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The Formation of Inflation Expectations: Micro-data Evidence from Japan

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Abstract

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Abstract

Using a unique survey of 50,000 households for 4 years, this study examines how households form inflation expectations. There are three findings. First, disagreements on inflation forecasts among households are larger for the shorter-term than those for the longer-term horizon; additionally, disagreements are predicted by how frequently households collect information about overall inflation rates. Inflation forecasts for the 1-year horizon are widely dispersed, while those for the 10-year horizon are anchored below 2%. Second, households heterogeneously update their information sets on prices. 46% of the households collect information about the consumer price index at least once a quarter, while the remaining households less frequently or never obtain this information. Third, forecast revisions are sensitive to a change in food prices. We show that more than half of households are attentive only to a change in food prices and may form their inflation expectations using food price changes as a signal of fluctuations in the overall inflation rates. The existence of numerous households that are inattentive to the nationwide inflation rates casts doubt on the transmission mechanism of the monetary policy through the management of expectations.

JEL Classification: C53; D84; E31

Keywords: disagreement; forecast bias; inflation expectations; sticky information; forecast revision

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1 Introduction

Under the effective lower bound of short-term nominal interest rates, how economic agents form their inflation expectations has been receiving increasing attention. Despite its importance in macroeconomic theory, the formation of expectations has not been fully uncovered. Bernanke (2007) highlights the lack of a precise understanding of the state of inflation expectations and how it should be measured. Kuroda (2017) admits that "we have learned a lot about inflation expectations in the past few years, but there still remain many research questions on this issue yet to be addressed."

This study aims to answer how households form inflation expectations. We focus on how and how often households process information about prices and how households form their shorter- and longer-term inflation forecasts. To this end, we conduct an online survey of approximately 50,000 households every quarter to collect their shorter- and longer-term forecasts on inflation rates and understand how they process information about prices. We also combine the survey with the data on the actual expenditure of each respondent and examine the effects of purchasing behavior on their expectations. By asking respondents to forecast the aggregate price level, and not percent change in inflation rates, we find that our survey can alleviate the "rounding number" problem, as documented in Binder (2017).

There are three findings. First, disagreements on inflation forecasts among households are larger for the shorter-term horizons than those for the longer-term horizon. They are predicted by socioeconomic factors and how frequently households collect information about overall inflation rates. Households' inflation forecasts for the shorter-term horizons are widely dispersed, while those for the 10-year horizon are anchored at 1%, which is much below Bank of Japan's inflation target level of 2%. Moreover, cross-sectional disagreements are predicted by socioeconomic factors of respondents, which decline after respondents update their information sets on price levels. The evidence of the decline in forecast disagreement is consistent with the *sticky* information hypothesis, as maintained in Mankiw and Reis (2002) and Carroll (2003).

Second, households heterogeneously update their information sets on prices. Only 40% of the households collect information about the nationwide price levels at least once a quarter, while the remaining households less frequently or never procure this informa-

tion. Half of the respondents update their information sets on the overall prices, implying that typical households disregard the consumer price index (CPI). The existence of numerous households that are inattentive to the nationwide price levels casts doubt on the transmission mechanism of the monetary policy through the management of expectations.

Third, we find that households' forecasts are sensitive to a change in food prices. Revisions of inflation forecasts react significantly and positively to changes in food prices. We also find that forecast revisions over longer horizons are sensitive to changes in food prices. While Binder (2018) and Coibion and Gorodnichenko (2015) report a high sensitivity to changes in oil prices in the United States, Japanese households revise their forecasts in response to a change in food prices and not energy prices. Moreover, the sensitivity of forecast revisions depends on the purchase volume of each respondent—a respondent who purchases a higher amount of food items in retail stores is more sensitive to a change in food prices. The evidence implies that a change in food prices matters in the formation of inflation expectations and that daily shopping may help Japanese households to predict the upcoming fluctuations in overall inflation rates.

Our study is related to three strands of the literature. First, our study is related to those exploring the determinants of households' inflation expectations. A large body of the literature examines how households form their inflation expectations; this literature reports that socioeconomic factors, such as income, age, or gender, play a significant role in shaping these expectations.[1] Beyond the well-known factors, Ehrmann et al. (2017) and Pfajfar and Santoro (2013) find that inflation expectations are related to respondents' financial situation, purchasing attitude, and macroeconomic perspectives and to news on inflation. Diamond et al. (2018) find a positive correlation between households' inflation expectations and age. Coibion and Gorodnichenko (2015) find that inflation forecasts of households react positively to changes in oil prices in the United States. Our findings contribute to the existing literature by presenting other determinants of households' inflation expectations.

Second, our approach is related to previous studies indicating that economic agents do

[1] See, for example, Cavallo et al. (2017), Coibion et al. (2018a), and Easaw et al. (2013). Concerning firms' expectation formation, see Coibion et al. (2018b) and Coibion et al. (2020). Coibion et al. (2018a) provide a comprehensive survey about the formation of inflation expectations.

not always update their information sets. While standard economic theories assume full-information rational expectations (FIRE), Mankiw and Reis (2002) and Carroll (2003) maintain the *sticky* information hypothesis that information disseminates slowly. Dupor et al. (2010) develop a model that integrates sticky prices and information and show that both rigidities are present in the U.S. data. Coibion and Gorodnichenko (2012) and Andrade and Le Bihan (2013) find information rigidities even among the board of governors of the Federal Reserve as well as professional forecasters. Patton and Timmermann (2010), Capistrán and Timmermann (2009), Andrade et al. (2016), and Falck et al. (2019) also examine disagreement in inflation expectations. Hori and Kawagoe (2013) report that the *sticky* information hypothesis is supported for Japanese households. Our unique survey data allows us to investigate whether FIRE holds, by directly asking respondents how often they collect price information. Our survey shows that half of the respondents never update their information sets. It is suggested that the disagreement on inflation forecasts among households is larger than that predicted by the existing theory.

