include controls for *all* of the variables described below (and detailed completely in Appendix C). Table 3 shows descriptive statistics on some of these variables, by bias category.

Controls for preferences include measures of risk preference, liquidity preference, and debt aversion; other work has shown that these are important determinants of household financial decisions. Risk preference is measured with the question: "Which of the following statements on this card comes closest to the amount of financial risk you are willing to take when you save or make investments?" Answers fall into four categories, ranging from "willing to take substantial financial risks to earn substantial returns" to "not willing to take any financial risks." Time preference or patience is measured with the question: "Which of the following statements on this card comes closest to how you feel about tying up your money in investments for long periods of time?" Answers range from "will tie up money in the long run to earn substantial returns" to

[25] If there is a causal link between bias and any of these variables, we may underestimate the relationship between bias and our outcomes of interest (Angrist and Krueger 1999).

"will not tie up money at all." Debt aversion (and perhaps an element of time preference) is measured with the question: "Do you think it is a good idea or a bad idea for people to buy things on the installment plan?" Tables 5-8, and the discussion in Section VI-D, highlight that these preference variables correlate with decisions in ways that are qualitatively intuitive and economically important.

Controls for expectations about lifetime wealth include measures of expected inheritance, expected tenure with current employer, and expected retirement age.

Controls for available resources and claims on resources include: total household labor income, homeownership, pension coverage, pension wealth and Social Security wealth (we exclude this wealth from our left-hand side wealth measure since it was plausibly beyond the direct control of most households in 1983), number of members in the household, gender, education, race, age, marital status, health status, years with current employer, industry, and occupation (including business ownership or self-employment activity). We also include standard measures of credit constraints in our full sample specifications (as noted above, other specifications split the sample based on credit constraints in order to test the prediction that the effects of bias will be strongest on those who are most able to borrow their desired amount).

Controls for problem-solving approaches/overall financial sophistication include whether the respondent evaluates loan offers by focusing on APRs or other terms (e.g., monthly payment, available loan amount, down payment, collateral requirement). Focusing on payments or other terms may reflect a lack of financial sophistication, conditional on credit constraints.[26] Two other proxies for financial sophistication are ATM use (only 17% of our sample used ATMs at all), and of course education. And we include the use of advice as control variables in our full sample specifications (as noted above, other specifications split the sample based on the use of advice in order to test the prediction that the effects of bias will be attenuated for those using external advice), using a categorical variable that classifies households as getting no advice, professional advice, advice from friends and family only, or advice from other sources.

[26] Focusing on non-interest terms may be rational for those who face binding liquidity constraints (Attanasio, Goldberg and Kryiazidou 2005; Karlan and Zinman 2006).

V. Results

This section reports results for each of the tests described above. In each case the coefficients on the payment/interest bias variables are measured relative to the omitted, least-biased quintile (quintile 1). Each model conditions on our full set of control variables; the tables suppress most of the control variable coefficients to save space.

A. Debt Maturity, Credit Constraints, and Bias

Table 4 shows some evidence supporting the predictions (#s 1a and 1b) that biased perceptions lead households to underestimate short-term but not long-term borrowing interest rates, and tilt their borrowing accordingly.

Columns 1-4 suggest that bias does indeed increase short-maturity debt holdings. Column 1 presents probit marginal effects from the model where the dependent variable equals one if the household used short-term installment debt to finance a recent large purchase (car, household item, or home improvement).[27] This model also controls for characteristics of the recent purchase (month/year, product purchased, and product price). The coefficients on each of the bias quintiles is positive, and households in quintiles 4 and 5 are significantly more likely have used short-term debt for the purchase. Evaluated at the sample mean, the coefficient on quintile 5 implies that the probability is 44% higher than for a household in the least-biased quintile. Columns 2-4 test whether more biased households have higher short-term debt-to-income ratios, conditional on having nonzero short-term debt.[28] Column 2 includes the entire sample of short-term borrowers. Again each point estimate on the bias quintiles is positive and economically large, and three of four coefficients are significant with 90% confidence. Prediction #4b implies that credit constraints dampen the effects of bias, so Columns 3 and 4 re-estimate the model after dropping households that face relatively severe credit constraints. Thus the

[27] This result is conditional on having made a large purchase; we find no significant relationship between bias and the probability of purchase.

[28] We find no relationship between bias and having nonzero short-term debt. It may be that the extensive margin is not very elastic— short-term installment debt is used primarily for financing vehicles and consumer durables, and the near-absence of second mortgage markets in 1983, along with small credit card credit lines, implies that savings was the main outside option for these types of purchase (responses to SCF question b5606, on the financing method for a large recent purchase, confirm this).

households remaining in these sub-samples have more control over their debt levels and maturity choices. The relationship between bias and short-term borrowing indeed appears stronger in these relatively unconstrained sub-samples: the coefficients on bias quintiles 2-5 are now all significant with at least 90% confidence. These point estimates suggest that the short-term debt-to-income ratio increases 4.5 to 9.1 percentage points with bias (i.e., 25% to 54% of the means). Households with a perceived rate that equals the add-on rate also carry significantly more short-term debt even after conditioning on their bias quintile.

Columns 5-7 support the prediction (#1b) that payment/interest bias should be uncorrelated with borrowing on longer maturities, because our data and theory suggest that payment/interest bias does not extend to long-maturity debt (even among households with severe payment/interest bias on short-maturity debt). Here the long-term installment debt to income ratio is the outcome of interest. None of the bias quintile or add-on coefficients is significant, although the estimates are imprecise.

Appendix Table 1 shows a similar pattern of results on short-term and long-term debt, for a more restrictive functional form that groups quintiles 2-5 into one category, creating a binary measure of bias.

B. Stocks, CDs, and Bias

Table 5 shows some evidence supporting prediction #2: that holdings of long-term, high-yielding assets (namely stocks) will fall with the degree of payment/interest bias exhibited on short-term debt. The prediction follows from the theoretical finding that consumers with exponential growth bias will tend to underestimate both short-term borrowing costs and compounded returns to saving. Odd-numbered columns present results from our usual specification, and even-numbered columns also include net worth decile as an additional control (Rosen and Wu 2004).

Columns 1 and 2 show that households in bias quintile 5 are significantly less likely to own any stock.[29] The marginal effects imply 25% or 20% decreases relative to the sample mean.

[29] We include the value of non-money market mutual fund shares in our measure of stocks. The mutual fund market was not yet well developed in 1983, and consequently only 8% of our sample holds any non-money market mutual funds.

The OLS[30] results in Columns 3-6 show statistically stronger negative relationships between the asset *share* of stocks and bias. Columns 3 and 4 show that households in quintiles 3-5 hold significantly fewer stocks as a share of *total* assets. These point estimates imply decreases of 28% to 67% relative to the sample average share. Columns 5 and 6 show that households in quintiles 2-5 hold significantly fewer stocks as a share of *financial* assets. These point estimates imply that more biased households have between 25% and 62% lower stock shares than average.

Columns 7-12 report the same ownership and share specifications for CDs. Most CDs held by households are short-term, and offer relatively low real yields. Our theory predicts that biased underestimation of compounded returns to saving is small at low periodic rates and short horizons, and hence that more biased households should be no less likely to hold CDs. The results bear out this prediction; if anything CD ownership *increases* with bias.

C. Saving and Bias

Table 6 shows some evidence supporting the prediction (#3) that saving will decrease with bias, since bias decreases the perceived opportunity cost of consumption. We estimate two models: an ordered probit where the categories are ranked (1=saved, 2=even, 3=dissaved),[31] and a probit where we combine the first two categories (1=dissaved, 0=saved/even). As with the debt maturity models we also report estimates for sub samples facing relatively slack credit constraints. In the full sample (Columns 1 and 4) each of the bias coefficients is positive, and quintiles 2 and 3 are significantly different from zero with 90% confidence or greater. Dropping credit constrained households tends to increase the size and significance of the point estimates (Columns 2-3, and 5-6), again suggesting that the effects of bias are stronger when households have more control over their borrowing choices. The statistically significant point estimates imply that more biased households are 16% to 24% more likely to dissave than the least-biased households.

[30] Estimating the share relationships using quantile regression (for the 90th percentile) or tobit instead of OLS produces similar results.
[31] Ordered logit and OLS produce very similar results.

D. Wealth Accumulation and Bias

Table 7 shows some further evidence supporting prediction #3: wealth holding will decrease with bias.[32] The first three columns report OLS results where the dependent variable is the log of net worth.[33] The first column shows bias quintile point estimates that imply 7% to 28% less wealth for more biased quintiles (relative to the least-biased quintile), and three of the four coefficients are significant. The next two columns restrict the sample to households that are relatively unconstrained in the credit market. The magnitudes of negative correlations between and wealth get slightly larger. We see a similar pattern of results with net worth percentile as the dependent variable (Columns 4-6).[34] These point estimates imply that more biased households hold between 1 and 3.5 percentile points less wealth than the least-biased households. This translates into approximately $2,000 to $7,000 less wealth for households near the middle of the wealth distribution (median wealth is $43,000).

E. Bias and Control: Summarizing the Results on Credit Constraints

The results thus far offer some support for the prediction (#4a) that the relationship between bias and outcomes will be stronger for households that are relatively unconstrained in credit markets and hence have more direct control over their borrowing choices.

F. Bias and Control: The Role of Advice in Mediating Outcomes

Table 8 shows some support for the prediction that the relationship between bias and outcomes will be weaker for households that use outside advice. We focus on wealth accumulation as a summary outcome. Column 1 reproduces the results on log(net worth) from Table 7 (Column

[32] As noted in Section IV-B, we exclude pension and Social Security wealth from our dependent variable measures of net worth, and include pension coverage and pension + Social Security wealth as control variables. The conditional relationships between pension coverage and bias offer a falsification test of sorts, since pensions were almost exclusively defined-benefit in 1983, and hence plausibly did not depend much on active or informed decision making by households. Unreported results suggest that we can indeed rule out economically significant correlations between whether the household currently has any workplace pension and bias, conditional on our usual control variables and the rest of net worth. We find no significant conditional correlations between the level of pension wealth and bias, but the results are very imprecise

[33] This drops the 7% of our sample with nonpositive wealth. We do not find any significant correlations between bias and having nonpositive wealth.

[34] The functional form here places more weight on the left and center of the wealth distribution, where the difference in wealth levels across percentiles is small, than on the right-tail of the wealth distribution, where the difference in wealth levels across percentiles is large. Appendix Table 2 shows wealth holdings by percentile.

1), and also shows the additional result that using professional advice is strongly and positively correlated with wealth, conditional on bias and everything else. Columns 2 and 3 explore whether the slope of the bias/wealth gradient varies with advice, by splitting the sample based on whether the household uses any advice. We find large and highly significant negative correlations between bias and wealth for households that do not use advice (Column 2). Most strikingly, we find no significant correlation between bias and wealth for households that do use advice (Column 3); i.e., more-biased households that use advice do not hold any less wealth than the least-biased households. We find a similar pattern of results using the percentile of net worth as the dependent variable (Columns 4-6).

G. Bias and the Propensity to get Advice

Given the results above, our theory predicts (#5) that more-biased households should be more likely to get outside advice if even some households are aware of their biased perceptions. Table 8, Column 7 offers some support for this prediction. Household in bias quintiles 3-5 are significantly more likely to get advice with 99% confidence, and these point estimates imply 17% to 22% increases relative to the sample mean. This result is consistent with the finding in Table 8 that using advice eliminates the wealth gap between more-biased and least-biased households; i.e., it is consistent with returns to advice that increase with bias (assuming that bias is unrelated to the cost of getting advice).

VI. Alternative Explanations

In all our results suggest that biased interest rate perceptions explain a substantial share of cross-sectional variation in household financial condition. We now discuss some alternative interpretations of our results. While some of these explanations might explain a subset of our results, none predicts a pattern of results that fully matches those in our data.

A. The Difficulty of the APR Questions, and Interpretation

One general concern starts with the observation that we define bias based on the answer to a very difficult problem: calculating an APR.

The problem is not intractable however. A simple heuristic—doubling the add-on rate—gets very close to the correct answer (this is analogous to the "rule of 72" in compounding), but the prevalence of bias indicates that it is not well-known.

Also, recall that we find substantial payment/interest bias on actual loans. This suggests that our variation in payment/interest bias is not the mechanical byproduct of a hypothetical question.

A related concern is that the difficulty of APR inference introduces substantial noise into the responses, and that observed responses are imprecise guesses or noise. But our measure of bias is clearly not random—it is strongly correlated not only with our outcomes, but with the most plausible covariates (such as income and education). Also recall that our identification strategy relies on cross-sectional variation in the size of bias; it does not require anyone to be correct.[35]

B. Bias as a Measure of Willingness to Pay (WTP) for Debt

A closely related concern is that our measure of bias measures willingness to pay (WTP) for debt rather than variation in interest rate perceptions.

WTP fails to explain why respondents' answers are internally inconsistent, however. There is no clear motive or cognitive microfoundation for consumers supplying WTP for their actual rate (calculated from their loan repayment total), and something much lower (presumably a fair market rate rather than WTP) when asked for a perceived rate.

Interpreting actual rates as WTP and perceived rates as perceptions about "fair rates" is equivalent to saying that consumers are not attempting to solve the problem as it is posed. But the data do not fit with that statement and are in fact consistent with problem-solving. To take two examples: 1) as noted above, the data fit a standard functional form found in lab experiments on exponential growth bias where researchers have been able to monitor and study problem-solving approaches; 2) actual and perceived rates are correlated; among those with actual APRs below the median, the correlation between actual and perceived rates is 0.46 in the 1983 data.

[35] A simpler question that was answered correctly by many consumers might actually provide less power.

Finally, the bias-as-WTP interpretation predicts relationships that run counter to the pattern of results. High "bias" (i.e., high WTP) households should borrow more, but not necessarily borrow more on non-mortgage installment debt in particular. High WTP households should invest less, but not necessarily invest less in stocks in particular. It seems unlikely that households with high WTP for debt should be more likely to get outside advice on savings or investment decisions. Nor is there a natural theory for why the relationship between WTP and net worth should disappear for households that do get advice (since in most models advisors implement preferences rather than correct bias).

C. Unobserved Heterogeneity in Access to Financial Services (Credit Risk, Participation Costs)

Because bias is strongly correlated with income and education, one concern might be that bias is correlated with unobserved variation in the price of financial services that could shift demand.

