How do inflation expectations form? Evidence from a high-frequency survey[1]

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Abstract

We provide new insights on the formation of inflation expectations, in particular at a time of great financial and economic turmoil, by evaluating results from a survey conducted from July 2009 through July 2010. Participants in this survey answered a weekly questionnaire about their short-, medium- and long-term inflation expectations. Participants received common information sets with data relevant to euro area inflation. The survey allows us to address a number of important issues in the macro literature. First, we find evidence that inflation expectations depend on realized inflation data and Greek Credit Default Swap prices (the euro area fiscal crisis culminated during the survey). Second, we find considerable expectations homogeneity across participant subgroups at the short horizon, largely disappearing however at the medium and long horizons. Third, our evidence regarding the anchoring of long-term expectations at the ECB's inflation target is ambiguous. While median long-term expectations are at the target throughout the survey, long-term expectation means have been sensitive to economic shocks. Last, we find evidence that inflation expectations of central bank staff Granger-cause expectations of groups outside the central bank.

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1. Introduction

Both the academic literature and policy discussions have highlighted the crucial importance of inflation expectations for the inflation process and hence central banks' ability to achieve price stability (Bernanke, 2007). At the same time, evidence on the process through which agents form expectations is hard to obtain. Our paper takes an innovative route that provides important new insights on this topic. The main novelty is that we provide empirical evidence on inflation expectations based on a survey that is both "accurate" and frequent, and in which we can assess the role of common information sets. The survey is accurate in the sense that we follow the experimental economics methodology and reward survey participants based on the accuracy of their responses. It is frequent because it is conducted on a weekly basis. We conducted our study from July 2009 through July 2010, which has the additional advantage of capturing information on inflation expectations formation at a time of great financial and economic turmoil.

Our survey is set up as a field experiment, based on three elements. First, participants answer a short questionnaire about short-, medium- and long-term inflation expectations at weekly frequency over a period of one year. Second, each week participants get new information on relevant macroeconomic and financial data. This allows us to analyze how inflation expectations depend on past expectations, realized inflation data and other relevant economic and financial variables. It also allows testing the role of focal points, such as the ECB's inflation target or the inflation predictions published by Consensus Economics. Third, we conducted interviews at the beginning and at the end of the survey period, and used the answers to test whether the participants' maximizing / satisficing attitude and background information significantly affected the process of expectations formation.

We had 129 participants divided into three groups, with roughly equal weights in the experiment: central bankers (consisting of economists and research assistants from the Dutch Central Bank), academics and students. The experiment lasts one calendar year, which gives enough time variation to conduct time series regressions on the experimental results. The questionnaire is short and easy to fill in, comprising three questions on euro area inflation expectations at different horizons (2010, 2011 and 2019).

In order to obtain results accurately reflecting inflation expectations, participants were, as much as practically possible, motivated to submit their subjective beliefs by means of rewards linked to the ex-post accuracy of their expectations. This follows standard practice in the experimental economics literature.

Our main results are as follows. The survey allows us to address a number of important issues in the macro literature. First, we find evidence that inflation expectations depend on realized inflation data and Greek Credit Default Swap prices (the euro area fiscal crisis culminated during the survey). Second, we find considerable expectations homogeneity across participant subgroups at the short horizon, largely disappearing however at the medium and long horizons. Third, our evidence regarding the anchoring of long-term expectations at the ECB's inflation target is ambiguous. While median long-term expectations are at the target throughout the survey, long-term expectation means have been sensitive to economic shocks. Last, we find evidence that inflation expectations of central bank staff Granger-cause expectations of groups outside the central bank. In future work, we plan to test whether survey participants are rational.

The remainder of the paper is organized as follows. In Section 2 we provide an overview of the relevant literature on the formation of inflation expectations and discuss alternative measures of inflation expectations. Section 3 describes the main features of our survey. In Section 4 we present our empirical approach and the main results. Section 5 concludes.

2. Literature review

Theory

Expectations play a central role in macroeconomics. If the central bank's objective function, minimizing deviations of inflation from target and, possibly, output gap volatility, is known and constant, the Rational Expectations Hypothesis (REH) implies that long-term inflation expectations do not change in response to the arrival of new information. In recent years, a series of papers departed from the REH and the assumption of a known and constant central bank objective function. This literature can be divided into three strands.

The first, which has received increasing attention, relies on learning and assumes that people do not have full information about the economy or the objectives of the central bank. Instead, they make statistical inferences about the unknown parameters of the economy. Orphanides and Williams (2005), for example, model agents who do not know the true model of the economy but rather constantly update their estimates based on all information available to them. As a result, inflation expectations are sensitive to economic shocks.

The second is based on the assumption that agents use rules of thumb ("heuristics") to make inflation forecasts. Brazier et al. (2008), for example, consider two heuristics: one is based on lagged inflation and the other on an inflation target announced by the central bank. In their model, agents switch between these two heuristics based on an imperfect assessment of how each has performed in the past.

A third strand models monetary policy as an information game in which individuals form their expectations based on all (public and private) available information, which will be noisy. In Demertzis and Viegi (2008), agents know that inflation depends both on monetary policy and on the average expectation formed by all agents. The relative weight that is assigned to these two factors in agents' expectations is determined within a higher-order expectations setup.

A number of papers rely on the concept of *self-control* (Gul and Pesendorfer, 2001) to derive the expectation formation process from assumptions about the form and type of agents' utility function. These papers formalize biases in expectations, and in particular model over-optimism or over-pessimism. In Brunnermeier and Parker (2004), for example, agents care about expected future utility flows, so they derive higher current felicity if they believe that better outcomes are more likely in the future. They then form optimal expectations by weighing the felicity gains from optimism against the losses incurred due to poor decisions and worse than expected realized outcomes. In this framework, agents tend to be overoptimistic, and aggregate forecasts tend to exhibit overconfidence and overoptimism.

Rational inattention (Sims, 2003, 2005; Mackowiak and Wiederholt, 2009) is a microfounded approach to expectation formation. The objective of modeling economic agents as being "rationally inattentive" is to capture the fact that people are constrained in their ability to acquire and process information. Agents have limited capacities to process information, and hence receive only noisy signals of actual shocks hitting the economy. In these models, the form of the observational errors is itself predicted by the theory and can be derived from the structure of the individuals' optimization problems.

Once the REH is abandoned, the way information is disseminated becomes crucial. In an influential study, Mankiw and Reis (2001) assume that information is disseminated slowly throughout the population. As result, the response of decision makers to new information is staggered. In their paper, the rate at which media news reaches economic agents determines the cross-sectional dispersion of expectations.

Information dissemination and absorption is a reason for *sticky expectations*: Caroll (2003) shows that while empirical household expectations are not rational in the usual sense, expectational dynamics are well-captured by a model in which households' views derive from news reports on the views of professional forecasters, which in turn may be rational. The model's estimates imply that people only occasionally pay attention to news reports; this inattention generates 'stickiness' in aggregate expectations, with important macroeconomic consequences.

Empirical work

The empirical literature on inflation expectations has relied on two measures of expectations: measures based on inflation surveys and measures derived from financial market instruments.

Surveys provide the most direct method for measuring expectations and have been commonly used in the literature. ECB (2006) provides a detailed overview of survey measures of euro area inflation expectations at different horizons. For one-year ahead expectations, surveys are available at monthly or quarterly frequency from the *European Commission Consumers Survey*, the ECB's *Survey of Professional Forecasters (SPF)* and the *Euro Zone Barometer*.[2] Survey data for medium-term horizons are available at quarterly frequency from the SPF. Figure 4.1.1 shows the time series of SPF data on expectations of euro area inflation over a five year horizon. The main source for longer-term expectations is *Consensus Economics*, which twice a year collects data on six to ten year ahead expectations for a number of countries including the euro area from a panel of some 30 professional forecasters.

Survey measures have several important shortcomings.[3] First, given their low frequency, survey measures appear well-suited for analyzing long-run properties of inflation expectations but less so for identifying the process of expectation formation. Second, survey results may not be reliable to the extent that respondents do not have to act on the basis of their responses – i.e. "do not put their money where their mouth is".[4] Third, survey results are sensitive to the wording of the questions (Van der Klaauw et al, 2009). Fourth, different types of survey measures may produce very different results. Mankiw et al. (2003), for example, looked at 50 years of data on inflation expectations in the United States, and documented substantial disagreement among both consumers and professional economists about expected future inflation. They found that this disagreement varied substantially through time, depending on the level of inflation, the absolute value of the change in inflation, and relative price variability. Fifth, survey measures of consumer inflation expectations provide useful information on the distribution of expectations across survey participants but not necessarily precise information on the uncertainty around individual agents' expectations (Bruine de Bruin et al, 2009). Based on regular surveys of US consumers included in the RAND American Life Panel, they find that while the two measures are positively correlated, disagreement and uncertainty have distinct features.

A second strand of the literature extracts inflation expectations from inflation-indexed financial market instruments, and looks at the relationship between inflation expectations and

[2] The SPF collects forecasts by a panel of some 70 professional forecasters on euro area HICP.

[3] For a careful analysis of the properties of survey measures, see Thomas (1999) and Clark and Davig (2008).

[4] This point is emphasised in the experimental economics literature (Smith, 1982, 1992).

macroeconomic variables at high (daily or intraday) frequency (Swanson, 2006; Gürkaynak et al., 2005; Gürkaynak et al. (forthcoming); Gürkaynak et al., 2006, Beechey et al., 2007).[5] One important advantage of this type of measure is that, given its high frequency, it allows examining more formally changes in the behavior of expectations over a relatively short horizon. Galati, Poelhekke and Zhou (forthcoming) applied this empirical strategy to investigate whether the behavior of long-term inflation expectations changed around the crisis.

One major shortcoming of inflation measures based on financial instruments is that backing out the expectation component requires strong assumptions. The reason is that break-even rates, i.e. the difference between the yields of conventional and inflation-indexed bonds, can be decomposed into four main factors: expected inflation, inflation risk premia, liquidity premia, and technical factors (Hördahl, 2009).[6]

There is a rich empirical literature that has tested the rationality of expectations, which has relied mostly on survey measures of expectations.[7] The results are generally mixed and depend, among other things, on the sample period and the types of participants of surveys. Mehra (2002), for example, analyzed the Michigan Survey and found that the median inflation forecasts of households outperform those of professional economists and forecasters in the period covering the 1980s and 1990s. In particular, he documented that households' forecasts are more accurate, unbiased, have predictive content for future inflation, and are efficient with respect to economic variables generally considered pertinent to the behavior of inflation.

In terms of forecasting power, survey measures have been found to dominate other types of methods. Bekaert et al. (2009) compared the out-of-sample forecasting power of four alternative methods of forecasting U.S. inflation: time-series ARIMA models; regressions using real activity measures motivated from the Phillips curve; different types of term structure models; and survey-based measures. They found that surveys outperform the other forecasting methods. Moreover, there is little evidence that combining forecasts produces superior forecasts to survey information alone.

A number of papers have explored the variability of expectations across survey respondents (Mankiw and Reis, 2003; Carroll, 2003b; Khan and Zhu, 2002; Capistran and Timmermann, 2009). Carroll (2003b), for example, analyzes the evolution of the standard deviation of inflation expectations in the Michigan Survey. Carroll (2003b) provides an epidemiological model of inflation expectations in which "expert opinion" slowly spreads person-to-person much as disease spreads through a population. Bonham and Cohen (2000) argue that parameter estimates in consensus regressions are either inconsistent or can lead to false acceptance of the unbiasedness hypothesis due to the averaging of individual biases. Badarinza and Buchmann (2010) examine the heterogeneous nature of individual forecasts and the determinants thereof.

The empirical literature on drivers of inflation expectations – surveyed carefully in a paper by Clark and Davig (2008) – has documented the role of past inflation and of macroeconomic variables. Demertzis et al. (2008), for example, tested whether long-run inflation expectations

[5] For an overview of methods to extract inflation expectations from inflation-indexed bonds or inflation swaps, see e.g. Swanson (2006) and Hurd and Relleen (2006).

[6] Hördahl (2008) argues that the same applies, albeit to a lesser extent, to inflation-indexed swaps.

[7] See Thomas (1999) for an example.

– derived from the Fed's FRB model and quarterly survey-based measures – are influenced by short-run inflation dynamics. They found that in recent years, the role of short-run dynamics has increased in the United States, but only slightly.

Levin et al. (2004) analyzed the behavior of private-sector inflation forecasts at horizons up to ten years – measured by quarterly Consensus forecasts – in the United States and the euro area over the period 1994–2003. They found that expectations were highly correlated with a three-year moving average of lagged inflation. By contrast, in industrial countries that have adopted inflation targeting (United Kingdom, Sweden, Canada, Australia and New Zealand), inflation expectations were found not to be sensitive to actual inflation. Levin et al. (2004) concluded that inflation targeting has played a significant role in anchoring long-run inflation expectations. Clark and Nakata (2008) found evidence of a declining impact of unexpected increases in inflation on long-term expectations in recent years in the United States.

Forsells and Kenny (2004) analyze survey data on consumers' inflation expectations in the euro area and find that they appear to incorporate – though not always completely – the information contained in a broad set of macroeconomic variables. In particular, past price developments as well as various cost and activity indicators do not explain consumers' prediction errors.