Third, our study is related to the literature analyzing longer-term inflation forecasts of households. The literature examining the formation of households' expectations uses data on inflation forecasts by households over the shorter-term horizons owing to data limitations. The past empirical studies usually utilize 1-year-ahead forecasts with few exceptions.[2] However, since our survey collects forecasts of inflation rates over the 1-, 3-, and 10-year horizons, we can investigate the formation of inflation expectations over both the shorter-term and longer-term horizons. Our survey allows us to examine the term structure of inflation expectations and check whether an inflation target contributes toward anchoring households' expectations over the longer-term horizon.

The structure of this paper is as follows. Section 2 summarizes the survey and the descriptions of the inflation forecasts by Japanese households. Section 3 shows how households revise expectations. Section 4 summarizes the findings and concludes.

[2]While Andrade et al. (2016) show that forecasters disagree at all horizons, including the long run, they use forecasts submitted by professionals. While Chan et al. (2018) also examine the link between trend inflation and the long-run forecasts, their approach depends on professionals' forecasts.

2 Survey and inflation expectations

2.1 Questionnaire

This section summarizes the survey data on household's inflation expectations and shows basic statistics. We conduct a quarterly online survey of Japanese households from 2015Q4 to collect inflation expectations over the short- and long-terms. Every quarter, approximately 30,000 consumers provide an outlook on price changes in Japan.[3] Respondents are asked the following questions:[4]

(1) Frequency of updating information on inflation rates.

  (a) "How often do you collect information on the overall levels of prices?"

  (b) "How often do you collect information on the prices of goods and services you frequently purchase?"

(2) Outlook of price levels over shorter- and longer-horizons.

  - "What do you think will be the levels of CPI over the next one-, three-, and ten-year horizons, given that the current level of CPI is 10,000? Provide price-level figures over each horizon, excluding the impact of consumption tax hike on the price levels."

Regarding Questions (1)-(a) and (1)-(b), respondents choose the most appropriate one from the following choices. These questions can directly reveal the manner of households' information collection. Our focus is on how they update their information sets; we also aim to determine whether there exist any differences in the frequency of updating their information sets among the aggregate price levels and prices of daily commodity.

Question (2) asks respondents to report their forecasts numerically for the next 1-, 3-, and 10 years, on an average. This question can directly measure households' inflation expectations over both the shorter- and longer horizons. The questionnaire is also beneficial in measuring households' inflation expectations owing to the following three reasons. First, the qualitative nature of the questionnaire on inflation expectations allows

[3] We ask approximately 50,000 online observers, who are registered with INTAGE Inc., to present inflation forecasts as well as an outlook on the financial variables. The response rate of the online survey is approximately 60%. Thus, the sample size is approximately 30,000 every quarter.

[4] Tables 1 and 2 show the basic statistics of inflation forecasts by households.

Options	
(1)	Almost every day
(2)	Four or five times a week
(3)	Twice or thrice a week
(4)	Once a week
(5)	One or more times a week
(6)	Twice or thrice a month
(7)	Once a month
(8)	Once every two to three months
(9)	Once in six months
(10)	Once a year
(11)	Less than once a year
(12)	Do not collect

us to compute "forward" and "spot" rates with precision. When responses on the forecasts on the aggregate price levels over the next 1-, 3-, and 10 years are 10,080, 10,080, and 11,000, respectively, the forecasts on annualized inflation rates are calculated as shown below. The respondents' forecasts on inflation rates over the next 1-, 3-, and 10 years (or

Years Later	1-year	3-year	10-year
Forecast on price levels	10,080	10,600	11,000

↓

Annualized inflation rates	"Spot" inflation rates			"Forward" inflation rates	
Years later	1-year	3-year	10-year	1 to 3-year	3 to 10-year
Inflation expectations: π^e	0.80%	1.96%	0.96%	2.55%	0.53%

the next 4-, 12-, and 40 quarters) are computed as 0.80%, 1.96%, and 0.96%, respectively. We call them "spot" rates and denote $E_t^i[\pi_{t,t+q}]$ as household i's inflation forecasts over the next q-quarter. We can also compute "forward" rates—an annualized forward rate for years n through $n+k$ is calculated from the forecasts of price levels over the next n- and $n+k$-year. When responses for the price level forecasts over the next 1-, 3-, and 10 years (or the next 4-, 12-, and 40 quarters) are 10,080, 10,600, and 11,000, the forward rates $E_t^i[\pi_{t+4,t+12}]$ and $E_t^i[\pi_{t+12,t+40}]$ are 2.55% and 0.53%, respectively.

Second, asking respondents to provide the figures of the aggregate price levels can mitigate the "round number" problem, indicated in Binder (2017). As Binder (2017) dis-

cusses, the literature on cognition and communication documents that survey respondents round numbers when asked for point predictions; this tendency of respondents conveys their uncertainty. Binder (2017) shows that a significant proportion of the respondents to the Michigan Survey of Consumers and the Federal Reserve Bank of New York Survey of Consumer Expectations reported inflation forecasts in multiples of five. Imaginably, our survey also includes forecasts in multiples of five. However, in our survey, since the measures used to capture inflation expectations are calculated by point predictions of certain price levels, the computed measures are not always a multiple of five. Binder (2017) reports that approximate half of the forecasts are reported in multiples of five in the case of Surveys of Consumers, University of Michigan, while our surveys shows that 24% of the forecasts are reported as multiples of five.[5] Providing the figures of the price levels can reduce the round numbers, approximately, by half. Our survey can alleviate the problem arising from the rounding behavior.