On the borrowing side, consider the possibility that bias captures unmeasured default risk or creditworthiness. But many of our control variables (income, education, employment history, occupation, credit constraints, homeownership) help capture variation in credit risk. And bias is actually uncorrelated with default risk conditional on the other covariates (results not reported). Nor does this interpretation fit the pattern of our results. It is silent or lacking specifics on the most of the relationships between bias and decisions, and predicts that bias should be *negatively* correlated with borrowing overall, since "biased" consumers face higher prices not captured by our control variables.[36]

A related interpretation is that bias captures unobserved participation costs. But this suggests that "bias" would have to be capturing unobservably *low* participation costs for borrowing (which is increasing with bias), and unobservably *high* participation costs for stockholding (which is decreasing with bias).

[36] Stango and Zinman (2007) find that more-biased households hold debt with higher interest rates, but only when borrowing from lightly-regulated (nonbank) lenders. Even if more-biased households pay higher rates overall, the fact that they also hold a higher quantity of (short-term) debt and save less implies an outward *shift* in demand for debt among more-biased households. Any movement along the demand curve (or any supply-shift explanation) would predict opposing movements in price and quantity.

D. Unobserved Heterogeneity in Preferences

Another concern is that our measure of bias is correlated with unobserved preference parameters related to patience and risk aversion. But three conditions must hold for unobserved preferences to confound our results: 1) our control variables for preferences are not sufficiently informative, 2) bias is correlated with unobserved features of preferences, conditional on our other control variables, and 3) unobserved correlations between bias and preferences would generate our particular pattern of results. Below we present some evidence that cast doubt on whether *any* of these conditions hold.

The available evidence casts some doubt on the notion that our control variables fail to capture important features of preferences. Recall that all of our specifications include a set of variables intended to capture patience and risk aversion. Our main specifications (Tables 5-8) show that these variables correlate with financial condition in economically large and intuitive ways. Some examples: households "not willing to take any financial risks" hold significantly fewer stocks as a share of assets (Table 5); debt averse households are significantly less likely to have borrowed recently to finance a recent large purchase (Table 4, Column 1);[37] and households with relatively strong preferences for liquidity (this presumably is correlated with impatience, particularly since we are conditioning on several proxies for liquidity constraints) hold significantly less wealth (Table 7).

The conditional correlations between bias and these preference measures are weak, suggesting that the second condition also fails to hold. Omitted preferences cloud the interpretation of our results only if they are correlated with payment/interest bias, conditional on our other covariates. If this were true one would also expect observed preferences to be correlated with payment/interest bias. Appendix Table 3 shows evidence to the contrary; observed preferences are not significantly correlated with bias conditional on our other covariates. Nor are the implied magnitudes large; the largest value contained in any of the 95% confidence intervals on preferences variables would shift bias by less than 1/3 of a quintile. Of

[37] The debt aversion question asks specifically about installment borrowing (see Appendix C for wording), so our outcome measure in Table 4, Column 1 (borrowed recently using installment debt) is the natural outcome for assessing whether the SCF debt aversion variable actually helps explain behavior. The fact that the debt aversion question asks specifically about installment debt may explain why we do not find significant correlations between debt aversion and other types of debt; see Dohmen et al (2005) for evidence that survey measures of preferences can be domain-specific in their predictive power.

course this exercise is not conclusive, but the lack of correlation with between bias and observed preferences is reassuring.

Finally, our pattern of results is not fully consistent with variation in unobserved preferences. Impatience might explain why our "biased" households borrow more, but not why they prefer short-term installment debt or appear to have unbiased perceptions of long-term but not short-term borrowing costs. Nor should impatience or risk aversion predict a higher propensity to use advice or benefit from it, since under this interpretation advisors presumably would be implementing advisee preferences, not changing them.

E. Unobserved Heterogeneity in Expected Future Income

Another concern is that bias might be correlated with unobserved future income. Perhaps bias is negatively correlated with expected income, or positively correlated with overly optimistic beliefs about future income.

We condition on variables that plausibly capture a substantial amount of information about future income and perceptions thereof: education, age, industry, occupation, pension coverage, pension + Social Security wealth, and respondent expectations about retirement age, length of stay at current job, and inheritance receipt.

Any remaining, unobserved heterogeneity that is correlated with payment/interest bias would have an ambiguous impact on financial condition. It would depend on the sign of the correlation between bias and omitted income expectations, and also on the gradient of the wage-age profile.[38]

F. Bias and Cognitive Ability

A related omitted variable concern is that bias captures unobserved cognitive ability or education quality rather than something specific regarding interest rate perceptions. This interpretation implies that including a more general measure of cognitive skill in the model (such as an intelligence or financial literacy/sophistication test score), would eliminate or

[38] See Grossman (2005) for an analogous and more thorough discussion on education and consumption decisions. We have split our sample by age groups and found no clear patterns in the correlation between bias and wealth, although the estimates are imprecise.

attenuate the observed correlations between bias and financial condition. But cognitive ability as traditionally defined is a measure of accuracy (correctness) and speed. It does not measure (or necessarily predict) *bias*: mistakes in a particular direction.[39] Thus it seems more plausible that cognitive ability would have direct effects on the avoidance of dominated alternatives (Fang, Keane and Silverman 2006) than that it would generate our particular pattern of results. Overall the evidence on conditional correlations between cognitive ability and financial decisions is limited, and mixed.[40]

Nevertheless it is important to consider the possibility that cognitive ability is a more fundamental decision input that drives biased perceptions of the opportunity cost of consumption. More generally, further work identifying interrelationships between a cognitive "bundle" of decision inputs may be particularly important for designing interventions that seek to counteract biased perceptions in household finance.[41] We discuss this further in the Conclusion.

G. Experience and Learning

Financial decisions are made repeatedly, and therefore it is important to consider how learning might affect or cloud the interpretation of our results. Two concerns are of particular importance.

One is that reverse causality might drive our results, with our outcome variables capturing experience that drives bias. But heterogeneous experience does not explain why any remaining errors tend to be biased in a particular direction. Moreover reverse causality does not fit our results on debt maturity choice and dissaving; to the contrary, those with more debt are *more* biased on average.

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[39] There is some evidence however that cognitive ability reduces susceptibility to framing effects that might induce bias in a market setting (Stanovich and West 1998; Peters, Vastfajall, Slovic, Mertz, Mazzocco and Dickert 2006).

[40] Fang et al find that low cognitive ability is correlated with failing to take up an insurance contract that looks like a good deal in expectation, in a sample of older households. Benjamin, Brown, and Shapiro show that math test scores are positively correlated with stockholding and net worth in the NLSY, conditional on a rich set of individual and family characteristics. But Zagorsky (forthcoming) uses different specifications and finds no such relationship. Hartog and Oosterbeek (1998) do not find any significant correlations between wealth and IQ in Dutch data.

[41] Existing work on cognitive interrelationships includes the evidence in this paper on the relationship between bias, preferences, and advice; and a growing literature showing that cognitive ability is correlated with preferences (Frederick 2005; Benjamin, Brown and Shapiro 2006; Dohmen, Falk, Huffman and Sunde 2007).

The second concern is how the effects of bias can be large and prevalent equilibrium, given the opportunities for learning. One possibility is that feedback is noisy and low-frequency; e.g., even most of the short-term debt in our data has maturities in years rather than months, and the consequences of "undersaving" relative to the true opportunity cost of consumption may not become apparent until late in life. Another possibility is that learning is difficult. Kahneman (2003) and Stanovich (2003) provide reviews of related literature from psychology suggesting that cognitive biases can persist, particularly in abstract (relatively nonsocial) domains like math and finance. Haigh and List (2005) show that even financial professionals may exhibit a persistent bias (myopic loss aversion) despite ample opportunities for learning.

Most likely, some households learn to de-bias themselves—or otherwise mitigate their tendency to underestimate the opportunity cost of consumption— and others do not. Our results that biased households are more likely to get and benefit from external advice are consistent with this interpretation.

VII. Conclusion

Work on alternative specifications of the neoclassical model of intertemporal choice is proceeding on many fronts. Here, we suggest another: relaxing the assumption that consumers correctly perceive borrowing costs and returns to saving. Our motivation comes from prior work showing that consumers tend to underestimate borrowing interest rates and savings returns.

Our innovations are threefold. First, we provide evidence that is both more representative and more detailed than prior work. We show that consumers underestimate borrowing interest rates on both actual and hypothetical loans. We also present new evidence that payment/interest bias is most severe on short-maturity loans, and less severe on long-maturity loans. Second, we show that the stylized facts on underestimation of borrowing costs and returns to saving can be explained by a parsimonious theory of biased interest perceptions. Our new theory is based on a mathematical microfoundation from cognitive psychology: exponential growth bias. Consumers have a strong tendency to underestimate exponential series in a wide range of domains, and this tendency causes underestimation of both borrowing costs and returns to saving under general assumptions. The theory generates several testable predictions on the

relationship between bias, portfolio choice, delegation, and financial outcomes. Third, we test the theory by developing the first empirical evidence on the relationship between a household-specific measure of biased interest rate perceptions and a range of financial outcomes. The results support the theory and suggest that biased interest rate perceptions explain a substantial amount of cross-sectional variation in household financial condition, including wealth holdings. We carefully consider alternative interpretations and find that none of them fit our pattern of results.

The findings have some methodological implications for future research. Biased interest rate perceptions should be incorporated into models of intertemporal choice. This should not too difficult; we have shown that it is straightforward to elicit an individual-level measure of biased interest rate perceptions using either two questions about a hypothetical loan, or a fuller set of questions about actual loans.

Our work also points to future research measuring this and other biases. Given that most of the existing data on biased interest rate perceptions is of older vintage, establishing the contemporary prevalence and impacts of exponential growth bias is important. Bias itself may be more or less prevalent. It also may be more or less empirically relevant. Cheap financial calculators and the mass marketing of advice have presumably made it easier for consumers to debias themselves and/or delegate financial decision making. But financial service offerings have also gotten more complex. Advancements in risk-based pricing, loan product development, and target marketing have both expanded the set of loan products that might appeal to biased consumers, and increased the scope for firms to take advantage of cognitive biases.[42] Consumers also have control over more dimensions of household finance than in the past; the transition from defined-benefit to defined-contribution retirement accounts is one example. Exploring the relationship between biased interest rate perceptions, the development of retail financial and advice markets, and household financial condition should be a fruitful line of inquiry.

Another promising descriptive avenue is asking how bias varies within consumers rather than across consumers. Our finding that bias increases the use of advice suggests that at least

[42] For example, mortgage refinancing and home equity loan markets were in their infancy during the period we study in this paper. Today many of these loans are offered at maturities and rates where payment/interest interest bias could make them appear relatively cheap. These loans are also often marketed in ways traditionally reserved for non-mortgage installment debt, with emphasis on low monthly payments and shrouded APRs.

some biased consumers are self-aware and taking steps to mitigate the effects of bias. But we are unable to examine learning and the evolution of bias over time in our data. Recent work on various financial decisions suggests that consumers do indeed learn to make better decisions over time (Agarwal, Chomsisengphet, Liu and Souleles 2006; Agarwal, Driscoll, Gabaix and Laibson 2007). Perhaps learning about interest rates is a mechanism underlying some of these findings.

Yet another important descriptive line of inquiry is the empirical relationships between biased interest rate perceptions and other cognitive inputs into financial decision making. As we discuss at length in Section VI, it seems plausible that interest rate perceptions, preferences, beliefs, and cognitive ability are correlated with each other, and that each have some independent effects on financial decisions. Yet no existing dataset has information on this full bundle of cognitive inputs. Data on the full bundle may be needed to develop properly specified empirical models in household finance. Identifying the main effects and interactions between different cognitive inputs would also inform the design of interventions to improve financial decision making.

This brings us to our final, more normative implications. Treating biased perceptions of intertemporal tradeoffs has a clear normative basis (compared to treating preferences or expectations). An optimistic view of the problem is that treating biased perceptions has relatively good prospects for being cost-effective (compared to, say, trying to increase cognitive ability). On the supply side, there is some evidence APR disclosure is effective when enforced (Stango and Zinman 2007). On the demand side, there is some evidence that simple interventions can improve decision-making. Arnott (2006) finds that a computer decision aid reduces exponential growth bias. Eisenstein and Hoch (2005) find that a brief tutorial on the Rule of 72 dramatically reduces the underestimation of returns to long-term savings.[43] Further development and testing of debiasing techniques would be valuable.

[43] As we noted in Section VI-A, an even simpler heuristic exists for short-term installment debt: doubling the add-on interest rate would get most consumers much closer to the APR than their biased estimates.

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Appendix A. Evidence on Exponential Growth Bias

Exponential growth bias has its intellectual origin in three papers by Wagenaar and Sagaria (1975) and Wagenaar and Timmers (1978; 1979). One motivation for the studies is a Chinese parable of the "pond and duckweed," describing how a mandarin underestimates how quickly his pond will be covered by duckweed that doubles in size every five years, despite a lifetime of observation.

Exponential growth bias is typically measured by asking subjects in laboratory experiments or surveys to extrapolate an exponential series of the general form:

$$y = f(x) = a^{bx}$$

Typically the problem focuses on extrapolation over time, where x above becomes t, the number of periods. The context of the problem varies; examples include forecasting population, pollution (Wagenaar and Sagaria 1975), duckweed (Wagenaar and Timmers 1979; Ebersbach and Wilkening 2007), prices (Keren 1983; Jones 1984; Kemp 1984) and others. Studies have varied the mode of data presentation (numerical, mathematical, or visual) and the format of questions; e.g., a study might show respondents how quickly the number of marbles grows in a jar, then ask how long it would take for the number of marbles to double or reach some other figure. Other studies graph an exponential function, then ask respondents to extend it by sketching the next few points. Most of the research focuses on *intuitive extrapolation* that does not rely on calculators; later work investigates how decision aids such as calculators or heuristics improve responses (Arnott and O'Donnell 1997; Arnott 2006).

The central finding of this research is that individuals persistently and substantially underestimate exponential growth: they display exponential growth bias. The result is general and robust to different contexts and presentations. The magnitude of underestimation appears to be essentially orthogonal to the context of the problem, the way the data are presented (numerically, mathematically, or visually), or the frame/format of the question.

The cognitive source of exponential growth bias seems to be a strong tendency for the brain to linearize functions when extrapolating or forecasting; this tendency causes particularly large errors when the data-generating process is exponential. It causes both persistent underestimates of growth and persistent overestimates of declining series; e.g., Kemp (1984) finds that

consumers' recollections of (actual) past prices are persistently too high. Whether this tendency to linearize is innate or learned is an open question. Ebersbach and Wilkening (2007) find that younger children display greater exponential growth bias but note that schooling orients children toward linear approximation. They discuss other work finding that exponential growth bias increases in early years of schooling, then falls.

