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# DANMARKS NATIONALBANK

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## Revisiting the inflation perception conundrum

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## Revisiting the inflation perception conundrum

### Abstract

Several studies have found that the levels of inflation perceived by households persistently exceed observed inflation levels measured by official Consumer Price Indices. In this paper, we revisit the issue based on rich and previously unexplored household-level data from the Danish part of the EU-Harmonised Consumer Expectations Survey (CES) linked to microdata from Danish administrative registers. We find that accounting for even several of the factors usually put forward to explain the overestimation bias can only reduce it slightly. Food prices seem to carry a larger weight in perceived inflation than in the official CPI, and we find clear seasonal effects in the inflation perception bias. The bias is also reflected in the households' expectations of the future inflation level. One should therefore not use the levels of survey-based inflation expectations from the CES in empirical works. We find a much smaller bias in the expectations regarding future changes in inflation rates. Implementing some form of guidance on the current or typical rate of inflation in the survey questions might reduce the bias. However, the bias might also indicate a more general need for enhanced communication by monetary authorities and statistical agencies regarding the rather abstract concept of "inflation".

### Resume

Flere studier har vist, at husholdningerne konsekvent overvurderer inflationen sammenholdt med det faktiske inflationsniveau målt ved officielle forbrugerprisindeks. I dette arbejdspapir analyserer vi problemstillingen på grundlag af detaljerede mikrodata fra den danske del af den EU-harmoniserede forbrugerforventningsundersøgelse samkørt med oplysninger fra administrative registre. Nogle typer af personer overvurderer inflationen mere end andre, men der er generelt tale om et meget udbredt fænomen. Det er ikke muligt at pege på én husstandstype, hvor der ikke er en betydelig gennemsnitlig forskel mellem opfattet og faktisk inflationsniveau. Fødevarerpriserne har en større vægt i den opfattede inflation end i det officielle forbrugerprisindeks, og der er tydelige sæsonudsving i overvurderingen af inflationsniveauet. Tendensen til at overvurdere inflationen genfindes i husholdningernes inflationsforventninger. Man bør derfor ikke anvende niveauet for inflationsforventninger fra den EU-harmoniserede forbrugerforventningsundersøgelse i empiriske analyser. Vi finder en langt højere grad af præcision, når vi ser på husholdningernes forventninger til ændringer i inflationen. Graden af overvurdering af inflationen kan muligvis reduceres, hvis interviewpersonerne vejledes om det nuværende eller typiske inflationsniveau. Den betydelige forskel mellem opfattet og faktisk inflation kan dog også være tegn på, at der er et behov for mere information fra statistikbureauer og centralbanker om inflation, som er et forholdsvis abstrakt begreb.

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### Key words

Inflation perceptions; Inflation expectations; Micro data.

### JEL classification

D12; E31.

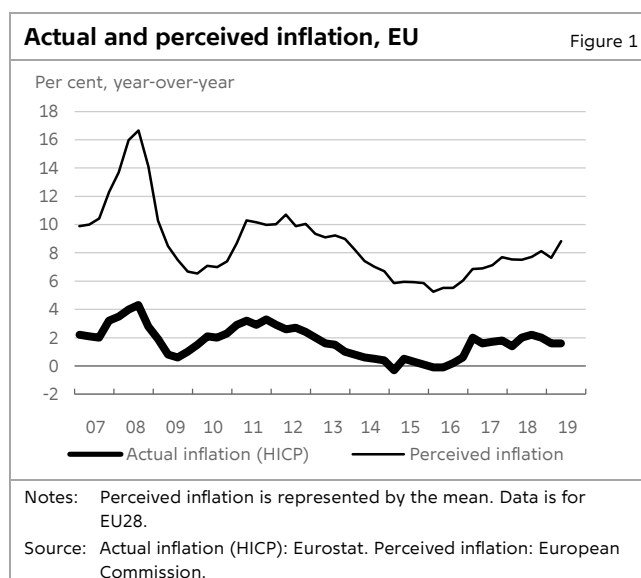
### Acknowledgements

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## 1. Introduction

Nothing is probably more important for monetary and macroeconomic stability than well-anchored inflation expectations. Inflation expectations are a crucial determinant of actual inflation, and heterogeneity in inflation expectations might matter to the monetary-policy transmission (Woodford, 2003; Falck, Hoffmann and Hürtgen, 2019). Information on consumers' inflation perceptions and expectations is therefore of huge interest for central banks and monetary authorities.

In the first part of 2019, the European Commission began to publish data on a regular basis on consumers' quantitative estimates of past and expected inflation as part of the EU-Harmonised Consumer Expectations Survey, cf. European Commission (2019). The data show that the levels of inflation perceived by European households persistently exceed the actual observed inflation levels measured by the official Harmonised Index of Consumer Prices (HICP), cf. Figure 1. For the Euro area, the actual year-over-year inflation rate was 1.5 per cent in the third quarter of 2019 whereas consumers on average perceived inflation to be 7.2 per cent.



This overestimation bias raises a number of issues of relevance for central banks and other policy makers. Do the households' overestimations of the actual inflation level reflect that they have another price concept than the Consumer Price Index (CPI) in mind when interviewed about inflation? Is the estimation bias a result of the phrasing of the survey questionnaire or lack of cognitive abilities and mathematical literacy to grasp the rather abstract concepts of "inflation" and "price increases" measured in per cent (Bruin *et al.*, 2012; Lusardi and Mitchell, 2014; D'Acunto, 2019)? The degree of heterogeneity is also important – is overestimation bias a general phenomenon for all types of households or is the estimation error particularly large for some types of households?

A deeper understanding of this "inflation perception conundrum" is important for several reasons. To utilize survey results on household inflation expectations, it is important to understand the price concept used by the households and/or any potential biases in the perceived and expected levels of inflation (Lein and Maag, 2011). Furthermore, the overestimation bias might indicate a need for an enhanced communication effort from the monetary authorities as well as statistical agencies regarding the concept of inflation, at least vis-à-vis certain segments of the household sector. If the price concept in focus among households mainly consists of prices of frequent purchases such as food, there might be an extra challenge for central banks that focus on core inflation concepts such as CPI excluding (unprocessed) food and energy in their communication activities. Last, but not least, inflation perceptions and expectations are of key importance for households' consumption, investment and savings decisions.

Unpublished data on quantitative inflation perception and expectations from the EU-Harmonised Consumer Expectations Survey have been studied by Lindén (2005), Biau *et al.* (2010), European Commission (2014) and Arioli *et al.* (2016, 2017). In this paper we use a rich and previously unexplored Danish household-level dataset to revisit the issue of overestimation bias in inflation perceptions and expectations. The dataset is based on the Danish part of the EU-harmonised Consumer Expectations Survey merged with household-level information from a wide range of Danish administrative registers. The dataset allows us to explore many of the drivers of the inflation perception and expectation biases usually put forward in existing literature as well as new factors and dimensions not previously analyzed due to data limitations.

Previous research has indicated that part of the overestimation bias reflects that households pay most attention to the price development on frequent out of pocket purchases (FROOPP) such as food, alcohol, tobacco, certain transport items, hotels and restaurants, *etc.* (Brachinger, 2008; Georganas *et al.*, 2014; Binder, 2018, D'Acunto *et al.*, 2019). However, Arioli *et al.* (2016, 2017) note that even though FROOPP inflation has tended to be higher than the general CPI inflation in Europe during the most recent decades, it can only explain part of the gap between perceived and actual inflation.

Earlier research also suggests that the overestimation bias in the European inflation perception surveys might be partly related to the use of open-ended questions (no range of suggested inflation rates offered to the survey participants as is the case in Bank of England's survey of inflation attitudes or the Japanese Intage Survey) and a lack of probing of unusual replies (as is the case in the University of Michigan survey of US consumer attitudes), cf. Biau *et al.* (2010), Arioli *et al.* (2016, 2017), European Commission (2019) and Diamondy *et al.* (2019). The overestimation bias might also partly reflect that households fail to properly adjust for quality changes when reporting their inflation perception or do not adjust for quality changes in the same way as the national statistical institutes do when compiling CPI statistics (Bosworth *et al.*, 1997; Arioli *et al.*, 2016, 2017). Households could also pay more attention to price increases than price decreases, and periodic

sales might play a role in this context. In addition, more attention could be given to large than small price changes and to frequent rather than rare price changes (Huber, 2011; Armantier *et al.*, 2013; Stanislawska, 2019).

Furthermore, existing research emphasizes the high degree of cross-household heterogeneity in the European survey results. Arioli *et al.* (2016, 2017) find that inflation perceptions tend to be lower for males, high income earners and highly educated individuals. Similar results have been found earlier for Sweden (Jonung, 1981; Palmqvist and Strömberg, 2004) and the US (Bryan and Venkatu, 2001a, 2001b). Moreover, the difference in inflation perception between men and women in the US seems not to be the result of men and women having different consumption bundles (Bryan and Venkatu, 2001b). Studies have also shown that inflation perception errors are highly autocorrelated at a household level (Jonung and Laidler, 1988) and that households' inflation expectations are related to news about inflation, which could also influence perceptions regarding historical inflation (Badarinza and Buchmann, 2009; Lamla and Lein, 2015; Ehrmann *et al.*, 2017). In addition, the level of inflation experienced through an individual's life-time has been shown to influence inflation expectations (Malmendier and Nagel, 2016; Goldfayn-Frank and Wohlfart, 2019).

Finally, several studies have uncovered a substantial cross-country heterogeneity regarding the size of the overestimation gap in inflation perceptions and expectations (Arioli *et al.*, 2016, 2017; Lamlaz, Pfajfar and Rendell, 2019; Lyziak, Paloviita and Stanislawska, 2019). The gap is, in general, significantly lower in the Nordic countries than in Southern and Eastern Europe.

The analysis in the paper at hand confirms the importance for the size of the overestimation bias in inflation perceptions of a range of well-established factors such as income, age, education and gender as well as the degree of pessimism in the respondents' answers to other survey questions. We also confirm that part of the bias reflects that the respondents may have another price concept in mind (food prices) rather than consumer prices in general when interviewed about the level of inflation. This issue is especially of importance in periods where food price inflation deviates markedly from the general CPI inflation.

Our rich dataset also allows us to explore the relation between overestimation bias in inflation perceptions and a range of other variables usually not addressed in earlier literature. We find e.g. that households with large overestimation biases in general are characterised by lower net wealth-to-income ratios, higher loan-to-value ratios, higher consumption-to-income ratios, lower holdings of stocks and mutual fund shares, higher employment shares within the public sector and lower employment shares within private business service and finance. We also find clear seasonality in the perception of inflation. Respondents on average perceive the level of inflation to be almost 1 percentage point higher in July than in February.

In addition, we use the time series dimension of our microdataset to explore the significance of overpessimism for the inflation perception bias. This has not previously been examined in the literature. We find that overpessimistic households – defined as households who are pessimistic

about their own future financial situation and who (in spite of their pessimism) experience an increase in real household income over a 3-year period following the interview – have a significantly larger perception bias than other households. This indicates that the inflation perception bias is related to fundamental personality traits. This conclusion is further underlined by our finding that respondents participating in the survey more than once tend to be persistent in their degree of perception bias.

Due to our ability to link the survey responses to administrative registers on family relations, we can also explore the link between inflation perception bias and the economic situation of the respondent as well as the economic situation of other members of the respondent's household. We find that households with unemployed adult members are overrepresented in the group of households with large inflation perception biases. Other events such as change of address or family increases by children seem of less importance.

However, accounting for even several of the above mentioned factors simultaneously is far from sufficient to explain the inflation perception bias. This underlines the broad-based nature of the bias.

We find a strong correlation between inflation perception and inflation expectation at a household level. Furthermore, there seems on average to be a very small bias when comparing the households' expectations regarding future change in inflation on a 1-year horizon with the *ex post* realized change in inflation over the same period. These findings suggest that one should use the expected change in inflation – rather than the expected level of inflation – in empirical works.

In addition, an assessment of the anchoring of inflation expectations in the household sector based on the survey data from the Consumer Expectations Survey should not be based on inflation expectations in levels but rather on expectations regarding future changes in inflation. We find that if inflation has recently increased, households expect this trend to reverse in the future, and if inflation has recently decreased, households to a larger degree than in other periods expect that inflation will increase in the future. This mean reversion indicates that households' inflation expectations are well-anchored. To the best of our knowledge, this issue has not previously been explored in the literature.

