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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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### Anchoring of consumers' long-term euro area inflation expectations during the pandemic<sup>1</sup>

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#### Abstract

This paper analyses the results from a new monthly survey of consumers' euro area inflation expectations before and during the pandemic. We find that consumers' long-term euro area inflation expectations have remained elevated above the ECB's inflation aim throughout the pandemic. Moreover, their distributions have continuously shown a greater probability of high inflation (2pp above the ECB's inflation aim of 2%) than of deflation during the pandemic. These results suggest that during the pandemic consumers' long-term euro area inflation expectations have been de-anchored on the upside rather than on the downside. This is in contrast to concerns by ECB policymakers about a de-anchoring on the downside during the pandemic. We find that during the pandemic consumers' expected probabilities in the long term of deflation in the euro area have been above those from the ECB Survey of Professional Forecasters, and below those implied by options. We also find based on consumers' point inflation expectations and on three measures calculated directly from their individual expected probability distribution, that consumers' long-term euro area inflation expectations have been better anchored for higher education levels and for higher net household income.

Keywords: Inflation expectations.

JEL classification: E31, E52, E58.

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#### 1. Introduction

The Covid-19 pandemic caused a sharp contraction in global activity and a marked decline in inflation, in some instances even into negative territory. Especially in this environment, inflation expectations are seen as playing a crucial role for the effectiveness and transmission of monetary policy. With inflation expectations by financial market participants in the euro area well below the ECB's inflation aim, a number of policymakers in the euro area have voiced concerns about the risk of expectations of low inflation becoming entrenched and long-term inflation expectations becoming less well anchored to the ECB's inflation aim (e.g. Cœuré, 2019a). The anchoring of long-term inflation expectations has also played a central role in the recent debate on monetary frameworks, such as price level targeting or average inflation targeting, which attribute a key role to expected inflation (e.g. Powell and Wessel, 2020).

In the past, central banks and researchers have mainly focused on the anchoring of expectations by market participants and professional forecasters, mainly because data on these measures are readily available at high frequency. Particularly since the seminal work by Coibion and Gorodnichenko (2015), a growing research literature has examined the dynamics and drivers of inflation expectations by households and firms. Research on consumers' expectations has been motivated by their direct effect on aggregate consumption decisions, and thereby growth and inflation<sup>2</sup>. Moreover, household inflation expectations have been found to be a good proxy of firms' pricing decisions, and firms seem to form their inflation expectations more like households than as professional forecasters.<sup>3</sup> In recent years, the policy debate has also increasingly turned its focus to the anchoring of expectations by households and firms, given their key role – at least as important as that of financial markets and professional forecasters – in the monetary transmission mechanism (e.g. Cœuré, 2019b; Tenreyro, 2019, Villeroy de Galhau, 2019; Weidmann, 2019).

This paper assesses how the Covid crisis has affected the anchoring of households' inflation expectations in the euro area. The paper analyses the results from a satellite

<sup>&</sup>lt;sup>2</sup> See Armantier et al. (2015), Duca et al. (2018) and Coibion et al. (2020).

<sup>&</sup>lt;sup>3</sup> See Coibion and Gorodnichenko (2015) and Kumar et al. (2015).

survey of the DHS on Dutch consumers' long-term euro area inflation expectations conducted shortly before and during the pandemic, from December 2019 to September 2020. An analysis of the first wave of this survey conducted in December 2019 was presented in Galati et al. (2020). In this paper we investigate the anchoring properties of consumers' long-term euro area inflation expectations over time, by relying on the responses for ten waves of the survey conducted between December 2019 and September 2020. We also compare the results of this survey with those from the ECB's Survey of Professional Forecasters, and with measures of expectations by financial market participants derived from inflation swaps, breakeven inflation rates and option prices.

We find that consumers' median long-term euro area inflation expectations have remained elevated above the ECB's inflation aim throughout the Covid-19 crisis. Moreover, the individual probability distributions of consumers' long-term euro area inflation expectations have implied a greater probability of high inflation (2 percentage points (pp) above the ECB's inflation aim of 2%) than of deflation during the pandemic, in contrast to market-based measures of long-term euro area inflation expectations. These results suggest that during the pandemic consumers' long-term euro area inflation expectations have continuously been de-anchored on the upside rather than on the downside. This is in contrast to concerns by ECB policymakers about a de-anchoring of long-term inflation expectations on the downside during the pandemic, based on market-based measures.

These results are consistent with findings that consumers tend to associate a more pessimistic economic outlook, as happened in the recession during the pandemic, with higher inflation. Empirical evidence confirms this supply-side view on inflation for households and to some extent also for firms in advanced economies (Candia et al. (2020), Coibion et al. (2019)). These results are also consistent with US households' long-term median inflation expectations having remained elevated and above the Federal Reserve's inflation target throughout the pandemic (Appendix Figure B1).

We find that during the pandemic consumers' expected probabilities in the long term of deflation in the euro area have been above those from the ECB Survey of Professional Forecasters, and below those implied by options.

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We also find that consumers who were provided with information about actual inflation and the ECB's inflation aim attached somewhat lower probabilities in the long term to high inflation and somewhat higher probabilities to deflation, compared with those who received no information.

We also find based on consumers' long-term euro area point inflation expectations, and based on three measures 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, that long-term euro area inflation expectations are better anchored for higher education levels and for higher net household income.

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

#### 2. DHS satellite survey of consumers' inflation expectations

This paper analyses the results from a new DHS satellite survey conducted from December 2019 to September 2020. The data are taken from a monthly survey about consumers' short- and long-term levels inflation expectations, of one and ten years ahead, respectively. Each quarter, the survey includes additional questions where consumers are asked to provide their individual probability distributions of expected short- and long-term levels inflation.

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. The fourth group was provided with information about actual inflation in the Netherlands and the ECB's price stability aim. 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 for inflation in the Netherlands and 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 A1 and A2 in Appendix A).

The anchoring properties of consumers' long-term euro area inflation expectations based on the first wave of the survey conducted in December 2019 were analysed in Galati et al. (2020). In this paper we analyse the anchoring properties of consumers' longterm euro area inflation expectations over time from ten waves of the survey conducted between December 2019 and September 2020. Appendix A provides the exact wording of survey questions.

#### 3. 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 before the Covid-19 pandemic is mixed. Since the outbreak of the pandemic, however, there has been increasing evidence that inflation expectations in the euro area have become less firmly anchored to the ECB's inflation aim,

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 between the Global Financial Crisis (GFC) and 2020. 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 longterm 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.

Studies that rely on data that include the Covid-19 crisis instead point to significant changes in the anchoring of professional forecasters' inflation expectations. Cecchetti et al. (2021), for example, report results of an analysis of the joint probability distribution of growth and inflation expectations of forecasters in the euro area derived from the SPF, and find evidence that survey respondents have come to view low inflation as increasingly likely.

Overall, research that uses market-based measures of long-term inflation expectations in the euro area points to some changes in their anchoring properties, particularly after the GFC, in the wake of the euro area sovereign debt crisis and around 2014. This is particularly the case for studies that focus on the information content of higher moments of the probability distribution of expectations derived from inflationlinked 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 longterm 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

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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.

More recent studies that are based on sample periods that include the sharp fall in market-based long-term inflation expectations in 2019 and the Covid-19 crisis in 2020, find evidence that long-term inflation expectations may have weakened more significantly (Cecchetti et al., 2021).

