Households' Liquidity Constraint, Optimal Attention Allocation, and Inflation Expectations

Hibiki ICHIUE, Maiko KOGA, Tatsushi OKUDA, and Tatsuya OZAKI

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Motivation

- Inflation expectations are important for monetary policy, particularly at the ELB on nominal interest rates.
  - Commitments and policy rules: Krugman (1998), Reifschneider and Williams (2000), Eggertsson and Woodford (2003)
  - Direct communications to households and firms: Coibion, Gorodnichenko, Kumar, and Pedemonte (2018) "Inflation Expectations as a Policy Tool"
- But our understanding on formation of inflation expectations is limited yet.
  - Evidence against rational expectations has accumulated.
- Imperfect information models have attracted attentions.

Literature on Inflation Expectations under Imperfect Information

- Coibion and Gorodnichenko (2015) show that expectations formation process of professional forecasters can be explained by imperfect information models.

- Coibion, Gorodnichenko, and Kumar (2018) show that wide dispersion in firms' beliefs can be explained by rational inattention motives (incentives to collect and process information).

- Cavallo, Cruces, and Perez-Truglia (2017) find:
  - Individuals in Argentina (a high/unstable-inflation country) have stronger priors about inflation rates than in the US (a low/stable inflation country), which supports rational inattention models.
  - Individuals place a significant weight on inaccurate sources of information, such as their memories of the price changes of the super market products they purchase.

What we do and find

(Theoretical Analysis)

- We develop a (partial equilibrium) rational inattention model.

- The model predicts that households with a tighter liquidity constraint will allocate:
  - less attention to information on the central bank's policy.
  - more attention to current prices (bargain-hunting).

(Empirical Analysis)

- We find empirical support for the predictions of our theory, using micro datasets of Japanese households.

Contents

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2. Theoretical Analysis
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2. THEORETICAL ANALYSIS

Overview of the Model

- Two-period utility
  - Timing (buy when cheaper)
  - Store (buy where cheaper)
- Two frictions
  - Liquidity constraint
  - Information capacity constraint
    - Central bank policy
    - Distribution of the store-level prices
- Two decisions
  - Attention allocation
  - Inter-temporal consumption allocation

Consumption Allocation Problem at the ELB

Expected utility

$$\mathbb{EU} = \ln C_0 + \beta \mathbb{E}_0 \left[\ln C_1 \right]$$

Budget constraint (in real term)

$$C_0 \chi_0 + \underbrace{S_0} = \underbrace{I_0}$$

Lack of intensity of price search Saving   Income
(lowered by bargain-hunting)

$$\chi_1 C_1 = I_1 + \underbrace{R_1 S_0}$$

$$(= \chi_0)$$

Real interest rate
($\fallingdotseq$ 1/ future inflation rate)

Liquidity Constraint

$$-\theta I_1 \leq S_0$$

$$\theta \in [0, 1]$$

smaller $\theta \rightarrow$ tighter liquidity constraint

How to Derive the Optimal Consumption/Attention Allocatons?

- First, we derive the optimal consumption allocation, taking information structure as given.

- Then, we characterize the expected loss from imperfect information as:

  – The expected utility when consumption is determined under perfect information minus that when consumption is determined under imperfect information.

- Finally, we identify the optimal attention allocation as:

  – The allocation that achieves the lowest expected loss.