Whether the process that respondents actually use to forecast exponential growth can be identified is also an open question. Much of the early work uses responses to fit general equations of the following form:

$$y = f(x) = \alpha \cdot a^{\beta bx}$$

Given a true data-generating process with $[\alpha, \beta] = [1,1]$ it is then possible to explicitly test for correct extrapolation of exponential growth. All studies we know that perform this test strongly reject correct extrapolation. Estimates of the coefficients vary, but in many cases, respondents underestimate the exponent by a factor of ten $(\beta = 0.10)$. It also appears that many respondents linearly compensate for underestimation of the exponent by inflating the scale term $(\alpha > 1)$. Jones (1984) argues that a polynomial specification fits the data better than the one above, while Keren (1984) correctly notes that the true function used by respondents for extrapolation is unidentified, and that the goal should be parsimonious description of the data rather than identification of the true data-generating process.

Despite the robust finding that exponential growth bias exists and is systematic, there has been relatively little work exploring its economic implications. This is a bit puzzling given how direct the application is, particularly for intertemporal choice. Exceptions include Keren (1983) and Jones (1984), who both find systematic underestimation of future price increases; Kemp (1984), who finds that consumers systematically overstate past (historical) price levels; and Eisenstein and Hoch (2005), which we discuss in the text.

Appendix B. The Mathematical Link Between Exponential Growth Bias and Perceptions of Borrowing Costs and Returns to Saving

In this section we discuss the relationship between exponential growth (EG) bias—the systematic tendency of individuals to underestimate exponentiated expressions—and inference about returns to saving and borrowing costs. We begin by illustrating how exponentiation enters financial calculations. We then show that a general formulation of EG bias implies that consumers will underestimate the return to long-term saving and the costs of short-term borrowing when inferring those parameters from information commonly available in the market.

A. Financial Calculations and Exponentiation

Both the formula for an installment loan interest rate and the formula for a future value contain exponential growth terms. The formula for the future value FV of an amount PV saved at an interest rate i for t periods is the following exponential function:

$$FV = PV(1+i)^t$$

A similar term enters the formula associating an installment loan payment p to an interest rate, maturity t and loan principal L:

$$p = Li + \frac{Li}{\left[(1+i)^t - 1\right]}$$

In some of what follows, we rely on the following condition: no profit-maximizing lender will offer a loan where $p < Li$ - that is, under which the periodic payment fails to cover the periodic interest charge on the loan.

B. Specifying Exponential Growth Bias

We define exponential growth bias as a parameter θ that produces underestimation of exponential functions. That is, given the exponential function

$$f(i,t) = (1+i)^t$$

There is a corresponding function $f(i,t,\theta)$ with the following properties:

$$f(i,t,0) = f(1+i)^t$$

$$\frac{\partial f(i,t,\theta)}{\partial \theta} < 0$$

$$\frac{\partial f(i,t,\theta)}{\partial i} > 0$$

$$\frac{\partial f(i,t,\theta)}{\partial t} > 0$$

$$\frac{\partial^2 f(i,t,\theta)}{\partial \theta \partial t} < 0$$

$$f(i,t,\theta) \geq 1, \forall \theta, i, t \geq 0$$

Thus, the function has the property that an unbiased consumer has $\theta = 0$, and that more biased consumers have higher values of θ. The function is increasing in the interest rate and time, and has a minimum value of 1 (precluding underestimation so severe that a consumer would view the future value as less than the present value with a positive interest rate). The cross-partial assumption states that exponential growth bias has a greater level effect on $f(i,t,\theta)$ at longer time horizons; the failure to compound is itself compounded. Finally, because $f(i,t,\theta)$ is an exponential function we also know that:

$$\frac{\partial f(i,t,\theta)}{\partial i} = f(i,t,\theta) \cdot \ln g(i,t,\theta)$$

Where $g(i,t,\theta)$ is the base of the exponent. Throughout the analysis below, we assume that

$$g(i,t,\theta) \leq g(i,t,0) = (1+i)$$

That is, we assume that the base of the exponent with EG bias is no greater than that without EG bias; in the most common specification of exponential growth bias used in cognitive psychology, respondents are held to correctly perceive the base but underestimate the exponent, implying that $g(i,t,\theta) = (1+i), \forall \theta$. Along with the approximation for small i that $\ln(1+i) = i$, this implies that

$$\frac{\partial f(i,t,\theta)}{\partial i} \leq f(i,t,\theta) \cdot i$$

C. EG Bias and Perceived Returns to Saving over Different Time Horizons

It is easy to show that EG bias implies underestimated returns to savings, with a greater degree of underestimation as θ rises. That is, if a consumer perceives the future value of a principal to be:

$$FV^p = PV \cdot f(i,t,\theta)$$

Then

$$FV^p = PV \cdot f(i,t,\theta) < PV \cdot f(i,t,0) = PV \cdot (1+i)^t = FV^*$$

This also implies that

$$\frac{\partial (FV^p - FV^*)}{\partial \theta} = \frac{\partial FV^p}{\partial \theta} < 0$$

In words, the level effect on underestimation of FV is greater with higher levels of exponential growth bias. The cross-partial assumption $\frac{\partial^2 f(i,t,\theta)}{\partial \theta \partial t} < 0$ guarantees that the degree of underestimation will be greater over longer time horizons for a given level of bias.

D. Exponential Growth Bias and Payment/Interest Bias

Identifying the correspondence between EG bias and payment/interest bias takes a bit more work. Recall that there is no closed form solution for the APR on an installment loan. So we define the perceived interest rate i^p as that solving the implicit function:

$$p = Li^p + \frac{Li^p}{\left[f(i^p,t,\theta) - 1\right]}$$

Recall that p is the periodic payment, t is the maturity, and L is the loan principal. Payment/interest bias is implied by EG bias if

$$\frac{\partial i^p(L,t,p,\theta)}{\partial \theta} < 0$$

To obtain this partial derivative we use the implicit function theorem. Begin by rewriting the implicit function above as:

$$F(p,L,i^p,t,\theta) = pf(i^p,t,\theta) - p - Li^p f(i^p,t,\theta) = 0$$

From the implicit function theorem we have:

$$\frac{\partial i^p}{\partial \theta} = -\frac{\partial F/\partial \theta}{\partial F/\partial i^p}$$

Taking the partial derivatives yields:

$$\frac{\partial i^p}{\partial \theta} = -\frac{p\frac{\partial f(i^p,t,\theta)}{\partial \theta} - Li^p\frac{\partial f(i^p,t,\theta)}{\partial \theta}}{p\frac{\partial f(i^p,t,\theta)}{\partial i^p} - Lf(i^p,t,\theta) - Li^p\frac{\partial f(i^p,t,\theta)}{\partial i^p}}$$

It is straightforward to show that the numerator is negative, because $\frac{\partial f(i^p,t,\theta)}{\partial \theta} < 0$ by definition, and $p \geq Li^p$.[44] The sign of the denominator, and hence $\frac{\partial i^p}{\partial \theta}$, will be negative if:

$$p\frac{\partial f(i^p,t,\theta)}{\partial i^p} - Lf(i^p,t,\theta) - Li^p\frac{\partial f(i^p,t,\theta)}{\partial i^p} < 0$$

Using $\frac{\partial f(i,t,\theta)}{\partial i} \leq f(i,t,\theta)\cdot i$ and substituting gives

$$pi^p - L - L\left(i^p\right)^2 < 0$$

This inequality holds for all loans on which the periodic payment is lower than the original loan amount, (i.e., for which $p < L$), because if $i < 1$ then $pi^p < L$, and if $i > 1$ then $pi^p < L\left(i^p\right)^2$.

E. Payment/Interest Bias and Loan Maturity

Section C showed that underestimation of future values is most severe at long time horizons. We now examine the underlying mathematical relationship between payment/interest bias and loan maturity if underestimation is due to exponential growth bias. EG bias will produce this

[44] This is true *a fortiori* given that $p \geq Li$ (where i is the true rate) to satisfy the lender's constraint.

pattern if lower (greater) exponential growth bias is required to achieve the same perceived interest rate at shorter (longer) maturities:[45]

$$\frac{\partial \theta(i^p, L, p)}{\partial t(i^p, L, p)} > 0$$

Again, by the implicit function theorem we have:

$$\frac{\partial \theta}{\partial t} = -\frac{p\frac{\partial f(i^p, t, \theta)}{\partial t} - Li^p \frac{\partial f(i^p, t, \theta)}{\partial t}}{p\frac{\partial f(i^p, t, \theta)}{\partial \theta} - Li^p \frac{\partial f(i^p, t, \theta)}{\partial \theta}}$$

The numerator is positive and the denominator is negative, which along with the negative sign makes the derivative positive overall.

[45] This is equivalent to showing that the cross-partial of the (implicitly defined) perceived rate with respect to exponential growth bias and maturity is positive, i.e. that: $\frac{\partial^2 i^p}{\partial \theta \partial t} > 0$.

Appendix C. Data Construction

This Appendix contains details on each of the variables included in our empirical tests. Our sample frame for these tests is the 4,103 households in the 1983 SCF's "cleaned area probability sample" and "high income sample" (see variable b3001). We drop the 159 "area probability excluded observations" that have incomplete data. Unless otherwise noted the SCF variables have no missing values due to perfect response or imputation.

RHS variables: Payment/Interest Bias, and Controls

Variables	Definitions based on SCF variable(s)
Payment/interest bias	*bias* = [*perceived rate* – *actual rate*]: *actual rate* (b5521) is an APR constructed by the SCF (and validated by us) based on the respondent's self-supplied *repayment total* response to question b5516 or b5517 *perceived rate* is constructed from b5518 and b5519; these questions ask the respondent to impute an interest rate based on the respondent's *repayment total* *bias unknown* = 1 unless both *perceived rate* and *repayment total* are supplied *addon* = 1 if (*perceived rate* = *add-on rate)*: *add-on rate* is the actual simple interest rate associated with the *repayment total*. This rate does not account for the declining balance implied by the survey's scenario; e.g., the *add-on rate* on a *repayment total* of $1,200 is 20%, while the APR is 35%.
Male head of household	b3126=1
Age of head	From b4503
Race of head	From b3111
Education category of head	From b3113, counting those who have junior college as highest attainment (b4507=1 & b4505<16) as "some college"
Risk aversion/attitude ("financial risks" categories)	Non-missing categories constructed directly from b5403; 94 non-responses grouped into one category.
Patience/liquidity attitude ("tie up money" categories)	Non-missing categories constructed directly from b5404; 114 non-responses grouped into one category.
Borrowing attitude ("thinks buying on credit" categories)	Non-missing categories constructed directly from b5501; 37 non-responses grouped into one category.
Expects to receive an inheritance	Categorical variable based on b4551: does not expect/expects/non-response
Expected retirement age	Categorical variable based on b4519: < 50, 50, 51-54, 55, 56-59, 60, 61, 62, 63-64, 65, 66-69, 70, >70, never, never worked full-time, already retired, non-response

Expected years before leave current job	Categorical variable based on b4551: one category for each year, top-coded at 11, with separate categories for "never," no current job, and non-response
Marital status	Based on b3112; binary variable that=1 if household head is married or lives with partner
Household size	Categories from b3101, top-coded at 7
Employment status	Head works full time: binary variable based on b4511, counting category 1 as full time. Spouse/partner works: Binary variable based on b4611, counting categories 1, 2, and 3 as working (includes those laid off who expect to return)
Health	Self-reported health status: excellent/good/fair/poor; we take categories for head (spouse/partner) directly from b4509 (b4609)
Homeownership	Binary variable based on b3702: we count category 1 as homeowners
Industry category	14 Categories taken directly from b4539 (Census/CPS major industry group); observations with missing values are dropped.
Occupation category	For head; 8 categories taken directly from b3114 (self-employment category in subsumed in broader self-employment definition directly below)
Self-employed	Binary variable set to 1 if any of the following hold: - Head lists occupation as self-employed (b3114) - Head lists self as employer (b4540) - Household reports nonzero business income (b3206, b3512) - Household has ownership and management interest in a business (nonzero b3502)
Household wage category	10 categories, constructed from b3205 based on the ranges (1983 dollars): 1: 0; 2: (0, 1,000]; 3: (1,000, 7,550]; 4: (7,550, 13,000]; 5: (13,000, 18,000]; 6: (18,000, 25,000]; 7: (25,000, 33,000); 8: [33,000, 50,000]; 9: (50,000, 100,000]; 10: (100,000+) Categories are constructed to have roughly equal frequencies, but must allow for the mass point at zero in the lowest category (1). To adjust for this, categories 2, 9, and 10 have relatively small frequencies.
Years in current job	From b4543: 10 categories, one for each year, top-coded at 10 years
Pension coverage	From b4512; 1 = head's job provides pension and/or thrift benefits.
Social Security + pension wealth	11 categories (including one for missing values), constructed from b3317. Nonzero categories have roughly equal frequencies.