The role of macroeconomic news is highlighted in the literature on the anchoring of long-term expectations. The periodical announcements of data on the state of the economy and forecasts released by various (statistical) offices and agencies form a steady source of information. To the extent that the information is unanticipated, beliefs about future inflation may be updated. If expectations are perfectly anchored, long-run inflation expectations should not be responsive to news about actual inflation, or more generally about macroeconomic conditions.

3. The survey

The data source for our analysis of inflation expectations is a new survey, which we carried out over the period July 2009 – July 2010. The survey has three novel features compared to existing surveys of inflation expectations. First, it has a considerably higher frequency than other surveys, especially those for long-term inflation expectations. This allows us to study more carefully some aspects of expectation formation, such as the frequency with which expectations at different horizons are revised. Second, participants in our survey are provided with common information sets. We can exploit this characteristic to provide new evidence on the role of information asymmetries in explaining the observed heterogeneity of expectations and to test for the role of focal points. Third, we introduce a pecuniary incentive for survey participants to respond as accurately as possible.

The main part of our survey consists of a short questionnaire about short-, medium- and long-run inflation expectations for the euro area, which 129 participants filled in each week for a year, starting on 22 June 2009. Participants were divided into three groups: staff from the Dutch central bank (De Nederlandsche Bank, DNB), Netherlands-based academics and students from Dutch universities. Every Monday morning, participants received an email asking them to answer the following three questions by 5pm that day:

1. What annual HICP inflation do you expect for 2010?
2. What annual HICP inflation do you expect for 2011?
3. What annual HICP inflation do you expect for 2019?

The email also contained an attachment with new information on euro area inflation that had arrived in the previous week. This information set consisted of three elements: an updated

graph of euro area HICP inflation, a table with new data releases on national and euro area-wide HICP (taken from Global Data Watch, a widely read market report on macroeconomic and financial developments), and – for a subset of participants, namely DNB staff, only – an updated table with Consensus mean forecasts for euro area inflation for 2010, 2011 and 5-10 years ahead.[8]

Participants were promised an accuracy-based reward for each forecast of 2010 inflation, to be paid out at the end of 2010. In addition, given that the accuracy for 2- and 10-year ahead expectations would be known only in the more distant future, participants were promised to be paid a flat reward for each answer to Questions 2 and 3. These rewards are also paid out at the end of 2010.

To get more background information about the participants, we also asked participants to fill in two questionnaires. The first was sent to participants at the beginning of our exercise, and contained questions based on the test proposed by Schwartz et al. (2002) to identify maximizers and satisficers. The full questionnaire is provided in Appendix 1. Based on the answers to this test, we classify survey participants into these two types and investigate whether the way they form inflation expectations differs significantly.

The second questionnaire, which participants filled in at the end of the exercise, included general questions on the respondents (e.g. on economic literacy, age, gender), on the way they formed expectations (e.g. the time they spent on answering the weekly questions, the importance of pecuniary rewards, the role of past expectations for current expectations) and the inputs, i.e. the type of information used to form expectations.

4. Results

4.1 An overview of the survey data

The main survey results consist of three panel data sets of inflation expectations associated with the horizons 2010, 2011 and 2019 respectively. Figures 4.1.1 and 4.1.2 show two measures of the central tendency in the data sets, i.e. the mean and median, over time. These are shown in comparison with inflation expectations based on Consensus surveys and the ECB's Survey of Professional Forecasters (SPF).

[Figures 4.1.1, 4.1.2 about here.]

Looking at Figures 4.1.1 and 4.1.2 , it is apparent that both the mean and median increase with the forecast horizon. This means that participants generally believed that the low levels of inflation seen since the beginning of 2009 would gradually rise, suggesting that they believed the economic climate in the euro area would gradually return to normal.

An eye-catching development in the means and medians with 2010 horizon is the substantial increase in both series towards the end of 2009. However, aside from slight increases in the 2011 and 2019 means and medians, most noticeably around Week 52 of 2009 when headline inflation was rapidly increasing, the longer-term expectations seem to be unaffected. This suggests that shocks affecting short-term expectations have not structurally

[8] For licensing reasons, survey participants outside DNB were not allowed to receive the Consensus Forecasts numbers.

affected longer-term expectations, which is consistent with the anchoring of expectations. That expectations across participants are well-anchored most of the time can easily be seen by looking at the 2019 medians in Figure 4.1.2. Even though the 2019 means (Figure 4.1.1) are all above 2%, the 2019 medians are equal to 2% in 91% of weeks. Putting the ECB's inflation target at 2%, Figure 4.1.2 suggests that long-term inflation expectations generally are well-anchored at the inflation target.

We can also see from Figures 4.1.1 and 4.1.2 that mean expectations track Consensus survey and SPF expectations relatively closely at the short horizon, while lying consistently above Consensus survey and SPF expectations at the medium- and long-term horizons. Figure 4.1.3 shows a comparison of mean expectations with market-based inflation expectations derived from inflation-indexed swaps, and from nominal and index-linked government bond yields, with maturities of 1, 2 and 10 years. In the latter case, break-even inflation rates are also shown after adjusting for term premia as in Hördahl (2009). We can see from Figure 4.1.3 that at the medium- and long-term horizons, mean expectations tended to be closest to those implied by inflation-indexed swaps.[9]

[Figures 4.1.3 about here.]

Disagreement

The evolution of standard and robust measures of disagreement is shown in Figures 4.1.4 and 4.1.5, in comparison with the corresponding measures for the Consensus surveys and the ECB's SPF. We find that disagreement within our survey is not larger at the long-term horizon than at the short and medium horizons. Indeed, on the measure of interquartile range, disagreement tended to be smaller at the long-term horizon (with an average of 0.5 percentage points over all weeks), than at both the short and medium-term horizons (with averages of 0.7 and 0.9 percentage points, respectively). We also find that disagreement decreased in the course of 2010 at the short horizon, especially on the robust measure of interquartile range. At the long-term horizon, disagreement as measured by the interquartile range was remarkably stable.

[Figures 4.1.4 and 4.1.5 about here]

Higher moments and non-normality

Comparing the means and medians in Figures 4.1.1 and 4.1.2 provides one measure of the skewness in the expectations distribution across participants at any one time, which may be measured by Pearson's second skewness coefficient, i.e. 3(mean-median)/standard deviation. When comparing the 2010, 2011 and 2019 series respectively of Figures 4.1.1 and 4.1.2, it can be seen that the expectation distributions across participants tend not to be symmetric on this measure. More specifically, the longer the forecast horizon, the more differences between means and medians are positive, implying that the expectation distributions tend to be more positively skewed according to Pearson's second coefficient. For the 2010 horizon, Pearson's coefficient is positive in 68% of weeks, while for the 2011 and 2019 horizons these percentages are 94% and 100% respectively. Interestingly, when the panel data set with the 2010 horizon is split in the first 27 and the last 26 weeks of the

[9] At the short horizon, the maturity mismatch between the 1-year market rate and expectations for 2010 is relatively larger, so the comparison is not as good.

survey, we observe a major shift in the skewness coefficient of the expectations distributions. In the first 27 weeks, the expectations are positively skewed in 89% of cases, while in the last 26 weeks this drops to 46%, making expectations negatively skewed slightly more frequently. Apparently, when inflation means and medians were low at the beginning of the survey, on balance more participants expected positive outliers than negative ones. Later on, when means and medians had risen noticeably, the balance shifted to the point of being slightly in favor of negative outliers.

Time series of standard measures of skewness and excess kurtosis (as defined in Appendix II) are shown in Figure 4.1.6. Interestingly, the standard skewness measure is negative much more often than Pearson's coefficient discussed above, creating ambiguity about the way in which the expectations distributions should be characterized. The Jarcque-Bera test of normality, which is based on these measures, rejects normality at the 1% significance level in all but nine weeks at the medium-term horizon, and in all weeks at both the short- and long-term horizons, as also shown in Figure 4.1.6. These results are evidence for a large degree of non-normality of the survey inflation expectations. However, these standard measures of higher moments are quite volatile, since they place a relatively large weight on outliers.

By contrast, robust measures of skewness and excess kurtosis (as defined in Appendix II) shown in Figure 4.1.7 are more stable over time. Robust measures of higher moments are particularly useful in cases of fat-tailed distributions with a large number of outliers. Both skewness and kurtosis on these robust measures show a clear pattern across horizons. Robust skewness becomes more positive as the horizon increases, for both the measure based on quartiles and octiles (see Appendix II). For robust skewness based on octiles, the average over all weeks increases from 0.07 at the short horizon to 0.29 at the medium- and 0.79 at the long-term horizon. Similarly, robust excess kurtosis increases at longer horizons (with an average over all weeks of -1.11, -0.69 and 0.25 at the short-, medium- and long-term horizons, respectively). Interestingly, robust skewness and excess kurtosis based on octiles are highly correlated at the short horizon, with a correlation coefficient in changes of 0.80. These measures are also evidence of non-normality of the expectations. They also show that, depending on the measure considered, results can differ on the direction of skew, since different measures probe different parts of the distribution, being for example more or less sensitive to outliers. The non-normality of expectations is illustrated in the histograms for the distribution of inflation expectations in the first and last weeks of the survey, and in the last week of 2009, which are shown in Figure 4.1.8.

Frequency of changes in inflation expectations

One distinguishing feature of our survey is that it is conducted at weekly frequency for all three horizons, including for long-term expectations. Typically, surveys on long-term expectations are at lower, monthly, quarterly or semi-annual frequency. We therefore investigate whether the weekly frequency captures more information over and above that available at lower frequencies. Figure 4.1.9 shows the proportion of changes in inflation expectations per week (see Baumgartner et al. (2005)). The average over all weeks of the proportion of changes in inflation expectations decreases from 38.5% at the short horizon to 37.0% and 23.5% at the medium and long horizons. This suggests that the weekly frequency carries useful information. It also shows that long-term expectations are revised less frequently in response to news.

A complementary measure is the duration of spells over which inflation expectations remain unchanged (see Baumgartner et al. (2005)), for which histograms are shown in Figure 4.1.10. We can see from these histograms that the short-duration spells of unchanged expectations are less frequent at the long-term horizon. Consistent with this, the mean duration of spells over which inflation expectations remain unchanged increases from around

2.4 weeks at the short and medium horizons to around 3.4 weeks at the long horizon, which suggests that long-term expectations are revised less frequently in response to news, consistent with our results above for the proportion of changes in expectations per week.

The distribution of changes in inflation expectations in shown in Figure 4.1.11. We can see that at the longer horizon, the mode at the interval containing no change is higher, consistent with our result above that respondents changed their expectations less frequently at the longer horizon. However, when expectations are changed (i.e. excluding weekly changes of zero, for which histograms are shown in Figure 4.1.12), the mean absolute change in expectations is larger at the longer horizon at 0.54 percentage points, compared with 0.40 pp at the short, and 0.47 pp at the medium horizon. Again, we find a clear pattern as a function of the horizon, with the mean absolute change increasing with the horizon. This suggests that at the long horizon respondents change their expectations less frequently, but if they do change their expectations, the magnitude of the change is larger.

4.2 Is the central bank credible?

An important issue is whether the ECB's credibility in pursuing stable inflation around its objective of close to but below 2% has changed during the crisis. One conjecture is that the unprecedented monetary easing – through both conventional and unconventional monetary policies – coupled with the accumulation of a large fiscal debt, may have undermined market participants' confidence in the ability of central banks to keep inflation at target in the longer run.

In order for the ECB to have remained credible, two conditions must hold. First, long-run inflation expectations must centre around the central bank's inflation objective. We therefore verify whether the mean of 10-year inflation expectations is not significantly different from 2% for all three groups of respondents over the whole sample period. Our results indicate that, due to the positive skewness of the long-term expectations distributions, the inflation means of the DNB and Academics groups tend to be significantly above the inflation target (see Section 4.5 for details). Similarly, the participants as a whole have long-term expectations significantly above the inflation target in 85% of weeks (t tests at 1% significance).

Second, if long-term inflation expectations do not change in response to news about macroeconomic indicators, in particular inflation, this would provide evidence for monetary policy being credible and inflation expectations being well-anchored.

To test this, we study whether changes in long-term inflation expectations have been associated with changes in Eurostat's flash estimates of the next euro area HICP data release, $\pi^{f,EA}_t$, in the week prior to the circulation of the survey on Monday of week t,[10]

$$\pi^{mean,h}_t - \pi^{mean,h}_{t-4} = \beta_1 + \beta_2 (\pi^{f,EA}_{t-1} - \pi^{f,EA}_{t-5}) + \varepsilon_t, \qquad (4.2.1)$$

where h=2010, 2011 or 2019 denotes the short-, medium- or long-term horizon of the mean inflation expectations, $\pi^{mean,h}_t$. In weeks where no new flash estimate was released, the latest available flash estimate is carried over in the weekly time series for $\pi^{f,EA}_t$. Results are shown in Table 4.2.1. We find that while mean inflation expectations are significantly affected at the short- and medium-term horizons by changes in HICP flash estimates (at the 1% and 5% levels, respectively), they are not affected at the long-term horizon. This suggests that

[10] This ensures that we consider information available to all survey respondents, including to those filling in the survey on the day of its circulation on Monday.

inflation expectations are well-anchored and monetary policy has remained credible over the sample period.

