Cabinet Office

ESRI Research Note No.87

Are Households' Decisions in Line with the Fisher Equation?

Takeshi Niizeki

September 2024

Economic and Social Research Institute
Cabinet Office
Tokyo, Japan

Are Households' Decisions in Line with the Fisher Equation? †

Takeshi Niizeki#
Chiba University
Economic and Social Research Institute, Cabinet Office

September, 2024

Abstract

This paper examines whether the saving, borrowing, and spending decisions of Japanese households are based on the Fisher equation. To this end, we conduct two experiments in which hypothetical scenarios are randomly assigned. The findings are threefold. First, households make saving and borrowing decisions based on nominal rather than real interest rates. Second, the loan interest rates that matter for the willingness to purchase durable goods is also nominal, not real. Third, we find no evidence that the more educated are less likely to suffer from money illusion.

Keywords: Fisher equation, money illusion, household behavior

†This paper forms part of the author's microdata-based research on household consumption at the Economic and Social Research Institute (ESRI), Japan. I would like to thank Yutaka Murayama, Hiroshi Nomura, Shingo Nakazawa, Kazuki Hiraga, and my colleagues at the ESRI for their helpful comments and iBRIDGE corporation for providing me with the data for this study. This research was supported by a grant-in-aid from JSPS KAKENHI Grant Number 23K01344. The views expressed in this paper are those of the author and do not represent those of the institutions with which we are affiliated.
Email: takeshi.niizeki@chiba-u.jp

1. Introduction

Monetary policy usually attempts to influence household behavior through changes in *real* interest rates. The Fisher equation states that to change the real interest rates, at least one of the following must change: nominal interest rates or inflation expectations. If households understand the Fisher equation correctly, it does not matter whether the change in the real interest rates is caused by nominal interest rates or by inflation expectations. However, several previous studies note the existence of money illusion in interest rates (Lioui and Tarelli 2022, Todorovic 2022, Darriet et al. 2020, Gemma 2016, Berro et al. 2015, Bruunermeier and Julliard 2008, Wilcox 1990). If household behavior is based on nominal rather than real interest rates, then the standard economic model needs to be modified.

Against this background, this paper examines whether households' saving, borrowing, and spending decisions are based on nominal or real interest rates. To do so, we conduct two randomized experiments, a saving experiment and a borrowing experiment. In both experiments, the real interest rate increases by five percentage points, and we test whether households' decisions differ when it is caused by a decline in inflation expectations or an increase in nominal interest rates.

This study aims to contribute to the literature in the following aspects. First, to the best of my knowledge, this is the first paper to examine whether Japanese households make decisions based on the Fisher equation. Unconventional monetary policy remains an important policy tool in Japan, where near-zero nominal interest rates have been in place for more than two decades. Therefore, it is important to examine whether Japanese households suffer from monetary illusion of interest rates. Second, this study focuses on three household behaviors: saving, borrowing, and spending. Previous studies mentioned above have focused on only one or two of these.

2. Data and experimental design

Two types of experiments were conducted in Japan from October 14 to 19, 2023: saving and borrowing experiments. Each experiment consists of three groups (C, T1, and T2), making a total of six groups. We recruited participants for the experiments from individuals registered with iBRIDGE Corporation and randomly assigned them to one of six groups. The hypothetical nominal interest rates (i) and inflation expectations (π^e) presented for each group are shown in Figure 1. r represents the real interest rate. That is, the real interest rates are higher in both T1 and T2 than in the control group, but for different reasons. If households do not suffer from monetary illusion, there should be no difference in their behavior between T1 and T2. Note that the near-zero nominal interest rate policy has been in place in Japan since 1999, and according to the Bank of Japan's "Opinion Survey on the General Public's Views and Behavior" conducted in September 2023, the median household's inflation expectations for the next one year was 10%. Thus, at least the situation in the control group is realistic.

This paper uses the following questions asked in our experiments, but only Q1 is different for each experiment. Q1 for the saving experiment is as follows.

Q1. Transfer (question only for the saving experiment)

(Hypothetical situation)

- Deposit interest rates at Bank A = x% (annual rate)
- Inflation expectations = y% (annual rate)

"If you could make a deposit at Bank A, how much of your current assets would you transfer to Bank A? Assuming that Bank A is in very good financial condition, please give an approximate figure up to 10 million yen."

On the other hand, Q1 for the borrowing experiment is as follows.