Uses advice on saving and investment decisions	Categorical variable constructed from b5340-b5347, which asks respondent ‘‘whether he/she sought advice concerning savings and investment decisions" from different sources. We categorize as: no advice/friends and family only/professional (accountant, banker, stockbroker, tax advisor, lawyer, financial advisor, insurance agent)/other
Uses ATM	b5301 (ATM uses per ‘‘typical year")>0
Denied//discouraged/turned down for credit	Binary variable = 1 if: household was turned down for credit, or did not get as much credit as it wanted, ‘‘in the past few years" (b5522), AND did not end up obtaining the desired credit (b5525), OR: household had, ‘‘in the past few years... thought about applying for credit... but changed their mind because... might be turned down" (b5526) missing values dropped
Owns a credit card	Binary variable = 1 if household has a bank card (b4108>0) or store card (b4114+b4117>0)
Compares loans terms on price or non-price margins	Binary variable = 1 if respondent reported that ‘‘size of the loan," ‘‘size of the monthly payments," ‘‘security for collateral for the loan," or ‘‘size of the down payment," would be ‘‘the most important... if you were going to use credit to purchase a car" (b5513)
Net worth categories (added to some of the stockholding specifications)	Net worth excluding pension and social security wealth (b3323), categorized into deciles except that we impose the restriction that the bottom decile include only those with negative and zero net worth; this makes the bottom ‘‘decile" somewhat smaller, and the next decile somewhat larger, than the top 8 deciles. Appendix Table 2 details the net worth distribution.
<u>Large recent purchase characteristics:</u>	Nonzero only if household ‘‘purchased a vehicle, large item for the home, a recreation item, or home improvements, that cost $500 or more within the previous year:" b5601=1
Purchase month and year	Binary variables for month*year constructed from b5603 and b5604;
Purchase: cost	log(b5605), replaced with zero if no purchase
Purchase purpose	We constructed 14 categories of purchases from the more disaggregated b5602; includes category for no purchase

LHS variables: Outcomes of Interest

Variables	Definitions based on SCF variable(s)
Financed a large recent purchase using non-mortgage installment debt	Binary variable = 1 if: - Household made large recent purchase (b5601=1, see above) - Installment loan used (b5606=11 or b5606=12)
Net worth	b3323, which excludes pensions and Social Security. In constructing our net worth percentile variable we account for the small mass point at zero; see Appendix Table 2 for details.
Short-term installment debt	Total amount outstanding on non-mortgage loans with regular payments (b4202). In our regressions we scale this by household income (b3201). Total income is <=0 in only two cases in our base sample of 3,911 observations, and never <=0 in our analysis samples for debt/income, where we restrict the sample to those with nonzero debt.
Long-term debt	(total debt outstanding – short-term installment debt) = (b3320 – b4202)
Owns any stock	Binary variable = 1 if households owns any publicly traded stock or non-money market mutal funds: b3462>0
Stock share of financial assets	(b3462)/(financial assets), where: Financial assets = b3302 = demand deposits+money market+bonds+stocks+mutual funds+trust accounts
Stock share of total assets	B3462/total assets, where we define total assets as financial assets + home value (b3708)
Certificate of Deposit (CD) ownership	Total dollar amount from b3453; any/share of financial assets/share of total assets defined as for stocks
Dissaving in 1982	Categories directly from b5406 as listed in Table 5; observations with missing values dropped from specifications in Table 5
Uses any advice	Binary variable constructed from b5340-b5347, which asks respondent "whether he/she sought advice concerning savings and investment decisions" from different sources: accountant, banker, stock broker, tax advisor, lawyer, spouse, friend or relative, financial advisor, media, insurance agent, employer, other source. We set the variable = 1 if respondent reports using any of these sources.
Uses professional advice	= 1 if respondent reports using advice from any of: accountant, banker, stockbroker, tax advisor, lawyer, financial advisor, insurance agent.

Figures 1a and 1b. Actual and Perceived Rates on Hypothetical Loans in the 1983 SCF

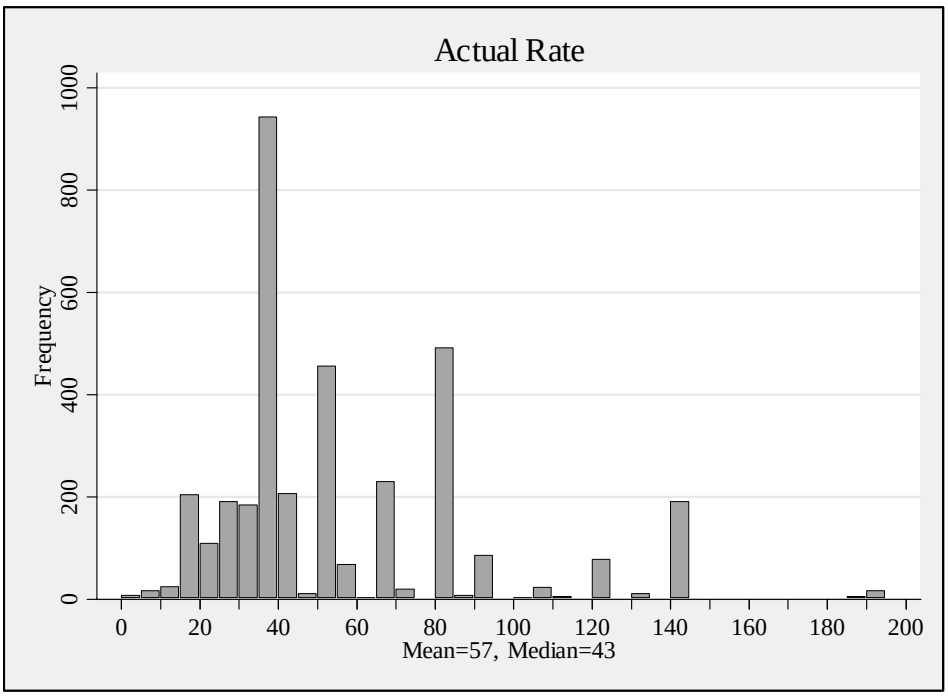

Figure 1a

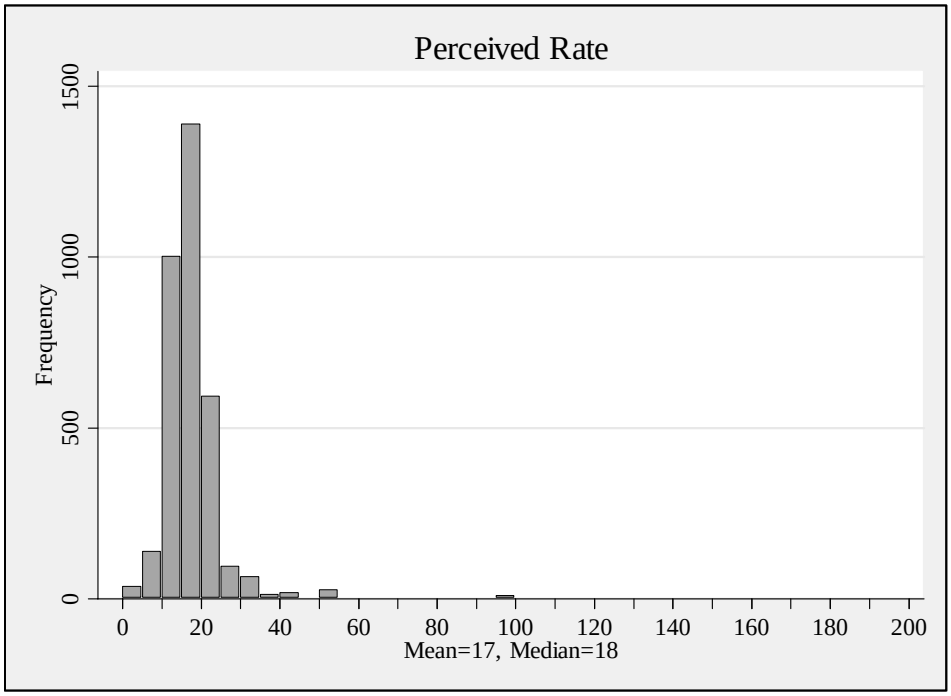

Figure 1b

Notes: "Actual rate" is APR derived from consumer's repayment total on a hypothetical $1000, 12-month installment loan. "Perceived rate" is what the consumer infers given the repayment total. See Section II-B for additional details.

Figures 2a and 2b. Payment/Interest Bias in the 1983 SCF

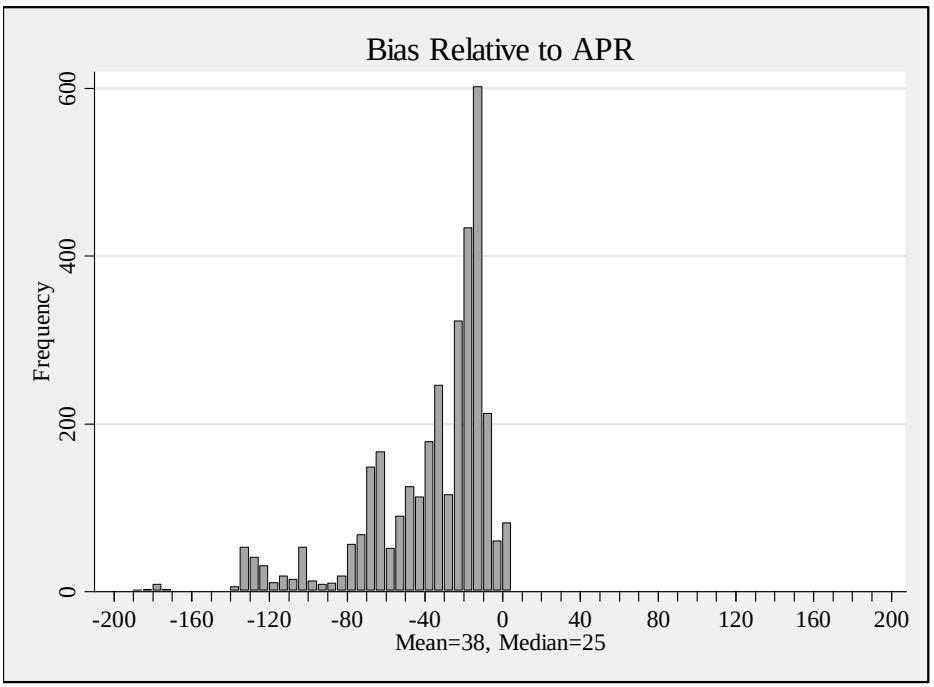

Figure 2a

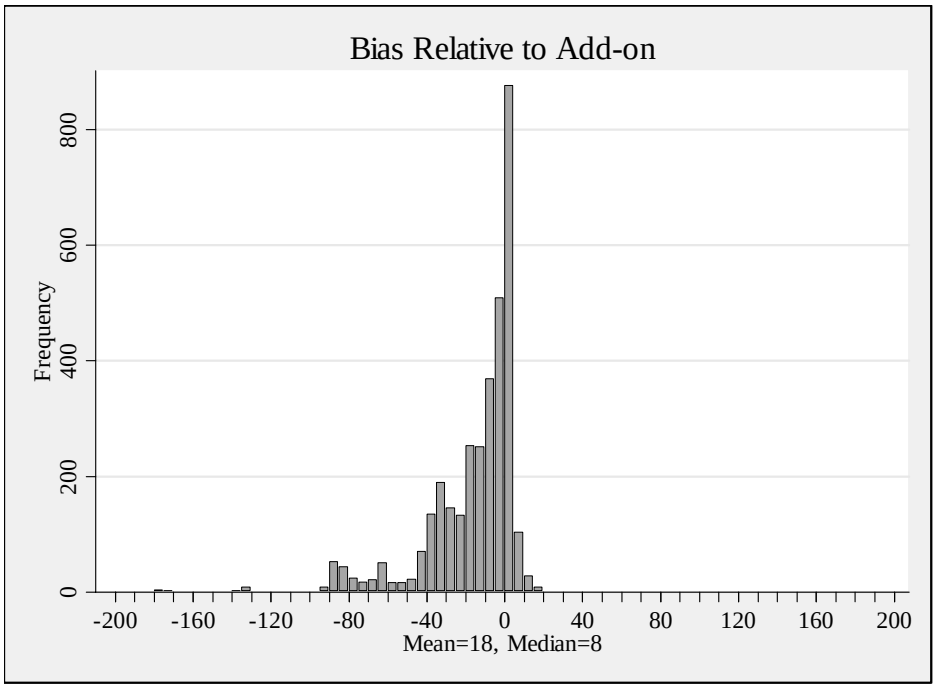

Figure 2b

Notes: Figure 2a shows the distribution of payment/interest bias (the difference between the Perceived and Actual rates) across households. Figure 2b measures bias as the difference between the Perceived and Add-on rates. The Add-on rate divides total interest per year by the loan principal, and does not account for declining balances.

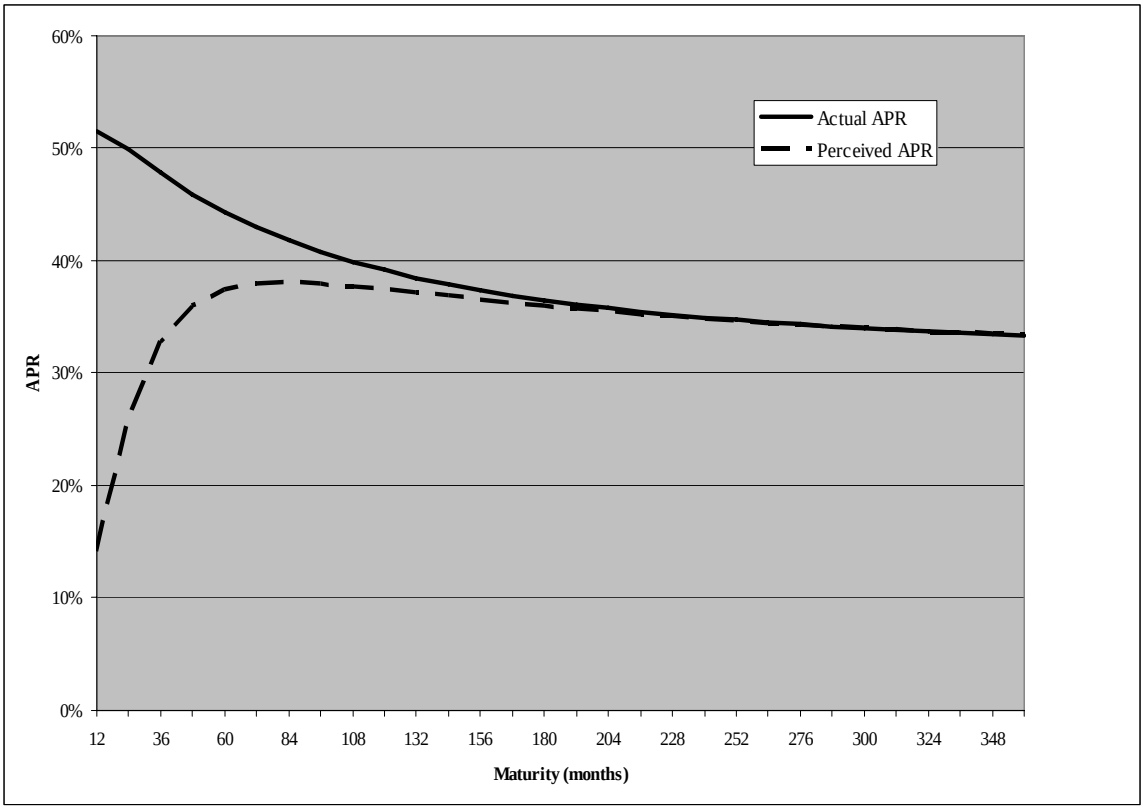

Figure 3. Payment/interest bias vs. maturity.

