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Households' Perceived Inflation and CPI Inflation: the Case of Japan

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Abstract

This study analyzes the mechanism of how households' inflation perceptions are formed in Japan and investigates the backdrop of why perceived inflation is higher than CPI inflation. Our cross-sectional analysis using micro-data shows that a variety of factors affect households' inflation perceptions, including their sociodemographic characteristics, which are likely to affect their consumption patterns, their sentiment, and their awareness of the Bank of Japan's "price stability target." We further show that such inflation perceptions, as well as sentiment and awareness of the "price stability target," influence households' tolerance towards price rises. We then analyze how changes in the price of individual goods and services influence perceived inflation using aggregate data and find that a large share of the fluctuations in perceived inflation can be explained by changes in food product and petroleum product prices. In addition, we show that house prices, which are not included in the CPI in Japan, also explain these fluctuations. These results imply that households have in mind a different basket of goods and services from the CPI when they form their inflation perceptions.

JEL classification: D12, E31, E58

Keywords: Inflation; Inflation perception; Consumer price index; Tolerance towards price rises

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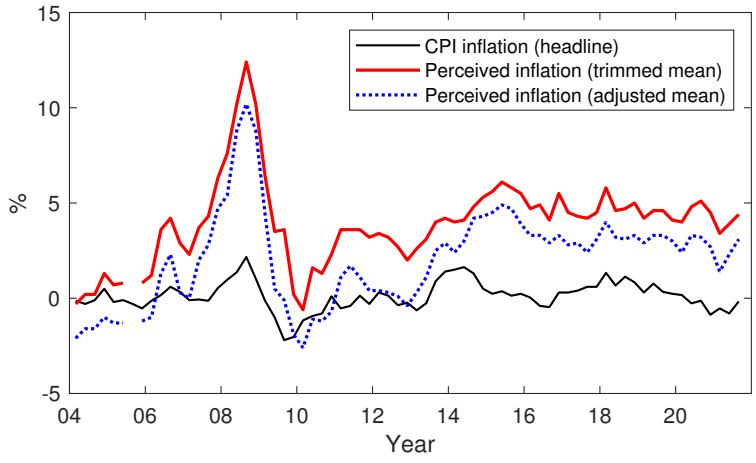
1 Introduction

It is regarded as ideal that the price index used as the central bank's target is in line with the general public's perception.[1] However, in Japan, households' perceived inflation is higher than CPI inflation, as shown in Figure 1. While this difference between perceived inflation and inflation indicated by statistics has commonly been observed across developed countries, much remains to be understood regarding its causes. The phenomenon has become known as the "inflation perception conundrum" and has gathered attention recently (Abildgren and Kuchler 2021).

Figure 1. Perceived inflation and CPI inflation



Sources: Statistics Bureau; Bank of Japan.

Notes: "Perceived inflation" is derived from *Opinion Survey on the General Public's Views and Behavior*. "Trimmed mean" is calculated by excluding perceived inflation over/below the upper/lower 0.5 percentile, and "Adjusted mean" is calculated by applying the method proposed by Kamada (2013). "CPI inflation (headline)" is adjusted for tax hike, etc.

Inflation expectations are of central interest to academics and central bankers, as modern macroeconomic theory points to the importance of its influence on actual inflation, and there are a number of studies that focus on inflation expectations. In contrast, inflation perceptions have attracted less attention, and only a relatively small amount of academic research has been conducted. While existing studies focusing on Japan have shown that perceived inflation is affected by households' sociodemographic characteristics, which are likely to affect their consumption patterns, as well as price changes of frequently purchased goods, little research has been conducted on the difference between perceived

[1]For example, see European Central Bank (2003) and Bank of Japan (2013).

inflation and CPI inflation.

In this study, we analyze the mechanism of how households' inflation perceptions are formed and investigate the backdrop of the difference in perceived inflation and CPI inflation using the *Opinion Survey on the General Public's Views and Behavior (Opinion Survey)* conducted by the Bank of Japan. First, we conduct a cross-sectional analysis using micro-data from the *Opinion Survey* and investigate the drivers of inflation perceptions, including well-established sociodemographic characteristics. Second, we make use of aggregate data and investigate how changes in the price of individual goods and services influence households' perceived inflation using LASSO (least absolute shrinkage and selection operator).

The main findings of this paper are twofold. First, our cross-sectional analysis shows that a variety of factors affect households' inflation perceptions, including their sociodemographic characteristics, which are likely to affect their consumption patterns, their sentiment, and their awareness of the Bank of Japan's "price stability target." We further show that such inflation perceptions, as well as sentiment and awareness of the "price stability target," influence households' tolerance towards price rises. Second, we show that a large share of the fluctuations in perceived inflation can be explained by changes in food product and petroleum product prices. In addition, we show that house prices, which are not included in the CPI in Japan, also explain these fluctuations. These results imply that households have in mind weights different from the CPI when they form their inflation perceptions.

Our study is related to the literature investigating the drivers of the heterogeneity in households' inflation perceptions focusing on household characteristics. Existing studies have shown that various characteristics of households influence their inflation perceptions, including sociodemographic characteristics (Jonung 1981; Bryan and Venkatu 2001; Christensen et al. 2006; Del Giovane et al. 2009; Suehiro et al. 2018). This paper contributes to the literature by using Japanese data to show that in addition to sociodemographic characteristics, sentiment and awareness of the inflation target are important factors that influence inflation perceptions.

Existing studies have also focused on the drivers of changes in households' inflation perceptions and have shown that price changes of frequently purchased goods and services—typically food and energy—are important factors (Ranyard et al. 2008; Georganas et al.

2014; Kamada et al. 2015; Abildgren and Kuchler 2021). More recent studies, however, emphasize that a broader range of factors, including costs related to housing, affect households' inflation perceptions (Hałka and Łyziak 2015; Stanisławska 2019; Zekaite 2020; European Central Bank 2021). Our findings add to this literature by presenting the possibility that households in Japan also view house prices, as well as food and energy, as important factors of price changes.

Finally, our study connects to the literature investigating how consumers perceive price changes from a behavioral point of view. Existing studies find that consumers often regard price increases as being unfair (Kahneman et al. 1986), thereby inducing regret and anger (Rotemberg 2009). This study shows that inflation perceptions and awareness of inflation targets influence consumers' tolerance towards price rises.

The rest of the paper is organized as follows. Section 2 provides an overview of the *Opinion Survey*. Section 3 investigates what household characteristics lead to the heterogeneity in inflation perceptions across households and discusses how these perceptions affect their tolerance towards price rises. Section 4 analyzes the drivers of the changes in perceived inflation using the sub-indices of the CPI and house prices. Section 5 concludes.

2 Overview of the Opinion Survey

This study uses both micro-data and aggregate-data from the *Opinion Survey*. The Bank of Japan introduced the survey in 1993 to monitor households' perceptions regarding various economic issues and has conducted the survey every quarter since 2004. The survey covers people living in Japan who are aged 20 and over. In each survey, 4,000 individuals are extracted based on a stratified two-stage random sampling method. Roughly 50 to 60 percent of the overall sample are valid responses. As the survey does not track individuals, it is a repeated cross-sectional survey. The sample period of this study is from March 2004 to September 2021, the period for which data on quantitative inflation perceptions are available.

The survey asks respondents about current and future inflation, both qualitatively and quantitatively. Similar to surveys in other countries, such as the consumer opinion survey conducted by the European Commission, the *Opinion Survey* asks how households perceive "price levels" have changed from the previous year.[2] In other words, the survey

[2]For example, the consumer opinion survey asks "By how many percent do you think that consumer

does not specify a price measure (e.g. CPI), thereby allowing households to have different price measures in mind when answering the survey questions. The qualitative question asks respondents whether they think prices have risen or fallen and whether they will rise or fall. The quantitative question was added in March 2004, and several characteristics regarding inflation perceptions and expectations are worth noting, as discussed in detail by Kamada (2013). For example, households tend to give their inflation perceptions and expectations in integers—especially zero and multiples of 5—and do not answer with negative figures.[3] Kamada (2013) focuses especially on the fact that households do not answer with negative figures and suggests that there is a downward-rigidity in households' inflation perceptions and expectations: while households have an "underlying" distribution of inflation expectations, downward rigidity emerges as a result of their strategic behavior, and the distribution of their actual survey answers is different from the "underlying" distribution.[4]

In addition to questions regarding inflation perceptions, the survey also asks whether households view price rises (falls) as either "rather favorable," "difficult to say," or "rather unfavorable." We use this question in our analysis to study whether households show tolerance towards price rises, which is regarded as playing a key role in the price changes.

Several questions have been added to the survey in line with developments in monetary policy. Since September 2013, the survey has asked respondents whether they are aware of the "'price stability target' of 2% inflation in terms of the year-on-year change in the CPI."[5] The survey also asks the sociodemographic characteristics of the respondent, such as gender, age, and income. In the next section, we use these micro-data to investigate the sources of heterogeneity in households' inflation perceptions and tolerance towards price rises.

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prices have gone up/down over the past 12 months? Please give a single figure estimate: consumer prices have increased by ... % / decreased by ... %." For a detailed review of the survey, see Arioli et al. (2017).

[3]The survey was conducted using the "in-home" method until June 2006, and the "mail" method thereafter. Kamada (2013) mentions that survey answers show different patterns between surveys conducted by the "in-home" method and the "mail" method.

