Fuzzy Math and Red Ink:
Payment/Interest Bias and Consumer Borrowing Decisions

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Abstract

We use a unique survey instrument to show that many consumers exhibit what we call "payment/interest bias:" they systematically understate the annual percentage interest rate (APR) associated with a stream of debt payments. Faced with a stream of payments implying a 50 percent APR, the typical consumer underestimates the APR by roughly thirty percentage points. We find that consumers with larger bias are more likely to be borrowers and less likely to be savers, conditional on a large set of household demographic and household characteristics. When shopping for loans, they are also less likely to compare loans using interest rates and more likely to compare using monthly payments. Consumers who compare using payments or other non-interest terms have recent loans with systematically different terms than those who shop based on rates. Our results suggest that framing loans in terms of payments may induce different decisions than framing them in terms of rates.

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1 Introduction

Economists typically model intertemporal choice by asserting that agents make tradeoffs between current and future consumption by using interest rates. In particular, the standard model of interremporal choice assumes that consumers make borrowing decisions by comparing interest rates across alternative assets and liabilities. But what if most consumers have difficulty making such calculations, in a way that affect their decisions? More precisely, what if the way in which loan terms are framed can affect borrowing decisions?

This paper examines a particular form of bias in consumers' ability to effectively translate a stream of loan payments into an annual percentage rate (APR). We use an interest rate quiz in the 1983 Survey of Consumer Finances to establish that consumers display "payment/interest bias:" a systematic tendency to underestimate the APR associated with a stream of payments. Because the quiz yields numerical answers, we can quantify payment/interest bias at the individual level. As one might expect, the degree of bias of bias is strongly correlated with education, age, and other household characteristics. Payment/interest bias has been documented in other studies, but ours is the first to ask the more important question: is payment/interest bias correlated with consumer borrowing decisions? While other work has found evidence of bias, it has neither shown its existence in nationally representative data nor examined the link between bias and behavior.[1]

We focus on two relationships in the data. We first examine the relationship between payment/interest bias and consumers' tendency to be borrowers rather than savers. *A priori,* the impact of the bias on borrowing and saving decisions is unclear. If loan offers tend to be framed in terms of payments, then consumers with payment/interest bias may borrow more and save less. On the other hand, consumer decision rules (e.g., focusing on payments, procuring outside expertise) may be adaptive, counteracting the bias. In fact we find that borrowing increases with payment/interest bias, and that saving decreases with bias. Biased consumers are more likely to carry a balance on their credit card, more likely to have borrowed rather than paid cash for a recent purchase, and less likely to have saved over the prior year. These correlations remain large and statistically significant even after controlling for household characteristics including income and wealth.

To support the notion that payment/interest bias affects cosumer behavior, we also estimate the relationship between payment/interest bias and the rules consumers use when comparing loans. We show that it is precisely those consumers with the greatest degree of payment/interest bias who use the size of monthly payments to shop for loans, rather than the interest rate. The former shopping rule suggests a rationale for the ubiquity of lender offers that focus on "low" monthly

[1] Both Juster and Shay (1964), Kinsey and McAlister (1981) find evidence consistent with our observed payment/interest bias using less representative data.

payments rather than APRs—and is consistent with the idea that framing loans differently can change consumer decisions, a la Glaeser (2004). We also find that many consumers are prone to relating a stream of payments to the "add-on" or simple interest rate associated with the loan; lenders' historical prediliction for promoting add-on rather than true interest rates motivated Truth-in-Lending disclosures that require financing costs to be displayed as an Annual Percentage Rate (APR). The connection between shopping rules and behavior is reinforced by the economically significant relationship between consumers' shopping rule and borrowing outcomes. Consumers who list monthly payments as the most relevant feature of a new loan are more likely to be borrowers than those listing the interest rate, even after controlling for the degree of payment/interest bias.

The findings suggest that payment/interest bias may provide a novel explanation for long-standing puzzles related to "overborrowing" and "undersaving." Calibrated consumption function models severly underpredict credit card borrowing [Carroll (2001)]. Allowing for "present-biased" preferences (via quasi-hyperbolic discounting) closes the gap, but not entirely [Angeletos, Labison, Repetto, Tobacman, Weinberg (2001)]. Our findings suggest that payment/interest bias may play a role as well. More generally our paper relates to a growing empirical literature that scrutinizes the specific assumptions underlying neoclassical models of intertemporal consumer choice, and examines the impact of violations on household financial decision-making. The literature review section provides more details.

2 Background

More than many other economic decisions, intertemporal consumer choice involves solving complex problems. This is perhaps why so much attention in behavioral economics and finance focuses on intertemporal choice problems as likely candidates for violations of neoclassical theory.[2] A stylized neoclassical model makes a number of assumptions about how consumers solve such complex problems, namely that they: 1) have stable preferences, 2) have full information on prices and choice sets, 3) have reasonable beliefs about probabilistic outcomes, 4) recognize when a problem needs solving, 5) solve a problem upon recognizing it, 6) solve it correctly, conditional on parameter values, and 7) actually implement the correct solution. Recent work has begun to test whether these assumptions hold in the real-world decisions related to household finance. Odean (1998) (and

[2] All of this work on the existence and implications of neoclassical violatons builds on much earlier work in economics and pyschology. "Behavioral" strands in economic theory related to household finance date at least to Smith (1759) – see commentary in Ashraf, Camerer, and Loewenstein (2005)— with Simon (1979) and Strotz (1955) among the more recent forerunners. Of course experimental psychology and experimental economics have also provided impetus for much of the above fieldwork; for reviews see, e.g., Conlisk (1996), Rabin (1998), Kahneman (2003), and Camerer and Loewenstein (2004).