Third, asking respondents to provide figures for the price levels can avoid response bias. As Dillman et al. (2014) discuss, many respondents use the response scale as a guide to help them formulate answer. For example, when asked inflation forecasts by a multiple choice question, respondents might assume that the range represents the low and high scales.[6] Another assumption is that the middle option represents the *average* forecast. Since the range is set from -10% to $+10\%$ and the midpoint as 0%, respondents might conclude that inflation rates vary from -10% to $+10\%$ and the average forecast is around 0%. In such a situation, the scale range and midpoint of a multiple-choice question will influence the answer. The range and midpoint tend to inform respondents when they are unfamiliar with the distribution of inflation rates; this leads to biased responses. Thus, by asking respondents to provide the price level, our survey can mitigate the bias resulting from providing scales that approximate the actual distribution of inflation rates in the population.

[5]The forecasts 10,500, 11,000, 11,500, 12,000, and 12,500 are reported in "multiples of five" because they are computed into 5%, 10%, 15%, 20%, and 25%, respectively, as annualized inflation forecasts.

[6]Another example is shown in Smyth et al. (2007).

2.2 Households' inflation expectations

Tables 1 and 2 show "spot" and "forward" inflation forecasts of households, respectively.[7] Tables 1 and 2 indicate disagreements among forecasters, especially for shorter-term horizons. Based on the simple average, Table 1 shows that inflation forecasts for the 1-year and 3-year horizons are above 2.0%, while 10-year-ahead forecasts are at 1.5%. This suggests that the "term structure" of inflation forecasts is not flat but inverted. The inversion of the term structure of inflation forecasts is also found in "forward" forecasts of inflation rates. Table 2 shows that the average of forecasts for the 1- to 3-year horizons is larger than those for the 3- to 10-year horizons. However, forecasts based on median values are 0.5%, 0.9%, and 1.0% for the 1-year, 3-year, and 10-year horizons, respectively. Basically, median values are all 1.0% or below, and the term structure is a little upward. The front end of the curve is upward-sloping and the back end is almost flat. The difference between the mean and median values for the shorter-term forecasts suggests that the forecasts are dispersed. For example, the difference between the mean and median values for the 1-year horizon is 2.0%, while those for the 10-year horizon is 0.5%. We find this outcome in Table 2; it implies that the disagreements among forecasters for the shorter-term horizons is more than those for the longer-term horizons. In fact, the median of forecasts for the 10-year horizon, which seems to be less influenced by a short-term disturbance, is partially "anchored" at 1.0%. Table 3 shows standard deviations of inflation forecasts and supports the above fact. Standard deviation for the shorter-term horizons is significantly larger than that for the longer-term horizons. This suggests disagreements on inflation forecasts among households; forecasts for shorter horizons are widely dispersed, while those for the 10-year horizon are partially anchored much below than 2%, which is the price stability target by the Bank of Japan.

Our measure to capture households' inflation expectations is reasonable in sense that respondents' covariates explain the level of forecasts. The average forecasts of female, lowly qualified, and lower-income respondents are higher than those who are male, highly qualified, and higher-income earners. This evidence is found in both spot and forward forecasts of inflation rates in Tables 1 and 2.

[7] The (annualized) inflation forecasts exclude all forecasts of inflation above 25 and below -2 percent.

In order to formally test whether covariates of respondents can predict inflation expectations, we regress inflation forecasts on their socioeconomic factors. Table 4 shows that the socioeconomic factors can explain inflation forecasts of each respondent over both the shorter- and longer horizons. The forecasts of female, lowly qualified, and lower-income respondents are higher than those who are male, highly qualified, and higher-income earners. This is consistent with several studies examining inflation expectations of households.

2.3 How often do households revise their inflation expectations?

In this subsection, we directly identify the updating frequency of households' information on the aggregate price levels and prices of goods and services they frequently purchase. The full information rational expectations hypothesis assumes that every economic entity makes decisions using the updated information set. However, the past studies support the *sticky information* hypothesis, which maintains that economic agents do not always revise their information sets. In fact, they are inattentive; even professional forecasters submit their forecasts based on the old information sets. For example, Carroll (2003) provides micro foundations for the sticky information theory and derives a simple equation suitable for empirical analysis. Dupor et al. (2010) develop a model that integrates sticky prices and information and find that both types of rigidities are present in the U.S. data. Using Japanese data, Hori and Kawagoe (2013) test the sticky information hypothesis for consumer inflation forecasts.

Table 5 shows the fraction of households that update their information sets on CPI; Figure 1 depicts the cumulative relative frequency of information, derived from the responses to Questions (1)-(a) and (1)-(b). In Figure 1, the blue and red lines refer to the cumulative probability of renewing information sets on CPI and the prices of goods and services households frequently purchase. First, the figure shows that more than half of the households hardly collect information on CPI. While less than 50% (46%) of the households update their information sets, the rest of them do not collect any information or procure it at least once in six months. However, more than 75% of the households pay their attention to the prices of regularly purchased items; more than three-fourths of the households collect information on the prices of items they frequently purchase at least

once a month.

Figure 1 shows that the frequency of updating information on the prices of daily commodities and services is considerably higher than that of the aggregate price levels. These results suggest that typical households are attentive to prices of daily goods and services, while they are inattentive to the nationwide price levels.

