Heterogeneity and Biases in Inflation Expectations of Japanese Households[1]

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(Abstract)
This study examines the formation of the inflation expectations of Japanese households using a micro-level dataset of forecast errors of expected inflation rates. The Japanese have recently come to be interested in policies that intend to positively influence the inflation expectations of households and firms. The effectiveness of these policies depends on the mechanism of expectation formation. Thus, whether expectations are formed adaptively or rationally, or whether expectations are homogeneous or heterogeneous, are important factors influencing policy effectiveness. In this study, we carefully examine the formation of inflation expectations of Japanese households by using a micro-level dataset of the "Consumer Confidence Survey" of the Japanese government. We observe that inflation expectations are stably biased upwards and are distributed in a dispersed way. We find that the "asymmetric loss function model," in which households incur asymmetric loss from either overestimation or underestimation of the future inflation rate, can explain the observed bias to a certain extent. Further, the relationships between expectations and age show a stable asymmetric inverted-U shape notwithstanding the survey period. The asymmetric loss function can also explain this shape, indicating that mid-aged consumers tend to show strong asymmetries in error aversion.

[1] This paper is a modified version of the ESRI discussion paper no.300 (July 2013) of the Cabinet Office. We appreciate helpful comments from Yosuke Takeda, as well as the seminar participants at Hitotsubashi University. Micro dataset employed in this analysis was made available by the ESRI of the Cabinet Office.
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1. Introduction

Inflation expectations play an essential role in the decision making of various economic agents, including households' consumption, savings, and firms' investments. Using the micro-level dataset of the forecast errors of inflation expectations, this paper aims to unearth the mechanism of how consumers' inflation expectations are formed. Given Japan's recent situation, wherein the nominal interest rate has been close to zero, policymakers are growing increasingly interested in policies aimed at exerting positive influences on the inflation expectations of consumers and firms. However, the effectiveness of these policies is dependent on how agents form their expectations. Hicks (1939) attempted to study this mechanism and argued that little is known about how economic agents form their expectations. In several studies that followed, economists have reached the consensus that the heterogeneity of expectations is caused by various factors. Regarding such heterogeneity, Pfajfar and Santoro (2008) surmised that there could be differences in any one of the following: in the model of expectation formation, in the information set, or in the capacity for information processing. It is considered that such information sets or processing capacities can vary depending on the social characteristics of the economic agents.

Based on the understanding provided by the above-mentioned studies, we precisely examine the formation of the inflation expectations of Japanese households by using a micro-level dataset of the "Consumer Confidence Survey" conducted by the Cabinet Office. The dataset reveals a stable upward bias in their inflation expectations as well as substantial heterogeneity at each observation point. We use these characteristics to set the starting point of our study.

We summarize our major findings as follows. First, our empirical study analyzes expectations based on the "asymmetric loss function model," which assumes various loss aversion levels among agents, and our results imply that this model can explain the observed bias in the data to a certain extent. Further, the model indicates that there are some departures in the expectations data from the rational level. Second, given the fact that the inflation expectations vary substantially among agents, we find that heterogeneity in the data can be explained by household characteristics only to a limited extent. A detailed examination of inflation expectations by household characteristics reveals stable asymmetric inverted-U shape relationships between age and expectation level notwithstanding the survey period. We also confirm that using the asymmetric loss function model can explain this asymmetric-U shape to a certain extent.

Several empirical studies in the Japanese context have examined the relationship between inflation expectations and household attributes. However, only few have discussed both the heterogeneity and the bias observed in the distribution of inflation expectations. Examples of empirical studies on bias include that of Kamata (2008), who examined the existence of downward rigidity in households' inflation expectations by using the results of the "Survey on Life Consciousness" conducted by the Bank of Japan. He argued that the rise in the inflation expectations of households is exactly reflected to survey responses during high inflation periods, while it is only partly reflected during low inflation periods. In addition, Hori and Terai (2004) estimated the level of inflation expectations by applying the Carlson–Parkin (CP) method to the results of the "Consumer Confidence Survey." They found that when they introduced asymmetry in the thresholds, consumers became quite sensitive to the acceleration of the inflation rate and less sensitive to its deceleration.[3]

Given the existence of asymmetry in inflation expectations, another strand of literature has focused on the background of asymmetry. For example, Elliott et al. (2008) found that the joint hypothesis of rational expectations and symmetric loss function is rejected with regard to the majority of households' inflation expectations. On the other hand, they argued that such rejection of rationality is much less likely in the case of the asymmetric loss function. Further, regarding the asymmetric loss function, they argued that people have a strong tendency to try to avoid "bad" outcomes for themselves, which includes a higher-than-expected inflation rate or a lower-than-expected growth rate. Captistran and Timmermann (2009) assumed that the cost for forecasters of forecast errors is asymmetric between overestimation and underestimation of the expectations. They introduced a loss function by Varian (1975) and found that asymmetry can arise in the level of inflation expectations even under the assumption of rational expectations. They provided concrete explanations based on three different types of mechanisms: asymmetric loss, heterogeneity in the individual loss function, and some irrational personal bias. They explained to what extent the heterogeneity in inflation expectations can vary over different periods and why such heterogeneity can affect the level and changes in expectations.[4]

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[3] When we examine the characteristics of households' inflation expectations, we also refer to the discussion on the downward rigidity of wages in the previous empirical literature (e.g. Kuroda and Yamamoto, 2003).

[4] Recently, Coibion and Gorodnichenko (2012) argued that the average expectations of the professional

The sticky-information model, such as the one discussed in Mankiw, Reis, and Wolfers (2004), provides useful clues to explain the heterogeneity in individual expectation levels. Stickiness indicates a situation in which forecasters update their expectations based on new information infrequently only; they argued that stickiness holds better with the formation of households' expectations rather than those of professional forecasters. They examined consistency between their model and the inflation expectations of US households. Using the micro-level dataset of Japan's "Consumer Confidence Survey," Hori and Kawagoe (2011) argued that regarding the inflation expectations of Japanese households, the sticky-information model is more consistent than the rational expectations model.

Many previous studies have empirically examined the relationship between respondents' characteristics and their expectations. Of these, a notable example that used Japanese data includes Murasawa's (2011) study, which used the aggregate data of Japanese households' inflation expectations by their major attributes and found that females' expectations are slower to decline during deflationary periods than males' expectations. Moreover, Murasawa (2011) observed that the change in the distribution of inflation expectations is asymmetric between inflationary and deflationary periods.

Previous studies focusing on the same issue have covered various countries and regions.[5] Linden (2005) used the results of a common consumer survey in the EU conducted by the European Commission. He found that the expected inflation rate exceeded the realized inflation rate, while consumers who planned to purchase houses in the near future had lower expectations with smaller forecast errors relative to the others. He argued that the results supported the hypothesis that consumers with greater incentive to collect information on future inflation rates tend to have smaller forecast errors. Based on the results of Swedish surveys, Palmqvist and Stromberg (2004) noted that females and people with low education or low income levels tended to have higher inflation expectations and that the younger age groups have the highest expectations followed by the elderly groups. Using the results of Italian surveys on inflation expectations, Malgarini (2008) found that it is quite widespread for households to have inflation expectations exceeding the actual inflation rates to a substantial extent. He observed three

forecasters in the US market are not consistent with the model of Captistran and Timmermann (2009). However, careful attention is required to interpret their empirical results as their discussion was not based on the heterogeneity in expectations at the individual level.

[5] The literature reviewed this point onwards includes studies that have used survey results that directly enquired about the expected inflation rates as well as those that transformed the original qualitative responses by using the Carlson–Parkin method.

background factors: 1) lack of knowledge in inflation rates (households do not use information that is available at a low cost), 2) relationship with social and demographic attributes (younger, lower-educated, and lower-income households have higher expectations), and 3) relationship with their economic situations (consumers with more pessimistic views about their economic situation tend to have higher expectations). Blanchflower and MacCoille (2009) examined the relationship between household characteristics and inflation expectations using the "Inflation Attitudes Survey" conducted by the Bank of England and concluded that certain characteristics, including age (up to 65 years), low educational level, low income, and rented housing, cause households to have pessimistic views on the future inflation rate and raise their inflation expectations significantly. In addition, they found that the expectations of the educated respondents cannot be explained by their personal perceptions of past inflation; on the other hand, they tended to trust the monetary policy (i.e., inflation targeting). Based on the survey results of German households, Sabrowski (2008) found that wealthier households tend to have higher inflation expectations and that the unemployed usually have exceptionally high expectations. Further, he empirically showed that consumers do not have rational expectations notwithstanding their types; rather, they have adaptive expectations.

Many empirical studies in this area have focused on the US as well. Bryan and Venkatu (2001) analyzed the results of the "Consumer Attitudes and Behavior Survey by Michigan University" (henceforth the Michigan Survey) and found that households' inflation expectations constantly exceed the actual consumer price index (CPI) growth rate; through the 1990s the average level of households' inflation expectations was 4.1%, while CPI growth rate was 3.0%. By attributes, low-income, young, nonwhite, and female respondents tend to have high expectations. Further, Pfajfar and Santoro (2008) used the results of the Michigan Survey and found that male, highly educated, and elderly respondents tend to have low expectations. They argued that socially and economically disadvantaged consumers form expectations by mainly referring to the prices they face in the market, while advantaged consumers are more likely to pay attention to the changes in the general CPI. In addition, they found that stickiness in inflation expectations is observed among low-income consumers. Anderson, Becker, and Osborn (2010) built a panel dataset from the results of the Michigan Survey and noted that the precision of the inflation expectations differs depending on consumer characteristics; they noted greater forecast errors among the young and low-income consumers. However, compared with the first survey, this difference in the precision diminished in the second survey, indicating that the group with greater forecast errors showed a greater learning effect through repeatedly responding to the same survey.

2. Data

We employ the CPI, calculated by the Ministry of Internal Affairs and Communications, as the dataset of the prices of consumption goods and the "Survey of Consumption Trend," conducted by the Economic and Social Research Institute of the Cabinet Office, as the dataset of inflation expectations.

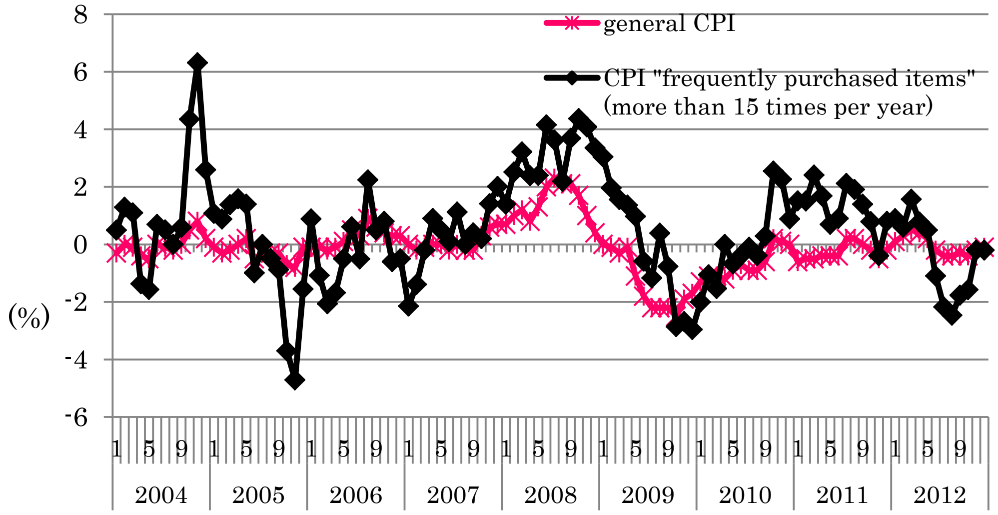
Regarding the inflation rate of the CPI, we use the year-to-year monthly growth rate of the "general" CPI at the national level with the base year as 2010. However, we need to consider that the target prices should be the prices of items purchased frequently by households, since the question on the prospect of prices is "what are your expectations of the prices of goods that you purchase frequently for the coming one year?" We thus estimate a year-to-year monthly growth rate of the prices of items categorized as "purchased frequently"[6] in a parallel way and employ this series in our estimation[7] for comparison.

Figure 2-1 compares the year-to-year growth rate of the "general" CPI with that of the CPI of "frequently purchased items" since 2004. The growth rate of the "general" CPI stayed around 0% until around early 2008, increased to up to around 2% during that year, and then decreased to a negative level in 2009 after the Lehman Shock. On the other hand, the inflation rate of "frequently purchased items" was more volatile than that of the "general" CPI and returned to a positive level soon after the Lehman shock. However, after 2012, both rates turned negative once again.

[6] This term corresponds to items purchased more than 15 times per year.

[7] We constructed a year-to-year growth rate by using series with the base year 2000 for the period before 2005, with the base year 2005 for the period 2006-2010, and with the base year 2010 for 2011 onwards.

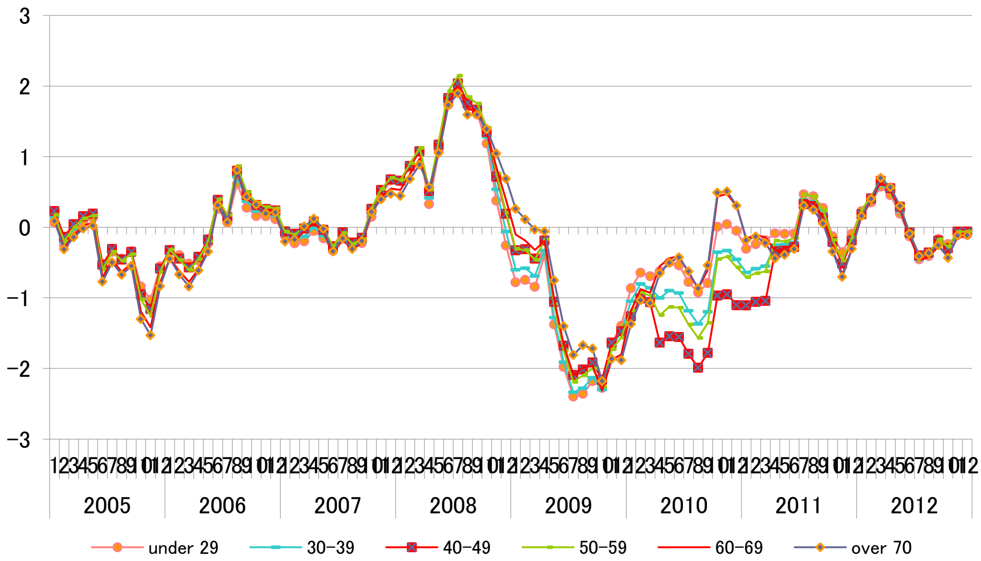
Figure 2-1 Year-to-year inflation rates of CPI



Further, as we focus on the age of the households' heads in our analysis, we estimate the CPI by age and employ the index in the following estimation. The CPI by age is estimated by weighting the price index by ten categories (i.e., food, residence, heating, lighting and water, furniture and household goods, clothes and shoes, health and medicine, transportation and communication, education, culture and recreation, and miscellaneous) with the base year 2010 by age group. We derive the weights in a simplified way by obtaining the proportions of expenses by category to the total expenses by age group[8]. Figure 2-2 shows the time-series trend of the derived year-to-year monthly growth rate of the price index by age group.