[Table 4.2.1. here]

Next, we study whether surprises in HICP data releases, π^{EA}_t, have affected mean inflation expectations. Here, surprises in HICP data releases in the week before the DNB survey are calculated relative to the median of the most recent Bloomberg survey, $\pi^{BB,EA}_t$,

$$\pi^{mean,h}_t - \pi^{mean,h}_{t-1} = \beta_1 + \beta_2 (\pi^{EA}_{t-1} - \pi^{BB,EA}_{t-1}) + \varepsilon_t. \qquad (4.2.2)$$

Results are shown in Table 4.2.2. The surprises in the euro area HICP based on Bloomberg surveys are not significant. Note however that the variation in the euro area HICP surprises is very low,. We therefore do not put much weight on this result.

The corresponding regressions to Table 4.2.2 when replacing surprises in actual euro area HICP by surprises with respect to the flash estimate of euro area HICP do not yield any significant coefficient on the surprise variable at any of the horizons.

Overall, the regression of long-term inflation expectations on macroeconomic news support the hypothesis that expectations have remained firmly anchored to the ECB's inflation objective.

4.3 Have concerns about public deficits and debt affected inflation expectations?

In this section we study whether concerns about public deficits and debt have affected inflation expectations. We do so by testing whether changes in inflation expectations have been significantly related to changes in CDS spreads of euro area economies,

$$\pi^{mean,h}_t - \pi^{mean,h}_{t-4} = \beta_1 + \beta_2 (CDS^{EA}_{t-1} - CDS^{EA}_{t-5}) + \varepsilon_t, \qquad (4.3.1)$$

where CDS^{EA}_{t-1} denotes the euro area CDS spread in the week prior to the survey (normalized by its standard deviation over the sample period), i.e. it contains information available to survey participants before the circulation of the survey on the Monday of each week.[11] The weekly time period is labeled by t, and changes are taken over four weeks. A caveat with this approach of using CDS spreads as measures of perceived risk of debt monetization through higher inflation is that expectations of debt monetization via the printing of money by central banks, and associated expectations of higher inflation, could be associated with lower sovereign risk, since higher inflation would lower the real burden of debt.

Results for the regression of equation (4.3.1) are shown in Table 4.3.1. We can see that changes in short- and medium-term mean DNB survey inflation expectations were significantly related to changes in euro area CDS spreads, while long-term expectations were not.

[11] This ensures that we consider information available to all survey respondents, including to those filling in the survey on the day of its circulation on Monday.

[Table 4.3.1 here]

We also study the reactions of mean DNB survey inflation expectations to changes in Greek CDS spreads,

$$\pi^{mean,h}_{t} - \pi^{mean,h}_{t-4} = \beta_1 + \beta_2 (CDS^{GR}_{t-1} - CDS^{GR}_{t-5}) + \varepsilon_t, \qquad (4.3.2)$$

which we consider separately since the focus of concern about public debt sustainability during the sample period was on Greece. CDS^{GR}_{t-1} denotes the Greek CDS spread in the week prior to the survey, normalized by its standard deviation over the sample period. Table 4.3.2 shows that the coefficient on changes in Greek CDS spreads is again significant at the short- and medium-term horizons of inflation expectations, but now it is also significant at the long-term horizon (at the 5%-level).

These results suggest that short- and medium-term inflation expectations have not been immune to concerns about possible debt monetization in order to deal with excessive public debt in Greece, and in the euro area as a whole. Moreover, our results suggest that concerns about the Greek sovereign debt crisis have significantly affected euro area long-term inflation expectations as measured within the DNB survey, though less so than at the shorter horizons. This would suggest a danger that long-term euro-area inflation expectations may have become less-well anchored due to worries about public debt and deficits in Greece. However, when using OLS regressions without Newey-West adjusted standard errors, the coefficient on changes in Greek CDS spreads remains significant at the 1%-level at the short- and medium-term horizons of inflation expectations, while no longer being significant at the long-term horizon.[12] This would suggest that long-term euro area inflation expectations have remained well-anchored.

[Table 4.3.2 here]

4.4 Expectations formation process

It is also of interest to test for the existence of focal points. One such focal point may be provided by the ECB's definition of price stability as referring to inflation being close to but below 2%. Although evidence presented in Section 4.2 shows that mean long-term expectations are significantly above the ECB's inflation target in the majority of the survey's weeks, the fact that median long-term expectations tend to equal 2% (see Figure 4.1.2) indicates that the inflation target nonetheless acts as a focal point for long-term expectations.

Another possible focal point are the Consensus survey expectations, which were circulated to some of the participants in our survey. To investigate this, we perform pairwise Granger causality tests on mean Consensus survey expectations for 2010 and 2011(both levels and changes) and mean expectations from our survey for the short-, medium- and long-term horizons (also both levels and changes). The timing of the series for which we perform

[12] The coefficient on changes in euro area CDS spreads remains significant at the short- and medium-term horizons of inflation expectations, and remains insignificant at the long-term horizon, when using OLS regressions without Newey-West adjusted standard errors.

Granger causality tests is as follows. Date t specifies the survey results of the Monday of week t; and the latest Consensus survey expectation available prior to the Monday of week t. Using this timing, we find no evidence at the 5% significance level that Consensus forecasts for 2010 or 2011 Granger-cause mean survey expectations at any horizon (see Tables 4.4.1 and 4.4.2). On the other hand, we do find evidence that mean survey expectations at the medium horizon Granger-cause Consensus forecasts at the corresponding horizon of 2011. However, this result could be due to the timing assumption of our two series: DNB survey expectations at date t-1 could help to predict Consensus forecasts at date t since they incorporate newer information than Consensus forecasts at date t-1.

[Tables 4.4.1 and 4.4.2 about here]

Next, we study whether pairwise Granger causality exists between mean survey expectations and expected inflation rates implied by inflation-indexed swaps at the 1-, 2- and 10-year maturities, again both for levels and weekly changes in expected inflation rates (see Tables 4.4.3 and 4.4.4). The inflation rates implied by inflation-indexed swaps are taken on Monday of each week, coinciding with the survey date. We find some evidence for Granger causality in both directions. At the 5% significance level, short-term mean inflation expectations Granger-cause 10-year inflation rates implied by inflation-indexed swaps, and 2-year inflation rates implied by inflation-indexed swaps Granger-cause short-term mean inflation expectations. Moreover, at the 5% significance level, changes in 10-year inflation rates implied by inflation-indexed swaps Granger-cause changes in medium-term mean inflation expectations. At the 10% significance level, there is evidence that changes in medium-term mean inflation expectations Granger-cause changes in 2-year implied inflation swap rates, and that changes in long-term mean inflation expectations Granger-cause changes in 10-year implied inflation swap rates.

[Tables 4.4.3 and 4.4.4 about here]

We also study whether pairwise Granger causality exists between mean survey expectations and breakeven inflation rates implied by nominal and real government bond yields, again both for levels and weekly changes in expected inflation rates (see Tables 4.4.5 and 4.4.6). The breakeven inflation rates implied by nominal and real government bond yields are also taken on the Monday of each week, coinciding with the survey date. We find evidence that at the 1% significance level, 2-year breakeven inflation rates Granger-cause medium-term survey inflation expectations, and short-term survey inflation expectations Granger-cause 10-year breakeven inflation rates. Regarding changes, we find evidence that at the 5% significance level, changes in 2-year breakeven inflation rates Granger-cause changes in medium-term survey inflation expectations. At the 10% level, we also find that changes in short-term survey inflation expectations Granger-cause changes in 10-year breakeven inflation rates.

[Tables 4.4.5 and 4.4.6 about here]

Moreover, expectations at different horizons may provide focal points for each other. To study this, we perform Granger causality tests for mean expectations at the three different horizons of our survey. We find no evidence at the 10% level for pairwise Granger causality between mean survey expectations at any two of the three horizons, both for levels and weekly changes (see Tables 4.4.1 and 4.4.2).

4.5 Rationality tests

Once data on the actual inflation outturns in 2010 will be available, we will be able to perform tests of unbiasedness and weak efficiency of the survey expectations in early 2011.

4.6 Cross-section analysis: are agents homogenous?

Figure 4.6.1 again shows expectation means across participants for 2010, 2011 and 2019 respectively (cf. Figure 4.1.1), but the means are now differentiated by the participant groups consisting of central bank staff, academics and students. Looking at the three graphs of Figure 4.6.1, we see considerable homogeneity across groups in Figures 4.6.1(a) and 4.6.1(c), and obvious heterogeneity in Figure 4.6.1(b). For some reason, the 2011 expectation means of the Academics are everywhere higher than those of the Students and Central bankers, which are mostly close together. Looking at Figures 4.6.1(a) and 4.6.1(c), we see that also on the 2010 and 2019 horizons the Academics have the largest prediction means in a majority of cases (92% in Figure 4.6.1a, 72% in Figure 4.6.1(b)). On the other hand, the inflation means of the Central Bankers are largest in only two cases over all prediction horizons (Week 44 of 2009 in Figure 4.6.1(a) and Week 23 of 2010 in Figure 4.6.1(c)).

[Figure 4.6.1 about here.]

Another form of heterogeneity, present in all three graphs of Figure 4.6.1, is the increase in volatility when going from the Central Bankers to the Academics to the Students. The standard deviations of the inflation means for the Central Bankers, Academics and Students respectively are as follows: 0.014, 0.092, 0.16 (2010 horizon; linear trend removed by OLS); 0.065, 0.086, 0.11 (2011 horizon); 0.047, 0.072, 0.12 (2019 horizon).

In Figures 4.6.1(b) and 4.6.1(c), inflation expectation means seem to be fluctuating around a constant. In Figure 4.6.1(a) however, there are clear trends in the prediction means of the three groups. The 2010 predictions of the Central Bankers closely follow a positive trend throughout the survey. The Academics and Students also seem to follow positive trends later in the survey, but they start out with negative trends. Both groups seem to switch from negative to positive trends around Week 44, corresponding to October 2009, when headline inflation started climbing rapidly.

To quantify expectations homogeneity across groups at different prediction horizons, we first calculate the correlations between group expectation means at each of the three horizons. Unsurprisingly, due to the positive trend the inflation expectations share at the 2010 horizon, cross-group correlations, as shown in Table 4.6.1(a), are high. Correlations are highest between DNB staff and Academics, followed by Academics and Students, and DNB staff and Students, and all are highly significant. Table 4.6.1(b) shows that, if the estimated linear trend is removed, all correlations decrease, while their ordering is preserved. The correlation between DNB staff and Academics remains highly significant, while Academics and Students are no longer significantly correlated at 1%, and the correlation between DNB staff and Students becomes insignificant. Looking at the 2011 and 2019 horizons (see Tables 4.6.2 and 4.6.3 respectively), we see that all cross-group correlations remain positive, but none are significant at the 5% level. Regarding their ordering, we see little similarity to the 2010 horizon. In Table 4.6.2, the correlation between DNB staff and Academics is largest, as in Tables 4.6.1(a)-(b), but the correlation between Academics and Students is clearly the

smallest. In Table 4.6.3, the ordering of the correlations is completely reversed compared to Tables 4.6.1(a)-(b).

[Tables 4.6.1(a), 4.6.1(b), 4.6.2 and 4.6.3 about here.]

Homogeneity between the inflation expectations of the three participant groups may be a symptom of expectation formation spreading gradually throughout the population. To investigate this hypothesis, we do pairwise Granger causality tests parallel to the estimated cross-group correlations of Tables 4.6.1 – 4.6.3. Table 4.6.4 shows that the high correlation between DNB staff and Academics at the 2010 horizon clearly runs one way, i.e. from the former to the latter. The significant correlation between Academics and Students on the other hand seems to run both ways, *p* values being below 10% in both cases. Between DNB staff and Students no Granger-causation is found, despite their significant correlation. At the 2011 horizon (see Table 4.6.5), the only significant Granger-causation is from DNB staff to Academics, and at the 2019 horizon (Table 4.6.6) Granger-causations from DNB staff to Students and Academics to Students are significant (at the 1% and 10% levels respectively) That significant Granger-causation is found at the medium- and long-term horizons is remarkable, given that no significant cross-group correlations were found at these horizons.

[Tables 4.6.4, 4.6.5 and 4.6.6 about here.]

The Granger-causality results provide evidence for the hypothesis that inflation expectation formation originates at the central bank staff, and then disseminates to the Academics and Students. Consistent with this hypothesis, the DNB inflation expectation means are at none of the three horizons Granger-caused by either the Academics of Students. At the same time, DNB expectation means Granger-cause the expectation means of Academics at the 2010 and 2011 horizons, and those of the Students at the long-term horizon. This originating role of inflation expectations of central bank staff may be due to the facts that central bankers tent to have the best access to economic data and policy information relevant to the inflation development, and that they are trained to correctly interpret such data and information.

Figure 4.6.2 shows inflation prediction means differentiated by group and horizon with 90% and 98% confidence bounds added. Looking across columns from left to right, it is clear that the within-group disagreement tends to increase. Central bankers are in other words most in agreement about their predictions, followed by the Academics and Students successively.[13] Looking across columns, another, less visible regularity is that disagreement on average is highest at the 2011 horizon for all three groups. This fact is consistent with the idea that disagreement is constrained both in the short term, due to the unlikeliness of major change in the inflation development, and in the long run, due to the consistency of ECB monetary policy.

