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* Views expressed are those of the authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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The anchoring of long-term inflation expectations of consumers: insights from a new survey¹

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Abstract

We provide new evidence on the level and probability distribution of consumers' long-term expectations of inflation in the euro area and the Netherlands, using a representative Dutch survey. We find that consumers' long-term (ten years ahead) euro area inflation expectations are not well anchored at the ECB's inflation aim. First, median long-term euro area inflation expectations are 4%, 2pp above the ECB's inflation aim of 2%. Second, individual probability distributions of long-term euro area inflation expectations show that expected probabilities of higher inflation (2pp or more above the ECB's inflation aim) are much higher, at 28% on average, than those of lower inflation (2pp or more below the ECB's inflation aim), at 12%. This suggests that the de-anchoring of Dutch consumers' long-term euro area inflation expectations is mainly due to expected high inflation, rather than to expected low inflation (or deflation). This finding is in contrast to recent concerns by ECB monetary policymakers about a possible de-anchoring of long-term inflation expectations on the downside. Furthermore, we find that consumers' long-term euro area inflation expectations are significantly higher if respondents have lower incomes. Based on measures of anchoring calculated directly from individual consumers' probability distributions of expected long-term inflation, namely the probability of inflation being close to target, the probability of inflation being far above target, and the probability of deflation, we also find that long-term euro area inflation expectations are better anchored for consumers with higher net household income.

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1. Introduction

Long-term inflation expectations are a common measure for the credibility of monetary policy in pursuing the goal of price stability, as perceived by private agents. Long-term inflation expectations are monitored and taken into account by monetary policymakers when taking monetary policy decisions. Since the Global Financial Crisis (GFC), a main concern has been that the prolonged period of low inflation may have led to lower long-term inflation expectations. This is particularly an issue at or close to the effective lower bound (ELB), where there are concerns about the effectiveness of monetary policy (Schnabel, 2020). A key question in the policy debate and the research literature is therefore whether long-term inflation expectations are firmly anchored to central banks' price inflation targets (see e.g. Draghi, 2014; Brainard, 2017; Coibion et al., 2015; Hartmann and Smets, 2019). This is particularly the case for the euro area, where significant cross-country differences in wage and price-setting make the coordinating role of a nominal anchor more important (Cœuré, 2019).

Against this background, long-term inflation expectations are currently also of particular relevance for the ongoing review of monetary policy frameworks by central banks (most notably the Federal Reserve, the ECB and the Bank of England). Different options for revised monetary policy strategies have been suggested. For example, one option is to employ make-up strategies such as average inflation targeting, partly in order to affect long-term inflation expectations at the ELB (see e.g. Bernanke, 2019; Clarida, 2019; Federal Reserve Bank of Chicago, 2020). Another option is to raise the inflation target, as done by the Bank of Japan in 2013 to counter persisting deflation (Nakata, 2020), or, in the case of the ECB, introducing a symmetric band around an inflation aim of 2%, again partly in order to affect long-term inflation expectations (Knot, 2019).

Most of the empirical work on the anchoring of long-term inflation expectations relies on measures for the expectations of professionals, which are easily available. There are financial market-based and survey-based measures of long-term inflation expectations of professionals. These can differ, and they both have advantages and draw-

backs.² A main disadvantage of survey-based measures is that they are usually only available at low frequency, and that respondents do not necessarily 'put their money where their mouth is'. A main disadvantage of financial market based measures is that they are usually affected by risk and liquidity premia. Moreover, market-based measures are quite volatile, and may overreact to central bank communication.³ A main advantage of survey-based measures is that they are closest to a direct measure of expectations, since they are not affected by risk and liquidity premia. A main advantage of market-based measures is that they are available at high frequency, and that market participants do act on the basis of these measures. Market-based expectations are well-suited to investigating changes in the behaviour of expectations that occur at high frequencies in response to particular events.

For the euro area, the evidence on anchoring of inflation expectations based on these measures is mixed. After a careful review of evidence until September 2018, Hartmann and Smets (2018) conclude that the behaviour of the mean or median of long-term inflation expectations shows that expectations are broadly anchored. At the same time, they note that the higher uncertainty and negative skew of inflation expectations since the GFC suggests that according to market participants there is an increased risk of low inflation. Since then the sharp fall in market-based long-term inflation expectations in 2019 has reinforced concerns that the anchoring of long-term inflation expectations may have weakened significantly.

One drawback of most of the empirical work on inflation expectations is that implicitly it assumes that results for professional forecasters or financial market participants carry over to households and firms (Cœuré, 2019).⁴ Studying consumers' expectations is relevant because they directly affect aggregate consumption decisions, and thereby growth and inflation (Armantier et al., 2015; Duca et al., 2018). Moreover,

² See Kose et al. (2019) for a recent overview.

³ See Shin (2017).

⁴ One important exception is Bernanke et al. (2019), who use simulations of the Fed's macroeconomic model to study the effectiveness of alternative monetary strategies at the ELB, in a set-up in which financial market participants and other agents form expectations differently.

household inflation expectations have been found to be a good proxy of firms' pricing decisions (Coibion and Gorodnichenko, 2015).

In spite of the growing literature on consumers' inflation expectations, evidence on the anchoring of consumers' long-term inflation expectations is still scarce. For the euro area, Cœuré (2019) for example cites evidence from "a very crude "deanchoring" measure", based on euro area households that at each point of time expect inflation to either "increase more rapidly" or "to fall" over the coming year. He argues that these expectations are potentially not consistent with the ECB's definition of price stability, depending on the state of the economy.

Our paper contributes to filling this gap in the literature by documenting and analysing a new survey on consumers' long-term expectations of inflation in the euro area and the Netherlands, including individual-specific measures for the level and probability distribution of inflation expectations. We commissioned a new survey, in which household members in the DNB Household Survey (DHS) panel for the Netherlands are asked questions about the levels and probability distribution of their short- and long-term inflation expectations. The importance of distributional information has recently been emphasized by Tenreyro (2019). A special feature of our survey is that half of the respondents are provided with information about actual inflation and the ECB's inflation aim. We investigate the effect of the provision of such information on individual expectations as well as the effects of consumers' characteristics (gender, age, education, and income) on their long-term inflation expectations.

We find that consumers' long-term euro area inflation expectations (ten years ahead) from the DHS panel for the Netherlands are not well anchored at the ECB's inflation aim. Median long-term euro area inflation expectations are 4%, 2 percentage points (pp) above the ECB's inflation aim of below, but close to, 2%. The interquartile range of long-term euro area level expectations, also reflecting disagreement among respondents, is high at 8pp. Mean long-term euro area inflation expectations are higher than median expectations, reflecting a positively skewed probability distribution. Importantly, short-term euro area inflation expectations are considerably lower (and show less disagreement). Hence, high long-term euro area inflation expectations are not simply a reflection of structurally high inflation expectations.

We find that the provision of information about actual euro area inflation and the ECB's inflation aim decreases consumers' median long-term euro area inflation expectations by 1pp, from 5% to 4%, but has no significant effect on mean long-term euro area inflation expectations.

As a measure of anchoring, we consider the individual probability distributions of expected inflation and calculate the expected probability of euro area inflation being in a range that is consistent with the inflation aim, that is between 1.0% and 3.0%. We find that this probability is relatively low at 35.4% on average.⁵

The individual probability distributions of long-term euro area inflation expectations further imply that expected probabilities of high inflation (2pp or more above the ECB's inflation aim, i.e. above 4%) are much higher, at 28.4% on average, than those of low inflation (2pp or more below the ECB's inflation aim, i.e. of deflation), at 12.2% on average. The individual probability distributions suggest both high levels of individual uncertainty as well as of disagreement among respondents.

The results suggest that the de-anchoring of long-term consumers' euro area inflation expectations is mainly due to expected higher inflation, rather than to expected lower inflation (or deflation). This is in contrast to recent concerns by ECB monetary policymakers about a possible de-anchoring of long-term inflation expectations on the downside, rather than on the upside.