[8] These proportions are estimated by using "Table 4-6 Expenses, Purchased Volumes, and Average Prices per Household by Age of Household Head" from the "Annual Book of Household Survey (2010)" published by the Ministry of Internal Affairs and Communications

Figure 2-2 Year-to-year inflation rate measured by CPI by age



The "Consumer Confidence Survey" published by the Cabinet Office is one of the few surveys that enquire about the inflation expectations of households. As we employ its responses for the main part of this analysis,[9] it is pertinent to provide brief additional details of this survey.

Around 50.6 million households[10] throughout Japan have been surveyed as of March 2013, including total households containing both multiple- (general) and single-person households. The sample contains 6,720 households selected through a three-stage sampling process (i.e., municipality, survey unit, and household) for general and single-person households. The 6,720 households comprise 4,704 general households and 2,016 single-person households. The surveyed households are classified into 15 groups, each of which consists of 450 samples, and each household is surveyed for 15 consecutive months with one group being rotated at each survey point. The survey frequency increased to 12 times annually after April 2004; up to FY 2003, the survey was executed every June, September, December, and March (quarterly). Further, in April 2007, the survey method was changed to one wherein people hired by the Government directly visit the surveyed households, request

[9] Data from other surveys, including the "Opinion Survey on the General Public View and Behavior" conducted by the Bank of Japan and the "Consumers' Sentiment Index" conducted by the Japan Research Institute, are also available. However, to the extent of our knowledge, only the "Consumer Confidence Survey" conducted by the Cabinet Office publishes long time-series data on a monthly or quarterly basis.

[10] The reshuffling of samples was implemented from July 2012; the samples are gradually shifting to the new sample scheme at the point of rotation. Before this reshuffling, the population was around 47.8 million households.

them to complete the questionnaire, and collect the same at a later date (referred to as the "self-reported survey collected by pollers" in this study).[11] The collection rate for each month was almost 100% until FY 2005 and has been around 75% from FY 2006. (It was around 75% as of March 2013.) The questionnaire contains consumers' thoughts regarding their future prospects in life as well as their inflation expectations. Further, the survey records households' attributes, including sex, age, and occupation of the household head and household income. Thus, we employ not only the inflation expectations but also the household information for our analysis.[12] The Cabinet Office publishes only aggregate data every month, while we use a micro-level dataset from June 1982 to June 2011. Each quarterly survey result contains around 5,025 samples (in total 370 thousand samples). We construct a panel dataset (around 297 thousand samples) from the monthly survey results for the period of April 2006 to June 2011.

The question on inflation expectations differs for the following three periods: 1) before March 1991, 2) between June 1991 and March 2004, and 3) after April 2004. Before March 1991, the question was "do you think that the inflation rate will increase compared to the current rate in the next one year?" The respondents were asked to select one answer from among five possible answers: will decrease, will decrease moderately, will remain stable, will increase moderately, or will increase. The question was slightly modified for the period of June 1991 to March 2004 as "do you think that the inflation rate will increase in the next six months?"[13,14] Figure 2-3 shows the share of the responses to this question. At first glance, it is obvious that the shares of those who responded either "will increase" or "will increase moderately" consistently exceed that of those who responded either "will decrease" or "will decrease moderately."

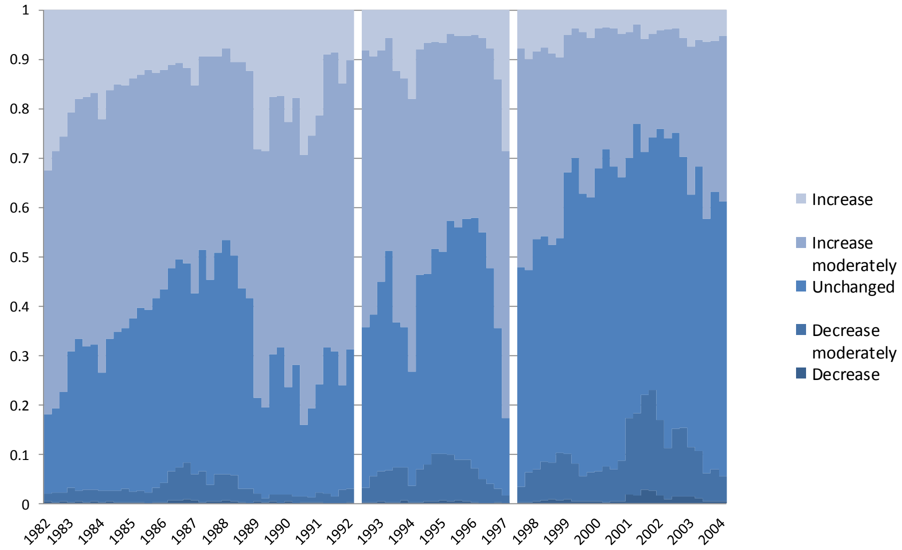
[11] From April 2013 onwards, the survey method changed from the self-reporting survey to the mailed survey.

[12] For general households, unless the respondent is the same as the household head, the responses cannot be regarded as the attributes of the respondent. However, as the survey requests the heads of the surveyed households to fill in the questionnaire on their own, we regard that the resulting attributes correspond to those of the respondents.

[13] Data are missing for the periods of June 1992 and June 1997.

[14] If we consider the dataset as time-series data, we need to exercise caution regarding this difference in questions; the response may be in terms of the expectation for one year or for six months.

Figure 2-3 Composition ratio of inflation expectations (June 1982-March 2004)



It is well known that the CP method (Carlson and Parkin, 1975) can be applied to estimate the expected inflation rate by using such qualitative responses.[15] Hori and Terai (2004) argued that the question regarding the prospect of the inflation rate in the "Consumer Confidence Survey" should actually be perceived as "…will the inflation rate increase compared to the current rate…?," thereby asking the respondent about their perception of the inflation rate relative to the current rate and not the comparison in the price level itself. This implies that we need to modify the original CP method in order to apply it to the "Consumer Confidence Survey." We try to measure the expected inflation rates during the corresponding period by using the CP method with an asymmetric threshold as suggested by Kano (2006). Figure 2-4 shows the estimated result;[16] the expected inflation moves almost in parallel to the current inflation rates. Further, the estimated threshold δ, through which the respondents recognize the positive or negative inflation rate, is 1.34 and -0.58 respectively; thus, there is an ignorable level of asymmetry. However, we need to interpret these results with caution as they have been tentatively derived by applying the CP method to the data under the following strong assumption: the dispersion of individual expectations and the volatility of realized inflation rates coincide. We thus do not use this estimation result of expected inflation rates in the following analysis.

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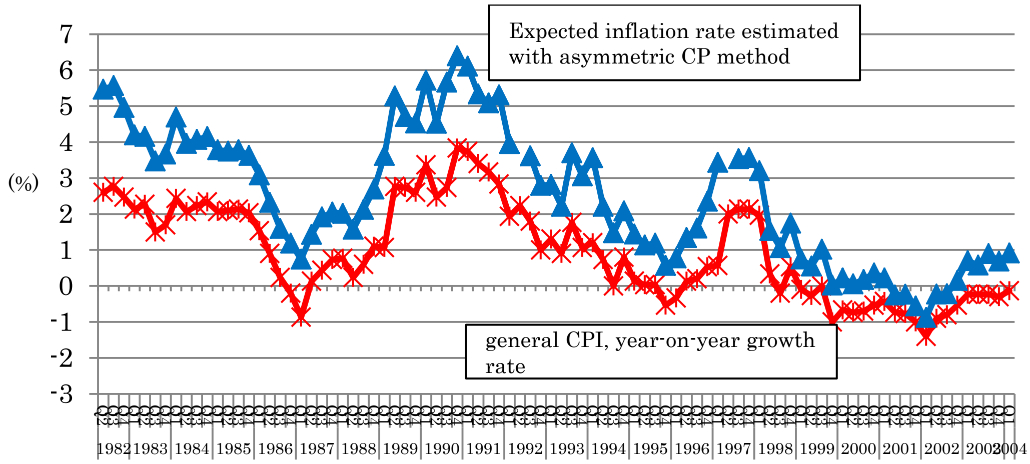
[15] Hori and Terai (2004), Takeda and Keida (2009), and Murasawa (2011) are notable in that they estimated the expected inflation rates by applying the CP method to the inflation expectation of the "Consumer Confidence Survey."

[16] After observing the characteristics of the expectation data after FY 2004, we further assume that the average expected inflation rates exceed the average actual inflation rates by 1.5% throughout the corresponding period in this estimation.

Figure 2-4 Estimated expected inflation rates by the asymmetric CP method



From April 2004, quantitative answers were introduced in the survey. Currently, the question is "What do you think the price levels of the goods you frequently purchase will become in a year?"[17] The response can be one of the following 10 choices: "Will decrease by more than 10%," "will decrease by 5-10%," "will decrease by 2-5%," "will decrease by less than 2%," "will remain stable at 0%," "will increase by less than 2%," "will increase by 2-5%," "will increase by 5-10%," "will increase by more than 10%," "do not know."[18] We transform the responses by taking the mid value of each choice[19].

Figure 2-5 compares the average expected inflation rate since April 2004 and the corresponding year-to-year inflation rate measured by the general CPI.[20]

The directions of both series look similar; thus, we infer that households form expectations in an adaptive way after referring to the current inflation rates. Although the actual inflation rate was negative quite often during the corresponding period, more households responded that prices would increase instead of decrease. Therefore, the average expected inflation rate tends to exceed

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[17] The following note is included below the question in the survey: "Please reply by guessing to what extent the prices of goods you purchase frequently will increase/decrease around one year later compared with the current prices, based on various sources of information, such as TV programs or newspapers."

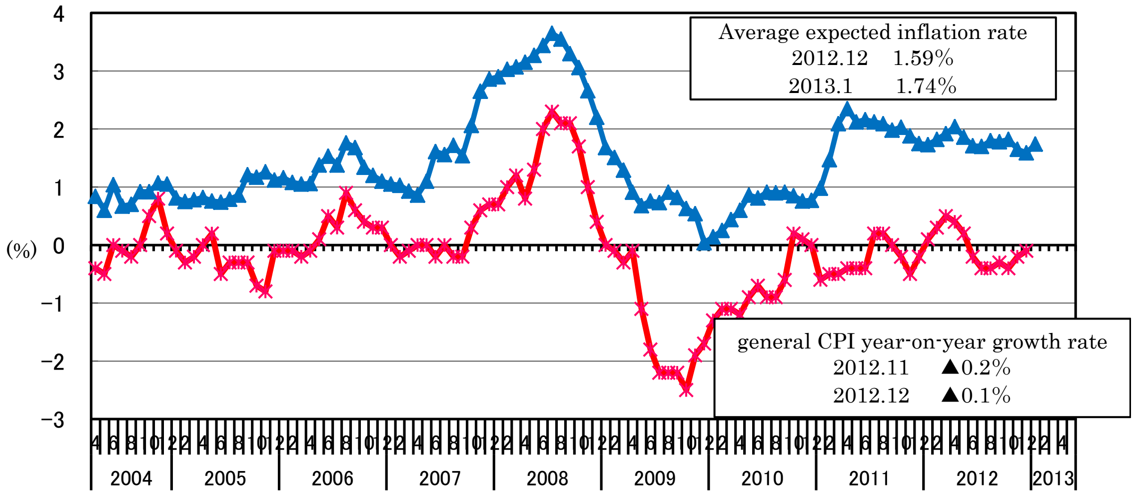
[18] Until March 2009, the choices "will decrease by more than 10%" and "will decrease by 5-10%," and "will increase by more than 10%" and "will increase by 5-10%," were combined as "will decrease by more than 5%" and "will increase by more than 5%," respectively.

[19] Note that for the responses at both ends, we use the threshold values (e.g., "will decrease by more than 5%" is considered as -5%).

[20] It is important to differentiate between the plotted general CPI and the "realized general CPI" in comparison with the "expected general CPI." For example, in January 2014, subjects would respond about the expected inflation in January 2015, and thus, the realized CPI should be that of January 2015. However, Figure 2-5 shows the plot for the current CPI (i.e., the CPI as of January 2014).

the actual inflation rate constantly by a certain level. The average gap between the two rates was around 1.5% between April 2004 and February 2013. To examine the forecast errors, Figure 2-6 shows the average expected inflation rate and the corresponding actual inflation rate realized one year later. We see that the average expected inflation rate exceeds the actual inflation rate throughout the period. Indeed, Figure 2-7 is a histogram that shows the average forecast error[21] per household (averaged throughout the survey period) distributed heavily in the negative region. In order to examine the existence of forecast errors by a simple statistical test, we regress the forecast errors on a constant for each household and implement a *t*-test. We find that we can reject the null hypothesis that the constant is equal to 0 at the 5% significance level for 12,562 households, which corresponds to 61.8% of all households.

Figure 2-5 Average expected inflation rate and year-to-year growth rate of the general CPI



[21] The forecast error in this study is derived by subtracting an expected rate from a realized rate.