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. Detmeister et al. (2016) and Draeger and Lamla (2018) analyse long-term US inflation expectations (five to ten years ahead) from the University of Michigan Surveys of Consumers.<sup>4</sup> Draeger and Lamla (2018) find that long-run consumers' US inflation expectations became more anchored over the last decades, as the degree of co-movement between short- and long-run expectations fell significantly. They also find that long-term inflation expectations of older cohorts remained less well-anchored than those of younger cohorts on this measure. Bruine de Bruin et al. (2011) study the Federal Reserve Bank of New York Survey of Consumer Expectations for the United States. Armantier et al. (2019) study how five-year-ahead US consumer inflation expectations in July 2019, where respondents are presented with hypothetical inflation scenarios. Binder and Rodrigue (2018) use an experiment embedded in a survey conducted online in March 2017 via a crowdsourcing web service to analyse the response of US consumers'

<sup>&</sup>lt;sup>4</sup> 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.

long-run inflation expectations to information about the Federal Reserve's inflation target and past inflation. They find that respondents revise forecasts toward the inflation target with the provision of either information. Research on inflation expectations in Canada shows that consumers' expectations moved farther above the Bank of Canada's inflation target as the horizon increased, and tend to be consistently above actual inflation and the inflation target (Kryvtsov and MacGee, 2020). Schembri (2020) suggests that this may reflect Canadian consumers' rational inattention, given that low and stable inflation in Canada over the past 25 years.

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. Vellekoop and Wiederholt (2019) find that households in the Netherlands with higher short-term inflation expectations save less. Andrade et al. (2020) study short-term (one-year-ahead) inflation expectations of French households. They find that the most important component is the share of households that expect prices to "stay about the same", and a significant effect on households' consumption decisions. Draeger et al. (2020) study short-term (one-year-ahead) inflation expectations of German households, and find that a majority of consumers believe that expected inflation is too high.

There has also been more literature on short-term inflation expectations of consumers in other countries. For example, Armantier et al. (2016) study one- and threeyear ahead inflation expectations of consumers in the United States. They find that respondents update these expectations in response to certain types of information, and do so sensibly, in a manner consistent with Bayesian updating. Gosselin and Kahn (2015) find that short-term inflation expectations of consumers in Canada are higher for lesseducated, lower-income and younger households. Moessner et al. (2011) study one yearahead 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.

#### 4. Method and results

In this section we analyse the responses to the monthly DHS satellite surveys conducted from December 2019 to September 2020, i.e. shortly before and during the pandemic.

We consider different measures of anchoring, which capture different aspects of the anchoring properties of long-term inflation expectations, namely "level anchoring" and "shock anchoring".<sup>5</sup> Ball and Mazumber (2011) distinguish between these two kinds of anchoring. Level anchoring means that long-term inflation expectations are tied to a particular level of inflation. Shock anchoring means that transitory shocks to inflation are not passed into long-term inflation expectations. A former chair of the Federal Reserve put this concept as follows: if "the public reacts to a short period of higher-than-expected inflation by marking up their long-run expectation considerably, then expectations are poorly anchored" (Bernanke, 2007).

<sup>&</sup>lt;sup>5</sup> For an overview of different ways to define and measure the anchoring of inflation expectations, see e.g. Grishchenko et al. (2019). There is no widely agreed-upon single definition of "anchored" inflation expectations (Kumar et al., 2015). For a literature review of the recent anchoring properties of long-term inflation expectations in the euro area see Galati et al. (2020).

One commonly used measure of the level anchoring of long-term inflation expectations captures how close long-term inflation expectations are to the level desired by monetary policymakers (e.g. Grishchenko et al., 2019). 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.

A commonly used measure for the shock anchoring of long-term inflation expectations captures whether changes in long-term inflation expectations are related to inflation news as reflected in changes in short-term inflation expectations (see e.g. Draeger and Lamla (2018), 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' point inflation expectations

The evolution of the median of consumers' long-term euro area point inflation expectations is shown in Figure 1. We can see that median expected inflation has remained above the ECB's inflation aim of 2% both shortly before and during the pandemic, for groups 3 and 4 together, as well as for each of the groups separately. The median has been around 1pp lower for respondents in group 4 who received information about the ECB's inflation aim and actual euro area inflation. The median of consumers' long-term euro area point inflation expectations has also been higher than the median short-term expectations which equal 2% (see Figure 2). We can also see that the median of consumers' long-term euro area point inflation expectations has been higher throughout the pandemic than market-based (implied by inflation swaps and breakeven

inflation rates) and professional survey-based (from the ECB Survey of Professional Forecasters and Consensus survey) long-term inflation expectations (Figure 3).<sup>6</sup>

Summary statistics for consumers' euro area inflation expectations from the levels expectations survey for all ten waves of the survey together are shown in Appendix Table B1. We can see that for short-term expectations, the median and interquartile range are very similar for groups 3 and 4. By contrast, for long-term expectations, the median for group 4, who received information about actual inflation and the ECB's inflation aim, the median is lower by 1pp, and the interquartile range is lower by 3pp. This suggests that such a provision of information can reduce both the level and the disagreement among consumers for long-term euro area inflation expectations.

We next consider whether mean long-term inflation expectations differ significantly between the two groups 3 and 4 to which respondents were assigned (see Appendix A). We estimate the following regression for euro area inflation expectations (responses for groups 3 and 4),

$$\pi_{it}^{LT} = c + \delta_t + \beta_4 \text{ gdum} 4_i + \varepsilon_{it} \quad (1)$$

where  $\pi^{LT}_{it}$  denotes 10 year ahead expected inflation of respondent *i* at time *t*, the dummy variable gdum4<sub>i</sub> indicates whether the respondent *i* belongs to group 4 (a value of one indicates that the respondent belongs to group 4, and a value of zero denotes that the respondent belongs to group 3), and  $\delta_t$  denotes time-specific effects.

Surveys of consumers' point inflation expectations generally have to deal with the methodological problem of outliers, in contrast to surveys of professionals. One way to address them is to report medians instead of means for first moments, and interquartile ranges instead of standard deviations for second moments. Another way to deal with outliers in regressions is to impose cutoffs. In this and other regressions for consumers' point inflation expectations, we deal with outliers by winsorizing the observations at - 30% and 30%, i.e. we set observations above a cutoff of 30% to 30% and those below -

<sup>&</sup>lt;sup>6</sup> This is also the case for the median calculated from the consumers' long-term probability distributions described in Section 4.2 as the midpoint of the interval where the cumulative distribution first reaches 50% (see Figure 4).

30% to -30%.<sup>7</sup> In order to investigate the robustness to the outlier treatment, we also report regression estimates in which we use cutoff levels for short and long-term inflation expectations of 10% and 50%, as well as for trimming (i.e. deleting) observations above these positive and below these negative cutoff levels.

An advantage of our survey is that for means of and regressions involving expected probabilities, outliers do not pose a problem, since they are included in the highest and lowest probability bins. Consequently, for means of and regressions involving expected probabilities below, no cutoff is applied.

We also consider 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  $Dedu_i^{mid} \text{ and } Dedu_i^{high}, \text{ respectively. The dummy variables } Dedu_i^{mid} \text{ and } Dedu_i^{high} \text{ equal}$ 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  $Dage_i^{mid}$  and  $Dage_i^{high}$ , respectively. The dummy variables  $Dage_i^{mid}$  and  $Dage_i^{high}$  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<sub>i</sub><sup>high</sup>. The dummy variable Dnethinc<sub>i</sub><sup>high</sup> 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<sub>i</sub> which equals one for female respondents and zero for male respondents. We estimate the following regression for euro area inflation expectations,

$$\pi_{it}^{LT} = c + \delta_t + \beta \operatorname{Dfem}_i + \gamma_1 \operatorname{Dage}_i^{mid} + \gamma_2 \operatorname{Dage}_i^{high} + \delta_1 \operatorname{Dedu}_i^{mid} + \delta_2 \operatorname{Dedu}_i^{high} + \beta_3 \operatorname{gdum}_i^4 + \varepsilon_{it}$$
(2)

<sup>&</sup>lt;sup>7</sup> The histogram of consumers' long-term euro area point inflation expectations corresponding to this cutoff is shown in Appendix Figure B3.