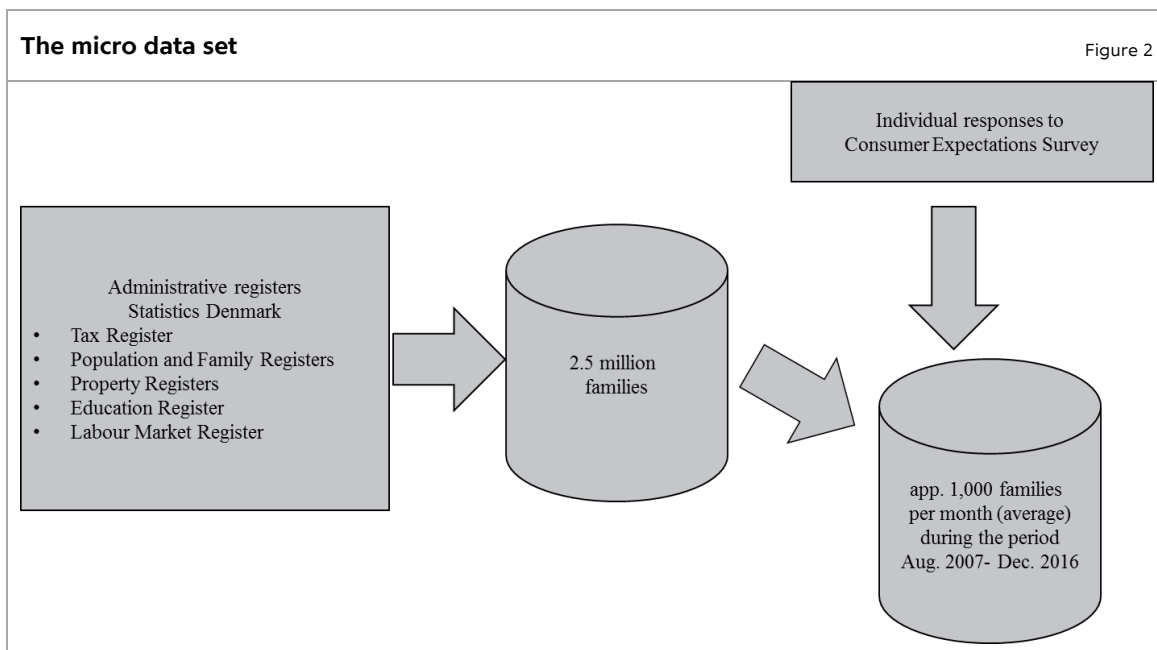
However, even when expected changes in inflation are considered, there are still substantial outliers that need to be addressed, and changes to the survey design might be a way forward in this area. Our empirical analysis shows that households with a relatively accurate perception of the current level of inflation do not overestimate future inflation to the same extent as households with less accurate perceptions of current inflation. This suggests that knowledge of current inflation is important for the accuracy of expectations regarding future inflation. Implementing some form of guidance on the current or typical rate of inflation in survey questions might therefore reduce the widely observed positive bias in inflation expectations.

## 2. Data

The core part of our dataset consists of microdata on inflation perception and inflation expectations collected by Statistics Denmark as part of the monthly Danish Consumer Expectations Survey. The survey follows guidelines laid out by the European Commission in the Harmonised EU Programme of Business and Consumer Surveys. Each month, a sample of around 1,500 representative persons aged 16-74 are selected to participate in an interview, and the average participation rate is around 67 per cent (Statistics Denmark, 2016a). Our dataset covers the period 2007m8-2016m12. Households are asked about e.g. their inflation perception in a two-step procedure. First, they are asked a qualitative question: "How do you think that prices are today compared to one year ago?". The possible answers are "Much higher", "Somewhat higher", "A little higher", "Unchanged", and "A little lower". Second, conditional on not having answered "Unchanged", respondents are asked a quantitative question: "By how many per cent do think that prices have gone up/down over the past 12 months?". We assign a value of 0 per cent to households that have answered "Unchanged" to the first question. Furthermore, for the calculation of mean inflation perception figures we discard responses larger than 50 per cent and smaller than -50 per cent. Similar questions are asked about inflation expectations over the coming 12 months, and the same approach is used to obtain a quantitative measure of inflation expectations for all respondents.

Statistics Denmark knows the identity of the individuals interviewed in the Consumer Expectations Survey and is therefore able to link the survey results to a large range of administrative registers, for instance the Tax Register with information on household-level income, taxes, assets and debts, the Population and Family Registers with information on age, area of residence and family relations, the Property Register with information on public valuation and sales prices on real estate, the Education Register with information on education, the Labour Market Register with information on employment status, etc. As a result, we have access to a unique and very rich household-level dataset on inflation perception and inflation expectations, cf. Figure 2.





We also make use of the official CPI statistics as well as household-group-specific consumer price indices compiled by Statistics Denmark for around 20 different groups of households, cf. Statistics Denmark (2016b) and Larsen (2016). The price series behind the household-group-specific consumer price indices comes from the official CPI whereas the weights are specific for each household group and are based on the household-group-specific expenditure pattern according to the household budget survey.

### 3. Explorative analysis of inflation perceptions based on household-group-level data

To get an overview of the dataset, we begin by exploring inflation perceptions at a household-group level. We compile unweighted averages of inflation perceptions on a monthly basis for the 18 household groups shown in Table 1. These household groups are used in the household budget survey as well as for the household-group-specific inflation rates published by Statistics Denmark. Figure 3 (left) shows the actual inflation level in Denmark over the past decade measured by the official CPI and the mean perceived inflation level across all households. Over most of the period, perceived inflation has been substantially higher than actual inflation. This has been the case for all groups of households, cf. Figure 3 (right).

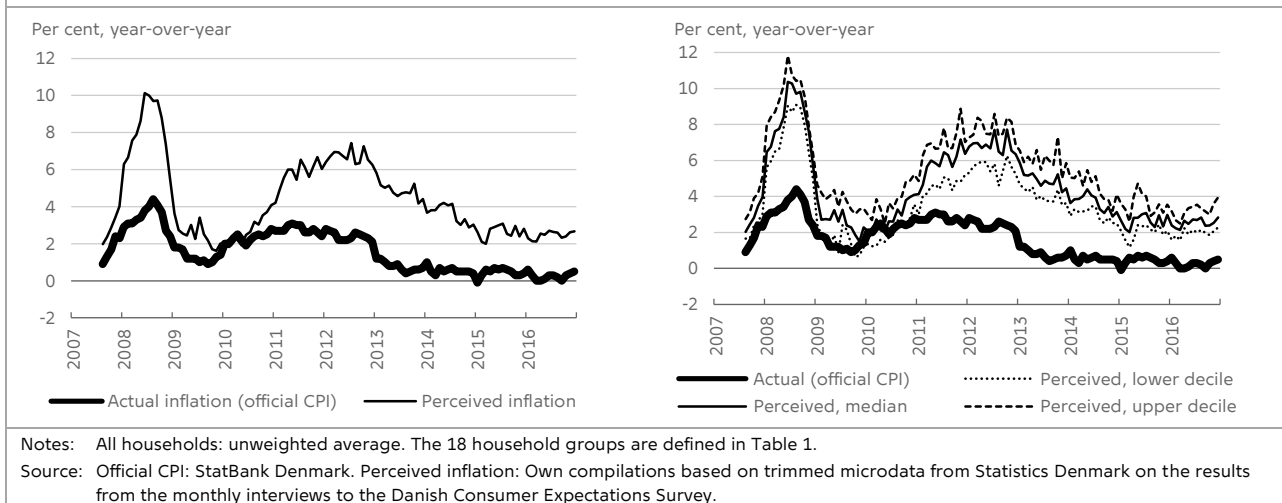
Table 1: Household groups

No.	Household type	No.	Household type
1	Single persons under 60 years without children.	10	Employees - basic level.
2	Single persons over 60 years without children.	11	Receiving education.
3	Single persons with children.	12	Pensioners and early retirement.
4	2 adults without children, household head under 60 years.	13	Other not economically active (excl. unemployed).
5	2 adults without children, household head over 60 years.	14	Income under 150,000 DKK.
6	2 adults with children.	15	Income 150,000-299,999 DKK.
7	Self-employed.	16	Income 300,000-499,999 DKK.
8	Employees - upper level.	17	Income 500,000-799,999 DKK.
9	Employees - medium level.	18	Income 800,000 DKK or over.

Notes: The household groups are not mutually exclusive.

Actual inflation (official CPI) and perceived inflation

Figure 3



A number of empirical studies based on household-level microdata have documented significant short-run heterogeneity in the actual price development experienced by households with different consumption bundles (Michael, 1979; Hagemann, 1982; Hobijn and Lagakos, 2005; Cepparulo *et al.*, 2012). However, the differences tend to be very limited in the medium term or longer run, and the use of household-group-specific CPIs as indicators for the actual inflation developments does not reduce the "inflation perception conundrum" in any significant way, cf. Figures 4 and 5.

**Distribution of household-group-specific inflation across household groups**

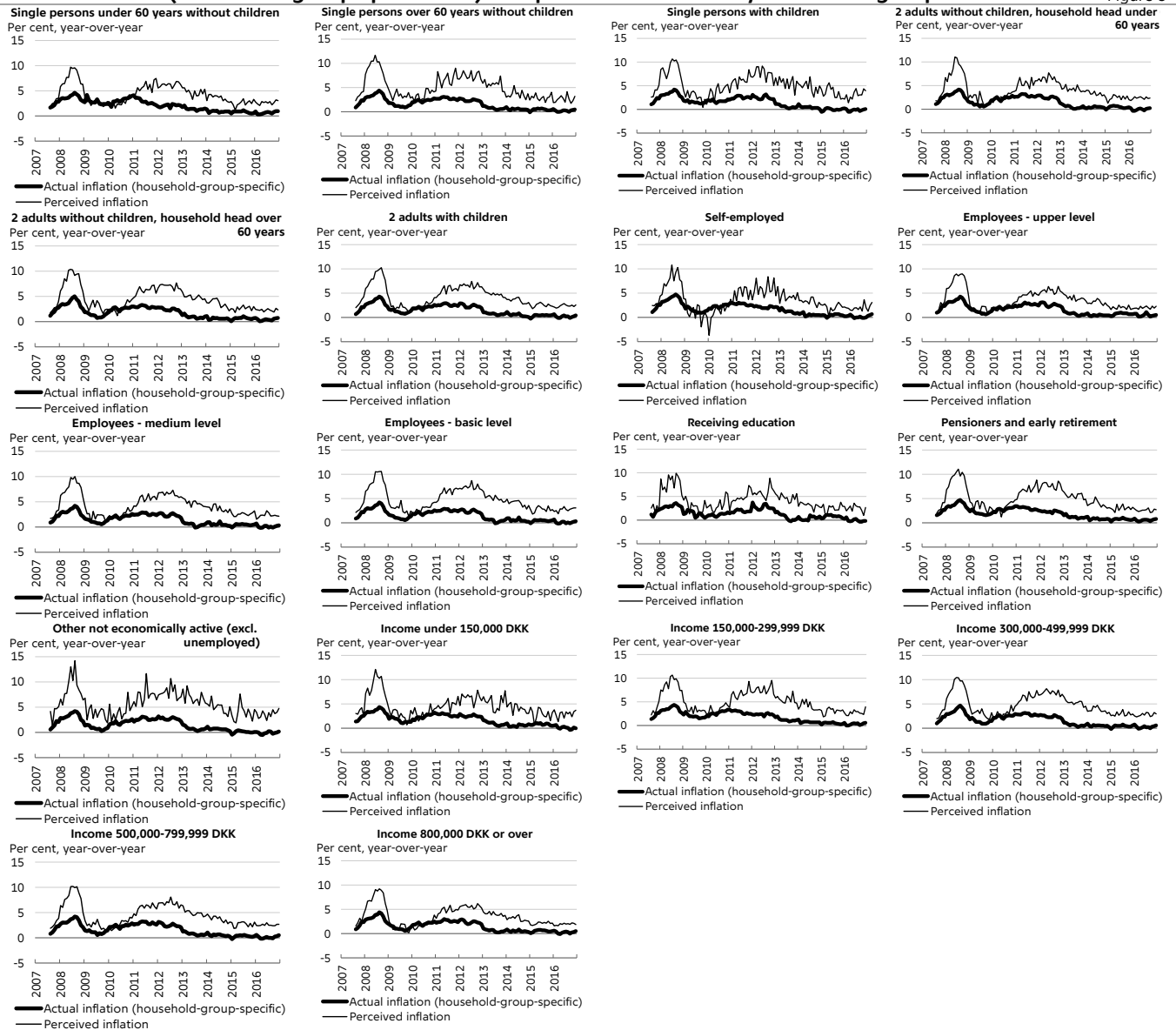
Figure 4



Notes: The 18 household groups are defined in Table 1. Own compilations based on StatBank Denmark.