Figure 2-6 Average expected inflation rate and realized inflation (general CPI)

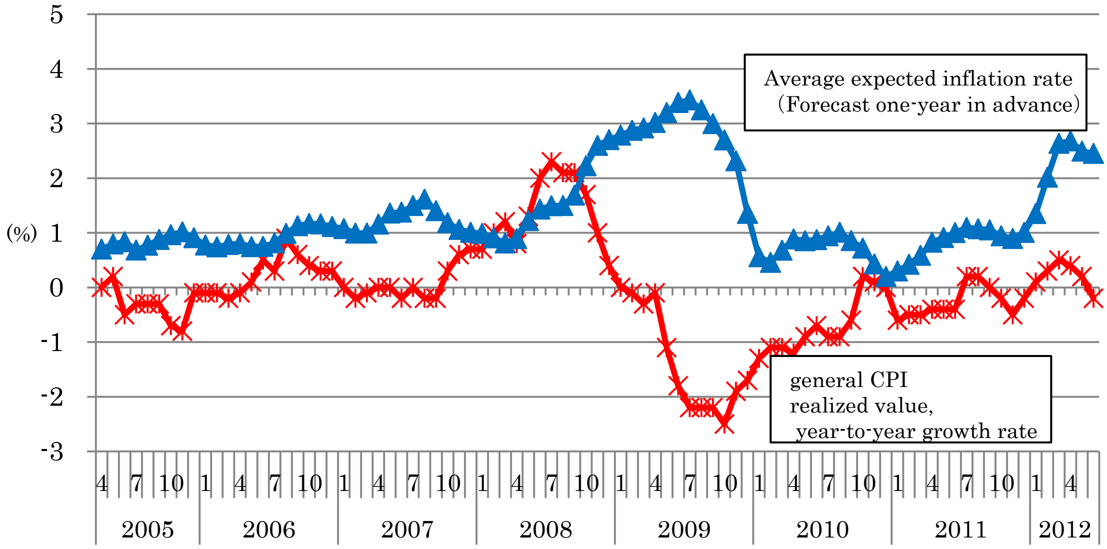
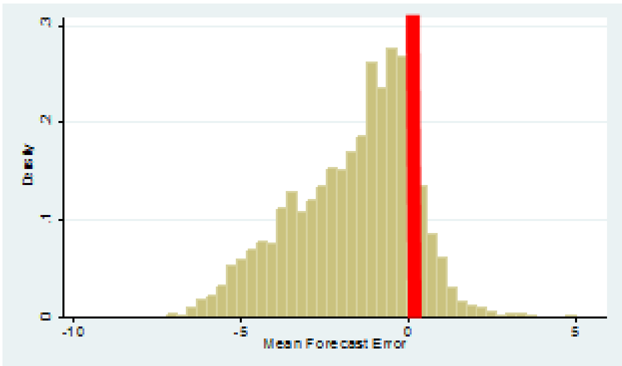


Figure 2-7 Distribution of the average forecast error
(Based on the general CPI, April 2006-June 2011)



Mean	Minimum	Maximum	Quanitile 0.25	Quanitile 0.50	Quanitile 0.75	Interquartile
−1.64	−7.50	5.60	−2.88	−1.27	−0.30	2.58

Figure 2-8, on the other hand, shows both the average expected inflation rate and the corresponding actual inflation rate measured by the price of “frequently purchased items.” As the price index of “frequently purchased items” is more volatile than the general index, it is difficult to distinguish whether the forecast error of inflation expectations tends to be negative or positive. Figure 2-9 shows a histogram of the average forecast errors measured at the household level. However, we observe that many households do not necessarily have average forecast errors close to 0. We again regress the measured forecast error on a constant, implement a *t*-test, and find that the null hypothesis that the constant is equal to 0 is rejected for 53.1% of households (10,801) at the 5% significance level.

Figure 2-8 Average expected inflation rate and realized inflation (CPI of "frequently purchased items")

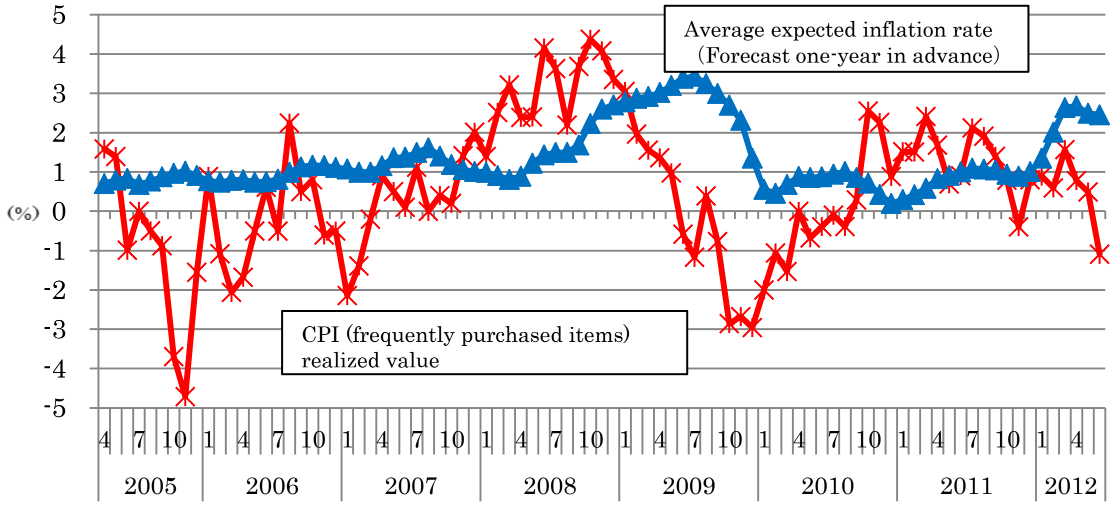
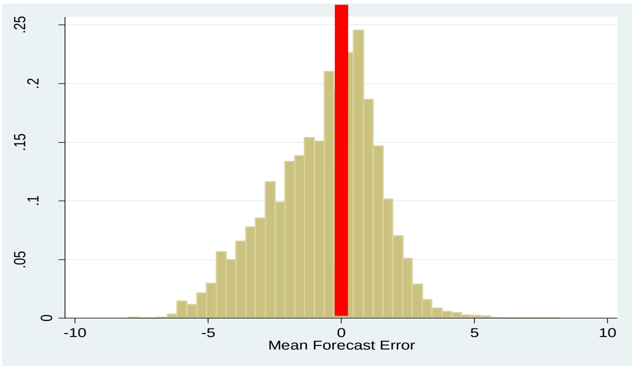


Figure 2-9 Distribution of the average forecast error
(CPI of "frequently purchased items," April 2006-June 2011)



Mean	Minimum	Maximum	Quanitile 0.25	Quanitile 0.50	Quanitile 0.75	Interquartile
−0.65	−8.00	8.20	−2.00	−0.33	0.75	2.75

The above analysis suggests that the inflation expectations of households tend to have an upward bias relative to the general CPI. We are interested in examining whether this tendency can be largely attributed to either a few households having extremely high expectations or to most households in general, having slightly high expectations. For this purpose, we use a simple measure to evaluate the distribution of expectations. As explained previously, respondents select one category from at least seven categories or "do not know" (from FY 2004). We thus employ a Lacy measure (Lacy, 2006) to compute the extent of the dispersion of the responses among the seven choices. By using the cumulative probability of discrete variables F^i

(cumulative probability by *i*th category), this index is defined as follows (the total number of categories being *K*):

$$\text{Lacy measure} = \sum_{i=1}^{K-1} F^i(1 - F^i)$$

If all the responses are centered only on one category, this index is at its minimum level (i.e., 0). As the responses become distributed across more varied categories, the index becomes larger and approaches 1. Figure 2-10 and Figure 2-11 show the estimated monthly Lacy measure from April 2004 to December 2012 and from April 1982 to March 2004. As the data at two points are missing, the graph in Figure 2-11 is discontinuous at the affected points.

Figure 2-10 Distribution of inflation expectations (April 2004-December 2012)

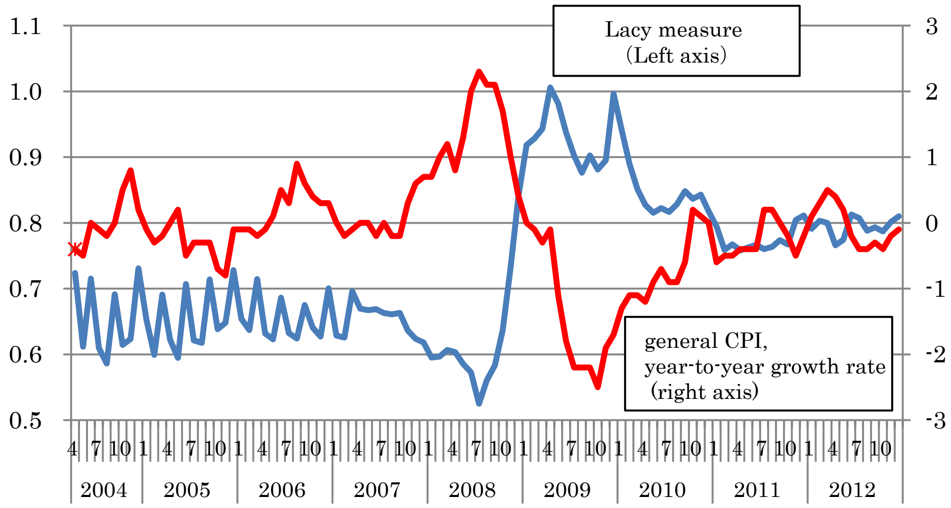
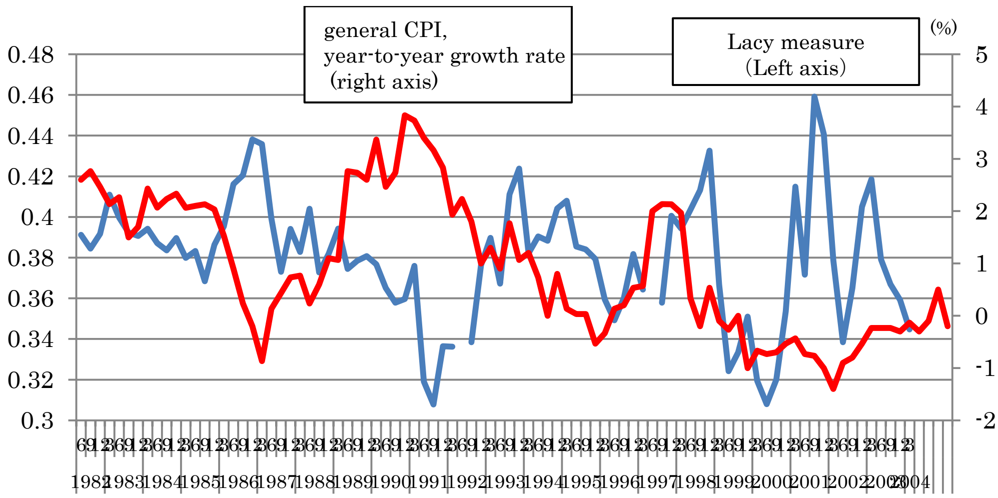


Figure 2-11 Distribution of inflation expectations (April 1982-March 2004)



First, the index exceeds 0.7 after 2009 and retains a relatively high value throughout the period. Although the minimum value of the index is 0.31 in June 2000, as the number of choices differs, we cannot make a simple comparison of the indexes before and after April 2004. In June 2000, the distribution of the responses is centered on "unchanged" (63.4% of the total responses), while the sum of the shares of "increase" and "decrease" at both ends is only 3.7%, corresponding to the least dispersed responses. We can infer that the responses are quite dispersed between the highest and the lowest category for each survey point.

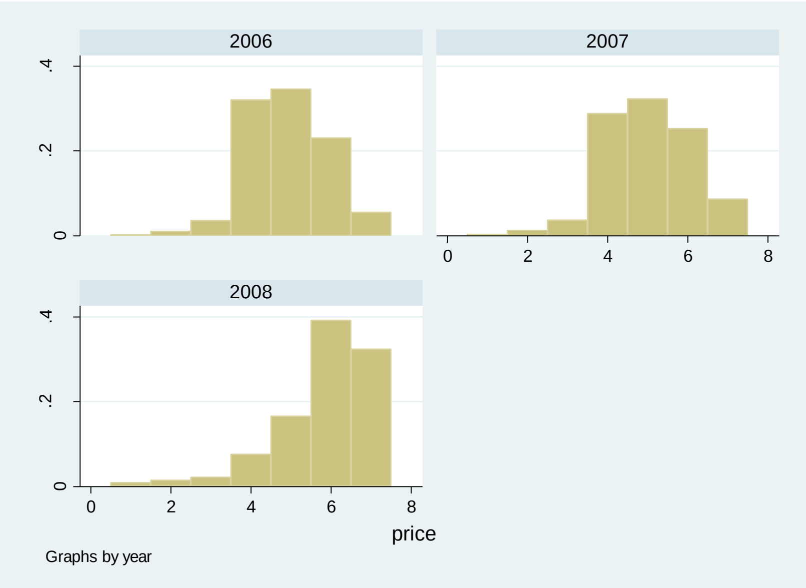
When we examine the relationship between the Lacy measure and the year-to-year growth rate of the general CPI, we find that after April 2004 in particular, the higher inflation rate and the lower inflation rate is linked to less discrete and more discrete responses, respectively. In other words, these two indexes are generally negatively correlated with each other.[22] A close examination of the changes in the response distribution shows that most consumers raise their expectations when the current inflation rate is accelerating, but they do not respond in a uniform way when the inflation rate is decelerating; in other words, only a limited number of consumers reduce their expectations when the current inflation rate is decelerating, while the others do not change expectations, or even raise them, when faced with a declining inflation rate.