Bertrand, Karlan, Mullainathan, Shafir, and Zinman (2005)), find that demand for an asset (loan) can be influenced by reference points (and subtle cues), suggesting preference instability. Chan and Stevens (2004) finds that information deficencies (on pension plan provisions) impact savings behavior. Ausubel (1991) (as well as Barber and Odean (2001) and Guiso and Jappelli (2005)) find that beliefs do not always square with realizations; namely, individual borrowers (investors) appear to be overly optimistic. Choi, Laibson, and Madrian (2005) suggests that consumers do not always recognize a problem, even when it presents an arbitrage opportunity. Ameriks, Caplin, and Leahy (2003) finds that consumers often lack the willpower to solve a complex problem upon recognizing it; one-third of adults in their 50s do not have any plan for retirement (Lusardi 2003). Following through on optimal solutions can be difficult if consumers face self-control problems: Shui and Ausubel (2004) find that time inconsistency can explain credit card contract choice (while exponential discounting can't), and Thaler and Bernartzi (2004) and Ashraf, Karlan, and Yin (forthcoming) find preferences for new commitment devices that are consistent with sophisticated responses to self-control problems.

While this prior work broadens our understanding regarding some ways in which neoclassical theory may not completely describe borrowing and saving, we know of no work other than our paper that looks specificially at the ability to correctly solve financial problems—and the relationship between this ability and behavior in the real-world. Bertrand, Karlan, Mullainathan, Shafir, and Zinman (2005) and Iyengar and Jiang (2003) have related findings on "choice overload" in borrowing and savings decisions. Ameriks, Caplin, and Leahy (2004) find that limited memory and monitoring produce "precuationary spending". Benjamin and Shapiro (2005) examines the relationship between a general measure of cognitive ability and portfolio decisions. The most similar paper to ours is Lusardi and Mitchell [in progress], which analyzes relationships between answers to multiple choice questions on financial literacy (re: interest compounding, inflation, and diversification) and savings portfolios in the Health and Retirement Survey. Our documentation of an payment/interest bias may also relate to the neuroscience of mathematical compuatation. The links are tenuous, since we have no information on how the survey respondent attempts to solve the interest rate quiz, and since the neuroscience literature is focused on problem-solving mechanics and mean error rates rather than bias. Nevertheless two sets of findings may be relevant: arithmethical accuracy declines as numbers get larger (for reviews see DeStefano and LeFevre 2004; Campbell and Xue 2001), and when the operation involves fractions, proportions, or decimals (Brase 2002; Dehaene 1997)

3 The SCF Interest Rate Quiz

The 1983 Survey of Consumer Finances asked household heads the following question:[3]

> *"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?"*

Consumers' responses to this question are lump sums (e.g., $1200). After recording the respondent's answer, the surveyer then followed up with this:

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

This pair of questions is unique becausethe *internal consistency* of the two answers provides a direct measure of conusmers' ability to relate a stream of payments to an interest rate. The calculation is fairly complex, as the monthly payments imply that the principal balance declines over the year. Thus, the simple "add-on" interest rate dividing the lump sum by the principal (e.g., $1200 for $1000 is 20%) is inappropriate. Further, given the complexity of the calculation we are unsurprised to find that consumers often make *mistakes*. The puzzle, we point out below, is that mistakes are not centered around the true answers (or even the add-on rate). It is this *bias* that is most compelling.

3.1 Bias and Fuzzy Math

Figures 1 and 2 illustrate the basic facts regarding consumers' answers. Figure 1 shows the distribution of what we call the *implied rate*: the annual percentage rate (APR) implied by the dollar figure supplied in the first question. Figure 2 shows the *stated rate*: the interest rate figure given in the second question. Independent of the level of the answer, these two figures should be equal if a consumer is adept at interest rate calculations.

As Figure 1 shows, the mean of the implied rate across all consumers is 57 percent, which corresponds to a stream of payments over the year totalling roughly $1350. The modal answer is $1200 (35%), with other popular responses being round numbers in the hundreds (1300, 1400, 1100, etc.). The twenty-fifth percentile is 35 percent and the seventy-fifth is 81 (corresponding to figures of $1200 and $1500). In figure 2, we show the distribution of stated interest rates. The modal answer is eighteen percent, with the twenty-fifth percentile at 12 percent and the seventy-fifth at 19 percent. Very few respondents give an answer above twenty percent.

[3] The SCF is a nationally representative household survey taken every three years. It typically covers roughly 4000 households, oversampling those at the top of the income distribution. We use the 1983 survey because it is the only one in which the quiz appeared. See Appendix A for a more detailed description of the data.

Casual inspection shows that the distribution of implied rates clearly lies to the right of the distribution of stated rates, a bias we document in Figure 3. The figure shows the difference between the implied APR supplied in the first answer and the stated APR supplied in the second. Fewer than 1% of answers are correct in that the stated and implied APRs match exactly. Both the degree of bias and its size are striking. More than 99% of errors lie to the right of zero, meaning that consumers systematically understate the interest rate associated with a flow of payments.

Before proceesing to the next section we discuss alternative interpretations of the result—interpretations that would render suspect our conclusion that we are measuring bias. One is that while (unsurprisingly) consumers are making mistakes, these mistakes are centered around a reasonable alternative answer to the question. This could occur, for example, if consumers supply add-on rates associated with their payments. Indeed, roughly 25% of respondents give the add-on rate. While this is technically incorrect (if one is comparing the interest rate to rates on other assets, for example), it may be most natural or convenient to simply supply the add-on rate. Although the add-on rate underestimates the true cost of borrowing, it did feature prominently in consumer installment loan markets in 1983. Combined with the open-ended wording of the quiz questions, this suggests that a respondent supplying the implied add-on rate could be considered as answering correctly, particularly given the time required to calculate the APR.

There are a few reasons to be skeptical regarding this view. Mistakes are highly skewed even relative to the add-on rate. In our sample, 778 people supply the add-on rate corresponding to their self-supplied stream of payments, 240 give a rate above the add-on rate and 3066 give a rate below the add-on rate. Thus, the number of consumers under-estimating the rate relative to add-on is over ten times greater than the number over-estimating it. So, defining add-on rates as "correct" does not eliminate the bias. Nor do we think that consumers are imputing other costs (such as loan processing fees) into the lump sum payments. These would have to be extremely large to explain the payment/interest bias we observe.