Investigating the relation between euro area inflation expectations and socio-demographic characteristics, we find that consumers' mean long-term inflation expectations are significantly higher if respondents have lower incomes.⁶ Based on three measures of anchoring calculated directly from the individual probability distribution of consumers' long-term inflation expectations, namely the probability of inflation being close to target, the probability of inflation being far above target, and the probability of deflation, we also find that long-term euro area inflation expectations are better anchored for higher net household income. This is in the sense that the expected probability in the

⁵ We base this definition on Grishchenko et al. (2019), who consider a range for long-term euro area inflation expectations between 1.5% and 2.5%. Since the bins in our survey are 1 rather than 0.5 percentage point wide, we use the integer values of 1% and 3% instead.

⁶ This association is also found for mean short-term inflation expectations.

long-term of inflation being close to target is higher, and that of inflation being far above and below target is lower.

The remainder of the paper is organised as follows. Section 2 presents a literature review, and Section 3 introduces the DHS satellite inflation expectations survey of consumers in the Netherlands. Section 4 presents the method and results. Finally, Section 5 concludes.

2. Literature review

The rich literature on the anchoring of long-term survey expectations in the euro area has been based on surveys of professional forecasters or on market-based expectations. The evidence presented in these studies on the anchoring of long-term inflation expectations is mixed.

Empirical studies that rely on surveys of professional forecasts tend to find some evidence of a (mostly subtle) weakening of the anchoring properties of long-term inflation expectations since the GFC. Buono and Formai (2018) study the effects of short-term on long-term expectations from Consensus surveys, using time-varying parameter regressions. They find that in the euro area long-term expectations have been de-anchored shortly after the global financial crisis and again starting in 2014. Grishchenko et al. (2019) use euro-area surveys of professional forecasters to estimate a dynamic factor model of inflation with time-varying uncertainty. They find that following the Great Recession, there was a mild de-anchoring of long-term inflation expectations in the euro area. Hartmann and Smets (2018) discuss evidence from individual probability distributions of the ECB's Survey of Professional Forecasters (SPF), and conclude that the behaviour of the mean or median of long-term inflation expectations shows that expectations have remained broadly anchored in the euro area. But they caution that the higher uncertainty and negative skew of inflation expectations (based on individual probability distributions) since the GFC suggests that market participants perceive the risk of low inflation as having increased. A similar conclusion is reached by Dovern and Kenny (2020), who show that both the variance and the skewness of individual probability distributions of long-term expectations have increased since the Great Recession,

indicating a weaker anchoring. A different conclusion, however, is reached by Apokoritis et al. (2019) who find that long-term euro area inflation expectations remained well anchored at the ECB's inflation aim using micro evidence from a survey among professional forecasters conducted between 2010 and 2019 at weekly frequency.

Similarly, research that uses market-based measures of long-term inflation expectations in the euro area points to subtle changes in their anchoring properties around 2014, in the wake of the euro area sovereign debt crisis, possibly also earlier. This is particularly the case for studies that focus on the information content of higher moments of the probability distribution of expectations derived from inflation-linked derivatives. Scharnagl and Stapf (2015) detect signs of weaker anchoring between 2009 and 2011. Cecchetti et al. (2015) test for the anchoring of inflation expectations using both linear correlations and measures of tail comovement between short- and long-term inflation expectations. They find that the tail comovement of short- and long-term expectations has tended to increase in the euro area between mid-2014 and early 2015. Galati et al. (2018) find subtle signs of slightly less well-anchored inflation expectations in the euro area for the period 2013-2015 compared with 2010-2012. They study the effects of oil prices on deflation risk in the euro area, using market-implied distributions of long-term inflation expectations derived from inflation-linked option prices. Natoli and Sigalotti (2018) find that the risk of less well-anchored inflation expectations in the euro area increased in 2014 but decreased somewhat subsequently. They test for the anchoring of inflation expectations by studying the tail comovement between short- and long-term inflation expectations derived from inflation-linked option prices. Corsello et al. (2019) also find evidence of a weaker anchoring of long-term inflation expectation.

Only very few papers have studied long-term inflation expectations from consumer surveys in the euro area, since very little survey data is available. An exception is Christensen et al. (2006), who analyse the influence of five year ahead inflation expectations on short-term inflation expectations for the Netherlands.

There has been more literature on long-term inflation expectations from consumer surveys in the United States. For example, Bruine de Bruin et al. (2011) study the Federal Reserve Bank of New York Survey of Consumer Expectations for the United States, and

Detmeister et al. (2016) analyse long-term US inflation expectations (five to ten years ahead) from the University of Michigan Surveys of Consumers.⁷

More papers have studied short-term inflation expectations from consumer surveys in the euro area. Christelis et al. (2020) find that higher trust in the ECB lowers short-term (one year ahead) inflation expectations on average, from a consumer survey in the Netherlands. Interestingly, the empirical evidence shows that trust in the ECB contributes to the anchoring of one year ahead inflation expectations around the ECB's inflation aim. Bruine de Bruin et al. (2017) study how consumers' short-term inflation expectations in the Netherlands are affected by survey design. Baerg et al. (2018) examine the impact of monetary policy communications on German households' inflation expectations. Coibion et al. (2019) study the effects of consumers' short-term inflation expectations on consumption in the Netherlands. They find that higher inflation expectations have a strong negative effect on durable spending.

There has also been more literature on short-term inflation expectations of consumers in other countries. For example, Moessner et al. (2011) study one year-ahead inflation expectations of consumers in the United Kingdom using GfK NOP consumer surveys from 2001-07. They find substantial disagreement among UK consumers and between the Bank of England's Monetary Policy Committee and consumers.

Only few surveys provide information about individual-specific probability distributions of inflation expectations, including the Survey of Professional Forecasters (e.g. Rich and Tracy, 2018) and Apokoritis et al. (2019) for the euro area, the Bank of England survey of external forecasters (Boero et al., 2008; Tenreyro, 2019), and the Survey of Professional Forecasters (D'Amico and Orphanides, 2008) and the Federal Reserve Bank of New York Survey of Consumer Expectations (Bruine de Bruin et al., 2011) for the United States.

⁷ The Survey of Consumer Expectations conducted monthly by the Federal Reserve Bank of New York only asks for inflation expectations up to 3 years ahead.

3. DHS satellite survey of consumers' inflation expectations

We present a new DHS satellite survey conducted in December 2019, in which household members in the DHS panel for the Netherlands were asked about the level and probability distribution of their short-term (one year ahead) and long-term (ten year ahead) inflation expectations.⁸ Of 3363 household members selected, 2482 provided complete survey responses (73.8% of all respondents), and 103 provided incomplete survey responses (3.1% of all respondents). Our analysis uses the survey responses from complete as well as incomplete surveys.

Respondents in the DHS satellite survey were randomly assigned to four different groups. The first and second groups were asked about inflation expectations for the Netherlands, while the third and fourth groups were asked about inflation expectations for the euro area. The second group was provided with information about actual inflation in the Netherlands and the ECB's price stability aim.⁹ The fourth group was provided with information about actual inflation in the euro area and the ECB's price stability aim. The first and third groups were not provided with information about actual inflation or the ECB's price stability aim. Members of these two groups were asked about their perception of current inflation. The information on actual inflation provided to groups 2 and 4 referred to the latest available inflation number, namely 2.6% for inflation in the Netherlands and 1.0% for inflation in the euro area, respectively. In addition, members of these two groups were provided with a time series plot of inflation developments over the last 20 years in the Netherlands and the euro area, respectively (see Figures B1 and B2 in Appendix B). The survey questions are presented in Appendix B.

4. Method and results

In this section we analyse the responses to the new DHS satellite survey conducted in December 2019.

⁸ Teppa and Vis (2012) provide detailed information on the DHS, its use and the selection of household panel members.

⁹ Based on a satellite survey of the DHS conducted in 2009, van der Cruysen et al. (2015) find that about half of the 1659 respondents correctly identify the ECB's inflation aim as below but close to 2%.