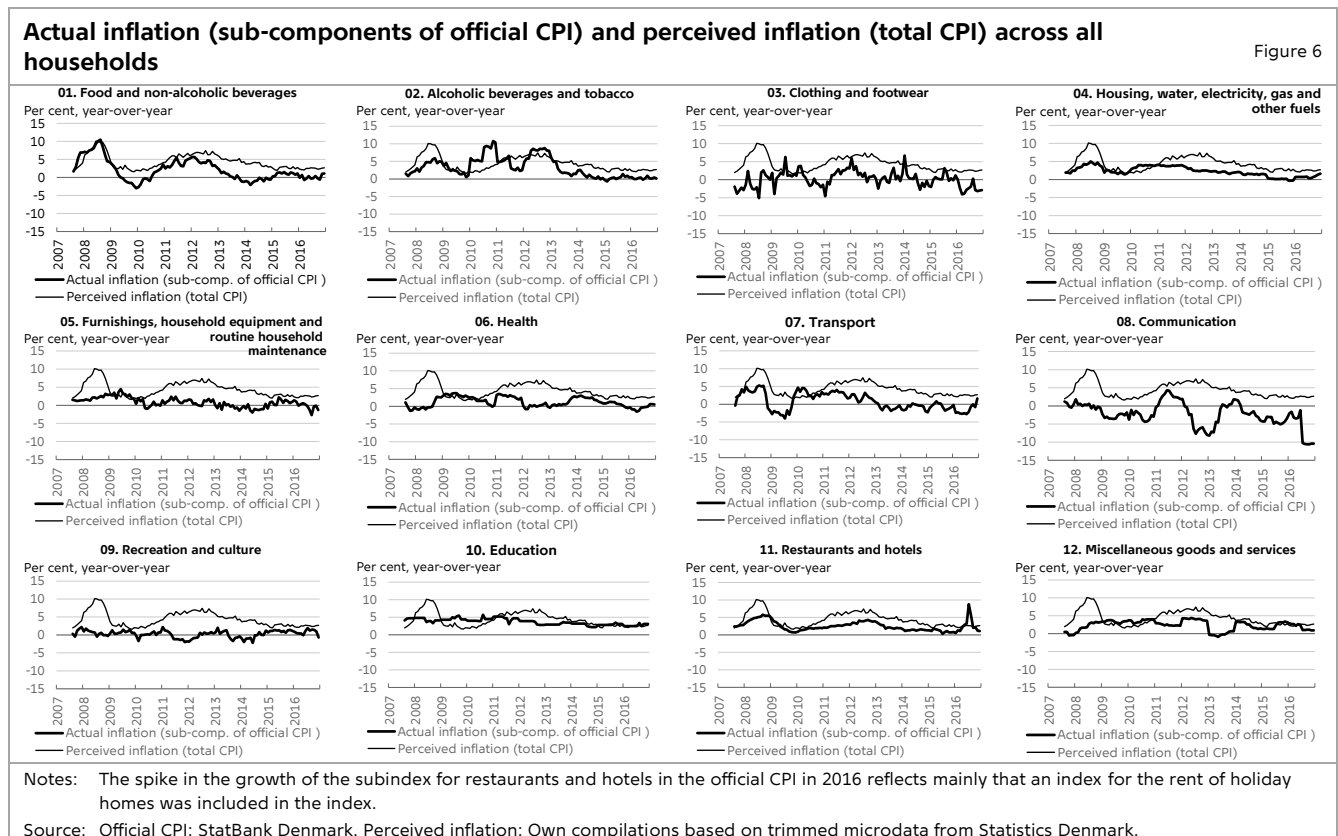
**Actual inflation (household-group-specific CPI) and perceived inflation by household group**

Figure 5



Source: Household-group-specific CPI: StatBank Denmark. Perceived inflation: Own compilations based on trimmed microdata from Statistics Denmark.

Figure 6 compares the perceived inflation level (total CPI) across all households with the actual inflation level for the main subcomponents of the official CPI. It can be noticed that the perceived inflation (total CPI) is higher than the actual price development for most subgroups of the CPI. Furthermore, there seems to be a fairly close correlation between perceived inflation (total CPI) and the development in food prices.

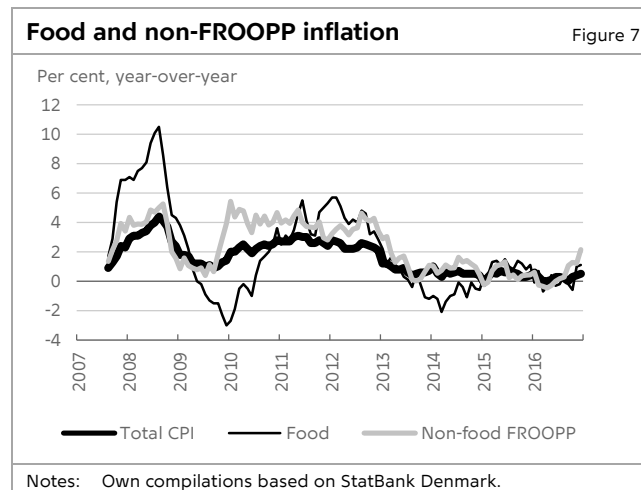


Food is a key component of the so-called "frequent out of pocket purchases" (FROOPP) special aggregate of the Harmonised Index of Consumer Prices (HICP) developed by Eurostat, cf. Mile (2009) and Eurostat (2017). The items included in FROOPP as defined by Eurostat are shown in Table 2. In Figure 7 we have calculated a subindex of the Danish CPI that covers all non-food FROOPP items such as alcohol, tobacco, certain transport items, hotels and restaurants, etc. During a large part of the period since mid-2007, food as well as non-food FROOPP inflation has been higher than the general CPI inflation.

Table 2: Items included in the HICP aggregate on frequent out of pocket purchases (FROOPP)

COICOP	Description	COICOP	Description
01	Food and non-alcoholic beverages	09.1.4	Recording media
02.	Alcoholic beverages, tobacco and narcotics	09.3.4-5	Pets and related products including veterinary and other services for pets
03.1.4	Cleaning, repair and hire of clothing	09.4.1	Recreational and sporting services
05.6.1	Non-durable household goods	09.4.2	Cultural services
05.6.2	Domestic services and household services	09.5.1	Books
06.1.1	Pharmaceutical products	09.5.2	Newspapers and periodicals
07.2.2	Fuels and lubricants for personal transport equipment	09.5.3-4	Miscellaneous printed matter
07.2.4	Other services in respect of personal transport equipment	11.1.1	Restaurants, cafés and the like
07.3.1	Passenger transport by railway	11.1.2	Canteens
07.3.2	Passenger transport by road	12.1.1	Hairdressing salons and personal grooming establishments
07.3.5	Combined passenger transport	12.1.2-3	Electrical appliances for personal care and other appliances, articles and products
08.1	Postal services		

Source: Eurostat (2017).



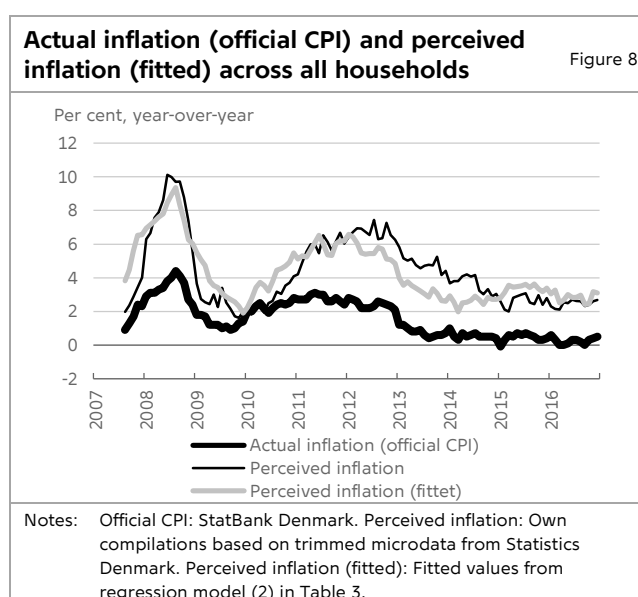
In Table 3 we explore to what extent the inflation perception bias can be attributed to the price concept that respondents have in mind when assessing inflation. Food accounts for around 12 per cent of the weighting basis of the official CPI whereas non-food FROOPP accounts for another 23 per cent. This is reflected in model (1) in Table 3, where we have regressed the annual inflation rate according to the official CPI on the subindices for food, non-food FROOPP and non-FROOPP items (also according to the official CPI). In model (2), we have replaced the official CPI with the average perceived inflation level from the CES survey data as the response variable. The results illustrate that households put a substantially larger weight on the development in food prices than the official CPI whereas the price development on non-food FROOPP seems not to have any significant impact on households' inflation perception. The relatively large and significant constant term confirms the impression from Figure 6 that households in general perceive inflation to be higher

than the actual inflation level for all main subgroups of the official CPI. The fitted values from model (2) are shown in Figure 8. Overall, the results in model (2) seem to confirm the findings in Arioli *et al.* (2016, 2017) that the households' pay huge attention to the prices on FROOP purchases such as food, but that this cannot fully explain the inflation overestimation gap.

TABLE 3. Actual and perceived inflation – summary regressions

Explanatory variable	Response variable					
	Model (1)		Model (2)		Model (3)	
	Actual inflation (official CPI)		Perceived inflation		Perceived inflation	
	Parameter estimate	Robust standard error	Parameter estimate	Robust standard error	Parameter estimate	Robust standard error
Constant	0.002441	0.002560	2.7024	0.3557***	2.6567	0.4096***
<i>Sub-components of official CPI</i>						
Food	0.1217	0.001384***	0.4859	0.08759***	0.4888	0.08353***
Non-food FROOPP	0.2287	0.001720***	-0.009769	0.1796	-0.03308	0.1868
Non-FROOPP goods and services	0.6493	0.003867***	0.5342	0.4062	0.6106	0.5077
House price inflation					0.01177	0.04456
Memo:						
Adjusted R-squared	0.9998		0.6633		0.6608	
Number of observations	113		113		113	

Notes: Sample period 2007m8-2016m12. Inflation measures year-over-year in percentage points. The price index for non-food goods and services is compiled by the authors using the relevant weights and price indices from the official CPI. OLS estimation. Heteroscedasticity and autocorrelation consistent standard errors. \*, \*\* and \*\*\* denote rejection of the null hypothesis that the estimated parameter is zero at respectively a 10, 5 and 1-per-cent significance level. Estimated via Gretl.



Translated from Danish into English, the wording of the question on inflation perception applied in the Danish CES survey is as follows: "By how many per cent do you think that prices have gone up/down over the past 12 months?". This phrasing might be seen as more general with respect to the price concept than the wording in the English version of the question of the EU-Harmonised Survey ("By how many percent do you think that consumer prices have gone up/down over the past 12 months?"). Döhring and Mordonu (2007) suggest that house prices might contribute to the inflation perception of households. In model (3) in Table 3, we have therefore tried to expand model (2) with the nationwide house price index. The house price inflation coefficient is not statistically different from zero at any conventional significance level. The high level of perceived inflation of the households seems therefore not to be related to developments in house prices.

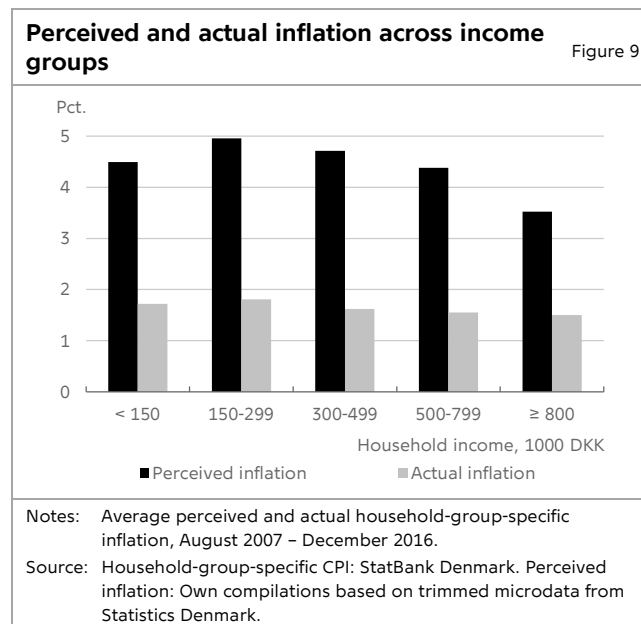
The findings from Table 3 are confirmed by household-group-level regressions, where we account for household-group-specific inflation developments, cf. Table 4. House prices are not significant for any of the 18 household groups, whereas food prices are very significant in all of the regressions. The constant term tends to be lower for high income earners. However, the relatively limited variation in the constant term (from 1.9 to 3.9 per cent per annum) across all household groups is notable. This indicates that the inflation overestimation bias is very broad-based, cf. also Figure 9.