From the perspective of theoretical view, the fact that not all households regularly update their information sets supports the *sticky information* hypothesis. If the *sticky information* hypothesis holds, then the disagreement among forecasters can be explained by whether households collect the price information when submitting their forecasts. In order to confirm whether the disagreement decreases when households update their information sets, we conduct the variance ratio test; the null hypothesis is that the standard deviation of inflation forecasts by respondents who do not update their information sets is larger than those by respondents who update their information sets. Theoretically, disagreement among forecasters, which can be measured by standard deviation, becomes smaller when all forecasters update their information sets when submitting forecasting variables. Thus, the variances of forecasts based on the updated information sets should be smaller than those based on the old information sets.

The top panel in Table 6 shows standard deviations for each forecast horizon. The table shows that the disagreement among forecasters decreases when the information sets are renewed in all cases. This evidence is consistent with the sticky information hypothesis, which predicts disagreement among forecasters when there are two types of forecasters—those who update their information sets and those who do not.

Our findings imply a discrepancy between the frequencies with which information on CPI and daily goods and services is updated. Table 5 and Figure 1 show that less than half of the households update information on the level of CPI more than once a year. However, households update their information sets on daily goods and services more frequently than those on CPI. In fact, more than three-fourths of the households update their information sets at least one month. The evidence implies that households collect information only about prices of daily goods and services more frequently than that forecasted through previous studies, while information about an aggregate price level diffuses more slowly than

expected. The discrepancy between the frequencies with which information on CPI and daily goods and services is updated may require reconsidering the assumption of information stickiness. Particularly, the existence of numerous households that are inattentive to the nationwide price levels casts doubt on the transmission mechanism of the monetary policy through the management of expectations.

3 Do households' forecasts respond to a change in the oil price?

3.1 Sensitivity of forecast revisions to changes in price of oil and food items

The previous section shows that typical households are inattentive to the consumer price index. Then, another question arises; How do households collect information about overall inflation rates. Coibion and Gorodnichenko (2015) discuss that household inflation forecasts in the United States respond to the price of oil closely and show the high sensitivity of households' inflation forecasts to oil prices relative to that of professional forecasts. Coibion and Gorodnichenko (2015) indicate that this is because households emphasize the prices they observe frequently. The literature implies that inattentive households use a change in commodity prices which they frequently observe as a signal of fluctuations in overall inflation rates.

While households in the United States emphasize the price of oil, Japanese households may be more attentive to food prices than other countries. Figure 2 shows the share of household's spending in the G7 countries. The figure shows that the share varies among the seven countries. Concerning food-related spending, the rate of food and non-alcoholic beverages to total expenditure in Japan is 15.3%, which is more than double of that of the United States. Since Japanese households observe the change in food prices more frequently than those in other countries, their inflation expectations may be sensitive to the change in food price rather than the oil price.

In order to examine which of the prices exert a higher influence on the inflation fore-

casts of Japanese households, we estimate the following equation;

$$E_t^i[\pi_{t\to t+k}] - E_{t-2}^i[\pi_{t-2\to t+k-2}] = \alpha + \beta_1 \times \pi_{p,t-2\to t}^{Oil} + \varepsilon_t^i, \tag{1}$$

where $E_t^i[\pi_{t\to t+k}]$ and $\pi_{p,t-2\to t}^{Oil}$ are denoted as inflation forecasts by individual i over the next k quarters at time t and a percent change in energy price in the previous two quarters in prefecture p where individual i resides, respectively. For example, when $k = 12$, $E_t[\pi_{t\to t+12}]$ is the inflation forecast over the next 12 quarters (*i.e.* over the next 3 years) at time t. We also estimate the sensitivity of inflation forecasts to the food price rather than the oil price:

$$E_t^i[\pi_{t\to t+k}] - E_{t-2}^i[\pi_{t-2\to t+k-2}] = \alpha + \beta_2 \times \pi_{p,t-2\to t}^{Food} + \varepsilon_t^i, \tag{2}$$

where $\pi_{p,t-2\to t}^{Food}$ is a percent change in food price in the previous two quarters in prefecture p where individual i resides, respectively. In the both equations, the coefficient β captures the sensitivity of inflation forecasts to price changes.

The top and middle panels in Table 7 summarize the estimation results of Equations (1) and (2). The table shows that households update their forecasts in response to the changes in food prices rather than the changes in energy prices. The top panel in Table 7 shows that an energy price change hardly influences forecast revisions of households. However, a food price change has a significant impact on forecast revisions—an increase in food prices induces an upward revision of forecasts. The impacts of a food price change on forecast revisions are larger when the forecast horizons are shorter—a one percent change in food prices induces an upward revision by approximately 0.18% when forecasts over the 1-year horizon are used. However, even the longer-term forecasts are revised in response to a food price change—β_2 is 0.05 when forecasts over the 3- to 10-year horizon are used. This result is robust when we use a percent change in the "core" CPI. The bottom panel in Table 7 shows, in the four out of five cases, a change in the food price index without fresh food positively impacts forecast revisions. The results suggest that Japanese households' forecasts respond to the changes in food prices and not energy prices.

The results here are consistent with Coibion and Gorodnichenko (2015), which show

that household inflation forecasts in the United States respond to the price of oil closely because households emphasize the prices they observe frequently. Furthermore, they document that the more the households spend energy on energy, the more their inflation forecasts will respond to the price change of oil. However, Japanese households revise inflation forecasts in response to changes in food prices.