We consider different measures of anchoring, which capture different aspects of the anchoring properties of long-term inflation expectations.¹⁰ One commonly used measure of the anchoring of long-term inflation expectations captures how close long-term inflation expectations are to the level desired by monetary policymakers. Such a measure can be based on the level or the distribution of long-term inflation expectations. Examples are the deviation of the level of mean long-term inflation expectations from target, or the expected probability of inflation being close to target ten years ahead. Another commonly used measure for the anchoring of long-term inflation expectations captures whether long-term inflation expectations are related to short-term inflation as reflected in short-term inflation expectations (see e.g. Jochmann et al., 2010; Lamla and Draeger, 2013; Łyziak and Paloviita, 2017; Buono and Formai (2018); Apokoritis et al., 2019; Moessner and Takats, 2020). The underlying idea is that while inflation developments are incorporated both in short- and long-term inflation expectations, they have a significant effect on short-term expectations but only a small effect on long-term inflation expectations if these are well-anchored (see e.g. Antunes, 2015).

4.1 Evidence of anchoring based on consumers' inflation expectations in levels

Table 1 presents the first moment (mean and median) of Dutch consumers' short-term and long-term level inflation expectations for the whole sample and across the four subgroups. Median long-term inflation expectations are 1pp lower, at 4%, for groups 2 and 4 who are provided with information about actual inflation and the ECB's inflation aim, than for groups 1 and 3 who are provided no such information, and whose expectations are at 5%.¹¹ Mean long-term inflation expectations are also somewhat lower for groups 2 and 4 than for groups 1 and 3, but not significantly so (see Table 6). We can see that mean long-term expectations are higher than median expectations, consistent with a positively skewed distribution of point expectations at the long-term horizon (Table 3). Information on the second moment reflecting disagreement among survey respondents (standard deviation and interquartile range) is shown in Table 2. The

¹⁰ For an overview of different ways to define and measure the anchoring of inflation expectations, see e.g. Grishchenko et al. (2019).

¹¹ Inflation expectations are not restricted to integers in the open-ended numeric survey questions about the levels of inflation expectations (see Appendix B). But respondents generally have some preference for integers when responding to open-ended numeric survey questions (Curtin (2013), Baker (1992), Edouard and Senthilselvan (1997)).

interquartile range is the same for all groups, and for all respondents, at 8pp. The standard deviation is higher than the interquartile range for all four groups, as well as for all respondents.

Information on the third moment (skewness) reflecting asymmetry is shown in Table 3. We can see that the point expectations are positively skewed. This is consistent with a greater perceived risk of much higher inflation than of much lower inflation at the long-term horizon, with respect to the mean expected inflation, in our sample of consumers. The distribution of point expectations of long-term inflation expectations is heavy-tailed, with large positive kurtosis (see Table 4).

The corresponding moments of consumers' short-term inflation expectations from the DHS satellite survey questions about levels are also shown in Tables 1 to 4. We can see that the mean, median, standard deviation and interquartile range are all higher for the long-term point expectations than for the short-term ones, for all respondents as well as for the four groups separately. By contrast, skewness and kurtosis are lower for long-term point expectations than for short-term ones. Thus while there is more disagreement among consumers on expected long term inflation, overall, they expect inflation in the long run to be higher than in the short run.

Table 5 presents the first moment (mean and median) of consumers' level of inflation perceptions for the two subgroups who received no information about actual inflation and were asked about their inflation perceptions. The mean of inflation perceptions is significantly higher than actual inflation, and much lower for Dutch inflation than for euro area inflation. But the median is the same, at 2%, indicating outliers of respondents perceiving very high inflation.

We next consider whether mean long-term inflation expectations differ significantly between the four different groups to which respondents were assigned (see Section 2), with the following regression,

$$\pi_i^{LT} = c + \beta_2 \text{gdum2}_i + \beta_3 \text{gdum3}_i + \beta_4 \text{gdum4}_i + \varepsilon_i \quad (1)$$

where π_i^{LT} denotes 10 year ahead expected inflation of respondent i , and the dummy variables gdum2_i , gdum3_i and gdum4_i indicate whether the respondent i belongs to group 2, 3 or 4, respectively (a value of zero indicates that the respondent does not

belong to the group, and a value of one denotes that the respondent belongs to this group). We find that mean long-term inflation expectations are not significantly different for the four different groups (Table 6).

We also estimate versions of this equation restricted to comparing groups 1 and 3 only (i.e. respondents who did not receive information on current and history of inflation),

$$\pi_i^{LT} = c + \beta_3 \text{gdum3}_i + \varepsilon_i \quad (2)$$

where the sample is restricted to household members assigned to groups 1 (NL inflation) and 3 (euro area inflation). We similarly compare groups 2 and 4 only (comparing expected inflation for the Netherlands and the euro area when provided with actual and history of inflation), groups 1 and 2 only (showing the impact of providing information on inflation expectations for the Netherlands), and groups 3 and 4 only (likewise for euro area inflation expectations). We find that the dummy variable is not significant for any of the pairwise comparison of two groups (see Table 6).

Interestingly, long term inflation expectations are lower on average when information on recent low inflation is provided. Also average inflation expectations are somewhat higher for the euro area. However, Table 6 shows that the provision of information about actual inflation and the ECB's price stability aim did not significantly affect mean long-term inflation expectations. Moreover, whether respondents were asked about long-term inflation expectations for the Netherlands or the euro area made no significant difference as well (Table 6).

Next, we look at the socio-demographic characteristics of survey respondents as possible determinants of long-term euro area inflation expectations. We consider the variables education, net household income, and age from the standard DHS survey. We construct dummy variables for middle and high education levels, denoted by $\text{Dedu}_i^{\text{mid}}$ and $\text{Dedu}_i^{\text{high}}$, respectively. The dummy variables $\text{Dedu}_i^{\text{mid}}$ and $\text{Dedu}_i^{\text{high}}$ equal one if respondent i has middle (i.e. secondary pre-university or intermediate vocational) or high (i.e. university or higher vocational) education levels, respectively, and equal zero otherwise. Similarly, we construct dummy variables for middle and high age, denoted by $\text{Dage}_i^{\text{mid}}$ and $\text{Dage}_i^{\text{high}}$, respectively. The dummy variables $\text{Dage}_i^{\text{mid}}$ and $\text{Dage}_i^{\text{high}}$ equal one if respondent i has middle (i.e. between 45 and 64 years) or high age (i.e. 65 years or

older), respectively, and equal zero otherwise. We also construct a dummy variable for high net household income, denoted by $Dnethinc_i^{high}$. The dummy variable $Dnethinc_i^{high}$ equals one if respondent i has high net household income (more than 2600 euro per month), and equals zero otherwise. We also construct a dummy variable $Dfem_i$ which equals one for female respondents and zero for male respondents. We estimate the following regression for euro area inflation expectations (responses for groups 3 and 4),

$$\pi_i^{LT} = c + \beta Dfem_i + \gamma_1 Dage_i^{mid} + \gamma_2 Dage_i^{high} + \delta_1 Dedu_i^{mid} + \delta_2 Dedu_i^{high} + \mu Dnethinc_i^{high} + \beta_4 gdum4_i + \varepsilon_i \quad (3)$$

The results are shown in Table 7. We also present the results when including the dummy variables for each of the demographic characteristics separately (Table 7). When all dummy variables are included together, we find that long-term euro area inflation expectations are significantly lower for respondents with higher net household incomes. When the dummy variables are included separately for the different demographic characteristics, we find that long-term euro area inflation expectations are significantly lower for respondents with higher net household incomes, higher education, and for respondents who are younger. For all specifications, we find no significant difference in long-term euro area inflation expectations between women and men. Moreover, it makes no significant difference whether respondents receive information about actual inflation and the ECB's inflation aim or not.

We also study the anchoring of long-term euro area inflation expectations by considering a regression of long-term inflation expectations on short-term inflation expectations,

$$\pi_i^{LT} = c + \beta \pi_i^{ST} + \beta_4 gdum4_i + \varepsilon_i \quad (4)$$

where π_i^{ST} denotes 1 year ahead expected inflation of respondent i . Long-term inflation expectations are well-anchored under this measure if β is not significantly different from zero. This is one commonly used measure for the anchoring of long-term inflation expectations (see e.g. Łyziak and Paloviita, 2017; Apokoritis et al., 2019; Moessner and Takats, 2020). Different measures of anchoring capture different aspects of the anchoring properties of long-term inflation expectations. This measure of anchoring captures whether long-term inflation expectations are related to short-term inflation as reflected

in short-term inflation expectations. The underlying idea, which is common in the literature on the anchoring of inflation expectations, is that while inflation developments are incorporated both in short- and long-term inflation expectations, they have a significant effect on short-term expectations but only a small effect on long-term inflation expectations if these are well-anchored (see e.g. Antunes, 2015). Other measures of the anchoring of long-term inflation expectations are considered below, such as the expected probability of inflation being close to target ten years ahead, which captures how close long-term inflation expectations are to the level desired by monetary policymakers. The results of equation (4) are shown in Table 8. We find that β is significantly different from zero, providing some evidence of long-term euro area inflation expectations by Dutch consumers not being well-anchored at the ECB's inflation aim.