The results of equation (1) are shown in column (1) of Table 1 (while column (2) reports the results when controlling for socio-demographic characteristics according to equation (2)). We find that mean long-term inflation expectations are significantly lower, by 1 pp, for group 4 whose respondents were provided with information about current and past euro area inflation and the ECB's inflation aim (which result holds irrespective of whether demographic characteristics are included or not). Notably, the most recent euro area inflation realisations shown to respondents vary between -0.2% and 1.4%, while the historical information documents a mean inflation rate of 1.6% (varying between a minimum value of -0.7% in July 2009 and a maximum value of 4.0% in July 2008). This suggests that communication about the inflation aim and actual inflation can affect consumers' long-term inflation expectations.

The results of equation (2) are shown in Table 2 (column (1)). We find that long-term euro inflation expectations are significantly lower at the 1% level for respondents with high net household income and with high education. These estimates are from a pooled OLS regression which treats the individual effects as part of the error term based on the assumption that individual effects are independent of the covariates.

Column (2) of Table 2 reports regression estimates of the same equation, except that short-term inflation expectations,  $\pi^{ST}_{it}$  (one-year ahead expected inflation of respondent *i* at time *t*), are included as an additional independent variable. The advantage is that the variation of short-term inflation expectations across different waves of the survey allows us to estimate a random correlated regression model (based on the assumption of a specific linear relation between individual effects and the covariates).<sup>8</sup> As expected, the results show a strong and positive correlation between short and long-term inflation expectations. The coefficient for the group 4 dummy (i.e. the group that is treated with information on current and past inflation) more than halves (from -1 to -0.4), and is significant at a confidence level of 10% only. Thus, while the information provision seems to lower inflation expectations both for the short and the long term, the impact of showing current and past inflation rates on lowering long-term inflation expectations is larger than the effect through lowering short-term inflation expectations. Furthermore,

<sup>&</sup>lt;sup>8</sup> Note that fixed effects regressions cannot provide estimates of time-invariant variables such as the socio-demographic characteristics of respondents.

once controlling for expected short-term inflation, high-income respondents continue to report significantly lower long-term inflation expectations. While the high education dummy turns insignificant, men and older respondents report significantly higher longterm inflation expectations over and above the impact of short-term inflation expectations.

Note that the regressions in Table 2 include time fixed effects (i.e. the wave dummies  $\delta_t$  in equation (2)), which are shown in Appendix Table B2 for each of the waves 2 to 10 of the survey. We can see that the mean long-term inflation expectations were significantly lower during these survey waves than in the December 2019 baseline survey, by between around 0.6pp and 2.5pp.

The panel structure of the survey enables us to study the anchoring of long-term euro area inflation expectations by estimating a regression of monthly changes in longterm inflation expectations on monthly changes in short-term inflation expectations,

$$\Delta \pi_{it}^{LT} = c + \delta_t + \beta \Delta \pi_{it}^{ST} + \beta_3 \text{ gdum} 4_i + \varepsilon_{it} \quad (3)$$

where  $\varDelta$  denotes the monthly difference operator, and  $\pi^{ST}_{it}$  denotes one-year ahead expected inflation of respondent *i* at time *t*. By using the panel structure to measure changes in expectations over time, we are able to control for unobserved individual heterogeneity without making more specific assumptions about the correlation between the individual effects and the covariates. Long-term inflation expectations are wellanchored under this measure if  $\beta$  is not significantly different from zero. This is a commonly used measure for the anchoring of long-term inflation expectations based on measures derived from financial instruments or surveys (see e.g. Draeger and Lamla (2018), Jochmann et al., 2010; Lamla and Draeger, 2013; Łyziak and Paloviita, 2017; Buono and Formai (2018); 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 changes in long-term inflation expectations are related to inflation news as reflected in changes 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 no or a small effect only 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 (3) are shown in panel A of Table 3 for a random effects regression, a fixed effects regression and a correlated random effects regression (where in the latter regression we include socio-demographic variables). As expected the estimation results are very similar across the three different panel regressions, since any linear individual effect that may have been present in the level specification has fallen out of the specification in first differences.<sup>9</sup>

We find across all three specifications that, at 0.55,  $\beta$  is significantly different from zero at the 1% significance level. This provides evidence of long-term euro area inflation expectations of Dutch consumers not being well-anchored at the ECB's inflation aim. In panel B of Table 3 we report a robustness analysis in which we do not winsorize very high or very low inflation expectations at 30% and -30%, but rather delete these observations. The results are quite robust to this alternative treatment of observations, we find that  $\beta$  equals 0.51 in all three specifications (again significantly different from zero at the 1% significance level). We conduct several additional robustness tests for different ways of dealing with outliers, and find that the conclusion that long-term euro area inflation expectations of Dutch consumers are not well-anchored at the ECB's inflation aim is robust to these treatments, with  $\beta$  still significantly different from zero at the 1% significance level, taking values of around 0.4 to 0.6 (see Appendix Table B3).<sup>10</sup>

<sup>&</sup>lt;sup>9</sup> Indeed, if we would have found evidence of fixed individual effects in equation (3), this would point to an incidental trend in the level specification.

<sup>&</sup>lt;sup>10</sup> When winsorizing inflation expectations at cutoffs of 10% and 50% instead of 30%,  $\beta$  is still significantly different from zero at the 1% significance level and takes values of 0.4 and 0.57-0.58, respectively (see panel A of Appendix Table B3). When trimming observations for cutoffs of 10% and 50%, the corresponding values of  $\beta$  are 0.38 and 0.58-0.59, respectively, and again significantly different from zero at the 1% level (panel B of Appendix Table B3).

## 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 4.1, since it includes both individual probability distributions and disagreement between individuals. By contrast, the distribution of point expectations presented in Section 4.1 only reflects disagreement among consumers, but not their individual probability distributions.

We consider measures of anchoring of long-term inflation expectations based on expected probabilities of consumers, which can be calculated directly by averaging individual probability distributions 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 at time t to interval j at horizon h is denoted by  $f_{it}^{j,h}$ . The frequency of the aggregate histogram at time t in each interval j,  $f_t^{i,h}$ , is then calculated according to (see Krueger and Nolte, 2016):

$$f_t^{j,h} = \frac{1}{N} \sum_{i=1}^{N} f_{it}^{j,h}$$
(4)

where  $f_t^{j,h}$  is the frequency assigned in the aggregated histogram to inflation being in interval *j* at horizon *h* at time *t*, 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 5 for both long-term euro area inflation expectations (from responses of groups 3 and 4 in the DHS satellite survey).

#### 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 5). 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,  $ptr_t^h$ , 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

$$ptr_t^{h} = \sum_{j=7}^{8} f_t^{j,h}$$
(5)

For euro area inflation, we obtain values of  $ptr_t^{LT}$  below 40% in each survey from December 2019 to September 2020 for this measure of the survey-based probability of inflation ten years ahead falling between 1% and 3% from equation (5) (see Figure 5). This measure based on the aggregate probability distribution suggests that Dutch consumers' long-term euro area inflation expectations have not been well anchored during the pandemic.

#### Tail probabilities

Next, we use the average of the individual probability distributions of expected inflation to compare the probability of inflation being very high (2pp or more above the ECB's inflation aim of 2%, i.e. above 4%), denoted by phigh<sup>h</sup><sub>t</sub>, with the probability of inflation being very low (2pp or more below the ECB's inflation aim, i.e. below 0%) at the long-term horizon (h=LT). The probability of expected long-term euro area inflation being above 4% is 28% or higher in each survey from December 2019 to September 2020 28.4%, which is shown directly in Figure 5. The probability of deflation expected in the long-term, pdef<sup>h</sup><sub>t</sub>, for horizon h=LT at time *t*, 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

$$pdef_t^{h} = \sum_{j=1}^{5} f_t^{j,h}$$
(6)

For euro area inflation, we obtain deflation probabilities  $pdef_t^{LT}$  above 9% in each survey from December 2019 to September 2020 based on the measure of equation (6). A comparison with the expected probability of euro area inflation being above 4%, phigh\_t^T, which was 28% or higher in each of these surveys (Figure 5), shows that respondents have perceived a greater risk of euro area inflation being very high (2pp or more above the ECB's inflation aim of 2%), than of euro area inflation being very low (2pp or more below the ECB's inflation aim) at the long-term horizon shortly before and during the pandemic. These results suggest that households' long-term euro area inflation expectations have not become de-anchored on the downside during the pandemic.