[Figure 4.6.2 about here.]

A third interesting point about Figure 4.6.2 is the fact that disagreement tends to decrease at the 2010 horizon for all three groups, in the sense that the average 98% confidence interval width in the second half of the survey is smaller than in the first half.[14] At the 2011 and 2019 horizons, this is not true however for the Students and the Academics and Students

[13] Mean widths for the 98% confidence bounds of Central Bankers, Academics and Students resp. are: 0.32, 0.55, 1.13 (2010 horizon); 0.57, 0.84, 1.16 (2011 horizon), 0.39, 0.58, 1.04 (2019 horizon).

[14] First half and second half average 98% confidence interval widths at the 2010 horizon are resp. 0.39, 0.25 (Central Bankers); 0.65, 0.46 (Academics); 1.23, 1.03 (Students).

respectively. The increasing agreement at the 2010 horizon across groups suggests that participants were able to integrate accumulating economic data into their predictions, narrowing their idiosyncratic components. On the other hand, for the indicated groups at the 2011 and 2019 horizons, incoming economic data apparently on balance created new uncertainty, pushing within-group predictions further apart.

The bottom row of Figure 4.6.2 allows for the testing of the anchoring of long-run inflation expectations. Ironically, the relatively high agreement among Central Bankers raises their lower confidence bounds in most weeks to above 2%. Based on t statistics, the hypothesis that their long-term expectations are anchored, is therefore convincingly rejected, despite the fact that absolutely speaking they are on average closest to the inflation target (see Figure 4.6.1(c)). The Academics, at a significance level of 1%, do only marginally better than the Central Bankers. The Students however, due to their relatively low agreement, are anchored at the 2% inflation target in most weeks.

Given that normality of the inflation expectations of all groups was rejected in the vast majority of weeks (see Figure 4.1.6), *t* tests on the inflation expectation means are an unreliable way to test for the anchoring of long-term expectations. Another, more robust way is to test for the influence of short- and medium-term inflation expectation means on the long-term means. If long-term expectations are anchored, they should be insensitive to economic developments manifesting themselves through short- or medium-term expectations. Table 4.6.7 shows the results of OLS regressions on the long-term expectation means of the three groups. A lagged dependent variable was added to the regression equation in order to improve the quality of the specification, as checked by the diagnostic tests on the right-hand side of the table.

[Table 4.6.7 about here.]

The coefficient estimates indicate that the Students' long-term expectation means are significantly influenced by their short-term means, which is inconsistent with expectations anchoring. The Academics and DNB staff on the other hand have no significant coefficients with their short- and medium-term expectation means, assuming that these estimates are accurate despite Ramsey's misspecification test (for the Academics) and White's heteroskedasticity test (for the DNB staff) being rejected. Regarding the anchoring of long-term expectations, Table 4.6.7 reaches a conclusion that is opposite to the one reached by the straightforward *t* tests discussed above. According to the *t* tests, the Students are the only group with long-term expectations consistent with expectations anchoring in a majority of weeks, while Table 4.6.7 identifies the Students as the only group violating anchoring. Therefore, we must conclude that the evidence regarding inflation expectations anchoring across participant groups is ambiguous, with all three groups satisfying one requirement, but violating another.

More than just verifying the anchoring of long-term inflation expectations at the ECB's inflation target, our survey setup allows us to estimate prediction rules for all participant groups and horizons. Potential regressors in these prediction rules are variables from the common information sets provided to participants, most notably the most recently published monthly inflation number (flash or actual) and the Consensus Economics forecast (available only to the DNB staff). Also, as seen in Section 4.2, the Credit Default Swap prices for the Euro Area and Greece (divided by their standard deviations) may have been part of the prediction rules.

A linear prediction rules specification including the mentioned variables is estimated in Table 4.6.8 for each group and prediction horizon. Two lagged dependent variables have been added to the specification to improve its quality, which is verified by the diagnostic tests on the right-hand side. For each group and horizon, the least significant regressor was

successively dropped, unless this worsened the specification as measured by the diagnostic tests, or led to nonsensical estimates.

[Table 4.6.8 about here.]

Looking first at the three prediction rules at the 2010 horizon, we see that they all have significantly positive constants and inflation coefficients. Moreover, these estimates are relatively close to another, reflecting considerable homogeneity between groups. The Consensus Economics forecast, which was only added to the DNB prediction rule, surprisingly does not have a significant influence on the short-term expectation of this group. On the other hand, both for DNB staff and the Academics, the CDS prices of Greece have pushed up short-term expectations significantly. Note that none of the diagnostic tests results in rejections for the 2010 prediction rules, suggesting that the chosen linear prediction rule specification suffices to capture the main elements of the participants' expectation formation.

Moving to the prediction rules at the 2011 horizon, we see two clear changes. First, all three estimated constants, which are still significant at the 1% level, are substantially higher than their 2011 counterparts (the same holds for the implied long-run constants, taking into account the lagged dependent variables). Second, the latest monthly inflation number is no longer significant in all three cases. These changes reflect the observations that medium-term expectations are at a higher level than short-term ones, and do not share the inflation trend visible in short-term expectations (see Figure 4.6.1). Interestingly, the Academics' 2011 expectations, like their 2010 expectations, were significantly inflated by the rising Greek CDS prices over the survey period. This shows that the Greek fiscal crisis impacted on inflation expectations beyond the short term.

At the 2019 prediction horizon, we again see an increase in the estimated constants, while the latest inflation number again has no significant positive impact. A remarkable finding for the prediction rules of the Academics and DNB staff is that Greek CDS prices have had a significantly positive impact on them. Apparently, the Greek fiscal crisis has influenced inflation expectations at short-, medium- and long-term horizons. The only group in our survey that has, according to the prediction rule estimates, remained unaffected to the CDS price developments, are the Students. A further interesting observation is that the Euro area CDS prices nowhere seem to significantly influence inflation expectation formation. This suggests that the contagion effects the Greek crisis has had on the rest of the Euro area in itself has not further influenced inflation expectations.

5. Conclusions

One distinguishing feature of our survey is that it is conducted at weekly frequency for all three horizons, including for long-term expectations. Typically, surveys on long-term expectations are at lower, monthly, quarterly or semi-annual frequency. We find that the average over all weeks of the proportion of changes in inflation expectations per week decreases from 38.5% at the short horizon to 37.0% and 23.5% at the medium and long horizons. This shows that long-term expectations are revised less frequently in response to news, but suggests that the weekly frequency also carries useful information. Consistent with this, we find that the mean duration of spells over which inflation expectations remain unchanged increases from around 2.4 weeks at the short and medium horizons to around 3.4 weeks at the long horizon, again indicating that long-term expectations are revised less frequently in response to news.

We find that when expectations are changed, the mean absolute change in expectations is larger at the longer horizon at 0.54 percentage points, compared with 0.40 pp at the short, and 0.47 pp at the medium horizon. Again, we find a clear pattern as a function of the horizon, with the mean absolute change increasing with the horizon. These results suggest that at the long horizon respondents change their expectations less frequently, but if they do change their expectations, the magnitude of the change is larger.

[More conclusions to be added.]

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Tables and Figures

Table 4.2.1 **Reactions of changes in mean inflation expectations to changes in flash estimates of euro area HICP, Equation 4.2.1**			
Horizon:	**2010**	**2011**	**2019**
Constant, β_1	0.001 (0.02)	-0.014 (0.01)	0.002 (0.008)
Change in flash estimate for next euro area HICP release, β_2	0.12*** (0.04)	0.05** (0.023)	-0.01 (0.04)
R^2	0.21	0.04	0.006
Number of observations	49	49	49
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; standard errors are given in brackets; Newey-West adjusted standard errors.			

Table 4.2.2 **Reactions of changes in mean inflation expectations to surprises in euro area HICP based on Bloomberg surveys, Equation 4.2.2**			
Horizon:	**2010**	**2011**	**2019**
Constant, β_1	-0.01 (0.02)	0.01 (0.03)	-0.002 (0.02)
Surprise in euro area HICP release, β_2	-0.53 (0.35)	-0.43 (0.45)	0.19 (0.32)
R^2	0.18	0.08	0.03
Number of observations	12	12	12
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; standard errors are given in brackets.			

Table 4.3.1 **Reactions of changes in mean inflation expectations to changes in euro area CDS spreads, Equation 4.3.1**			
Horizon:	**2010**	**2011**	**2019**
Constant, β_1	0.01 (0.02)	-0.02 (0.01)	0.000 (0.01)
Change in euro area CDS spread, β_2	0.07*** (0.02)	0.05*** (0.01)	-0.002 (0.01)
R^2	0.20	0.13	0.001
Number of observations	49	49	49
***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; standard errors are given in brackets; Newey-West adjusted standard errors.			

Table 4.3.2

Reactions of changes in mean inflation expectations to changes in Greek CDS spreads, Equation 4.3.2

Horizon:	**2010**	**2011**	**2019**
Constant, β_1	0.0005 (0.02)	-0.02* (0.01)	-0.005 (0.01)
Change in Greek CDS spread, β_2	0.08*** (0.03)	0.06*** (0.02)	0.022** (0.01)
R^2	0.21	0.15	0.03
Number of observations	49	49	49

***, ** and * denote significance at the 1%, 5% and 10% levels, respectively; standard errors are given in brackets; Newey-West adjusted standard errors.

Table 4.4.1

Granger causality tests for mean inflation expectations

Pairwise Granger Causality Tests
Sample: 6/22/2009 7/11/2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
MEAN2011_ALL does not Granger Cause MEAN2010_ALL	51	1.73603	0.18757
MEAN2010_ALL does not Granger Cause MEAN2011_ALL		0.27158	0.76339
MEAN2019_ALL does not Granger Cause MEAN2010_ALL	51	0.88636	0.41908
MEAN2010_ALL does not Granger Cause MEAN2019_ALL		0.46503	0.63104
CE_2010 does not Granger Cause MEAN2010_ALL	51	2.04431	0.14107
MEAN2010_ALL does not Granger Cause CE_2010		1.68985	0.19580
CE_2011 does not Granger Cause MEAN2010_ALL	51	2.90063	0.06510*
MEAN2010_ALL does not Granger Cause CE_2011		0.98250	0.38209
MEAN2019_ALL does not Granger Cause MEAN2011_ALL	51	0.10643	0.89926
MEAN2011_ALL does not Granger Cause MEAN2019_ALL		0.77305	0.46751
CE_2010 does not Granger Cause MEAN2011_ALL	51	0.13481	0.87423
MEAN2011_ALL does not Granger Cause CE_2010		2.03243	0.14262
CE_2011 does not Granger Cause MEAN2011_ALL	51	0.66753	0.51787
MEAN2011_ALL does not Granger Cause CE_2011		4.42442	0.01748**
CE_2010 does not Granger Cause MEAN2019_ALL	51	1.84025	0.17028
MEAN2019_ALL does not Granger Cause CE_2010		0.52043	0.59772
CE_2011 does not Granger Cause MEAN2019_ALL	51	0.44688	0.64237
MEAN2019_ALL does not Granger Cause CE_2011		0.17557	0.83954
CE_2011 does not Granger Cause CE_2010	51	2.57761	0.08689*
CE_2010 does not Granger Cause CE_2011		0.47522	0.62476

Note: Mean20xx_ALL denotes mean DNB survey expectations at the 20xx horizon; CE_20xx denotes mean Consensus survey expectations at the 20xx horizon. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 4.4.2

Granger causality tests for changes in mean inflation expectations

Pairwise Granger Causality Tests
Sample: 6/22/2009 7/11/2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
D(MEAN2011_ALL) does not Granger Cause D(MEAN2010_ALL)	50	0.10134	0.90383
D(MEAN2010_ALL) does not Granger Cause D(MEAN2011_ALL)		0.30501	0.73862
D(MEAN2019_ALL) does not Granger Cause D(MEAN2010_ALL)	50	0.97045	0.38670
D(MEAN2010_ALL) does not Granger Cause D(MEAN2019_ALL)		0.32962	0.72092
D(CE_2010) does not Granger Cause D(MEAN2010_ALL)	50	1.58259	0.21666
D(MEAN2010_ALL) does not Granger Cause D(CE_2010)		1.50343	0.23332
D(CE_2011) does not Granger Cause D(MEAN2010_ALL)	50	0.10363	0.90178
D(MEAN2010_ALL) does not Granger Cause D(CE_2011)		1.14610	0.32698
D(MEAN2019_ALL) does not Granger Cause D(MEAN2011_ALL)	50	0.09747	0.90732
D(MEAN2011_ALL) does not Granger Cause D(MEAN2019_ALL)		0.94196	0.39741
D(CE_2010) does not Granger Cause D(MEAN2011_ALL)	50	1.44525	0.24642
D(MEAN2011_ALL) does not Granger Cause D(CE_2010)		2.33634	0.10830
D(CE_2011) does not Granger Cause D(MEAN2011_ALL)	50	1.36947	0.26463
D(MEAN2011_ALL) does not Granger Cause D(CE_2011)		6.64945	0.00295***
D(CE_2010) does not Granger Cause D(MEAN2019_ALL)	50	1.39714	0.25782
D(MEAN2019_ALL) does not Granger Cause D(CE_2010)		0.94184	0.39746
D(CE_2011) does not Granger Cause D(MEAN2019_ALL)	50	1.68391	0.19713
D(MEAN2019_ALL) does not Granger Cause D(CE_2011)		0.03119	0.96931
D(CE_2011) does not Granger Cause D(CE_2010)	50	0.52125	0.59732
D(CE_2010) does not Granger Cause D(CE_2011)		0.05385	0.94764