TABLE 4. Perceived inflation – regressions by household groups

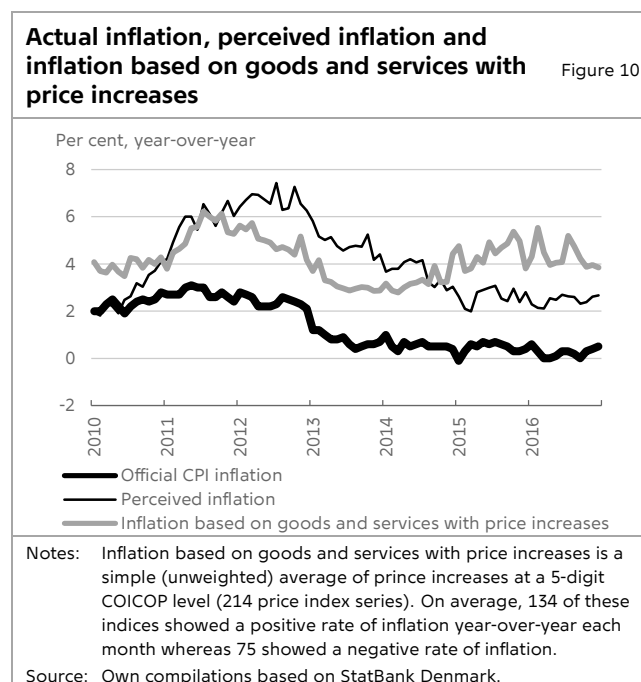
Household group	Explanatory variable – Parameter estimate (robust standard error)				
	Constant	Sub-components of household-group-specific CPI		House price inflation	Adjusted R-squared
		Food	Non-food goods and services		
Single persons under 60 years without children	2.7907*** (0.3643)	0.3779*** (0.1069)	0.4763 (0.3058)	-0.006086 (0.03582)	0.5984
Single persons over 60 years without children	3.3694*** (0.4314)	0.5723*** (0.07343)	0.1467 (0.1689)	-0.03504 (0.04333)	0.5922
Single persons with children	3.5215*** (0.3518)	0.4970*** (0.08929)	0.4274* (0.2562)	0.03393 (0.04100)	0.5458
2 adults without children, household head under 60 years	2.6481*** (0.3365)	0.4956*** (0.1072)	0.3173 (0.2238)	0.0001136 (0.03347)	0.6231
2 adults without children, household head over 60 years	2.8770*** (0.4052)	0.4844*** (0.09224)	0.3312 (0.2463)	-0.05111 (0.03962)	0.6413
2 adults with children	2.4594*** (0.3652)	0.4797*** (0.09486)	0.5436* (0.3059)	0.01516 (0.03859)	0.6666
Self-employed	2.0019*** (0.3701)	0.5958*** (0.1217)	0.2075 (0.3118)	0.03624 (0.04038)	0.5413
Employees - upper level	1.9232*** (0.4036)	0.4309*** 0.09141	0.4927* (0.2670)	0.004548 (0.03772)	0.6323
Employees - medium level	2.6741*** (0.3785)	0.4697*** (0.1021)	0.3937 (0.2881)	-0.005294 (0.04070)	0.6072
Employees - basic level	3.1569*** (0.3356)	0.4743*** (0.1045)	0.4307 (0.2620)	-0.01338 (0.03821)	0.6360
Receiving education	2.9689*** (0.3498)	0.3720*** (0.08775)	0.3540 (0.2886)	-0.01606 (0.03447)	0.4938
Pensioners and early retirement	3.3487*** (0.4589)	0.5373*** (0.07524)	0.2392 (0.2260)	-0.05437 (0.04283)	0.6332
Other not economically active (excl. unemployed)	3.9469*** (0.3240)	0.3389*** (0.1244)	0.7707** (0.3114)	-0.001229 (0.03428)	0.4526
Income under 150,000 DKK	3.5414*** (0.4235)	0.4804*** (0.1064)	0.0002266 (0.2451)	-0.005633 (0.033490)	0.4759
Income 150,000-299,999 DKK	3.3898*** (0.4256)	0.4847*** (0.07662)	0.3259 (0.2421)	-0.03052 (0.04397)	0.5928
Income 300,000-499,999 DKK	3.2291*** (0.3931)	0.4908*** (0.09722)	0.3228 (0.2558)	-0.02372 (0.03891)	0.6314
Income 500,000-799,999 DKK	2.7991*** (0.3471)	0.4901*** (0.1020)	0.4065 (0.2600)	-0.001694 (0.03633)	0.6484
Income 800,000 DKK or over	1.9700*** (0.3719)	0.4843*** (0.09717)	0.4073 (0.2850)	0.02928 (0.03899)	0.6472

Notes: OLS estimation. Heteroscedasticity and autocorrelation consistent standard errors. \*, \*\* and \*\*\* denote rejection of the null hypothesis that the estimated parameter is zero at respectively a 10, 5 and 1-per-cent significance level. 113 observations in all regressions. Estimated via Gretl.





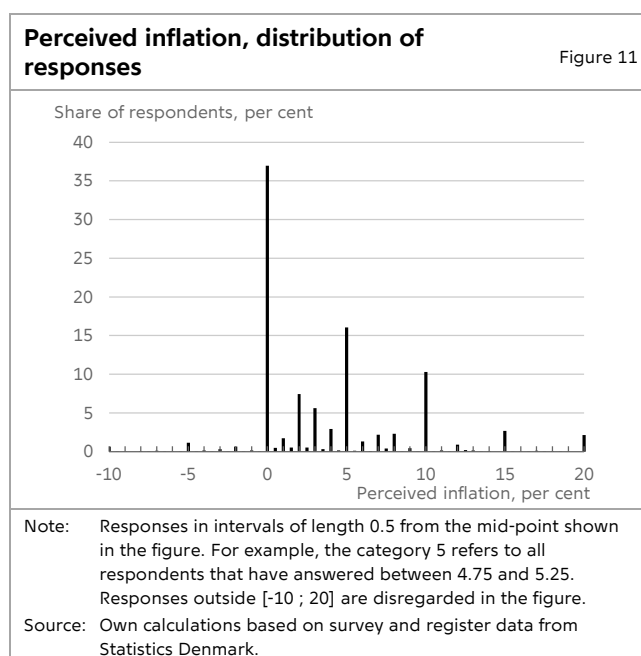
Earlier research has suggested that households pay more attention to price increases than price decreases, which might partly explain the inflation perception bias, cf. also Figure 10. There might be a psychological difference between facing price increases and price decreases, which is consistent with the line of reasoning behind loss aversion within behavioural economics (Kahneman and Tversky, 1984).



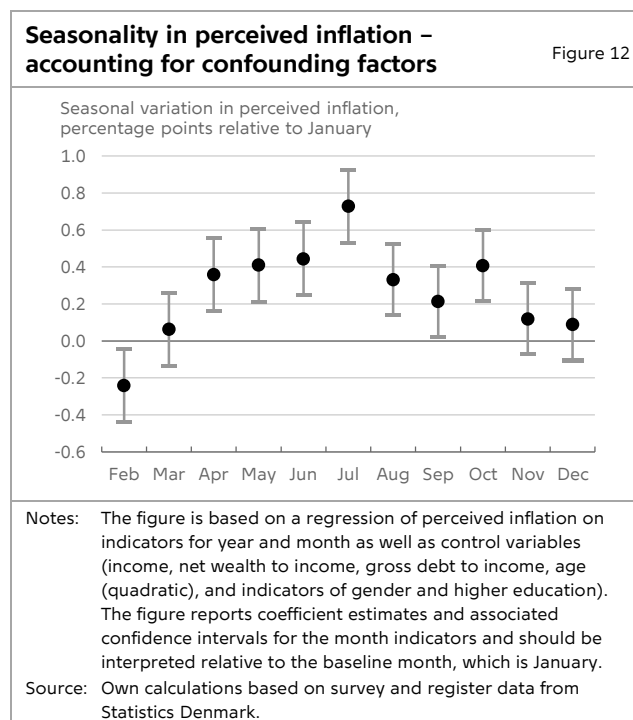
#### 4. Inflation perception and household characteristics – a closer look at the microdata

The results in Section 3 indicate that overestimation of inflation is a very broad-based characteristic across household groups. To assess whether important heterogeneities exist, e.g. within household groups, we take a closer look at the microdata from the CES survey. Statistics Denmark is, as mentioned in Section 2, able to merge survey results with administrative registers. We can therefore obtain precise measures of e.g. income and balance sheet variables at the household level for all participants in the survey.

As a starting point, we consider the distribution of responses to the question on perceived inflation. We note that most households answer in round numbers when asked to assess the current level of inflation, and also that many households seem to vastly overestimate actual inflation (which on average has been 1.6 per cent over the sample period), cf. Figure 11.

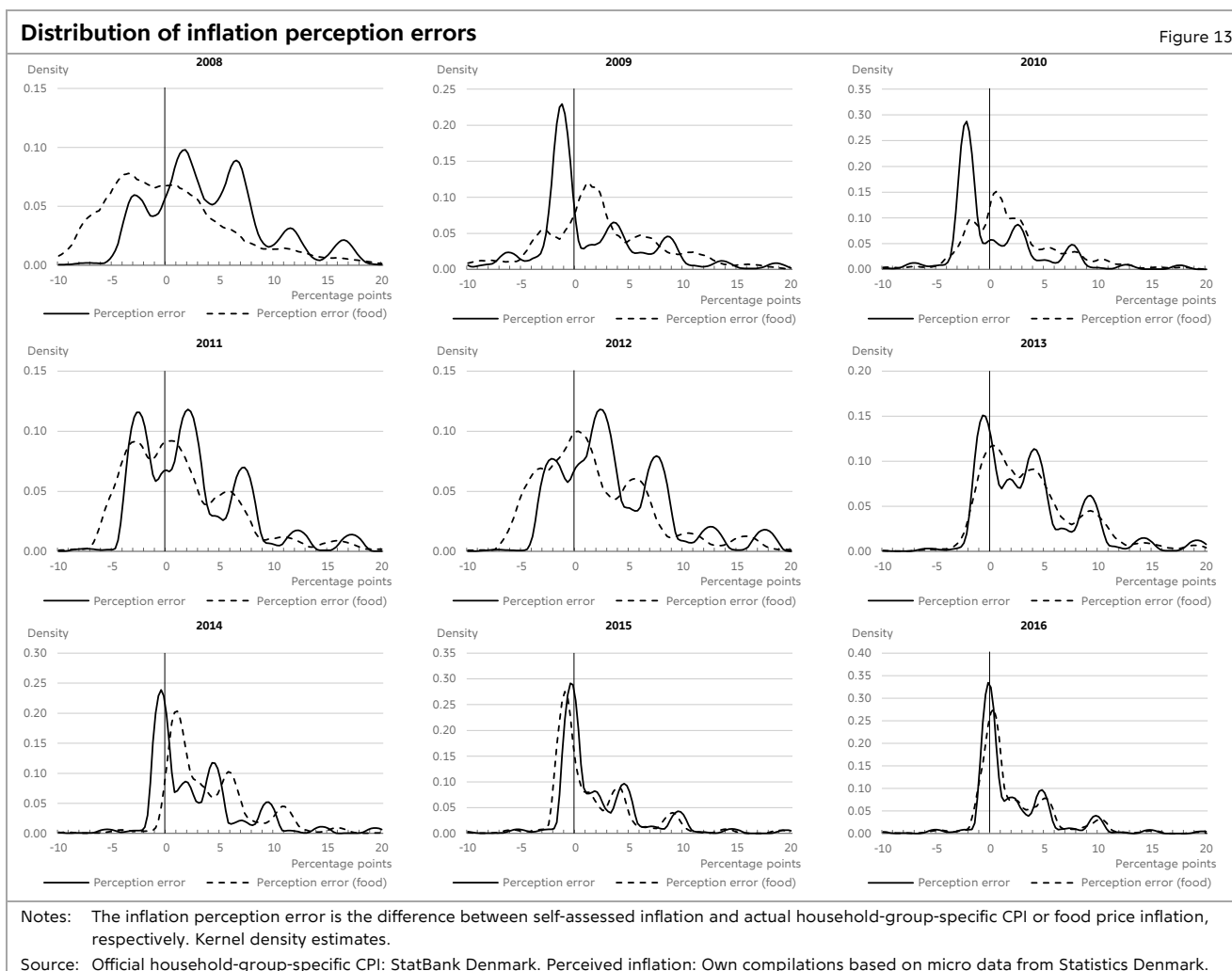


There is also a clear seasonal variation in inflation perception, cf. Figure 12. Respondents on average perceive the level of inflation to be almost 1 percentage point higher in July than in February. This might reflect a tradition for major sales early in the year (January/February) and an impression of high prices during holiday periods (July and October). It could also simply reflect that people spend more money during holidays and therefore think that goods and services have become more expensive.