Optimal Consumption Allocation, Given Information Structure

Perfect Information

$$c_0^{**} = \min\left\{\frac{1}{2}\pi_1, \theta\right\} \qquad c_1^{**} = \max\left\{-\frac{1}{2}\pi_1, -\theta\right\}$$

Imperfect Information

$$c_0^* = \min\left\{\frac{1}{2}\mathbb{E}_0\left[\pi_1\right], \theta\right\} - x_0$$

$$\mathbb{E}_0\left[c_1^*\right] = \max\left\{-\frac{1}{2}\mathbb{E}_0\left[\pi_1\right], -\theta\right\} - x_0$$

Expected Loss
from Imperfect Information

$$\widehat{c}_t \equiv c_t^* - c_t^{**}$$

$$
\begin{aligned}
\mathbb{EL} \;\approx\;& -\mathbb{E}\left[\widehat{c}_0 + \widehat{c}_1 - \frac{1}{2}\left(\widehat{c}_0\right)^2 - \frac{1}{2}\left(\widehat{c}_1\right)^2\right] \\
=\;& \mathbb{E}\left[2x_0 + x_0^2\right] + \mathbb{E}\left[\left(\min\left\{\frac{1}{2}\mathbb{E}_0\left[\pi_1\right], \theta\right\} - \min\left\{\frac{1}{2}\pi_1, \theta\right\}\right)^2\right]
\end{aligned}
$$

Expected loss from insufficient bargain-hunting

Expected loss from inefficient inter-temporal consumption allocation due to imprecise inflation expectations

Store-level Prices, Inflation Perceptions, and Insufficient Bargain-hunting

$$p_t(i) = p_t + x(i) \qquad x(i) \sim \mathcal{N}(0, \sigma_x^2)$$

- Under the assumption that the log prices are zero in all stores at time -1:

$$\widetilde{\pi}_0 \equiv \frac{1}{n} \sum_{i=1}^{n} p_0(i) \sim \mathcal{N}(\pi_0, \sigma_{x|s}^2) \qquad \sigma_{x|s}^2 \equiv \frac{1}{n}\sigma_x^2$$

- The log costs of insufficient bargain-hunting are assumed to be proportional to the imprecision of inflation perceptions.

$$x_0 = \Gamma \cdot \sigma^2{}_{x|s}$$

Perceived Aggregate Inflation Dynamics

- Households are assumed to perceive that the aggregate inflation rate is determined by:
  - The inflation rate at the previous period
  - The inflation rate that the central bank aims to achieve in the long run
  - An aggregate shock
- For simplicity, we assume:
  - The inflation rate at time -1 is zero.
  - There is no aggregate shock in time 1.

$$\pi_0 = (1 - \rho)\,\pi^* + \epsilon_0 \qquad \epsilon_0 \sim \mathcal{N}(0, \sigma_\epsilon^2)$$

$$\pi_1 = \rho\pi_0 + (1 - \rho)\,\pi^* \qquad \pi^* \sim \mathcal{N}(0, \sigma_{\pi*}^2)$$

Information Capacity Constraint

$$\frac{1}{2}\log_2\left(\frac{\sigma_{x|s}^{-2}}{\sigma_x^{-2}}\right) + \Omega\frac{1}{2}\log_2\left(\frac{\sigma_{\pi^*|s}^{-2}}{\sigma_{\pi^*}^{-2}}\right) \leq \kappa$$

Improvement in the precision of inflation perception

Improvement in the precision of the belief about the central bank's policy

$$\sigma_{x|s}^{-2} \succeq \sigma_x^{-2}, \sigma_{\pi^*|s}^{-2} \succeq \sigma_{\pi^*}^{-2}$$

Main Results

- The optimal precisions of inflation perceptions and the belief about the central bank's policy, $\left(\left(\sigma_{x|s}^{-2}\right)^*, \left(\sigma_{\pi^*|s}^{-2}\right)^*\right)$, are decreasing and increasing, respectively, in θ .

- The dependency of inflation expectations on inflation perceptions is decreasing in θ, according to the numerical analysis.