Note: d(Mean20xx_ALL) denotes weekly change in mean DNB survey expectations at the 20xx horizon; d(CE_20xx) denotes weekly change in mean Consensus survey expectations at the 20xx horizon. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 4.4.3

Granger causality tests for mean inflation expectations with implied inflation-indexed swap rates

Pairwise Granger Causality Tests
Sample: 6/22/2009 7/11/2010; Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
IS_1 does not Granger Cause MEAN2010_ALL	48	5.61898	0.00679
MEAN2010_ALL does not Granger Cause IS_1		0.21526	0.80719
IS_2 does not Granger Cause MEAN2010_ALL	51	4.24050	0.02041**
MEAN2010_ALL does not Granger Cause IS_2		1.13576	0.33002
IS_10 does not Granger Cause MEAN2010_ALL	51	0.43099	0.65246
MEAN2010_ALL does not Granger Cause IS_10		4.48498	0.01662**
IS_1 does not Granger Cause MEAN2011_ALL	48	1.05424	0.35729
MEAN2011_ALL does not Granger Cause IS_1		1.49399	0.23589
IS_2 does not Granger Cause MEAN2011_ALL	51	1.25666	0.29419
MEAN2011_ALL does not Granger Cause IS_2		2.05690	0.13945
IS_10 does not Granger Cause MEAN2011_ALL	51	1.69655	0.19458
MEAN2011_ALL does not Granger Cause IS_10		0.87576	0.42338
IS_1 does not Granger Cause MEAN2019_ALL	48	0.22475	0.79965
MEAN2019_ALL does not Granger Cause IS_1		1.54900	0.22408
IS_2 does not Granger Cause MEAN2019_ALL	51	0.74636	0.47974
MEAN2019_ALL does not Granger Cause IS_2		0.23103	0.79463
IS_10 does not Granger Cause MEAN2019_ALL	51	0.73266	0.48615
MEAN2019_ALL does not Granger Cause IS_10		1.54722	0.22371
IS_2 does not Granger Cause IS_1	48	1.94810	0.15492
IS_1 does not Granger Cause IS_2		0.33137	0.71976
IS_10 does not Granger Cause IS_1	48	0.33190	0.71938
IS_1 does not Granger Cause IS_10		3.58488	0.03631**
IS_10 does not Granger Cause IS_2	51	0.02528	0.97505
IS_2 does not Granger Cause IS_10		1.37799	0.26229

Note: Mean20xx_ALL denotes mean DNB survey expectations at the 20xx horizon; IS_x denotes inflation rates implied by inflation-indexed swaps x years ahead. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 4.4.4

Granger causality tests for changes in mean inflation expectations and implied inflation-indexed swap rates

Pairwise Granger Causality Tests Sample: 6/22/2009 7/11/2010; Lags: 2Null Hypothesis:	Obs	F-Statistic	Probability
D(IS_1) does not Granger Cause D(MEAN2010_ALL)	46	0.88702	0.41964
D(MEAN2010_ALL) does not Granger Cause D(IS_1)		0.10456	0.90096
D(IS_2) does not Granger Cause D(MEAN2010_ALL)	50	0.65697	0.52332
D(MEAN2010_ALL) does not Granger Cause D(IS_2)		0.61525	0.54499
D(IS_10) does not Granger Cause D(MEAN2010_ALL)	50	0.55122	0.58009
D(MEAN2010_ALL) does not Granger Cause D(IS_10)		0.26479	0.76856
D(IS_1) does not Granger Cause D(MEAN2011_ALL)	46	2.12023	0.13297
D(MEAN2011_ALL) does not Granger Cause D(IS_1)		1.39443	0.25949
D(IS_2) does not Granger Cause D(MEAN2011_ALL)	50	1.53178	0.22721
D(MEAN2011_ALL) does not Granger Cause D(IS_2)		2.75678	0.07423*
D(IS_10) does not Granger Cause D(MEAN2011_ALL)	50	4.52885	0.01614**
D(MEAN2011_ALL) does not Granger Cause D(IS_10)		0.83065	0.44234
D(IS_1) does not Granger Cause D(MEAN2019_ALL)	46	0.59871	0.55425
D(MEAN2019_ALL) does not Granger Cause D(IS_1)		1.19196	0.31393
D(IS_2) does not Granger Cause D(MEAN2019_ALL)	50	0.37245	0.69115
D(MEAN2019_ALL) does not Granger Cause D(IS_2)		0.37485	0.68952
D(IS_10) does not Granger Cause D(MEAN2019_ALL)	50	0.66821	0.51764
D(MEAN2019_ALL) does not Granger Cause D(IS_10)		2.65338	0.08141*
D(IS_2) does not Granger Cause D(IS_1)	46	2.61771	0.08513*
D(IS_1) does not Granger Cause D(IS_2)		0.12563	0.88228
D(IS_10) does not Granger Cause D(IS_1)	46	0.29504	0.74607
D(IS_1) does not Granger Cause D(IS_10)		1.32756	0.27628
D(IS_10) does not Granger Cause D(IS_2)	50	0.58723	0.56007
D(IS_2) does not Granger Cause D(IS_10)		0.55693	0.57686

Note: d(Mean20xx_ALL) denotes weekly changes in mean DNB survey expectations at the 20xx horizon; d(IS_x) denotes weekly changes in inflation rates implied by inflation-indexed swaps x years ahead. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 4.4.5

Granger causality tests for mean inflation expectations with breakeven inflation rates implied by government bonds

Pairwise Granger Causality Tests
Sample: 6/22/2009 7/11/2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
RBEI_2 does not Granger Cause MEAN2010_ALL	51	2.60422	0.08484*
MEAN2010_ALL does not Granger Cause RBEI_2		0.70850	0.49768
RBEI_10 does not Granger Cause MEAN2010_ALL	51	0.25328	0.77733
MEAN2010_ALL does not Granger Cause RBEI_10		6.89825	0.00240***
RBEI_2 does not Granger Cause MEAN2011_ALL	51	6.59010	0.00304***
MEAN2011_ALL does not Granger Cause RBEI_2		0.17192	0.84258
RBEI_10 does not Granger Cause MEAN2011_ALL	51	1.35717	0.26750
MEAN2011_ALL does not Granger Cause RBEI_10		0.40346	0.67035
RBEI_2 does not Granger Cause MEAN2019_ALL	51	0.79003	0.45989
MEAN2019_ALL does not Granger Cause RBEI_2		0.97552	0.38466
RBEI_10 does not Granger Cause MEAN2019_ALL	51	0.63876	0.53257
MEAN2019_ALL does not Granger Cause RBEI_10		0.87585	0.42334
RBEI_10 does not Granger Cause RBEI_2	51	0.44824	0.64151
RBEI_2 does not Granger Cause RBEI_10		0.79225	0.45890

Note: Mean20xx_ALL denotes mean DNB survey expectations at the 20xx horizon; RBEI_x denotes breakeven inflation rates implied by government bonds x years ahead. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 4.4.6

Granger causality tests for changes in mean inflation expectations and breakeven inflation rates implied by government bonds

Pairwise Granger Causality Tests
Sample: 6/22/2009 7/11/2010
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
D(RBEI_2) does not Granger Cause D(MEAN2010_ALL)	50	0.03748	0.96325
D(MEAN2010_ALL) does not Granger Cause D(RBEI_2)		0.47155	0.62709
D(RBEI_10) does not Granger Cause D(MEAN2010_ALL)	50	0.44299	0.64489
D(MEAN2010_ALL) does not Granger Cause D(RBEI_10)		2.59444	0.08582*
D(RBEI_2) does not Granger Cause D(MEAN2011_ALL)	50	5.08052	0.01025**
D(MEAN2011_ALL) does not Granger Cause D(RBEI_2)		0.32952	0.72099
D(RBEI_10) does not Granger Cause D(MEAN2011_ALL)	50	1.99442	0.14794
D(MEAN2011_ALL) does not Granger Cause D(RBEI_10)		0.60221	0.55195
D(RBEI_2) does not Granger Cause D(MEAN2019_ALL)	50	0.22491	0.79948
D(MEAN2019_ALL) does not Granger Cause D(RBEI_2)		0.16493	0.84847
D(RBEI_10) does not Granger Cause D(MEAN2019_ALL)	50	0.89503	0.41574
D(MEAN2019_ALL) does not Granger Cause D(RBEI_10)		1.42920	0.25016
D(RBEI_10) does not Granger Cause D(RBEI_2)	50	0.82371	0.44531
D(RBEI_2) does not Granger Cause D(RBEI_10)		0.74317	0.48135

Note: d(Mean20xx_ALL) denotes weekly changes in mean DNB survey expectations at the 20xx horizon; d(RBEI_x) denotes weekly changes in breakeven inflation rates implied by government bonds x years ahead. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 4.6.1(a)

Correlation between group inflation expectation means at 2010 horizon

Specification: $\pi_t^{g_2,2010} = c + \alpha_1 \pi_t^{g_1,2010} + \varepsilon_t$,

g_2 \ g_1	ACA	STU	DNB
ACA	1	0.56**	0.78**
STU	0.56**	1	0.48**
DNB	0.78**	0.48**	1

Note: Correlation coefficients estimated by OLS. ** and * denote significance at the 1% and 5% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB).

Table 4.6.1(b)

Correlation between detrended group inflation expectation means at 2010 horizon

Specification: $\pi^{*g_2,2010}_t = c + \alpha_1 \pi^{*g_1,2010}_t + \varepsilon_t$,

g_2 \ g_1	ACA	STU	DNB
ACA	1	0.34*	0.40**
STU	0.34*	1	0.13
DNB	0.40**	0.13	1

Note: Correlation coefficients estimated by OLS. ** and * denote significance at the 1% and 5% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB). π^* denotes an inflation expectation mean detrended by its linear trend (estimated by OLS).

Table 4.6.2

Correlation between group inflation expectation means at 2011 horizon

Specification: $\pi_t^{g_2,2011} = c + \alpha_1 \pi_t^{g_1,2011} + \varepsilon_t$,

g_2 \ g_1	ACA	STU	DNB
ACA	1	0.01	0.08
STU	0.01	1	0.04
DNB	0.08	0.04	1

Note: Correlation coefficients estimated by OLS. ** and * denote significance at the 1% and 5% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB).

Table 4.6.3

Correlation between group inflation expectation means at 2019 horizon

Specification: $\pi_t^{g_2,2019} = c + \alpha_1 \pi_t^{g_1,2019} + \varepsilon_t$

g_2 \ g_1	ACA	STU	DNB
ACA	1	0.13	0.04
STU	0.13	1	0.23
DNB	0.04	0.23	1

Note: Correlation coefficients estimated by OLS. ** and * denote significance at the 1% and 5% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB).

Table 4.6.4

Pairwise Granger causality tests on group inflation expectation means, 2010 horizon

↗ does not cause →	ACA	STU	DNB
ACA	—	0.085*	0.242
STU	0.062*	—	0.433
DNB	0.026**	0.255	—

Note: p values of pairwise Granger causality tests (2 lags). ***, ** and * denote significance at the 1%, 5% and 10% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB).

Table 4.6.5

Pairwise Granger causality tests on group inflation expectation means, 2011 horizon

↗ does not cause →	ACA	STU	DNB
ACA	—	0.212	0.228
STU	0.495	—	0.491
DNB	0.023**	0.476	—

Note: p values of pairwise Granger causality tests (2 lags). ***, ** and * denote significance at the 1%, 5% and 10% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB).

Table 4.6.6

Pairwise Granger causality tests on group inflation expectation means, 2019 horizon

↗ does not cause →	ACA	STU	DNB
ACA	—	0.098*	0.693
STU	0.726	—	0.528
DNB	0.532	0.007***	—

Note: p values of pairwise Granger causality tests (2 lags). ***, ** and * denote significance at the 1%, 5% and 10% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB).

Table 4.6.7

Impact of 2010 and 2011 group inflation expectation means on 2019 expectations means

Specification: $\bar{\pi}_t^{G,2019} = c + \alpha_1 \bar{\pi}_t^{G,2019} + \alpha_2 \bar{\pi}_t^{G,2011} + \alpha_3 \bar{\pi}_{t-1}^{G,2019} + \varepsilon_t$

	Estimated coefficients:					Diagnostics (*p* values):		
Group (*g*)	*c*	$\bar{\pi}_t^{G,2019}$	$\bar{\pi}_t^{G,2011}$	$\bar{\pi}_{t-1}^{G,2019}$	R^2	B-G	White	Ramsey
ACA	1.81**	0.04	0.21	—	0.08	*0.70*	*0.80*	*0.008***
STU	1.41**	0.28**	0.02	0.20	0.45	*0.44*	*0.09*	*0.72*
DNB	1.16**	-0.06	0.31	0.27*	0.16	*0.98*	*0.03**	*0.97*

Note: Coefficients estimated by OLS. ** and * denote significance at the 1% and 5% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB). Diagnostic tests are Breusch-Godfrey, 2 lags (B-G); White heteroskedasticity test, no cross terms (White); Ramsey RESET test, 1 fitted term (Ramsey).