Consumers' long-term euro area inflation expectations have implied a greater probability in the long term of high inflation than of deflation during the pandemic both for respondents who were provided with information about actual inflation and the ECB's inflation aim and those who were not (see Figures 6 and 7). Respondents who were provided with information about actual inflation and the ECB's inflation aim attached somewhat lower probabilities to high inflation and somewhat higher probabilities to deflation, compared with those who received no information (see Figures 6 to 9).

We next quantify the effect of the provision of information on expected probabilities by estimating the following regression for expected probabilities (responses for groups 3 and 4),

$$\text{prob}_{it}^{h} = c + \delta_{t} + \beta_{4} \text{ gdum} 4_{i} + \varepsilon_{it} \quad (7)$$

where  $\text{prob}_{it}^{h}$  can equal  $\text{ptr}_{it}^{h}$ ,  $\text{phigh}_{it}^{h}$ , or  $\text{pdef}_{it}^{h}$ , for h=LT. We again use random effects panel estimation. The results of equation (7) are shown in columns (3), (5) and (7) of Table 1 (results when in addition controlling for sociodemographic characteristics are shown in columns (4), (6) and (8)). We find that the long-term expected probability of deflation and of inflation being close to target is significantly higher and that of high inflation is significantly lower for group 4 whose respondents were provided with information about current and past euro area inflation and the ECB's inflation aim. This suggests that communication about the inflation aim and actual inflation can affect consumers' longterm expected probabilities of euro area inflation.

Candia et al. (2020) find that households tend to interpret inflation news differently to professional forecasters. They find that households tend to associate lower expected growth with higher expected inflation, consistent with a supply-side view. This is in contrast to professional forecasters who tend to associate lower expected growth with lower expected inflation, consistent with a demand-side view. Candia et al. (2020) conclude that central bank communication with the public therefore needs to be designed carefully. Some studies have shown that news about higher future inflation with a more pessimistic economic outlook. Other empirical evidence confirms this supply-side view on inflation for households and to some extent also for firms in advanced economies (Coibion et al. (2019)).

The evolution of consumers' expected probabilities in the long term of deflation are shown in Figure 10. Also shown for comparison are the corresponding measures implied by financial markets (by options) and by professional surveys (the ECB Survey of Professional Forecasters). We can see that during the pandemic consumers' expected probabilities in the long term of deflation have been above those from the ECB Survey of Professional Forecasters, and below those implied by options.

The evolution of consumers' expected probabilities in the long term of high inflation are shown in Figure 11. Also shown for comparison are again the corresponding measures implied by options and by the ECB Survey of Professional Forecasters. We can see that during the pandemic consumers' expected probabilities in the long term of high inflation have been above those of both professional forecasters and those implied by options.

The evolution of consumers' expected probabilities in the long term of inflation being close to the ECB's inflation aim are shown in Figure 12. We can see that during the pandemic consumers' expected probabilities in the long term of inflation being close to the ECB's inflation aim have been below those of professional forecasters, and above those implied by options.

A comparison of the expected probability distributions of consumers with those of professional surveys and those implied by options are shown in Figures 13 and 14 for December 2019 and for September 2020. We can see differences in the shape of the probability distributions between consumers and professionals, and also between those of professional surveys and those implied by options.

These results suggest that households' long-term euro area inflation expectations have not become de-anchored on the downside during the pandemic, in contrast to market-based measures.

## 4.3 Determinants of individual probability distributions of consumers' inflation expectations

In this section we study the determinants of the individual probability distributions of Dutch consumers' euro area 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* at time *t* of future euro area inflation lying between 1.0% and 3.0%, is calculated as the sum of the frequencies assigned by respondent *i* at time *t* in the histogram at the long-term or short-term horizon (h=LT or *ST*) 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

$$ptr_{it}^{h} = \sum_{j=7}^{8} f_{it}^{j,h}$$
(8)

The survey-based probability for consumer *i* at time *t* of future euro area inflation being negative (i.e. of deflation) is calculated as the sum of the frequencies assigned by respondent *i* at time *t* 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

$$pdef_{it}^{h} = \sum_{j=1}^{5} f_{it}^{j,h}$$
(9)

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

$$phigh_{it}^{h} = f_{it}^{10,h}$$
(10)

We study the determinants of these individual probability distributions of consumers' euro area inflation expectations. As determinants we consider the same sociodemographic 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,

$$prob_{it}^{h} = c + \delta_{t} + \beta Dfem_{i} + \gamma_{1} Dage_{i}^{mid} + \gamma_{2} Dage_{i}^{high} + \delta_{1} Dedu_{i}^{mid} + \delta_{2} Dedu_{i}^{high} + \mu Dnethinc_{i}^{high} + \beta_{4} gdum4_{i} + \varepsilon_{it}$$
(11)

where  $\text{prob}_{it}^{h}$  can equal  $\text{ptr}_{it}^{h}$ ,  $\text{phigh}_{it}^{h}$ , or  $\text{pdef}_{it}^{h}$ , for h=LT, for each of which we run separate regressions, and with the dummy variables as defined above. We again use random effects panel estimation.

The results are shown in Table 4 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<sub>it</sub><sup>LT</sup>, is significantly higher if the education level is higher, if net household income is higher, for older respondents and for men (column (5) of Table 4). These results suggest that long-term inflation expectations are better anchored for men, for older respondents, for higher education levels and 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 (2pp or more) above target in the long term, phigh<sup>LT</sup><sub>it</sub>, is significantly lower if education is higher, if net household income is higher, and for men (column (1) of Table 4). These results suggest that long-term inflation expectations are better anchored for higher education

level, for higher net household income and for men, 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. 2pp or more below target) in the long term, pdef<sub>it</sub><sup>LT</sup>, is significantly lower if the education level is higher, if net household income is higher, for older respondents and for men (column (3) of Table 4). 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<sub>it</sub><sup>LT</sup>, the probability of inflation being far above target,  $phigh_{it}^{LT}\text{,}$  and the probability of deflation,  $pdef_{it}^{LT}\text{,}$  we find that long-term euro area inflation expectations are better anchored for higher education levels, for higher net household income, and for men. These results are based on pooled OLS regressions which assume that individual effects are not correlated with the sociodemographic variables. We can relax this assumption once we include short-term inflation expectations. The correlated random effects regressions in columns (2), (4) and (6) of Table 4 show that there is a positive correlation between the individual probabilities of having short-term inflation expectations close to (far above/far below) target and the individual probabilities of having long-term inflations expectations close to (far above/far below) target. Taking into account the individual probabilities of short-term inflation expectations takes away some explanatory power of the sociodemographic characteristics for long-term inflation expectations (these characteristics apparently feed into the long-term inflation expectations via their effect on short-term inflation expectations). However, mostly the sociodemographic characteristics still contribute to the explanation of long-term inflation expectations over and above the contribution through short-term inflation expectations. In particular, the expected probability of long-term inflation being close to the inflation aim is higher for men, respondents with high education and high income, and those who are between 45 and 65 years old (over and above the effect of the expected probability of short-term inflation being close to target).

