Inflation expectations in the Survey of Professional Forecasters: An exploratory analysis

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Abstract

We explore the inflation forecasts of the respondents to the Survey of Professional Forecasters, and assess the role of the conditioning variables in driving their dynamics. (JEL: E31, E52, E58)

Introduction

E xpectations about future inflation play an important role in decisionmaking by private agents, and can have a significant impact on economic outcomes, including realised inflation. For instance, higher expected future inflation may induce households to demand higher wages for their labour, and businesses to raise the prices of their goods and services. It is therefore crucial for central banks, whose goal is maintaining price stability, to pay close attention to measures of the private sector's inflation expectations.

Measures of inflation expectations come in several forms: marketbased measures, derived from the prices of financial securities, surveybased measures, obtained from forecasts or expectations by professionals or households, and model-based measures, extracted from estimated structural models of the economy. Each of these measures has advantages and disadvantages, and is used as a complementary indicator in central banks' continuous assessment of the inflation outlook and the accompanying risks.

In this article we present an overview of one of the main sources of information about inflation expectations in the euro area – the Survey of Professional Forecasters. The survey (SPF hereafter) is conducted by the European Central Bank (ECB) and, in its 20 years of existence, has become a valuable point of reference regarding the private sector's expectations to both policymakers and academic researchers.

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Our objective in the article is twofold. We first describe the evolution of inflation expectations over the last 20 years, and highlight some salient features that have emerged during that period. Second, we try to shed light on some of the drivers behind the observed dynamics of SPF inflation forecasts. To that end, we exploit the fact that, in addition to their inflation forecasts, the SPF participants are also asked to provide information about their underlying assumptions with respect to future values of a number of relevant variables. We examine and assess the role these variables have played in driving the survey's results.

A particular question we are interested in and explore is whether there are significant differences between the behaviour of inflation forecasts in the periods before and after 2013. As we discuss in more detail below, after 2013 inflation in the euro area has been relatively low when compared with the ECB's objective. This has raised concerns that low inflation becomes entrenched in expectations, with potentially highly disruptive effects in the effectiveness of policy. Our results suggest that, along the dimensions we explore, there has not been a fundamental change in the relative role of assumptions with respect to the formation of inflation expectations. Furthermore, the association between developments in inflation and longerterm expectations appears limited both before and after 2013.

The rest of the article is organised in four sections. The first provides some background information about the SPF and the dataset of individual responses, with a particular emphasis on features of the survey that we explore in the article. The second section describes the evolution of the SPF inflation forecasts for different horizons, and offers some historical context on developments in the euro area during the sample period. We present survey results both in terms of point forecasts, as well as density forecasts, and discuss the ways in which information obtained from these distinct sources can be helpful to gain insights about the nature of inflation expectations. In the third section we evaluate the relationship between inflation expectations and the assumptions of survey respondents about future values of conditioning variables. We also consider the extent to which movements in short-term inflation expectations influence long-term expectations. The last section offers some concluding remarks.

The ECB's Survey of Professional Forecasters

In this section we provide a brief description of the ECB's SPF and the dataset of survey responses, which will serve as a background for the analysis in the rest of the article. More detailed information about the survey can be found in Garcia (2003).

The SPF was launched in the first quarter of 1999, and since then has been conducted on a quarterly basis. The results from the surveys are publicly

available and the sample we use in this article includes all surveys up to the 2018Q4 survey.¹ While the main aim of the survey is to gather forecasts for the euro area harmonized index of consumer price inflation (HICP) – the price index over which the ECB defines its price stability objective –, each respondent is also asked to report forecasts for the euro area real GDP growth rate and for the euro area unemployment rate.

The majority of respondents to the survey are expert economists working in financial institutions, although a significant number of non-financial institutions also contribute. On average, each SPF round has about 60 respondents, which is a relatively high number compared to other surveys. Importantly, even though the respondents are anonymous, their responses can be identified by a unique number assigned to each one of them. The participation in the survey is, however, irregular, and even respondents who reply on a regular basis often fail to submit replies to some of the questions, which creates recurrent gaps in the dataset. We do not attempt to interpolate any missing observations. Working with such an unbalanced panel poses nevertheless challenges to our analysis.