Table 4.6.8

Inflation prediction rules by group and horizon

Specification: $\bar{\pi}_t^{G,h} = c + \alpha_1 \pi_t + \alpha_2 CE_t^h + \alpha_3 CDS_t^{EA} + \alpha_4 CDS_t^{GR} + \alpha_5 \bar{\pi}_{t-1}^{G,h} + \alpha_6 \bar{\pi}_{t-2}^{G,h} + \varepsilon_t$

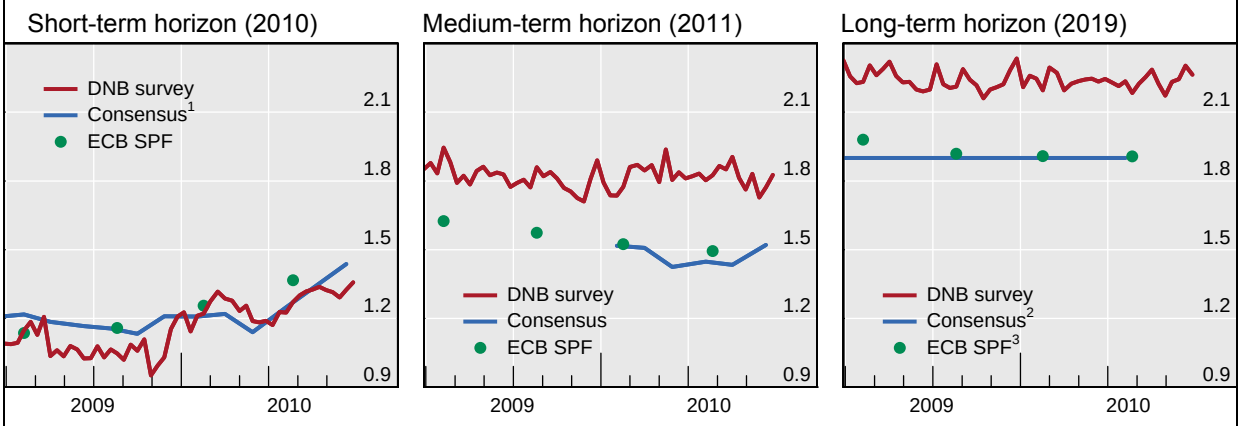
		Estimated coefficients:								Diagnostics (*p* values):		
g	*h*	*c*	π_t	CE_t^h	CDS_t^{EA}	CDS_t^{GR}	$\bar{\pi}_{t-1}^{G,h}$	$\bar{\pi}_{t-2}^{G,h}$	R^2	B-G	White	Ramsey
ACA	2010	0.68**	0.05*	—	—	0.047*	—	0.41**	0.84	*0.21*	*0.63*	*0.09*
STU	2010	0.52**	0.09**	—	—	—	0.48**	—	0.56	*0.12*	*0.07*	*0.41*
DNB	2010	0.87**	0.03*	0.14	—	0.059**	—	—	0.83	*0.22*	*0.25*	*0.82*
ACA	2011	2.17**	-0.05	—	—	0.061*	—	—	0.12	*0.26*	*0.25*	*0.45*
STU	2011	1.19**	0.03	—	—	—	0.49**	-0.21	0.27	*0.12*	*0.97*	*0.10*
DNB	2011	1.18**	—	—	—	—	0.28*	—	0.09	*0.13*	*0.001***	*0.57*
ACA	2019	2.57**	-0.03	—	—	0.047*	—	-0.13	0.16	*0.36*	*0.08*	*0.047**
STU	2019	2.25**	-0.05*	—	—	—	—	—	0.10	*0.19*	*0.57*	*0.15*
DNB	2019	2.16**	—	—	—	0.029**	—	—	0.33	*0.32*	*0.19*	*0.85*

Note: Coefficients estimated by OLS. ** and * denote significance at the 1% and 5% levels, resp. Groups are Academics (ACA), Students (STU) and DNB staff (DNB). Diagnostic tests are Breusch-Godfrey, 2 lags (B-G); White heteroskedasticity test, no cross terms (White); Ramsey RESET test, 1 fitted term (Ramsey). For the regressors, *CE* stands for Consensus Economics, *CDS* for Credit Default Swap (*EA* denoting Euro area and *GR* Greece), π is the most recent inflation number (flash or actual), and $\bar{\pi}$ is an inflation expectation mean.

Figure 4.1.1

Mean of individual forecasts

In percent



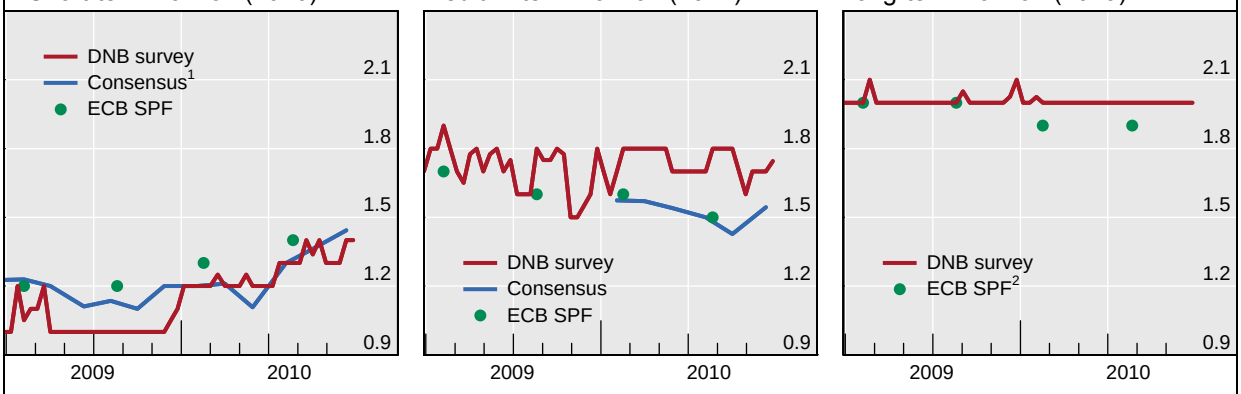
[1] First observation is from June 8 2009 Consensus Forecasts issue. [2] First observation is from April 14 2009 Consensus Forecasts issue. Forecasted period is 2015–2019 in year 2009 and 2016-2020 in year 2010. [3] Five years ahead.

Sources: © Consensus Economics; ECB, Survey of Professional Forecasters.

Figure 4.1.2

Median of individual forecasts

In percent



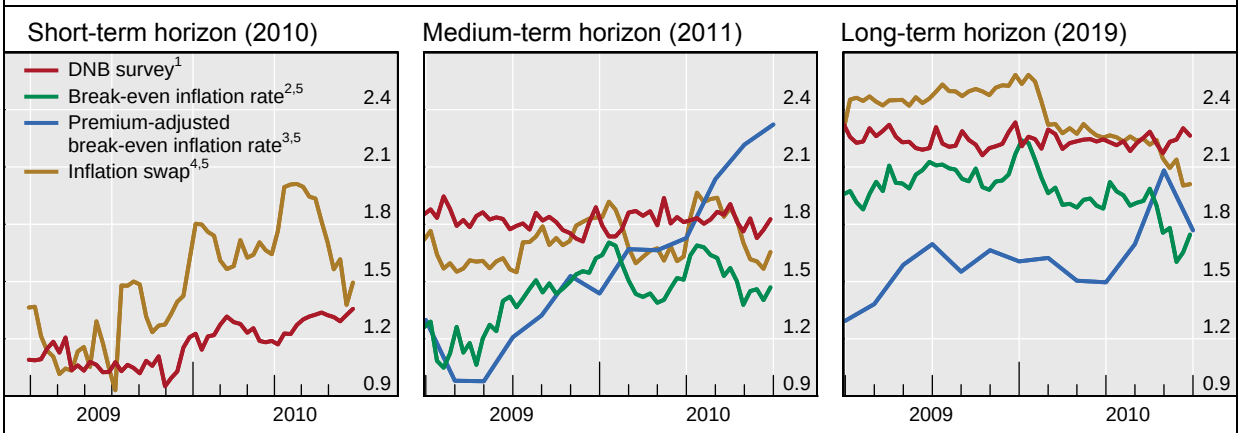
[1] First observation is from June 8 2009 Consensus Forecasts issue. [2] Five years ahead.

Sources: © Consensus Economics; ECB, Survey of Professional Forecasters.

Figure 4.1.3

Mean forecasts and implied market expectations

In percent



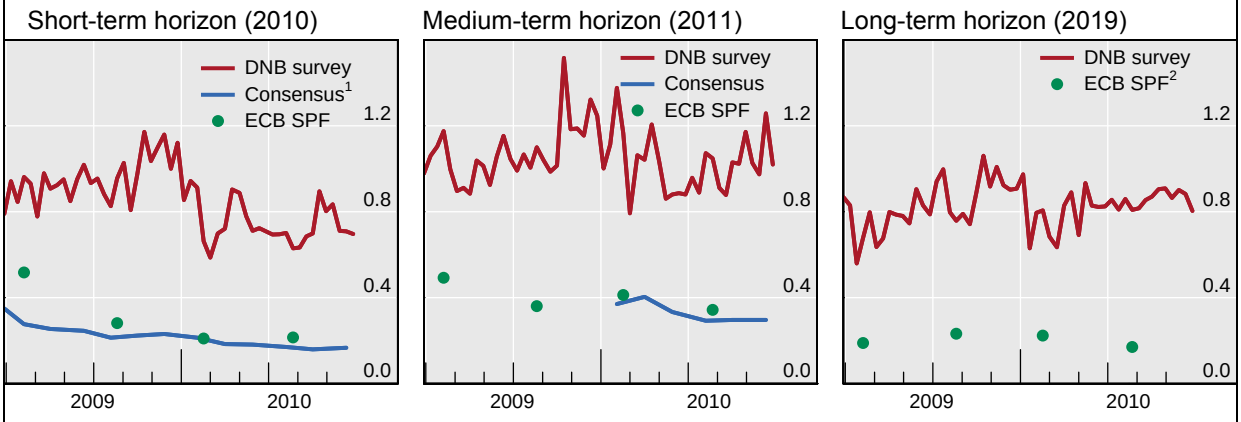
[1] Survey mean expectations of inflation, as reported in the DNB survey. [2] All break-even inflation rates are based on zero coupon real and nominal rates calculated using the Nelson-Siegel-Svensson method on nominal and index-linked government bond prices; end-of-month data. [3] Break-even inflation rate less the estimated 10-year inflation risk premium. [4] Zero coupon fixed rate leg necessary to build a par swap against a leg on zero coupon CPI appreciation. [5] Market anticipation 1, 2 and 10 years ahead of the observation time.

Sources: Bloomberg; ECB; Federal Reserve Bank of Philadelphia; BIS calculations.

Figure 4.1.4

Standard deviation of individual forecasts

In percentage points



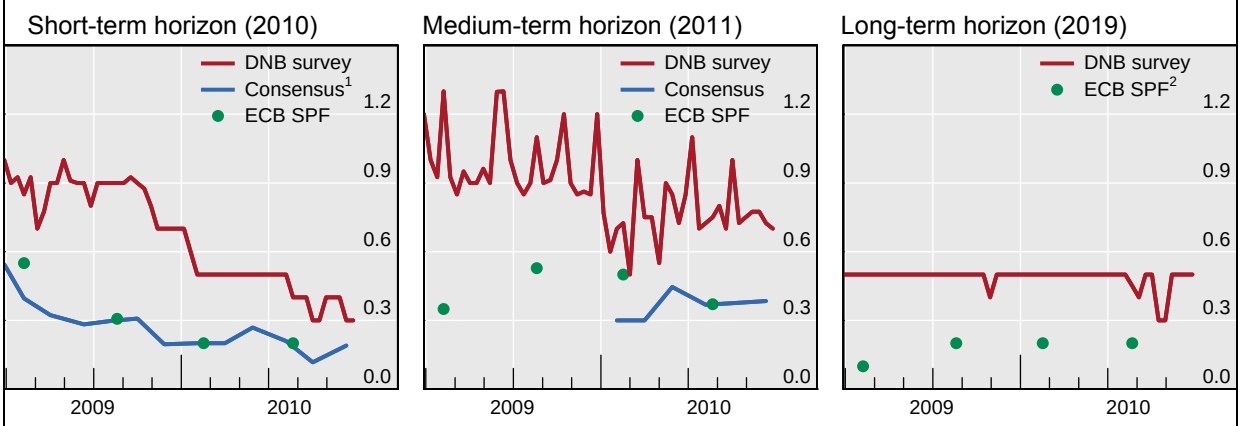
[1] First observation is from June 8 2009 Consensus Forecasts issue. [2] Five years ahead.

Sources: © Consensus Economics; ECB, Survey of Professional Forecasters.