The results may imply that changes in retail prices of food items serve as one of the main sources of information on price changes for Japanese households. In order to check the validity of the implication, we link the survey data on households' inflation expectations with the data on the households' purchase records, by using the monthly purchase volume of each household as the proxy for how households observe a change in prices. The data on households' consumption expenditure is the panel data (SCI-personal) in Japan collected by a marketing company, Intage.[8] Intage asks over 50,000 individuals to report what items they buy on a daily basis. The data covers consumer goods with a barcode.[9] Thus, the data records details of the buyer, items purchased, time of purchase, and the price incurred on the items. We assume that households purchasing a high volume of daily commodities have more opportunities to observe a change in food prices than those who do not, and hence data on purchase volume predicts the degree of sensitivity of revisions in households' inflation forecasts.[10]

In order to estimate the sensitivity of forecast revisions to a food price change, we add the total volume purchased by survey respondents to the estimating equations. Using quarterly-based purchase volume of each household, we construct a dummy variable D^{volume} that takes one if a respondent purchases more volume than the median values; otherwise zero: The estimating equation is the following;

$$E_t^i[\pi_{t\to t+k}] - E_{t-2}^i[\pi_{t-2\to t+k-2}] = \alpha + \beta \times \pi_{p,t-2\to t}^{Food} + \gamma \times \pi_{p,t-2\to t}^{Food} \times D_{i,t}^{volume} + \varepsilon_t^i, \quad (3)$$

Our focus is on the sign of γ; if a respondent who buys more food in retail stores is more sensitive to a change in food prices, γ is significantly positive.

Table 8 shows the estimation result for Equation (3) and supports our intuition. The

[8] Diamond et al. (2018) also use the panel data (SCI-personal) that we use here.
[9] The data covers neither fresh foods nor durable goods.
[10] The idea is supported by the data in Section 3.2.

table shows significant and positive γ in all the cases. The positive and significant γ shows a higher sensitivity of forecast revisions to a change in the food price when households make high-volume purchases than those who do not. The high sensitivities are found in not only the shorter-term forecasts but also in the longer-term forecasts. These results suggest that the changes in food prices, which households regularly and predominantly observe in their consumption experiences, determine the forecast revisions of inflation expectations.

For robustness check, we also estimate Equation (2) using the sub-samples by income sizes. Table 9 shows the sensitivity of forecast revisions to a change in the food price. The top and bottom panels in Table 9 are based on the data from higher- and lower-income households, respectively. The table shows that the sensitivity is significantly positive in all cases. The evidence shows that our baseline results are robust.

3.2 Who update their information sets?

Our next strategy also provides evidence that households that pay attention to the prices they frequently and dominantly observe respond to a change in the food price more than those who do not. The fact that households purchasing a higher volume of food items have a higher sensitivity of forecast revisions to a food price change implies that they update their information sets more frequently than those who purchase lesser volume. In order to examine the chief factors that predominantly determine the renewal of information sets, we use a probit model. In the model, a dummy variable ($D^{updated}$) represents that the individual who updates an information set regresses on a set of respondents' covariates, which comprise all indicator variables.[11] Table 10 shows the result of the probit model. The independent variables influence when updating price information—the impacts are all significantly positive (except for constant). The probability of updating price information is larger when a respondent is male, highly educated, earns more, married, and purchases a higher volume. Notably, the table shows that the purchase volume most significantly impacts the probability of updating an information set. The higher the purchase volume

[11] As we introduce in Section 2, our online survey asks respondents how often they collect information on prices. $D^{Updated}$ takes one when a respondent collects information on prices when submitting an inflation forecast; otherwise zero.

of households, the higher will be the probability of updating price information. This suggests that households see (food) price changes in retail stores, such as supermarkets and convenience stores, and the price changes induce them to update their information sets, in turn, shaping their inflation expectations.

The above results in this section suggest that respondents purchasing a higher volume update their information sets more frequently and have a higher sensitivity of forecast revisions to changes in food prices. This may suggest that Japanese households collect information about prices in retail stores. In sum, food prices play a significant role in the formation of inflation expectations of Japanese households. While typical households are inattentive to overall inflation rates, they may use a change in food prices which they frequently observe as a signal of fluctuations in overall inflation rates.

4 Conclusion

We examine how households form their inflation expectations, combining a unique survey for inflation expectations with their actual expenditure data. Our measure to capture inflation expectations can not only alleviate the problem arising from the rounding behavior but also mitigate the response bias resulting from providing scales.

There are three findings. First, disagreements on inflation forecasts among households are larger for the shorter-term horizons than those for the longer-term horizon. Inflation forecasts for the shorter-term horizons are widely dispersed, while those for the 10-year horizon are anchored at 1%. We also find that cross-sectional disagreements decline after respondents update their information sets on price levels. The evidence is consistent with the *sticky* information hypothesis.

Second, households heterogeneously update their information sets on prices. Only 40% of the households collect information about the consumer price index at least once a quarter, and more than half of the households never obtain this information. The existence of inattentive households to the nationwide price levels casts doubt on the transmission mechanism of the monetary policy through the management of expectations.

Third, forecast revisions are sensitive to a change in food prices and a respondent

who buys more food is more sensitive to the price change. Additional analysis reveals that households that purchase large quantities of daily food update their information sets more frequently than those who do not make such purchases. The evidence implies that a change in food prices influences the formation of inflation expectations and inattentive households may use a change in food prices as a signal of fluctuations in overall inflation rates.

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Table 1: Basic statistics of households' inflation forecasts: "Spot" forecasts

	1-year average			3-year average			10-year average		
	Mean	Median	Obs.	Mean	Median	Obs.	Mean	Median	Obs.
All	2.5%	0.5%	143,612	2.1%	0.9%	144,806	1.5%	1.0%	144,835
Female	2.8%	0.8%	69,474	2.4%	1.0%	69,843	1.6%	1.0%	69,802
Male	2.2%	0.5%	73,694	1.8%	0.6%	74,517	1.3%	1.0%	74,589
High school graduate or below	2.8%	1.0%	64,212	2.3%	1.0%	64,650	1.6%	1.0%	64,671
Four-year college graduate or above	2.2%	0.5%	73,706	1.8%	0.6%	74,340	1.3%	1.0%	74,159
Households' annual income below 4 million yen	2.7%	0.9%	63,077	2.3%	1.0%	63,570	1.6%	1.0%	63,625
Households' annual income 7 million yen and above	2.2%	0.5%	54,290	1.8%	0.6%	54,742	1.3%	1.0%	54,676
Information set updated	2.6%	0.8%	88,539	2.1%	1.0%	89,257	1.4%	1.0%	89,011
Information set NOT updated	2.4%	0.5%	55,073	2.1%	0.6%	55,549	1.5%	1.0%	55,824

Note: The forecasts of inflation above 25 and below -2 percent are trimmed. The data cover from 2015Q4.