Next we additionally include the effect of perceived inflation, π_i^P , on long-term euro area inflation expectations, for the group that was asked the question about euro area inflation and not provided with information about actual inflation,¹²

$$\pi_i^{L,T} = c + \beta \pi_i^{S,T} + \gamma \pi_i^P + \varepsilon_i \quad (5)$$

where $\pi_i^{S,T}$ denotes 1 year ahead expected euro area inflation of respondent i . The results are shown in Table 8. The coefficient on short-term inflation expectations remains significant, and the coefficient on perceived inflation is not significant. This again provides some evidence of long-term consumers' euro area inflation expectations not being well-anchored. Table 8 also shows the results when including just perceived inflation on the right-hand side of equation (5) and dropping short-term inflation expectations. We can see that the coefficient on perceived inflation is larger and becomes significant in that case, also suggesting that long-term euro area inflation expectations are not well anchored.

Comparison with regression results for short-term inflation expectations

For comparison, we present the results for the corresponding regressions using short-term euro area expectations as the left-hand side variable in equations (1) to (3)

¹² Relatedly, Christensen et al. (2006) study the effects of perceived inflation and long-term inflation expectations on short-term inflation expectations.

and (5), instead of long-term inflation expectations (while simultaneously dropping short-term inflation expectations as a right-hand side variable in equation (5)).

The results for equations (1) and (2) when replacing long-term by short-term inflation expectations as left-hand side variable are shown in Table 9. We find that as for long-term inflation expectations, the group dummy variables are not significant, except for one case. When comparing groups 3 and 4, the group 4 dummy variable is negative and significant. This implies that mean short-term inflation expectations for the euro area are significantly lower when respondents are provided information about actual euro area inflation and the ECB's price stability aim. The difference in mean expected short-term inflation is almost 1 percentage point and significant at the 10 percent significance level.

The results for equation (3) when replacing long-term by short-term euro area inflation expectations as left-hand side variable are shown in Table 10. As for long-term inflation expectations, we find that mean short-term inflation expectations are significantly lower for respondents with higher net household incomes. In addition, we find that mean short-term inflation expectations are significantly lower for higher levels of education and for older respondents.

The results for equation (5) when replacing long-term by short-term euro area inflation expectations as left-hand side variable, and dropping short-term expectations as right-hand side variable, are shown in Table 11. As for long-term inflation expectations, we find that perceived inflation has a significantly positive effect on mean short-term inflation expectations. Actually, in both regressions the coefficient is around 0.8 suggesting that respondents perceive inflation rates to be relatively persistent.

4.2 Evidence of anchoring based on consumers' probability distributions of expected inflation

The average of the individuals' probability distributions, of expected inflation is different from the cross-sectional distribution of individuals' point expectations considered in Section 3.1, since it includes both individual probability distributions and disagreement between individuals. By contrast, the distribution of point expectations

presented in Section 3.1 only reflects disagreement among consumers, but not their individual probability distributions.

We consider measures of anchoring of long-term inflation expectations, tail probabilities and asymmetry which can be calculated directly by averaging individual probability distributions in Figure 1 as described below.

In the survey question on the distribution of expected inflation, survey respondents are asked to assign probabilities (i.e. percentage chances) to expected inflation (in percent) falling in $J=10$ intervals $j, j=1,...,J$, defined as <-4.0 , $[-4.0,-3.0[$, $[-3.0,-2.0[$, $[-2.0,-1.0[$, $[-1.0,0]$, $[0.0,1.0[$, $[1.0,2.0[$, $[2.0,3.0[$, $[3.0,4.0[$, and >4.0 . We construct an aggregate or average histogram for the probability distribution of expected inflation by a linear combination of the histograms of the individual distributions, with equal weights. The frequency assigned by respondent i to interval j at horizon h is denoted by $f_i^{j,h}$. The frequency of the aggregate histogram in each interval j , $f^{j,h}$, is then calculated according to (see Krueger and Nolte, 2016):

$$f^{j,h} = \frac{1}{N} \sum_{i=1}^N f_i^{j,h} \quad (6)$$

where $f^{j,h}$ is the frequency assigned in the aggregated histogram to inflation being in interval j at horizon h , and N is the number of respondents to the survey questions about the distribution of inflation expectations. The resulting frequencies of the aggregate histogram are shown in Figure 1 for both short- and long-term euro area inflation expectations (from responses of groups 3 and 4 in the DHS satellite survey). The corresponding frequencies of the aggregate histogram for both short- and long-term Dutch inflation expectations (from responses of groups 1 and 2 in the DHS satellite survey) are shown in Figure 2.

Measure of anchoring at ECB's inflation aim

As a measure of the anchoring of long-term inflation expectations at the ECB's inflation aim, we consider long-term expectations of inflation being close to the ECB's inflation aim calculated from the aggregate histogram (see Figure 1). Specifically, we use the survey-based probability of future inflation being in a range that is consistent with the inflation aim as a measure of anchoring. In particular, we consider the probability of

expected long-term inflation lying between 1.0% and 3.0% (see Grishchenko et al., 2019). This probability, ptr^h , is calculated as the sum of the frequencies assigned in the aggregated histogram at the long-term horizon ($h=LT$) to inflation being in the two intervals $j=7$ and $j=8$, which together make up the interval between 1.0% and 3.0%, according to

$$\text{ptr}^h = \sum_{j=7}^8 f^{j,h} \quad (7)$$

For euro area inflation, we obtain $\text{ptr}^{LT}=35.4\%$ for this measure of the survey-based probability of inflation ten years ahead falling between 1% and 3% from equation (6) (see Figure 1). This measure based on the aggregate probability distribution suggests that Dutch consumers' long-term euro area inflation expectations are not well anchored.

Tail probabilities and asymmetry

Next, we use the average of the individual probability distributions of expected inflation to compare the probability of inflation being very high (2% or more above the ECB's inflation aim of 2%, i.e. above 4%), denoted by phigh^{LT} , with the probability of inflation being very low (2% or more below the ECB's inflation aim, i.e. below 0%) at the long-term horizon. The probability of expected long-term euro area inflation being above 4% is 28.4%, which is shown directly in Figure 1. The probability of deflation expected in the long-term, pdef_t^h , for horizon $h=LT$, is calculated as the sum of the frequencies assigned in the aggregated histogram at the long-term horizon to inflation being in the five intervals $j=1$ to $j=5$, which together make up the intervals below 0%, according to

$$\text{pdef}^h = \sum_{j=1}^5 f^{j,h} \quad (8)$$

For euro area inflation, we obtain for the deflation probability $\text{pdef}^{LT}=12.2\%$ based on the measure of equation (8). A comparison with the expected probability of euro area inflation being above 4%, of $\text{phigh}^{LT}=28.4\%$ (Figure 1), shows that respondents perceive a greater risk of euro area inflation being very high (2% or more above the ECB's inflation aim of 2%), than of euro area inflation being very low (2% or more below the ECB's inflation aim) at the long-term horizon. This finding is consistent with the positive skewness of consumers' long-term euro area inflation expectations in levels (Section 3.1).

Comparison with results for short-term inflation expectations

Next we compare the results for these measures of long-term euro area expectations based on the aggregate histogram with those of short-term expectations. We find that for long-term euro area expectations, $\text{ptr}^{\text{LT}}=35.4\%$ for the measure of the survey-based probability of euro area inflation falling between 1% and 3% from equation (7) is smaller than the result of $\text{ptr}^{\text{ST}}=51\%$ for short-term euro area expectations.