[4]Many of the characteristics observed in the *Opinion Survey* are shared with surveys in other countries (Arioli et al. 2017). Some recent studies take these observed characteristics as given and explore their macroeconomic implications. For example, Gorodnichenko and Sergeyev (2021) focus on the fact that households do not give negative figures for their inflation expectations (the zero lower bound on inflation expectations) and show that unconventional monetary policies are less effective under such assumptions.

[5]While the survey is conducted every quarter, some of the questions are asked only semi-annually. For example, questions asking respondents whether they are aware that "'price stability' is one of the mandates of the Bank of Japan" was conducted every quarter until June 2009, but has been conducted only semi-annually since December 2009.

3 Households' inflation perceptions and tolerance towards price rises

In this section, we focus on household characteristics and conduct a cross-sectional analysis regarding the fact that households tend to form inflation perceptions higher than the CPI inflation. First, we investigate the relation between inflation perception and households' characteristics and show that various characteristics affect their inflation perceptions, including their sociodemographic characteristics, which are likely to affect their consumption patterns, their sentiment, and their awareness of the "price stability target." We further show that lower inflation perceptions, better sentiment, and enhancing the awareness of the "price stability target" contributes to improving households' tolerance towards price rises.

3.1 Inflation perceptions and household characteristics

3.1.1 Empirical method

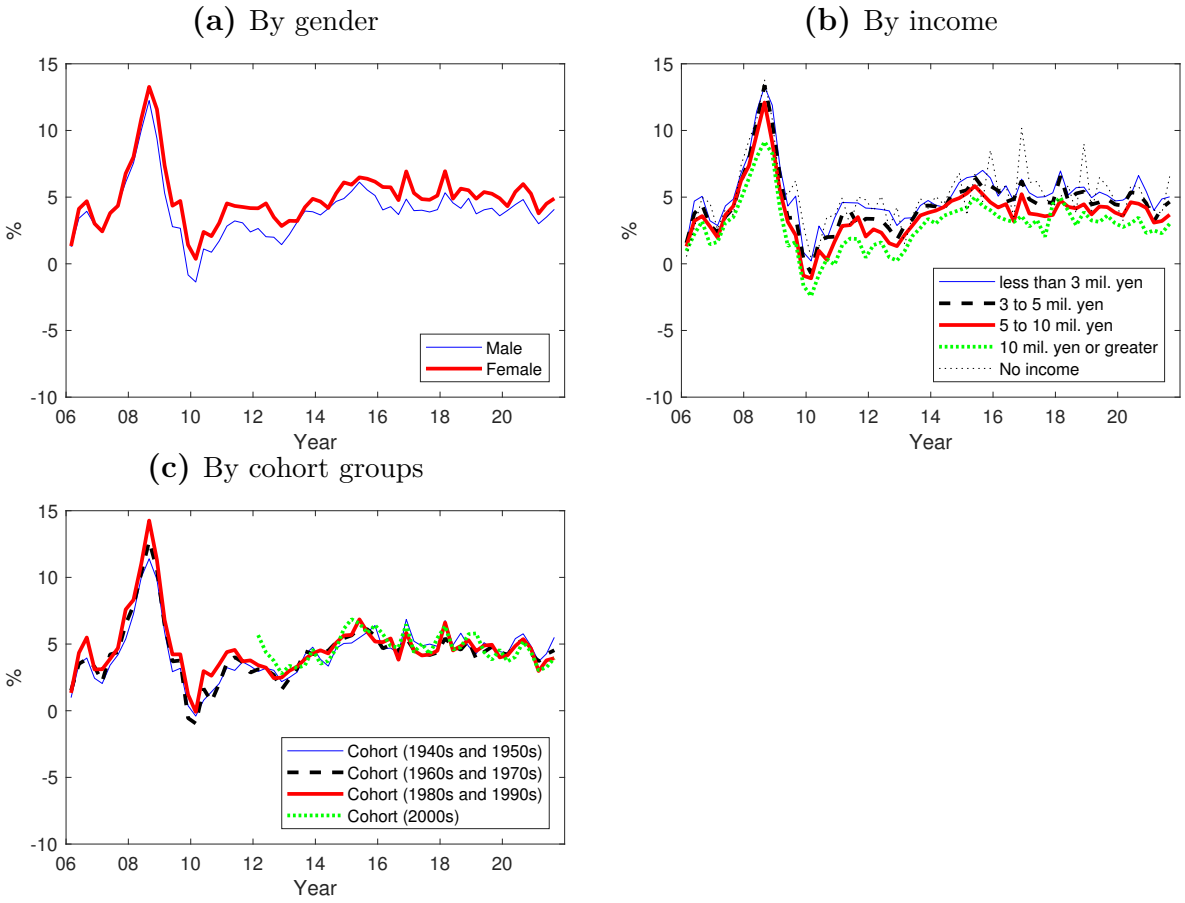
In this subsection, we investigate the determinants of the heterogeneity in households' inflation perceptions as our first step to understanding the difference between perceived inflation and CPI inflation. In the analysis, we follow recent studies such as Abildgren and Kuchler (2021), Meyler and Reiche (2021), and Kikuchi and Nakazono (forthcoming) in taking a linear regression approach specified as follows:[6]

$$\pi^{perc}_{i(t)} = \alpha + \beta X_{i(t)} + \sum_{j=1}^{T-1} \gamma_j TD^j_t + \varepsilon_{i(t)}, \tag{1}$$

where $\pi^{perc}_{i(t)}$ is household i's perceived inflation and $X_{i(t)}$ is a vector of household i's various characteristics surveyed at period t. We include the time dummy TD^j_t in the regression since our focus here is to investigate the factors that lead to the heterogeneity across households with different characteristics. To avoid having outliers affect our results, we exclude from our estimation those observations with perceived inflation over/below the upper/lower 0.5 percentile in each survey round.

[6] Abildgren and Kuchler (2021) take inflation perception bias (defined as the difference between perceived inflation and household-group-specific inflation) as the dependent variable, and Meyler and Reiche (2021) and Kikuchi and Nakazono (forthcoming) take inflation expectation as the dependent variable.

Figure 2. Perceived inflation by sociodemographics



Notes: Each panel shows the trimmed mean of the perceived inflation by each household characteristic.

In order to investigate the various determinants of households' inflation perceptions, we include the following four groups of household characteristics in our estimation: sociodemographics, sentiment, awareness of the "price stability target," and trust in the central bank. Figure 2 and Figure 3 provide a snapshot of perceived inflation aggregated by these different household characteristics. We provide an overview of the literature on how each of these characteristics affects inflation perceptions.

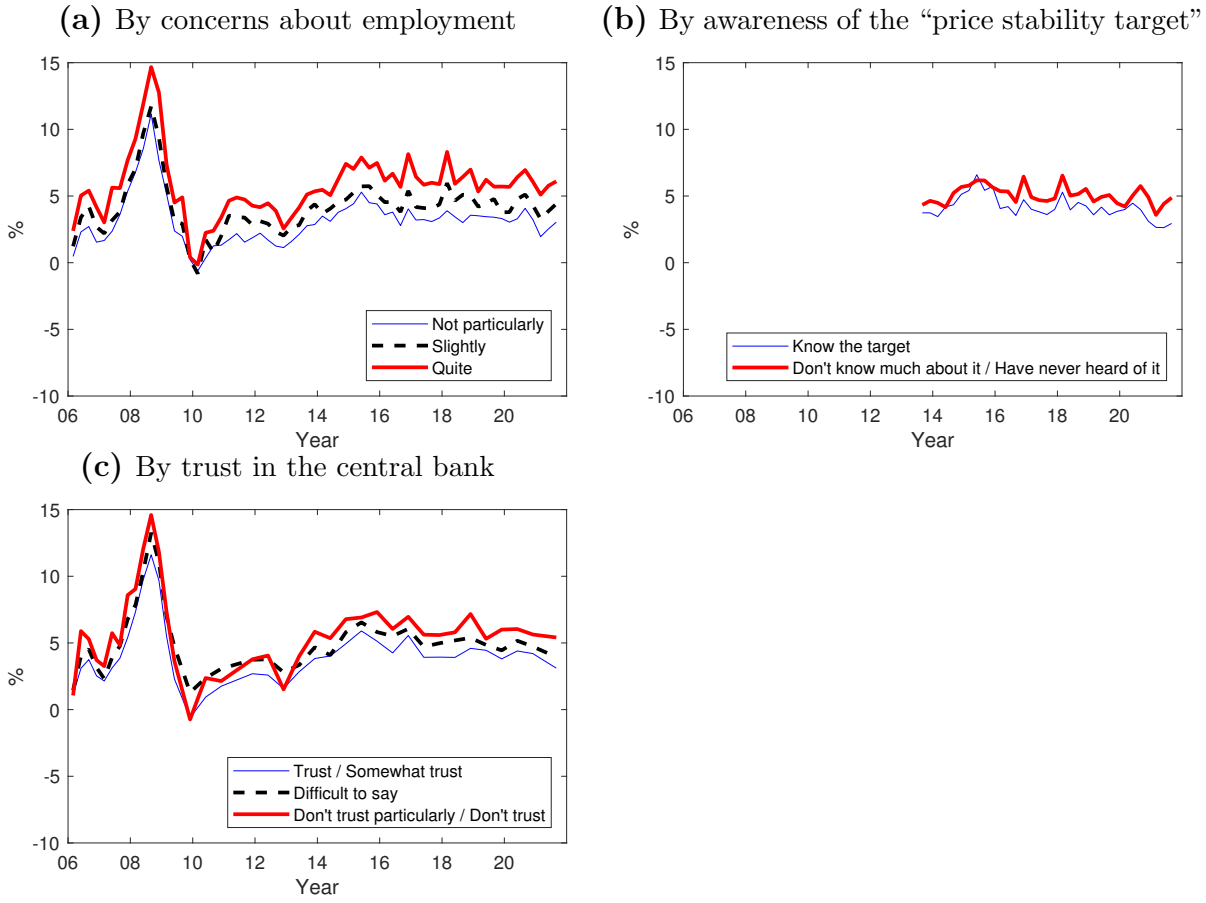
Sociodemographics. Existing studies have shown the importance of the influence of sociodemographic characteristics on inflation perceptions. As shown in Figure 2 (a) and (b), male respondents and those with higher income tend to form lower inflation perceptions, which is consistent with existing studies (Jonung 1981; Bryan and Venkatu 2001; Christensen et al. 2006; Del Giovane et al. 2009).