For a given household, we define the inflation perception error as the difference between self-assessed inflation and actual household-group-specific inflation over the 12 months before the survey date. We only have access to household-group-specific inflation rates – not household-level inflation rates. Since the household groups used are overlapping, cf. Table 1 in Section 3, we have chosen to use household-group-specific inflation by household income level as the measure of 'true' inflation for a given household. As we found in the previous section, some households may have food prices in mind when answering questions regarding price developments. We have therefore also defined an alternative measure of inflation perception error as the difference between self-assessed inflation and actual household-group-specific food price inflation.

The tendency for inflation perceptions to be above actual inflation seems to be primarily driven by a fat tail of households that overestimate inflation quite significantly, cf. Figure 13. The spikes around (just below) 0 in most of the figures reflect the significant share of respondents that believe prices have been unchanged over the past 12 months, cf. Figure 11. Average CPI inflation in the sample period was, as mentioned, 1.6 per cent, so respondents believing that prices were unchanged will typically be assigned a somewhat negative inflation perception error.



Following up on our previous hypothesis that households pay more attention to certain consumption items, in particular food, we see that perception errors calculated on the basis of household-group-specific food CPI inflation are generally more symmetrically distributed around 0 than perception errors based on overall group-specific CPI inflation in times when there are large differences between the two types of inflation (e.g. the period 2008-10, cf. Figure 7). In 2008, where differences between food CPI and overall CPI inflation were the largest, the average perception error based on food price inflation was 0.1, whereas it was 3.9 based on overall CPI. In periods with smaller differences between food price inflation and overall inflation (e.g. the years 2015-16), the two measures are nearly identical. In line with our previous findings, this suggests that households place a larger than proportional weight on food price inflation when asked about price changes. This conclusion is further underlined by the results presented in Table 5. Here, we use our micro-level dataset to replicate the results from Table 3, which were based on aggregate time series data. In line with the macro-based results, the micro-based results in Table 5 indicate that households put a substantially larger weight on the development in food prices than the official CPI, and that house price inflation can explain the level of perceived inflation only to a very limited extent.

TABLE 5. Actual and perceived inflation – aggregate and micro level regressions

Explanatory variable	Response variable					
	Model (1)		Model (2)		Model (3)	
	Actual inflation (official CPI)		Perceived inflation		Perceived inflation	
	Parameter estimate	Robust standard error	Parameter estimate	Robust standard error	Parameter estimate	Robust standard error
<i>Sub-components of official CPI</i>						
Food	0.1217	0.0014***	0.4943	0.0095***	0.4980	0.0096***
Non-food FROOPP	0.2287	0.0017***	-0.0203	0.0206	-0.0493	0.0231**
Non-FROOPP goods and services	0.6493	0.0039***	0.5719	0.0428***	0.6656	0.0542***
House price inflation					0.0145	0.0052***
Memo:						
Adjusted R-squared	0.9998		0.0887		0.0888	
Number of observations	113		84,343		84,343	

Notes: Model (1) is similar to model (1) in Table 3, which is based on aggregate time series data. Model (2) and (3) are based on individual-level responses to survey questions about perceived inflation merged with data from administrative registers. Sample period 2007m8-2016m12. Inflation measured year-over-year in percentage points. The price index for non-food goods and services is compiled by the authors using the relevant weights and price indices from the official CPI. OLS estimation. \*, \*\* and \*\*\* denote rejection of the null hypothesis that the estimated parameter is zero at respectively a 10, 5 and 1 per cent significance level. Control variables in models (2) and (3): Income, net wealth to income, gross debt to income, age (quadratic), and indicators of gender and higher education.

To get a step closer to characterizing the households in the upper tail (i.e. households with particularly high inflation perception errors), Table 6 compares the characteristics of two groups of households. The first is households with inflation perception errors close to 0, and the second is households with inflation perception errors larger than 5 percentage points.

A number of interesting findings emerge. First, we find patterns similar to those previously found in the literature regarding e.g. income and gender (Arioli *et al.*, 2016, 2017). Respondents from lower-income families as well as women and respondents without higher education are overrepresented in the group of respondents with high inflation perception errors. The same is the case for respondents from households with lower net wealth as well as tenants. These latter results might indicate that there is a certain degree of 'rational attention' to inflation levels, i.e. those individuals to whom inflation matters more are more knowledgeable about inflation. However, this cannot explain for instance the gender gap. There is almost no difference in the age composition of the two groups, so differences cannot be ascribed to households being in different life cycle phases. A related hypothesis could be that respondents in households that have recently moved or become parents may be more aware of price developments since such life events may be

associated with large out of pocket expenses. This effect seems relevant although differences between the two groups in Table 6 are not large.

One could also expect that individuals buying larger consumption items (e.g. durables) or investing in e.g. real estate are more informed about actual inflation levels and the broader macroeconomic situation than other individuals. This hypothesis is partly confirmed since a smaller fraction of households with high inflation perception errors purchased real estate in the survey year. However, there is no difference in the share of households that bought a car. Relatedly, we investigate whether there is a difference in the inflation perception errors of more versus less impatient households. We find that the median consumption-to-income ratio is only slightly higher for households with high inflation perception errors.

TABLE 6: Characteristics of households with low and high inflation perception errors

	Inflation perception error	
	Between -2 and +2 pct. points	> 5 pct. points
After-tax income (DKK, median)	430,169	375,418
Gross debt to income (% , median)	206.1%	194.7%
Net wealth to income (% , median)	143.0%	104.0%
Household has negative net wealth (share)	23.5%	27.9%
Loan-to-value ratio (only homeowners, median)	65.7%	68.0%
Consumption to income (% , median)	93.8%	95.8%
Age (years, median)	48	49
Higher education (share)	35.0%	25.9%
Women (share)	47.5%	56.0%
Tenants (share)	29.3%	34.0%
Self-employed (share)	7.9%	6.9%
Household has unemployed adult members (share)	6.5%	8.1%
Household has moved during past 3 years	17.8%	16.7%
Household got children during past 3 years	9.2%	8.2%
Bought or sold real estate (share)	5.6%	4.1%
Bought a car (share)	22.3%	22.0%
Household has interest only mortgage loan (share)	44.6%	46.6%
Household has variable rate mortgage loan (share)	60.5%	60.4%
Household owns stocks and mutual fund shares > 50,000 DKK (share)	22.0%	15.2%
Respondent employed within finance (share)	4.4%	2.8%
Respondent employed within business services (share)	10.5%	8.3%
Respondent employed within information and communication (share)	4.1%	2.7%
Respondent employed within retail trade (share)	6.3%	7.5%
Respondent employed in public sector (share)	35.8%	40.9%
North Jutland Region	10.7%	10.9%
Middle Jutland Region	24.4%	22.4%
Southern Region	22.4%	22.4%
Capital Region	28.4%	28.4%
Region Zealand	14.1%	15.9%
Optimists (own future financial situation) (share)	28.7%	26.0%
Pessimists (own future financial situation) (share)	9.7%	18.0%
Positive assessment of own current financial situation (share)	24.5%	19.6%
Negative assessment of own current financial situation (share)	15.0%	27.5%
Optimists (macroeconomic situation) (share)	40.4%	31.8%
Pessimists (macroeconomic situation) (share)	18.0%	30.4%
Optimists (aggregate unemployment) (share)	34.4%	22.2%
Pessimists (aggregate unemployment) (share)	29.1%	43.6%
Thinks now is a good time to purchase durables (share)	18.9%	17.6%
Thinks it is better to postpone purchasing durables (share)	22.4%	33.5%
Inflation expectation error (percentage points, trimmed mean)	1.57	6.99
Has inflation expectation error between -2 and +2 pct. points (share)	64.9%	17.3%
Has inflation expectation error > 5 pct. points (share)	2.9%	51.8%
Number of observations	37,895	22,599

Notes: Inflation perception error is defined as the difference between self-assessed inflation and actual household-group-specific inflation over 12 months before the survey date. The household-group-specific inflation rates used are those based on household income. Income, net wealth, gross debt, loan-to-value ratio, consumption, self-employed, loan characteristics as well as car and house purchase are measured at the household level, while remaining characteristics and responses are those of the respondent. Consumption is imputed as in Abildgren *et al.* (2018).

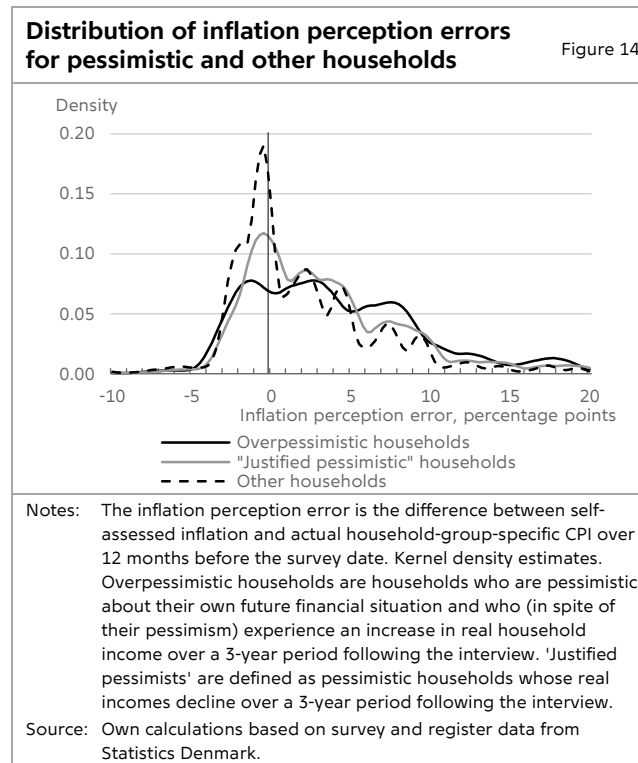
A clearer result is that stock-market participants are more likely to have low inflation perception errors. Respondents employed within finance and business services might be expected to be more knowledgeable about inflation to the extent that it is directly relevant for their work. Also, employees in the retail trade sector could be expected to be more knowledgeable about prices because they may be exposed to price developments on a daily basis. Furthermore, employees in the retail distribution sector might get a discount on purchases, which could give them an extra incentive to follow the price development. Respondents working within information and communication may also have a more accurate assessment of inflation since they may be more informed in general about societal matters and notice news to a larger extent than people working in other industries. With the exception of retail trade employees, these hypotheses are confirmed. Employees within retail trade are overrepresented in the group of households with high perception errors. This finding could, in principle, be the result of employees within retail trade placing a larger weight on food prices when assessing inflation, but supplementary results (not reported for brevity) indicate that this is not the case, since these individuals also tend to be overrepresented in the group of households that overestimate inflation when food prices are used as the benchmark.

Next, we consider respondents' answers to other survey questions. Interestingly, a distinctive feature of the households with high inflation perception errors is that they are much more pessimistic than households with lower perception errors. A larger share of households with high inflation perception errors thinks that it is better to postpone purchases of durable goods. Also, both when assessing households' own financial situation currently and in the future as well as the general macroeconomic situation and the expectations for the unemployment rate, a larger share of the households that overestimate inflation are pessimistic compared to the group of households with smaller perception errors. And conversely, fewer of these households are optimistic. These results confirm the findings by Ehrmann *et al.* (2017).

A number of hypotheses may be relevant in this context. For example, pessimism might represent a fundamental personality trait, implying that pessimistic households have a general negative response bias in all questions in which an assessment is demanded, irrespective of whether their pessimism is 'justified'. Alternatively, pessimism might reflect unobserved factors at the household level, for example uncertainty, that also impact the assessment of price changes or expectations. To test whether personality traits are important, we split pessimistic households into two groups, namely overpessimists and 'justified' pessimists. Following an approach similar to Abildgren, Hansen and Kuchler (2018), we utilize the time series dimension of our data to define overpessimists as households who are pessimistic about their own future financial situation and who (in spite of their pessimism) experience an increase in real household income over a 3-year period following the interview. 'Justified pessimists' are defined as pessimistic households whose real incomes decline over a 3-year period following the interview. Pessimists do indeed have a tendency to overestimate inflation relative to other respondents, cf. Figure 14. This is particularly



so for overpessimistic households, indicating that fundamental personality traits may play a role in the accuracy of inflation perceptions.



Many of the characteristics included in Table 6 may be correlated. To complement these bivariate analyses, Table 7 reports the results from regressing inflation perception error on a range of background variables. In general, the results confirm the bivariate relations suggested by Table 6. In line with our previously discussed results, we also note that the differences are not very large in magnitudes. For example, the difference between expected inflation perception errors for an average 30-year-old and an average 50-year-old is only around 0.2 percentage points, and a one standard deviation increase in household income decreases the inflation perception error by around half a percentage point. The regression results in Table 7 also confirm that pessimistic households indeed have larger forecast errors than other households, and that overpessimistic households have significantly larger forecast errors compared to 'justified pessimists'.