The deflation probability $\text{pdef}^{\text{LT}}=12.2\%$ for long-term euro area expectations is similar to the deflation probability of $\text{pdef}^{\text{ST}}=11.9\%$ for short-term expectations. But strikingly, the probability expected for euro area inflation being above 4% is much higher at the long-term horizon, at $\text{phigh}^{\text{LT}}=28.4\%$, than at the short-term horizon, at $\text{phigh}^{\text{ST}}=10.2\%$.¹³

4.3 Anchoring and determinants of individual probability distributions of consumers' inflation expectations

In this section we study the determinants of the individual probability distributions of Dutch consumers' inflation expectations. A strength of the DHS satellite survey is that we directly observe the expected probabilities that long-term and short-term inflation fall in the intervals specified in the survey, and do not need to be derived via approximations or fitting functional forms for distributions. We take advantage of this by analysing the determinants of the expected probabilities of inflation being close to target, and of the tail probabilities, i.e. inflation expected to be 2 percentage points above or below target.

The survey-based probability for consumer i of future euro area inflation lying between 1.0% and 3.0%, is calculated as the sum of the frequencies assigned by respondent i in the histogram at the long-term or short-term horizon ($h=\text{LT}$ or ST) to

¹³ In Appendix A we consider measures of the mean and uncertainty of the distribution of long-term inflation expectations, which cannot be directly inferred from the aggregate histogram of Figure 1, but require further assumptions about the tails of the distribution. Since the probability mass in the highest interval of the histogram of euro area inflation being above 4% is quite high at 28%, assumptions about the tails, which are somewhat arbitrary, affect the estimated mean and uncertainty. As these measures do not directly follow from the survey data, in contrast to the measures calculated directly from the aggregate histogram above, we relegate them to an appendix.

inflation being in the two intervals $j=7$ and $j=8$, which together make up the interval between 1.0% and 3.0%, according to

$$ptr_i^h = \sum_{j=7}^8 f_i^{j,h} \quad (9)$$

The survey-based probability for consumer i of future euro area inflation being negative (i.e. of deflation) is calculated as the sum of the frequencies assigned by respondent i in the histogram at the long-term or short-term horizon ($h=LT$ or ST) to inflation being in the five intervals $j=1$ to $j=5$, which together make up the interval below 0%, according to

$$pdef_i^{LT} = \sum_{j=1}^5 f_i^{j,h} \quad (10)$$

The survey-based probability for consumer i of future euro area inflation being 2 percentage points or more above the target of 2% is the frequency assigned by respondent i in the histogram at the long-term or short-term horizon ($h=LT$ or ST) to inflation being in the interval $j=10$,

$$phigh_i^h = f_i^{10,h} \quad (11)$$

We study the determinants of these individual probability distributions of consumers' euro area inflation expectations. As determinants we consider the same socio-demographic variables gender, age, education and net household income from the baseline DHS survey, as we did for the determinants of mean inflation expectations above. We run the following regressions,

$$\begin{aligned} prob_i^h = & c + \beta Dfem_i + \gamma_1 Dage_i^{mid} + \gamma_2 Dage_i^{high} + \delta_1 Dedu_i^{mid} + \delta_2 Dedu_i^{high} + \\ & \mu Dnethinc_i^{high} + \beta_4 gdum4_i + \varepsilon_i \end{aligned} \quad (12)$$

where $prob_i^h$ can equal ptr_i^h , $phigh_i^h$, or $pdef_i^h$, for $h=LT$ or $h=ST$, for which we each run separate regressions, and with the dummy variables as defined above.

The results for are shown in Table 12 for the long-term horizon. We can see that the probability of expected euro area inflation being close to target in the long-term, ptr_i^{LT} , is significantly higher if the education level is higher, if net household income is higher, for older respondents and for men. These results suggest that long-term inflation expectations are better anchored for men, for older respondents, for higher education

levels, for higher net household income, in the sense that the expected probability of inflation being close to target in the long term is higher.

We can also see that the probability of expected euro area inflation being far (2 percentage points or more) above target in the long-term, $phigh_i^{LT}$, is significantly lower if net household income is higher. Gender, age and education have no significant effects. These results suggest that long-term inflation expectations are better anchored for higher net household income, in the sense that the expected probability of inflation being far above target in the long term is lower.

Moreover, we can see that the expected euro area deflation probability (of inflation below 0%, i.e. 2 percentage points or more below target) in the long-term, $pdef_i^{LT}$, is significantly lower if the education level is higher, if net household income is higher, if respondents are older, and for men. These results suggest that long-term euro area inflation expectations are better anchored for higher education levels, for higher net household income, for older respondents and for men, in the sense that the expected probability of inflation being far below target in the long term is lower.

Based on all three measures calculated directly from the individual probability distribution of consumers' long-term inflation expectations, namely the probability of inflation being close to target, ptr_i^{LT} , the probability of inflation being far above target, $phigh_i^{LT}$, and the probability of deflation, $pdef_i^{LT}$, we find that long-term euro area inflation expectations are better anchored for higher net household income.

Comparison with regression results for short-term inflation expectations

For comparison, we next present the corresponding results for equation (12) for the short-term horizon, $h=ST$. For the short-term horizon, the results in equation (12) are shown in Table 13.

As was the case for long-term inflation expectations, we find that the probability of expected euro area inflation being close to target in the short-term, ptr_i^{ST} , is significantly higher if the education level is higher, if net household income is higher, for older respondents and for men.

Also as in the case of long-term expectations, we find that the probability of expected euro area inflation being far (2 percentage points or more) above target in the short term, $\text{phigh}_i^{\text{ST}}$, is significantly lower if net household income is higher. In addition, $\text{phigh}_i^{\text{ST}}$ is significantly lower for higher education levels and for men.

Again as in the case of long-term expectations, we find that the expected euro area deflation probability (of inflation below 0%, i.e. 2 percentage points or more below target) in the short term, $\text{pdef}_i^{\text{ST}}$, is significantly lower if the education level is higher, if net household income is higher, for older respondents and for men.

4.4 Evidence of anchoring based on the relation between short-term and long-term individual expected probabilities

Next, we study the anchoring properties of long-term euro inflation expectations by estimating the relation between individual expected probabilities of short-term and long-term expected inflation lying in intervals at, below or above the ECB-target with the following regressions,

$$\text{prob}_i^{\text{LT}} = c + \beta \text{prob}_i^{\text{ST}} + \beta_4 \text{gdum4}_i + \varepsilon_i \quad (13)$$

where prob_i^{h} can equal ptr_i^{h} , $\text{phigh}_i^{\text{h}}$, or pdef_i^{h} , for which we each run separate regressions. These regressions correspond to that of equation (4) for inflation expectations in levels. A related measure has been considered in Galati et al. (2016) for the effects of short-term on long-term expected deflation probabilities implied by options on euro area inflation swaps. The hypothesis is that if long-term inflation expectations are well-anchored, these long-term probabilities should not co-move with the corresponding short-term probabilities, i.e. $\beta=0$. As discussed above, the underlying idea, which is common in the literature on the anchoring of inflation expectations, is that while inflation developments are incorporated both in short- and long-term inflation expectations, they have a significant effect on short-term expectations but only a small effect on long-term inflation expectations if these are well-anchored (see e.g. Antunes, 2015). The results are shown in Table 14. We find for all three probabilities ptr_i^{h} , $\text{phigh}_i^{\text{h}}$, and pdef_i^{h} , that β is positive and significantly different from zero. These results therefore also suggest that consumers' long-term euro area inflation expectations are not well anchored.

5. Conclusions

We document and analyse new survey data on consumers' long-term euro area and Dutch inflation expectations, both including individual expectations on the level and on the probability distribution of long-term inflation. We have commissioned a new DHS satellite survey, in which members of the DHS household panel for the Netherlands were asked questions about the level and probability distribution of their short- and long-term euro area and Dutch inflation expectations. Half of the respondents are provided with information about actual inflation and the ECB's inflation aim. We study the effect of the provision of such information and the effects of consumers' characteristics (education, age and income) on long-term inflation expectations.