Q1. Borrow (question only for the borrowing experiment)

(Hypothetical situation)

- Loan interest rates at Bank A = x% (annual rate)
- Inflation expectations = y% (annual rate)

"Suppose you suddenly need to make a payment of 5 million yen (due to illness, accident, etc.). How much of the 5 million yen would you like to borrow from Bank A?"

Subsequently, in both experiments, we asked about satisfaction with the offered interest rates and the willingness to purchase durable goods as follows. Note that the hypothetical situation is always displayed at the top of the question (not restated here).

Q2. Satisfaction

"What is your level of satisfaction with the interest rate offered by Bank A? Please answer this question after taking into account the rate of increase in prices given."

Q3. Durable

"Suppose you now have one durable good (refrigerator, car, computer, etc.) that you want to buy. Under the interest rates and price increases offered, do you think now is a good time to buy it?"

Note that satisfaction with the interest rates is asked after taking into account the inflation rates offered. Thus, if there is no monetary illusion, there should be no difference between T1 and T2 in terms of satisfaction.

Table 1 summarizes the descriptive statistics of the data used. Respondent demographics are provided free of charge by the survey firm. They do not appear to differ significantly on average across

groups and it has been verified in Table A1 that each group is actually balanced. However, the sample size and composition of the two experiments were not necessarily balanced, as the proportion of respondents who answered "I don't know/I don't want to answer" was slightly higher in the borrowing experiment than in the saving experiment. Therefore, we should be careful when comparing the results between the two experiments.

For each experiment, we estimate the following equation:

$$y_i = \beta_0 + \beta_1 T1_i + \beta_2 T2_i + \beta_3 x_i + \varepsilon_i, \quad (1)$$

where y_i represents the various outcome variables, $T1_i$ and $T2_i$ are the respective treatment group dummies, x_i is the respondent characteristics listed in Table 1, and ε_i is the error term. Since the control group is excluded from the right-hand side of Equation (1), β_1 and β_2 represent the extent to which the outcome of each treatment group deviates from the control group. By virtue of random assignment, the respondent characteristics and each treatment group dummy are nearly orthogonal. However, since there may be efficiency gains, we estimate β_1 and β_2 after controlling for the respondent characteristics.

3. Estimation results

Table 2 shows the regression results. In the saving experiment, column (1) shows that the transfer amount is not significantly different between the control group and the T1 group (π^e down), but is significantly higher by 1.75 million yen in the T2 group (i up). A similar pattern is observed in column (2). Satisfaction with the *real* deposit interest rate increases significantly by 2.44 points on a 10-point scale when the *nominal* deposit interest rate is high, but no significant difference is observed with the control group when inflation expectations are low. There results indicate that respondents refer to *nominal* rather than *real* interest rates when making saving decisions. Finally, there were no significant differences among all groups with respect to willingness to purchase durable goods.

Turning to the borrowing amount in column (4), the T1 group (π^e down) borrows less than the control group, but the difference is limited to 0.25 million yen. On the other hand, the borrowing amount by the T2 group (i up) is about 1 million yen less than that of the control group, and the difference is significant at the 1% level. A similar pattern is observed for satisfaction with the *real* loan interest rates, with satisfaction decreasing only as the *nominal* interest rates increase (column 5). Thus, it appears that respondents are making decisions based primarily on *nominal* rather than *real* interest rates, not only for saving but also borrowing.

With respect to the willingness to purchase durable goods (column 6), only the T2 group (i up) shows a significant drop in willingness to purchase. This is a reasonable result since about 40% of Japanese purchase automobiles (major durable goods) with a loan (Japan Automobile Manufacturers Association 2021), but again, it is the nominal interest rate, not the real one, that matters here.

Finally, we examine whether the money illusion about interest rates observed in Table 2 is mitigated for the more educated respondents. To this end, we add an additional explanatory variable, a college-educated dummy that takes one if the respondent has a college degree and zero otherwise, interacted with each treatment dummy. Table 3 shows the estimation results. No significant differences in average treatment effects are observed across educational backgrounds for all dependent variables.[1]

4. Conclusions

In this study, we examined whether Japanese households save, borrow, and spend based on the Fisher equation, i.e., real rather than nominal interest rates. To do so, we conducted two randomized experiments. We found that households make decisions primarily based on nominal rather than real interest rates. In other words, their decisions are not in line with the Fisher equation. This was also true even for those with higher education.