If we assume that inflation expectations will rise (i.e., the distribution of the expectations would shift to the right) during an inflationary period and will hardly decrease during a deflationary period, it is likely that the whole distribution would not shift smoothly to the left, although the shift to the right would be quite smooth. According to the previous literature, if the expected inflation rate is hardly negative, we are likely to observe a peak around zero in the distribution of the expectations with a decline in the CPI. The histogram of the expected inflation rates by year (Figure 2-12) indicates that few responses are at the negative level. Simultaneously, the responses are concentrated around zero (unchanged) when the inflation rate evaluated by the general CPI was zero or negative (e.g., 2006-2007 or 2010).[23]

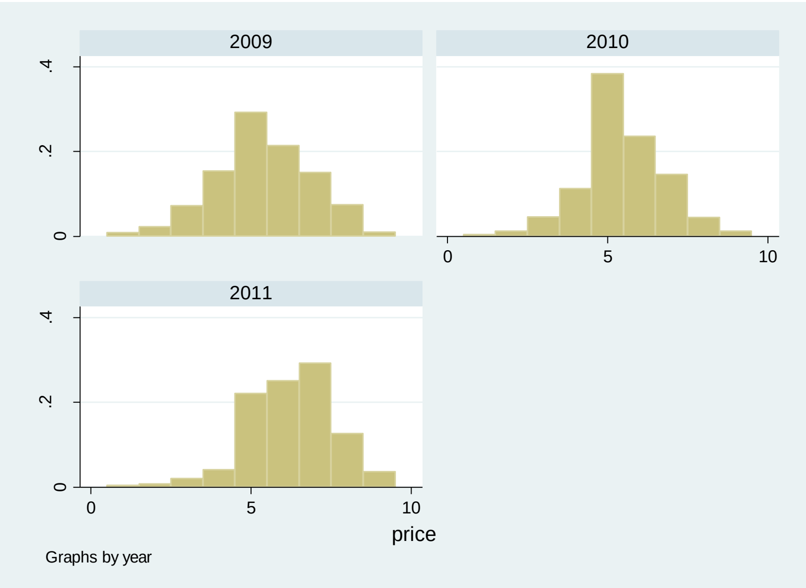
[22] In Figure 2-10, the Lacy measure oscillates regularly around the period between 2004 and 2006. This can be attributed to the differences in the tendency of responses arising from differing survey methods (telephone survey and door-to-door survey).

[23] Kamata (2008) tested the downward rigidity of household inflation expectations by using data from the "Opinion Survey on the General Public View and Behavior" conducted by the Bank of Japan. He argued that consumers who have negative expected inflation tend to choose zero instead of the true value because of downward rigidity.

Figure 2-12 Distribution of expected inflation responses (2006-2011, by year)



Note: The numbers along the *x*-axis denote the following response categories: 1 - will decrease by more than 5%, 2 - will decrease by 2-5%, 3 - will decrease by 0-2%, 4 - will remain stable, 5 - will increase by 0-2%, 6 - will increase by 2-5%, 7 - will increase by 5%.



Note: The numbers along the *x*-axis denote the following response categories: 1 - will decrease by more than 10%, 2 - will decrease by 5-10%, 3 - will decrease by 2-5%, 4 - will decrease by 0-2%, 5 - will remain stable, 6 - will increase by 0-2%, 7 - will increase by 2-5%, 8 - will increase by 5-10%, 9 - will increase by more than 10%. The data for 2011 are the results of the January-June surveys.

We further examine the extent of strain in the distribution by employing another statistical tool. Skewness, which uses the third moment of the responses, is the most general statistical tool to measure the distortion in distribution. It is positive when the distribution of expectations is distorted to the right and negative when the distortion is to the left. It equals zero if the distribution is symmetric.

Figure 2-13 shows the scatterplot with the regional inflation rate (general CPI excluding fresh groceries) along the *y*-axis and the skewness of inflation expectations along the *x*-axis (for nine regions with monthly data from April 2006). With a positive inflation rate, the absolute value of skewness increases in the negative direction. (For a distribution distorted to the left, its tail becomes longer in the direction greater than the median.) When the inflation rate close to zero, the relationship between it and skewness is not necessarily clear; the skewness is distributed in a dispersed way, both in the positive and the negative regions. With a negative inflation rate, the skewness is distributed in a centered way around zero. This is because unlike the case of positive inflation, even when the absolute level of inflation rate is greater, the distortion in the distribution is limited.

Figure 2-13 Skewness and inflation rate (April 2006-June 2011, by region)

3. Asymmetric loss function model

As indicated in Section 2, on average, inflation expectations are likely to be biased upward. In this section, we consider a model that can explain the existence of such bias. Based on the model of Captistran and Timmermann (2009), we assume that loss for agents is asymmetric between the following two cases: when the realized inflation rate turns out to be higher than the expected inflation rate and when it turns out to be lower than the expected inflation rate. In other words, we set the loss function for forecasters as below:[24,25]

$$L(e_{t+12,t}:\phi) = \frac{1}{\phi^2}\left[\exp(\phi e_{t+12,t}) - \phi e_{t+12,t} - 1\right]$$

…(3-1)

where $e_{t+12,t}$ is a forecast error of the inflation rate predicted at period t and realized at period $t+12$. ϕ is a parameter that indicates the extent of asymmetry; if $\phi > 0$, the loss increases rapidly with a positive $e_{t+12,t}$, and if $\phi < 0$, the loss increases rapidly with a negative $e_{t+12,t}$. As ϕ approaches zero, the loss function is closer to becoming symmetric.

We assume (1) identical ϕ for all households, (2) rational expectations, and (3) identical information sets for all households. Given the information set at period t, when the inflation rate at period $t+12$ is expected to follow a normal distribution with average $\mu_{t+12,t}$ and variance $\sigma^2_{t+12,t}$, the optimal forecast for households $f^*_{t+12,t}$ that minimize the expected loss can be expressed as follows:[26]

$$f^*_{t+12,t} = \mu_{t+12,t} + \frac{\phi}{2}\sigma^2_{t+12,t}$$

…(3-2)

We then relax some of the above-mentioned assumptions as follows: (1)' the extent of asymmetry with regards to loss varies among households, and (2)' a departure $\pi_{b,i}$ from the optimal forecast under rational expectations exists. From (3-2), the expected inflation rate $f_{t+12,t,i}$ for period $t+12$ of household i at period t can be expressed as follows:

$$f_{t+12,t,i} = \mu_{t+12,t} + \frac{\phi_i}{2}\sigma^2_{t+12,t} + \pi_{b,i}$$

…(3-3)

where ϕ_i is a parameter that represents the extent of asymmetry of household i.

We denote the inflation rate at period $t+12$ as π_{t+12} and the information set at period t as Ω_t. Then, the expected value of the forecast error for period $t+12$, given the information set $(E[\pi_{t+12} - f_{t+12,t,i}|\Omega_t])$ equals $(-\pi_{b,i} - \frac{\phi_i}{2}\sigma^2_{t+12,t})$. This implies that the

---

[24] This function is called the linear exponential loss function (the Linex loss function). For details, see Varian (1975) and Zellner (1986). The formulation of (3-1) is based on Captistran and Timmermann (2009).

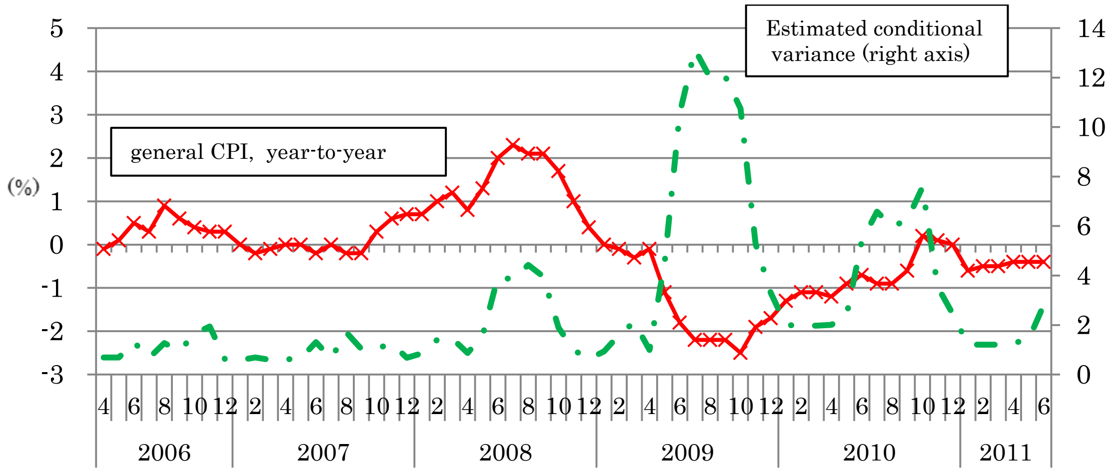
[25] An intuitive explanation of the background of this asymmetry is provided in the Appendix.

[26] See Zellner (1986) and Captistran and Timmermann (2009) for details of the derivation.

gap between the expected and the realized inflation rates would not be equal to zero in the long run despite the assumption of rational expectations ($\pi_{b,i} = 0$) if we assume an asymmetric loss function defined as (3-1).

When we apply the above-mentioned asymmetric loss function model to the forecast error defined in Section 2, under the assumption $\pi_{b,i} = 0$, we can derive the asymmetry parameter as $\phi_i = -2/T_i \sum(e_{t+12,t,i} / \sigma^2_{t+12,t})$, where $e_{t+12,t,i}$ is the forecast error of inflation expectations forecasted at t by households and realized at $t + 12$, and T_i is the sample size of the households.[27]

Figure 3-1 Estimated Conditional Variance



[27] In order to derive the estimated value of conditional variance $\sigma^2_{t+12,t}$ at period $t + 12$, given the information set at t, we estimate a generalized autoregressive conditional heteroskedasticity (GARCH) model as below. The GARCH model by Bollerslev (1986) is a generalized version of the autoregressive conditional heteroskedasticity (ARCH) model by Engel (1982).

$$\pi_{t+12} = \beta_0 + \beta_1 \pi_t + \beta_2 \pi_{t-1} + \varepsilon_{t+12}$$

$$\varepsilon_{t+12} \sim N\left(0, \sigma^2_{t+12,t}\right)$$

$$\sigma^2_{t+12,t} = \gamma_0 + \gamma_1 \varepsilon_t^2 + \gamma_2 \sigma^2_{t+12,t}$$

where β_0, β_1, β_2, and γ_0, γ_1, γ_2 are parameters, and ε_{t+12} is an error term. The estimation result with the general CPI is summarized in Table 3-1, and the estimated conditional variance is shown in Figure 3-1.

Table 3-1 Estimation results of the GARCH model

Data: General CPI year-to-year growth rate			
Estimation period: January 1971–June 2012			
GARCH model			
	Coefficient	Std. error	z-value
β_0	0.13	0.66	1.98
β_1	0.91	0.14	6.67
β_2	−0.26	0.13	−2.01
γ_0	0.29	0.56	5.06
γ_1	0.72	0.56	12.91
γ_2	0.47	0.24	19.59
T			485
Log-likelihood			−1036.85

Figure 3-2 Distribution of the estimated ϕ_i ($\pi_{b,i} = 0$) based on the general CPI

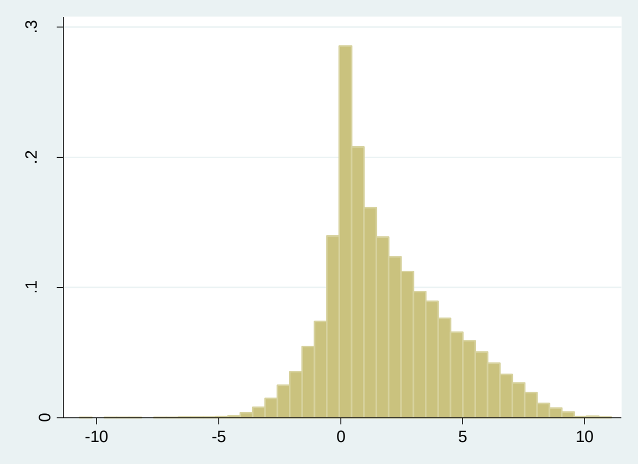


Figure 3-2 shows the distribution of the estimated ϕ_i. The distribution of ϕ_i has a thicker tail towards the right-hand side, indicating that most households have positive ϕ_i. In other words, for these households, the loss from underestimating the expected inflation rate compared with the realized rate is greater than the loss of overestimating this rate.[28]

Next, we consider the case when $\pi_{b,i} \neq 0$ using the simple regression model given below:

$$e_{t+12,t,i} = c_{0,i} + c_{1,i}\sigma_{t+12,t}^2 + \varepsilon_{t+12,i} \quad \ldots(3\text{-}4)$$

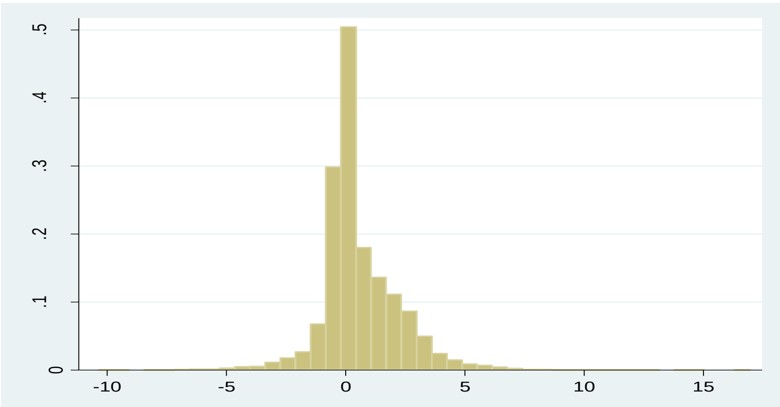
where $c_{0,i}$, $c_{1,i}$ are parameters, and $\varepsilon_{t+12,i}$ is an error term.

[28] As shown in Figure 3-1, since the GARCH estimation assumes a normal distribution of error terms, the conditional variance increased significantly after the CPI inflation rate became volatile. In order to check the robustness of the estimated ϕ_i, we replace the conditional variances from the GARCH results with the observed cross-sectional variances of the expectations. We derive consistent results for both cases.

Here, we simply use the ordinary least squares (OLS) model and implement t-tests on the estimated coefficient and intercept. As the panel data of expected inflation rates is available, we can estimate (3-4) at the household level.