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

We also study the anchoring of long-term euro area inflation expectations by estimating a regression of quarterly changes in long-term expected probabilities on quarterly changes in the corresponding short-term expected probabilities,

$$\Delta \text{prob}_{it}^{\text{LT}} = c + \delta_t + \beta \Delta \text{prob}_{it}^{\text{ST}} + \beta_3 \text{ gdum} 4_i + \epsilon_{it} \quad (12)$$

where  $\Delta$  denotes the quarterly difference operator, and prob<sup>h</sup><sub>it</sub> denotes the short-term (h=ST) or long-term (h=LT) expected probability of respondent *i* at time *t* for inflation to be high (prob<sup>h</sup><sub>it</sub> = phigh<sup>h</sup><sub>it</sub>), negative (prob<sup>h</sup><sub>it</sub> = pdef<sup>h</sup><sub>it</sub>), or close to the inflation aim (prob<sup>h</sup><sub>it</sub> = ptr<sup>h</sup><sub>it</sub>). This equation is estimated with random effects panel regressions. The results of equation (12) are shown in columns (1), (3) and (5) of Table 5, in particular in (columns (2), (4) and (6) extend these regressions by including sociodemographic characteristics). We can see that the coefficient  $\beta$  is positive and significant for all three different probabilities, phigh<sup>h</sup><sub>it</sub>, pdef<sup>h</sup><sub>it</sub> and ptr<sup>h</sup><sub>it</sub>. The interpretation is that any adjustment in the expected probability distribution of short-term inflation (12 months ahead) partly translates into a shift of the expected probability distribution of long-term inflation expectations, when well anchored, would not respond to short-term inflation expectations, this is further evidence of some de-anchoring of the long-term euro area inflation expectations of Dutch consumers.

### 5. Conclusions

This paper analyses the results from a new survey of consumers' long-term euro area inflation expectations before and during the pandemic. We find that consumers' long-term euro area inflation expectations have remained elevated above the ECB's inflation aim throughout the pandemic. Moreover, the distributions of consumers' long-term euro area inflation expectations have implied a greater probability of high inflation (2pp above the ECB's inflation aim of 2%) than of deflation during the pandemic.

These results suggest that during the pandemic consumers' long-term euro area inflation expectations have been de-anchored on the upside rather than on the downside, in contrast to market-based measures of long-term euro area inflation expectations. This is in contrast to concerns by ECB policymakers about a de-anchoring of long-term inflation expectations on the downside during the pandemic. These results are consistent with US households' long-term median inflation expectations having remained elevated throughout the pandemic.

We find that during the pandemic consumers' expected probabilities in the long term of deflation in the euro area have been above those from the ECB Survey of Professional Forecasters, and below those implied by options.

We find that consumers who were provided with information about actual inflation and the ECB's inflation aim attached somewhat lower probabilities in the long term to high inflation and somewhat higher probabilities to deflation, compared with those who received no information.

We also find based on consumers' long-term euro area point inflation expectations, and based on three measures 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, that long-term euro area inflation expectations are better anchored for higher education levels and for higher net household income.

#### References

Andrade, P., Gautier, E. and E. Mengus (2020). "What matters in households' inflation expectations?", CEPR Discussion Paper No. 14905.

Antunes, A. (2015). "Co-movement of revisions in short- and long-term inflation expectations". Banco de Portugal Economic Studies, May.

Apokoritis, N., Galati, G., Moessner, R. and F. Teppa (2019). "Inflation expectations anchoring: new insights from micro evidence of a survey at high-frequency and of distributions", DNB Working Paper No. 809.

Aramonte, S, M Jahan-Parvar, S Rosen and J Schindler (2019): "Firm-specific risk neutral distributions with options and CDS", https://ssrn.com/abstract=2908524 .

Armantier, O., Bruine de Bruin, W., Topa, G., van der Klaauw, W. and B. Zafar (2015). "Inflation expectations and behavior: Do survey respondents act on their beliefs?", International Economic Review, 56(2), 505-36.

Armantier, O., van der Klaauw, W., Nelson, S., Topa, G. and B. Zafar (2016). "The price is right: Updating of inflation expectations in a randomized price information experiment." Review of Economics and Statistics, 98(3) (July), 503-23.

Armantier, O., Sbordone, A., Topa, G. and W. van der Klaauw (2019). "Are consumer inflation expectations well-anchored?" Mimeo, Federal Reserve Bank of New York.

Bachmann, R., Berg, T. and E. Sims (2015). "Inflation expectations and readiness to spend: Cross-sectional evidence". American Economic Journal: Economic Policy 7(1), 1–35.

Baerg, N., Duell, D. and W. Lowe (2018). "Central bank communication as public opinion? Experimental evidence". Mimeo, University of Essex.

Baker, M. (1992). "Digit preferences in CPS unemployment data". Economic Letters 39(1), 117-121.

Ball, L. and S. Mazumber (2011). "Inflation dynamics and the Great Recession". Brookings Papers on Economic Activity, Spring, 311-405. Bernanke, B. (2007). "Inflation expectations and inflation forecasting". Speech given at the Monetary Economics Workshop of the National Bureau of Economic Research Summer Institute, Cambridge, Massachusetts, 10 July.

Bernanke, B. (2019). "Evaluating lower-for-longer policies: Temporary price-level targeting". Brookings blog, 21 February.

Bernanke, B., Kiley, M. and J. Roberts (2019). "Monetary policy strategies for a low-rate environment". AEA Papers and Proceedings, 109, May, 421-26.

Binder, C. and A. Rodrigue (2018). "Household informedness and long-run inflation expectations: Experimental evidence". Southern Economic Journal, 85(2), 580-98.

Boero, G., Smith, J. and K. Wallis (2008). "Uncertainty and disagreement in economic prediction: the Bank of England survey of external forecasters", Economic Journal 118, 1107–1127.

Brainard, L. (2017). "Understanding the disconnect between employment and inflation with a low neutral rate". Speech at The Economic Club of New York, 5 September.

Bruine de Bruin, W., Manski, C., Topa, G. and W. van der Klaauw (2011). "Measuring consumer uncertainty about future inflation", Journal of Applied Econometrics, 26, 454-478.

Bruine de Bruin, W., van der Klaauw, W., van Rooij, M., Teppa, F. and K. de Vos (2017). "Measuring expectations of inflation: Effects of survey mode, wording, and opportunities to revise", Journal of Economic Psychology 59, 45–58.

Buono, I. and S. Formai (2018). "The evolution of the anchoring of inflation expectations", Journal of Macroeconomics 57(3), 39-54.

Busetti, F., Delle Monache, D., Gerali, A. and A. Locarno (2017). "Trust, but verify. Deanchoring of inflation expectations under learning and heterogeneity," ECB Working Paper Series No. 1994.

Candia, B., Coibion, O. and Y. Gorodnichenko (2020). "Communication and the beliefs of private agents", paper presented at the Jackson Hole Economic Symposium, Kansas.

Carney, M. (2020). "A framework for all seasons?" Speech given at the Bank of England Research Workshop on The Future of Inflation Targeting. 9 January.

Cecchetti, S., Natoli, F. and L. Sigalotti (2015). "Tail comovement in option-implied inflation expectations as an indicator of anchoring", Banca d'Italia Temi di Discussione No. 1025.

Christelis, D., Georgarakos, D., Jappelli, T. and M. van Rooij (2020). "Trust in the central bank and inflation expectations", International Journal of Central Banking, forthcoming.

Christensen, van Els, P. and M. van Rooij (2006). "Dutch households' perceptions of economic growth and inflation", De Economist 154(2). 277-94.

Clarida, R. (2019). "The Federal Reserve's review of its monetary policy strategy, tools, and communication practices". Remarks at "Fed Policy: A Shadow Review" Cato Institute's 37th Annual Monetary Conference Washington, D.C., 14 November.

Cœuré, B. (2019). "Inflation expectations and the conduct of monetary policy". Speech at an event organised by the SAFE Policy Center, Frankfurt am Main, 11 July.

Coibion, O. and Gorodnichenko, Y. (2015). "Is the Phillips curve alive and well after all? Inflation expectations and the missing disinflation". American Economic Journal: Macroeconomics, 7(1), 197-232.

Coibion, O. Gorodnichenko, Y. and R. Kamdar (2017). "The formation of expectations, inflation and the Phillips curve". Journal of Economic Literature. 56 (4). December, 1447-91.

Coibion, O., Georgarakos, D., Gorodnichenko, Y. and M. van Rooij (2019). "How does consumption respond to news about inflation? Field evidence from a randomized control trial", DNB Working Paper No. 651.

Coibion, O., Gorodnichenko, Y., Kumar, S. and M. Pedemonte (2020). "Inflation expectations as a policy tool?". Journal of International Economics, 124, 103297.