More compelling, however, is the fact that we find little evidence that our bias is centered around something higher than the APR. If this were true, then consumers at this higher rate would be "more correct" than those supplying the APR. Since in general education should be a good indicator of facility with math, we should expect these consumers to be more highly educated than those on the tails of the distribution. In fact, we find the opposite. Consumers on the left-most tail—those giving answers closest to the add-on rate—are the most highly educated. They also have substantially higher net worth and income than those in the middle of the distribution.

Nor does the bias appear to be an artifact of the survey design. Mistakes were not likely due to survey fatigue or incongruence, since the quiz questions were asked very early in the adminstration of the survey, and followed other questions on borrowing. The quiz questions themselves appear

robust, as other surveys have found a similar payment/interest bias from questions that are framed differently. Juster and Shay (1964) is most comparable; they find a large (1500 bp on average) bias using quiz questions that were identical to the 1983 SCF's, except that the loan amount and maturity was chosen by the respondent (rather than pegged at $1,000), based on an actual recent transaction.[4] Juster and Shay's finding is notable given that their sample and survey design was such that quiz respondents should be relatively knowledgeable. Several studies conducted in individual states in the 1970s found that respondents systematically underestimated the APR associated with a stream of 12 equal monthly payments (see Kinsey and McAlister 1981 for a review).

Finally, we note simply that a spurious or mismeasured payment/interest bias should work against finding any systematic relationship between our measure of the bias and consumer behavior. With this in mind, we now discuss how such a relationship might manifest itself.

4 payment/interest bias and Financial Decisions: Theoretical Framework

While there is intuitive logic to the idea that payment/interest bias might induce borrowing if loans are framed in terms of payments, the theoretical relationship between payment/interest bias and financial decisions is not clear. As an illustration, consider a standard model of intertemporal consumer in which a consumer trades consumption today with consumption tomorrow, where the "interest rate" represents the cost of foregone future consumption. The most common formulation of this problem produces an Euler equation (e.g, Deaton 1992; Laibson and Harris 2004). In the exponential discounting case, the optimizing consumer equates the ratio of marginal utilities in sucessive periods to a ratio of her discount rate to "the" real interest rate, or:

$$\frac{U'_{t+1}}{U'_t} = \frac{1+d}{1+r}$$

Where d is the consumer's discount rate and r is the interest rate. Now consider a consumer who is neoclassical in every way (see the assumptions discussed in the literature review section) but possesses interest-rate bias. She may well be offered a loan that is framed as a stream of monthly payments, given the seeming ubiquity of this marketing approach in debt and durable goods markets. Should this occur, she may borrow more than a unbiased consumer who computes the true interest rate associated with such an offer. Or she may not. Rather, she may develop

[4] Bernheim [1995], Bernheim [1998], and Moore [2003] also find evidence consistent with limited understanding of loan terms, including interest rates.

decision or shopping rules that enable her to optimize as if she knew the true cost of borrowing. For example, she may ignore monthly payments and focus on APRs, or retain a financial advisor.

Another possibility is that biased consumers demand more debt, but lenders balk at supplying it. Consumers who fail to comprehend the true cost of borrowing may be relatively poor credit risks; if this is (partially) observable to lenders, and interest rate ceilings or information asymmetries prevent credit suppliers from using price to clear the market, then biased consumers may be rationed.

We consider the possibilities that decision rules and supply responses dampen or eliminate the impact of payment/interest bias on financial decisions in our empirical work below.

5 Empirical Evidence on Bias and Consumer Behavior

In this section we explore the relationship between payment/interest bias and consumer behavior. We first describe the correlation between bias and a standard set of household characteristics. In addition to these standard characteristics we show that there is a relationship between bias and what we call shopping rules—whether a consumer compares loans based on payments or interest rates. The main empirical section estimates the relationship between bias, shopping rules and borrowing, controlling for a rich set of household characteristics. Finally, we test whether bias and shopping rules are related to the terms of consumers' most recent loans.

In order to highlight the summary relationships in the data, we classify the degree of bias by constructing four categories of error. Table 1 shows our classification and the values of stated rates, implied rates and errors for each category. Consumers in the "best" category are those with stated rates no more than 500 basis points away from their implied rate (in either direction). There are relatively few of these households. The next three categories measure successively larger mistakes, and there is a "n/a" category for households who failed to supply one or both rates and whose bias can therefore not be measured. Looking at the relative movements in stated and implied rates across the columns, it becomes clear that nearly all variation in bias comes from variation in the implied rate. From the first to fourth column the mean implied rate rises by almost 100 percentage points or 10,000 basis points. The stated rate stays flat, although it may be slightly lower in the worst category than in the best.

One point to note about this variation is that it seems likely that consumers are anchoring on market rates when supplying the stated rate. Market rates for debt (such as credit card rates) were extremely similar to the states rates supplied by consumers. It is likely that consumers have no such benchmark when supplying the total payment figure that yields the implied rate. While this is a feature of the data, it is not clear that it would affect our ability to infer bias. Whatever the source of variation, it still seems sensible to think of those with larger errors as having greater bias.

5.1 Bias and Household Characteristics

Table 2 shows the relationship between bias and household characteristics. There is a strong relationship between bias and education, with biased households generally having less education. In the best category, three times as many households have college degrees as have no high school education; the ratio is reversed for those in the fourth category. Those in the "n/a" category are even less likely to be highly educated. While there is little systematic relationship between age and bias, there is a strong relationship between bias, income and financial assets. On average, a household in the best category has income and wealth 2.5 and 5 times greater than a household in the worst category.

We take two things from this table. First, these data reinforce the notion that our definition of bias—deviations from the APR—is sensible. By any metric consumers in the best group are those who we would intuitively expect to be less biased; they are far more highly educated (and more educated than those who supply the add-on rate). They are also far more successful financially than those in any other group, though we ascribe no causality to the relationship. A second lesson from this table is that our measure of bias is correlated with observable variables in economically meaningful ways. The differences in terms of observable characteristics between those in different groups are striking.