Existing studies have shown mixed results with regard to the age of the respondents: Jonung (1981) shows that there is no relation between age and inflation perceptions, while

Bryan and Venkatu (2001) report that young respondents tend to show higher inflation perceptions compared with middle aged respondents. Using data for Japan, Suehiro et al. (2018) find a U-shaped relation between age and inflation perceptions.[7]

As our study spans a relatively long period from 2004 to 2021, respondents in their 50s, for example, belong to different cohort groups depending on the round of the survey. To consider this effect, in the rest of the study, we convert age data into cohort data under simplifying assumptions.[8] Figure 2 (c) shows the perceived inflation for different cohort groups, though we cannot detect a clear relation between the different groups.

Figure 3. Perceived inflation by sentiment, awareness of the "price stability target," and trust in the central bank



Notes: Each panel shows the trimmed mean of the perceived inflation by each household characteristic.

Households with different sociodemographic characteristics may have different con-

[7]Existing studies have shown that inflation expectations are affected by past experience, thus differs across cohort groups (Malmendier and Nagel 2016; Diamond et al. 2020; Bank of Japan 2021).

[8]The *Opinion Survey* asks the age of the respondent in a certain range (e.g. between 40 and 49). While far from accurate, we split the entire sample before and after 2012 to convert age groups into cohort groups: as for the survey rounds from 2004 to 2011, respondents in their 50s are classified as the cohort born in the 1960s, while for 2012 to 2021, those who in their 60s are classified as the cohort born in the 1960s.

sumption basket and thus face different price changes. In this regard, some studies attempt to measure the household-specific inflation rate that reflects these household characteristics (Diamond et al. 2020; Abildgren and Kuchler 2021). However, in general, these household-specific inflation rates do not sufficiently explain the heterogeneity of inflation perceptions across different sociodemographic groups.[9]

Sentiment. Households' sentiment regarding their economic situation (e.g. anxiety or pessimism) is also known to affect their inflation perceptions and expectations (Del Giovane et al. 2009; Ehrmann et al. 2017; Suehiro et al. 2018). Indeed, Figure 3 (a) shows that those who have concerns about employment tend to form higher inflation perceptions. Based on these observations, we include "evaluation of current economic conditions" as the independent variable that captures households' sentiment regarding general economic issues and "concerns about employment" as the variable that captures their sentiment regarding issues specific to employment.

Awareness of the "price stability target." Existing studies have shown that households who are aware of the 2% "price stability target" tend to form inflation expectations closer to 2% (Nishiguchi et al. 2014; Diamond et al. 2020). Recent studies exploiting experimental methods also suggest that providing survey respondents with information on past inflation or inflation targets can improve the accuracy of their inflation expectations (Binder and Rodrigue 2018; Coibion et al. forthcoming). While these studies have focused only on inflation expectations, their findings can be applied to inflation perceptions as well. Indeed, Figure 3 (b) confirms that households who are aware of the "price stability target" have relatively lower inflation perceptions.

Prior to the introduction of the 2% "price stability target," the *Opinion Survey* has asked respondents whether they were aware that "'price stability' is one of the mandates of the Bank of Japan." In order to make use of longer data, we use this survey question on "price stability" (noted hereafter as awareness of the "price stability mandate") instead of the 2% "price stability target" to confirm the robustness of our estimation results.

Trust in the central bank. Recent studies emphasize the role of trust in the cen-

[9]The Statistics Bureau publishes the CPI for different age and income groups. These data show that inflation rates do indeed differ across groups, reflecting the difference in their consumption basket.

tral bank and show that households who trust the central bank tend to form inflation expectations lower and closer to the inflation target (Kamada 2013; Mellina and Schmidt 2018; Christelis et al. 2020; Rumler and Valderrama 2020). Since inflation expectations are concerned with the future state of the economy, they are more likely to be affected by trust. Figure 3 (c) shows that households who trust the central bank perceive inflation to be lower, indicating that trust seems to be relevant for inflation perceptions as well.

Table 1. Summary statistics of household characteristics

	Mean	Standard deviation	Min	Max
Perceived inflation	3.859	6.635	-30	60
Sociodemographics				
Gender				
Male	0.481	0.500	0	1
Female	0.519	0.500	0	1
Cohort group				
Cohort (1940s)	0.070	0.256	0	1
Cohort (1950s)	0.203	0.403	0	1
Cohort (1960s)	0.200	0.400	0	1
Cohort (1970s)	0.173	0.378	0	1
Cohort (1980s)	0.175	0.380	0	1
Cohort (1990s)	0.128	0.334	0	1
Cohort (2000s)	0.050	0.218	0	1
Income				
No income	0.035	0.183	0	1
Less than 3 million yen	0.337	0.473	0	1
3 to 5 million yen	0.304	0.460	0	1
5 to 10 million yen	0.243	0.429	0	1
10 million yen or greater	0.082	0.274	0	1
Household composition				
Single	0.106	0.308	0	1
One-generation	0.261	0.439	0	1
Two-generation	0.482	0.500	0	1
Three-generation	0.131	0.337	0	1
Other	0.021	0.142	0	1

Notes: Summary statistics for perceived inflation are calculated after excluding observations over/below the upper/lower 0.5 percentile.

Summary statistics. Table 1 provides the summary statistics of the variables included

Table 1. Summary statistics of household characteristics (continued)

	Mean	Standard deviation	Min	Max
Sentiment				
Evaluation of current economic conditions				
Favorable	0.004	0.066	0	1
Somewhat favorable	0.069	0.254	0	1
Difficult to say	0.298	0.458	0	1
Somewhat unfavorable	0.427	0.495	0	1
Unfavorable	0.201	0.400	0	1
Concerns about employment				
Not particularly concerned	0.173	0.378	0	1
Slightly concerned	0.494	0.500	0	1
Quite concerned	0.333	0.471	0	1
Awareness of the 2% "price stability target"				
Know about it	0.262	0.440	0	1
Have read or heard of it, but don't know much about it	0.347	0.476	0	1
Have never heard of it	0.391	0.488	0	1
Awareness of the "price stability mandate"				
Know about it	0.318	0.466	0	1
Have read or heard of it, but don't know much about it	0.450	0.497	0	1
Have never heard of it	0.233	0.423	0	1
Trust in the central bank				
Trust	0.131	0.337	0	1
Somewhat trust	0.277	0.447	0	1
Difficult to say	0.489	0.500	0	1
Don't trust particularly	0.073	0.261	0	1
Don't trust	0.031	0.173	0	1
Opinions on the rise in prices				
Rather favorable	0.042	0.200	0	1
Rather unfavorable	0.815	0.388	0	1
Difficult to say	0.143	0.350	0	1

in our analysis. Since all of the household characteristics are surveyed in the form of discrete choices, we convert them into dummy variables. A summary of the sociodemographic characteristics is shown in the first half of Table 1. We can confirm that respondents are distributed widely across all cohort groups. Regarding income level, the most frequent is those with less than 3 million yen. Almost half of the respondents are households with two generations living together.

The second half of Table 1 shows the statistics for variables such as sentiment and awareness of the "price stability target." First, we can confirm that households generally view economic conditions to be unfavorable: over 60% of the respondents view current economic conditions as either "unfavorable" or "somewhat unfavorable," while 6.9% of the households view it as "somewhat favorable," and a mere 0.4% as "favorable." A similar pattern appears in concerns about employment: more than 80% of the households are either "slightly concerned" or "quite concerned" about their employment circumstances.

Roughly 30% of the respondents are aware of the 2% "price stability target" or the "price stability mandate." On the other hand, the ratio of respondents who have never heard of the "price stability target" is higher than the ratio of those who have never heard of the "price stability mandate." In addition, half of the households are uncertain as to whether they trust the Bank or not, while only 10% show distrust. In the following analysis we empirically investigate how these elements lead to heterogeneity in perceived inflation.

3.1.2 Estimation results

Table 2 shows the estimation results of our model specified as eq.(1). Variables chosen as the reference are indicated in the table. The first column shows the results of our baseline model, which does not include trust in the central bank as the independent variable. Estimation results for the coefficients on sociodemographic characteristics are in line with existing studies: male respondents and respondents with higher income have lower inflation perceptions. There is no clear relation between the cohort group of the respondent and their inflation perceptions. Single households tend to perceive inflation to be lower, while there is not much difference between one-generation, two-generation, and three-generation households.

Households with negative sentiment tend to have higher inflation perceptions: house-

holds who view current economic conditions as being "unfavorable" perceive inflation to be roughly 2% points higher than those who find it "difficult to say." Similarly, those who have concerns about employment tend to have higher inflation perceptions.