Notes: This numerical example uses interest payments of $300 per $1000 borrowed, per year (an add-on rate of 30%). Actual APR is 51% for a one-year loan, and approaches 30% as maturity increases.

The interest rate on installment debt is defined implicitly by:

$$p = Li^* + \frac{Li^*}{[f(i,t)-1]}.$$

Actual APR uses the correct assessment of exponential growth:

$$f(i,t) = (1+i)^t$$

Perceived APR uses a parameterized underestimate of exponential growth:

$$f(i,t) = 1.01*(1+i)^{0.7t}$$

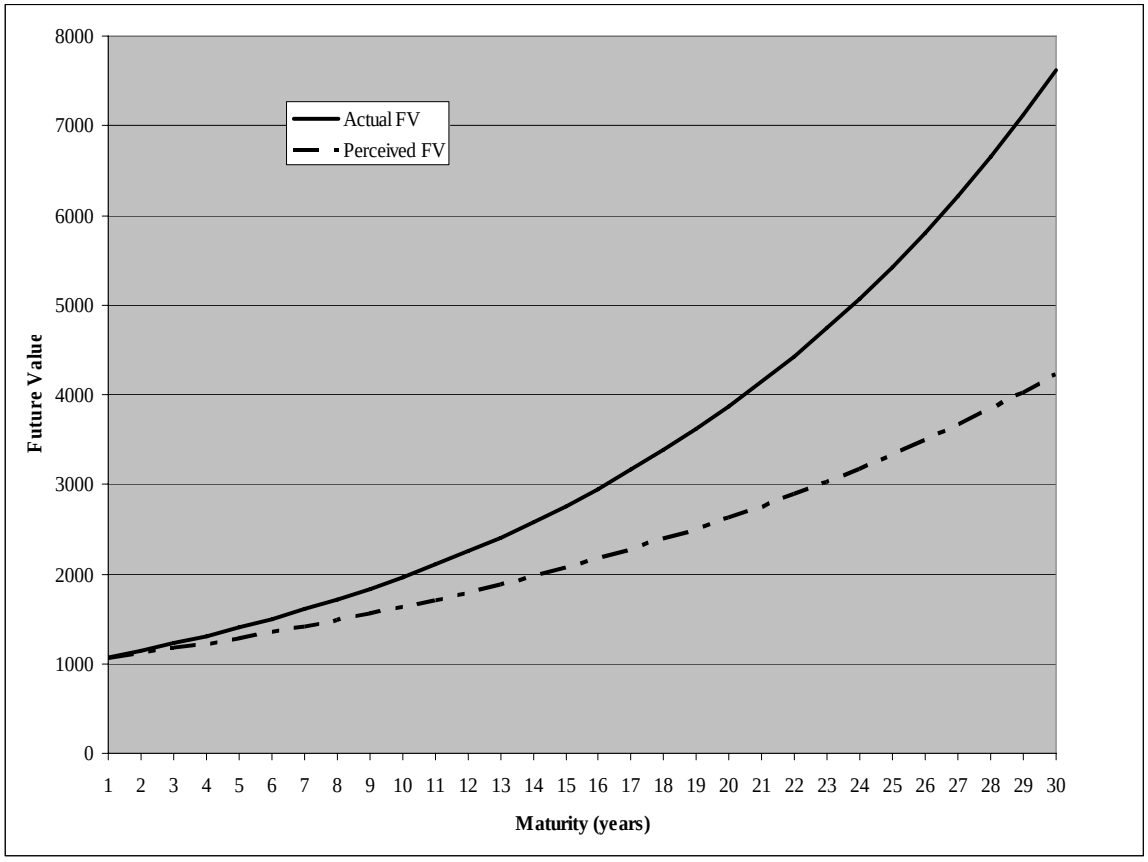

Figure 4. Misperceived compounded returns to saving vs. maturity.

Notes: This numerical example uses present value = PV = \$1000. Annual interest rate is 7%. Future values are calculated using:

$$FV = PV \cdot f(i,t)$$

Actual FV uses the correct assessment of exponential growth:

$$f(i,t) = (1+i)^t$$

Perceived FV uses a parameterized underestimate of exponential growth:

$$f(i,t) = 1.01*(1+i)^{0.7t}$$

Table 1. Payment/Interest Bias on Hypothetical Loans in the 1983 and 1977 SCFs

	Bias Quintile, 1983 Data					
	1	2	3	4	5	n/a
Stated repayment total (P+I)	1135	1200	1255	1398	1772	1492
Actual APR	24	35	44	66	114	76
Perceived APR	16	18	17	18	15	16
Payment/Interest Bias = Perceived APR - Actual APR	-8	-16	-27	-48	-99	–
Share supplying add-on rate	0.58	0.42	0.09	0.02	0	–
Range of bias in quintile	[-100, 14]	[14, 20]	[20, 33]	[33, 63]	[63, 290]	–
Number of households	698	713	662	729	612	689

	Bias Quintile, 1977 Data					
	1	2	3	4	5	n/a
Stated repayment total (P+I)	1107	1177	1211	1284	1542	1362
Actual APR	19	31	37	48	87	59
Perceived APR	13	16	15	14	15	15
Payment/Interest Bias = Perceived APR - Actual APR	-6	-15	-22	-34	-73	–
Share supplying add-on rate	0.55	0.46	0.08	0.03	0.00	–
Range of bias in quintile	[-5, 10]	[11, 17]	[18, 25]	[26, 42]	[43, 255]	–
Number of households	202	275	214	173	173	68

Notes: Each sample includes all households in the SCF for that year. Rates and bias are in hundreds of basis points. Payment, APR and bias measures are means by quintile. Quintiles are by bias relative to APR. "n/a" bin includes households who fail to supply either a repayment total or a perceived APR, or report neither. Observations per quintile differ due to clustered values of bias.

Table 2. Payment/Interest Bias on Actual Loans, by Maturity and Hypothetical Loan Bias

	Installment Loans: Maturity (months)				Mortgage
	[0, 24]	[25, 36]	[37, 48]	[49, 120]	Loans
		All Loan Holders			All
Actual APR	30	28	22	17	9.8
Perceived APR	13	12	12	12	9.2
Payment/Interest Bias	-15	-15	-8	-3	-0.6
		Low Hypothetical Loan Bias			Low Bias
Actual APR	26	27	21	17	9.4
Perceived APR	12	12	11	11	9.0
Payment/Interest Bias	-13	-14	-9	-5	-0.3
		High Hypothetical Loan Bias			High Bias
Actual APR	35	29	23	18	10.3
Perceived APR	13	13	13	12	9.5
Payment/Interest Bias	-19	-17	-7	-1	-0.8

Notes: ''Actual APR'' is calculated from loan payment, maturity and principal. ''Perceived APR'' is supplied by loan holder. Bias is (Perceived APR - Actual APR). Each cell presents a sample mean. lnstallment loan data are from 1977 SCF. Mortgage data are from 1983 SCF; actual mortgage APRs are difficult to calculate in 1977 with any precision because the survey does not specify whether escrow payments (for taxes and insurance) are included in the household's monthly payment. Mortgage maturity ranges from 120-360 months. ''Low" and ''High" bias are from quintiles 1-3 and 4-5 on Table 1, respectively.

Table 3. Payment/Interest Bias and Household Characteristics, Descriptive Statistics

		Bias quintile 1	Bias quintile 2	Bias quintile 3	Bias quintile 4	Bias quintile 5	n/a
Financial Outcomes							
(1) Financed large recent purchase	mean	0.23	0.30	0.33	0.37	0.41	0.31
	N	458	456	382	412	301	236
(2) Short-term installment debt outstanding/income	mean	0.16	0.19	0.18	0.16	0.20	0.21
	N	254	318	271	340	273	179
(3) Long-term debt outstanding/income	mean	0.89	0.86	1.12	0.79	0.81	0.78
	N	483	538	450	499	347	251
(4) Stock share of assets		0.12	0.09	0.05	0.04	0.02	0.03
(5) Stock share of financial assets		0.20	0.15	0.10	0.08	0.04	0.05
(6) Dissaved last year		0.28	0.39	0.45	0.44	0.43	0.37
(7) Total assets, median (000s)	median	$90	$74	$41	$39	$31	$19
(8) Total debt, median (000s)	median	$7	$12	$5	$5	$2	$0
(9) Net worth, median (000s)	median	$93	$75	$40	$35	$27	$19
(10) Net worth percentile, mean		62	58	49	47	42	39
Number of observations, unconditional outcomes		698	713	662	729	612	689
Demographics							
(11) Did not finish high school		0.08	0.04	0.08	0.10	0.17	0.36
(12) Some high school		0.07	0.07	0.12	0.14	0.16	0.19
(13) Finished high school		0.23	0.26	0.34	0.32	0.34	0.26
(14) Some college		0.19	0.23	0.22	0.22	0.17	0.11
(15) Finished college		0.43	0.40	0.24	0.21	0.16	0.09
(16) Age	mean	50	46	45	44	46	56
(17) Male head		0.88	0.86	0.81	0.78	0.69	0.56
(18) White		0.90	0.91	0.87	0.83	0.83	0.72
(19) Labor income, mean ($1983)	mean	$53,973	$37,209	$22,229	$23,459	$16,189	$9,316
	sd	(118,815)	(68,841)	(46,566)	(48,452)	(23,078)	(22,953)
	median	$18,995	$20,000	$15,000	$16,257	$12,000	$0
Number of observations		698	713	662	729	612	689
Borrowing Constraints							
(20) Denied/discouraged/rationed		0.12	0.15	0.16	0.19	0.20	0.15
(21) Has a credit card		0.81	0.82	0.70	0.65	0.55	0.39
Number of observations		698	713	662	729	612	689
Preferences							
Risk							
(22) Takes substantial financial risks		0.10	0.05	0.06	0.08	0.06	0.04
(23) Takes > average financial risks		0.21	0.17	0.14	0.13	0.10	0.06
(24) Takes average financial risks		0.39	0.48	0.43	0.40	0.34	0.24
(25) Not willing to take any financial risks		0.30	0.30	0.37	0.39	0.50	0.65
Debt aversion							
(26) Thinks buying on credit is good idea		0.46	0.50	0.47	0.47	0.44	0.36
(27) Thinks buying on credit is good and bad		0.32	0.31	0.32	0.31	0.31	0.28
(28) Thinks buying on credit is bad idea		0.22	0.19	0.20	0.22	0.25	0.32
Patience/liquidity							
(29) Will tie up money long-run to earn substantial returns		0.16	0.17	0.12	0.15	0.11	0.09
(30) Will tie up money medium-run to earn > average returns		0.39	0.34	0.29	0.28	0.24	0.13
(31) Will tie up money short-run to earn average returns		0.26	0.30	0.33	0.33	0.29	0.24
(32) Will not tie up money at all		0.18	0.17	0.23	0.25	0.36	0.46
Number of observations		689-698	706-713	655-662	721-729	606-612	633-689
Financial Advice							
(33) Uses any financial advice		0.50	0.57	0.56	0.58	0.52	0.43
(34) Uses professional financial advice		0.32	0.37	0.31	0.29	0.28	0.21
(35) Uses advice from friends/family		0.25	0.31	0.31	0.37	0.33	0.26
(36) Uses advice from friends/family only		0.16	0.19	0.23	0.27	0.24	0.21
Number of observations, unconditional outcomes		698	713	662	729	612	689

The SCF's advice question asks specifically about getting help on savings and investment decisions.

Number of observations are shown for borrowing measures that are conditional on having nonzero debt. 1983 dollars.

Table 4. Short-Term Debt, Long-term Debt and Payment/Interest Bias

	Short-term installment debt				Long-term debt		
LHS variable:	*financed recent large purchase*	*debt/income*	*debt/income*	*debt/income*	*debt/income*	*debt/income*	*debt/income*
Estimator:	Probit		OLS			OLS	
Mean(LHS):	0.32	0.18	0.18	0.17	0.88	0.82	0.82
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bias quintile 2	0.036	0.044*	0.057**	0.059**	-0.047	0.086	0.066
	(0.036)	(0.025)	(0.027)	(0.029)	(0.108)	(0.093)	(0.099)
Bias quintile 3	0.041	0.043*	0.053**	0.044*	0.225	0.025	0.013
	(0.042)	(0.024)	(0.026)	(0.026)	(0.249)	(0.109)	(0.116)
Bias quintile 4	0.079*	0.038	0.045*	0.049*	-0.124	0.036	0.078
	(0.045)	(0.024)	(0.026)	(0.027)	(0.154)	(0.135)	(0.146)
Bias quintile 5	0.138***	0.054*	0.075**	0.091***	-0.134	0.066	0.067
	(0.051)	(0.029)	(0.032)	(0.033)	(0.171)	(0.131)	(0.134)
Bias unknown	0.100*	0.049	0.067	0.051	-0.220	-0.055	0.008
	(0.055)	(0.039)	(0.046)	(0.043)	(0.189)	(0.129)	(0.145)
Perceived rate = add-on	0.090**	0.057**	0.054**	0.059**	-0.112	-0.008	-0.023
	(0.035)	(0.024)	(0.026)	(0.027)	(0.112)	(0.088)	(0.095)
Male	0.012	0.035	0.023	0.015	-0.404	-0.147	-0.095
	(0.047)	(0.034)	(0.038)	(0.044)	(0.291)	(0.169)	(0.183)
Black	0.151***	0.012	-0.001	0.009	-0.011	-0.051	-0.062
	(0.050)	(0.023)	(0.028)	(0.033)	(0.108)	(0.114)	(0.108)
Hispanic	-0.100*	0.029	0.037	0.037	0.158	0.119	0.022
	(0.054)	(0.034)	(0.046)	(0.046)	(0.175)	(0.153)	(0.177)
Other nonwhite	-0.039	-0.015	-0.074	-0.137**	0.004	0.165	0.004
	(0.077)	(0.058)	(0.057)	(0.060)	(0.264)	(0.273)	(0.203)
Age	0.001	-0.003	-0.008	-0.019**	0.078**	0.040*	0.041
	(0.006)	(0.005)	(0.007)	(0.009)	(0.037)	(0.023)	(0.025)
Age squared	-0.000	0.000	0.000	0.000*	-0.001**	-0.001**	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Some high school	0.020	0.038	0.020	0.057	0.201	0.161	0.037
	(0.056)	(0.037)	(0.042)	(0.066)	(0.159)	(0.169)	(0.206)
Finished high school	-0.027	0.011	0.019	0.011	0.458*	0.257	0.117
	(0.047)	(0.032)	(0.038)	(0.056)	(0.240)	(0.176)	(0.218)
Some college	-0.043	0.040	0.051	0.016	0.445**	0.511**	0.411
	(0.050)	(0.037)	(0.046)	(0.060)	(0.216)	(0.235)	(0.277)
Finished college	-0.107**	0.025	0.046	0.015	0.328	0.437**	0.272
	(0.051)	(0.039)	(0.048)	(0.062)	(0.226)	(0.215)	(0.247)
Take > average financial risks expecting to earn > average returns	0.084	-0.047	-0.057	-0.058	-0.331	-0.400	-0.465
(omitted=take substantial financial risks expecting to earn substantial returns)	(0.056)	(0.038)	(0.047)	(0.059)	(0.219)	(0.248)	(0.285)
Take average financial risks expecting to earn average returns	0.094**	-0.037	-0.054	-0.071	-0.407*	-0.534**	-0.645**
	(0.046)	(0.036)	(0.045)	(0.055)	(0.210)	(0.243)	(0.283)
Not willing to take any financial risks	0.083*	-0.015	-0.023	-0.039	-0.091	-0.395	-0.556**
	(0.050)	(0.037)	(0.047)	(0.054)	(0.295)	(0.242)	(0.280)
Thinks buying on credit is good and bad	-0.077***	0.012	0.012	0.012	0.146	0.038	0.033
(omitted= thinks buying on credit is good idea)	(0.022)	(0.016)	(0.017)	(0.017)	(0.129)	(0.071)	(0.078)
Thinks buying on credit is bad idea	-0.112***	-0.002	0.010	-0.022	-0.017	-0.072	-0.029
	(0.023)	(0.019)	(0.023)	(0.020)	(0.084)	(0.077)	(0.091)
Will tie up money medium-run to earn > average returns	-0.025	-0.026	-0.019	-0.021	0.216	0.082	0.097
(omitted= will tie up money long-run to earn substantial returns)	(0.032)	(0.025)	(0.027)	(0.028)	(0.172)	(0.089)	(0.095)
Will tie up money short-run to earn average returns	0.002	0.006	0.009	0.014	-0.028	0.106	0.158
	(0.034)	(0.027)	(0.029)	(0.029)	(0.139)	(0.104)	(0.118)
Will not tie up money at all	0.016	-0.033	-0.025	-0.015	-0.174	0.101	0.156
	(0.039)	(0.029)	(0.032)	(0.032)	(0.240)	(0.130)	(0.151)
(Pseudo-) R-squared	0.32	0.13	0.15	0.18	0.10	0.14	0.14
Sample:	made large recent purchase	nonzero short-term installment debt			nonzero long-term debt		
Exclude those denied, discouraged, or rationed in past few years?	no	no	yes	yes	no	yes	yes
Exclude those lacking a credit card?	no	no	no	yes	no	no	yes
Number of observations	2221	1635	1300	1011	2568	2177	1869