5.2 Bias and Shopping Rules

We also identify a systematic relationship between bias and the way in which consumers shop for loans. The SCF also asks consumers this question:

> *"... in choosing an automobile loan, which of the credit terms listed on this card would be most important to you if you were going to use credit to purchase a car?"*

Consumers list their top three choices from a list of over ten. The most popular responses are "interest rate" and "size of the monthly payment," which together comprise roughly half of all responses.[5] As we noted above, a purely neoclassical model would have little to say about which terms consumers use to compare loans, and even less about how these terms would be related to bias. Nonetheless, we see in Table 3 that there is a strong relationship between bias and consumers' first choice on loan term. In the best category, half of consumers shop based on interest rates—this share falls to twenty percent in the worst category. The share of consumers listing "payments" or "other" consequently rises substantially moving from best to worst.

Again, it is unclear how to interpret this result in isolation. There appears to be a relationship between shopping rules and bias, but we hesitate to ascribe any causal relationship to the link. It

[5] Others include: the total size of interest/loan payments, the size of the loan, and fees for late or early payment.

is possible, furthermore, that shopping based on payments may be helpful or harmful relative to shopping based on interest rates, and that the relationship between shopping rules and outcomes might vary with bias. We will examine these issues below.

5.3 Bias, Borrowing and Saving

Our primary interest is in understanding the relationship between our measure of bias and consumers' financial decisions. While it seems plausible that consumers with bias make decisions differently, the extent to which they do so is an empirical matter. To examine this issue we look at three measures of borrowing/saving from the SCF:

1. Whether the consumer carries a balance on their credit card "sometimes" or "often;"
2. Whether the consumer borrowed to fund a recent purchase, or paid cash;
3. Whether the consumer reports saving, breaking even or dissaving over the last month.

We choose these variables to measure borrowing rather than others because they measure the extensive debt margin ("are people borrowing?") rather than the intensive margin ("how much are people borrowing?"). We prefer to look at the extensive margin for a number of reasons. First, any of our results are likely to be clouded by omitted variable bias, but we feel that such bias is less of an issue for extensive margins rather than intensive margins. Consider the decision to examine debt levels. If consumers with bias also appear riskier, they will tend to face credit constraints. This will reduce their observed debt even if they demand greater debt at a particular price. To the extent that such constraints operate on the intensive margin, focusing on the measures above should provide a clearer picture of how bias is linked to borrowing. A second issue is that SCF underreporting of credit card debt (see e.g., Gross and Souleles 2002) is likely to be less severe on the extensive margin (Draut and Silva 2003). A third reason for focusing on the extensive margin of borrowing is functional form. Debt levels are extremely right-skewed and often have medians of zero, leaving one to choose among parameterizations that are prone to bias induced by outliers or selection.

Table 4 shows summary statistics for the borrowing/savings measures based on category of bias. On each dimension, consumers with greater bias are more likely to be borrowers. It is again difficult to interpret these results definitively, because the categories vary so tremendously on other characteristics that might be correlated with borrowing decisions (such as income).

Each of the three variables induces a different sample. The last variable (saving vs. dissaving) is available for the entire sample. For the credit card borrowing question, we condition on credit card ownership. Again, this is aimed at reducing the effect of omitted variables such as riskiness.

For the recent purchase question, we condition on the consumer having made such a large purchase (costing more than $500).

To learn more about the relationship between bias and borrowing, we estimate a series of models with borrowing outcomes as dependent variables, and bias and other household characteristics as independent variables. These include a set of household demographic and financial characteristics: log(income), log(assets), homeownership, mortgage holdings, a set of education dummies, dummies for employment and marital status, race and gender categories, age (level and squared), and a full set of industry and occupation dummies.[6] Appendix B (to be completed) details the definitions of these variables and presents summary statistics. We also include our measure of shopping rules, to understand whether they are systematicallly related to borrowing. Tables 4a and 4b suggest that there is such a relationship.

5.4 Results

Tables 5-7 shows the results of the borrowing models. The first two—examining credit card borrowing and borrowing for a recent purchase—are discrete choice models where the dependent variable takes on a value of one if the consumer is a borrower. We estimate these models using a logit specification. The third model examining savings is an ordered probit model, with higher values indicating greater borrowing and less savings. In general, the tables show sensible patterns for the coefficients on the household financial variables, though we do not discuss them at length here. Not surprisingly, income and assets are negatively correlated with borrowing. Where they are significant, employment and marriage are positively correlated with borrowing. Homeownership is negatively correlated with borrowing while holding a mortgage is positively correlated with borrowing. The sets of dummies are significant, with the exception of the industry and occupation sets which are not jointly significant in some specifications; we include them nonetheless.

In each table we include a variety of measures of bias. We first include a dummy variable for "any error," defined as a stated rate more than ten percentage points (1000 basis points) away from the implied APR. We also include dummies for the categories used in the tables of descriptive statistics. Finally, we include the level of the error and its squared value. We also include a dummy variable, "like payments," equal to one if the respondent's preferred shopping term is something other than the interest rate.

Table 5 shows results for the credit card borrowing model. Both the "any error" dummy variable

[6] It is difficult to include net worth in these models because it is highly skewed, meaning that its level offers little explanatory variable. We can not include its log (as we do with income and assets) because it takes on many values less than or equal to zero. We have estimated the model including liabilities and liabilities squared; the inclusion of these variables leaves the main results unaffected.

and the parametric specification for errors have statistically significant coefficient estimates. The category dummy coefficients are not significant, although the point estimates are all positive. The results suggest that making any error is associated with a borrowing probability 0.06 higher, which is substantial relative to the sample mean of 0.50. The parametric specification suggests that bias is positively correlated with borrowing as well. Although the effect of bias takes on a maximum below the sample maximum, the estimated relationship between bias and borrowing is positive for all but the highest values of bias. As an example, the parametric specification suggests that a consumer with the mean level of bias is about 0.05 more likely to be a borrower than a consumer with zero bias.