Our analysis also has some room for improvement. First, our findings are based on hypothetical scenarios and may differ from those based on actual changes in circumstances. Second, our analysis has not been able to clarify the mechanism by which respondents have fallen into the monetary illusion. The regime change triggered by the end of zero interest rates may have brought about a significant change in their attitudes. Third, in our experiment, we do not distinguish between short-term and long-term interest rates. These are left for future research.

[1] We have confirmed that the responses do not differ depending on income (see Table A2).

References

Berro, K., Colman, G., and Dave, D. (2015) "The reality of the real rate," *Business and Economic Research*, Vol. 5, No. 2, pp. 270–287.

Brunnermeier, K. M., and Julliard, C. (2008) "Money illusion and housing frenzies," *The Review of Financial Studies*, Vol. 20, No. 5, pp. 135–180.

Darriet, E., Guille, M., Vergnaud, J., and Shimizu, M. (2020) "Money illusion, financial literacy and numeracy: Experimental evidence," *Journal of Economic Psychology*, Vol. 76, 102211.

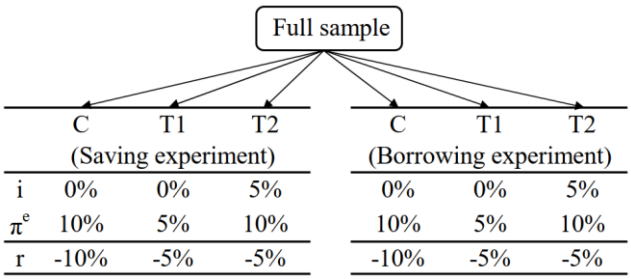
Gemma, Y. (2016) "Money illusion matters for consumption-saving decision-making: An experimental investigation," *IMES Discussion Paper Series*, No. 2016-E-6.

Lioui, A., and Tarelli, A. (2022) "Money illusion and TIPS demand," Journal of Money, Credit and Banking, Vol. 55, Issue 1, pp. 171–214.

Todorovic, A. (2022) "Negative interest rates and money illusion," Mimeo.

Wilcox, A. J. (1990) "Nominal interest rate effects on real consumer expenditure," *Business Economics*, Vol. 25, No. 4, pp. 31–37.

Figure 1: Sample assignments



Notes: Each group is given a scenario with nominal interest rates (i) and inflation expectations (π^e) as shown in Figure 1.

Table 1: Descriptive statistics

Group	Saving experiment			Borrowing experiment		
	C	T1 (π^e down)	T2 (i up)	C	T1 (π^e down)	T2 (i up)
Respondent demographics						
Male dummy	0.64	0.65	0.60	0.65	0.65	0.65
Age	48.5	48.0	48.1	48.7	48.4	48.8
No job dummy	0.11	0.10	0.11	0.13	0.10	0.13
Full-time worker dummy	0.57	0.56	0.57	0.59	0.60	0.58
Child dummy	0.54	0.54	0.54	0.54	0.56	0.53
Household pretax income (10,000 yen)	622	624	645	624	633	637
Marriage dummy	0.60	0.62	0.62	0.59	0.61	0.63
University dummy	0.58	0.58	0.59	0.56	0.57	0.57
Decision-making under hypothetical scenarios						
Transfer or borrowing amount (million yen)	1.94	1.92	3.73	2.52	2.27	1.55
Satisfaction with interest rates (0-10)	3.02	2.99	5.51	7.03	6.88	4.81
Durable dummy (good time to buy?)	0.42	0.43	0.45	0.53	0.57	0.36
Number of respondents	672	626	654	535	574	539

Notes: Transfer and borrowing amounts represent the response to Q1 in each experiment. Satisfaction with interest rates and durable dummy represent responses to Q2 and Q3, respectively.

Table 2: Regression results

	Saving experiment			Borrowing experiment		
Dependent variable:	(1) Transfer (million yen)	(2) Satisfaction (0-10 scale)	(3) Durable (1=Yes, 0=No)	(4) Borrow (million yen)	(5) Satisfaction (0-10 scale)	(6) Durable (1=Yes, 0=No)
T1 (π^e down)	-0.04	-0.08	0.02	-0.25*	-0.15	0.04
	(0.17)	(0.15)	(0.03)	(0.13)	(0.15)	(0.03)
T2 (i up)	1.75***	2.44***	0.04	-0.97***	-2.22***	-0.17***
	(0.18)	(0.15)	(0.03)	(0.13)	(0.16)	(0.03)
Mean of dependent variable for Control group	1.94	3.02	0.42	2.52	7.03	0.53
p-values for T1=T2	0.00	0.00	0.57	0.00	0.00	0.00
Control variables	YES	YES	YES	YES	YES	YES
Number of respondents	1,952	1,952	1,952	1,648	1,648	1,648

Notes: The table summarizes estimation results based on Equation (1). Since the control group is excluded, the coefficients on T1 and T2 are the number of units by which the outcome variable differs from the control group, other things being constant. Robust standard errors are shown in parentheses. ***, **, * indicate statistical significance level at 1%, 5%, and 10%, respectively.