* p<0.10, ** p<0.05, *** p<0.01.

Huber-White standard errors. Probit results are marginal effects. All specifications also include controls (not shown) for marital status, household size, employment status, health, homeownership, industry, occupation (including self-employment), household wage income decile, pension coverage, Social Security + pension wealth decile, years in current job, any expected inheritance, expected retirement age, expected tenure at current job, use of advice on saving and investment decisions, ATM use, and comparing loan terms on price vs. non-price margins. Columns (1), (2), and (5) also include controls for denied/discouraged/turned down for credit, and for credit card holding. Column 1 also includes controls for purchase characteristics: month/year, purpose, and cost.

Table 5. Stocks, CDs, and Payment/Interest Bias

	Stocks						Certificates of deposit					
LHS variable:	*1 = owns any*		*share of total assets*		*share of financial assets*		*1 = owns any*		*share of total assets*		*share of financial assets*	
Estimator:	Probit		OLS		OLS		Probit		OLS		OLS	
Mean(LHS):	0.26		0.06		0.10		0.21		0.04		0.09	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Bias quintile 2	-0.006	-0.005	-0.012	-0.012	-0.027**	-0.025**	0.019	0.020	0.007	0.008	0.018	0.021*
	(0.020)	(0.021)	(0.010)	(0.009)	(0.013)	(0.013)	(0.019)	(0.017)	(0.007)	(0.007)	(0.012)	(0.012)
Bias quintile 3	-0.024	-0.013	-0.023**	-0.018*	-0.034**	-0.027**	0.023	0.022	0.011	0.011	0.026**	0.028**
	(0.023)	(0.023)	(0.010)	(0.010)	(0.014)	(0.014)	(0.023)	(0.020)	(0.008)	(0.008)	(0.013)	(0.013)
Bias quintile 4	-0.040*	-0.031	-0.024**	-0.017*	-0.043***	-0.036***	0.023	0.023	0.012	0.013*	0.029**	0.030**
	(0.022)	(0.022)	(0.010)	(0.009)	(0.014)	(0.013)	(0.023)	(0.021)	(0.008)	(0.008)	(0.013)	(0.013)
Bias quintile 5	-0.065***	-0.053**	-0.040***	-0.033***	-0.062***	-0.054***	0.002	0.009	0.004	0.006	0.006	0.009
	(0.022)	(0.022)	(0.009)	(0.009)	(0.013)	(0.013)	(0.023)	(0.021)	(0.008)	(0.008)	(0.013)	(0.013)
Bias unknown	-0.076***	-0.060**	-0.021**	-0.013	-0.040***	-0.031**	0.036	0.039	0.014	0.017*	0.037**	0.042***
	(0.023)	(0.024)	(0.010)	(0.010)	(0.014)	(0.014)	(0.027)	(0.025)	(0.009)	(0.009)	(0.015)	(0.015)
Perceived rate = add-on	0.003	0.008	-0.008	-0.006	-0.015	-0.013	0.019	0.014	0.013*	0.012*	0.020*	0.019*
	(0.020)	(0.020)	(0.009)	(0.008)	(0.012)	(0.012)	(0.018)	(0.016)	(0.007)	(0.007)	(0.011)	(0.011)
Male	-0.012	-0.019	0.001	-0.000	-0.009	-0.011	-0.012	-0.022	-0.010	-0.010	-0.017	-0.017
	(0.028)	(0.029)	(0.010)	(0.010)	(0.012)	(0.012)	(0.023)	(0.023)	(0.009)	(0.009)	(0.014)	(0.013)
Black	-0.045*	-0.024	-0.014**	-0.008	-0.014*	-0.007	-0.110***	-0.081***	-0.024***	-0.017***	-0.050***	-0.038***
	(0.025)	(0.027)	(0.005)	(0.005)	(0.008)	(0.008)	(0.013)	(0.014)	(0.005)	(0.005)	(0.008)	(0.008)
Hispanic	-0.167***	-0.152***	-0.027***	-0.023***	-0.031***	-0.029***	-0.070**	-0.059**	-0.013	-0.010	-0.021	-0.021
	(0.017)	(0.018)	(0.007)	(0.006)	(0.010)	(0.009)	(0.028)	(0.024)	(0.010)	(0.010)	(0.014)	(0.014)
Other nonwhite	-0.067	-0.076*	-0.025	-0.029*	-0.056**	-0.061**	0.069	0.072	0.024	0.026	0.039	0.042
	(0.049)	(0.042)	(0.016)	(0.016)	(0.025)	(0.025)	(0.063)	(0.063)	(0.021)	(0.021)	(0.034)	(0.036)
Age	-0.003	-0.011***	-0.004***	-0.005***	-0.004***	-0.005***	0.003	-0.004	-0.001	-0.003**	-0.001	-0.003*
	(0.004)	(0.004)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)
Age squared	0.000*	0.000***	0.000***	0.000***	0.000***	0.000***	0.000	0.000*	0.000*	0.000***	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Some high school	0.066	0.034	0.015**	0.005	0.020**	0.007	0.037	0.023	0.024***	0.022**	0.039**	0.033**
	(0.041)	(0.037)	(0.007)	(0.006)	(0.009)	(0.008)	(0.028)	(0.024)	(0.009)	(0.009)	(0.016)	(0.016)
Finished high school	0.135***	0.082**	0.014**	-0.001	0.030***	0.012	0.051**	0.027	0.025***	0.021***	0.030*	0.022
	(0.037)	(0.035)	(0.006)	(0.006)	(0.009)	(0.009)	(0.025)	(0.022)	(0.008)	(0.008)	(0.015)	(0.015)
Some college	0.163***	0.076**	0.017**	-0.008	0.032***	0.003	0.070**	0.042	0.021**	0.016*	0.024	0.017
	(0.043)	(0.039)	(0.008)	(0.008)	(0.011)	(0.011)	(0.031)	(0.027)	(0.009)	(0.009)	(0.017)	(0.017)
Finished college	0.226***	0.126***	0.053***	0.020*	0.085***	0.046***	0.083**	0.047	0.020*	0.014	0.024	0.015
	(0.046)	(0.043)	(0.011)	(0.011)	(0.015)	(0.015)	(0.034)	(0.029)	(0.011)	(0.011)	(0.019)	(0.019)
Take > average financial risks expecting to earn > average returns	0.070**	0.080**	0.015	0.017	0.014	0.016	-0.030	-0.027	0.008	0.007	-0.023	-0.025
(omitted=take substantial financial risks expecting to earn substantial returns)	(0.034)	(0.035)	(0.014)	(0.013)	(0.018)	(0.017)	(0.023)	(0.020)	(0.009)	(0.009)	(0.016)	(0.016)
Take average financial risks expecting to earn average returns	0.002	0.023	-0.016	-0.009	-0.029*	-0.022	-0.014	-0.011	0.010	0.008	-0.013	-0.016
	(0.026)	(0.027)	(0.011)	(0.010)	(0.015)	(0.014)	(0.023)	(0.020)	(0.007)	(0.007)	(0.015)	(0.015)
Not willing to take any financial risks	-0.031	0.001	-0.028***	-0.016	-0.048***	-0.035**	0.007	0.011	0.018**	0.017**	0.014	0.010
	(0.027)	(0.028)	(0.011)	(0.010)	(0.015)	(0.014)	(0.024)	(0.022)	(0.008)	(0.008)	(0.016)	(0.016)
Thinks buying on credit is good and bad	0.005	0.009	-0.007	-0.004	-0.008	-0.005	0.017	0.013	0.004	0.004	0.004	0.003
(omitted= thinks buying on credit is good idea)	(0.016)	(0.016)	(0.005)	(0.005)	(0.008)	(0.007)	(0.013)	(0.012)	(0.005)	(0.005)	(0.008)	(0.008)
Thinks buying on credit is bad idea	-0.010	-0.013	0.001	0.003	-0.006	-0.005	0.045***	0.033**	0.010*	0.007	0.017*	0.012
	(0.017)	(0.017)	(0.006)	(0.006)	(0.008)	(0.008)	(0.016)	(0.014)	(0.006)	(0.005)	(0.009)	(0.009)
Will tie up money medium-run to earn > average returns	-0.014	-0.003	-0.023**	-0.019**	-0.021*	-0.015	0.016	0.018	0.002	0.003	0.016	0.017
(omitted= will tie up money long-run to earn substantial returns)	(0.020)	(0.020)	(0.009)	(0.009)	(0.013)	(0.012)	(0.017)	(0.016)	(0.007)	(0.007)	(0.012)	(0.012)
Will tie up money short-run to earn average returns	-0.057***	-0.047**	-0.031***	-0.023***	-0.035***	-0.027**	-0.034**	-0.030**	-0.005	-0.005	-0.004	-0.003
	(0.019)	(0.019)	(0.009)	(0.008)	(0.012)	(0.012)	(0.016)	(0.014)	(0.008)	(0.007)	(0.013)	(0.012)
Will not tie up money at all	-0.095***	-0.055**	-0.025***	-0.016*	-0.025**	-0.013	-0.173***	-0.137***	-0.052***	-0.042***	-0.100***	-0.083***
	(0.021)	(0.023)	(0.009)	(0.008)	(0.012)	(0.012)	(0.013)	(0.013)	(0.008)	(0.007)	(0.013)	(0.013)
Controls for net worth decile?	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
(Pseudo-) R-squared	0.35	0.40	0.29	0.37	0.31	0.34	0.23	0.27	0.12	0.16	0.16	0.20
Number of observations	4103	4103	4103	4103	4103	4103	4103	4103	4103	4103	4103	4103

* p<0.10, ** p<0.05, *** p<0.01.

We define stock ownership as holding any public equities or non-money market mutual funds. Only 8% of the sample holds any mutual funds. Huber-White standard errors. Probit results are marginal effects. All specifications also include controls (not shown) for marital status, household size, employment status, health, homeownership, industry, occupation (including self-employment), household wage income decile, pension coverage, Social Security + pension wealth decile, years in current job, any expected inheritance, expected retirement age, expected tenure at current job, use of advice on saving and investment decisions, ATM use, comparing loan terms on price vs. non-price margins, denied/discouraged/turned down for credit, and credit card holding.