For each functional form of bias, we show results with and without the "like payments" dummy. Its inclusion does not materially affect any of the results regarding bias. Moreover, in every specification, liking payments is positively related to borrowing. the point estimates imply that liking payments has about the same effect on the probability of borrowing as does making any error, or being at the mean level of bias. Because bias and liking payments are correlated, their cumulative effect can be quite large (increasing the probability of borrowing by well over ten percentage points).

Table 6 shows results for the recent purchase model. Again, bias is associated with significantly higher probabilities of borrowing. In fact, the marginal effects are slightly larger on average than those for credit card borrowing, even though the sample share borrowing for a recent purchase is not as high (it is roughly 0.40). The like payments variable is also positive and significant. Together, the results are striking - a consumer who has the mean level of bias and likes payments has a probability of borrowing that is over 0.15 higher than a consumer with zero bias who shops based on interest rates.

The pattern of results in Table 7 is a bit different. In contrast to the results in the previous two tables, in this table only the set of dummies for bias is significant. Nor are shopping rules significant. We plan to explore this more in future versions of the paper, but because this question relates to more general behavior (while that examined in Table 6 more precisely addresses recent borrowing decisions) it is noisier.

6 Discussion and Interpretation

While are results are suggestive that payment/interest bias induces borrowing, there are several identification issues that might affect the interpretation of our findings. These issues are typical of studies using individual-level cross-sectional data. The first potential confound is that errors might be correlated with other unobservable characteristics that influence borrowing. On the demand side, the concern is that consumers with bias are more interested in borrowing, but for reasons

unrelated to their interest calculations. It would certainly be true that, for example, consumers with bias would spuriously borrow more if bias were correlated with consumers' discount rates. Of course, the question is how such correlation would operate and why. Our view is that if bias were indeed correlated with discount rates, this would be an interesting result to be explored more fully rather than an alternative explanation for the results that would lead us to ignore the role of bias.

On the supply side, the most plausible concern is that consumers with bias are: a) flagged as relatively risky by lenders based on information that is not observable in the SCF; and b) rationed due to market frictions (information asymmetries, interest rate ceilings) that prevent lenders from efficiently pricing this risk. This channel probably works against finding a systematic relationship between the payment/interest bias and financial decisions. Moreover, the SCF asks two questions of consumers that relate to this: whether they have recently made a late payment on any loan, and whether they have recently been turned down after applying for credit. We have included these variables in the models; they do not change the results. Furthermore, we have estimated models with risk as the dependent variable (measured by either of the two), and payment/interest bias as an independent variable (along with the other covariates discussed above). There appears to be no relationship between bias and late payments or being turned down for credit.

A second potential issue is reverse causality; e.g., if the process of making financial decisions provides learning opportunities that change the level of payment/interest bias. This almost certainly works against finding the observed positive relationship between bias and borrowing, since more experienced borrowers should then be more accurate in their interest rate calculations. Note however that reverse causality stacks the deck in favor of finding a negative correlation between bias and wealth accumulation.

A third potential confound is "over-controlling." The concern here is that payment/interest bias may have an causal effect on one or more of the included covariates that is independent of its effect on borrowing. This may well be the case with income and assets, for example. Under these conditions the covariates would capture part of the bias' effect on borrowing, with the implication that our estimates provide a lower bound on the true causal effect of bias on borrowiing

In short, while there are almost certainly unobserved variables correlated with bias and borrowing, most of them push against our findings. In future versions of the paper we plan to address this issue more fully.

7 Conclusion

We document that consumers display significant payment/interest bias: they systematically underestimate interest rates when confronted with a stream of interest rate payments. Consumers with greater bias are more likely to be borrowers than consumers with less bias. They are also more

likely to compare loans using monthly payments rather than interest rates. Even controlling for bias, consumers with shopping rules based on payments are more likely to be borrowers. Taken together, the results suggest that how loans are framed can affect consumer behavior.