Regarding awareness of the "price stability target," the coefficients show the expected results: households who "have read or heard of it, but don't know much about it" perceive inflation to be higher, and those who "have never heard of it" form even higher perceptions. The estimation results show that those who have never heard of the 2% "price stability target" perceive inflation to be 0.6% points higher compared with those who are aware of the target.[10]

The second column of Table 2 shows the estimation results with trust in the central bank added to the independent variables. Our main result that various household characteristics significantly affect inflation perceptions remains valid. In addition, the results show that those who show little trust towards the central bank perceive inflation to be higher, which is consistent with expected results. However, it should be noted that trust is a highly subjective trait of individuals, so we cannot exclude the reverse causality that households who perceive inflation to be high show less trust towards the central bank.[11]

To confirm the robustness of the above results, we replace the awareness of the "price stability target" with that of the "price stability mandate."[12] The third column of Table 2 shows the results. We can confirm that the results are largely unchanged from our baseline model: those who have never heard of the "price stability mandate" have relatively higher inflation perceptions, which is similar to the case when using the "price stability target."

[10]There are two hypotheses on the mechanism of how the awareness of the "price stability target" affects households' inflation perceptions and tolerance towards price rises. First, some households may not necessarily have a concrete benchmark for the inflation rate, which leads them to form a rather extreme inflation perception. Therefore, becoming aware of the "price stability target" may play a role in providing households with a benchmark for the inflation rate and lower their inflation perception. Second, awareness of the "price stability target" may be correlated with households' financial literacy or interest in financial economy more generally. Households with higher financial literacy are likely to gather information about financial economy more actively, and they are likely to obtain information on inflation through these activities. In that case, enhancing not only awareness of the "price stability target" but also financial literacy more broadly contributes to lower inflation perceptions.

[11]In order to avoid the reverse causality, Christelis et al. (2020) proposes an instrument variable that correlates with trust in the central bank but does not have a direct association with inflation expectations and confirms that trust influences inflation expectations. More concretely, they survey "general trust towards others" and use it as an instrumental variable considering that such trust does not affect inflation expectations but does affect trust towards authorities such as central banks.

[12]Note that while using the households awareness of the "price stability mandate" allows us to use a longer sample period (since December 2006, when the survey on "current economic conditions" began), the number of observations does not increase compared with our baseline estimation because awareness of the "price stability mandate" and trust in the central bank are surveyed only semi-annually.

Table 2. Estimation results for the cross-sectional model

	(1) Perceived inflation		(2) Perceived inflation		(3) Perceived inflation	
Sociodemographics						
Gender						
Male	reference		reference		reference	
Female	0.743***	(0.0463)	0.778***	(0.0670)	0.903***	(0.0532)
Cohort						
Cohort (1940s)	—		—		-0.482***	(0.130)
Cohort (1950s)	0.140*	(0.0800)	0.0637	(0.115)	-0.319***	(0.0919)
Cohort (1960s)	0.039	(0.0751)	-0.0218	(0.108)	-0.240***	(0.0859)
Cohort (1970s)	reference		reference		reference	
Cohort (1980s)	0.123*	(0.0723)	0.0613	(0.104)	0.162*	(0.0858)
Cohort (1990s)	-0.0681	(0.0787)	-0.134	(0.113)	0.0613	(0.0952)
Cohort (2000s)	-0.239**	(0.0932)	-0.189	(0.135)	-0.242*	(0.135)
Income						
No income	0.0534	(0.149)	0.236	(0.217)	-0.0289	(0.155)
Less than 3 million yen	reference		reference		reference	
3 to 5 million yen	-0.184***	(0.0568)	-0.198**	(0.0820)	-0.387***	(0.0664)
5 to 10 million yen	-0.599***	(0.0645)	-0.585***	(0.0930)	-0.882***	(0.0738)
10 million yen or greater	-1.027***	(0.0992)	-1.090***	(0.143)	-1.538***	(0.115)
Household composition						
Single	reference		reference		reference	
One-generation	0.418***	(0.0799)	0.423***	(0.116)	0.525***	(0.0961)
Two-generation	0.393***	(0.0734)	0.462***	(0.106)	0.583***	(0.0879)
Three-generation	0.470***	(0.0980)	0.355**	(0.142)	0.612***	(0.112)
Other	0.762***	(0.169)	0.675***	(0.247)	0.775***	(0.197)

Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2. Estimation results for the cross-sectional model (continued)

	(1) Perceived inflation		(2) Perceived inflation		(3) Perceived inflation	
Sentiment						
Evaluation of current economic conditions						
Favorable	0.290	(0.288)	0.161	(0.420)	0.311	(0.413)
Somewhat favorable	-0.0899	(0.0795)	-0.0573	(0.116)	-0.0145	(0.111)
Difficult to say	reference		reference		reference	
Somewhat unfavorable	1.006***	(0.0522)	0.996***	(0.0759)	0.950***	(0.0662)
Unfavorable	1.978***	(0.0788)	1.993***	(0.114)	1.683***	(0.0858)
Concerns about employment						
Not particularly concerned	-0.710***	(0.0590)	-0.698***	(0.0851)	-0.549***	(0.0747)
Slightly concerned	reference		reference		reference	
Quite concerned	1.076***	(0.0534)	1.037***	(0.0776)	0.965***	(0.0606)
Awareness of the 2% "price stability target"						
Know about it	reference		reference		—	
Don't know much about it	0.425***	(0.0589)	0.326***	(0.0872)	—	
Have never heard of it	0.585***	(0.0616)	0.438***	(0.0891)	—	
Awareness of the "price stability mandate"						
Know about it	—		—		reference	
Don't know much about it	—		—		0.387***	(0.0616)
Have never heard of it	—		—		0.649***	(0.0769)
Trust in the central bank						
Trust	—		-0.0444	(0.102)	-0.196**	(0.0839)
Somewhat trust	—		-0.244***	(0.0761)	-0.406***	(0.0629)
Difficult to say	—		reference		reference	
Don't trust particularly	—		0.299**	(0.131)	0.244**	(0.102)
Don't trust	—		1.105***	(0.212)	1.003***	(0.164)
Constant	1.878***	(0.165)	2.025***	(0.205)	2.251***	(0.197)
Time fixed effect	Yes		Yes		Yes	
Sample Period	Sep 2013 to Sep 2021		Sep 2013 to Jun 2021		Dec 2006 to Jun 2021	
Observations	63,130		30,999		63,983	
Adjusted R^2	0.061		0.060		0.160	

Notes: Standard errors in parentheses. Reference is set to June 2021 for the time fixed effects. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

3.2 Tolerance towards price rises and inflation perceptions

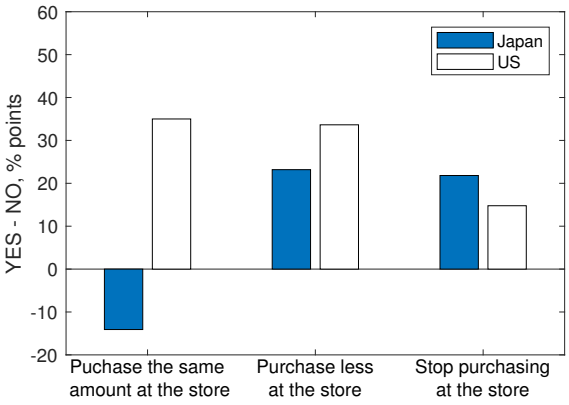
Our cross-sectional analysis so far indicates that various household characteristics, such as sociodemographics, sentiment, and awareness of the "price stability target," affect households' inflation perceptions. In this subsection, we analyze households' tolerance towards price rises, which is one of the channels through which inflation perceptions can affect household behavior.

3.2.1 Modelling households' tolerance towards price rises

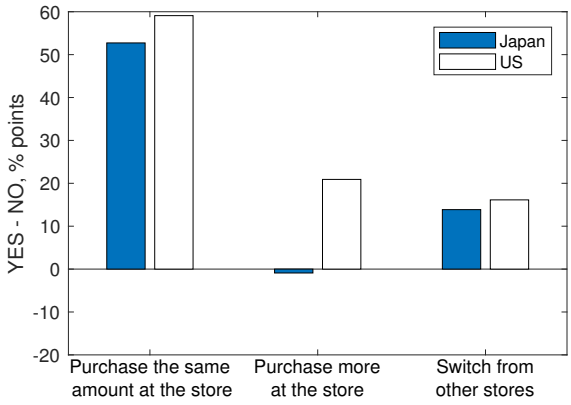
While it is a global standard for central banks to target a positive rate of inflation, existing studies have indicated that price rises often induce regret and anger among consumers (Rotemberg 2009), and have found that customer fairness plays a key role in whether a firm can raise prices (Kahneman et al. 1986).