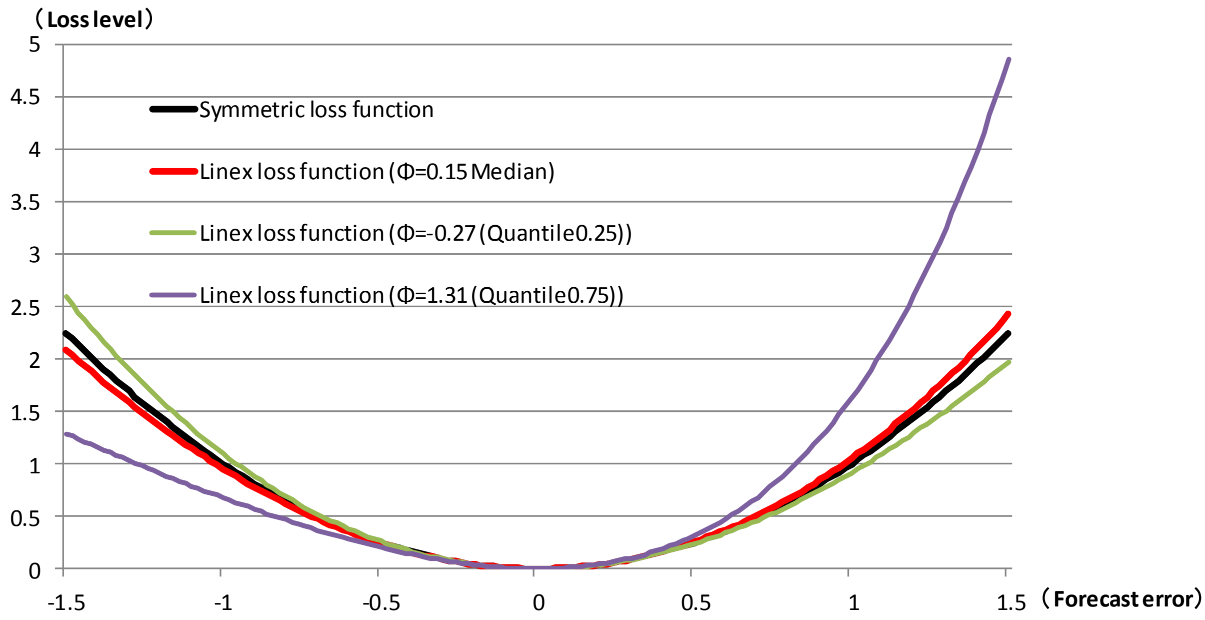
Figure 3-3 shows the distribution of ϕ_i derived from the estimation results of $c_{1,i}$. We use the year-to-year growth rate of the general CPI as the inflation rate and the estimated value from the GARCH model as the conditional variance.[29] Again, ϕ_i takes a positive value for most households. Figure 3-4 provides an intuition of the extent of the asymmetry. When ϕ_i is 1.31, which corresponds to the third quartile of the distribution, households incur twice as large a loss for underestimation by 1% compared to overestimation by 1%. Further, the null hypothesis $c_{0,i} = 0$ is rejected at the 5% significance level for 7,327 households (36.0% of the total), and the null hypothesis $c_{1,i} = 0$ is rejected at the 5% level for 3,337 households (16.4% of the total).

Figure 3-3 Distribution of the estimated $\boldsymbol{\phi_i}$ ($\boldsymbol{\pi_{b,i} \neq 0}$) based on the general CPI



[29] Again, consistent results are derived when we use the cross-sectional variances.

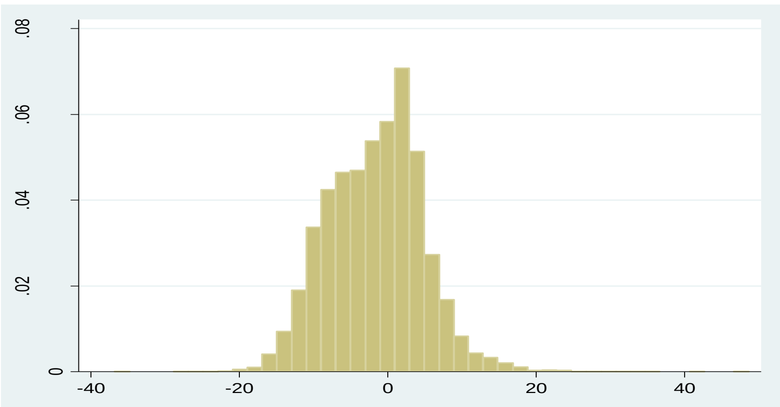
Figure 3-4 Loss level and forecast error



Note: One standard deviation of forecast error is around 1.5.

Similarly, Figure 3-5 shows the result derived with the inflation rate of "frequently purchased items." In this case, there is no clear tendency that the majority of households has either a positive or a negative ϕ_i. The null hypothesis $c_{0,i} = 0$ is rejected at the 5% significance level for 5,720 households (28.1% of the total), and the null hypothesis $c_{1,i} = 0$ is rejected at the 5% level for 4,902 households (24.1% of the total).

Figure 3-5 Distribution of estimated ϕ_i ($\pi_{b,i} \neq 0$)
based on the CPI of "frequently purchased items"



In conclusion, we find evidence of the gap between expected and related inflation rate because of the asymmetry of the loss function for the majority of households. The skewness observed in the forecast errors in the dataset can possibly be caused by such a mechanism. We also find that a sizable number of households form expectations that are not necessarily rational.

Next, we derive an implication on the dispersion of expected inflation rates by using the asymmetric loss function model. The index $s_{t+12,t}$ denotes the extent of the dispersion of the observed distribution and is defined as follows:

$$s_{t+12,t} \equiv \left[\frac{1}{N_t}\sum_{i=1}^{N_t}\left(f_{t+12,t,i} - f_{t+12,t}^{a}\right)^2\right]^{\frac{1}{2}}$$

...(3-5)

where N_t is the number of households at period t, and $f_{t+12,t}^{a}$ is the average expected inflation rate at t for period $t + 12$ ($f_{t+12,t}^{a} = \frac{1}{N_t}\sum_{i=1}^{N_t} f_{t+12,t,i}$). We assume rational expectations, substitute $f_{t+12,t,i}$ with $\pi_{b,i} = 0$ in (3-3) into (3-5), and derive the following results.

$$s_{t+12,t} = \frac{\left[\frac{1}{N_t}\sum_{i=1}^{N_t}(\phi_i - \phi^a)^2\right]^{\frac{1}{2}}}{2}\sigma_{t+12,t}^2$$

...(3-6)

where $\phi^a = \frac{1}{N_t}\sum_{i=1}^{N_t}\phi_i$. (3-6) implies that the dispersion index $s_{t+12,t}$ is positively correlated with the conditional variance $\sigma_{t+12,t}^2$, given the model is consistent with the data. We thus estimate the OLS regression as seen below. In this estimation, we employ the estimated conditional variance derived from the year-to-year growth rate of the general CPI.

$$s_{t+12,t} = \delta_0 + \delta_1\sigma_{t+12,t}^2 + \varepsilon_{t+12}$$

...(3-7)

where δ_0, δ_1 are parameters, and ε_{t+12} is an error term.

The estimation result is summarized in Table 3-2. The coefficient of δ_1 is quite small, but it is significantly positive at the 1% level, as expected from the model. We thus conclude that the cross-sectional dispersion of the expected inflation rate is consistent to a certain extent with the asymmetric loss function model. At the same time, the intercept δ_0 is significant at the 1% level, which indicates a deviation from rational expectations.

Thus, the observed distribution of the expected inflation rate from our dataset shows a level of consistency with the asymmetric loss function model that assumes heterogeneity in the asymmetry level with respect to loss aversion, and we confirm that deviations exist from the rational expectation. Based on these findings, in Section 4, we investigate the extent of heterogeneity of expectations among households, focusing on the relationship between households' attributes and inflation expectation levels.

Table 3-2 Estimation results of the cross-sectional dispersion

Estimation period: April 2006–June 2011			
	Coefficient	t-value	p-value
δ_0	1.91	49.65	0.000
δ_1	0.025	2.75	0.008
T			63
R2			0.11

4. Relationship between household attributes and inflation expectations

(1) Overview of the dataset

In this section, we implement an empirical analysis to examine the relationships between households' attributes and inflation expectations. First, we use monthly data from April 2006 to provide an overview of inflation expectations by the attributes of the respondents in Table 4-1. Further, Table 4-2 shows the composition of household heads' ages in our dataset.

Table 4-1 Summary statistics of expected inflation by household attributes (April 2006-June 2011)

		Mean (%)	SD
	Total	1.539	2.178
Age group	18-24	1.237	2.111
	25-29	1.288	2.080
	30-34	1.454	2.021
	35-39	1.427	2.075
	40-44	1.527	2.108
	45-49	1.570	2.158
	50-54	1.576	2.207
	55-59	1.610	2.219
	60-64	1.592	2.233
	65-69	1.594	2.252
	70-74	1.589	2.195
	75-90	1.491	2.158
Income	Below 3million	1.593	2.244
	3-4 million	1.524	2.162
	4-5.5 million	1.562	2.131
	5.5-7.5 million	1.529	2.119
	7.5-9.5 million	1.450	2.135
	9.5-12 million	1.458	2.150
	Above 12 million	1.331	2.161
Job	Non-employed	1.626	2.186
	Employed	1.534	2.128
	Self-employed	1.382	2.262
Mortgage	Yes	1.515	2.165
	No	1.545	2.182

Table 4-2 Age composition of households' heads (1982-2004)

	Age											
Year	18-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-90
1982	0.5%	3.3%	10.5%	12.0%	13.1%	14.5%	13.5%	11.0%	8.2%	6.1%	4.2%	3.0%
1983	0.4%	3.3%	9.5%	12.2%	13.2%	13.6%	13.5%	11.9%	8.4%	6.4%	4.2%	3.4%
1984	0.5%	2.8%	7.3%	12.2%	13.7%	13.7%	13.6%	12.4%	9.0%	6.1%	4.5%	4.4%
1985	0.4%	2.7%	7.1%	12.5%	12.4%	13.5%	13.8%	12.1%	9.1%	6.4%	5.3%	4.7%
1986	0.4%	2.7%	6.1%	12.4%	12.8%	13.0%	13.7%	12.4%	10.1%	6.5%	5.3%	4.6%
1987	0.3%	2.5%	6.2%	11.6%	12.0%	13.2%	13.7%	12.6%	10.6%	6.9%	5.3%	5.1%
1988	0.4%	2.5%	6.4%	11.4%	12.9%	12.9%	12.7%	12.5%	11.0%	6.8%	4.8%	5.6%
1989	0.4%	2.3%	5.8%	10.3%	12.3%	13.5%	12.9%	12.9%	11.3%	7.8%	4.7%	5.6%
1990	0.4%	2.3%	5.4%	9.2%	13.3%	12.9%	13.2%	12.9%	11.5%	7.7%	5.7%	5.6%
1991	0.4%	2.5%	5.3%	8.6%	14.0%	12.1%	12.4%	12.8%	11.4%	8.8%	5.7%	6.0%
1992	0.4%	2.4%	5.1%	7.8%	13.5%	12.6%	12.6%	13.4%	11.7%	9.1%	5.2%	6.2%
1993	0.4%	2.2%	5.0%	7.6%	12.9%	13.3%	13.3%	12.6%	11.4%	9.5%	5.5%	6.3%
1994	0.5%	2.0%	5.1%	7.6%	11.7%	13.3%	12.9%	12.7%	11.9%	9.9%	6.1%	6.3%
1995	0.4%	2.2%	4.9%	6.9%	10.0%	13.4%	12.7%	11.9%	12.7%	10.6%	7.0%	7.3%
1996	0.5%	2.2%	4.5%	7.0%	9.4%	14.3%	12.7%	11.7%	11.8%	11.2%	7.2%	7.4%
1997	0.5%	2.4%	5.5%	7.5%	8.9%	13.3%	12.1%	11.4%	11.7%	11.2%	7.9%	7.5%
1998	0.5%	2.4%	5.6%	7.3%	8.6%	12.5%	13.4%	12.0%	11.8%	10.7%	7.8%	7.6%
1999	0.3%	2.5%	5.2%	7.3%	8.8%	11.1%	13.6%	12.5%	11.9%	10.5%	8.4%	7.8%
2000	0.4%	2.2%	5.0%	7.2%	7.8%	10.4%	14.3%	12.2%	11.8%	11.0%	8.9%	8.9%
2001	0.4%	2.3%	4.5%	6.1%	7.9%	10.4%	14.6%	11.8%	12.3%	10.8%	8.8%	10.1%
2002	0.4%	2.0%	4.4%	6.0%	7.5%	9.6%	14.4%	12.0%	11.3%	11.3%	10.0%	11.2%
2003	0.3%	1.9%	4.6%	6.0%	7.6%	9.0%	12.0%	12.3%	12.8%	11.7%	10.0%	11.9%
2004	0.3%	1.5%	4.6%	6.6%	7.8%	8.6%	11.1%	11.7%	13.7%	11.2%	11.1%	11.7%

Note: Sample size = 448,185

Age composition of households' heads (2006-2011)

	Age											
Year	18-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-90
2006	1.7%	3.7%	4.9%	6.1%	6.7%	7.0%	7.8%	11.9%	11.5%	11.8%	11.3%	15.8%
2007	1.7%	3.4%	5.0%	5.9%	6.8%	6.8%	7.8%	11.5%	11.3%	12.0%	11.7%	16.1%
2008	1.8%	3.3%	4.6%	5.8%	6.7%	6.5%	7.6%	10.3%	12.3%	12.3%	11.7%	17.1%
2009	1.6%	2.8%	3.9%	5.4%	5.9%	6.5%	7.7%	10.5%	12.4%	13.3%	12.1%	17.8%
2010	1.3%	2.7%	3.4%	5.3%	5.9%	6.1%	7.7%	9.8%	13.0%	13.3%	12.5%	19.0%
2011	1.3%	2.4%	3.3%	5.2%	6.4%	6.6%	8.4%	9.7%	13.0%	12.2%	12.6%	18.8%

Note: Sample size = 325,148

Table 4-1 indicates that the differences in the expected inflation rates by age and income are particularly distinct among all characteristics. With regard to income, lower-income households tend to have higher expected inflation rates. Further, household heads who drop out of labor force, which are likely to be positively correlated with low-income households, tend to have relatively high expectations as well. With regard to age, the expectation level is neither monotonically increasing nor decreasing. Rather, the level is low among the young (i.e., those aged below 30), the highest in the mid-aged (i.e., those aged 45-59), and tends to decline again among the elderly.