Figure 4.1.5

Interquartile range of individual forecasts

In percentage points

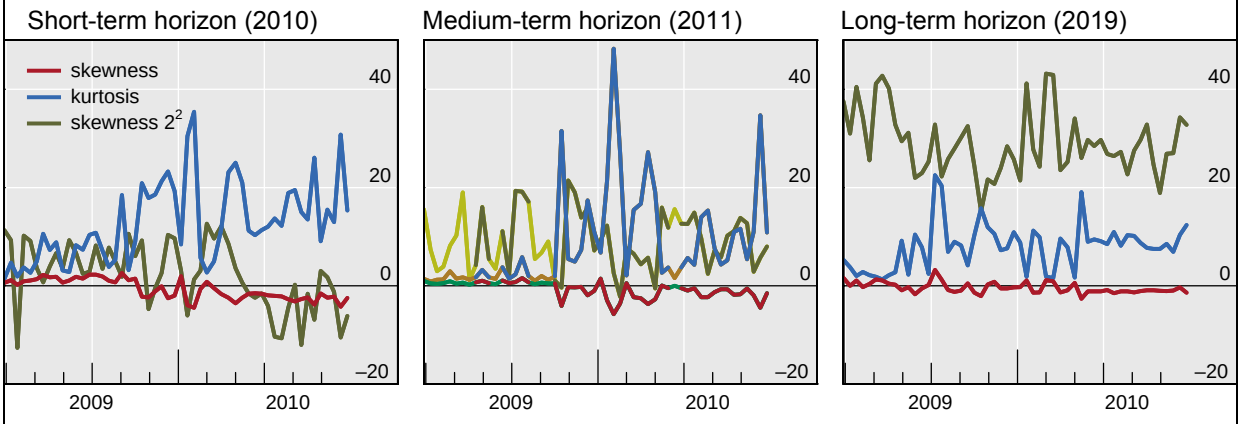


[1] First observation is from June 8 2009 Consensus Forecasts issue. [2] Five years ahead.

Sources: © Consensus Economics; ECB, Survey of Professional Forecasters.

Figure 4.1.6

Skewness and excess kurtosis of individual forecasts[1]



[1] Green, beige and olive colors represents periods where 1% Jarque-Bera test suggests normal distributions. 2 Skewness measure based on the formula: (mean-median)/standard deviation.

Figure 4.1.7

Skewness and excess kurtosis based on percentiles of individual forecasts

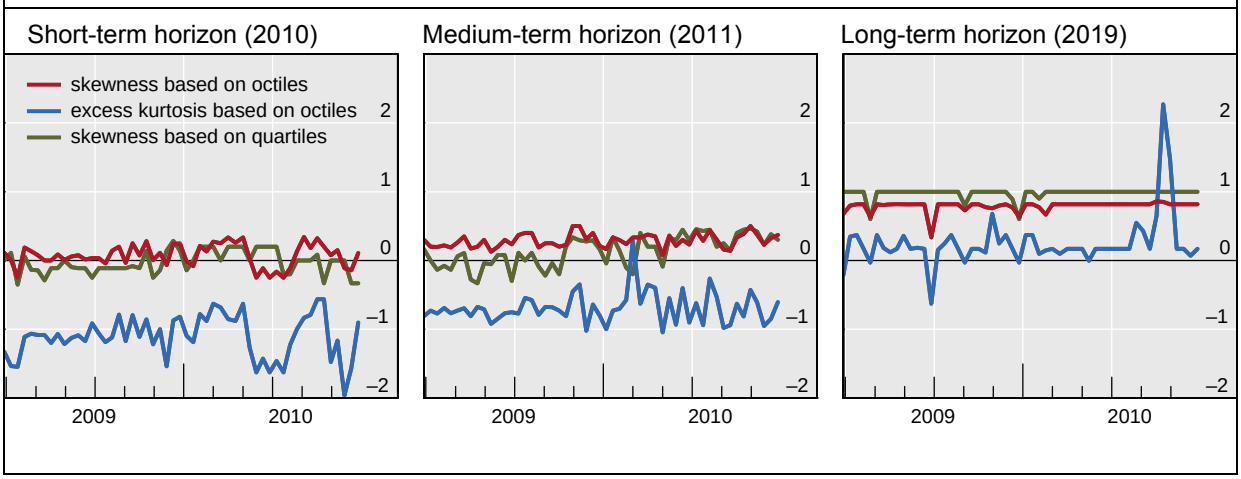
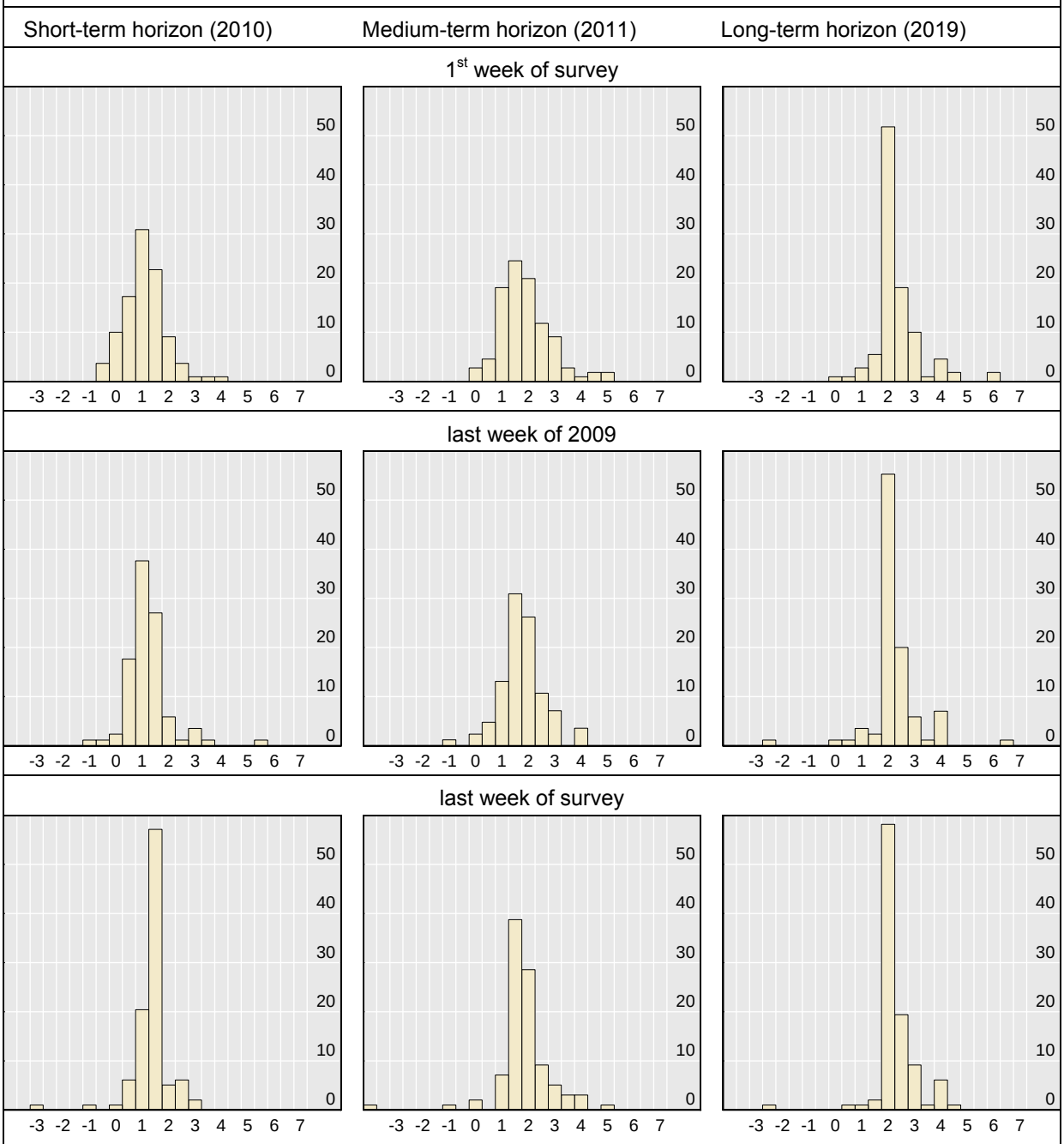


Figure 4.1.8

Survey distributions[1]

In percentage of respondents

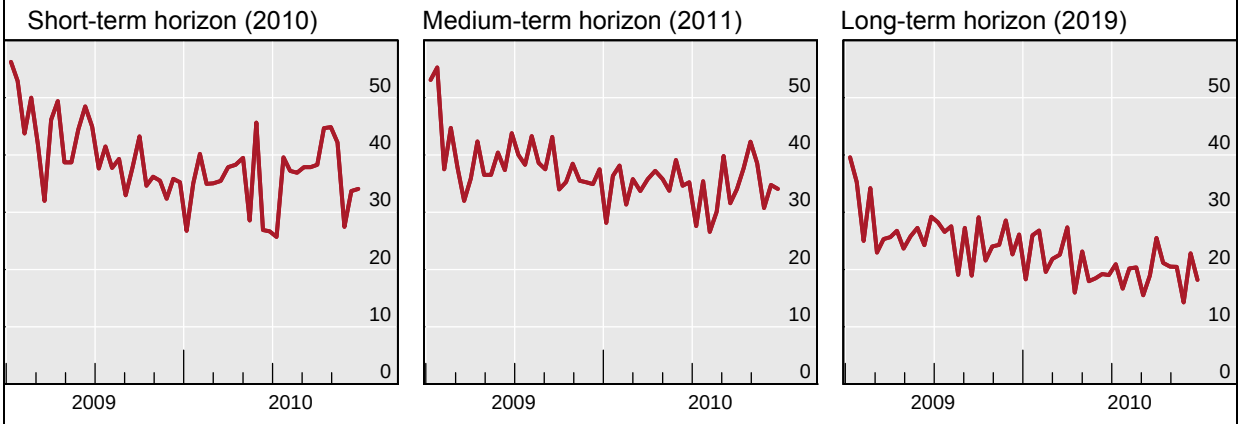


[1] Non-missing responses considered.

Figure 4.1.9

Proportion of changes in inflation expectations per week[1]

In percentage of respondents

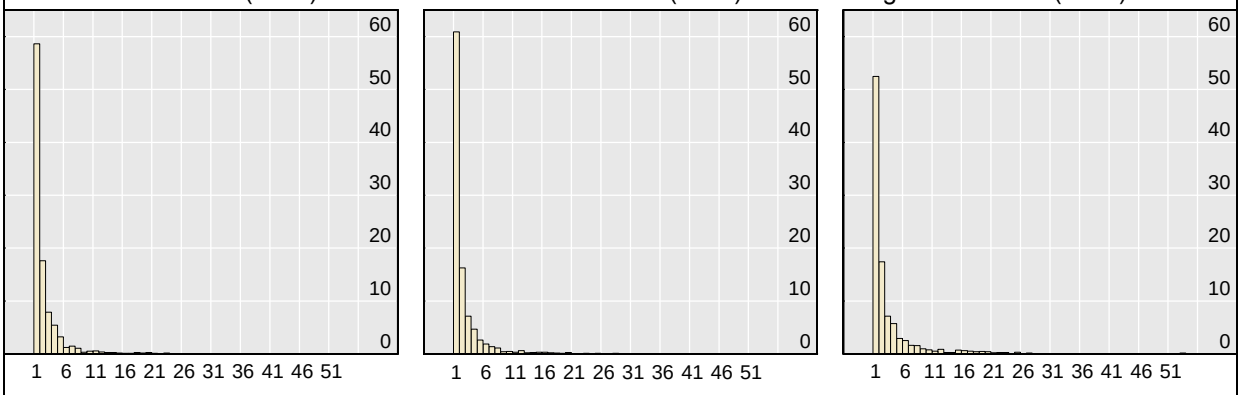


[1] A change in inflation expectation is considered if responses are given and differ for two consecutive weeks

Figure 4.1.10

Duration of spells when expectations are unchanged[1]

In percentage of total number of spells

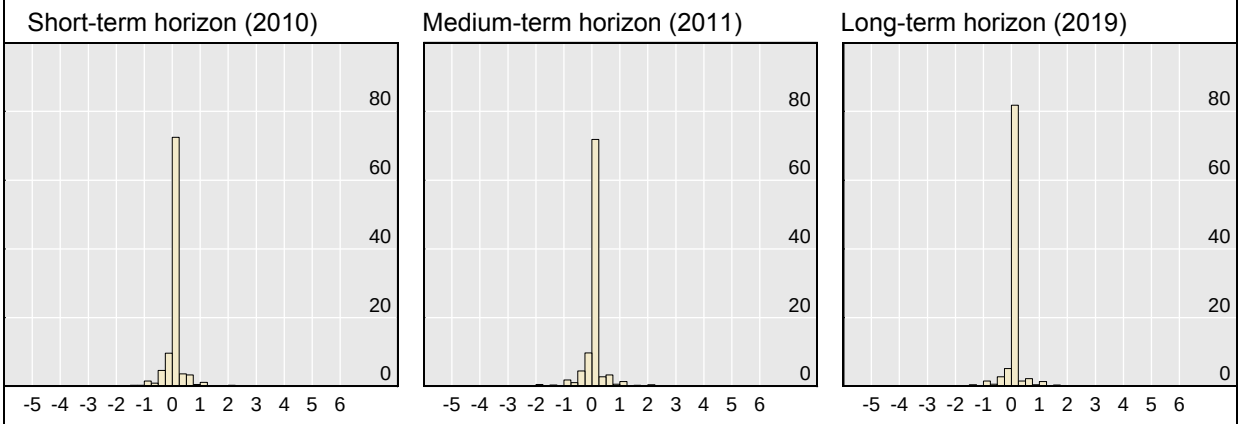


[1] A spell of inflation expectation is considered if a minimum of two consecutive responses are given.