Figure 4. Consumer's responses to price rises and price cuts

(a) 10% price rise



(b) 10% price cut



Source: Watanabe (2022)

The purchasing attitude of consumers in Japan implies that they are sensitive to price rises. Figure 4 shows the results of a survey on consumers' responses towards price rises and price cuts for both Japan and US in Watanabe (2022). Figure 4(a) shows the results for the question what consumers would do "if the price of a certain product has been raised by 10% at the store you often use." Regarding the choice "purchase the same amount," the ratio answering "No" is about 15% higher than the ratio answering "Yes" for Japanese consumers. In contrast, the ratio of answering "Yes" is about 35% higher than "No" for US consumers. Figure 4(b) shows the case for "if the price of a certain product has been cut by 10%." As for the choice "purchase more at the store," the

Figure 5. Reasons for not passing on cost increases to sales prices

Sources: Cabinet Office (2013)

ratio of those who answered "No" is slightly higher than "Yes" for Japan, while "Yes" is approximately 20% higher than "No" for the US, which is also in stark contrast. These survey results indicate that consumers show asymmetric responses towards price rises and price cuts in Japan, and this asymmetry may be causing the cautious price setting behavior of firms in Japan.[13]

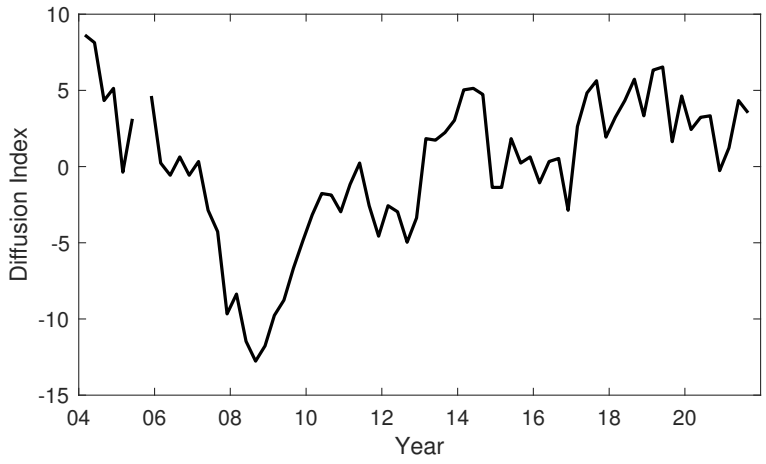
Turning to the price setting behavior of firms in Japan, survey results show that they have refrained from raising prices to maintain the relationship with their customers: Figure 5 shows a survey result in Cabinet Office (2013) that asked firms why they do not pass-through increases in costs to their customers. The dominant reason is that firms view their relationship with customers to be the most important factor in setting prices, therefore they are concerned that raising prices may damage this relationship. As this survey shows that firms struggle to raise prices even when they face increase in costs, it appears to be much harder for them to raise prices when costs are not rising.

These observations suggest that whether households and firms can agree on raising prices plays an important role in the determination of price changes.[14] In this regard, the *Opinion Survey* asks respondents whether they consider price increases favorable or not. We use this question and calculate households' tolerance towards price rises (expressed in

[13]While households' asymmetric responses towards price rises and price cuts are likely to be affecting inflation in Japan, the difference in the responses between Japan and US may be due to differences in economic conditions such as the rate of wage increase between the two countries.

[14]For studies investigating the role of customer fairness on aggregate price dynamics, see Rotemberg (2005) and Eyster et al. (2021).

Figure 6. Tolerance towards price rises



Notes: Demeaned by the sample average (March 2004 to September 2021).

the diffusion index, or DI) by subtracting the ratio of "rather unfavorable" from "rather favorable."

Figure 6 shows developments in the DI. The index started to deteriorate during the commodity price boom in the mid-2000s, and has gradually increased after reaching its lowest point with the outbreak of the global financial crisis. Regarding such changes in the tolerance towards price rises, Bank of Japan (2018) empirically shows that a rise in both households' perceived and expected inflation puts downward pressure on their tolerance, while improvements in households' current views and future outlooks on employment, wages, and economic conditions drive their tolerance in a favorable direction. In this subsection, we build on these findings and investigate how various household characteristics affect their tolerance towards price rises. Since households' characteristics themselves affect inflation perceptions, we estimate an econometric model of household choices to disentangle the effects arising from different household characteristics.

As the *Opinion Survey* asks respondents to select from three discrete choices "rather favorable," "rather unfavorable," and "difficult to say," we estimate a multinomial logit model to investigate households' behavior.[15] We take these choices as the dependent

[15]In this study, we estimate a multinomial logit model rather than an ordered logit model as there is no clear ordering between the choices "rather favorable," "rather unfavorable," and "difficult to say."

variable and estimate the model specified as follows:

$$Pr(d_{i(t)} = k|X_{i(t)}) = \frac{exp(X_{i(t)}\beta^{(k)})}{\sum_k exp(X_{i(t)}\beta^{(k)})}, \tag{2}$$

where $d_{i(t)}$ is household i's choice ($k \in$ {favorable, unfavorable, difficult to say}) and $X_{i(t)}$ is a vector of household i's characteristics at period t. We include households' inflation perceptions in addition to sociodemographics, sentiment, and their awareness of the "price stability target" as the independent variables. We allow the coefficients $\beta^{(k)}$ to differ across choices, since the impact of independent variables may differ depending on the choice. In the regression, "difficult to say" is chosen as the reference, therefore the probability implied from our model is relative to this choice. The coefficients are estimated by the maximum likelihood method.

3.2.2 Estimation results

Estimation results are presented in Table 3. The first column shows the coefficients for the choice of "favorable" and the second column for the "unfavorable" in our baseline estimation labeled as model (A). First, the coefficients on inflation perceptions show interesting results: while an increase in inflation perception does not affect the probability of choosing "favorable" significantly, it increases the probability of choosing "unfavorable" significantly. Figure 7 shows the average probability of choosing either "favorable" or "unfavorable" by different level of perceived inflation based on our baseline estimation results. When the perceived inflation declines from 10% to 2%, the probability of choosing "favorable" increases by 1.8% points, while the probability of choosing "unfavorable" decreases by 7.9% points. Putting these figures together suggests that tolerance towards price rises (calculated as the difference of probabilities) improves by approximately 10% points.

Household sentiment also affects significantly the tolerance towards price rises, which is consistent with the findings by Bank of Japan (2018). Figure 8 shows the probabilities of choosing either "favorable" or "unfavorable" for respondents with different sentiment. Those who view current economic conditions as favorable tend to show higher probability of viewing price rises as favorable as well, while it should be noted that the share of respondents who answered that current economic conditions are "favorable" is less than 1%.

Table 3. Estimation results of the multinomial logit model

	Model (A)				Model (B)			
	Favorable		Unfavorable		Favorable		Unfavorable	
Perceived inflation	-0.00513	(0.00746)	0.0475***	(0.00316)	0.00128	(0.00779)	0.0456***	(0.00312)
Sociodemographics								
Gender								
Male	reference		reference		reference		reference	
Female	-0.555***	(0.0666)	0.0720**	(0.0292)	-0.602***	(0.0774)	0.0705**	(0.0322)
Cohort								
Cohort (1940s)	—		—		-0.434*	(0.227)	0.283***	(0.0863)
Cohort (1950s)	-0.166	(0.109)	-0.0706	(0.0498)	-0.191	(0.129)	-0.114**	(0.0552)
Cohort (1960s)	-0.176*	(0.102)	-0.0378	(0.0469)	-0.0955	(0.118)	-0.0863*	(0.0517)
Cohort (1970s)	reference		reference		reference		reference	
Cohort (1980s)	0.158*	(0.0949)	0.0480	(0.0457)	0.0815	(0.118)	-0.00103	(0.0523)
Cohort (1990s)	0.432***	(0.102)	0.141***	(0.0508)	0.425***	(0.126)	0.0612	(0.0586)
Cohort (2000s)	0.392***	(0.129)	0.191***	(0.0628)	0.364**	(0.172)	0.0913	(0.0811)
Income								
No income	0.317	(0.227)	0.0354	(0.108)	-0.156	(0.282)	0.0158	(0.108)
Less than 3 million yen	reference		reference		reference		reference	
3 to 5 million yen	0.246***	(0.0840)	-0.0335	(0.0366)	0.0403	(0.100)	-0.0503	(0.0409)
5 to 10 million yen	0.218**	(0.0906)	-0.178***	(0.0408)	0.180*	(0.105)	-0.105**	(0.0448)
10 million yen and greater	0.467***	(0.111)	-0.449***	(0.0584)	0.484***	(0.129)	-0.320***	(0.0645)
Household composition								
Single	reference		reference		reference		reference	
One-generation	0.0212	(0.103)	0.203***	(0.0496)	0.141	(0.125)	0.242***	(0.0559)
Two-generation	-0.120	(0.0947)	0.185***	(0.0459)	-0.0870	(0.116)	0.246***	(0.0514)
Three-generation	-0.00223	(0.134)	0.280***	(0.0627)	0.190	(0.156)	0.434***	(0.0696)
Other	-0.0735	(0.246)	0.0766	(0.108)	0.0335	(0.295)	0.185	(0.123)

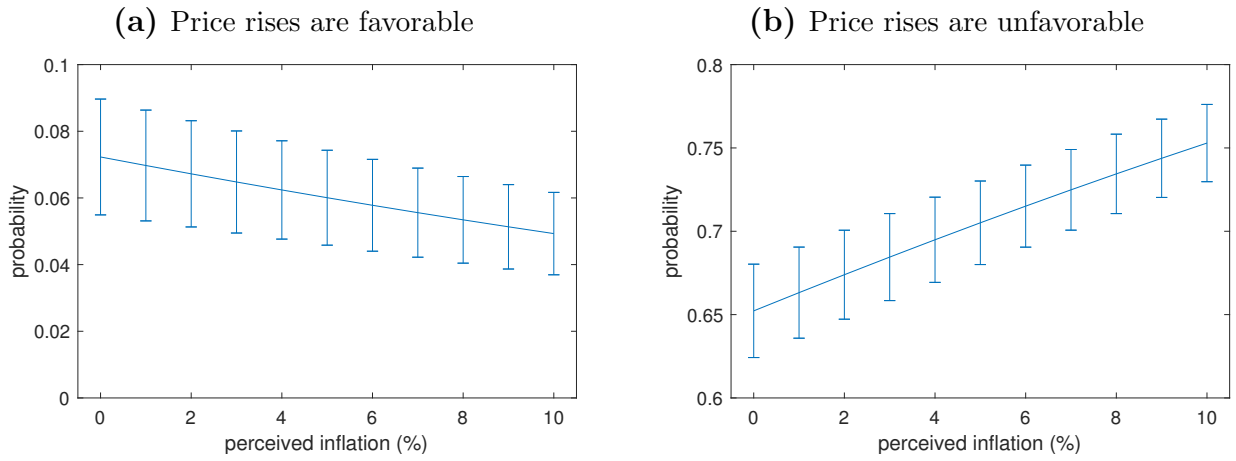
Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Estimation results of the multinomial logit model (continued)