Mechanism

- Households with tighter liquidity constraint:
  - ➤ Less room to adjust consumption, even when they realize the rise in future inflation rate
  - ➤ Fewer benefits of forming precise inflation expectations
  - ➤ Less attentive to central bank policy, but more attentive to current prices across stores
  - ➤ Less precise belief of the inflation rate that the central bank aims to achieve in the long run, but more precise Inflation perceptions
  - ➤ Inflation expectations depend more on inflation perceptions

EMPIRICAL ANALYSIS

Two Micro Datasets

	Preference Parameters Study (Osaka University)	**Opinion Survey on the General Public's Views and Behavior (BoJ)**
Sample periods	2004 – 2013 (every Q1 for 11 years)	Sep. 2006 – Sep. 2018 (for 49 quarters)
# of samples	Around 4,000/wave	Around 2,000/wave
Data type	Panel	Repeated cross-section
Question type	Largely quasi-quantitative	Mostly qualitative
Variables	Inflation expectations Consumption plan Income profile Financial assets Education	Inflation expectations Consumption plan Income profile Inflation perceptions Financial literacy (proxy) Literacy on the BoJ

Examples of Qs of the PPS

- By what percentage do you expect consumer prices will change in 2013, compared with the previous year?
    - 11 choices, such as
        - Decrease by at least 4.5%
        - Decrease by at least 3.5% but less than 4.5%
        - Change by less than 0.5% in either direction
    - We assign [-5%, -4%,..., 5%] to these choices.
- In 2013 what will be the approximate percentage change in your family's total annual expenditures compared with 2012?
    - 11 choices, such as
        - Decrease by at least 9%
        - Decrease by at least 7% but less than 9%
    - We assign [-10%, -8%,..., 10%] to these choices.

A Measurement Issue: Distributions of 1Y-ahead Inflation Expectations for 2004-2013

PPS
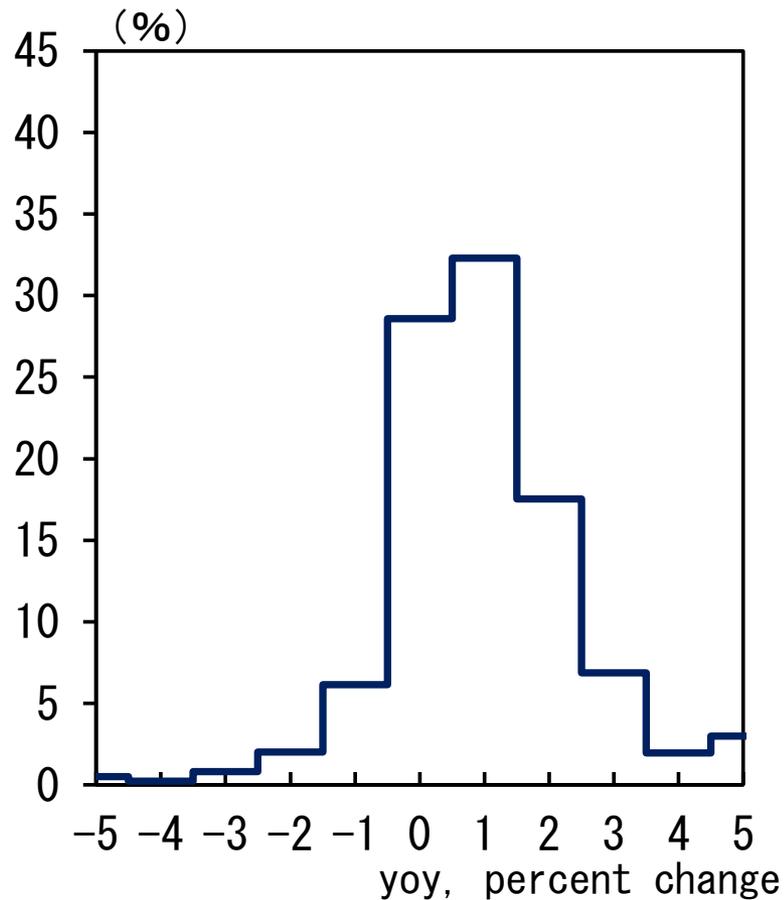
Opinion Survey
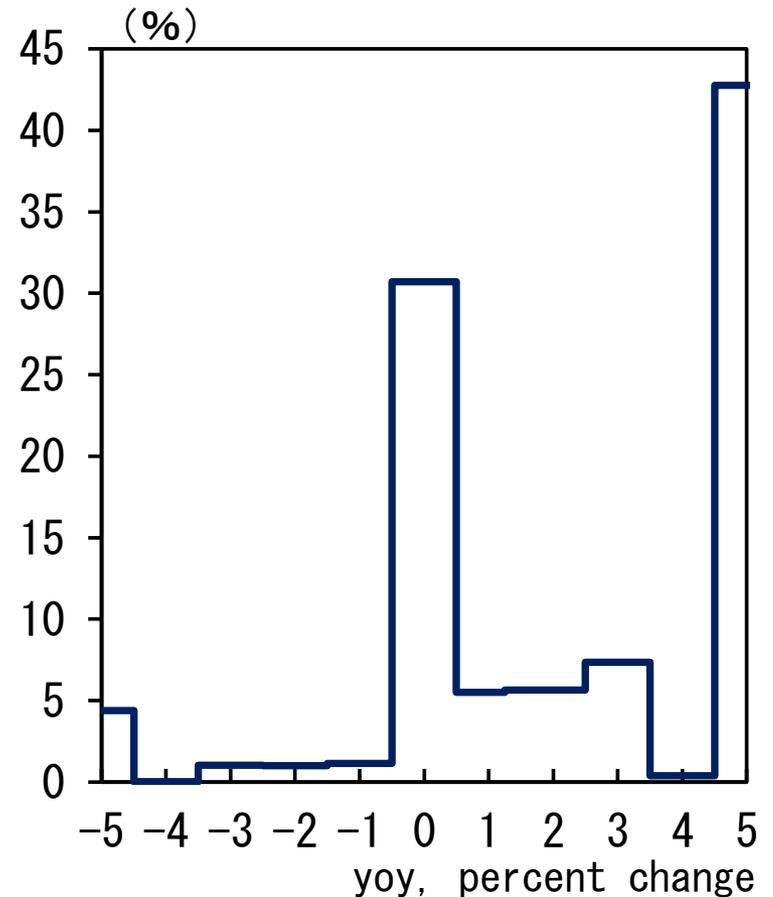
Source: Ichiue, Uno, Okuda, Fueki, and Maehashi (2019)