Corsello, F., Neri, S. and A. Tagliabracci (2019). "Anchored or de-anchored? That is the question". VOXEU, 5 November.

van der Cruijsen, C., Jansen, D.J. and J. de Haan (2015). "How Much Does the Public Know about the ECB's Monetary Policy? Evidence from a Survey of Dutch Households". International Journal of Central Banking, 11(4), 169-218.

27

Curtin, R. (2013), "Inflation expectations and empirical tests", in *Inflation expectations*, P. Sinclair (ed.), Routledge, p. 34-61.

D'Acunto, F., Hoang, D., Paloviita, M. and M. Weber (2019a). "Human frictions in the transmission of economic policy," Karlsruhe Institute of Technology Working Paper No. 128.

D'Acunto, F., Hoang, D., Paloviita, M. and M. Weber (2019b). "Cognitive abilities and inflation expectations", Karlsruhe Institute of Technology Working Paper No. 126.

D'Amico, S. and A. Orphanides (2008). "Uncertainty and disagreement in economic forecasting", Federal Reserve Board Finance and Economics Discussion Series No. 2008-56.

Detmeister, A., Lebow, D. and E. Peneva (2016). "Inflation perceptions and inflation expectations." FEDS Notes, Washington: Board of Governors of the Federal Reserve System, December 5 (accessed on 15 February 2020).

Dovern, J. and G. Kenny (2020). "Anchoring inflation expectations in unconventional times: Micro evidence for the euro area", International Journal of Central Banking, forthcoming.

Draeger, L. and M. Lamla (2018). "Are consumers' inflation expectations shaped by their inflation experience?", CESIfo Working Paper No. 7042.

Draeger, L., Lamla, M. and D. Pfajfar (2020). "The hidden heterogeneity of inflation expectations and its implications", University of Hannover Discussion Paper No. 666.

Draeger, L. and G. Nghiem (2020). "Are consumers' spending decisions in line with an Euler equation?. Review of Economics and Statistics, forthcoming.

Draghi, M. (2014a). "Monetary policy in the euro area", Opening keynote speech at the Frankfurt European Banking Congress, Frankfurt am Main, 21 November.

Draghi, M. (2014b). "Monetary policy in a prolonged period of low inflation". Speech at the ECB Forum on Central Banking on Monetary Policy in a Changing Financial Landscape. Sintra, 25-27 May. Duca, I., Kenny, G. and A. Reuter (2018). "Inflation Expectation, Consumption and the Lower Bound: micro evidence from a large euro area survey". ECB Working Paper No 2196.

Edouard, L. and A. Senthilselvan (1997), "Observer error and birthweight: Digit preference in recording", Public Health 11(2), 77-79.

Federal Reserve Bank of Chicago (2020). Summary of President Evans' Presentation on Countering Downward Bias in Inflation. A summary of a presentation delivered on February 27, 2020, at the Central Banking Conference sponsored by the Global Interdependence Center and Banco de México in Mexico City, Mexico.

Galati, G, Moessner, R and M van Rooij (2020): "The anchoring of long-term inflation expectations of consumers: insights from a new survey", DNB Working Paper No. 688, 2020.

Galati, G., Gorgi, Z., Moessner, R. and C. Zhou (2016). "Deflation risk in the euro area and central bank credibility". DNB Working Paper No. 509, April.

Galati, G., Gorgi, Z., Moessner, R. and C. Zhou (2018). "Deflation risk in the euro area and central bank credibility", Economics Letters 167, 124-126.

Gosselin, M.-A. and M. Kahn (2015): "A survey of consumer expectations for Canada". Bank of Canada Review, Autumn, 14-23.

Grishchenko, O., Mouabbi, S. and J.-P. Renne (2019). "Measuring inflation anchoring and uncertainty: A U.S. and euro area comparison", Journal of Money, Credit and Banking, 51(5).

Hartmann, P. and F. Smets (2018). "The first 20 Years of the European Central Bank: Monetary Policy". Brookings Papers on Economic Activity, September. Also available as ECB Working Paper 2219, December.

Jochmann, M., Koop, G. and S. Potter (2010). "Modeling the dynamics of inflation compensation". Journal of Empirical Finance 17, 157–167.

Knot, K. (2019). "The quest for policy scope: Implications for monetary policy strategies". Speech at the fourth annual high-level conference Racing for Economic Leadership: EU-US Perspectives, 16 October.

29

Kryvtsov, O. and J. MacGee (2020). "Has the Inflation Process Changed? Selective Review of Recent Research on Inflation Dynamics". Bank of Canada Staff Discussion Paper/Document d'analyse du personnel — 2020-11.

Kose, A., Matsuoka, H., Panizza, U., Vorisek, D. (2019). "Inflation Expectations: Review and Evidence". Policy Research working paper no. WPS 8785. Washington, D.C.: World Bank Group.

Krueger, F. and I. Nolte (2016). "Disagreement versus uncertainty: Evidence from distribution forecasts", Journal of Banking and Finance 72, S172–S186.

Kumar, S., Afrouzi, H., Coibion, O. and Y. Gorodnichenko (2015). "Inflation targeting does not anchor inflation expectations: Evidence from firms in New Zealand". NBER Working Paper No. 21814.

Lamla, M. and L. Draeger (2013). "Anchoring of consumers' inflation expectations". KOF Working Paper No. 339.

Łyziak, T. and M. Paloviita (2017). "Anchoring of inflation expectations in the euro area: Recent evidence based on survey data". European Journal of Political Economy 46, 52– 73.

Moessner, R. and E. Takats (2020). "How well-anchored are long-term inflation expectations?". BIS Working Paper No. 869.

Moessner, R., F. Zhu and C. Ellis (2011). "Measuring disagreement in UK consumer and central bank inflation forecasts", BIS Working Paper No. 339.

Nakata, T. (2020). "Raising the Inflation Target: Lessons from Japan". FEDS Notes, 8 January.

Natoli, F. and L. Sigalotti (2018). "Tail co-movement in inflation expectations as an indicator of anchoring", International Journal of Central Banking 14, 35–71.

Powell, T. and D. Wessel (2020). "What are inflation expectations? Why do they matter?". Brookings Blog, 30 November.

Rich, R. and J. Tracy (2018). "A closer look at the behavior of uncertainty and disagreement: Micro evidence from the euro area", Dallas Fed Working Paper No. 1811.

30

Scharnagl, M. and J. Stapf (2015). "Inflation, deflation, and uncertainty: What drives euro area option-implied inflation expectations and are they still anchored in the sovereign debt crisis?", Economic Modelling 48, 248–269.

Schembri, L. (2020). "Perceived Inflation and Reality: Understanding the Difference." Remarks at the Canadian Association for Business Economics, Kingston, Ontario, 25 August.

Schnabel, I. (2020). "How long is the medium term? Monetary policy in a low inflation environment". Speech at the Barclays International Monetary Policy Forum. London, 27 February.

Shin, H. (2017). "Can central banks talk too much?". Speech at the ECB conference on *Communications challenges for policy effectiveness, accountability and reputation*, Frankfurt, 14 November.

Tenreyro, S. (2019). "Understanding Inflation: Expectations and Reality". Ronald Tress Memorial Lecture, Birkbeck University of London, London, 10 July.

Teppa, F. and C. Vis (2012). "The CentERpanel and the DNB Household Survey: Methodological aspects", DNB Occasional Study 10(4).

Vellekoop, N. and M. Wiederholt (2019). "Inflation expectations and choices of households: Evidence from linked survey and administrative data," SAFE Working Paper no. 250.

### **Figures**

### Figure 1: Consumers' long-term euro area point inflation expectations, median from level expectations



### Figure 2: Consumers' short-term euro area point inflation expectations, median from level expectations



### Figure 3: Consumers' long-term euro area inflation expectations, median from level expectations, and professionals' expectations



Notes: DHS: Median from levels survey; SPF: ECB Survey of Professional Forecasters, five-year ahead euro area HICP inflation expectations, in the corresponding quarter, mean; Consensus survey: Five-year/five-year forward horizon, mean; Inflation swaps: Five-year/five-year forward horizon, at start of the month; Breakeven inflation rates: Five-year/five-year forward horizon, simple average for France and Germany, at start of the month.