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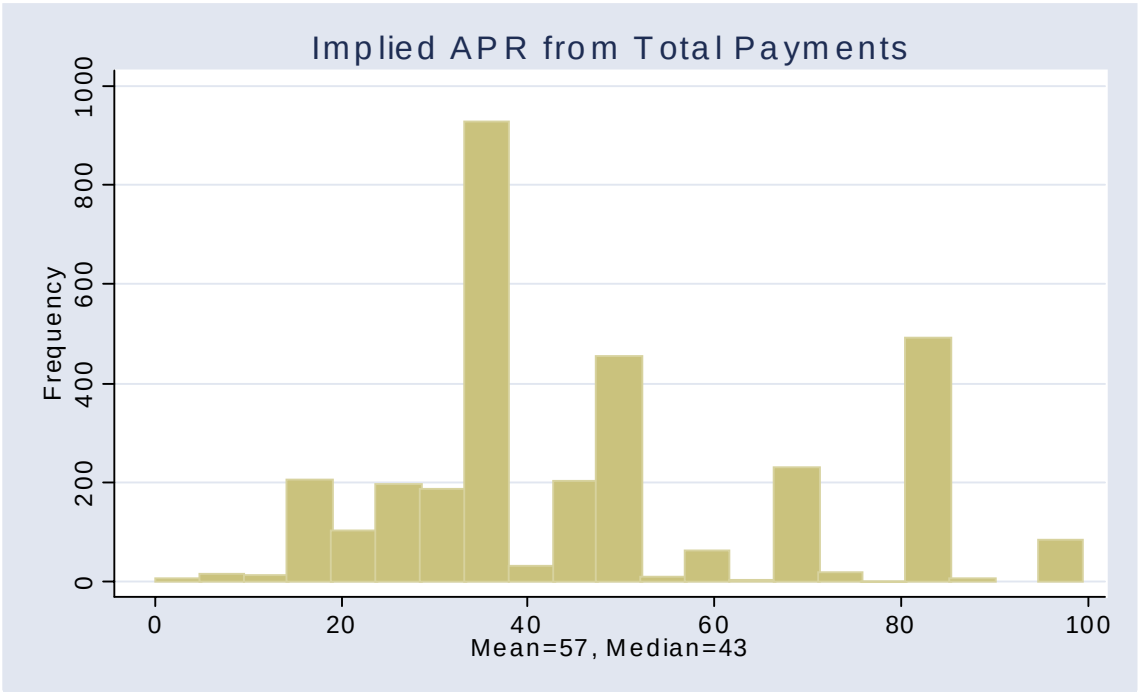
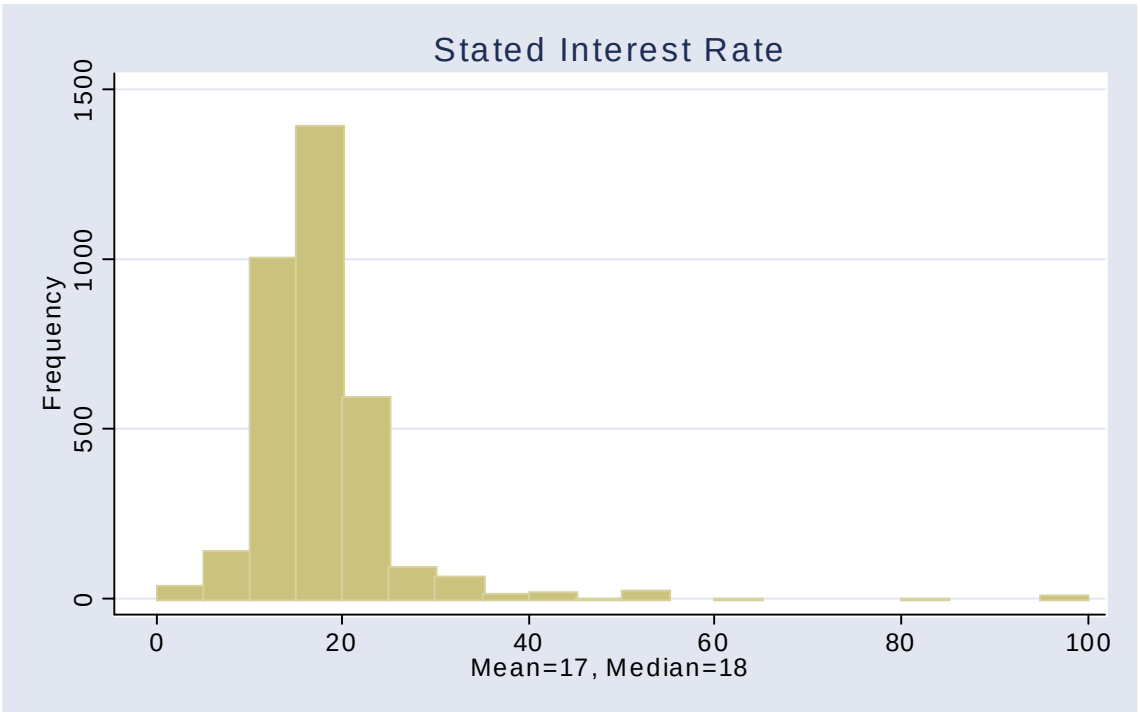

Implied APR from Total Payments
Frequency
0
200
400
600
800
1000
0
20
40
60
80
100
Mean=57, Median=43


Stated Interest Rate
Frequency
0
500
1000
1500
0
20
40
60
80
100
Mean=17, Median=18