Inflation Qs in the Opinion Survey

- How do you think prices have changed compared with one year ago? (Note: Prices are defined as overall prices of goods and services you purchase.)
  - (a) Have gone up significantly
  - (b) Have gone up slightly
  - (c) Have remained almost unchanged
  - (d) Have gone down slightly
  - (e) Have gone down significantly
- What is your outlook for prices one year from now?
  - (a) Will go up significantly
  - (b) Will go up slightly
  - (c) Will remain almost unchanged
  - (d) Will go down slightly
  - (e) Will go down significantly

Three Types of Regressions about the Effect of Liquidity Constraint on:

The Euler equation (the relationship between expected inflation and expenditure) at the ELB	Panel regressions with the PPS
Attention to central bank policy (literacy on the BoJ)	Ordered probit models with the Opinion Survey
Dependency of inflation expectations on inflation perceptions	Ordered probit models with the Opinion Survey

The Effect of Liquidity Constraint on the Euler equation at the ELB

Expected real expenditure changes over the next 1Y

Expected Inflation over the next 1Y

Control variables (e.g., expected real income changes, planning large expenditures in the near future)

$$y_{i,t}^e = \beta_1 \pi_{i,t}^e + \beta_2 \pi_{i,t}^e D_{LC} + \beta_3 D_{LC} + \mathbf{x}_{i,t} \gamma + \epsilon_{i,t}$$

$(-)$ $(+)$

Dummies for lower income or fewer asset holding

Estimation Results for the Effect of Liquidity Constraint on the Euler equation at the ELB