### Figure 4: Consumers' long-term euro area inflation expectations, median from distributions survey, and professionals' expectations



Notes: DHS: Median calculated from probability distributions as midpoint of interval where cumulative distribution first reaches 50%; SPF: ECB Survey of Professional Forecasters, five-year ahead euro area HICP inflation expectations, in the corresponding quarter, mean; Consensus survey: Five-year/five-year forward horizon, mean; Inflation swaps: Five-year/five-year forward horizon, at start of the month; Breakeven inflation rates: Five-year/five-year forward horizon, simple average for France and Germany, at start of the month.

### Figure 5: Average of consumers' probability distributions of expected euro area inflation, all respondents



### Figure 6: Average of consumers' probability distributions of expected euro area inflation, respondents without information provided



### Figure 7: Average of consumers' probability distributions of expected euro area inflation, respondents with information provided



### Figure 8: Average of consumers' probability distributions of expected euro area inflation, December 2019



### Figure 9: Average of consumers' probability distributions of expected euro area inflation, September 2020



### Figure 10: Probability distributions of expected long-term euro area inflation, probability of deflation



Notes: SPF: ECB Survey of Professional Forecasters, five-year ahead euro area HICP inflation expectations, in the corresponding quarter; DHS: DHS satellite survey of consumers; Options: average annual HICP inflation over 5 years implied by option prices, at start of the month, derived based on Aaramonte et al. (2019).

### Figure 11: Probability distributions of expected long-term euro area inflation, probability of high inflation



Notes: SPF: ECB Survey of Professional Forecasters, five-year ahead euro area HICP inflation expectations, in the corresponding quarter; DHS: DHS satellite survey of consumers; Options: average annual HICP inflation over 5 years implied by option prices, at start of the month, derived based on Aaramonte et al. (2019).

### Figure 12: Probability distributions of expected long-term euro area inflation, probability of inflation close to target



Notes: SPF: ECB Survey of Professional Forecasters, five-year ahead euro area HICP inflation expectations, in the corresponding quarter; DHS: DHS satellite survey of consumers; Options: average annual HICP inflation over 5 years implied by option prices, at start of the month, derived based on Aaramonte et al. (2019).





Notes: DHS: DHS satellite survey of consumers; SPF: ECB Survey of Professional Forecasters, five-year ahead euro area HICP inflation expectations, in the corresponding quarter; Options: average annual HICP inflation over 5 years implied by option prices, at start of the month, derived based on Aaramonte et al. (2019).



Figure 14: Probability distributions of expected long-term euro area inflation, September 2020

Notes: DHS: DHS satellite survey of consumers; SPF: ECB Survey of Professional Forecasters, five-year ahead euro area HICP inflation expectations, in the corresponding quarter; Options: average annual HICP inflation over 5 years implied by option prices, at start of the month, derived based on Aaramonte et al. (2019).

### Tables

Table 1: Effect of group assignment on consumer's long-term euro area inflation expectations
and their expected probabilities of long term inflation

Dependent variable:	$\pi^{LT}$	$\pi^{\scriptscriptstyle LT}$	phigh <sup>LT</sup>	phigh <sup>LT</sup>	$pdef^{LT}$	$pdef^{LT}$	<i>ptr<sup>LT</sup></i>	<i>ptr</i> <sup>LT</sup>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
gdum4 (EA, with info)	-1.01***	-1.00***	-7.72***	-7.70***	3.05***	2.96***	4.16***	4.20***
time dummies socio-demographics	yes no	yes yes	yes no	yes yes	yes no	yes yes	yes no	yes yes
No. of observations	12585	12533	4935	4918	4934	4917	4935	4918
Notes: ***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Cluster-robust standard errors.								

Results from pooled OLS regressions. For  $\pi^{LT}$  observations above 30% set to 30% and below -30% set to -30%. Sample period: December 2019 to September 2020.

able 2: Effects of socio-demographic characteristics on consumer's long-term	
euro area inflation expectations	

Dependent variable:	$\pi^{\scriptscriptstyle LT}$	$\pi^{LT}$
	(1)	(2)
$\pi^{ST}$		0.56***
Dfem	-0.37	-0.68***
Dage <sup>mid</sup>	-0.08	0.21
Dage <sup>high</sup>	-0.02	0.61**
Dedu <sup>mid</sup>	-0.26	0.52*
Dedu <sup>high</sup>	-1.34***	0.10
$Dnethinc^{high}$	-1.04***	-0.65***
gdum4 (EA, with info)	-1.00***	-0.41*
time dumnies	Noc	Not
ume aummies	усъ	yes
No. of observations	12533	12533

Notes: \*\*\*, \*\* and \* represent significance at the 1%, 5% and 10% levels, respectively. Cluster-robust standard errors. Results from pooled OLS regression (column (1)) and correlated random effects panel regression (column (2)). For  $\pi^{LT}$  and  $\pi^{ST}$  observations above 30% set to 30% and below -30% set to -30%. Sample period: December 2019 to September 2020.

<b>Panel A:</b> Winsorizing inflation expectations at -30 percent and +30 percent							
Dependent variable:	$\varDelta \pi^{LT}$	$\varDelta \pi^{LT}$	$\varDelta \pi^{LT}$				
	(1)	(2)	(3)				
$\Delta \pi^{ST}$	0.55***	0.55***	0.55***				
gdum4 (EA, with info)	-0.004		-0.01				
time dummies	yes	yes	yes				
socio-demographic char.	no	no	yes				
No. of observations	10002	10002	9963				
Panel B: Trimming inflatio	on expectatio	ons at -30 pe	ercent and $+3$	0 percent			
Dependent variable:	$\varDelta \pi^{LT}$	$\varDelta \pi^{LT}$	$\varDelta \pi^{LT}$				
	(1)	(2)	(3)				
$\varDelta \pi^{ST}$	0.51***	0.51***	0.51***				
gdum4 (EA, with info)	0.03		0.02				
time dummies	yes	yes	yes				
socio-demographic char.	no	no	yes				
No. of observations	9348	9348	9315				

### Table 3: Effects of changes in short-term inflation expectations on changes in long-term euro area inflation expectations of consumers

Notes: \*\*\*, \*\* and \* represent significance at the 1%, 5% and 10% levels, respectively. Cluster-robust standard errors. Results from pooled OLS regressions (column (1)), fixed effects panel regressions (column (2)) and correlated random effect panel regressions (column (3)). In panel A observations for  $\pi^{LT}$  and  $\pi^{ST}$  above 30% are set to 30% and below -30% set to -30%. In panel B observations for  $\pi^{LT}$  and  $\pi^{ST}$  above 30% are removed. Sample period: December 2019 to September 2020.

Dependent variable:	phigh <sup>LT</sup>	phigh <sup>LT</sup>	pdef <sup>LT</sup>	pdef <sup>LT</sup>	<i>ptr<sup>LT</sup></i>	<i>ptr<sup>LT</sup></i>
	(1)	(2)	(3)	(4)	(5)	(6)
phigh <sup>ST</sup>		$0.40^{***}$				
pdef <sup>ST</sup>				0.47***		
<i>ptr<sup>ST</sup></i>						0.29***
Dfem	2.91*	1.03	2.24**	0.55	-4.70***	-3.22***
Dage <sup>mid</sup>	-3.59*	-1.22	-3.19***	0.34	6.77***	3.28**
Dage <sup>high</sup>	-1.78	0.10	-5.14***	-0.05	5.97***	1.47
Dedu <sup>mid</sup>	-0.83	1.36	-4.65***	-1.44**	4.46***	1.75
Dedu <sup>high</sup>	-5.32***	-0.90	-8.11***	-2.78***	10.57***	6.15***
<i>Dnethinc</i> <sup><i>high</i></sup>	-5.72***	-2.93**	-2.21**	0.07	6.90***	3.99***
gdum4 (EA, with info)	-7.70***	-3.92***	2.96***	0.51	4.20***	3.40***
time dummies	yes	yes	yes	yes	yes	yes
No. of observations	4918	4916	4917	4915	4918	4916

 Table 4: Effects of socio-demographic characteristics on consumer's expected

 probabilities of long-term euro area inflation

Notes: \*\*\*, \*\* and \* represent significance at the 1%, 5% and 10% levels, respectively. Cluster-robust standard errors. Results from pooled OLS regressions (columns (1), (3) and (5)) and correlated random effects panel regressions (columns (2), (4) and (6)). Sample period: December 2019 to September 2020.

