Financial innumeracy:
Consumers cannot deal with interest rates

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Abstract

Consumers often have to make decisions involving computations with interest rates. It is well known from the literature that computations with percentages and thus with interest rates amount to a difficult task. We survey a large group of consumers, and we find that questions on interest rates are answered correctly in about 20% of the cases, which in our setting amounts to a random choice. Additional to the available literature, we also document that consumers are too optimistic in the sense that they believe loans are paid off sooner than is true, which provides empirical evidence of self-serving bias. We further find that optimism can be reduced by increasing the monthly payments. The results are robust to corrections for general numeracy.

Key words: Financial innumeracy; Percentages, Interest rates; Numeracy
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1. Introduction

Today it is very common to purchase products now and to pay later. This can be done using credit cards, for example, or via loans. These loans can be taken from a bank, but today also many companies offer financial products. For example, car dealers have their own financial offers when a consumer purchases a car. When agreeing upon a loan, a consumer has to decide on the amount to be borrowed, and the consumer has to consider the interest rate, monthly payback amount and the time it thus takes to pay off the debt. An important figure in the computations that a consumer needs to do concerns the interest rate. Usually, an interest rate is quoted as a percentage, and when it comes to loans to be paid off in the future, the consumer needs to perform calculations concerning its impact on future amounts of money. In this paper we address this consumer task in more detail.

At present it is also well acknowledged that many households face problems while keeping their personal finances. At the heart of the 2008 credit crisis was the large fraction of households, particularly in the United States, with substantial debts due to personal mismanagement of for example credit cards. Individual homes had to be sold as households could not pay the mortgage anymore.

It is of substantial interest to study the potential causes for the financial problems of so many households. Recent studies in for example Hilgert et al (2003), Lusardi and Mitchell (2008), Lusardi and Tufano (2009) go in-depth as regards the potential causes of over-indebtedness and financial literacy. Indeed, it may well be that consumers do not have financial literacy and are simply not able to perform the computations that are necessary to manage personal finances. A recurrent example is that many individuals fail to understand that stock markets can go up but also can go down, which is associated with the processing of gains and losses, see for example Chatterjee et al. (2000). .

In the present paper we zoom in on the computations that individuals have to make and in particular on the computations that concern interest rates. Interest rates are percentages, and it is well known that consumers find it difficult to perform computations with interest rates, see Paulos (1988) and recently Chen and Rao (2007). What is unknown, however, is to what extent consumers make mistakes and also whether there is

any bias in these mistakes. That is, do consumers make computations such that the results are in their (believed) favor, instead of correct?

To this end, we carry out a simple survey amongst a large group of bachelor students, taking courses on Methods and Techniques in their second bachelor year. Additional to a range of questions on interest rates, we also have questions concerning innumeracy in order to single out whether mistakes on interest rates are perhaps due to general problems with calculations.

Our main findings are quite striking. First we find that the probability of choosing the right answer from K answer categories is about 1/K. This holds for the total sample and for the sample where we focus on those students (about 60%) with all other more general questions on calculations correct. A second finding is in correspondence with the literature on self-serving bias and it is that consumers have a tendency to underestimate the consequences of interest rates. More precise, they believe that debts are paid off earlier than is true. We put forward that this self-serving bias could be one of the factors that causes people to have problems with debts. The third finding is that higher monthly payment amounts reduce this bias, and we propose that this can be translated into a simple recommendation.

Our paper is structured as follows. In Section 2 we review the relevant literature (without claiming to be exhaustive) and we put forward a few hypotheses. In Section 3 we discuss the survey and in Section 4 we present the results. Section 5 concludes this paper with a few recommendations.

2. Literature

There are three literatures that are of interest to our study. The first literature deals with personal financial management. The observation, and this holds for many countries all over the world, is that many households face difficulties with their personal financial management. This can be illustrated by a wealth of examples where individuals get involved in financial pyramid games and loose large sums of money to deceivers. On a more accepted side, there are also many people who loose much money by trading on

stock markets, in various cases simply due to a lack of knowledge and a overly strong belief that when they trade the stock market will go up. There are brochures of financial products where the suppliers never mention the possibility that stock markets also can go down (and in fact, could go down very quickly), and where it also turns out that the consumers apparently also do not ask about this issue. Mortgages are sometimes sold with such amounts that households inevitably must fail to pay years later. Of course, there is a supply side responsibility, that is for example, pyramid games are simply not legal, but it is now also well acknowledged that consumers do have a responsibility themselves.