Table 3: Regression results interacted with the college-educated dummy

	Saving experiment			Borrowing experiment		
	(1) Transfer (million yen)	(2) Satisfaction (0-10 scale)	(3) Durable (1=Yes, 0=No)	(4) Borrow (million yen)	(5) Satisfaction (0-10 scale)	(6) Durable (1=Yes, 0=No)
T1 (π^e down)	-0.03	-0.18	0.02	-0.14	0.03	0.08*
	(0.25)	(0.23)	(0.04)	(0.19)	(0.22)	(0.04)
T2 (i up)	1.70***	2.36***	0.08*	-0.96***	-2.13***	-0.15***
	(0.27)	(0.21)	(0.04)	(0.19)	(0.23)	(0.04)
T1 (π^e down)	-0.02	0.16	-0.00	-0.19	-0.31	-0.08
×College-educated	(0.31)	(0.28)	(0.05)	(0.24)	(0.28)	(0.05)
T2 (i up)	0.09	0.15	-0.07	-0.01	-0.14	-0.02
×College-educated	(0.34)	(0.27)	(0.05)	(0.23)	(0.30)	(0.05)
Mean of dependent variable for Control group	1.94	3.02	0.42	2.52	7.03	0.53
p-values						
for T1=T2	0.00	0.00	0.20	0.00	0.00	0.00
for T1+T1×Univ=T2+T2×Univ	0.00	0.00	0.75	0.00	0.00	0.00
Control variables	YES	YES	YES	YES	YES	YES
Number of respondents	1,952	1,952	1,952	1,648	1,648	1,648

Notes: See notes in Table 2.

Appendix: An additional Table

Table A1: Predictability of treatment status

Group	F-statistic	p-value	N
Saving experiment			
C	0.47	0.88	1,952
T1 (π down)	0.69	0.70	1,952
T2 (i up)	0.75	0.65	1,952
Borrowing experiment			
C	0.54	0.83	1,648
T1 (π down)	0.75	0.65	1,648
T2 (i up)	0.82	0.59	1,648

Notes: The table reports the F-statistic and p-value in the F test where all coefficients are zero when each treatment dummy is regressed on all respondent characteristics and asset-related variables obtained before the treatment.

Table A2: Regression results (high v.s. low income)

	Saving experiment			**Borrowing experiment**		
	(1) Transfer (million yen)	(2) Satisfaction (0-10 scale)	(3) Durable (1=Yes, 0=No)	(4) Borrow (million yen)	(5) Satisfaction (0-10 scale)	(6) Durable (1=Yes, 0=No)
T1 (π^e down)	-0.08	-0.12	0.03	-0.19	-0.11	0.04
	(0.19)	(0.17)	(0.03)	(0.15)	(0.17)	(0.03)
T2 (i up)	1.67***	2.42***	0.02	-0.93***	-2.29***	-0.16***
	(0.21)	(0.16)	(0.03)	(0.14)	(0.18)	(0.03)
T1 (π^e down)	0.13	0.14	-0.04	-0.20	-0.15	-0.00
×High income	(0.31)	(0.29)	(0.05)	(0.25)	(0.28)	(0.05)
T2 (i up)	0.29	0.07	0.05	-0.16	0.25	-0.05
×High income	(0.37)	(0.28)	(0.05)	(0.24)	(0.31)	(0.05)
Mean of dependent variable for Control group	1.94	3.02	0.42	2.52	7.03	0.53
p-values						
for T1=T2	0.00	0.00	0.74	0.00	0.00	0.00
for T1+T1×High income =T2+T2×High income	0.00	0.00	0.12	0.01	0.00	0.00
Control variables	YES	YES	YES	YES	YES	YES
Number of respondents	1,952	1,952	1,952	1,648	1,648	1,648

Notes: See notes in Table 2. The high income is a dummy variable that takes a value of one if the household pretax income is at or above the 75th percentile (8.5 million yen), and zero otherwise.