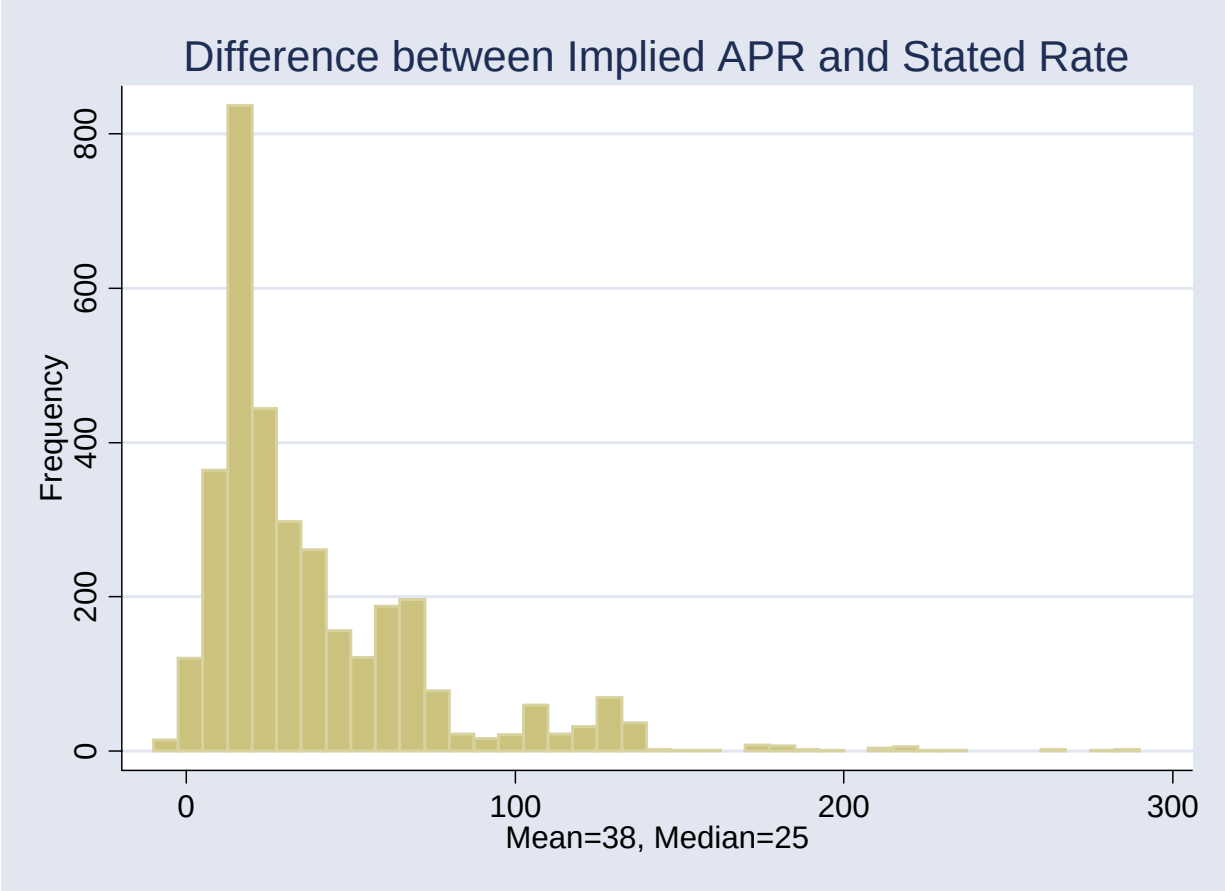

Difference between Implied APR and Stated Rate
Frequency
0
200
400
600
800
0
100
200
300
Mean=38, Median=25

Table 1. Quiz answers by error category

	Bias				
Variable	[-5, 10]	[10, 20)	[20, 50]	>50	n/a
Stated payment total (P&I)	1107	1188	1295	1680	1493
Stated interest rate	13	18	17	16	15
Implied APR	19	33	50	102	76
Mistake relative to APR	6	15	33	86	--
Share with d/k as initial payment response	0.05	0.03	0.07	0.13	0.32
Share with d/k as initial rate response	0.09	0.05	0.08	0.08	0.73
n	356	1,036	1,102	901	689

Errors are in percentage points, or hundreds of basis points.
Statistics are population-weighted means within category.

Table 2: Bias and household characteristics

	Bias				
	[-5, 10]	[10, 20)	[20, 50]	>50	n/a
Share with:					
No high school education	0.19	0.13	0.22	0.32	0.54
HS education only	0.29	0.29	0.35	0.34	0.27
Some college	0.23	0.25	0.24	0.18	0.12
College degree or beyond	0.29	0.32	0.20	0.16	0.07
Age	47	45	43	45	56
Income (1983$)	37963	36165	26952	23185	15500
Net worth (1983$)	111298	94350	47768	42929	42835
n	356	1,036	1,102	901	689

Errors are in percentage points, or hundreds of basis points.
Statistics are population-weighted mean within category.

Table 3: Bias and shopping habits

	Bias				
	[-5, 10]	[10, 20)	[20, 50]	>50	n/a
Share using:					
Interest	0.35	0.30	0.22	0.18	0.12
Payments/other	0.65	0.70	0.78	0.82	0.88
n	356	1,036	1,102	901	689

Shopping habits are self-reported as most important attribute of a new car loan.

Table 4: Bias and borrowing/saving

	Bias				
Variable	[-5, 10]	[10, 20)	[20, 50]	>50	n/a
Borrowing:					
Carries credit card balance	0.42	0.48	0.57	0.54	0.43
Recent purchase - borrowed	0.29	0.40	0.46	0.49	0.37
Saving:					
Saving	0.51	0.41	0.34	0.28	0.23
Even	0.22	0.20	0.20	0.28	0.39
Dissaving	0.28	0.39	0.45	0.44	0.38

Errors are in percentage points, or hundreds of basis points.
Carries credit card balance is conditional on credit card ownership.
Recent purchase - borrowed is conditional on recent purchase of $500 or more.

Table 4a: Bias and borrowing/saving, "like interest"

	Bias				
Variable	[-5, 10]	[10, 20)	[20, 50]	>50	n/a
Borrowing:					
Carries credit card balance	0.29	0.48	0.49	0.50	0.25
Recent purchase - borrowed	0.32	0.29	0.37	0.41	0.29
Saving:					
Saving	0.57	0.44	0.38	0.40	0.35
Even	0.19	0.18	0.14	0.22	0.31
Dissaving	0.24	0.38	0.48	0.38	0.35
n	126	313	242	162	85

Table 4b: Bias and borrowing/saving, "like payments"

	Bias				
Variable	[-5, 10]	[10, 20)	[20, 50]	>50	n/a
Borrowing:					
Carries credit card balance	0.48	0.49	0.59	0.56	0.48
Recent purchase - borrowed	0.29	0.47	0.47	0.52	0.39
Saving:					
Saving	0.38	0.41	0.33	0.27	0.21
Even	0.25	0.19	0.22	0.28	0.40
Dissaving	0.37	0.40	0.45	0.46	0.39
n	230	723	860	739	604

Table 5. Bias and credit card borrowing

	Dependent variable: carries credit card balance					
	(1)	(2)	(3)	(4)	(5)	(6)
any error (>10)	**0.07**	**0.06**				
	(0.03)*	**(0.03)***				
error in [10, 20]			0.03	0.02		
			(0.04)	(0.04)		
error in [20, 50]			0.06	0.06		
			(0.04)	(0.04)		
error > 50			0.04	0.04		
			(0.04)	(0.04)		
no answer on quiz			-0.05	-0.05		
			(0.05)	(0.05)		
error					**1.64e-03**	**1.55e-03**
					(8.29e-04)*	**(8.29e-04)+**
error^2					**-1.16e-05**	**-1.13e-05**
					(5.09e-06)*	**(5.08e-06)***
like payments		**0.06**		**0.06**		**0.05**
		(0.03)*		**(0.03)***		**(0.03)***
employed	**0.15**	**0.15**	**0.15**	**0.14**	**0.14**	**0.14**
	(0.05)**	**(0.05)****	**(0.05)****	**(0.05)****	**(0.05)****	**(0.05)****
married	**0.12**	**0.12**	**0.12**	**0.12**	**0.13**	**0.13**
	(0.04)**	**(0.04)****	**(0.04)****	**(0.04)****	**(0.04)****	**(0.04)****
ln(income)	**-0.06**	**-0.05**	**-0.06**	**-0.05**	**-0.06**	**-0.06**
	(0.02)**	**(0.02)****	**(0.02)****	**(0.02)****	**(0.02)****	**(0.02)****
ln(assets)	**-0.08**	**-0.08**	**-0.08**	**-0.08**	**-0.08**	**-0.08**
	(0.01)**	**(0.01)****	**(0.01)****	**(0.01)****	**(0.01)****	**(0.01)****
homeowner	**-0.15**	**-0.15**	**-0.15**	**-0.15**	**-0.16**	**-0.17**
	(0.04)**	**(0.04)****	**(0.04)****	**(0.04)****	**(0.04)****	**(0.04)****
has mortgage	**0.13**	**0.14**	**0.13**	**0.14**	**0.15**	**0.15**
	(0.03)**	**(0.03)****	**(0.03)****	**(0.03)****	**(0.03)****	**(0.03)****
Race dummies	Yes	Yes	Yes	Yes	Yes	Yes
Gender/age vars.	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes
Occupation effects	Yes	Yes	Yes	Yes	Yes	Yes
Education dummies	Yes	Yes	Yes	Yes	Yes	Yes