The interesting aspect of this latter presumption is to what extent households are anyhow able to perform financial management in a proper way. Recent studies of Hilgert et al. (2003), Lusardi and Mitchell (2008) and Lusardi and Tufano (2009) among others seek to shed light on to what extent consumers are actually able to perform proper management of personal management. Exemplary findings are that individuals face difficulties with financial planning when it concerns further-away horizons and that individuals can behave quite different from what they actually planned. For example, Lusardi and Tufano (2009) demonstrate that debt literacy is low.

One important issue that is touched upon in these studies concerns numerical skills. Indeed, a basic premise of the ability to perform proper financial management is that consumers can perform basic computational tasks. One of these tasks is concerned with dealing with percentages, and hence a second relevant literature concerns dealing with percentages and interest rates. Examples are Chatterjee et al. (2000) and Chen and Rao (2007). Subjects in these studies were found to have difficulties with computations with percentages and in particular mistakes were made concerning the asymmetry that is involved. That is, the difference between N% gain and N% loss is often misunderstood. Lusardi and Tufano (2009) also document that "only one-third of their population does seem to understand interest compounding".

The third literature deals with self-serving bias, that is, a tendency for people to evaluate ambiguous information in a way that is beneficial to their interests. We propose that one potential cause for households to end up in financial problems is that if they make mistakes with interests these are also made in the wrong way. That is, costs of loans

are estimated as lower that they really are. Tversky and Khaneman (1974) summarized a range of heuristics and biases that individuals can have, and some of these are translated to the issue of handling price changes in Heath et al. (1995).

Taking a few key results in these three literatures together, we postulate

Hypothesis 1: Consumers face difficulties with calculations using interest rates

This hypothesis follows from many studies, and our findings will most likely support earlier results, although to which extent is yet to be investigated.

The second hypothesis follows from the literature on cognitive bias, and reads as

Hypothesis 2: Consumers have a tendency for self-serving bias when it comes to paying back loans

If we find support for this hypothesis, then we could have an indication of one of the sources of debt literacy. In our analysis we will also seek for moderators of this bias, if there is any.

Finally, based on Paulos (1988) and the like, we do not have any a priori thoughts about whether general numerical skills are beneficial to skills concerning interest rates. So, we postulate

Hypothesis 3: Findings are independent from general numeric skills

In the next section we discuss the survey that we use to examine these three hypotheses.

3. Design of survey

Our questionnaire basically has one single question, which we repeat seven times. It deals with an amount Y to one borrows with an interest rate of x% per month. Also known is that monthly payment M to pay back the loan, and the very basic question concerns the

number of months that it takes to pay back the full *Y*. Additional to these questions, we ask a few general numeracy questions and a few demographics. The general idea of the first seven questions appears in Appendix A.

The survey was set out at the start of the class on Methods and Techniques for second-year bachelor students at the Erasmus School of Economics. These students all should have general computational skills. Also, students are used to borrowing money to pay for tuition, accommodation and general expenses. Even, most students additionally borrow money to afford driving a car or to have mobile phones and many other electronic gadgets. In sum, we can see these students as regular consumers who also make decisions concerning interest rates.

The survey was supervised by the second author, and it was stressed that students could not use a calculator. The whole survey took less than 15 minutes and after that, we had collected 433 questionnaires, which were almost all complete. We display the survey in Appendix B. The amounts *Y* are either 10000 or 20000 euros. The interest rates are either 0.6% per month or 0.8% per month. And, the monthly payment *M* is either 200 or 250 euros. Prior testing of the survey revealed that these numbers match with numbers that these consumers (in this age category) can encounter.

The general numeracy questions are taken from a range of questions that were all tested at other occasions to measure numeracy. Of course, these questions should be such that people can answer them quickly, and also such that at least a sizeable fraction of the respondents has all answers correct. Prior testing on another set of students revealed that the four questions N1 to N4 in Appendix B would work well.

In Appendix C we give the correct answers to the seven questions on interest rates and on the four general questions. The method in Appendix A is used (as it is available in Excel using PMT) to compute the correct answers. In Appendix D we re-iterate the survey settings so that we can use these later on to see if they have a moderating role in the empirical results.

4. Results

Our focus is on examining the relevance of hypotheses 1 to 3, and hence we summarize the empirical results such that conclusions can be drawn easily.

Insert Table 1 about here

Table 1 indicates that, on average (and also if we take the median), in only about 20% of the times the correct answer is given. If we were to excluding the two extreme categories (a) and (g), then this 20% matches with the level of a random guess. This low level of correct answers seems to provide strong support for Hypothesis 1, and is also in accordance with the findings in the literature.