Table 2: Basic statistics of households' inflation forecasts: "Forward" forecasts

	1 to 3-year average			3 to 10-year average		
	Mean	Median	Observation	Mean	Median	Observation
All	1.8%	0.4%	141,686	1.1%	0.6%	141,667
Female	2.0%	0.7%	68,192	1.1%	0.6%	68,131
Male	1.7%	0.4%	73,058	1.0%	0.6%	73,107
High school graduate or below	2.0%	0.9%	63,139	1.1%	0.6%	63,061
Four-year college graduate or above	1.6%	0.4%	73,062	1.0%	0.5%	72,975
Households' annual income 7 million yen and above	2.0%	0.7%	61,986	1.2%	0.6%	61,865
Households' annual income below 4 million yen	1.6%	0.4%	53,782	0.9%	0.6%	53,822
Information set updated	1.8%	0.7%	87,517	1.0%	0.6%	87,270
Information set NOT updated	1.9%	0.4%	54,169	1.1%	0.6%	54,397

Note: The forecasts of inflation above 25 and below -2 percent are trimmed. The data cover from 2015Q4.

Table 3: Variance ratio test: Forecasts for shorter- and longer horizons

$$H_0 : \sigma^2_{longer\ horizon}/\sigma^2_{shorter\ horizon} > 1$$

			F-statistics		
Forecast horizon	Standard deviation		1-year	3-year	10-year
1-year	4.364%	1-year	—	—	—
3-year	3.241%	3-year	1.813***	—	—
10-year	2.395%	10-year	3.321***	1.832***	—

Note: We test whether variance of forecasts for longer horizons is larger than that for shorter horizons. For example, F-statistics, which tests whether variance of forecasts for the three-year horizon is larger than those for the one-year horizon, is 1.813, which is significant at the 1% level. Here, *** indicates 1% significance.

Table 4: Determinants of Households' Inflation Expectations

$$E_t^i[\pi_{t\to t+k}] = \alpha + \gamma \times X_t^i + \varepsilon_t^i,$$

	"Spot"			"Forward"	
	1 year	3 year	10 year	1 – 3 year	3–10 years
Female	0.455***	0.404***	0.248***	0.273***	0.129***
	(0.112)	(0.088)	(0.045)	(0.058)	(0.020)
Age	−0.240***	−0.294***	−0.230***	−0.220***	−0.081***
	(0.064)	(0.052)	(0.044)	(0.039)	(0.026)
Age^2	0.015***	0.017***	0.013***	0.012***	4.83e-03**
	(0.005)	(0.004)	(0.003)	(0.003)	(0.002)
Households' annual income 7 million yen and above	−0.297***	−0.272***	−0.207***	−0.235***	−0.113***
	(0.046)	(0.023)	(0.006)	(0.012)	(0.005)
Four-year college graduate or above	−0.452***	−0.371***	−0.246***	−0.281***	−0.123***
	(0.021)	(0.023)	(0.026)	(0.019)	(0.013)
Marital Status	−0.241***	−0.136***	−0.103***	−0.106**	−0.060***
	(0.022)	(0.022)	(0.023)	(0.035)	(0.001)
Constant	3.660***	3.410***	2.530***	2.920***	1.490***
	(0.100)	(0.093)	(0.132)	(0.087)	(0.068)
Observations	130,299	131,374	131,335	128,600	128,517

Note: Standard errors in parentheses are clustered at individual levels, * indicates 10%, ** indicates 5% and *** indicates 1% significance.

Table 5: The fraction of households who update information sets on the aggregate price levels at least once a quarter.

	Information set		
	Updated	NOT Updated	Total
All	46%	54%	100%
Female	49%	51%	100%
Male	52%	48%	100%
High school graduate or below	43%	57%	100%
Four year college graduate or above	52%	48%	100%
Households' annual income 7 million yen and above	44%	56%	100%
Households' annual income below 4 million yen	51%	49%	100%
Purchase volume above median	45%	55%	100%
Those who purchase less items than median	62%	38%	100%

Note: "Updated" means the fraction of households who update information sets on the aggregate price levels at least once a quarter.

Table 6: Variance ratio test: Do cross-sectional disagreements among forecasters decrease when the information set is updated?

	Information set	Standard deviation
1-year ahead forecast	Updated	4.346%
	NOT updated	4.393%
3-year ahead forecast	Updated	3.151%
	NOT updated	3.382%
10-year ahead forecast	Updated	2.292%
	NOT updated	2.550%
1 to 3-year forecast	Updated	2.969%
	NOT updated	3.256%
3 to 10-year forecast	Updated	1.722%
	NOT updated	1.830%

$$Ratio = \sigma^{Old}/\sigma^{Updated}$$

$H_0 : Ratio > 1$	F statistics
1-year ahead forecast	1.022***
3-year ahead forecast	1.153***
10-year ahead forecast	1.238***
1 to 3-year forecast	1.202***
3 to 10-year forecast	1.130***

Note: *** indicates 1% significance.

Table 7: Which price changes influence forecast revisions?