	Model (A)				Model (B)			
	Favorable		Unfavorable		Favorable		Unfavorable	
Sentiment								
Evaluation of current economic conditions								
Favorable	1.627***	(0.186)	-0.622***	(0.173)	1.375***	(0.248)	-0.318	(0.215)
Somewhat favorable	0.840***	(0.0742)	-0.440***	(0.0435)	0.585***	(0.0953)	-0.462***	(0.0536)
Difficult to say	reference		reference		reference		reference	
Somewhat unfavorable	-0.107	(0.0802)	0.415***	(0.0325)	-0.149	(0.0927)	0.484***	(0.0372)
Unfavorable	-0.0410	(0.128)	0.494***	(0.0520)	-0.249*	(0.136)	0.635***	(0.0514)
Concerns about employment								
Not particularly concerned	0.190***	(0.0674)	-0.448***	(0.0348)	0.0770	(0.0839)	-0.441***	(0.0408)
Slightly concerned	reference		reference		reference		reference	
Quite concerned	0.0584	(0.0839)	0.362***	(0.0358)	0.00546	(0.0972)	0.258***	(0.0390)
Awareness of the 2% "price stability target"								
Know about it	reference		reference		—		—	
Don't know much about it	-0.685***	(0.0724)	0.177***	(0.0346)	—		—	
Have never heard of it	-0.891***	(0.0874)	0.456***	(0.0385)	—		—	
Awareness of the "price stability mandate"								
Know about it	—		—		reference		reference	
Don't know much about it	—		—		-0.460***	(0.0804)	0.141***	(0.0355)
Have never heard of it	—		—		-0.488***	(0.127)	0.442***	(0.0498)
Trust in the central bank								
Trust	—		—		0.912***	(0.105)	-0.172***	(0.0492)
Somewhat trust	—		—		0.512***	(0.0932)	-0.129***	(0.0371)
Difficult to say	—		—		reference		reference	
Don't trust particularly	—		—		0.441***	(0.157)	0.134**	(0.0654)
Don't trust	—		—		0.716***	(0.267)	0.313**	(0.124)
Constant	-1.338***	(0.141)	0.862***	(0.0670)	-1.849***	(0.181)	1.050***	(0.0781)
Sample period	Sep 2013 to Sep 2021				Dec 2006 to Jun 2021			
Observations	42,543				39,914			
Pseudo R^2	0.090				0.087			

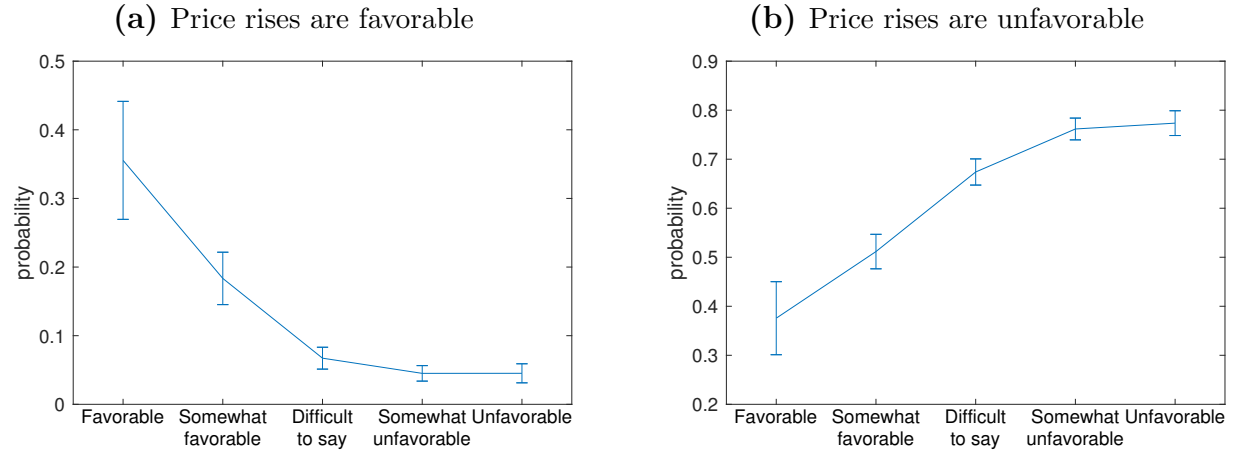
Notes: Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 7. Probability of choosing "favorable" or "unfavorable" with different perceived inflation rates



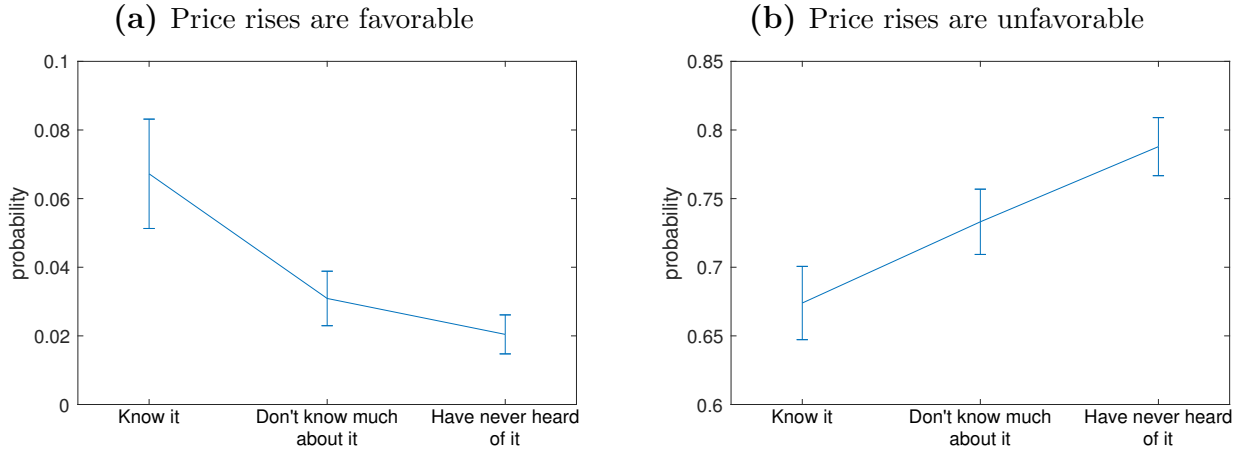
Notes: Vertical bands indicate the 95% confidence intervals. All variables are set equal to the reference except for the variables of interest (also applies to the Figures below).

Figure 8. Probability of choosing "favorable" or "unfavorable" with different evaluation of current economic conditions



Notes: Vertical bands indicate the 95% confidence intervals.

Figure 9. Probability of choosing "favorable" or "unfavorable" with different awareness of the "price stability target"



Notes: Vertical bands indicate the 95% confidence intervals.

Estimation results suggest that awareness of the "price stability target" also affects tolerance towards price rises. Figure 9 displays the average probabilities of choosing either "favorable" or "unfavorable" for respondents by different awareness of the "price stability target." Compared with those who have never heard of the 2% "price stability target," respondents who are aware of the target choose "favorable" with probability 4.7% points higher and "unfavorable" with probability 11.4% points lower. Putting these figures together suggests that the tolerance towards price rises improves 16% points once a respondent becomes aware of the "price stability target."

Next, we replace households' awareness of the 2% "price stability target" with awareness of the "price stability mandate" to confirm the robustness of our results using longer data. In addition, we include trust in the central bank as the independent variable. Estimation results are shown in the third and fourth columns of Table 3, labeled Model (B). We can confirm that our key results remain unchanged. In addition, the results indicate that enhancing trust in the central bank lowers the probability of households viewing price rises as unfavorable, which improves tolerance towards price rises.

While we have emphasized the role of household characteristics on tolerance, as indicated by Bank of Japan (2018), macroeconomic circumstances, such as developments in real wages, also affect tolerance toward price rises. Our analysis shows that, ceteris paribus, lower inflation perceptions, better sentiment, and enhanced awareness of the "price stability target" leads to an improvement in households' tolerance towards price rises.

4 Changes in the price of individual goods and services and households' inflation perceptions

In the previous section, we conducted a cross-sectional analysis to investigate the backdrop of the differences between households' inflation perceptions and the CPI inflation. In this section, we follow the findings of previous studies which show that the consumption basket affecting inflation perceptions is different from that of the CPI and investigate how different goods and services affect inflation perceptions.