We find that consumers' long-term euro area inflation expectations (ten years ahead) from the DHS panel for the Netherlands are not well anchored at the ECB's inflation aim. Median long-term euro area inflation expectations are 4%, 2 percentage points (pp) above the ECB's inflation aim of 2%. The interquartile range of long-term euro area point expectations, reflecting disagreement among respondents, is high at 8pp. Mean long-term euro area inflation expectations are higher than median expectations, reflecting a positively skewed cross-sectional distribution of inflation expectations.

We find that the provision of information about actual inflation and the ECB's inflation aim decreases consumers' median long-term euro area inflation expectations by 1pp, from 5% to 4%, but there is no significant effect on mean long-term inflation expectations.

As a measure of anchoring, we consider the individual probability distributions of expected inflation and calculate the probability of future euro area inflation being in a range that is consistent with the inflation aim, i.e. between 1.0% and 3.0%. We find that this probability is relatively low at 35.4% on average.

From the individual probability distributions of expected long-term euro area inflation, we infer that the expected probability of high inflation (2pp or more above the ECB's inflation aim, ie above 4%) is much higher, at 28.4% on average, than that of low inflation (2pp or more below the ECB's inflation aim, i.e. of deflation), at 12.2%. These numbers contain individual uncertainty as well as disagreement among respondents.

These results suggest that the de-anchoring of long-term euro area inflation expectations held by Dutch consumers is mainly due to expected higher inflation, rather than to expected lower inflation (or deflation). This is in contrast to recent concerns by ECB monetary policymakers about a possible de-anchoring of long-term inflation expectations on the downside, rather than on the upside. Another result is that consumers' mean long-term euro area inflation expectations are significantly higher if respondents have lower incomes.

Based on three measures of anchoring calculated directly from the individual consumer's probability distributions of expected long-term euro area inflation, namely the probability of inflation being close to target, the probability of inflation being far above target, and the probability of deflation, we find that long-term euro area inflation expectations are better anchored for higher net household income. In other words, the expected probability of long-term euro area inflation being close to target is higher, and of inflation being far above or far below target is lower.

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Figures

Figure 1: Average of consumers' probability distributions of expected euro area inflation

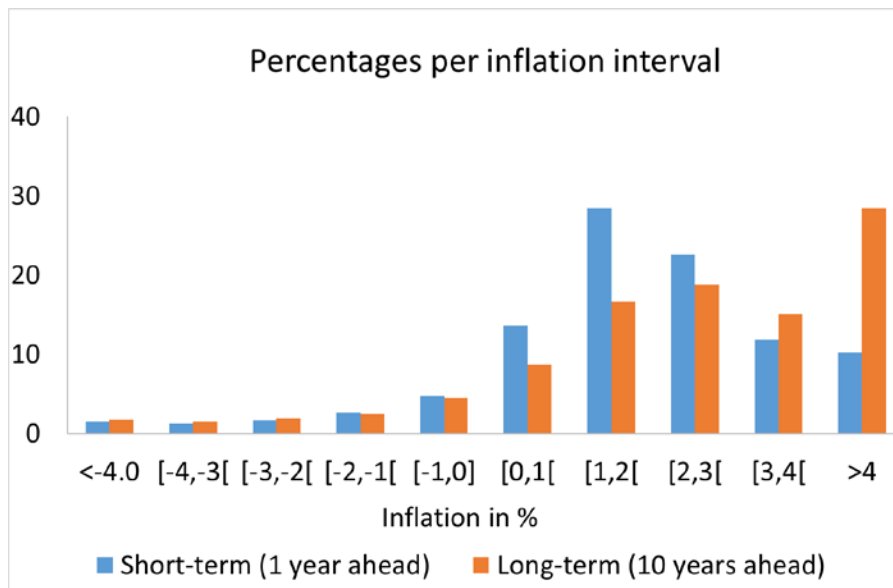
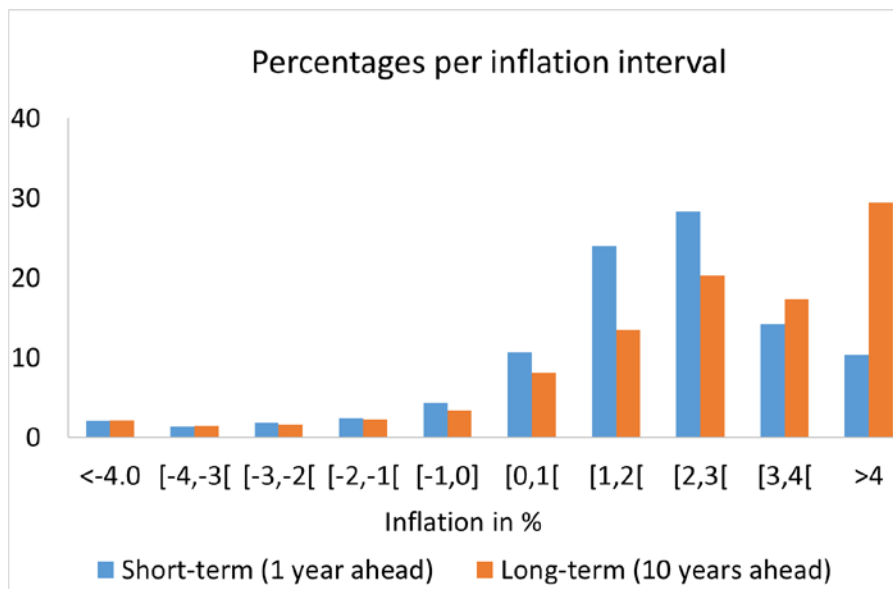


Figure 2: Average of consumers' probability distributions of expected Dutch inflation



Tables

Table 1: Mean and median of inflation expectations by consumers

	Short-term			Long-term		
Group	Num. obs.	Mean	Median	Num. obs.	Mean	Median
#1 NL, no info	648	3.97%	2%	634	10.56%	5%
#2 NL, with info	636	3.57%	2%	616	9.74%	4%
#3 EA, no info	628	4.31%	2%	608	11.26%	5%
#4 EA, with info	672	3.36%	1.95%	645	9.90%	4%
All respondents	2584	3.80%	2%	2503	10.36%	4%

Notes: This table shows the cross-sectional mean and median of short-term (1 year ahead) and long-term (10 year ahead) point inflation expectations for the whole sample and across subgroups.

Table 2: Standard deviation and interquartile range of inflation expectations by consumers

	Short-term		Long-term	
Group	stdev	interquartile range	stdev	interquartile range
#1 NL, no info	8.88pp	1.5pp	16.51pp	8pp
#2 NL, with info	8.50pp	1.5pp	16.53pp	8pp
#3 EA, no info	9.52pp	1.5pp	18.20pp	8pp
#4 EA, with info	10.68pp	1.25pp	17.90pp	8pp
All respondents	9.45pp	1.8pp	17.30pp	8pp

Notes: This table shows the cross-sectional standard deviation and interquartile range of short-term (1 year ahead) and long-term (10 years ahead) point inflation expectations for the whole sample and across subgroups.

Table 3: Skewness of consumers' inflation expectations

	Short-term	Long-term
Group	Skewness	Skewness
#1 NL, no info	6.31	3.48
#2 NL, with info	6.16	3.41
#3 EA, no info	6.36	3.19
#4 EA, with info	4.92	3.01
All respondents	5.83	3.26

Notes: This table shows the cross-sectional skewness of short-term (1 year ahead) and long-term (10 years ahead) point inflation expectations for the whole sample and across subgroups. Skewness of variable x is defined as the normalised third central moment, $\text{skew} = E\left(\frac{(x-\mu)^3}{\sigma^3}\right)$, where μ is the mean and σ the standard deviation; see Appendix 1 of Moessner et al. (2011).

Table 4: Kurtosis of consumers' inflation expectations

	Short-term	Long-term
Group	Kurtosis	Kurtosis
#1 NL, no info	49.9	16.9
#2 NL, with info	45.9	16.3
#3 EA, no info	51.6	14.0
#4 EA, with info	53.2	15.6
All respondents	52.5	15.6

Notes: This table shows the cross-sectional kurtosis of short-term (1 year ahead) and long-term (10 years ahead) point inflation expectations for the whole sample and across subgroups. Kurtosis of variable x is defined as the normalised fourth central moment minus 3, $\text{kurt} = E\left(\frac{(x-\mu)^4}{\sigma^4}\right) - 3$, where μ is the mean and σ the standard deviation; see Appendix 1 of Moessner et al. (2011).