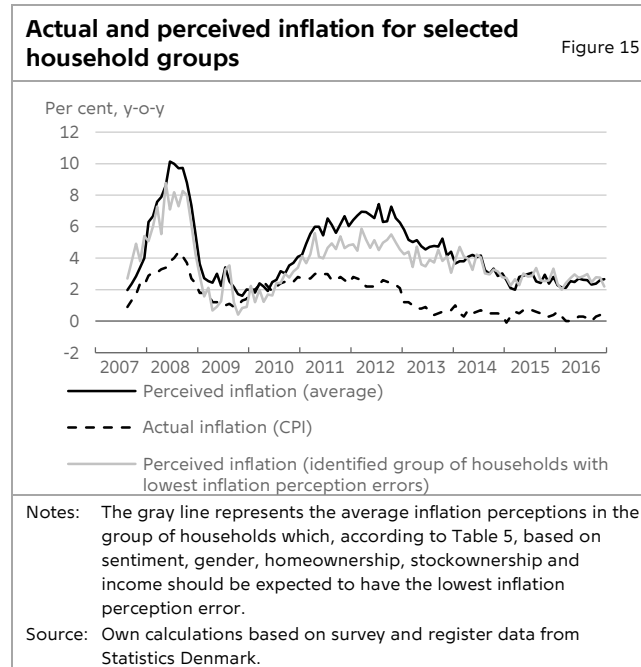
TABLE 7: Determinants of inflation perception error (regression results)

	(1)	(2)	(3)	(4)	(5)	(6)
Income	-0.0017*** (0.0001)	-0.0017*** (0.0001)	-0.0019*** (0.0001)	-0.0015*** (0.0001)	-0.0018*** (0.0001)	-0.0021*** (0.0002)
Net wealth to income	-0.0844*** (0.0064)	-0.0802*** (0.0063)	-0.0757*** (0.0068)	-0.0762*** (0.0063)	-0.0833*** (0.0067)	-0.0948*** (0.0082)
Gross debt to income	-0.0703*** (0.0092)	-0.0680*** (0.0090)	-0.0758*** (0.0102)	-0.0597*** (0.0090)	-0.0656*** (0.0102)	-0.0614*** (0.0119)
Age	-0.0425*** (0.0085)	-0.0392*** (0.0084)	-0.0449*** (0.0086)	-0.0392*** (0.0083)	-0.0382*** (0.0087)	-0.0584*** (0.0112)
Age squared	0.0006*** (0.0001)	0.0005*** (0.0001)	0.0006*** (0.0001)	0.0005*** (0.0001)	0.0005*** (0.0001)	0.0007*** (0.0001)
Higher education	-0.7811*** (0.0501)	-0.7868*** (0.0489)	-0.7546*** (0.0500)	-0.7768*** (0.0487)	-0.7871*** (0.0508)	-0.8124*** (0.0653)
Woman	1.2895*** (0.0448)	1.2997*** (0.0437)	1.3074*** (0.0448)	1.2674*** (0.0436)	1.3040*** (0.0453)	1.4437*** (0.0582)
Borrower			0.1666** (0.0692)			
Purchased real estate			-0.3961*** (0.1219)			
Purchased a car			0.0364 (0.0529)			
Consumption to income				-0.0432 (0.0360)		
Optimistic					0.0329 (0.0516)	
Pessimistic					1.7540*** (0.0694)	1.4064*** (0.1257)
Increase in real income						-0.0295 (0.0645)
Overpessimistic (Pessimistic * Increase in real income)						0.7203*** (0.1525)
Year fixed effects	No	Yes	Yes	Yes	Yes	Yes
No of obs.	84,343	84,343	79,709	79,729	83,758	52,957
R sq	0.0205	0.0677	0.0692	0.0662	0.0747	0.0863

Notes: OLS estimation. \*, \*\* and \*\*\* denote rejection of the null hypothesis that the estimated parameter is zero at respectively a 10, 5 and 1 per cent significance level. The dependent variable is inflation perception error, defined as the difference between self-assessed inflation and actual household-group-specific inflation over 12 months before the survey date. Top and bottom 1 per cent in terms of income, net wealth to income and gross debt to income, as well as households with an absolute inflation perception error of more than 50 percentage points have been excluded from the estimation sample. The household-group-specific inflation rates used are those based on household income. Income, net wealth, gross debt, borrower, car and house purchase and consumption are measured at the family level, while age, gender education and sentiment are those of the respondent. Borrower refers to a household whose liabilities exceed its liquid financial assets. Consumption is imputed as in Abildgren et al. (2018). Due to properties of the imputation procedure, model (4) only includes households that are not involved in a real estate transaction in the given year, and top and bottom 1 per cent of households in terms of consumption to income are excluded from the estimation sample.

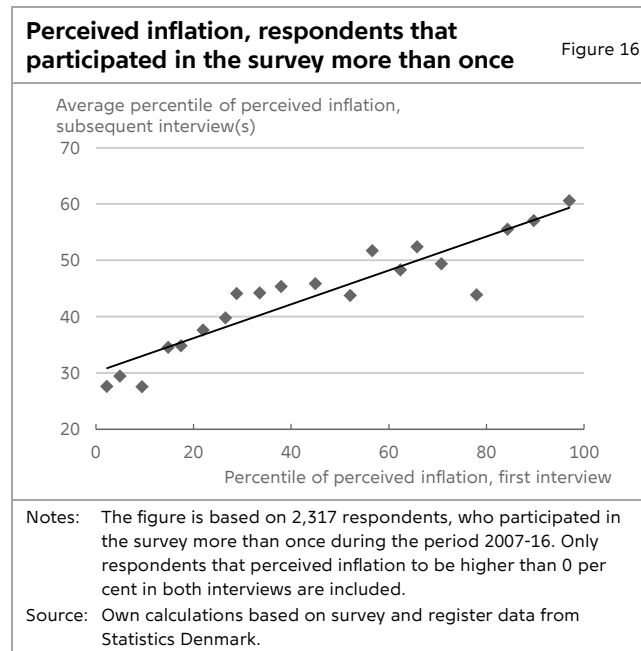
The results in Tables 6 and 7 indicate a correlation between the size of the inflation perception error and numerous household characteristics. However, these differences in socioeconomic characteristics across households are not enough to explain the general perception gap. Even in the group of households (based on sentiment, gender, homeownership, stockownership and

income) in which the lowest inflation perception errors are to be expected according to Tables 6 and 7, households vastly overestimate actual inflation levels in most years of our sample period, cf. Figure 15.



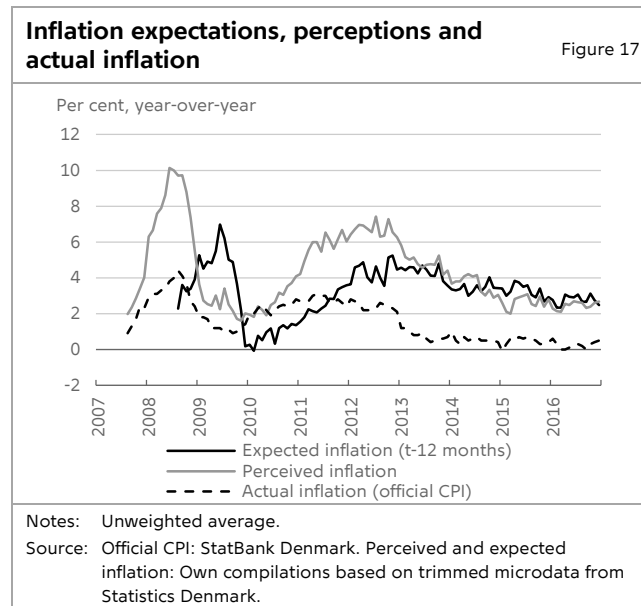
Based on 2,317 individuals that participated in the survey more than once, we also find individual overestimation bias to be persistent, cf. Figure 16. Respondents that reported a relatively high level of perceived inflation in an interview are also more likely to report a relatively high level of perceived inflation in subsequent interview rounds.<sup>1</sup> This is a further indication that inflation perception is closely related to fundamental personality traits.

<sup>1</sup> Similar results are found regarding the probability to report non-0 values for perceived inflation. 51 per cent of respondents that perceived inflation to be 0 per cent in their first interview also perceived inflation to be 0 per cent in the subsequent round(s), whereas that was the case for only 38 per cent of respondents that reported a non-0 value in their first interview.

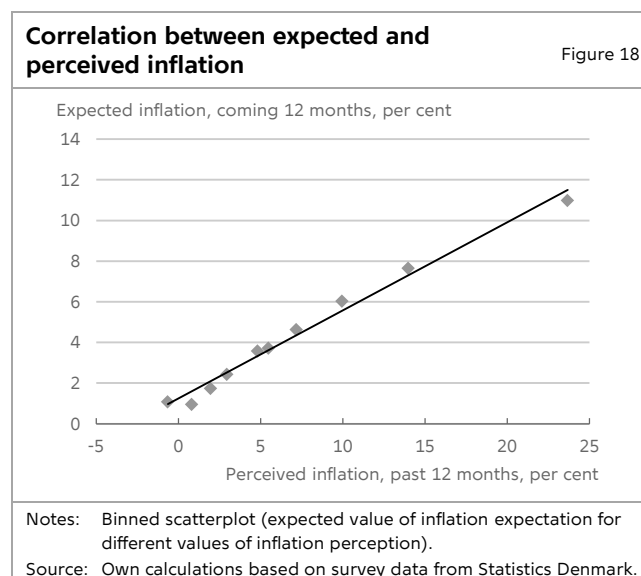


## 5. Inflation expectations and inflation perception

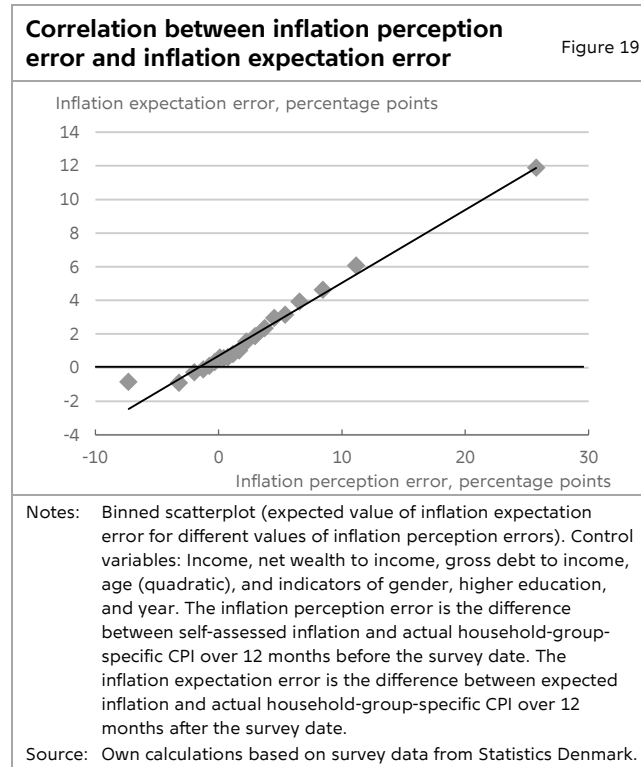
As summarized in Section 1, earlier research has found that inflation expectations are subject to biases similar to those at play for inflation perceptions. This is confirmed in our dataset. Except for two years, inflation expectations overshoot actual inflation throughout our sample horizon, cf. Figure 17. Furthermore, the level of average inflation expectations for the coming 12 months is generally quite comparable to the level of average perceived inflation over the past 12 months, although somewhat lower in most periods (note that the time stamp for expected inflation in Figure 17 is 12 months after the survey month to make it comparable to actual inflation developments). Hence, it seems that households on average expect the perceived level of current inflation to continue or decline slightly over the forecast horizon. In the remainder of this section, we will first show that this relationship between perceived and expected inflation is strongly present at the household level, cf. also Duffy and Lunn (2009) and Axelrod, Lebow and Peneva (2018). We will thereafter utilize this fact to evaluate whether households' assessment of changes in inflation (i.e. expectations conditional on the perceived level of inflation) is more accurate than the assessment of actual or expected inflation measured in levels. As a side point it might be noted that the inflation expectations in Figure 17 – taken at face value – do not seem to indicate that fear of deflation has been widespread among the households during the downturn that followed the global financial crisis.



First, we note that perceived and expected inflation are highly correlated at the household level, cf. Figure 18. To further assess the properties and implications of this correlation, we define the inflation expectation error as the difference between survey reported expected inflation and actual household-group-specific CPI inflation over a forward-looking 12-month horizon (not overall CPI as used in Figure 17). We refer to this measure as the inflation expectation error, even though it might not be thought of as an error in the same way as the inflation perception error. Even a household that may have used all available information at the time of the survey to make the best possible forecast may find itself ending up with a non-zero inflation expectation error *ex post* due to random variation or e.g. new information emerging over the forecast horizon.