Probit estimastes, coefficients are marginal effects
Standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 6. Bias and recent purchase

	Dependent variable: borrowed for recent purchase					
	(1)	(2)	(3)	(4)	(5)	(6)
any error (>10)	**0.07**	**0.07**				
	(0.03)*	**(0.03)***				
error in [10, 20]			**0.09**	0.08		
			(0.05)+	(0.05)		
error in [20, 50]			**0.10**	**0.09**		
			(0.05)+	**(0.05)+**		
error > 50			**0.12**	**0.11**		
			(0.05)*	**(0.05)***		
no answer on quiz			0.05	0.05		
			(0.06)	(0.06)		
error					**2.22e-03**	**2.03e-03**
					(9.41e-04)*	**(9.47e-04)***
error^2					**-1.21e-05**	**-1.14e-05**
					(5.68e-06)*	**(5.71e-06)***
like payments		**0.08**		**0.07**		**0.08**
		(0.03)**		**(0.03)****		**(0.03)****
employed	0.07	0.06	0.07	0.06	0.08	0.07
	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
married	**0.07**	0.07	**0.07**	**0.07**	**0.08**	**0.08**
	(0.04)+	(0.04)	**(0.04)+**	**(0.04)**	**(0.04)+**	**(0.04)+**
ln(income)	-0.01	-0.00	-0.00	0.00	-0.01	-0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln(assets)	**-0.07**	**-0.07**	**-0.07**	**-0.07**	**-0.07**	**-0.07**
	(0.01)**	**(0.01)****	**(0.01)****	**(0.01)****	**(0.01)****	**(0.01)****
homeowner	**-0.10**	**-0.11**	**-0.11**	**-0.11**	**-0.13**	**-0.14**
	(0.05)*	**(0.05)***	**(0.05)***	**(0.05)***	**(0.05)****	**(0.05)****
has mortgage	**0.11**	**0.11**	**0.11**	**0.12**	**0.11**	**0.11**
	(0.04)**	**(0.04)****	**(0.04)****	**(0.04)****	**(0.04)****	**(0.04)****
Race dummies	Yes	Yes	Yes	Yes	Yes	Yes
Gender/age vars.	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes
Occupation effects	Yes	Yes	Yes	Yes	Yes	Yes
Education dummies	Yes	Yes	Yes	Yes	Yes	Yes

Probit estimastes, coefficients are marginal effects
Standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 7. Bias and saving

	Dependent variable: recent saving behavior (saved, even, dissaved)					
	(1)	(2)	(3)	(4)	(5)	(6)
any error (>10)	0.08	0.08				
	(0.05)	(0.05)				
error in [10, 20]			**0.15**	**0.15**		
			(0.08)+	**(0.08)+**		
error in [20, 50]			**0.23**	**0.22**		
			(0.08)**	**(0.08)****		
error > 50			**0.18**	**0.18**		
			(0.08)*	**(0.08)***		
no answer on quiz			**0.19**	**0.18**		
			(0.09)*	**(0.09)***		
error					4.14e-04	3.84e-04
					(6.36e-04)	(6.37e-04)
error^2					-2.90e-06	-2.77e-06
					(3.77e-06)	(3.77e-06)
like payments		0.07		0.07		0.02
		(0.05)		(0.05)		(0.02)
employed	-0.11	-0.11	-0.11	-0.11	-0.01	-0.01
	(0.08)	(0.08)	(0.08)	(0.08)	(0.04)	(0.04)
married	**0.16**	**0.16**	**0.16**	**0.16**	0.04	0.04
	(0.07)*	**(0.07)***	**(0.07)***	**(0.07)***	(0.03)	(0.03)
ln(income)	**-0.14**	**-0.13**	**-0.13**	**-0.13**	**-0.04**	**-0.04**
	(0.03)**	**(0.03)****	**(0.03)****	**(0.03)****	**(0.01)****	**(0.01)****
ln(assets)	**-0.12**	**-0.12**	**-0.12**	**-0.12**	**-0.03**	**-0.03**
	(0.01)**	**(0.01)****	**(0.01)****	**(0.01)****	**(0.01)****	**(0.01)****
homeowner	-0.01	-0.01	-0.02	-0.02	-0.00	-0.01
	(0.06)	(0.06)	(0.06)	(0.06)	(0.03)	(0.03)
has mortgage	0.03	0.03	0.03	0.04	0.01	0.01
	(0.06)	(0.06)	(0.06)	(0.06)	(0.03)	(0.03)
Race dummies	Yes	Yes	Yes	Yes	Yes	Yes
Gender/age vars.	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes
Occupation effects	Yes	Yes	Yes	Yes	Yes	Yes
Education dummies	Yes	Yes	Yes	Yes	Yes	Yes

Ordered probit estimates
Standard errors in parentheses
+ significant at 10%; * significant at 5%; ** significant at 1%