Table 1 further indicates that the average fraction of "too low" answers, meaning that the number of months is estimated smaller than the actual number of months, is larger than the average fraction of "too high" answers. This finding is robust to using the median instead of the mean, although now the difference becomes smaller. The median is used to meet the possible effects of Question 6 for which the correct answer is (g).

In sum, Table 1 suggests support for Hypothesis 1 and for Hypothesis 2.

Insert Table 2 about here

In Table 2 we report on the regression results where we relate the fractions in Table 1 with the experimental settings in Appendix D. From the second column we learn that the fraction of correct answers is independent from the amount Y, quoted interest rate x% and monthly payments M. The same holds for the fractions "too high". Interestingly, the fraction "too low" does depend on the payment amount M. When the value M gets larger, then the fraction of "too low" gets smaller.

This finding is interesting as it can suggest at least one simple instrument to reduce the size of self-serving bias. When people get offered higher monthly payments, they may perhaps be less likely to underestimate their debts.

Insert Table 3 about here

Table 3 presents the same fractions as in Table 1, but now only for respondents who got gave all correct answers to questions N1 to N4. It appears that there are not many differences across the fractions in Table 1 and Table 3, and hence we are tempted to support Hypothesis 3. We also ran the same regressions as in Table 2 for this subset of the sample, and we find qualitatively the same results.

In sum, also for the numerically gifted, we document that they underestimate the number of months it takes to pay back the full amount (although slightly less so than the full sample). And, again, higher monthly payments reduce the degree of underestimation.

Insert Table 4 about here

Table 4 provides a few summary statistics on the other questions in the survey. We see that about 60% of the students had all correct answers to N1 to N4. Not reported is that the fraction of students with all questions wrong is 0%. In terms of gender and age, we see no differences in numerical skills, and this further supports the aggregate analysis in Tables 1 to 3. Finally, there was no consumer with all seven questions on interest rates correct. And, there are 58 consumers who gave always "too low" answers and 55 of the consumers gave always a "too high" answer. These results also motivate looking at the full sample, as is done in Table 1 to 3.

5. Conclusion

The main conclusions that can be drawn from our survey results are that consumers face substantial difficulties dealing with interest rates. Not only are they generally not able to correctly estimate the number of months it takes for them to pay back a loan, they also seem to systematically underestimate this number of months. This could be viewed as a first cause for households to run into financial problems, as they believe that they are earlier done with a loan than is really the case, and this in turn may lead to accepting new

loan offers too soon. And it is this pattern that inevitably will lead to financial problems. We also found that these results hold no matter if a consumer as excellent numerical skills or not.

A final important finding is that the monthly payment serves as a moderator. When this amount increases, then the size of self-serving bias decreases. To us this seems to suggest a simple instrument to reduce potential future financial problems. When loans come with higher monthly payments, consumers will make less biased mistakes. Indeed, if consumers believe it will take longer to pay off, then this is beneficial for personal financial management.

Appendix A:

Computing the number of months within which a loan of size Y is paid off, given a monthly interest rate of x% and a monthly payment of M euros.

	Amount left
Month 1:	$(1+x)Y$
Month 2:	$(1+x)Y - M$
Month 3:	$(1+x)[(1+x)Y - M] - M$
Month K:	$(1+x)^K Y - \sum_{i=0}^{K-1}(1+x)^i M$

Appendix B: The questionnaire

Example question: If you borrow 10000 euros at a MONTHLY interest rate of 0.6%, and pay back 250 euros per month, how many months (that is, the number of payments) do you approximately need to pay back the total loan with interest?

Panel 1: Seven questions about interest rates

Q1: The loan amount is 10000 euros, the monthly interest rate is 0.6% and the payback per month is 250 euros. The number of payments is

(a) < 40
(b) 40-45
(c) 45-50
(d) 50-55
(e) 55-60
(f) 60-65
(g) > 65

Q2: The loan amount is 10000 euros, the monthly interest rate is 0.8% and the payback per month is 250 euros. The number of payments is

(a) < 40
(b) 40-45
(c) 45-50
(d) 50-55
(e) 55-60
(f) 60-65
(g) > 65

Q3: The loan amount is 10000 euros, the monthly interest rate is 0.8% and the payback per month is 200 euros. The number of payments is

(a) <40
(b) 40-45
(c) 45-50
(d) 50-55
(e) 55-60
(f) 60-65
(g) > 65

Q4: The loan amount is 20000 euros, the monthly interest rate is 0.6% and the payback per month is 200 euros. The number of payments is

(a) < 100
(b) 100-120
(c) 120-140
(d) 140-160
(e) 160-180
(f) 180-200
(g) > 200

Q5: The loan amount is 20000 euros, the monthly interest rate is 0.6% and the payback per month is 250 euros. The number of payments is