We regress the inflation expectation error on the inflation perception error, controlling for a number of background characteristics such as income, age, balance sheet position, education and gender. Even after accounting for the influence of these socioeconomic background characteristics on inflation expectations, the inflation perception error is a very strong predictor of the inflation expectation error, cf. Figure 19.



The strong correlation between inflation perception and inflation expectations may suggest that households base their inflation expectations on perceived inflation, or at least that respondents most likely have the same price concept in mind when assessing actual and future inflation. This implies that it might be informative to interpret the level of households' inflation expectations *relative* to the perceived level of inflation. In other words, the difference between households' inflation expectations and perception may be more informative than the level of inflation expectations *per se*.

Let us define the expected change in inflation as the difference between expected inflation for the coming 12 months and perceived inflation over the past 12 months:

$$\Delta\pi_{t+1}^e = \pi_{t+1}^e - \pi_t^p. \quad (1)$$

The observed (actual) change in the inflation rate is given by:

$$\Delta\pi_{t+1}^o = \pi_{t+1}^o - \pi_t^o. \quad (2)$$

The expectation error in terms of the change in inflation rate is then:

$$\Delta\pi_{t+1}^e - \Delta\pi_{t+1}^o. \quad (3)$$

The average expected *change* in inflation rates (Figure 20 – left) is more comparable to the actual change in inflation than was the case when we compared the expected (and perceived) *level* of inflation to the actual level. In all but one year, interpreting inflation expectations in terms of changes yields more accurate predictions of actual inflation over the following year than interpreting expectations in terms of the level of inflation, cf. Table 8. Correspondingly, the distribution of expectation errors in terms of the change in the inflation rate (Figure 20 – right) is more symmetric and closer to having mean 0 than was the case for the distribution of inflation perception errors measured in levels. However, even if inflation expectations are more meaningfully interpreted when measured in changes than in levels, they are still not necessarily very accurate. The distribution of expectation errors for a naïve forecast of no change in the inflation rate would have a smaller standard deviation (1.2) than the distribution of actual forecast errors (3.2).

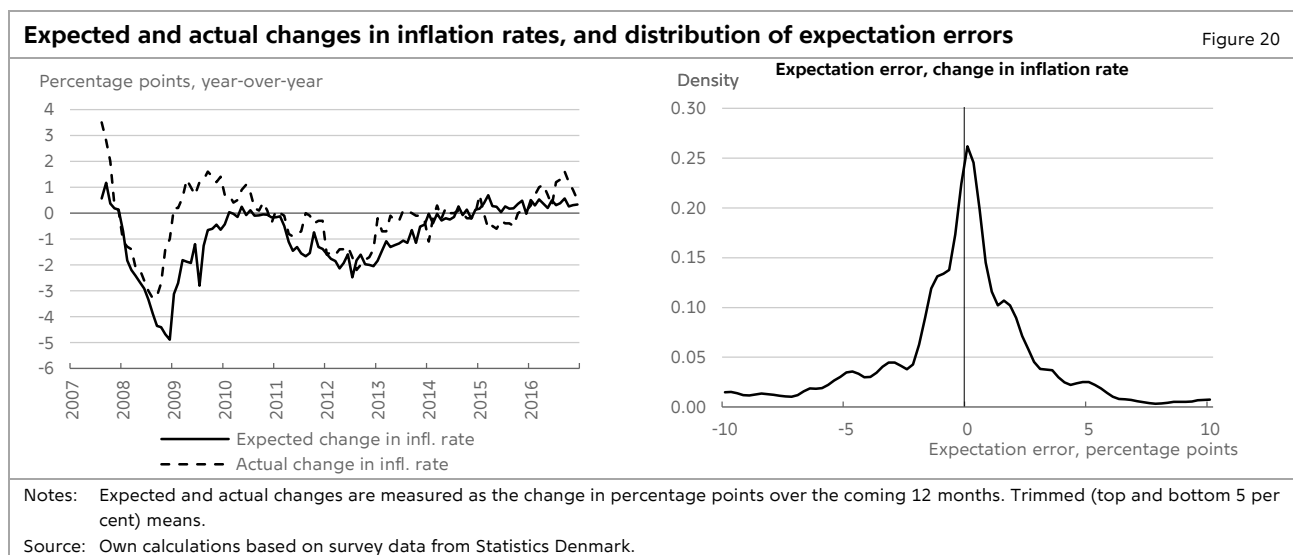


TABLE 8: RMSE for expected inflation levels and changes

	CPI		Food inflation	
	Level	Change	Level	Change
2008	7.07	4.48	7.88	7.32
2009	4.43	5.60	4.98	6.48
2010	4.81	4.56	5.18	5.25
2011	6.58	4.36	6.23	4.52
2012	6.97	4.04	7.21	4.77
2013	6.25	3.97	7.13	4.23
2014	5.63	3.77	5.35	3.88
2015	4.93	3.54	5.07	3.84
2016	4.71	3.32	4.40	3.97

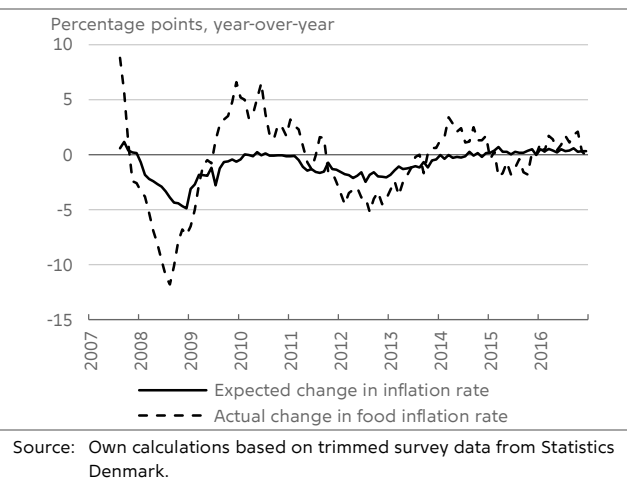
Notes: The table shows Root Mean Squared Errors (RMSE) for inflation expectations interpreted in levels and changes, respectively. The expectation error for the level of inflation is the difference between expected inflation and actual household-group-specific inflation over 12 months after the survey date. The expectation error for the change in inflation is the difference between expected change in inflation and actual household-group-specific change in inflation over 12 months after the survey date, as defined in equation (3). Top and bottom 5 per cent of expectation errors have been excluded from the calculations.

The mean expectation error with regard to changes in inflation is -0.7 percentage points. Restricting the focus to the years after 2011 in which the volatility of changes in inflation rates has been smaller reduces the mean expectation error to -0.3. We can also compare expected changes in inflation rates with changes in food price inflation. Changes in food price inflation have been larger than changes in the CPI – in particular in the beginning of our sample period. The magnitude of inflation changes is not picked up by expected changes in inflation, but developments are picked up to a large extent, cf. Figure 21. When comparing expected changes in inflation with changes in food price inflation, the mean expectation error is smaller than the mean expectation error based on the CPI, namely -0.5 (-0.3 in the period after 2011). But the variability of expectation errors is larger when comparing with food price inflation than when comparing with the CPI, cf. Table 8 and Figure 22.



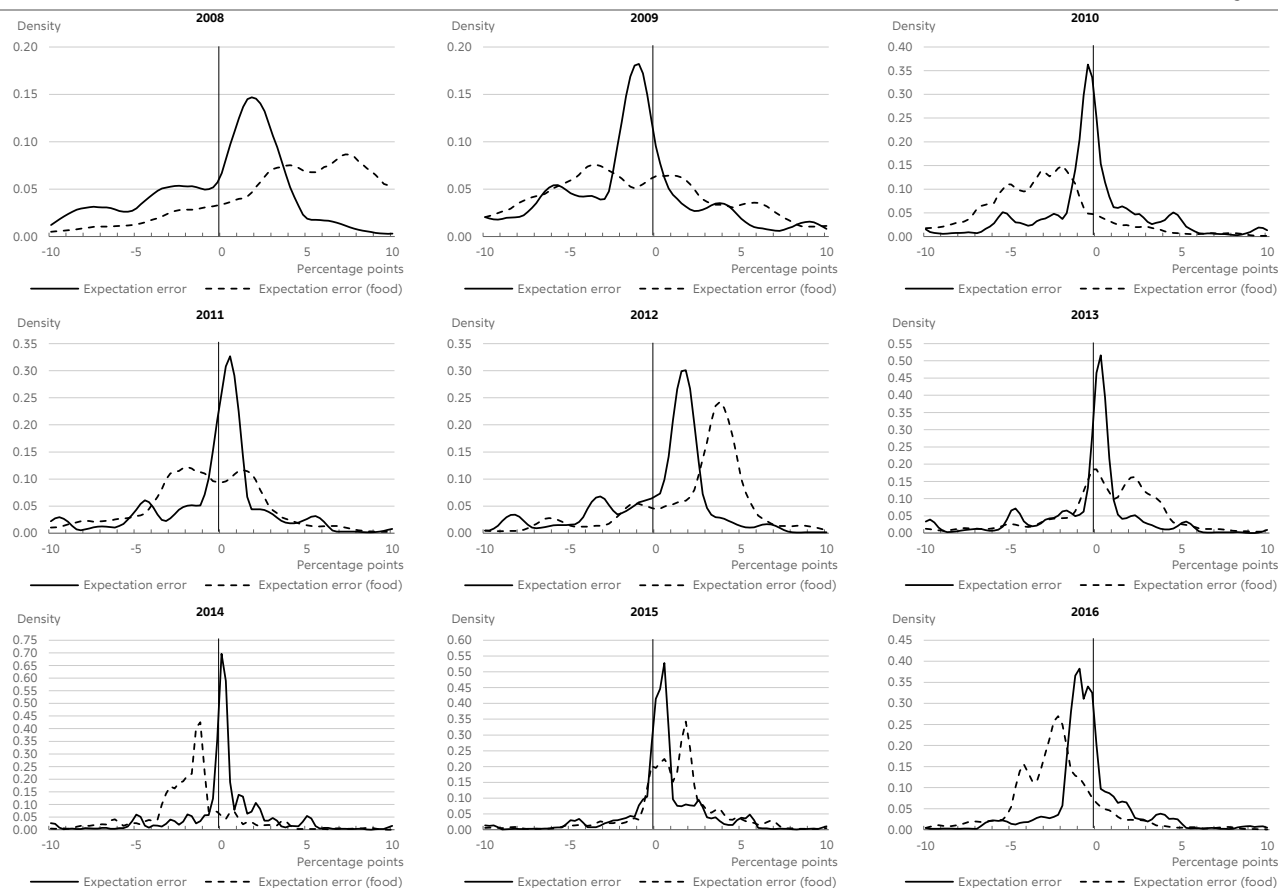
**Expected change in inflation and actual change in food price inflation**

Figure 21



**Distribution of expectation errors for change in inflation**

Figure 22

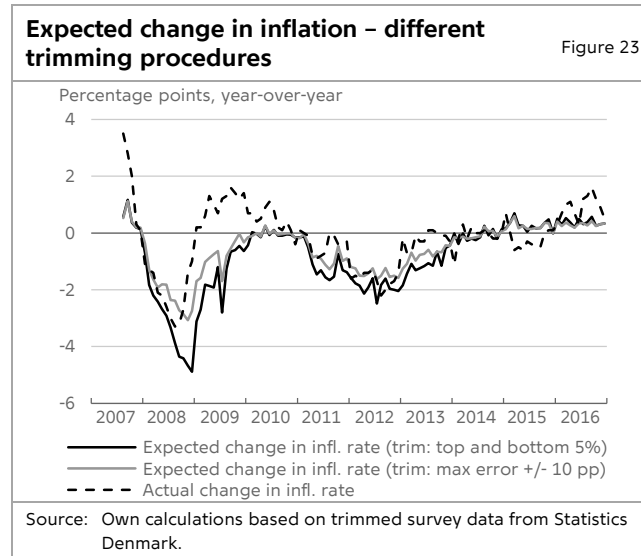


Notes: Kernel density estimates.

Source: Official household-group-specific CPI: StatBank Denmark. Perceived inflation: Own compilations based on micro data from Statistics Denmark.

The distribution of forecast errors with regard to changes in CPI is somewhat right skewed because of more households expecting a decline in the inflation rate than the opposite. The mean expectation in Figure 20 is based on trimmed data, where we have removed top and bottom 5 per

cent of expected changes in each month. This symmetric trimming procedure seems to be the most reasonable since no assumptions about 'reasonable' maximum or minimum values for inflation changes are needed. Using an alternative trimming approach that drops households expecting a change in the inflation rate outside the range between -10 and +10 percentage points makes expected and realized changes in inflation rates coincide somewhat more, cf. Figure 23.