In each survey round, respondents provide three types of forecasts. The first is a "calendar horizon" forecast for the current and for the following two calendar years.² For instance, in 2018Q1 respondents were surveyed about their forecasts for 2018, 2019 and 2020. The second type of forecasts is a "rolling horizon" forecast for two specific months (quarters for the GDP growth rate) one and two years ahead of the latest available data for the respective variables. To be specific, for example in 2018Q1 the survey was sent out after the official release of the December 2017 figure for HICP inflation, 2017Q3 figure for GDP growth and November 2017 figure for the unemployment rate. Each forecaster was thus surveyed about her inflation forecast for December 2018 and December 2019, her GDP (y-o-y) growth forecast for 2018Q3 and 2019Q3, and her unemployment rate forecast for November 2018 and November 2019. Finally, forecasters are asked to provide forecasts for a "long-term horizon" set as four calendar years ahead in the Q1 and Q2 survey rounds, and five calendar years ahead in the Q3 and Q4 rounds. The aim is to gather information about private sector expectations for long-term GDP growth and unemployment rate, as well as to get an idea of the level of longer-term inflation expectations, which provides an indication on forecasters' confidence in the ECB being able to achieve its inflation objective.

To gather information about the uncertainty surrounding point forecasts for inflation, GDP growth and the unemployment rate, forecasters are also asked to provide probability distributions around their forecasts. These

^{1.} The data is available on the web site of the ECB – https://www.ecb.europa.eu/stats/ecb_surveys/survey_of_professional_forecasters/html/index.en.html

^{2.} Until 2012, the survey asked for the two-year ahead forecasts only twice a year (in Q3 and Q4 survey rounds).

distributions are expressed in terms of the probabilities assigned to the variable being within specific ranges in the future. For example, in the 2018Q1 survey, forecasters were asked about the probability of inflation being below -1%, between -1% and -0.6%, between -0.5% and -0.1%, and so on. This distribution reflects quantitatively how uncertain forecasters are about their point forecasts, and is helpful to assess how forecasters gauge the risk of the actual inflation outcome being above or below the most likely value.

Specifically for inflation forecasts, the SPF also requests information about the assumptions underlying the survey participants' forecasts. In particular, forecasters are asked to report their expectations about the interest rate on Eurosystem's main refinancing operations, the price in US dollars of Brent crude oil, the USD/EUR exchange rate, and the annual rate of change of compensation per employee.

How have inflation expectations evolved?

Point forecasts

Figure 1a shows the evolution over time of SPF inflation expectations for three calendar horizon targets: the next calendar year (t + 1), two years ahead (t + 2) and the long term (t + 5).³ While expectations for one and two-year ahead inflation show frequent and often large movements over the entire sample period, long-term expectations have been relatively stable until the end of 2012, and have not moved closely with either shorter term expectations, or with actual inflation outcomes. This remains true even in the period 2008-2010, when realised inflation fluctuated significantly (Figure 1b). The fact that long-term expectations remained stable is in line with the notion that, if agents are confident that the ECB will achieve its price stability objective, long-term expectations in current inflation.

However, in the beginning of 2013, long-term expectations started to decline in tandem with those for shorter horizons and actual inflation, and reached a historical low in the beginning of 2015. These developments were followed closely by the ECB. In September 2014, faced with increased risks of persistent low inflation and inflation expectations potentially becoming de-anchored,⁴ the ECB launched two asset purchase programmes of private

^{3.} Long-term expectations refer to year t + 4 in Q1 and Q2 survey rounds, and to t + 5 in Q3 and Q4 rounds. For simplicity, we label them as t + 5.

^{4.} In September 2014, the ECB dropped the sentence "Inflation expectations for the euro area over the medium to long term continue to be firmly anchored in line with our aim of maintaining inflation rates below, but close to, 2%" from the introductory statement to the press conference that follows the Governing Council monetary policy meetings.



(A) Inflation expectations for one, two, and four/five-year ahead horizons



(B) Euro area HICP inflation

FIGURE 1: SPF inflation expectations and euro area HICP inflation Sources: ECB and Eurostat.

sector assets: covered bonds (CBPP3) and asset-backed securities secured by claims against the euro area non-financial private sector (ABSPP). In January 2015, in a context of continued low inflation and a further fall of inflation expectations, it was considered that the degree of monetary accommodation already achieved was insufficient, and the ECB announced the Expanded Asset Purchase Programme (APP), encompassing the existing purchase programmes for asset-backed securities and covered bonds and a new Public Sector Purchase Programme.

As can be seen in Figure 2, the APP announcement coincided with the reversal of the decline of medium and long-term inflation expectations.⁵ In fact, Bulligan (2018) finds that the APP announcement led to a statistically significant upward revision of medium-term inflation expectations, as was the conviction of the president of the ECB at that time: "We believe and are convinced and have good arguments to think that the monetary policy measures that we have decided today will contribute to lift inflation expectations" (ECB (2015)). Since then, expectations, as well as realised inflation, have recovered, but stand below their pre-crisis averages. As a consequence, concerns remain regarding the convergence of inflation towards a path consistent with the ECB's objective in a sustained manner. Moreover, risks of a potential de-anchoring of long-term expectations continue to be carefully monitored.