Table 5: Summary statistics for inflation perceptions by consumers

Group	Num. obs.	Mean	Median	SE(mean)
#1 NL, no info	648	3.91%	2%	0.33pp
#3 EA, no info	629	7.66%	2%	3.20pp
Memo: Latest available data at time of survey: Dutch inflation: 2.6%, euro area inflation: 1.0%.				

Notes: This table shows the cross-sectional mean and median of inflation perceptions, and the standard error of the mean, for the two subgroups who received no information about actual inflation and were asked about their inflation perceptions.

Table 6: Effects of group assignment on long-term inflation expectations of consumers

Dependent variable: π^{LT}					
	All respondents	Groups 1 and 3	Groups 2 and 4	Groups 1 and 2	Groups 3 and 4
<i>c</i>	10.6***	10.6***	9.7***	10.6***	11.3***
<i>gdum2 (NL, with info)</i>	-0.82	-	-	-0.82	-
<i>gdum3 (EA, no info)</i>	0.70	0.70	-	-	-
<i>gdum4 (EA, with info)</i>	-0.66	-	0.16	-	-1.36
R ²	0.001	0.0004	0.0000	0.001	0.001
No. of observations	2503	1242	1261	1250	1253
***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.					

Table 7: Effects of socio-demographic characteristics on long-term euro area inflation expectations of consumers

Dependent variable: π^{LT}					
<i>c</i>	12.06***	10.94***	9.14***	12.95***	13.39***
<i>Dfem</i>	0.60	0.71			
<i>Dage^{mid}</i>	2.37*		3.07**		
<i>Dage^{high}</i>	1.66		2.52**		
<i>Dedu^{mid}</i>	-0.19			-0.74	
<i>Dedu^{high}</i>	-2.24			-3.84***	
<i>Dnethinc^{high}</i>	-3.25***				-4.09***
<i>gdum4 (EA, with info)</i>	-1.42	-1.38	-1.31	-1.41	-1.38
R ²	0.021	0.002	0.006	0.011	0.014
No. of observations	1248	1253	1253	1251	1250
***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.					

Table 8: Effects of short-term on long-term euro area inflation expectations of consumers

Dependent variable: π^{LT}			
c	8.12***	7.75***	7.15***
π^{ST}	0.76***	-	0.95***
π^p	-	0.82***	0.04
$gdum4$ (EA, with info)	-0.64	-	-
R^2	0.166	0.187	0.250
No. of observations	1253	608	608

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.

Table 9: Effects of group assignment on short-term inflation expectations of consumers

Dependent variable: π^{ST}					
	All respondents	Groups 1 and 3	Groups 2 and 4	Groups 1 and 2	Groups 3 and 4
c	3.97***	3.97***	3.57***	3.97***	4.31***
$gdum2$ (NL, with info)	-0.40	-	-	-0.40	-
$gdum3$ (EA, no info)	0.34	0.34	-	-	-
$gdum4$ (EA, with info)	-0.61	-	-0.21	-	-0.95*
R^2	0.002	0.0003	0.0001	0.001	0.002
No. of observations	2584	1276	1303	1284	1300

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.

Table 10: Effects of socio-demographic characteristics on short-term euro area inflation expectations of consumers

Dependent variable: π^{ST}					
c	6.99***	3.83***	4.76***	5.88***	4.81***
$Dfem$	0.74	1.04*			
$Dage^{mid}$	-0.26		0.18		
$Dage^{high}$	-2.07**		-1.32*		
$Dedu^{mid}$	-2.12**			-1.63**	
$Dedu^{high}$	-2.91***			-2.69***	
$Dnethinc^{high}$	-0.55				-0.95*
$gdum4$ (EA, with info)	-0.97*	-0.98*	-0.94*	-0.93*	-0.96*
R^2	0.024	0.005	0.007	0.014	0.004
No. of observations	1295	1300	1300	1298	1297

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.

Table 11: Effects of perceived inflation on short-term euro area inflation expectations of consumers

Dependent variable: π^{ST}	
c	0.74**
π^p	0.80***
R^2	0.716
No. of observations	628

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.

Table 12: Effects of socio-demographic characteristics on probabilities of expected long-term euro area inflation of consumers

Dependent variable:	ptr^{LT}	$phigh^{LT}$	$pdef^{LT}$
c	23.74***	34.69***	19.43***
$Dfem$	-5.75***	2.74	3.57***
$Dage^{mid}$	4.62**	0.58	-4.06**
$Dage^{high}$	5.08**	1.38	-4.05**
$Dedu^{mid}$	2.64	0.73	-5.50***
$Dedu^{high}$	6.62***	-0.38	-8.83***
$Dnethinc^{high}$	9.38***	-7.51***	-3.23**
$gdum4$ (EA, with info)	4.77***	-8.80***	2.14*
R^2	0.056	0.030	0.050
No. of observations	1241	1241	1240

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.

Table 13: Effects of socio-demographic characteristics on probabilities of expected short-term euro area inflation of consumers

Dependent variable:	ptr^{ST}	$phigh^{ST}$	$pdef^{ST}$
c	39.03***	17.98***	16.18***
$Dfem$	-8.29***	2.94**	4.49***
$Dage^{mid}$	8.23***	-1.53	-3.31**
$Dage^{high}$	6.95***	-0.86	-3.09*
$Dedu^{mid}$	3.44	-2.62	-3.73**
$Dedu^{high}$	10.10***	-4.70***	-6.55***
$Dnethinc^{high}$	6.64***	-4.50***	-3.23**
$gdum4$ (EA, with info)	3.49**	-6.36***	2.62**
R^2	0.068	0.056	0.048
No. of observations	1270	1270	1269

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.

Table 14: Effects of short-term on long-term individual expected probabilities for euro area inflation to be in specified interval

Dependent variable: $prob_i^{LT}$			
Probability considered:	ptr_i^h	$phigh_i^h$	$pdef_i^h$
c	13.84***	24.63***	3.39***
$prob_i^{ST}$	0.39***	0.62***	0.74***
$gdum4$ (EA, with info)	3.23*	-5.05***	-0.04
R^2	0.151	0.146	0.489
No. of observations	1246	1246	1245

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Robust standard errors.

Appendix A

In this appendix we consider measures of the mean and uncertainty of the distribution of long-term inflation expectations, which cannot be directly inferred from the aggregate histograms of Figures 1 and 2, but require further assumptions about the tails of the distribution. Since the probability mass in the highest interval of the histogram of inflation being above 4% is quite high, at 28.4% for euro area inflation and 29.5% for Dutch inflation, such assumptions about the tails, which are somewhat arbitrary, can strongly affect the estimated mean and uncertainty. These measures do not directly follow from the survey data, in contrast to the measures calculated directly from the aggregate histogram above, and are therefore more uncertain and relegated to an appendix.

We quantify the mean and uncertainty of expected inflation based on the aggregate full distribution of inflation expectations. The mean and uncertainty of expectations at horizon h are calculated from the aggregate histogram according to

$$\mu^h = \sum_{j=1}^J \pi^j f^{j,h} \quad (A1)$$

$$\sigma^{\text{unc},h} = \sqrt{\sum_{j=1}^J (\pi^j - \mu^h)^2 f^{j,h}} \quad (A2)$$

where $f^{j,h}$ is the frequency assigned in the aggregated histogram to inflation being in interval j at horizon h ; π^j is the midpoint of the interval j of the histogram. That is, we assume that the probability mass in each interval is concentrated at its midpoint. For the open intervals at either end of the distribution, we truncate the distribution by assuming that the interval has the same size as the other intervals, of 1.0 pp. Both these assumption are based on D'Amico and Orphanides (2008). μ^h is the mean of the inflation expectations based on the aggregate histogram, at horizon h .