(2) Estimation results

In order to examine the relationship between households' characteristics and inflation expectations, Table 4-3 (Model 3) comprises the estimation results of the panel analysis on a household basis, wherein the expected inflation rate is an explained variable and households' attributes are explanatory variables. In this estimation, as the households' attributes used for the estimation are basically supposed to remain unchanged for most households during the survey period of 15 months,[30] we employ the random effects model instead of the fixed effects model.

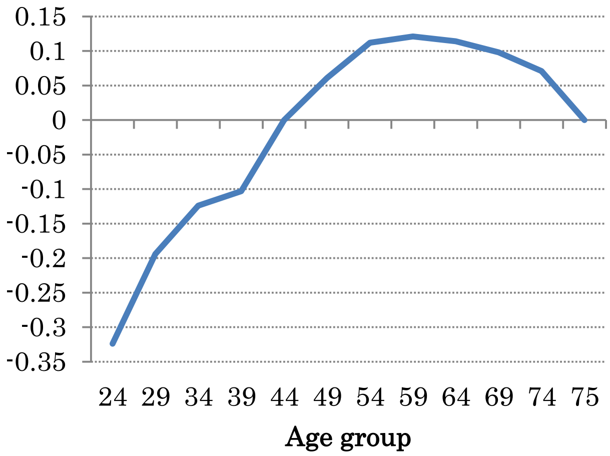
[30] To be precise, the age of the household's head would increase by one during the survey period.

Table 4-3 Household attributes and expected inflation (1)

Explained variable= Inflation expectations (mid-value)								
Estimation period: April 2006-June 2011								
	Model 1		Model 2		Model 3		Model 4	
	Pooling estimation		Pooling estimation (IPW)		Random effects model		Interval estimation	
Employed	−0.081	**	−0.091	**	−0.067		−0.115	***
	(0.032)		(0.039)		(0.054)		(0.037)	
Self-employed	0.055	***	0.091	***	0.030	*	0.047	***
Age dummies	(0.010)		(0.014)		(0.017)		(0.012)	
18-24	−0.356	***	−0.337	***	−0.324	***	−0.417	***
	(0.031)		(0.043)		(0.058)		(0.036)	
25-29	−0.279	***	−0.314	***	−0.194	***	−0.311	***
	(0.024)		(0.034)		(0.044)		(0.028)	
30-34	−0.121	***	−0.125	***	−0.124	***	−0.154	***
	(0.021)		(0.030)		(0.040)		(0.025)	
35-39	−0.111	***	−0.154	***	−0.103	***	−0.131	***
	(0.020)		(0.027)		(0.037)		(0.023)	
40-44	−0.009		−0.079	***	0.000		−0.003	
	(0.019)		(0.026)		(0.036)		(0.022)	
45-49	0.088	***	0.077	***	0.061	*	0.117	***
	(0.019)		(0.026)		(0.035)		(0.022)	
50-54	0.116	***	0.121	***	0.112	***	0.156	***
	(0.018)		(0.025)		(0.033)		(0.020)	
55-59	0.153	***	0.186	***	0.121	***	0.193	***
	(0.016)		(0.022)		(0.030)		(0.018)	
60-64	0.115	***	0.114	***	0.114	***	0.151	***
	(0.014)		(0.019)		(0.028)		(0.017)	
65-69	0.122	***	0.116	***	0.098	***	0.154	***
	(0.014)		(0.019)		(0.027)		(0.016)	
70-74	0.099	***	0.148	***	0.071	***	0.118	***
	(0.014)		(0.019)		(0.026)		(0.016)	
Income (mid-value)	−0.00042	***	−0.001	***	−0.0002903	***	−0.0005	***
	(0.000)		(0.000)		(0.000)		(0.000)	
Number of household members	0.043	***	0.067	***	0.036	***	0.046	***
	(0.003)		(0.004)		(0.006)		(0.003)	
Mortgage	−0.046	***	−0.077	***	−0.028		−0.052	***
	(0.010)		(0.014)		(0.018)		(0.012)	
CPI general (year-to-year growth rate)	0.448	***	0.431	***	0.375	***	0.542	***
	(0.007)		(0.009)		(0.006)		(0.008)	
Constant	101.382	***	102.297	***	102.062	***	102.276	***
	(0.023)		(0.034)		(0.037)		(0.028)	
Monthly dummies	○		○		○		○	
Year dummies	○		○		○		○	
City size dummies	○		○		○		○	

Note: 1. Base of job dummies= non-employed or farms
2. Base of age dummies= 75-90 years old
3. Statistically significant at 10% (*), at 5% (**), at 1% (***), standard errors are in parenthesis

Figure 4-1 Age effects on expected inflation (random effects model)



The estimation results can be evaluated as follows. First, the expected inflation rates are formed in accordance with the current inflation rate (adaptive expectation formation); thus, when the current inflation rate rises (drops), it is clear that expectations would increase (decrease) as well. By controlling the impact of the changes in the current inflation rate, we examine the relationship between households' characteristics and expectations and discover the following. 1) The employed tend to have lower expectations relative to the unemployed, and the self-employed tend to have higher expectations. 2) With regard to age groups, the younger group (below 40) has lower expectations, the mid-aged group has higher expectations, and the elderly group (over 60), again, has lower expectations. These age effects are evident in Figure 4-1 from the asymmetric inverse U-shaped curve with its peak around the age group of 55-59. This variation in the expected inflation rates among the age groups can also be observed when we include age itself, instead of age-group dummies, as an explanatory variable.[31]

[31] The estimation results appear in Table 4-4.

Table 4-4 Household attributes and expected inflation (2)

Explained variable= Inflation expectations (mid-value)						
Estimation period: April 2006-June 2011						
Random effects model	Model 1		Model 2		Model 3	
Employed	-0.069		-0.066		-0.066	
	(0.054)		(0.054)		(0.054)	
Self-employed	0.047	***	0.035	**	0.036	**
	(0.017)		(0.017)		(0.017)	
Age	0.0038	***	0.039	***	0.036	**
	(0.001)		(0.003)		(0.015)	
Age*Age	-		-0.0003	***	-0.0003	
			(0.000)		(0.000)	
Age*Age*Age	-		-		-0.0000002	
					(0.000)	
Income (mid-value)	-0.0002	***	-0.0003	***	-0.0003	***
	(0.000)		(0.000)		(0.000)	
Number of household members	0.0403	***	0.0336	***	0.0337	***
	(0.006)		(0.006)		(0.006)	
Mortgage	-0.0099		-0.0281		-0.0278	
	(0.018)		(0.018)		(0.018)	
General CPI (year-to-year growth rate)	0.373	***	0.374	***	0.374	***
	(0.006)		(0.006)		(0.006)	
Constant	101.88	***	101.06	***	101.10	***
	(0.054)		(0.092)		(0.239)	
Month (dummies)	yes		yes		yes	
Year (dummies)	yes		yes		yes	
Size of cities	yes		yes		yes	
Note: 1. Base of job dummies= non-employed or farms						
2. Statistically significant at 10% (*), at 5% (**), at 1% (***),						
standard errors are in parenthesis						

Notably, when we add the age and power-of-age terms to the explanatory variables, the model performs best with age and squared age.[32] If we estimate the possible impact of age on inflation expectations by using the estimated coefficients, the positive impact of age on expectations is maximized at the age of 58.5. Thus, the younger the respondent (for ages less than 58.5), the smaller the impact, and the older the respondent (for ages exceeding 58.5), the smaller the impact. Further, lower income levels and bigger households indicate significantly higher expected inflation rate. Table 4-3 presents the estimation results with the other models, [33] and they are generally consistent irrespective of the model.

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[32] Estimation results employing ages up to the cubed age are shown in Table 4-4. We estimate various patterns by using ages up to the sixth-power and implement a Wald test to identify the limit of the terms to be included in the estimation.

[33] The other models include the pooled OLS model with all samples (Model 1), the pooled regression model with inverse probability weighting to control attrition bias (Model 2), and the interval regression model with each interval as the explained variables (Model 4). The inverse probability weight used in Model 2 is estimated based on the logit estimation result (Table 4-5), wherein the probability of dropping out during the survey period is explained by household characteristics.

Table 4-5 Estimation of attrition probability

Explained variable= Dropped during survey period=1, not dropped=0		
Estimation period: April 2006–June 2011		
Probability of attrition	Logit model	
Employed	0.213	*
	(0.126)	
Self-employed	−0.039	
Age dummies	(0.040)	
18–24	0.868	***
	(0.108)	
25–29	0.609	***
	(0.088)	
30–34	0.579	***
	(0.082)	
35–39	0.455	***
	(0.077)	
40–44	0.266	***
	(0.076)	
45–49	0.146	**
	(0.074)	
50–54	0.155	**
	(0.070)	
55–59	0.060	
	(0.062)	
60–64	−0.016	
	(0.056)	
65–69	−0.066	
	(0.054)	
70–74	−0.127	**
	(0.055)	
Income (mid-value)	0.000	
	(0.000)	
Number of household members	−0.171	***
	(0.012)	
Mortgage	−0.073	*
	(0.041)	
Constant	−0.145	
	(0.131)	
Monthly dummies	○	
Trend	○	
City size dummied	○	

Note: 1. Base of job dummies = non-employed or farms
2. Base of age dummies = 75–90 years old
3. Statistically significant at 10% (*), at 5% (**), at 1% (***), standard errors are in parenthesis

The above-mentioned estimation results use all the samples, including single-person and multiple-person households. As explained in Section 3, in case of multiple-person households, the actual respondent can possibly be different from the household head (for example, the child of the household's head might have responded instead of the household head). We thus repeat the same estimation using only single-person households (Table 4-6 (6)) and find that the estimated coefficients are, in general, similar with regards to most explanatory variables, compared with the estimation using all samples. The asymmetric inverse U-shaped age effects are also stable.

Table 4-6 Estimation results with age-group dummies (April 2006-June 2011)

	Random effects model											
Estimation period	April 2006-June 2011											
							1st-3rd survey months		13th-15th survey month		Single-person household only	
	(1)		(2)		(3)		(4)		(5)		(6)	
Employed	-0.067		-0.073		-0.068		0.152	**	0.153	***	0.118	***
	(0.054)		(0.054)		(0.054)		(0.033)		(0.034)		(0.038)	
Self-employed	0.030	*	0.032	*	0.030	*	0.139	**	0.091	***	0.014	
Age dummies	(0.017)		(0.017)		(0.017)		(0.031)		(0.032)		(0.038)	
18-24	-0.324	***	-0.317	***	-0.280	***	-0.118		-0.186	*	-0.205	***
	(0.058)		(0.058)		(0.058)		(0.086)		(0.104)		(0.072)	
25-29	-0.194	***	-0.192	***	-0.155	***	-0.068		-0.213	***	-0.115	*
	(0.044)		(0.044)		(0.044)		(0.070)		(0.077)		(0.065)	
30-34	-0.124	***	-0.124	***	-0.076	*	-0.019		-0.047		-0.107	
	(0.040)		(0.040)		(0.040)		(0.064)		(0.068)		(0.071)	
35-39	-0.103	***	-0.098	***	-0.051		-0.007		-0.012		0.071	
	(0.037)		(0.037)		(0.037)		(0.060)		(0.062)		(0.075)	
40-44	0.000		0.002		0.067	*	0.063		0.135	**	0.116	
	(0.036)		(0.036)		(0.036)		(0.058)		(0.060)		(0.078)	
45-49	0.061	*	0.063	*	0.128	***	0.162	***	0.147	**	0.203	***
	(0.035)		(0.036)		(0.036)		(0.057)		(0.059)		(0.075)	
50-54	0.112	***	0.116	***	0.150	***	0.104	*	0.262	***	0.143	**
	(0.033)		(0.033)		(0.033)		(0.054)		(0.056)		(0.067)	
55-59	0.121	***	0.124	***	0.154	***	0.186	***	0.295	***	0.219	***
	(0.030)		(0.030)		(0.030)		(0.049)		(0.050)		(0.058)	
60-64	0.114	***	0.116	***	0.125	***	0.132	***	0.161	***	0.143	***
	(0.028)		(0.028)		(0.028)		(0.044)		(0.045)		(0.053)	
65-69	0.098	***	0.101	***	0.107	***	0.167	***	0.169	***	0.115	**
	(0.027)		(0.027)		(0.027)		(0.041)		(0.043)		(0.050)	
70-74	0.071	***	0.072	***	0.073	***	0.067		0.143	***	0.039	
	(0.026)		(0.026)		(0.026)		(0.041)		(0.043)		(0.046)	
Income	-0.0003	***	-0.0003	***	-0.0003	***	-0.0004	***	-0.0004	***	-0.0005	***
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Number of HH members	0.036	***	0.035	***	0.036	***	0.055	***	0.041	***	-	
	(0.006)		(0.006)		(0.006)		(0.008)		(0.009)			
Mortgage	-0.028		-0.027		-0.025		-0.052	*	-0.034		-0.004	
	(0.018)		(0.018)		(0.018)		(0.029)		(0.030)		(0.048)	
CPI general (year-to-year)	0.375	***	-		-		0.425	***	0.487	***	0.343	***
	(0.006)						(0.016)		(0.016)		(0.011)	
CPI frequently purchased (year-to-year)	-		0.126	***	-		-		-			
			(0.003)									
CPI by age (year-to-year)	-		-		0.366	***	-		-			
					(0.006)							
Constant	102.062	***	101.729	***	101.972	***	101.872	***	101.830	***	102.042	***
	(0.037)		(0.039)		(0.037)		(0.064)		(0.065)		(0.068)	
Month (dummies)	yes		yes		yes		yes		yes		yes	
Year (dummies)	yes		yes		yes		yes		yes		yes	
Size of cities	yes		yes		yes		yes		yes		yes	
Quarter (dummies)	-		-		-		-		-		-	
Trend	-		-		-		-		-		-	
N	297,200		297,200		297,200		61,226		54,629		87,839	

Note: 1. Base of job dummies is set on "non-employed."
2. Base of age dummies is set on "75-90 years old."
3. *,**,*** stands for statistically significant at 10%, 5%, 1% level, respectively. Standard errors are in parentheses.
4. Explained variable is a mid-value of the categories of inflation expectations (end-value at both ends). Normalized to 100=0%.