	(1)	(2)	(3)
Inflation expectations (1Y from now)	-0.159***	-0.241***	-0.204***
×**Income per HH member (¥1.5-3.0 mil.)**		0.096*	
×**Income per HH member (< ¥1.5 mil.)**		0.112**	
×**Financial assets (< ¥2.5 mil.)**			0.129**
# of observations	27,911	27,861	25,918
# of HHs	7,472	7,467	7,077
HH fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes

Notes: Robust standard errors in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively. We omit households that purchased a house (or apartment) in the previous year or whose ratio of spending on durable goods to income is in the top 1% of the sample.

Literature on Micro Data Analysis of the Euler Equation at the ELB

- Bachmann, Berg, and Sims (2015) find a negative (althoguh small) impact on higher inflation expectations on spending in the US.

- Ichiue and Nishiguchi (2013), who use the Opinion Survey, are the first paper to find a positive impact.

- Crump et al. (2015), D'Acunto, Hoang and Weber (2016), Dräger and Nghiem (2018), Duca, Kenny and Reuter (2018), and Coibion et al. (2019) confirm a positive impact.

Evidence for the Effect of Liquidity Constraint in the Literature

- Ichiue and Nishiguchi (2013) find supportive evidence by defining asset holders as those who responded:
  - In the questions about the reasons why household circumstances have become better (worse):
    - Because my interest income and dividend payments have increased (decreased).
    - Because the value of my household's assets such as real estate and stocks has increased (declined).
  - In the question about the reasons behind the increased (decreased) spending:
    - Because the value of my household's nonfinancial assets such as real estate has increased (decreased).
    - Because the value of my household's financial assets such as stocks and bonds has increased (decreased).

BoJ Literacy Qs in the Opinion Survey

- How would you describe your level of interest in the Bank's activities?
  - (a) Interested
  - (b) Somewhat interested
  - (c) Difficult to say
  - (d) Not particularly interested
  - (e) Not interested
- How would you describe the Bank's relationships with your lives?
- Do you know that one of the Bank's objectives is to achieve price stability?
- Do you know that the Bank has been implementing aggressive monetary easing measures to achieve the price stability target of 2 percent in terms of the year-on-year rate of change in the CPI?

The Effect of Liquidity Constraint on the BoJ Literacy

$$AT_{i,t} = \begin{cases} 3 \text{ (Know about the inflation target)} & \text{if } \alpha_2 < AT_i^* \\ 2 \text{ (Do not know much about the inflation target)} & \text{if } \alpha_1 < AT_{i,t}^* \leq \alpha_2 \\ 1 \text{ (Have never heard of the inflation target)} & \text{if } AT_{i,t}^* \leq \alpha_1 \end{cases}$$

Indicator for the degree of attention to the central bank's policy

Control variables (e.g., financial literacy, age, gender, future income)

$$AT_{i,t}^* = \beta_7 D_{LC} + \mathbf{x}_{i,t}\gamma + \epsilon_{i,t}$$
$$(-)$$

Dummies for lower income

Estimation Results for the Effect of Liquidity Constraint on the BOJ Literacy

	Aggressive policy for 2%	Price stability	Interest in the activities	Relationship to our lives
Income (¥1.5-3.0 mil.)	-0.268***	-0.232***	-0.152***	-0.144***
Income (< ¥1.5 mil.)	-0.435***	-0.451***	-0.268***	-0.279***
High financial literacy	0.536***	0.383***	0.497***	0.263***
Estimation period	Sep. 2013-	Sep. 2006-	Sep. 2006-	Sep. 2006-
# of observations	42,568	62,700	62,648	62,658
Year dummies	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Estimation Results for Literacy on the BOJ's Policies (Cont.)