4.1 The drivers of fluctuations in inflation perceptions

Schembri (2020) discusses the drivers of the differences between households' inflation perceptions and CPI inflation in Canada from the following five aspects: (i) representativeness of the CPI basket, (ii) quality adjustment, (iii) the price of housing services versus the prices of houses, (iv) asymmetric response to price rises and price cuts, and (v) purchase frequency. The first three elements are closely related to the measurement of CPI, while the last two are more related to the behavioral aspects of households. With these aspects in mind, we investigate the possibility that households have in mind a different basket of goods and services from the CPI when they form their inflation perceptions.[16]

As mentioned above, several studies have shown that frequently purchased goods affect households' inflation perceptions significantly (Ranyard et al. 2008; Del Giovane et al. 2009; Georganas et al. 2014). Accordingly, fluctuations in households' inflation perceptions tend to reflect price changes of a subset of goods and services, rather than headline inflation. Food and energy in particular are mentioned as the goods that affect inflation perceptions (Kamada et al. 2015; Abildgren and Kuchler 2021), and these goods have often shown a higher rate of price increase compared with the headline CPI inflation rate.

More recent studies suggest that in addition to food and energy, a wider range of goods and services affects the formation of households' inflation perceptions (Hałka and Łyziak 2015; Stanisławska 2019; Zekaite 2020; European Central Bank 2021). For instance, European Central Bank (2021) shows that in addition to the range of goods and services included in the HICP basket, owner-occupied housing (OOH) costs, which are not included in the current HICP, are important drivers of households' inflation perceptions. In the following analysis, we investigate whether these findings also hold true for Japan.

4.2 Empirical method

In this section, we apply the method introduced by Zekaite (2020) to the data for Japan and investigate what goods and services in the CPI are important in forming households' inflation perceptions. We estimate the coefficients using LASSO, which is a penalized least squares method. More specifically, we obtain the coefficients by minimizing the

[16] Shimizu (2008) shows that considering the effects of (ii) and (v) helps to explain the difference between perceived inflation and CPI inflation using data for Japan.

following equation:

$$\frac{1}{2N}(y - X\beta')'(y - X\beta) + \lambda \sum_{l=1}^{p} |\beta_l|, \tag{3}$$

where $(y - X\beta')'(y - X\beta)/2N$ is the mean squared prediction error and $\lambda \sum_{l=1}^{p} |\beta_l|$ penalizes including more variables in the regression. In the case of positive penalty parameter ($\lambda > 0$), the method penalizes the non-zero values of coefficients, which results in assigning zero to the coefficients of the variables that are less important.[17] LASSO is useful in our case since the time-series of our data is relatively short, while many of the goods and services are correlated with each other.[18]

As our specific model, we regress the aggregate perceived inflation (π_t^{perc}) on the inflation rate of the 19 goods and services in the CPI ($\pi_{m,t-1}^{CPI}$) as follows:[19]

$$\pi_t^{perc} = \beta_0 + \sum_{m=1}^{19} \beta_m \pi_{m,t-1}^{CPI} + \varepsilon_t. \tag{4}$$

As we shall see shortly in the following subsection, the coefficient on housing rent in the CPI shrinks to zero under the above specification. Therefore, we follow Zekaite (2020) and include house prices (π_{t-1}^{HP}) in addition to the goods and services in the CPI as follows:

$$\pi_t^{perc} = \beta_0 + \sum_{m=1}^{19} \beta_m \pi_{m,t-1}^{CPI} + \beta_{HP} \pi_{t-1}^{HP} + \varepsilon_t. \tag{5}$$

All independent variables are standardized to zero mean and standard deviation equal to one before we apply LASSO.[20]

[17] In our estimation, λ is chosen based on a cross-validation procedure and the number of cross-validation folds is set to 10. For our baseline case with house prices, our estimation is optimal at $\lambda = 0.15$ with 6 nonzero coefficients.

[18] In addition to LASSO, Ridge is known as an effective method when the independent variables are correlated with each other. In the case of Ridge, the coefficients of relatively less important variables shrink to zero, while they do not take exactly zero. This difference arises due to the fact that corner solution (zero) is often obtained under the constraint of LASSO ($\lambda \sum_{l=1}^{p} |\beta_l|$), while zero is not obtained under the constraint of Ridge ($\lambda \sum_{l=1}^{p} \beta_l^2$).

[19] We take lags for the independent variables for the following two reasons. First, the *Opinion Survey* is conducted in the middle of the quarter (i.e. conducted in February for the March survey), thus not all information for a given quarter is available at the time of the survey. Second, existing studies have found that inflation perceptions react both instantaneously and with a time lag to the actual rate of inflation (Lein and Maag 2011).

[20] It is known that estimation results can vary depending on how the variables are standardized when LASSO or Ridge is applied. In this study, we standardize to zero mean and standard deviation equal to one, which is the most standard method, while there are other methods that standardize the variables so that the size of the coefficients on the variables become similar.

Table 4. Summary statistics

	CPI weight (%)	Purchase frequency	Mean	Standard deviation
Fresh goods	6.6	4.9	1.4	4.3
Other agricultural, fishery, and livestock products	0.6	3.6	-0.4	7.0
Food products	15.2	4.6	0.5	1.4
Textiles	3.8	1.8	0.0	0.8
Petroleum products	2.8	5.0	2.5	10.8
Other industrial products	15.0	1.8	-1.0	1.6
Utilities	5.3	4.6	0.6	4.2
Publications	1.2	3.2	0.7	0.6
Public services				
Domestic duties	5.0	2.6	0.7	1.5
Medical care and welfare	3.0	5.1	0.4	1.2
Transportation and communications	2.5	2.7	0.1	1.1
Education	0.3	1.0	2.0	4.0
Culture and recreation	0.9	2.9	-0.1	0.8
General services				
Domestic duties	4.8	1.7	0.3	0.4
Medical care and welfare	0.4	1.7	1.8	3.1
Education	2.7	1.2	0.4	0.8
Communications, culture and recreation	7.2	3.2	-0.8	2.5
Meals outside home	4.6	2.8	0.6	0.6
Housing rent	18.3	1.9	-0.2	0.2
CPI (headline)	100	—	0.1	0.8
House price	—	—	1.2	4.0
Perceived inflation	—	—	2.1	2.5

Notes: Among goods and services, "school lunch" and "eating out" are aggregated as "meals outside home." Similarly, "housing rent (public), rent for Urban Renaissance Agency, and rent for public corporation," "housing rent (private)," and "imputed rent" are all aggregated as "housing rent." CPI (headline) and goods and services sub-indices are adjusted for the tax hike in 2014 and 2019, as well as policies concerning the provision of free education, etc. (author's calculation for the sub-indices). Mean and standard deviation are calculated using monthly year-on-year inflation rate from January 2004 to September 2021. Purchase frequency is calculated by taking the weighted average of the frequency index provided by the Statistics Bureau, which ranges from 1 (seldom purchased) to 6 (frequently purchased).

Table 4 presents the summary statistics of the variables.[21] In our sample period, average inflation rates for food product and petroleum product, as well as house prices have been higher than the headline CPI inflation. We also calculate the weighted average of the purchase frequency for each goods and services in the sub-indices to examine their relation with perceived inflation. The purchase frequency is high for food products and petroleum products, as well as some essential services such as medical care and welfare (public). For the house prices, we use the "JREI home price index (composite)" published by Japan Real Estate Institute, which is an index available with a long observation period.[22]

4.3 Estimation results

The estimation results using LASSO are presented in Table 5. The first column shows the results without house prices, specified as eq.(4). The non-zero coefficients indicate that several goods and services are important in explaining the fluctuations in perceived inflation; Coefficients on food products and petroleum products are large, indicating that those sub-indices are important, which is consistent with existing studies indicating the relation with purchase frequency. In addition, services such as domestic duties (general) and transportation and communications (public) also influence the formation of inflation perceptions. On the other hand, while mobile phone charges have been putting significant downward pressure on headline CPI recently, the coefficients on services related to communications, culture and recreation (general), which includes those mobile phone charges, shrinks to zero. This result implies that the recent sharp decline in mobile phone charges has not affected households' inflation perceptions. Similarly, it is worth noting—given the large weight of housing in the cost of living—that the coefficients on housing rent in the CPI shrink to zero as well.

We can also confirm that while the coefficient on food products (processed foods) is large, the coefficient on fresh goods (fresh foods and flowers) shrinks to zero. Although

[21] The aggregate perceived inflation rate used in this section is adjusted by applying the method proposed by Kamada (2013). As this adjustment mainly affects the level of the aggregate series by considering the downward rigidity of households' inflation perceptions and expectations, the time-series variation is similar to that of the trimmed mean (both shown in Figure 1). Therefore, replacing the adjusted mean with the trimmed mean in our estimation does not affect the key results of our analysis.

[22] The index is calculated by tracking prices of repeated transactions (repeated sales method) and covers existing condominiums in the Tokyo Metro Area. While our analysis is not limited to the Tokyo Metro Area, we use the index as a proxy for house prices across Japan.