In addition, we estimate the following patterns (Table 4-6): (1) replacing the control (general CPI) with the CPI of "frequently purchased items" and (2) using a year-to-year growth rate of CPI that considers the variation in the consumption basket by age group.[34] In both cases, we hardly observe any impact on the inverse-U shape of age effects; thus, we can confirm that the variance in the consumption basket by age group cannot explain the difference in the expected inflation rates by age group.

In order to examine whether these results would also apply to the dataset of the 80s and 90s, we implement the same estimation using a quarterly dataset. The estimation period spans from June 1982 to March 2004.[35] As explained previously, we use the dataset as a cross-sectional dataset instead of a panel dataset, because the same households were traced for a limited period only. As the choice variables are five qualitative categorical variables, we use the ordered logit model.[36] Although differences exist with regard to the explained variables and estimation models, the derived results are mostly consistent with the previous ones for the data after 2006. Regarding marginal age effects, the young show small effects, the mid-aged, particularly those aged 45-59, show large effects, and the elderly show small effects. Moreover, regarding income effects, the lower the income, the greater the effects. Regarding the number of household members, the bigger the household, the higher the expectation. In the case of the estimation using age itself as an explanatory variable[37], the performance of the estimation using up to the squared age is the best, much like the estimation using the recent dataset, and the marginal positive age effect on the expected inflation rate is the highest for the age of 58.1.

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[34] As explained in Section 2, although the CPI of "frequently purchased items" is published by the Ministry of Internal Affairs and Communications, the CPI by age group is not available publicly. We thus estimate it using a simple method, namely the expenditure weight of households by age group from the "Family Income and Expenditure Survey," and we apply this value in this estimation. The growth rate of the CPI by age group is not so different from that of the general CPI, and only limited gaps are observed among the age groups. Compared with these gaps, the discrepancies in inflation expectations among age groups are more distinct.

[35] During the corresponding period, the economy experienced great structural changes in the form of the bubble and its bursting. Thus, while implementing the estimation models, we include not only the usual trend but also additional trends that indicate the bubble period as well as the structural changes.

[36] The estimation results appear in Table 4-8.

[37] The estimation results appear in Table 4-7.

Table 4-7 Estimation results with age (June 1982-March 2004)

	Ordered logit model							
Estimation period	June 1982–March 2004		June 1982–December 1989		June 1982–December 1989		March 1990–March 1999	
	(6)		(7)		(8)		(9)	
Employed	0.032	***	0.078	***	0.077	***	-0.012	
	(0.007)		(0.014)		(0.014)		(0.010)	
Self–employed	-0.133	***	-0.115	***	-0.117	***	-0.116	***
	(0.009)		(0.015)		(0.015)		(0.014)	
Age	0.033	***	-0.288	***	0.247	***	-0.425	***
	(0.001)		(0.074)		(0.041)		(0.070)	
Age*Age	-0.00028	***	-0.157	***	-0.006	***	-0.498	***
	(0.000)		(0.036)		(0.001)		(0.033)	
Income	-		-		0.0001	***	-	
					(0.000)			
Number of HH members	-		-		-0.0000002	***	-	
					(0.000)			
Mortgage	-0.001	***	-0.001	***	-0.001	***	-0.001	***
	(0.000)		(0.000)		(0.000)		(0.000)	
CPI general (year-to-year)	0.022	***	0.012	***	0.012	***	0.016	***
	(0.002)		(0.004)		(0.004)		(0.004)	
CPI frequently purchased (year-to-year)	0.053	***	0.057	***	0.057	***	0.031	***
	(0.007)		(0.011)		(0.011)		(0.010)	
CPI by age (year-to-year)	0.249	***	0.048	***	0.049	***	0.156	***
	(0.004)		(0.008)		(0.008)		(0.006)	
Constant	-		-				-	
Month (dummies)	-		-		-		-	
Year (dummies)	-		-		-		-	
Size of cities	-		-		-		-	
Quarter (dummies)	yes		yes		yes		yes	
Trend	yes		yes		yes		yes	
N	448,178		171,321		171,321		191,226	

Note: 1. Base of job dummies is set on "non-employed."
2. Base of age dummies is set on "75-90 years old."
3. *,**,*** stands for statistically significant at 10%, 5%, 1% level, respectively. Standard errors are in parentheses.
4. Explained variable is a category variable of inflation expectations.

Table 4-8 Estimation results with age-category dummies (June 1892-March 2004)

	Ordered logit model					
Estimation period	June 1982-March 2004		June 1982-December1989		March 1990-December1999	
	(7)		(8)		(9)	
Employed	0.077	***	0.078	***	-0.012	
	(0.007)		(0.014)		(0.010)	
Self-employed	-0.076	***	-0.115	***	-0.116	***
Age dummies	(0.009)		(0.015)		(0.014)	
18-24	-0.268	***	-0.288	***	-0.425	***
	(0.046)		(0.074)		(0.070)	
25-29	-0.300	***	-0.157	***	-0.498	***
	(0.022)		(0.036)		(0.033)	
30-34	-0.134	***	0.045		-0.306	***
	(0.017)		(0.029)		(0.026)	
35-39	-0.045	***	0.082	***	-0.142	***
	(0.015)		(0.027)		(0.024)	
40-44	0.057	***	0.171	***	0.002	
	(0.015)		(0.027)		(0.022)	
45-49	0.097	***	0.147	***	0.078	***
	(0.014)		(0.027)		(0.022)	
50-54	0.072	***	0.079	***	0.108	***
	(0.014)		(0.026)		(0.022)	
55-59	0.064	***	0.079	***	0.086	***
	(0.014)		(0.026)		(0.022)	
60-64	0.049	***	0.076	***	0.054	**
	(0.014)		(0.026)		(0.021)	
65-69	0.032	**	0.036		0.048	**
	(0.015)		(0.028)		(0.022)	
70-74	0.021		0.006		0.056	**
	(0.016)		(0.030)		(0.024)	
Income	-0.001	***	-0.001	***	-0.001	***
	(0.000)		(0.000)		(0.000)	
Number of HH members	0.017	***	0.012	***	0.016	***
	(0.002)		(0.004)		(0.004)	
Mortgage	0.041	***	0.057	***	0.031	***
	(0.007)		(0.011)		(0.010)	
CPI general (year-to-year)	0.254	***	0.048	***	0.156	***
	(0.004)		(0.008)		(0.006)	
CPI frequently purchased (year-to-year)	-		-		-	
CPI by age (year-to-year)	-		-		-	
Constant	-		-		-	
Month (dummies)	-		-		-	
Year (dummies)	-		-		-	
Size of cities	-		-		-	
Quarter (dummies)	yes		yes		yes	
Trend	yes		yes		yes	
N	448,178		171,321		191,226	

Note: 1. Base of job dummies is set on "non-employed."
2. Base of age dummies is set on "75-90 years old."
3. *,**,*** stands for statistically significant at 10%, 5%, 1% level, respectively. Standard errors are in parentheses.
4. Explained variable is a category variable of inflation expectations.

(3) Heterogeneity in expectations by age: A background

The above results suggest that our finding that the age effect on expected inflation rates is asymmetric inverse U-shaped, notwithstanding the survey timing, is robust. In order to examine the background of this heterogeneity among age groups, we investigate possible factors including: 1) heterogeneity in the information that households refer to in forming their expectations, and 2) the mixture of heterogeneity among ages, including that among generations.

a. Heterogeneity in reference information

According to the previous literature, the information that consumers refer to is likely to be (a) media information on recent economic and financial developments (including news on price forecasts by professionals) and/or (b) prices of goods and services observed frequently at shops. Regarding the latter, we have already found that the heterogeneity among age groups is not affected by controlling the heterogeneity in the consumption basket among age groups. Regarding the former, we cannot deny the possibility that the difference in the interest level in media information is reflected in the preciseness of inflation expectations. For example, it may be that certain age groups are keen on collecting media information, whereas others are not interested in such information. As a result, the former group forms more accurate expectations than the latter. In this study, following the method of Anderson, Becker, and Osborn (2010), we assume that the age groups, who are not as interested in the news on economic conditions around the beginning of the survey period of 15 months, come to be gradually interested in such news. Thus, our hypothesis to be tested here is that the information gap will diminish through the survey period, decreasing the extent of heterogeneity in inflation expectations across age groups around the end of the period rather than around its beginning. We select samples from the first month to the third month as well as those from the thirteenth month to the fifteenth month of the survey and apply a random effect model with household characteristics as explanatory variables. The estimation results appear in Table 4-6 ((4) and (5)). Both results are almost consistent with the previous ones and show a stable asymmetric inverse-U shape of age effects. We thus conclude that the hypotheses that the discrepancy in the information set among age groups diminishes, and that the distribution of expectations would converge towards the end of the survey period, are not likely to hold.

b. Heterogeneity among generations

While we have focused on the age effects of expected inflation, the generational effects can also be included in the estimated coefficients of age dummies. As indicated by the previous literature, the heterogeneity of expectations among generations may originate mainly from the different inflation rates experienced by each generation throughout their lives.[38] In order to examine whether such impacts actually exist, we divide the samples by decades during the survey time and analyze whether there is a change in the estimated age effects. Given the change in the survey method from April 2004, we divide the samples before and after this period, following which, we further divide the former into those of the 80s and of the 90s. For each set of samples, we implement the ordered logit estimation to examine the relationship between the attributes and expectations (Table 4-8 (8) and (9), Table 4-7 (7) and (9)). A comparison of the estimated age effects of (8) and (9) in Table 4-8 shows that both are similarly inverse U-shaped, while the peak age is younger in (8) than in (9). The theoretical peak age is around 51.8 in (7) and around 61.4 in (9). Regarding the samples of the 80s, however, the result of the Wald test shows that it is the most appropriate to include up to the fourth-power of the age term in the estimation (Table 4-7 (8)). According to this result, the local maximum is reached at the age of 56.1, and local minimum, at 78.5. All the estimation results indicate that the pattern of age effects of the 80s shifted to the right in the 90s (higher peak age). These results suggest that the peak shifted to the right as a generation with relatively high expectations grew older; thus, we consider that a generation-specific effect exists with regard to expected inflation.[39,40]

(4) Interpretation of asymmetry in loss

One of the interpretations of the concept of "asymmetric loss" in the practical economy is related to the discussion on debt deflation (Fisher, 1933). The argument of debt deflation considers a mechanism in which unexpected deflation induces a decline in the consumption of debtors—whose propensity for consumption is higher than that of savers—and accelerates deflationary expectations.[41] The "Consumer Confidence

[38] As intuitive examples, the generation that never experienced inflation since early childhood and the generation that experienced hyper-inflation after World War II or around the time of the oil shocks can form quite different inflation expectations based on their previous memories.

[39] It is possible that the difference observed in the estimation results can be attributed to significant structural changes in Japan's economy in the 80s, 90s, and 2000s. Indeed, the coefficients of not only age but also of other variables vary because of these structural changes. Further, as explained in Section 2, we should note that there is a slight difference between the survey question in the 80s and that in the '90s, which could have affected the response distribution.

[40] On the contrary, although we employ different models, the peak of age effects is 58 in the 2000s, which is slightly younger than the peak age in the 90s. Thus, it would be difficult to provide a consistent interpretation to all estimation results based solely on simple generational effects.

[41] Takeda and Keida (2009) analyzed the dataset from the "Consumer Confidence Survey" and concluded that debtors and savers have greater confidence in situations in which they incur relatively

Survey" does not include a question on the household's asset level; it does however ask whether the household has mortgage. We can thus compare households with mortgage to those without and examine whether the former perceives greater penalty (loss) towards deflation relative to inflation than the latter; in other words, households with mortgage are expected to have a smaller asymmetry parameter ϕ_i . We implement an additional estimation in this section to identify whether this mortgage effect serves as a background factor for the asymmetric inverse-U shape on which we have so far focused.

Table 4-9 Estimation results with mortgage dummy and interaction terms between age and mortgage dummies

	Random effects model	
Estimation period	April 2006-June 2011	
Interaction term between mortgage dummy and age dummy		
18-24	-0.355	
	(0.291)	
25-29	0.217	
	(0.146)	
30-34	-0.020	
	(0.070)	
35-39	-0.035	
	(0.058)	
40-44	-0.056	
	(0.052)	
45-49	-0.128	***
	(0.049)	
50-54	0.025	
	(0.047)	
55-59	-0.061	
	(0.043)	
60-64	-0.027	
	(0.047)	
65-69	-0.077	
	(0.054)	
70-74	-0.052	
	(0.064)	
75 and above	0.091	
	(0.062)	
Month (dummies)	yes	
Year (dummies)	yes	
Size of cities	yes	
Other controls	Job dummies, income dummies, Number of household members, CPI general (year-to-year growth rate), constant	
N	279,144	

Note: 1. *,**,*** stands for statistically significant at 10%, 5%, 1% level, respectively. Standard errors are in parentheses.
2. Explained variable is a mid-value of the categories of inflation expectations (end-value at both ends). Normalized to 100=0%.