(a) < 100
(b) 100-120
(c) 120-140
(d) 140-160
(e) 160-180
(f) 180-200
(g) > 200

Q6: The loan amount is 20000 euros, the monthly interest rate is 0.8% and the payback per month is 200 euros. The number of payments is

(a) < 100
(b) 100-120

(c) 120-140
(d) 140-160
(e) 160-180
(f) 180-200
(g) > 200

Q7: The loan amount is 20000 euros, the monthly interest rate is 0.6% and the payback per month is 200 euros. The number of payments is

(a) < 100
(b) 100-120
(c) 120-140
(d) 140-160
(e) 160-180
(f) 180-200
(g) > 200

Panel 2: Questions about general numeracy

N1 One chair costs 75 euros. When you buy 4 chairs, you get a 5% overall discount. How much do you need to pay when you buy 8 chairs?

- Less than 600 euros
- 600 euros
- More than 600 euros
- I do not know

N2 You buy 5 chairs for each 100 euros, Again, you receive 5% discount. However, you have to pay 19% tax over the total amount. How much do you need to pay, approximately?

- 425 euros
- 595 euros
- 565 euros
- I do not know

N3 There is a promotion in the supermarket for detergents. Each second package is half the price. How much do you need to pay if you buy 4 packages and each of them costs 5 euros?

- □ 7,50 euros
- □ 12,50 euros
- □ 15 euros
- □ 20 euros
- □ I do not know

N4 The weather forecast says that the average temperature for the next 3 days is 30 degrees Celsius. Tomorrow and the day after are predicted at 28 and 29 degrees. What will be the forecasts for the third day?

- □ 30 degrees
- □ 31 degrees
- □ 32 degrees
- □ 33 degrees
- □ 34 degrees
- □ I do not know

Panel 3: Demographics

G1 Gender

- □ woman
- □ man

G2 Age

- □ < 19
- □ 19
- □ 20-21
- □ 22-23
- □ > 23

Appendix C: The correct answers to the questions in Appendix B

Question

Q1	c (46)	N1	a
Q2	c (48)	N2	c
Q3	f (64)	N3	c
Q4	d (153	N4	d
Q5	b (109)		
Q6	g (202)		
Q7	c (128)		

Appendix D: The experimental setting

Question	Amount	Rate	Payback amount
Q1	0	0	1
Q2	0	1	1
Q3	0	1	0
Q4	1	0	0
Q5	1	0	1
Q6	1	1	0
Q7	1	1	1

Table 1: Frequency of answers to questions Q1 to Q7

Question	Sample size	Too low	Correct	Too high
Q1	432	0.382	0.256	0.362
Q2	431	0.244	0.197	0.559
Q3	429	0.548	0.148	0.268
Q4	428	0.484	0.178	0.339
Q5	428	0.266	0.231	0.509
Q6	429	0.795	0.205	0.000
Q7	428	0.381	0.154	0.465
Mean		0.443	0.201	0.357
Median		0.382	0.197	0.362

Table 2: Regression results of fractions in Table 1 on the variables in Appendix D (p-values on parentheses, based on HAC estimates of variance)

	Dependent variable is fraction		
Variable	Correct	Too low	Too high
Intercept	0.232 (0.005)	0.517 (0.028)	0.252 (0.200)
Amount	-0.025 (0.357)	0.059 (0.615)	-0.032 (0.812)
Rate	-0.039 (0.249)	0.080 (0.531)	-0.043 (0.774)
Payback amount	0.010 (0.741)	***-0.268 (0.061)***	0.259 (0.106)
P-value of F-test	0.464	0.212	0.354

Table 3: Frequency of answers to questions Q1 to Q7, computed for those respondents who gave the correct answers to all N1 to N4 questions

Question	Sample size	Too low	Correct	Too high
Q1	260	0.338	0.274	0.338
Q2	260	0.212	0.177	0.612
Q3	259	0.510	0.189	0.305
Q4	259	0.432	0.193	0.375
Q5	259	0.247	0.243	0.510
Q6	259	0.768	0.232	0.000
Q7	259	0.367	0.174	0.459
Mean		0.411	0.212	0.378
Median		0.367	0.193	0.388

Table 4: Some summary statistics

Correct answers to questions N1 to N4		
N1	0.942	
N2	0.737	
N3	0.907	
N4	0.812	
To all questions	0.596	
Demographics		Correct answers, all four
Men	0.613	0.630
Women	0.387	0.370
Age		
<19	0.026	0.023
19	0.313	0.335
20-21	0.339	0.323
22-23	0.202	0.202
> 23	0.120	0.117

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