The results above indicate that survey results regarding expected inflation are more meaningfully interpreted relative to perceived inflation rather than in levels. A corollary to this finding is that one should be very careful in using the levels of expected inflation from the EU-Harmonised Consumer Expectations Survey in empirical works.

To assess whether, and how, households adjust their inflation expectations in response to recent inflation developments, we estimate the following relation:

$$\Delta\pi_{t+1}^e = \alpha + \delta(\pi_t^o - \pi_{t-1}^o) + \beta x + \varepsilon \quad (4)$$

where  $\pi_t^o$  is the inflation rate over the 12 months before the survey date and  $\pi_{t-1}^o$  is the inflation rate over the 12 months before that. We expect  $\alpha$  to be negative, since we know from the previous results that households in general expect inflation to become lower in the next period than their perceived inflation level in the current period. A positive value of  $\delta$  can be interpreted as an indication that households adjust their expectations in the same direction as recent developments in inflation, whereas a negative value of  $\delta$  indicates mean reversion in inflation expectations. Results using respectively overall CPI inflation and food CPI inflation as independent variables are presented in Table 9. We do indeed find  $\alpha$  to be negative, and we also see that  $\delta$  is negative and significant. If inflation has recently increased, households expect this trend to reverse in the future, and if inflation has recently decreased, households to a larger extent than in other periods expect that inflation will increase in the future. This mean reversion is an indication that households' inflation expectations are well-anchored.

TABLE 9: Adjustment of inflation expectations in response to recent inflation developments (regression results)

	(1)	(2)
Change in inflation	-0.1528*** (0.0158)	
Change in food price inflation		-0.0227*** (0.0050)
Constant	-1.2418*** (0.1569)	-0.7660*** (0.1570)
No of obs.	77,375	77,375
R sq	0.0069	0.0171

Notes: OLS estimation of equation (4). \*, \*\* and \*\*\* denotes rejection of the null hypothesis that the estimated parameter is zero at respectively a 10, 5 and 1-per-cent significance level. The dependent variable is the expected change in inflation,  $\Delta\pi_{t+1}^e$ . Top and bottom 1% in terms of income, net wealth to income and gross debt to income, as well as households with an absolute inflation perception error of more than 50 percentage points have been excluded from the estimation sample. Actual change in inflation and food price inflation are household-group-specific, based on household income. Control variables: Income, net wealth to income, gross debt to income, age (quadratic), and indicators of gender, higher education, and year.

As a final exercise, we will consider the extent to which forecast errors for changes in inflation vary with household characteristics. Generally, forecast errors for changes in inflation seem to vary less with household characteristics than inflation perceptions, cf. Table 10. However, some dimensions, such as education and gender, are still important determinants of forecast errors for changes in inflation. Regression results in Table 11 broadly confirm this picture; the accuracy of forecasted changes in inflation is higher among males and increases with household income and education, as also found by previous studies (e.g. Souleles, 2004). We also find that the accuracy increases with wealth, but there is no significant correlation between the forecast error for the change in inflation and consumption-to-income ratios.

TABLE 10: Characteristics of households with low and high forecast errors for change in inflation

	Forecast error, change in inflation		
	< -2 pct. points	Between -2 and +2 pct. points	> 2 pct. points
After-tax income (DKK, median)	371,983	421,446	415,234
Gross debt to income (% , median)	191.2%	204.7%	207.4%
Net wealth to income (% , median)	119.7%	134.8%	129.3%
Household has negative net wealth (share)	26.2%	24.1%	25.1%
Loan-to-value ratio (only homeowners, median)	65.5%	66.7%	66.8%
Consumption to income (% , median)	95.9%	94.1%	95.1%
Age (years, median)	49	49	48
Higher education (share)	25.9%	34.3%	31.3%
Women (share)	56.8%	48.5%	45.5%
Tenants (share)	33.3%	30.1%	29.6%
Self-employed (share)	7.3%	7.4%	8.2%
Household has unemployed adult members (share)	7.4%	7.1%	6.9%
Household has moved during past 3 years	16.7%	17.4%	17.8%
Household got children during past 3 years	8.3%	8.9%	9.3%
Bought or sold real estate (share)	4.4%	5.3%	5.2%
Bought a car (share)	21.9%	22.0%	23.1%
Household has interest only mortgage loan (share)	45.6%	44.8%	45.4%
Household has variable rate mortgage loan (share)	59.2%	61.0%	60.4%
Household owns stocks and mutual fund shares > 50,000 DKK (share)	16.2%	21.0%	18.6%
Respondent employed within finance (share)	2.8%	4.3%	3.8%
Respondent employed within business services (share)	8.8%	10.1%	9.3%
Respondent employed within information and communication (share)	2.8%	4.0%	3.9%
Respondent employed within retail trade (share)	7.5%	6.4%	6.9%
Respondent employed in public sector (share)	39.4%	36.5%	34.8%
North Jutland Region	11.2%	10.6%	11.1%
Middle Jutland Region	23.3%	23.9%	23.5%
Southern Region	22.8%	22.1%	23.2%
Capital Region	27.4%	29.2%	27.5%
Region Zealand	15.3%	14.2%	14.7%
Optimists (own future financial situation) (share)	27.1%	26.9%	29.2%
Pessimists (own future financial situation) (share)	12.9%	12.3%	12.8%
Positive assessment of own current financial situation (share)	20.9%	22.8%	25.2%
Negative assessment of own current financial situation (share)	21.9%	18.4%	17.7%
Optimists (macroeconomic situation) (share)	35.4%	39.0%	37.1%
Pessimists (macroeconomic situation) (share)	24.1%	19.9%	26.1%
Optimists (aggregate unemployment) (share)	26.1%	31.8%	28.9%
Pessimists (aggregate unemployment) (share)	39.7%	31.5%	37.7%
Thinks now is a good time to purchase durables (share)	18.7%	18.5%	23.1%
Thinks it is better to postpone purchasing durables (share)	32.2%	22.6%	27.1%
Number of observations	34,456	52,210	15,552

Notes: Income, net wealth, gross debt, loan-to-value ratio, consumption, self-employed, loan characteristics as well as car and house purchase are measured at the household level, while remaining characteristics and responses are those of the respondent. Consumption is imputed as in Abildgren *et al.* (2018).

TABLE 11: Determinants of absolute forecast error for change in inflation (regression results)

	(1)	(2)	(3)	(4)	(5)	(6)
Income	-0.0014*** (0.0001)	-0.0009*** (0.0001)	-0.0009*** (0.0001)	-0.0009*** (0.0001)	-0.0010*** (0.0001)	-0.0010*** (0.0001)
Net wealth to income	-0.0227*** (0.0047)	-0.0402*** (0.0046)	-0.0376*** (0.0050)	-0.0381*** (0.0047)	-0.0419*** (0.0049)	-0.0422*** (0.0061)
Gross debt to income	0.0171** (0.0068)	0.0126* (0.0066)	0.0069 (0.0075)	0.0102 (0.0066)	0.0145* (0.0075)	0.0162* (0.0089)
Age	-0.0272*** (0.0064)	-0.0534*** (0.0062)	-0.0548*** (0.0064)	-0.0550*** (0.0062)	-0.0545*** (0.0064)	-0.0597*** (0.0084)
Age squared	0.0001* (0.0001)	0.0005*** (0.0001)	0.0005*** (0.0001)	0.0005*** (0.0001)	0.0005*** (0.0001)	0.0005*** (0.0001)
Higher education	-0.5856*** (0.0370)	-0.5397*** (0.0361)	-0.5188*** (0.0368)	-0.5466*** (0.0361)	-0.5308*** (0.0375)	-0.5359*** (0.0488)
Woman	0.3752*** (0.0332)	0.3868*** (0.0324)	0.4096*** (0.0331)	0.3930*** (0.0325)	0.3941*** (0.0335)	0.4427*** (0.0436)
Borrower			0.1050** (0.0512)			
Purchased real estate			-0.0927 (0.0894)			
Purchased a car			0.0644* (0.0391)			
Consumption to income				-0.0083 (0.0267)		
Optimistic					0.2766*** (0.0383)	
Pessimistic					0.1463*** (0.0516)	-0.0757 (0.0943)
Increase in real income						0.0240 (0.0483)
Overpessimistic (Pessimistic * Increase in real income)						0.1752 (0.1332)
Year fixed effects	No	Yes	Yes	Yes	Yes	Yes
No of obs.	81,195	81,195	76,732	76,708	80,728	51,128
R sq	0.0133	0.0612	0.0624	0.0602	0.0620	0.0459

Notes: OLS estimation. \*, \*\* and \*\*\* denote rejection of the null hypothesis that the estimated parameter is zero at respectively a 10, 5 and 1 per cent significance level. The dependent variable is the absolute value of forecast error for changes in inflation. Top and bottom 1 per cent in terms of income, net wealth to income and gross debt to income, as well as households with an absolute inflation perception error of more than 50 percentage points have been excluded from the estimation sample. The household-group-specific inflation rates used are those based on household income. Income, net wealth, gross debt, borrower, car and house purchase and consumption are measured at the family level, while age, gender, education and sentiment are those of the respondent. Borrower refers to a household whose liabilities exceed its liquid financial assets. Consumption is imputed as in Abildgren et al. (2018b). Due to properties of the imputation procedure, model (4) only includes households that are not involved in a real estate transaction in the given year, and top and bottom 1 per cent of households in terms of consumption to income are excluded from the estimation sample.

## 6. Survey design

Earlier research has suggested that the overestimation bias in the EU-Harmonised Consumer Expectations Surveys might be partly related to the use of open-ended questions (no guidance on the current or typical rate of inflation offered to the survey participants) and a lack of probing of

unusual replies (Biau *et al.*, 2010; Arioli *et al.*, 2016, 2017). The idea that guidance regarding e.g. current levels of inflation could be important for increasing the accuracy of inflation expectations has not been directly tested, but comes from comparison of surveys in which such guidance or probing of unusual replies is part of the questionnaire and surveys, such as ours, in which it is not. We can also not provide a direct test of the impact of providing guidance to respondents. But we do indeed see that households with a relatively accurate ( $\pm 2$  percentage points) perception of the current level of inflation do not overestimate future inflation to the same extent as households with less accurate perceptions of current inflation, cf. Figure 24. This suggests that knowledge of current inflation is important for the accuracy of expectations regarding future inflation, and thereby that implementing some form of guidance in survey questions could potentially reduce the widely observed positive bias in inflation expectations. Naturally, one needs to keep in mind that a too strong priming of the respondents might reduce the information value of the survey.



Earlier studies have also found that the precise wording of the questions asked can have implications for the level of inflation perception. Bruin *et al.* (2010) found for instance that asking about expected changes to "prices in general" yields on average higher inflation rates than asking about the "rate of inflation". Finally, as indicated by the analysis in the paper at hand, specification of the price concept to which the question refers seems also to be important.

As mentioned in Section 2, households in the EU-Harmonised Consumer Expectations Surveys are asked about their inflation perception in a two-step procedure. In the first step, they are asked a qualitative question: "How do you think that prices are today compared to one year ago". The possible answers are "Much higher", "Somewhat higher", "A little higher", "Unchanged", and "A little

lower". In the second step, conditional on not having answered "Unchanged", respondents are asked a quantitative question: "By how many per cent do think that prices have gone up/down over the past 12 months?". It is notable that "Unchanged" is not in the center of the five-point scale in step one but only number four. It could be an interesting subject for field research to explore whether this scale implies an upward bias in inflation perceptions relative to a using a five-point scale where "Unchanged" is located in the middle of the possible answers.

## 7. Final remarks

Two main conclusions emerge from the study based on the Danish part of the EU-Harmonised Consumer Expectations Survey (CES) linked to rich microdata from Danish administrative registers.

First, the inflation perception bias is a very broad-based characteristic across household types, and accounting for even several of the factors traditionally believed to contribute to the bias is not sufficient to reduce it much. Earlier research has indicated that households pay more attention to price increases than price decreases, which might partly explain the inflation perception bias.

Second, one should be very careful in using the levels of expected inflation from the EU-Harmonised CES in empirical works. Expected changes in inflation rates from the survey seem much more meaningful and easier to interpret than the expected future levels of inflation.

However, there are still substantial outliers that need to be addressed, and changes to the survey design might be a way forward for the inflation part of the EU-Harmonised CES rather than focusing on various metrically trimmed measures. For example, respondents may need more guidance on the current or typical rate of inflation, and additional probing of unusual replies may be needed. Furthermore, specification of the price concept to which the question refers seems also to be important. The widespread bias in households' inflation perceptions and expectations might also indicate a more general need for enhanced communication by monetary authorities and statistical agencies regarding the rather abstract concept of "inflation".

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