Figure 4.1.11

Distributions of weekly changes in inflation expectations[1]

In percentage of respondents

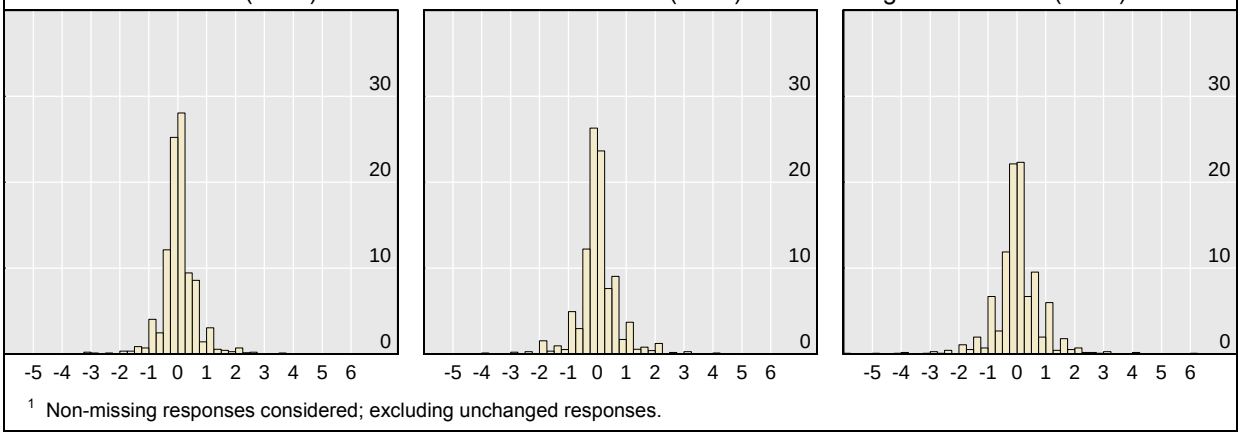


[1] Non-missing responses considered.

Figure 4.1.12

Distributions of non-zero weekly changes in inflation expectations[1]

In percentage of respondents

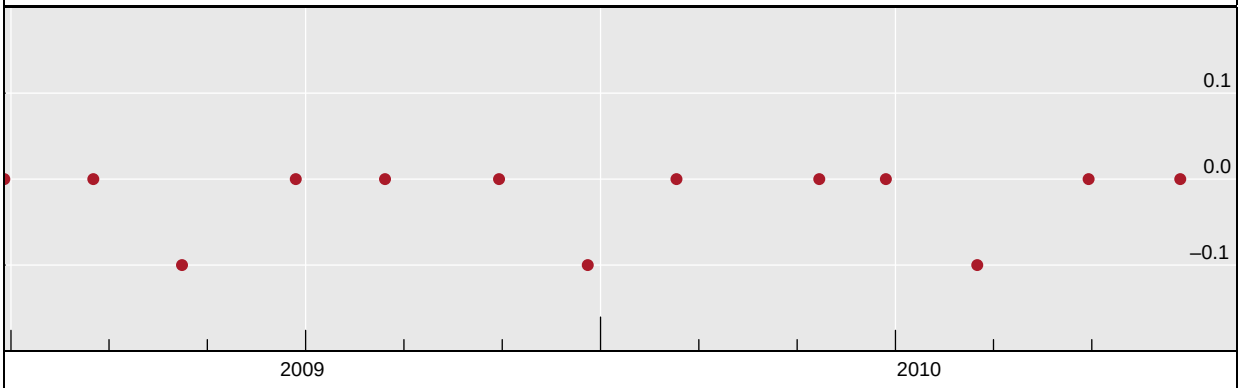


[1] Non-missing responses considered; excluding unchanged responses.

Figure 4.2.1:

Surprise in euro area HICP data releases[1]

In percentage points



[1] Based on Bloomberg surveys

Sources: Bloomberg.

Figure 4.6.1

Mean of individual forecasts by groups

In percent

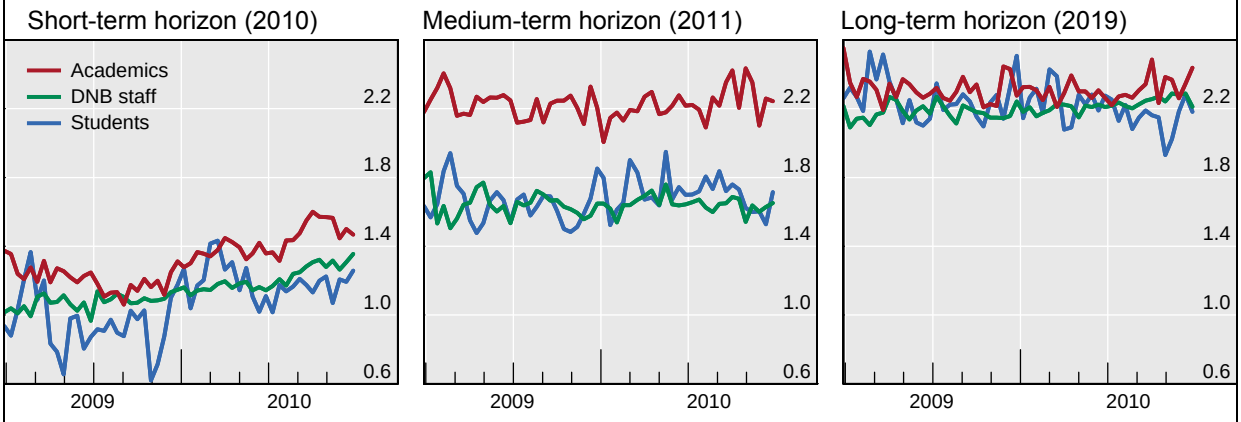
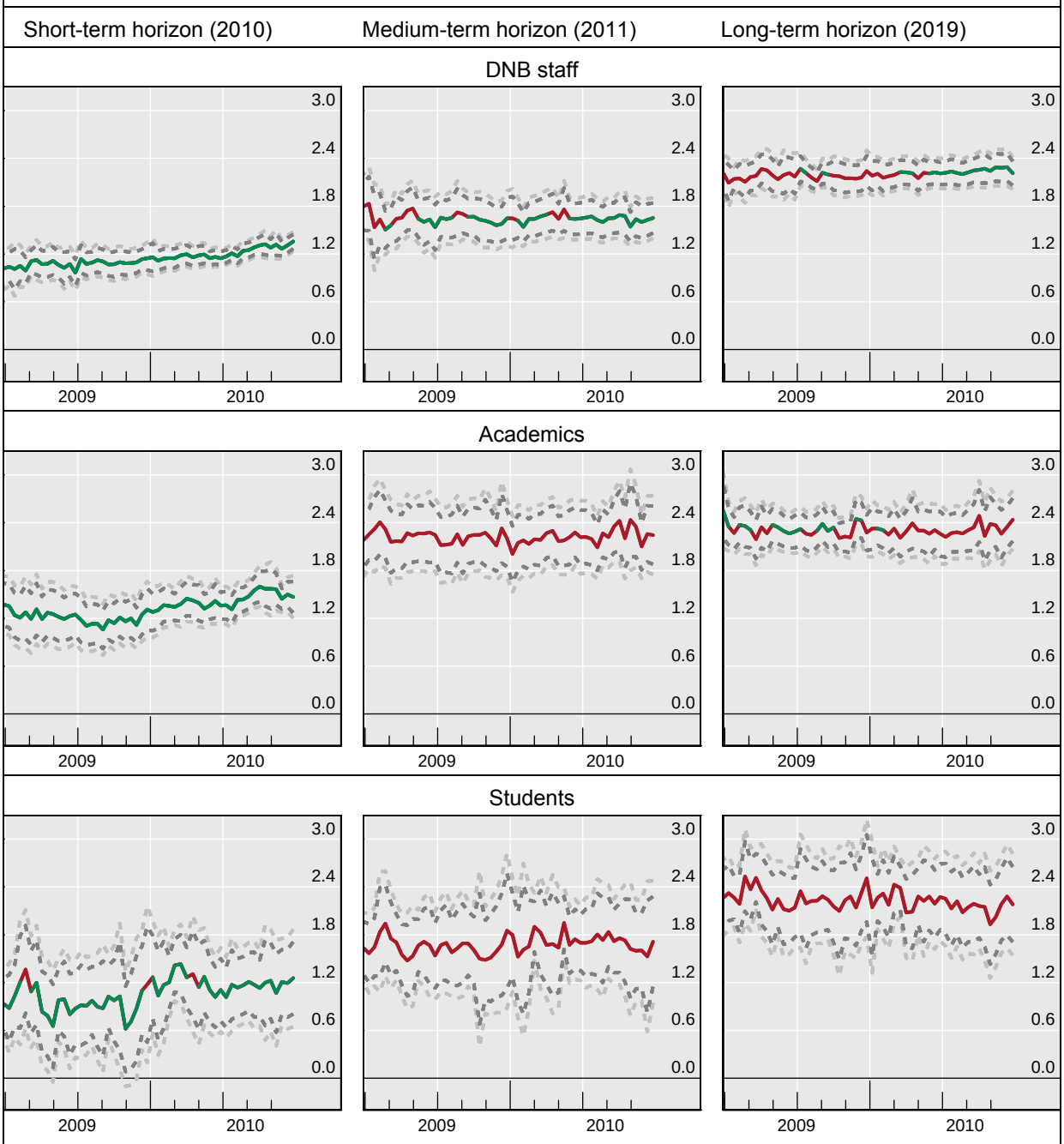


Figure 4.6.2

Mean of individual forecasts by groups

In percent



[1] Green colour represents periods where 1% t-test suggests that mean forecast is different from 2%. Dark and light dashed lines show 95% and 99% confidence intervals, respectively.

Appendix 1 Short questionnaire for participants of the weekly inflation survey

The following questions are taken from the psychology literature. Your answers will remain strictly anonymous. Please indicate to which extent you agree with the following 13 statements. Give an answer between **1 (completely disagree)** and **7 (completely agree)** to each question. An answer of 4 about a particular statement indicates that you don't know whether you agree or disagree, or are completely neutral, about that statement.

Statement	**Score (1 to 7)**
1. Whenever I am faced with a choice, I try to imagine what all the other possibilities are, even ones that aren't present at the moment.	
2. No matter how satisfied I am with my job, it's only right for me to be on the lookout for better opportunities.	
3. When I am in the car listening to the radio, I often check other stations to see if something better is playing, even if I am relatively satisfied with what I am listening to.	
4. When I watch TV, I channel surf, often scanning through the available options even while attempting to watch one program.	
5. I treat relationships like clothing: I expect to try a lot on before finding the perfect fit.	
6. I often find it difficult to shop for a gift for a friend.	
7. Renting videos is really difficult. I'm always struggling to pick the best one.	
8. When shopping, I have a hard time to finding clothing that I really love.	
9. I'm a big fan of lists that attempt to rank things (the best movies, the best singers, the best athletes, the best novels, etc.)	
10. I find that writing is very difficult, even if it's just writing a letter to a friend, because it's so hard to word things just right. I often do several drafts of even simple things.	
11. No matter what I do, I have the highest standards for myself.	
12. I never settle for second best.	
13. I often fantasize about living in ways that are quite different from my actual life.	

Source: The American Psychological Association.

Appendix II: Definitions of robust and standard higher moments

This appendix presents definitions of the robust and standard higher moments used in the paper, drawing on Moessner et al. (2010). The interquartile range (IQR) of a probability distribution is defined as

$$IQR = Q_{0.75} - Q_{0.25}\,, \qquad \text{(A1)}$$

where $Q_{0.75}$ and $Q_{0.25}$ are the 75th and 25th percentiles, respectively.

The standard skewness measure is defined as the normalised third central moment

$$Skew = E[(x-\mu)^3/\sigma^3], \qquad \text{(A2)}$$

where μ and σ are the mean and standard deviation of x. E(·) is the expectations operator. Hinkley (1975) suggested a class of robust skewness measures of the following form:

$$Skew_R^p = \frac{(Q_{1-p} - Q_{0.5}) - (Q_{0.5} - Q_p)}{Q_{1-p} - Q_p}, \qquad \text{(A3)}$$

where Q_p is the p-th quantile, $p \in (0,1)$, and $Q_{0.5}$ is the median. For p=0.25, the quartile-based skewness is given by

$$Skew_R^{0.25} = \frac{(Q_{0.75} - Q_{0.5}) - (Q_{0.5} - Q_{0.25})}{Q_{0.75} - Q_{0.25}}, \qquad \text{(A4)}$$

For p=1/8, the octile-based skewness is defined analogously.

The standard excess kurtosis measure is defined as the normalized fourth central moment minus 3 (which is the value of the kurtosis for the standard normal distribution),

$$Kurt = E[(x-\mu)^4/\sigma^4] - 3 \qquad \text{(A5)}$$

Moors (1988) proposed a robust, octile-based measure of excess kurtosis as

$$Kurt_R^{1/8} = \frac{(Q_{7/8} - Q_{5/8}) - (Q_{3/8} - Q_{1/8})}{Q_{6/8} - Q_{2/8}} - 1.23, \qquad \text{(A6)}$$

The value of 1.23 corresponds to the Moors coefficient of kurtosis for the standard normal distribution.