	Aggressive policy for 2%	Price stability	Interest in the activities	Relationship to our lives
Female	-0.593***	-0.334***	-0.212***	-0.033***
Age 30-39	0.152***	0.095***	0.116***	-0.069***
Age 40-49	0.378***	0.326***	0.251***	-0.077***
Age 50-59	0.593***	0.488***	0.365***	-0.060***
Age 60-69	0.875***	0.604***	0.569***	-0.006
Age 70+	0.954***	0.547***	0.675***	-0.066***
Work in agriculture...	-0041	-0.165***	0.015	-0.010
Self-employed...	0.075***	-0.035**	0.090***	0.059***
Non-regular employee	-0.128***	-0.189***	-0.105***	-0.067***
Student, pensioner...	0.069***	-0.034**	-0.002	0.044***

Ordered Probit Model of Inflation Expectations Formation

Inflation perceptions compared with 1Y ago

Control variables (e.g., financial literacy, age, gender, work status, future income)

$$\pi_{i,t}^{e*} = \beta_4 \pi_{i,t}^{p} + \beta_5 \pi_{i,t}^{p} D_{LC} + \beta_6 D_{LC} + \mathbf{x}_{i,t}\gamma + \epsilon_{i,t}$$

(+)

Inflation expectations over the next 1 or 5Y

Dummy variables for lower income

Estimation Results for Inflation Expectations Formation

	1Y	5Y
Inflation perceptions (from 1Y ago)	0.588***	0.342***
× Income per HH member (¥1.5-3.0 mil.)	-0.003	0.020
× Income per HH member (< ¥1.5 mil.)	0.033***	0.049***
× High financial literacy	-0.005	-0.048***
# of observations	27,911	27,861
Year Dummy	YES	YES

Notes: Robust standard errors in parentheses. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Estimation Results for Inflation Expectations Formation (Cont.)

	1Y	5Y
Female	0.005	-0.028***
Age 30-39	-0.037***	0.054***
Age 40-49	-0.023	0.026*
Age 50-59	0.055***	0.076***
Age 60-69	0.159***	0.134***
Age 70+	0.128***	0.057***
Work in agriculture…	-0.087***	-0.127***
Self-employed…	-0.083***	-0.061***
Non-regular employee	-0.010	-0.003
Student, pensioner…	-0.036***	-0.031***

Proxy for Financial Literacy

Q1: How do you think economic conditions have changed compared with 1 year ago?

– (a) Have improved
– (b) Have remained the same
– (c) Have worsened

Q2: With regard to Q1, what makes you think so?

(Choose up to two answers.)

– (a) Media reports
– (b) Economic indicators and statistics
– (c) Business performance of the company I work for, or of my own company
– (d) Income level for myself or other family members
– (e) Bustle of shopping streets and amusement quarters
– (f) Other

How to Measure Income per Household Members in the Opinion Survey?

- The Opinion Survey asks to choose from five answers about household composition.

	Choice	Assumed # of HH members
(a)	Single-person household	1
(b)	Married-couple household	2
(c)	Two-generation household	3
(d)	Three-generation household	3
(e)	Other	3

- We divide income of the respondent and spouse by the assumed number of household members.
- We checked the robustness to using:
  - Only samples with answers (a) and (b).
  - Total Household income, instead.

CONCLUDING REMARKS

What we do and find

(Theoretical Analysis)

- We develop a (partial equilibrium) rational inattention model.

- The model predicts that households with a tighter liquidity constraint will allocate:

  – less attention to information on the central bank's policy.

  – more attention to current prices (bargain-hunting).

(Empirical Analysis)

- We find empirical support for the predictions of our theory, using micro datasets of Japanese households.

A Policy Implication

- Our results suggest that incentives of paying attention to central bank policy change, depending on liquidity constraints.

  – Alleviation of households' liquidity constraint (through monetary easing) could promote more effective central bank communication.

Future work

- General equilibrium models to:
  - Explore the interaction between households' attention allocation and inflation dynamics.
  - Endogenize the extent to which households are liquidity constrained.
- Test our model using data in other countries.