Table 6. Dissaving and Payment/Interest Bias

LHS variable:	*category for net inflow/outflow in 1982:* 1= saved (37% of full sample) 2= consumed income (24%) 3= dissaved (39%)			*1= dissaved*		
Estimator:	Ordered probit			Probit		
Mean(*LHS*):	2.02	1.96	1.88	0.39	0.36	0.35
	(1)	(2)	(3)	(4)	(5)	(6)
Bias quintile 2	0.130*	0.135*	0.127	0.062**	0.064**	0.051
	(0.068)	(0.074)	(0.081)	(0.029)	(0.031)	(0.033)
Bias quintile 3	0.144*	0.166**	0.203**	0.066**	0.075**	0.085**
	(0.076)	(0.082)	(0.094)	(0.032)	(0.035)	(0.039)
Bias quintile 4	0.069	0.118	0.171*	0.037	0.059*	0.070*
	(0.077)	(0.084)	(0.098)	(0.032)	(0.035)	(0.040)
Bias quintile 5	0.090	0.192**	0.239**	0.024	0.066*	0.063
	(0.079)	(0.087)	(0.103)	(0.034)	(0.038)	(0.044)
Bias unknown	0.055	0.113	0.242**	0.013	0.029	0.082*
	(0.081)	(0.087)	(0.111)	(0.036)	(0.039)	(0.049)
Perceived rate = add-on	-0.077	-0.034	0.007	-0.043*	-0.023	-0.009
	(0.062)	(0.067)	(0.077)	(0.025)	(0.027)	(0.030)
Male	-0.199***	-0.158*	-0.143	-0.065**	-0.041	-0.073
	(0.073)	(0.082)	(0.119)	(0.032)	(0.036)	(0.051)
Black	0.230***	0.183**	0.242**	0.105***	0.076**	0.081*
	(0.064)	(0.075)	(0.114)	(0.029)	(0.034)	(0.048)
Hispanic	-0.002	-0.103	-0.023	0.000	-0.059	-0.044
	(0.112)	(0.126)	(0.217)	(0.050)	(0.053)	(0.082)
Other nonwhite	0.177	0.365	0.228	0.097	0.171*	0.141
	(0.204)	(0.232)	(0.306)	(0.083)	(0.093)	(0.115)
Age	0.010	0.008	0.011	0.001	0.001	0.006
	(0.010)	(0.011)	(0.017)	(0.004)	(0.005)	(0.007)
Age squared	-0.000**	-0.000**	-0.000*	-0.000	-0.000	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Some high school	-0.010	-0.018	0.012	-0.009	-0.010	-0.002
	(0.069)	(0.074)	(0.116)	(0.034)	(0.035)	(0.053)
Finished high school	-0.034	-0.039	-0.038	0.008	0.011	-0.007
	(0.069)	(0.075)	(0.109)	(0.032)	(0.034)	(0.048)
Some college	-0.066	-0.067	-0.043	0.002	0.014	0.014
	(0.080)	(0.088)	(0.119)	(0.036)	(0.039)	(0.053)
Finished college	-0.149	-0.185*	-0.145	-0.023	-0.032	-0.025
	(0.092)	(0.100)	(0.128)	(0.040)	(0.042)	(0.055)
Take > average financial risks expecting to earn > average returns	-0.178*	-0.237**	-0.237*	-0.071*	-0.091**	-0.075*
(omitted=take substantial financial risks expecting to earn substantial returns)	(0.100)	(0.110)	(0.130)	(0.037)	(0.038)	(0.045)
Take average financial risks expecting to earn average returns	-0.343***	-0.430***	-0.446***	-0.136***	-0.165***	-0.164***
	(0.089)	(0.098)	(0.116)	(0.034)	(0.035)	(0.043)
Not willing to take any financial risks	-0.204**	-0.287***	-0.294**	-0.084**	-0.115***	-0.106**
	(0.091)	(0.101)	(0.123)	(0.035)	(0.037)	(0.045)
Thinks buying on credit is good and bad	-0.008	-0.046	0.018	-0.024	-0.041**	-0.021
(omitted= thinks buying on credit is good idea)	(0.045)	(0.049)	(0.058)	(0.019)	(0.020)	(0.023)
Thinks buying on credit is bad idea	-0.013	-0.038	-0.020	-0.008	-0.020	-0.022
	(0.050)	(0.056)	(0.072)	(0.021)	(0.023)	(0.028)
Will tie up money medium-run to earn > average returns	0.039	0.037	0.001	0.011	0.009	-0.026
(omitted= will tie up money long-run to earn substantial returns)	(0.068)	(0.074)	(0.083)	(0.027)	(0.029)	(0.032)
Will tie up money short-run to earn average returns	0.246***	0.245***	0.229***	0.083***	0.081***	0.070**
	(0.068)	(0.074)	(0.085)	(0.028)	(0.030)	(0.034)
Will not tie up money at all	0.260***	0.272***	0.368***	0.042	0.044	0.081*
	(0.073)	(0.080)	(0.099)	(0.031)	(0.034)	(0.042)
Pseudo-R-squared	0.08	0.08	0.09	0.08	0.08	0.10
Exclude those denied, discouraged, or rationed in past few years?	no	yes	yes	no	yes	yes
Exclude those lacking a credit card?	no	no	yes	no	no	yes
Number of observations	4024	3395	2394	4024	3395	2394

* p<0.10, ** p<0.05, *** p<0.01.

Huber-White standard errors in parentheses. Columns 4-6 are probit marginal effects. Sample sizes are slightly lower than in comparable specifications in previous tables because the SCF did not impute values for nonresponse to the saving question. All specifications also include controls (not shown) for marital status, household size, employment status, health, homeownership, industry, occupation (including self-employment), household wage income decile, pension coverage, Social Security + pension wealth decile, years in current job, any expected inheritance, expected retirement age, expected tenure at current job, use of advice on saving and investment decisions, ATM use, and comparing loan terms on price vs. non-price margins. Columns 1 and 4 also include controls for denied/discouraged/turned down for credit, and for credit card holding.

Table 7. Net Worth and Payment/Interest Bias

LHS variable:	*log(net worth)*			*net worth percentile*		
Estimator:	OLS			OLS		
Mean(LHS), in 000s of $1983 or percentiles	631	710	944	49	53	60
	(1)	(2)	(3)	(4)	(5)	(6)
Bias quintile 2	-0.07	-0.10	-0.09	-1.24	-1.27	-1.51*
	(0.07)	(0.07)	(0.08)	(0.78)	(0.81)	(0.86)
Bias quintile 3	-0.17**	-0.20**	-0.21**	-1.97**	-2.39**	-2.98***
	(0.08)	(0.09)	(0.10)	(0.87)	(0.94)	(1.06)
Bias quintile 4	-0.13*	-0.17**	-0.18*	-1.74**	-2.03**	-2.03*
	(0.08)	(0.08)	(0.09)	(0.87)	(0.94)	(1.07)
Bias quintile 5	-0.28***	-0.29***	-0.34***	-2.48***	-2.67***	-3.53***
	(0.09)	(0.09)	(0.10)	(0.92)	(1.01)	(1.17)
Bias unknown	-0.29***	-0.26***	-0.32***	-3.09***	-2.96***	-3.40***
	(0.09)	(0.09)	(0.11)	(0.92)	(1.01)	(1.25)
Perceived rate = add-on	-0.03	-0.08	-0.11	-0.15	-0.46	-0.81
	(0.06)	(0.07)	(0.07)	(0.70)	(0.74)	(0.82)
Male	0.13	0.21**	0.17	1.09	2.19**	1.61
	(0.09)	(0.10)	(0.14)	(0.95)	(1.07)	(1.59)
Black	-0.32***	-0.34***	-0.29***	-4.86***	-5.43***	-4.72***
	(0.08)	(0.08)	(0.11)	(0.76)	(0.90)	(1.38)
Hispanic	-0.05	-0.27*	-0.33	-0.90	-2.84*	-2.26
	(0.16)	(0.17)	(0.22)	(1.29)	(1.49)	(2.49)
Other nonwhite	0.04	0.03	0.16	0.52	-0.91	0.56
	(0.19)	(0.18)	(0.19)	(1.81)	(2.01)	(2.52)
Age	0.07***	0.07***	0.06***	0.92***	1.01***	1.23***
	(0.01)	(0.01)	(0.02)	(0.12)	(0.14)	(0.21)
Age squared	-0.00***	-0.00***	-0.00	-0.01***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Some high school	0.40***	0.35***	0.44***	4.78***	4.38***	5.38***
	(0.08)	(0.09)	(0.12)	(0.93)	(1.01)	(1.54)
Finished high school	0.50***	0.50***	0.70***	6.25***	6.41***	8.91***
	(0.08)	(0.08)	(0.11)	(0.86)	(0.95)	(1.43)
Some college	0.66***	0.65***	0.79***	8.07***	8.14***	9.81***
	(0.09)	(0.09)	(0.12)	(0.99)	(1.11)	(1.55)
Finished college	0.91***	0.90***	0.98***	10.85***	10.88***	11.90***
	(0.10)	(0.10)	(0.13)	(1.10)	(1.19)	(1.62)
Take > average financial risks expecting to earn > average returns	-0.02	-0.11	-0.15	0.54	-0.07	-0.09
(omitted=take substantial financial risks expecting to earn substantial returns)	(0.10)	(0.11)	(0.12)	(1.05)	(1.17)	(1.38)
Take average financial risks expecting to earn average returns	-0.15*	-0.25***	-0.34***	-0.58	-1.58	-1.97
	(0.09)	(0.09)	(0.11)	(0.94)	(1.04)	(1.27)
Not willing to take any financial risks	-0.25***	-0.33***	-0.43***	-1.65*	-2.52**	-3.14**
	(0.09)	(0.10)	(0.11)	(0.97)	(1.10)	(1.38)
Thinks buying on credit is good and bad	0.01	-0.00	-0.01	-0.07	0.02	0.03
(omitted= thinks buying on credit is good idea)	(0.05)	(0.05)	(0.05)	(0.52)	(0.56)	(0.65)
Thinks buying on credit is bad idea	0.09*	0.07	0.08	1.02*	1.31**	1.32*
	(0.05)	(0.06)	(0.07)	(0.59)	(0.64)	(0.80)
Will tie up money medium-run to earn > average returns	-0.17***	-0.20***	-0.17**	-1.64**	-2.00***	-1.44*
(omitted= will tie up money long-run to earn substantial returns)	(0.06)	(0.07)	(0.07)	(0.72)	(0.77)	(0.86)
Will tie up money short-run to earn average returns	-0.22***	-0.26***	-0.30***	-2.05***	-2.55***	-2.76***
	(0.06)	(0.07)	(0.07)	(0.74)	(0.79)	(0.90)
Will not tie up money at all	-0.51***	-0.55***	-0.52***	-6.44***	-7.11***	-7.02***
	(0.07)	(0.08)	(0.09)	(0.82)	(0.91)	(1.14)
R-squared	0.73	0.73	0.72	0.77	0.77	0.73
Exclude those denied, discouraged, or rationed in past few years?	no	yes	yes	no	yes	yes
Exclude those lacking a credit card?	no	no	yes	no	no	yes
Number of observations	3800	3274	2368	4103	3456	2421

* p<0.10, ** p<0.05, *** p<0.01.

OLS with Huber-White standard errors. Wealth outcome measures exclude pensions and Social Security. All specifications also include controls (not shown) for marital status, household size, employment status, health, homeownership, industry, occupation (including self-employment), household wage income decile, pension coverage, Social Security + pension wealth decile, years in current job, any expected inheritance, expected retirement age, expected tenure at current job, use of advice on saving and investment decisions, ATM use, and comparing loan terms on price vs. non-price margins. Columns 1 and 4 also include controls for turned down/discouraged/denied credit, and for credit card holding.

Table 8. Net Worth, Bias, and Advice

Dependent variable:	*ln(net worth)*			*net worth percentile*			*=1 if household uses any advice*
	subsample:			subsample:			mean = 0.54
	All	*No advice*	*Advice*	*All*	*No advice*	*Advice*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bias quintile 2	-0.07	-0.29***	0.08	-1.24	-3.35***	0.05	0.03
	(0.07)	(0.10)	(0.10)	(0.78)	(1.13)	(1.09)	(0.03)
Bias quintile 3	-0.17**	-0.32***	-0.01	-1.97**	-3.27***	-0.81	0.09***
	(0.08)	(0.11)	(0.12)	(0.87)	(1.26)	(1.22)	(0.03)
Bias quintile 4	-0.13*	-0.32***	0.03	-1.74**	-4.11***	-0.14	0.12***
	(0.08)	(0.11)	(0.11)	(0.87)	(1.26)	(1.21)	(0.03)
Bias quintile 5	-0.28***	-0.45***	-0.14	-2.48***	-4.20***	-1.52	0.10***
	(0.09)	(0.12)	(0.12)	(0.92)	(1.34)	(1.29)	(0.03)
Bias unknown	-0.29***	-0.62***	0.08	-3.09***	-6.09***	0.10	0.09***
	(0.09)	(0.12)	(0.13)	(0.92)	(1.30)	(1.34)	(0.03)
Perceived rate = add-on	-0.03	-0.17*	0.06	-0.15	-1.13	0.15	0.06**
	(0.06)	(0.09)	(0.09)	(0.70)	(1.02)	(0.99)	(0.03)
Uses Advice From Friends + Family Only	-0.03			0.02			
(omitted = no advice)	(0.05)			(0.58)			
Uses Professional Advice	0.30***			3.65***			
	(0.05)			(0.56)			
Male	0.13	0.10	0.25*	1.09	1.12	1.65	-0.06*
	(0.09)	(0.13)	(0.14)	(0.95)	(1.33)	(1.38)	(0.03)
Black	-0.32***	-0.26***	-0.39***	-4.86***	-4.34***	-5.25***	-0.07**
	(0.08)	(0.10)	(0.13)	(0.76)	(0.99)	(1.22)	(0.03)
Hispanic	-0.05	-0.16	-0.05	-0.90	-1.41	-0.14	0.04
	(0.16)	(0.28)	(0.20)	(1.29)	(1.65)	(2.05)	(0.05)
Other nonwhite	0.04	-0.19	0.18	0.52	-3.70	3.12	0.08
	(0.19)	(0.34)	(0.22)	(1.81)	(3.06)	(2.11)	(0.08)
Age	0.07***	0.06***	0.10***	0.92***	0.82***	1.16***	-0.01***
	(0.01)	(0.02)	(0.02)	(0.12)	(0.18)	(0.18)	(0.00)
Age squared	-0.00***	-0.00	-0.00***	-0.01***	-0.00***	-0.01***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Some high school	0.40***	0.47***	0.26**	4.78***	5.18***	3.78**	0.02
	(0.08)	(0.11)	(0.13)	(0.93)	(1.22)	(1.49)	(0.03)
Finished high school	0.50***	0.52***	0.44***	6.25***	6.19***	5.66***	0.04
	(0.08)	(0.10)	(0.12)	(0.86)	(1.12)	(1.38)	(0.03)
Some college	0.66***	0.67***	0.63***	8.07***	7.92***	7.79***	0.08**
	(0.09)	(0.12)	(0.13)	(0.99)	(1.40)	(1.50)	(0.04)
Finished college	0.91***	1.01***	0.81***	10.85***	11.07***	10.23***	0.11***
	(0.10)	(0.14)	(0.14)	(1.10)	(1.57)	(1.61)	(0.04)
Take > average financial risks expecting to earn > average returns	-0.02	-0.14	0.18	0.54	1.24	1.39	0.03
(omitted=take substantial financial risks expecting to earn substantial returns)	(0.10)	(0.15)	(0.13)	(1.05)	(1.63)	(1.43)	(0.04)
Take average financial risks expecting to earn average returns	-0.15*	-0.12	-0.07	-0.58	0.99	-0.60	0.02
	(0.09)	(0.13)	(0.12)	(0.94)	(1.42)	(1.28)	(0.03)
Not willing to take any financial risks	-0.25***	-0.14	-0.26**	-1.65*	0.57	-2.54*	-0.02
	(0.09)	(0.13)	(0.13)	(0.97)	(1.41)	(1.37)	(0.04)
Thinks buying on credit is good and bad	0.01	0.10	-0.06	-0.07	0.56	-0.77	0.00
(omitted= thinks buying on credit is good idea)	(0.05)	(0.07)	(0.07)	(0.52)	(0.75)	(0.75)	(0.02)
Thinks buying on credit is bad idea	0.09*	0.19**	0.03	1.02*	1.94**	0.15	0.01
	(0.05)	(0.08)	(0.08)	(0.59)	(0.89)	(0.82)	(0.02)
Will tie up money medium-run to earn > average returns	-0.17***	-0.33***	-0.06	-1.64**	-3.04***	-0.54	-0.03
(omitted= will tie up money long-run to earn substantial returns)	(0.06)	(0.10)	(0.09)	(0.72)	(1.10)	(0.97)	(0.03)
Will tie up money short-run to earn average returns	-0.22***	-0.35***	-0.14	-2.05***	-3.11***	-1.50	-0.03
	(0.06)	(0.10)	(0.09)	(0.74)	(1.11)	(1.00)	(0.03)
Will not tie up money at all	-0.51***	-0.61***	-0.53***	-6.44***	-7.47***	-6.14***	-0.19***
	(0.07)	(0.10)	(0.11)	(0.82)	(1.16)	(1.24)	(0.03)
R-squared/Pseudo R-squared	0.73	0.75	0.74	0.77	0.78	0.77	0.09
Number of observations	3800	1725	2075	4103	1899	2204	4103

* p<0.10, ** p<0.05, *** p<0.01.