Table 4-9 comprises the estimation results of Model 3 of Table 4-3. However, we add an

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greater loss (inflation and deflation, respectively).

interaction term between the dummy of households with mortgage and dummies of age category. In doing so, we expect to identify an additional impact of mortgage on inflation expectations. Although none of the coefficients of the interaction terms, except for the age group 45-49, are significant, most of them are estimated to be negative, indicating a tendency that households with mortgage have lower expectations than those without it. If we try to explain the heterogeneity in expectations by using the asymmetric loss function discussed in Section 3, we get an interpretation that parameter ϕ_i that represents the extent of asymmetry differs depending on household characteristics. In order to examine the age effects with the asymmetric inverted-U shape, we estimate the average ϕ_i and compare the level for each age group. Figure 4-2 describes the estimation result of an asymmetric parameter $\phi_i = -2/T_i \sum(e_{t+12,t,i} / \sigma^2_{t+12,t})$ under the assumption that $\pi_{b,i} = 0$. When ϕ_i is positive and larger, the loss of underestimation becomes greater, thus resulting in higher expectations. Figure 4-2 shows that the estimated ϕ_i by age has an inverted-U shape with its peak in the age group of 55-59. This result is consistent with the estimation results shown earlier in this section. Even if we use a cross-sectional dispersion of inflation expectations as a proxy for conditional variance, the result looks quite similar (Figure 4-3). Further, the difference in ϕ_i with and without mortgage is not distinct if we use the conditional variance from the GARCH model, whereas if we use a cross-sectional variance, ϕ_i is lower on average among households with mortgage than among those without it for almost all age groups (Figure 4-4).[42]

[42] If we derive ϕ_i by (3-4) (in other words, if we derive $\phi_i = -c_{1,i}/2$ by using the point estimate of the coefficient $c_{1,i}$ from the OLS estimation result), the peak appears at around the mid-30s (Figure 4-5), which is not necessarily consistent with the previous analysis. Further, using the estimated average level of the constant bias $\pi_{b,i}(= -c_{0,i})$ (i.e., the discrepancy from the optimal estimation under rational expectations) by age group, the peak appears at around the 50s and the 60s (Figure 4-6). These results of Figures 4-5 and 4-6 are derived by using the conditional variance from the GARCH estimates, while the level of $\pi_{b,i}$ is close to zero and is relatively high around the 50s and low around the 60s if we use the cross-sectional variance. In any case, if we allow a constant bias from the optimal forecast level, the heterogeneity in the observed expectations cannot necessarily be explained by the variation in the asymmetry parameter ϕ_i.

Figure 4-2 Average ϕ_i by age group

($\pi_{b,i} = 0$, estimated with GARCH conditional variance)

Figure 4-3 Average ϕ_i by age group

($\pi_{b,i} = 0$, estimated with cross-sectional variance)

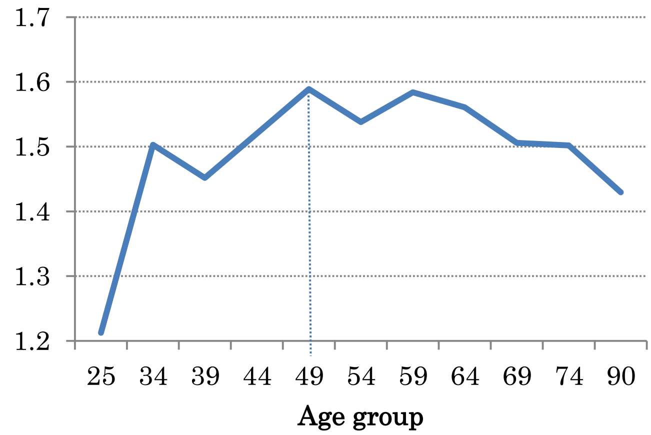
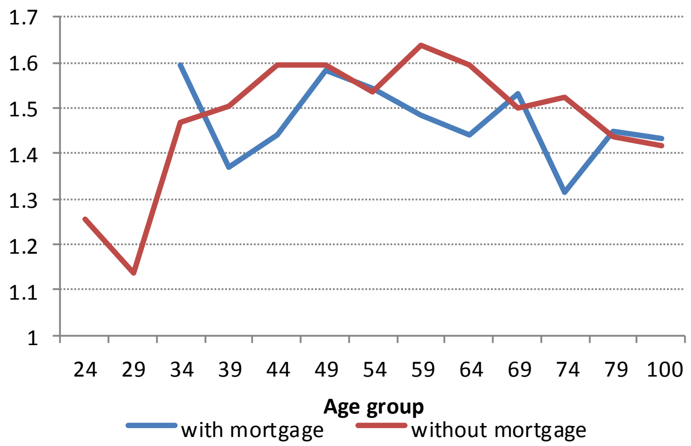


Figure 4-4 Average ϕ_i by age group (comparison between households with/without mortgage)

($\pi_{b,i} = 0$, estimated with cross-sectional variance)



Note: The estimation results of the sample aged 18-29 with mortgage are not shown in the figure because of the limited number of samples.

Figure 4-5 Average ϕ_i by age group

($\pi_{b,i} \neq 0$, estimated with GARCH conditional variance)

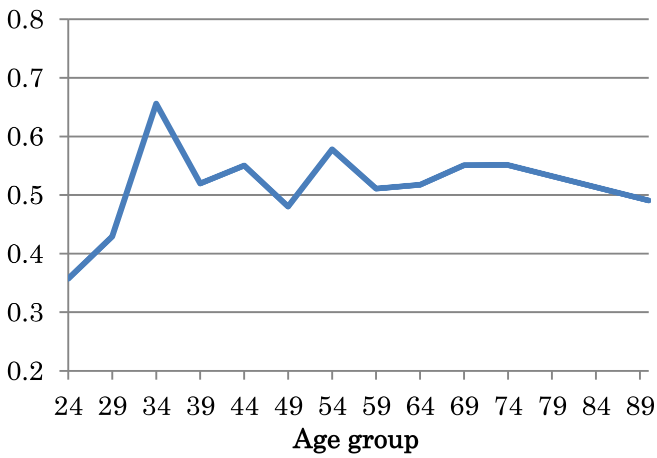
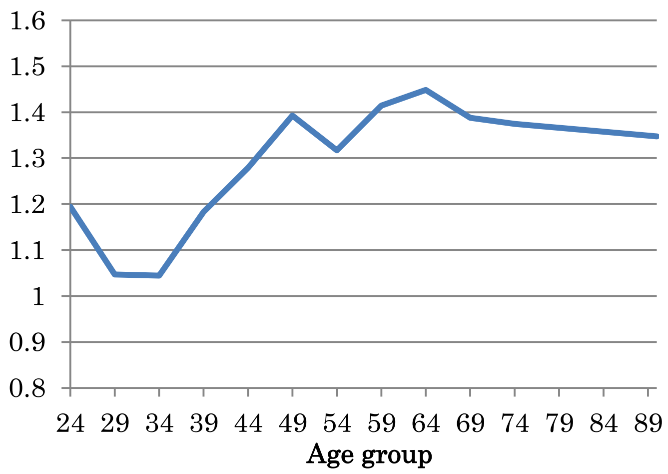


Figure 4-6 Average $\pi_{b,i}$ by age group

($\pi_{b,i} \neq 0$, estimated with GARCH conditional variance)



We summarize the estimation results of this section as follows. The relationship between inflation expectations and age is quite stable and denoted by an asymmetric inverted-U shape; expectations are higher for the mid-aged group and gradually become lower for the elderly. While analyzing this shape, we considered two possibilities, including: 1) varying the information set by age group (or varying the consumption basket by age group), and 2) the generation effect. Neither can be solely attributed as the reason for the shape. However, the latter factor, at least, displayed some consistency with the observed data. Further, based on the idea of asymmetric loss, we hypothesized that households with debt should be more cautionary against deflation (instead of inflation) than households without debt, and that such households should have a smaller asymmetry parameter and lower inflation expectations. While this tendency was not found to be necessarily consistent with the micro-level dataset, the possibility remains. On the other hand, inverse U-shaped age effects can be explained by the asymmetric loss function model to a certain extent.

5. Conclusions

We observed an upward bias in the inflation expectations of Japanese households and found that these expectations are distributed in a dispersed way. The data for this study were sourced from the "Consumer Confidence Survey" collected and published by the Cabinet Office. The formation of households' expectations is adaptive, given that they are closely correlated with recent developments in realized inflation. However, the manner in which the expectations follow recent developments in inflation is asymmetric between inflationary and deflationary periods, and the expectations do not shift lower smoothly.

According to our intuition, consumers would be more defensive against inflation rather than deflation, as inflation reduces the value of future income in real terms. We empirically examined this upward bias in the inflation expectations by using the asymmetric loss function of the forecast errors based on a model from the previous literature. We found evidence that this model can partly explain the bias observed in the data under the framework of rational expectations, while constant deviation exists from the levels of rational expectations.

Further, while we found that expectations vary depending on households' characteristics, they could not explain a certain extent of heterogeneity. By examining the behavior of expectations by households' attributes, we found that the relationship between the expectation level and age is a stable asymmetrically inverted-U shape. This shape is consistent with the above-mentioned asymmetric loss function to a certain extent; in other words, the extent of loss aversion with regard to forecast errors varies among age groups and shows a similar inverse-U shape.

In the seniority wage system, which is still implemented in the majority of Japanese firms, the income level reaches its peak for the mid-aged groups. Therefore, we infer that the cautionary outlook towards future inflation should be relatively low among the mid-aged relative to the young or the elderly. Given this understanding, the result that this age group forms relatively higher inflation expectations than the other age groups is hard to interpret. In order to analyze additional details of the cause of the heterogeneity in expectations by age group, we examined two factors: the heterogeneity in information households refer to in forming expectations and the possibility that the heterogeneity among generations is mixed and may be regarded as heterogeneity by age. The result of this examination indicated that, taken singly, either factor can provide sufficient explanation for the observed heterogeneity by age. Moreover, the latter factor displays a certain consistency with such heterogeneity.

Regarding the heterogeneity in expectations among age groups, the reason for relatively high expectations among the mid-aged might be explained by the fact that they are the most defensive among all the age groups about future inflation as well as its possible negative impact on real income; they have almost reached the peak in their seniority wage curve and cannot expect further income growth. In addition, they may have a pessimistic view towards future income from the public pension system. Unfortunately, this is merely a conjecture; in order to derive supportive evidence, we would need to directly interview households about the actual causes for their responses on inflation expectations. In addition, as mentioned above, it could be that age effects and generational effects are mixed. We propose to continue the discussion about generation-specific effects in a future extension of this study.

Finally, another possible extension of this study would be improving the fit of the CP method with the data and sourcing a longer time-series data of inflation expectations for a more detailed study. Most of the analysis in the current paper is based on the dataset after 2006; however, policy discussions could benefit through an extended study of the behavior of inflation expectations during the inflationary period up to the early 90s.

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Appendix: Note on asymmetric loss for households[43]

This note provides a simple framework for considering the extent of welfare loss, wherein the realized real interest rate does not coincide with the expected one. In particular, we are interested in the situation where households face asymmetric loss in underestimating and overestimating the real interest rate. As Hall (1988) pointed out, a higher expected real interest rate makes consumers defer consumption (referred to as intertemporal substitution in consumption). Thus, the actual movements of consumption differ from planned movements because an unpredictable variable (i.e., the inflation rate) was not incorporated in the consumption planning process in the previous period.

Here, we assume that households' budgets are allocated between two periods (t = 1,2), where the second period is interpreted as an approximation for all future periods. Another interpretation of this setup is that for every period, a given budget is allocated discretely to immediate consumption and future consumption (Beznoska and Ochmann, 2013).

We further assume that this allocation is made based on the expected inflation rate for future periods, whereas the realized inflation rate is not yet known to households at the point of deciding the level of immediate consumption. In addition, for simplicity of discussion, we assume that households do not receive any income for future periods and that they cannot consume above their budget level (i.e., they cannot avail of loans).

The problem of the intertemporal consumption decision for a household is thus modeled as follows:

$$max_{c_1,c_2,\lambda}\left[u(c_1,c_2)+\lambda(W_1-\left(c_1+\left(\frac{1}{1+\rho^E}\right)c_2\right))\right]$$

where

c_t: consumption level in Period t, in quantity terms

u(c_t): direct utility function

π^E: expected inflation rate in Period 2 (the price level in Period 1 is normalized to one)

W_1: household budget level

r: nominal interest rate (fixed)

ρ^E: expected real interest rate

By definition, $1+\rho^E=\frac{1+r}{1+\pi^E}$.

[43] Varian (1975) originally introduced the asymmetric loss function approach. He provided the background of asymmetric loss based on the actual experiences of the losses that arise because of the gap between the "true" value of real estate and the market prices observed in the real estate market in the US.

The first order condition of this problem indicates that the budget allocation in the first period is dependent on ρ^E and that a higher ρ^E leads to deferring the budget to Period 2 to a greater extent.

Suppose that the expected utility level is U^0 with the expected inflation rate π^E, but the utility level changes to U^1 when the inflation rate becomes π^R in Period 2. We define an expenditure function $\mathrm{E(p, U)}$, which is the minimized cost of achieving the utility level U with price level p in Period 2. Formally,

$$\mathrm{E(p, U)} = min_{c_1, c_2}[c_1 + pc_2 : u(c_1, c_2) \geq U\ ]$$

If the realized inflation rate turns out to be higher than the expected inflation rate (i.e., $\pi^R > \pi^E$), the quantities a household can consume in the future would decrease because the real interest rate is lower than expected. Further, as households can no longer change the level of immediate consumption in Period 1, when they know the realized inflation rate, they can achieve U^1 with a lower expenditure level in Period 2 if they do not face this constraint (referred to as consumption with rationing; see, for example, Neary and Roberts (1980)).

The related welfare loss can be expressed as the sum of the usual loss of equivalent variations EV (Creedy, 2000) and the additional expenditure required to achieve U^1 with constraints on the immediate consumption level in Period 1 and is given as follows:

$$\int_{p^E}^{p^R} \frac{\partial E(p, U^1)}{\partial p} dp + (\tilde{E}(p^R, U^1) - E(p^R, U^1))$$

where

$\tilde{E}(p^R, U^1)$: conditional expenditure function (minimized expenditure level with fixed c_1)

$$\tilde{\mathrm{E}}(\mathrm{p}, \bar{c_1}, \mathrm{U}) = min_{c_2}[\bar{c_1} + pc_2 : u(\bar{c_1}, c_2) \geq U\ ]$$

When the realized inflation rate was lower than the expected inflation rate, the first term (EV) has a negative value, which implies a welfare gain for households. On the other hand, the second term (the difference between the conditional and unconditional expenditure functions) should be positive.

While we cannot numerically compare the welfare losses for $\pi^R > \pi^E$ and $\pi^R < \pi^E$, we note that at least the sign of EV is opposite. Thus, it is natural to assume that the welfare loss in the former case is greater than that in the latter.

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