FIGURE 2: Inflation expectations for the medium and long term Source: ECB.

Density forecasts

In addition to point forecasts, SPF respondents provide an additional valuable source of information about their views on future inflation: an inflation histogram, i.e., the probabilities that they assign to different inflation outcomes in the future. The density curves obtained from those histograms have experienced significant movements since the survey inception, especially those for shorter-term inflation, as illustrated in Figure 3.

^{5.} Throughout the article, we consider medium and long-term horizons when we discuss the APP impact, as these two horizons are more relevant for evaluating the effectiveness of monetary policy. Medium-term expectations refer to the month two years ahead from the latest available HICP data (M + 24). Long-term expectations refer to four/five years ahead.



FIGURE 3: Aggregate probability distributions Sources: ECB and authors' calculations.

Note: Gaussian kernel densities obtained from individual inflation histograms. Colour gradient reflects evolution over time.

In particular, distributions for two and four/five-year ahead expectations have shifted to the left after 2013. As a consequence, the probability of inflation outcomes in the medium and long term below those consistent with the ECB's objective has increased significantly until the beginning of 2015, as seen in Figure 4.⁶ From 2015Q2 onwards this probability stopped increasing and even declined sharply in the case of medium-term expectations. A plausible explanation for this reversal in the trend is the APP announcement, indicated in the figure. This is corroborated by Bulligan (2018), which finds that the APP announcement shifted the individual probability distributions to the right.

Individual distributions can be used to make a quantitative assessment of uncertainty and risks surrounding inflation forecasts. In particular, in this section we look carefully at two moments of those distributions, the variance and the asymmetry, to investigate how both the individual uncertainty and the balance of risks associated with point forecasts have evolved over time.

With respect to uncertainty, for each forecaster we compute the standard deviation of the probability distribution and divide it by the respective

^{6.} The ECB aims at inflation rates of below, but close to, 2% over the medium term. Taking into account the lower and upper bounds of the bins for which the forecasters are asked to assign probabilities, we sum the probabilities assigned to the outcomes up to 1.5%, given that the next bin ends at 1.9%.



FIGURE 4: Probability of inflation outcomes below 1.5% in the medium and long term Sources: ECB and authors' calculations.



(C) Uncertainty – t + 5 inf. expectations

(D) Euro area HICP inflation volatility

FIGURE 5: Uncertainty measures and euro area HICP inflation volatility

Sources: ECB, Eurostat and authors' calculations. Note: Inflation volatility is defined as the standard deviation of HICP y-o-y inflation divided by the mean; the figure shows 5 and 10-year moving averages.

probability distribution mean.⁷ Subsequently, we average this statistic across

^{7.} We normalise the standard deviation by the mean because the means have changed significantly over time, making the standard deviations at different points in time less comparable.

forecasters. As uncertainty tends to increase with the forecast horizon, a careful analysis requires having uncertainty measures for target periods that are equally distant. Therefore, we use expectations for rolling horizons M + 12 and M + 24 and for the long term.⁸

Figures 5a, 5b and 5c show that in general uncertainty has been at historically high levels over the low-inflation period. The significant rise of uncertainty occurred however at the time of the financial crisis. In part, the higher uncertainty about future inflation relative to the pre-crisis period might reflect the higher volatility of actual inflation outcomes since mid-2007. In fact, a visual inspection of Figure 1b shows that before that period inflation fluctuated only slightly around values close to 2%, while afterwards the volatility has been significantly higher, to some extent due to strong fluctuations in oil and other commodity prices. This is corroborated by Figure 5d, which shows that average volatility of actual y-o-y HICP outcomes – measured by the rolling standard deviation over the mean – is now substantially higher than it was before the crisis. Experiencing volatile inflation outcomes might explain at least in part why forecasters seem to be more uncertain about inflation in the future.

With respect to the balance of risks associated with point forecasts, for each respondent we first compute the difference between the mean of the probability distribution and the point forecast, and divide that difference by the standard deviation of the probability distribution. This statistic, akin to the Pearson's coefficient of skewness, gauges whether each respondent assesses the risk of the actual inflation outcome to be above or below the point forecast. Subsequently, we compute two different measures: (i) the average of that statistic across forecasters; (ii) the share of forecasters for which that statistic is below zero, i.e., the share of forecasters that see risks on the downside.