For long-term inflation expectations (from all responses to the DHS satellite survey), we obtain a mean of $\mu^{\text{LT}} = 2.4\%$ and uncertainty of $\sigma^{\text{unc,LT}} = 2.1\text{pp}$ according to equations (A1) and (A2). But these are underestimates of the true mean and uncertainty of the full aggregate distribution (reflecting both individual consumers' uncertainty and disagreement among consumers), since the distribution of point expectations is strongly positively skewed and has large kurtosis (Tables 3 and 4), which is reflected in a large

probability of 29% being assigned in the aggregate histogram for all responses to the interval of 4% or higher. Consequently, the assumption that the uppermost interval has a size of 1pp is likely violated. Assuming the size of this interval to be larger will lead to a higher measure of mean and uncertainty, but this assumption is somewhat arbitrary. In the main text, we therefore focus on the information contained directly in the aggregate histogram shown in Figure 1, in particular the probabilities of inflation being close to target, or the tail probabilities and their asymmetry.

Appendix B: DHS satellite survey of inflation expectations

DHS Satellite survey questions

This paper analyses the results from a new DHS satellite survey conducted in December 2019.

The sample of DHS survey respondents is split into four groups. The first and third groups do not receive background information on current and past inflation, as well as the ECB's inflation aim. The second and fourth group receive some information on current and past inflation, as well as the ECB's inflation aim (see items 1. and 2. in the section "Background information").

The sample of respondents is split into four equally large sets of participants:

- 1) The first set of respondents is asked for expectations about inflation in the Netherlands without any additional background information.
- 2) The second set is asked for expectations about inflation in the Netherlands with some additional background information (the past month's inflation in the Netherlands, a graph of inflation in the Netherlands over the past 20 years, and the ECB's aim for euro area inflation).
- 3) The third set of respondents is asked for expectations about euro area inflation without any additional background information
- 4) The fourth set of respondents is asked for expectations about euro area inflation with some additional information (the past month's euro area inflation, a graph of euro area inflation over the past 20 years, and the ECB's inflation aim).

The survey questions were provided in Dutch. Below is an English translation of the survey questions.

1. (Question 1 only for respondents who do not receive background information as described above)

What do you think inflation currently is in the Netherlands/euro area? Please provide a percentage (%). Inflation is the percentage change in consumer prices over twelve months. If you think prices increased, please fill in a positive percentage. If you think prices decreased, please fill in a negative percentage (insert a minus sign (-) before the number). If you think prices did not change, please fill in 0 (zero).

Answer: %

2. We are interested in your opinion on what will happen to inflation in the Netherlands/euro area **over the next twelve months**. Inflation is the percentage change in consumer prices over twelve months. What do you think the rate of inflation will be **over the next twelve months**? Please give your best guess. If you think prices will increase, please fill in a positive percentage. If you think prices will decrease, please fill in a negative percentage (insert a minus sign (-) before the number). If you think prices will not change, please fill in 0 (zero).

Answer: %

3. Now we would like you to think about the different things that may happen to inflation in the Netherlands/euro area **over the next 12 months**. Please allocate 100 points in the table below indicating how likely in your view the listed inflation rates, were 0 points means no chance at all and 100 points means absolutely sure. In your view, what is the chance that, **over the next 12 months**,

	Points
the rate of inflation will be 4% or higher
the rate of inflation will be 3% or higher, but less than 4%
the rate of inflation will be 2% or higher, but less than 3%
the rate of inflation will be 1% or higher, but less than 2%
the rate of inflation will be 0% or higher, but less than 1%
the rate of deflation (negative of inflation) will be between 0% and 1%
the rate of deflation (negative of inflation) will be between 1% and 2%
the rate of deflation (negative of inflation) will be between 2% and 3%
the rate of deflation (negative of inflation) will be between 3% and 4%
the rate of deflation (negative of inflation) will be 4% or higher
Total (the points should sum to a total of 100)	100

4. We are interested in your opinion on what will happen to inflation in the Netherlands/euro area **10 years in the future**. What do you think the rate of inflation will be **10 years in the future**? Please give your best guess. If you think prices will increase, please fill in a positive percentage. If you think prices will decrease, please fill in a negative percentage. If you think prices will not change, please fill in 0 (zero).

Answer: %

5. Now we would like you to think about the different things that may happen to inflation in the Netherlands/euro area **10 years in the future**. Please allocate 100 points in the table below indicating how likely in your view the listed inflation rates, were 0 points means no chance at all and 100 points means absolutely sure. In your view, what is the chance that, **10 years in the future**,

	Points
the rate of inflation will be 4% or higher
the rate of inflation will be 3% or higher, but less than 4%
the rate of inflation will be 2% or higher, but less than 3%
the rate of inflation will be 1% or higher, but less than 2%
the rate of inflation will be 0% or higher, but less than 1%
the rate of deflation (negative of inflation) will be between 0% and 1%
the rate of deflation (negative of inflation) will be between 1% and 2%
the rate of deflation (negative of inflation) will be between 2% and 3%
the rate of deflation (negative of inflation) will be between 3% and 4%
the rate of deflation (negative of inflation) will be 4% or higher
Total (the points should sum to a total of 100)	100

Background information

1. Inflation is the percentage change in consumer prices over twelve months. Most recently, inflation in the Netherlands/euro area was 2.6%/1.0% (see Figure B1/B2).
2. The primary objective of the European Central Bank (ECB) is to maintain price stability. The ECB has defined price stability as inflation in the euro area below but close to 2%.

Figure B1: Inflation in the Netherlands (information provided to group 2)

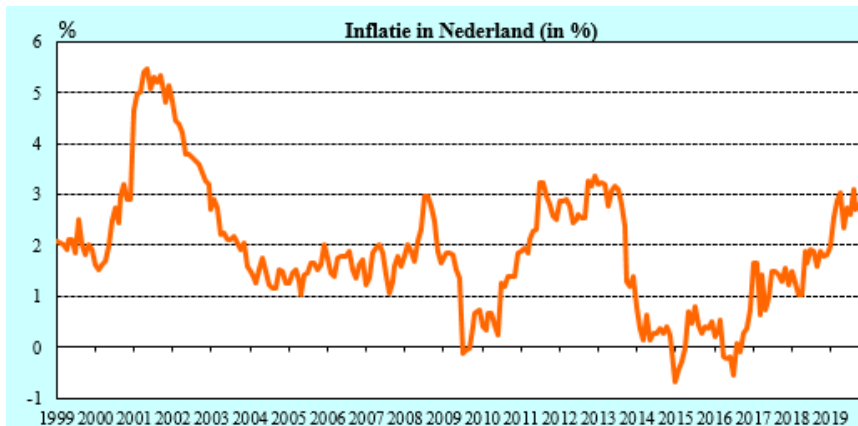
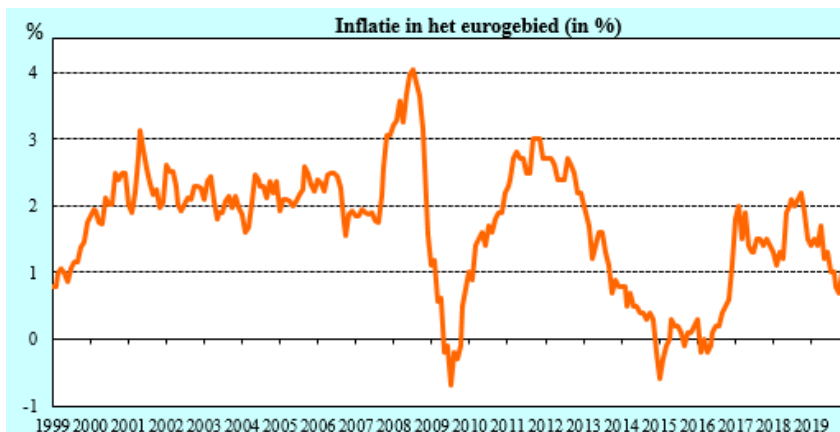


Figure B2: Inflation in the euro area (information provided to group 4)



Group 2 was provided with information of actual inflation in the Netherlands of 2.6% and a time series of inflation in the Netherlands as shown in Figure B1. Group 4 was provided with information of actual inflation in the euro area of 1.0% and a time series of inflation in the euro area as shown in Figure B2. No such information was provided to groups 1 and 3.

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