Columns (1) and (4) reproduce the same columns from Table 7. Advice in the sample splits and the dependent variable (Col 7) is defined as using advice from any external source. All specifications also include controls (not shown) for marital status, household size, employment status, health, homeownership, industry, occupation (including self-employment), household wage income decile, pension coverage, Social Security + pension wealth decile, years in current job, any expected inheritance, expected retirement age, expected tenure at current job, ATM use, comparing loan terms on price vs. non-price margins, denied/discouraged/turned down for credit, and credit card holding.

Appendix Table 1. Functional Form Robustness: Debt Maturity and Binary Parameterization of Payment/Interest Bias

	Short-term installment debt				Long-term debt		
LHS variable:	*financed recent large purchase*	*debt/income*	*debt/income*	*debt/income*	*debt/income*	*debt/income*	*debt/income*
Estimator:	Probit		OLS			OLS	
Mean(LHS):	0.32	0.18	0.18	0.17	0.88	0.82	0.82
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1= More biased (i.e., 1=in bias quintiles 2-5)	0.052*	0.044**	0.056**	0.058**	-0.014	0.062	0.057
	(0.029)	(0.022)	(0.023)	(0.024)	(0.097)	(0.094)	(0.099)
Bias unknown	0.075	0.048	0.065	0.047	-0.203	-0.045	0.009
	(0.052)	(0.039)	(0.046)	(0.044)	(0.181)	(0.127)	(0.144)
Perceived rate = add-on	0.066**	0.057**	0.054**	0.058**	-0.107	0.008	-0.021
	(0.031)	(0.024)	(0.027)	(0.029)	(0.110)	(0.083)	(0.089)
Male	0.004	0.034	0.024	0.015	-0.378	-0.148	-0.098
	(0.048)	(0.035)	(0.039)	(0.045)	(0.273)	(0.171)	(0.185)
Black	0.152***	0.013	0.001	0.012	-0.025	-0.049	-0.058
	(0.050)	(0.023)	(0.028)	(0.034)	(0.106)	(0.115)	(0.107)
Hispanic	-0.106**	0.028	0.036	0.031	0.139	0.120	0.024
	(0.053)	(0.033)	(0.046)	(0.045)	(0.165)	(0.152)	(0.177)
Other nonwhite	-0.032	-0.015	-0.076	-0.138**	0.001	0.165	0.006
	(0.079)	(0.058)	(0.057)	(0.058)	(0.261)	(0.272)	(0.202)
Age	0.000	-0.003	-0.008	-0.019**	0.075**	0.041*	0.042
	(0.006)	(0.005)	(0.007)	(0.009)	(0.035)	(0.024)	(0.025)
Age squared	-0.000	0.000	0.000	0.000*	-0.001**	-0.001**	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Some high school	0.017	0.038	0.020	0.057	0.207	0.158	0.037
	(0.055)	(0.037)	(0.042)	(0.065)	(0.160)	(0.170)	(0.206)
Finished high school	-0.030	0.011	0.016	0.008	0.466*	0.257	0.115
	(0.047)	(0.032)	(0.038)	(0.056)	(0.246)	(0.176)	(0.217)
Some college	-0.048	0.039	0.049	0.013	0.450**	0.512**	0.411
	(0.049)	(0.037)	(0.045)	(0.060)	(0.214)	(0.235)	(0.276)
Finished college	-0.110**	0.024	0.043	0.013	0.325	0.440**	0.274
	(0.051)	(0.039)	(0.048)	(0.062)	(0.227)	(0.215)	(0.246)
Take > average financial risks expecting to earn > average returns	0.082	-0.047	-0.057	-0.057	-0.324	-0.398	-0.465
(omitted=take substantial financial risks expecting to earn substantial returns)	(0.056)	(0.038)	(0.047)	(0.059)	(0.219)	(0.248)	(0.285)
Take average financial risks expecting to earn average returns	0.091**	-0.036	-0.054	-0.070	-0.397*	-0.532**	-0.644**
	(0.046)	(0.036)	(0.045)	(0.054)	(0.210)	(0.243)	(0.282)
Not willing to take any financial risks	0.081	-0.015	-0.023	-0.038	-0.085	-0.392	-0.555**
	(0.050)	(0.037)	(0.047)	(0.054)	(0.298)	(0.242)	(0.280)
Thinks buying on credit is good and bad	-0.076***	0.012	0.012	0.013	0.149	0.037	0.033
(omitted= thinks buying on credit is good idea)	(0.022)	(0.016)	(0.017)	(0.017)	(0.132)	(0.071)	(0.078)
Thinks buying on credit is bad idea	-0.109***	-0.002	0.010	-0.022	-0.017	-0.072	-0.029
	(0.023)	(0.019)	(0.023)	(0.020)	(0.084)	(0.077)	(0.091)
Will tie up money medium-run to earn > average returns	-0.025	-0.025	-0.018	-0.021	0.224	0.082	0.095
(omitted= will tie up money long-run to earn substantial returns)	(0.032)	(0.025)	(0.027)	(0.028)	(0.179)	(0.090)	(0.096)
Will tie up money short-run to earn average returns	0.002	0.006	0.009	0.014	-0.024	0.106	0.159
	(0.034)	(0.027)	(0.029)	(0.028)	(0.136)	(0.104)	(0.117)
Will not tie up money at all	0.019	-0.032	-0.023	-0.013	-0.169	0.100	0.155
	(0.039)	(0.028)	(0.031)	(0.031)	(0.237)	(0.130)	(0.151)
(Pseudo-) R-squared	0.32	0.13	0.15	0.18	0.09	0.14	0.14
Sample:	made large recent purchase	nonzero short-term installment debt			nonzero long-term debt		
Exclude those denied, discouraged, or rationed in past few years?	no	no	yes	yes	no	yes	yes
Exclude those lacking a credit card?	no	no	no	yes	no	no	yes
Number of observations	2221	1635	1300	1011	2568	2177	1869

* p<0.10, ** p<0.05, *** p<0.01.

Huber-White standard errors. Probit results are marginal effects. All specifications also include controls (not shown) for marital status, household size, employment status, health, homeownership, industry, occupation (including self-employment), household wage income decile, pension coverage, Social Security + pension wealth decile, years in current job, any expected inheritance, expected retirement age, expected tenure at current job, use of advice on saving and investment decisions, ATM use, and comparing loan terms on price vs. non-price margins. Columns (1), (2), and (5) also include controls for denied/discouraged/turned down for credit, and for credit card holding. Column 1 also includes controls for purchase characteristics: month/year, purpose, and cost.

Appendix Table 2. Wealth Distribution in the 1983 SCF

Wealth percentile	Number of observations	Min. wealth amount	Max. wealth amount	Wealth percentile	Number of observations	Min. wealth amount	Max. wealth amount
1	42	-73.4	-3.0	50	41	43.8	45.8
2	41	-2.9	-1.4	51	42	46.0	47.8
3	42	-1.4	-0.6	52	41	47.8	49.6
4	42	-0.6	-0.2	53	41	49.6	51.3
5	31	-0.2	0.0	54	42	51.4	53.9
6	105	0.0	0.0	55	41	53.9	55.8
7	29	0.0	0.1	56	42	55.9	59.5
8	43	0.1	0.3	57	41	59.5	61.8
9	41	0.3	0.5	58	42	61.9	64.0
10	40	0.5	0.7	59	41	64.0	66.5
11	42	0.7	0.9	60	42	66.6	69.4
12	41	0.9	1.1	61	41	69.4	73.0
13	42	1.1	1.4	62	41	73.1	76.6
14	41	1.4	1.6	63	42	76.7	80.2
15	44	1.6	2.0	64	41	80.3	84.0
16	39	2.0	2.3	65	42	84.1	87.5
17	41	2.3	2.7	66	41	87.8	91.0
18	42	2.7	3.0	67	42	91.0	95.4
19	41	3.0	3.4	68	41	95.4	100.6
20	42	3.4	4.1	69	42	100.7	105.3
21	41	4.1	4.7	70	41	105.5	109.6
22	42	4.7	5.3	71	41	109.8	115.2
23	41	5.3	6.0	72	42	115.2	122.6
24	42	6.0	6.7	73	41	123.1	129.7
25	41	6.7	7.8	74	42	130.7	139.2
26	42	7.8	9.0	75	41	139.5	146.1
27	42	9.0	10.0	76	42	146.1	157.6
28	40	10.0	10.8	77	41	157.9	169.7
29	42	10.9	12.0	78	42	169.8	184.4
30	41	12.0	13.2	79	41	184.8	203.2
31	42	13.2	14.4	80	41	203.2	223.4
32	41	14.5	15.7	81	42	223.4	259.3
33	42	15.7	17.5	82	41	259.5	283.0
34	41	17.5	19.0	83	42	283.4	314.8
35	41	19.0	20.6	84	41	317.8	374.3
36	42	20.6	21.8	85	42	374.7	436.0
37	41	21.8	23.4	86	41	436.5	508.3
38	42	23.4	25.3	87	42	509.6	603.5
39	41	25.4	26.6	88	41	605.5	714.9
40	42	26.7	28.2	89	41	715.4	826.5
41	41	28.3	29.7	90	42	838.0	1,107.3
42	42	29.8	31.5	91	41	1,116.4	1,342.2
43	41	31.5	33.2	92	42	1,351.0	1,780.7
44	41	33.3	34.8	93	41	1,785.9	2,211.7
45	42	34.8	36.5	94	42	2,272.7	2,853.5
46	41	36.6	38.2	95	41	2,868.8	4,058.9
47	42	38.2	40.0	96	42	4,068.1	6,015.7
48	41	40.0	42.1	97	41	6,056.3	11,566.0
49	42	42.1	43.7	98	41	11,959.6	86,852.0

For our main analysis sample of 4,103 households, unweighted. Thousands of 1983 dollars. We rescaled the percentile variable to account for the mass point at zero; consequently there is no 99th percentile.

Appendix Table 3. Conditional Correlations Between Payment/Interest Bias and Preferences

LHS variable:	*bias quintile, dropping unknown*			
LHS values:	range [1, 5]; mean = 2.95			
	(1)	(2)	(3)	(4)
Take > average financial risks expecting to earn > average returns	0.036			0.040
(omitted=take substantial financial risks expecting to earn substantial returns)	(0.102)			(0.103)
Take average financial risks expecting to earn average returns	0.035			0.030
	(0.091)			(0.092)
Not willing to take any financial risks	0.126			0.072
	(0.093)			(0.097)
Thinks buying on credit is good and bad		0.012		0.010
(omitted= thinks buying on credit is good idea)		(0.053)		(0.053)
Thinks buying on credit is bad idea		0.005		-0.005
		(0.062)		(0.062)
Will tie up money medium-run to earn > average returns			-0.060	-0.061
(omitted= will tie up money long-run to earn substantial returns)			(0.071)	(0.072)
Will tie up money short-run to earn average returns			0.018	0.013
			(0.073)	(0.074)
Will not tie up money at all			0.146*	0.125
			(0.081)	(0.085)
Male	-0.375***	-0.383***	-0.381***	-0.379***
	(0.095)	(0.095)	(0.095)	(0.095)
Black	0.165*	0.172**	0.146*	0.144*
	(0.085)	(0.085)	(0.085)	(0.086)
Hispanic	-0.095	-0.079	-0.096	-0.104
	(0.145)	(0.145)	(0.145)	(0.145)
Other nonwhite	-0.377	-0.363	-0.389	-0.394
	(0.242)	(0.243)	(0.241)	(0.241)
Age	-0.006	-0.007	-0.007	-0.007
	(0.013)	(0.013)	(0.013)	(0.013)
Age squared	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Some high school	-0.112	-0.118	-0.099	-0.101
	(0.112)	(0.112)	(0.112)	(0.112)
Finished high school	-0.292***	-0.303***	-0.272**	-0.273**
	(0.106)	(0.106)	(0.107)	(0.107)
Some college	-0.429***	-0.445***	-0.404***	-0.402***
	(0.116)	(0.116)	(0.117)	(0.117)
Finished college	-0.552***	-0.574***	-0.522***	-0.518***
	(0.125)	(0.124)	(0.125)	(0.125)
Probability that preference variables = 0	0.27	0.93	0.05	0.29
R-squared	0.15	0.15	0.15	0.15
Number of observations	3414	3414	3414	3414

* p<0.10, ** p<0.05, *** p<0.01.

Full sample except for those with unknown bias. Huber-White standard errors. OLS regressions of payment/interest bias quintile (parameterized linearly) on the RHS variables listed in the row headings and the rest of our usual control variables for marital status, household size, employment status, health, homeownership, industry, occupation (including self-employment), household wage income decile, pension coverage, Social Security + pension wealth decile, years in current job, any expected inheritance, expected retirement age, expected tenure at current job, use of advice on saving and investment decisions, ATM use, comparing loan terms on price vs. non-price margins, denied/discouraged/turned down for credit, and credit card holding.