Table 5: The relation between changes in individual probabilities of expected short-term euro area inflation and changes in consumer's probabilities of expected long-term euro area inflation

Dependent variable:	$\Delta phigh_i^{LT}$	$\Delta phigh_i^{LT}$	$\Delta pdef_i^{LT}$	$\Delta pdef_i^{LT}$	$\Delta ptr_i^{LT}$	$\Delta ptr_i^{LT}$		
	(1)	(2)	(3)	(4)	(5)	(6)		
⊿phighi <sup>ST</sup>	0.54***	0.92***						
⊿pdef <sub>i</sub> <sup>ST</sup>			0.45***	0.45***				
⊿ptr <sub>i</sub> <sup>ST</sup>					0.29***	0.30***		
gdum4 (EA, with info)	2.31**	1.52*	0.33	0.35	-0.68	-0.73		
time dummies	yes	yes	yes	yes	yes	yes		
socio-demographic char.	no	yes	no	yes	no	yes		
No. of observations	3234	3227	3233	3226	3234	3227		

Notes: \*\*\*, \*\* and \* represent significance at the 1%, 5% and 10% levels, respectively. Cluster-robust standard errors. Results from pooled OLS regressions (columns (1), (3) and (5)) and correlated random effects panel regressions (columns (2), (4) and (6)). Sample period: December 2019 to September 2020.

### Appendix A: DHS satellite survey of inflation expectations

#### DHS Satellite survey questions

This paper analyses the results from a new DHS satellite survey conducted from December 2019 to September 2020.

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 groups 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. Questions 1, 2 and 4 were asked each month. Questions 3 and 5 were only asked every three months (in December 2019, March 2020, June 2020 and September 2020).

1. (Question 1 only for respondents who <u>do not</u> 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**,

F	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%	) <b></b>
the rate of deflation (negative of inflation) will be 4% or higher	
<b>Total</b> (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%					
T-4-1	(the maintend englisher to a total of 100)	100			
1 otal	(the points should sum to a total of 100)	100			

#### Background information

The following information was provided to respondents of the December 2019 survey. This information was updated each month for subsequent waves of the survey.

- 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 A1/A2).
- 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 A1: Inflation in the Netherlands (information provided to group 2)



Figure A2: Inflation in the euro area (information provided to group 4)



In December 2019, 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 A1. 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 A2. No such information was provided to groups 1 and 3. In the following months of the survey the information provided to groups 2 and 4 on actual inflation was updated each month.

### Appendix B: Appendix Tables and Figures

	Short-term			Long-term		
Group	Num. obs.	Median	Interquartile range	Num. obs.	Median	Interquartile range
#3 EA, no info	6174	2	2	6096	4	8
#4 EA, with info	6616	2	2	6489	3	5
All respondents	12790	2	1.9	12585	3.2	6

#### Table B1: Consumers' euro area inflation expectations, summary statistics from level expectations

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

#### Table B2: Multivariate analysis of consumer's long-term euro area inflation expectations, reporting coefficients for socio-demographic variables and time dummies

Dependent variable	$\pi^{LT}$	$\pi^{\scriptscriptstyle LT}$	
	(1)	(2)	
$\pi^{ST}$		0.56***	
Dfem	-0.37	-0.68***	
Dage <sup>mid</sup>	-0.08	0.21	
Dage <sup>high</sup>	-0.02	0.61**	
Dedu <sup>mid</sup>	-0.26	0.52*	
Dedu <sup>high</sup>	-1.34***	0.10	
<i>Dnethinc</i> <sup><i>high</i></sup>	-1.04***	-0.65***	
gdum4 (EA, with info)	-1.00***	-0.41*	
Dwave <sub>2</sub>	-0.65**	-0.59**	
Dwave <sub>3</sub>	-1.48***	-1.30***	
$Dwave_4$	-0.82***	-0.66**	
$Dwave_5$	-1.95***	-2.11***	
Dwave <sub>6</sub>	-2.10***	-2.28***	
Dwave <sub>7</sub>	-1.33***	-1.35***	
$Dwave_8$	-2.25***	-2.28***	
Dwave <sub>9</sub>	-2.45***	-2.46***	
$Dwave_{10}$	-1.77***	-1.70***	

No. of observations 12533 12533

Notes: \*\*\*, \*\* and \* represent significance at the 1%, 5% and 10% levels, respectively. Cluster-robust standard errors. Dwavek, k=2,...,10: dummy variable for kth wave of survey. Results from pooled OLS regression (column (1)) and correlated random effects panel regression (column (2)). For  $\pi^{LT}$  observations above 30% set to 30% and below -30% set to -30%. Sample period: December 2019 to September 2020.

## Table B3: Effects of changes in short-term inflation expectations on changes in long-term euro area inflation expectations of consumers: robustness to outlier treatment

<b>Panel A:</b> Winsorizing inflation expectations at -10%/+10% and -50%/+50%, respectively										
Dependent variable:	$\varDelta \pi^{LT}$									
	(1)	(2)	(3)	(4)	(5)	(6)				
$\Delta \pi^{ST}$ gdum4 (EA, with info)	0.40*** -0.02	0.40***	0.40*** -0.03	0.59*** 0.00001	0.59***	0.59*** -0.01				
time dummies socio-demographic char.	yes no	yes no	yes yes	yes no	yes no	yes yes				
No. of observations	10002	10002	9963	10002	10002	9963				
<b>Panel B:</b> Trimming inflation expectations at -10%/+10% and -50%/+50%, respectively										
Dependent variable:	$\varDelta \pi^{LT}$									
	(1)	(2)	(3)	(4)	(5)	(6)				
$\Delta \pi^{ST}$ gdum4 (EA, with info)	0.38*** -0.06*	0.38***	0.38*** -0.07*	0.59*** -0.01	0.58***	0.59*** -0.02				
time dummies socio-demographic char.	yes no	yes no	yes yes	yes no	yes no	yes yes				
No. of observations	7554	7554	7525	9719	9719	9684				

Notes: \*\*\*, \*\* and \* represent significance at the 1%, 5% and 10% levels, respectively. Cluster-robust standard errors. Results from pooled OLS regressions (columns (1) and (4)), fixed effects panel regressions (columns (2) and (5)) and correlated random effect panel regressions (columns (3) and (6)). In columns (1)-(3) observations for  $\pi^{LT}$  and  $\pi^{ST}$  above 10% and below 10% are either set to 10% and - 10% (panel A) or removed (panel B). In columns (4)-(6) observations for  $\pi^{LT}$  and  $\pi^{ST}$  above 50% and below 50% are either set to 50% and -50% (panel A) or removed (panel B). Sample period: December 2019 to September 2020.

Figure B1: Long-term household inflation expectations in the United States (in percent)



Notes: Expected change in prices during the next five to ten years. Source: University of Michigan, Surveys of Consumers.

Figure B2: Consumers' euro area inflation expectations, levels survey



Notes: DHS satellite survey of consumers, with inflation expectations above 30% set to 30% and values below -30% set to -30%.



Figure B3: Histogram of consumers' long-term euro area point inflation expectations, levels survey

Notes: DHS satellite survey of consumers, with observations with values above 30% set to 30% and values below -30% set to -30%.

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