Table 5. Estimation results using LASSO

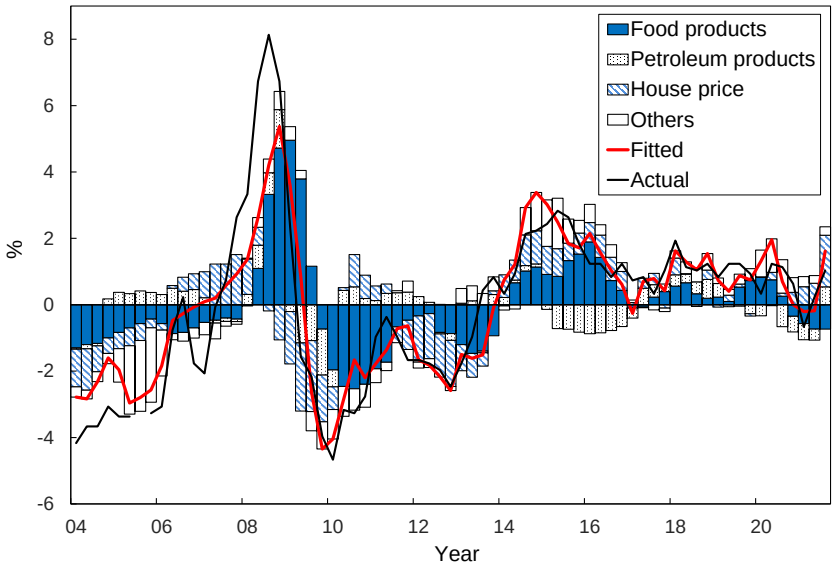
	(1) Perceived inflation	(2) Perceived inflation	(3) Perceived inflation	(4) Perceived inflation
House price	-	0.836	1.004	0.103
Fresh goods	0	0	0	0
Other agricultural, fishery, and livestock products	-0.275	0	0	-0.0661
Food products	0.918	1.428	1.295	0.224
Textiles	0.0823	0	0	0
Petroleum products	0.708	0.489	0.440	0
Other industrial products	0.306	0	0	0
Utilities	0	0	0	0
Publications	-0.0481	0	-0.196	0
Public services				
Domestic duties	0	0	0	0
Medical care and welfare	0	0	0	0
Transportation and communications	0.906	0.582	0.561	0.279
Education	0	0	0	0
Culture and recreation	-0.0888	-0.155	0	0.109
General services				
Domestic duties	0.460	0.256	0.843	0
Medical care and welfare	0	0	0	0
Education	0	0	0	0.0557
Communications, culture and recreation	0	0	0	0
Meals outside home	0	0	0	0
Housing rent	0	0	0	0
Constant	2.031	2.027	1.071	3.063
Observations	70	70	35	35
Sample period	Mar 2004 to Sep 2021	Mar 2004 to Sep 2021	Mar 2004 to Mar 2013	Jun 2013 to Sep 2021

Notes: Coefficients equal to zero indicates that the variable was excluded from the regression by LASSO.

both fresh goods and food products are purchased frequently, the price of fresh goods is more volatile as it is affected by transitory factors such as the weather (Table 4). As such, our estimation results suggest that households consider fresh goods as a rather "noisy" sub-index and pay little attention to their price changes when they form their inflation perceptions.

The second column shows the estimation results including house prices as specified in eq.(5). The coefficient on house prices is positive and large, indicating the importance of house prices in households' inflation perceptions. This is in contrast with the result where the coefficient on housing rent in CPI shrinks to zero. These results are likely driven by the fact that house prices have shown different movements from housing rent in the CPI throughout the sample period. Besides, several goods and services, which had non-zero coefficients under eq.(4) have zero coefficients under eq.(5). This indicates that in explaining inflation perceptions, house price is more important than combining several goods and services in the CPI. These results imply that households have in mind a different basket of goods and services from the CPI when they form their inflation perceptions.

Figure 10. Breakdown of the estimation results by LASSO



Notes: Demeaned by the sample average (March 2004 to September 2021).

Figure 10 shows the breakdown of the estimation results. We can confirm that the

estimates explain the actual time-series well. Food products, depicted by blue bars, show the largest contribution to the changes in inflation perceptions. This is consistent with the findings of previous studies that frequently purchased goods are important drivers of perceived inflation. Petroleum products, depicted by black dotted bars, also show a sizable contribution. They show an especially large swing during and after the commodity price boom in the mid-2000s. Finally, house prices, shown in striped bars, have also contributed to the cyclical movements in perceived inflation.

To confirm the robustness of our estimation results, we split the sample into two periods, before and after the launch of the quantitative and qualitative easing in 2013. The results are shown in the third and fourth columns of Table 5, respectively. Our key conclusion that food products and house prices are important drivers of perceived inflation remains unchanged, while petroleum products is no longer important in the latter half of the period. This result likely reflects the fact that households' perceived inflation did not decline despite the large drop in commodity prices in the latter half of the sample period.

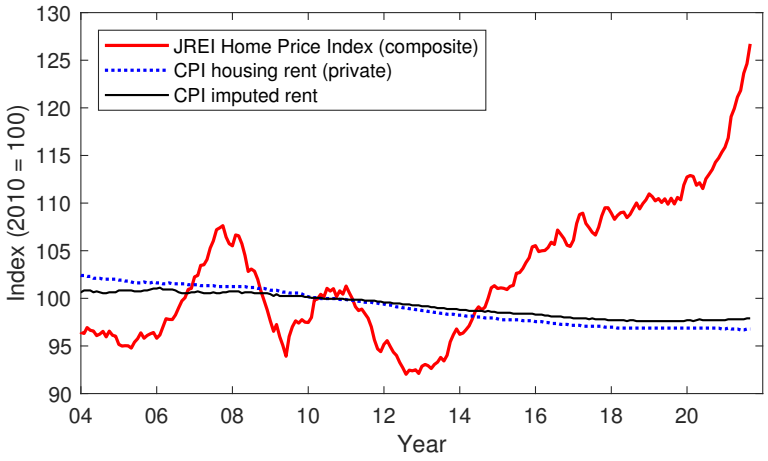
4.4 House prices, housing costs, and inflation perceptions

While our empirical results suggest that changes in house prices play an important role in the formation of households' inflation perceptions, there is no consensus among existing studies on this point. For example, Aucremanne et al. (2007) investigate the difference between perceived inflation and HICP inflation and argue that OOH costs do not help explain the difference. Del Giovane et al. (2009) report that having been engaged in a dwelling transaction over the last few years does not affect inflation perceptions. On the other hand, Döhring and Mordonu (2007) find that the price of residential real estate contributes significantly to inflation perceptions, suggesting that households have a broader view of the cost of living when forming inflation perceptions. More recent studies such as Zekaite (2020) and European Central Bank (2021) support the view that house prices play an important role in households' inflation perceptions.

These findings are closely related to the issue of how OOH costs should be measured in the CPI. Indeed, the measurement of OOH costs is an important issue and has been discussed for decades (Goodhart 2001). While several measurement methods have been proposed, consensus has not been reached. For example, in the euro area, OOH costs have been excluded from the HICP due to the difficulty of measurement. However, given the

concerns that excluding a large portion of the housing costs may undermine the credibility of the price index and monetary policy, the ECB has launched a roadmap to include OOH costs in the official statistics in the coming years (European Central Bank 2021).

Figure 11. Housing rent and imputed rent in the CPI and house prices



Sources: Statistics Bureau; Japan Real Estate Institute.

The difficulty of measuring housing costs has also been discussed in Japan. Figure 11 shows how house prices, as well as housing rent and imputed rent in the CPI, have evolved over the past two decades in Japan. The figure shows that both actual rent and imputed rent have shown a declining trend in spite of the rising trend in house prices. Our results in the previous subsection showing that the coeffeicients of housing rent in the CPI shrink to zero when we apply LASSO likely reflects the fact that the underlying trend in housing rent is different from that of households' inflation perceptions.

One possible reason for the declining trend in actual rent is that an upward-rigidity exists for housing rent in Japan due to tenant-protection laws (the Act on Land and Building Leases), which restrict owners from raising rent (Suzuki et al. 2021). In addition to such institutional factors, some issues have been discussed regarding the measurement of both actual and imputed rent. For example, the Committee of Statistics has pointed out that considering the decline in quality of the property due to depreciation pushes up housing rent inflation.[23]

It is worth noting that our results do not necessarily rule out the possibility of households perceiving rises in asset prices as rises in inflation. While inflation measures used

[23]Following such recommendations, the Statistics Bureau estimates the impact of depreciation on the inflation rate.

today do not include asset prices, consensus is yet to be reached regarding whether asset price changes should be considered in the measurement of households' cost of living (for example, Shibuya 1992, Shiratsuka 1999, and Goodhart 2001 provide discussions regarding asset prices and inflation). Even if the inflation measure should not include asset prices, houses have both aspects—they can be considered as both durable goods and assets—making it difficult to distinguish between the two.[24]

5 Conclusion

In this study, we investigated the backdrop of the "inflation perception conundrum" in Japan. Our cross-sectional analysis using micro-data from the *Opinion Survey* showed that a variety of factors affect the inflation perceptions of households, including their sociodemographic characteristics, which are likely to affect their consumption patterns, their sentiment, and their awareness of the Bank of Japan's "price stability target." We further showed that such inflation perceptions, as well as sentiment and awareness of the "price stability target," influence households' tolerance towards price rises. We then analyzed how changes in the price of individual goods and services influence perceived inflation using aggregate data and found that a large share of the fluctuations in perceived inflation could be explained by changes in food product and petroleum product prices. In addition, we showed that house prices, which are not included in the CPI in Japan, also explain these fluctuations. These results imply that households have in mind a different basket of goods and services from the CPI when they form their inflation perceptions.

Throughout the study, we have limited our focus to inflation perceptions, excluding their relation to inflation expectations from the scope of our study. Needless to say, how inflation perceptions and expectations affect each other is of great importance from both an academic and a policy point of view. Besides, understanding how inflation perceptions influence economic entities' behavior—other than their tolerance towards price rises—is also an important research question. Moreover, issues related to the measurement of inflation, especially with regard to housing costs, also warrant further investigation. We leave such questions for future research.

[24] OOH costs measured by the net acquisition approach principally distinguish between land prices and structure prices, despite operational difficulties in distinguishing between the two.

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