	"Spot"			"Forward"	
	1 year	3 year	10 year	1 – 3 year	3 – 10 year
β_1 : $\pi^{Oil}_{p,t-2\to t}$	0.003	0.005	0.000	0.007	−0.002
	(0.014)	(0.010)	(0.005)	(0.008)	(0.004)
α	−0.092	−0.087	−0.0420	−0.099	−0.035
	(0.151)	(0.100)	(0.054)	(0.079)	(0.034)
Observations	59,791	60,468	60,144	58,893	58,643
β_2 : $\pi^{Food}_{p,t-2\to t}$	0.179**	0.162**	0.083**	0.156***	0.052**
	(0.079)	(0.058)	(0.033)	(0.049)	(0.021)
α	−0.177*	−0.155**	−0.084**	−0.156***	−0.070***
	(0.091)	(0.062)	(0.036)	(0.049)	(0.022)
Observations	59,791	60,468	60,144	58,893	58,643
β_3 : $\pi^{FWF}_{p,t-2\to t}$	0.164*	0.142**	0.072**	0.120***	0.027
	(0.090)	(0.048)	(0.032)	(0.034)	(0.030)
α	−0.152	−0.129	−0.071	−0.124*	−0.054
	(0.147)	(0.090)	(0.054)	(0.060)	(0.037)
Observations	59,791	60,468	60,144	58,893	58,643

Note: $\pi^{Oil}_{p,t-2\to t}$, $\pi^{Food}_{p,t-2\to t}$, and $\pi^{FWF}_{p,t-2\to t}$ are denoted as percent changes in energy price, food price, and food price less fresh foods in the previous tow quarters in prefecture p where individual i resides, respectively. Standard errors in parentheses are clustered at individual levels; * indicates 10%, ** indicates 5%, and *** indicates 1% significance.

Table 8: Do purchase volumes have an impact on forecast revisions?

$$E_t^i[\pi_{t\to t+k}] - E_{t-2}^i[\pi_{t-2\to t+k-2}] = \alpha + \beta \times \pi_{p,t-2\to t}^{Food} + \gamma \times \pi_{p,t-2\to t}^{Food} \times D_{i,t}^{volume} + \varepsilon_t^i,$$

	"Spot"			"Forward"	
	1 year	3 year	10 year	1 – 3 year	3 – 10 year
β : $\pi_{p,t-2\to t}^{Food}$	0.127	0.123**	0.062	0.124**	0.036
	(0.077)	(0.056)	(0.038)	(0.048)	(0.027)
γ: interaction	0.072***	0.050***	0.028***	0.039***	0.024**
	(0.013)	(0.009)	(0.008)	(0.008)	(0.009)
α	−0.171	−0.149	−0.082	−0.151*	−0.069**
	(0.153)	(0.102)	(0.056)	(0.079)	(0.030)
Observations	59,791	60,468	60,144	58,893	58,643

Note: $\pi_{p,t-2\to t}^{Food}$ is denoted as a percent change in food price in the previous tow quarters in prefecture p where individual i resides. $D_{i,t}^{volume}$ takes one when purchase volume by household i is larger than median; otherwise zero. Standard errors in parentheses are clustered at individual levels; * indicates 10%, ** indicates 5%, and *** indicates 1% significance.

Table 9: Does households' annual income influence forecast revisions?

Households' annual income 7 million yen and above					
		"Spot"		"Forward"	
	1 year	3 year	10 year	1 – 3 year	3 – 10 year
β_1 : $\pi^{Food}_{p,t-2\to t}$	0.150*	0.143**	0.079**	0.138***	0.058***
	(0.072)	(0.052)	(0.031)	(0.042)	(0.018)
α	−0.158*	−0.146**	−0.091**	−0.148***	−0.075***
	(0.077)	(0.051)	(0.030)	(0.043)	(0.019)
Observations	24,080	24,402	24,266	23,826	23,816
Households' annual income below 4 million yen					
		"Spot"		"Forward"	
	1 year	3 year	10 year	1 – 3 year	3 – 10 year
β_2 : $\pi^{Food}_{p,t-2\to t}$	0.208**	0.191**	0.086**	0.180***	0.053**
	(0.088)	(0.066)	(0.035)	(0.056)	(0.023)
α	−0.202**	−0.178**	−0.083**	−0.179***	−0.073***
	(0.088)	(0.066)	(0.037)	(0.055)	(0.022)
Observations	25,121	25,351	25,185	24,621	24,407

Note: $\pi^{Food}_{p,t-2\to t}$ is denoted as a percent change in food price in the previous tow quarters in prefecture p where individual i resides. Standard errors in parentheses are clustered at individual levels; * indicates 10%, ** indicates 5%, and *** indicates 1% significance.

Table 10: Who updates their information sets: A Probit analysis

Dependent Variable: Dummy variable ($D^{Updated}$)	
Independent Variables	
Purchase volume above median	0.445***
	(0.005)
Male	0.210***
	(0.004)
Four-year college graduate or above	0.159***
	(0.004)
Households' annual income 7 million yen and above	0.070***
	(0.004)
Marital status	0.226***
	(0.005)
Constant	−0.518***
	(0.005)
Observations	389,026

Note: Standard errors are in parentheses; *** indicates 1% significance. $D^{Updated}$ takes one when a respondent's information set is updated in forecasting inflation rates; otherwise zero.

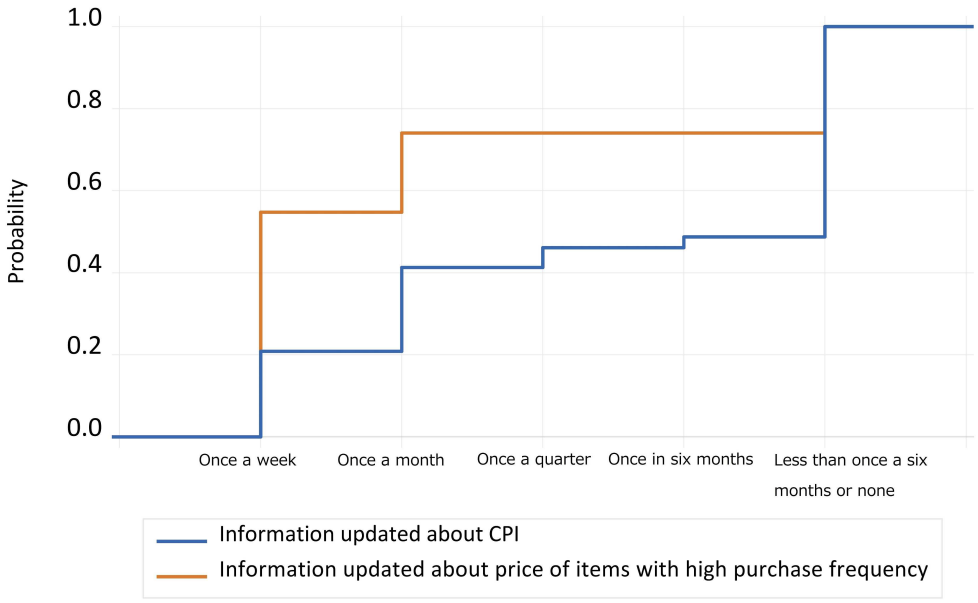

Figure 1: Cumulative relative frequency of information updated.

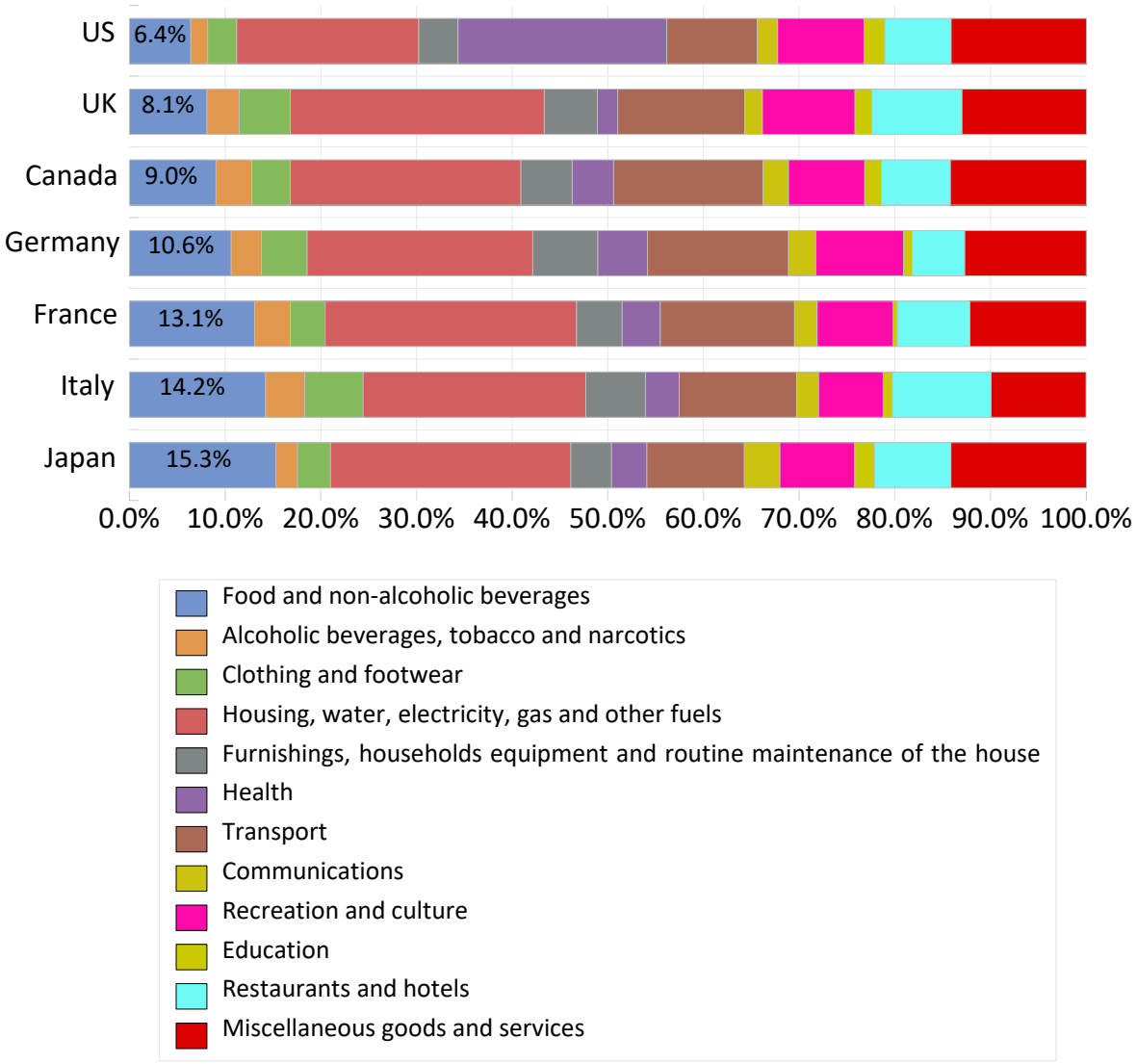

Figure 2: International comparison of final consumption expenditure of household. Source: OECD (2017). As for Canada and France, the data is from 2018.