Figure 6 presents the first aforementioned measure – the average balance of risks across forecasters. As this measure is quite volatile, we average it by year. We can see that over the low-inflation period the balance risks has been in general skewed to the downside over the different horizons. Moreover, while some improvements are observable in the last two years, after historically low levels in 2016, our measure remains at relatively low levels, especially when compared to the pre-crisis period.

The assessment of the balance of risks as skewed to the downside in recent years has been quite generalised across forecasters: for the three horizons considered the majority of respondents sees risks on the downside (Figure 7). The share of respondents seeing downside risks is particularly high by past standards for the two-year ahead horizon.

^{8.} The evolution of inflation expectations for year t + 1 and month M + 12 is not fundamentally different over time, and the same holds for expectations for year t + 2 and month M + 24.



FIGURE 6: Balance of risks: average across forecasters

Sources: ECB and authors' calculations.

Note: Results for years before and during the low-inflation period are shown in red and blue, respectively.



FIGURE 7: Percentage of forecasters seeing risks on the downside

Sources: ECB and authors' calculations. Note: See the note to Figure 6.

Overall, while most forecasters still see risks on the downside, the balance is now less negative than it was in 2016 for the three horizons considered.

What drives the dynamics of inflation forecasts?

So far, we have described the historical evolution of euro area inflation forecasts, and have discussed some of the ways in which the SPF results on inflation point forecasts and probability density distributions can be informative about the private sector's perceptions about future inflation. Our aim in this section is to gain some insights about the factors that have affected SPF inflation expectations, and their dynamics over time. We know that inflation is influenced by many different variables, which are in turn driven by a complex interplay between exogenous shocks and endogenous responses of economic agents to those shocks. Consequently, there are many observable variables that could be potentially useful sources of information about future inflation. Clearly, sophisticated forecasters, such as the participants in the SPF, closely monitor a wide variety of economic variables and use that information to produce their forecasts. Furthermore, different forecasters are likely to have very different forecasting models; that would further obscure the relationship between their inflation forecasts, on one hand, and the underling factors, on the other. Here we will not attempt to evaluate all variables that may be influencing the forecasters' expectations about several conditioning variables, which are part of the survey, have played a role in determining their inflation forecasts.

As was mentioned earlier, a feature of the ECB's SPF is that the survey includes questions about the participants' assumptions with respect to future values of oil prices, the USD/EUR exchange rate, and annual growth in compensation per employee (henceforth referred to as wage growth). The stated reason for asking these questions is to collect information on the main drivers underlying each respondent's expectations about inflation. Therefore, our goal is to analyse to what extent each one of those variables has played a role in forming inflation expectations.⁹ This is the subject of the first part of this section. In the second part we extend the analysis by examining the relationship between short and long-term forecasts.

The role of assumptions

This section seeks to answer three questions: (1) have assumptions about the price of oil, USD/EUR echange rate, and wage growth played a role in driving inflation expectations? (2) how much heterogeneity is there among forecasters in terms of the role of different assumptions? (3) are there notable differences before and after 2013 with respect to the first two questions?

We start by plotting the time series of each conditioning variable together with those of inflation forecasts. The plots appear in Figure 8, where inflation forecasts are shown for the next calendar year, while the assumptions are for the current quarter in the case of oil price and exchange rate, or the current year in the case of wage growth. In addition to the time series plot, in each case we also show a scatter plot of the two variables.

^{9.} The survey questionnaire also asks about the participants' assumptions with respect to future values of the Eurosystem's main refinancing operations rate. However, since the end of 2014, the interest rate assumptions have remained very stable at close-to-zero levels, and do not display any meaningful relationship with inflation expectations. Therefore, in this section we will not discuss the relationship between the interest rate assumption and inflation expectations.



(A) Inflation expectations for the next year and oil price assumption for the current quarter



(B) Inflation expectations for the next year and USD/EUR assumption for the current quarter



(C) Inflation expectations for the next year and wage growth assumption for the current year

FIGURE 8: Inflation expectations and underlying assumptions Sources: ECB and authors' calculations.

At first sight, the plots suggest a fairly strong association of inflation expectations with the wage growth series, and a much weaker one with the oil price and the exchange rate series. However, a closer examination of the patterns, facilitated by the color coding of the scatter plots, reveals a significant time variation in the relationships. This is most apparent in the case of oil prices, where there are distinct parallel shifts over time in what appears to be otherwise a linear pattern. While it is historically unusual to see any relationship between the *level* of oil prices and the *rate of change* in consumer prices (expected or realised) the fact that such an empirical relationship emerged in the recent years has been well documented and has been a reason for concern to policy makers.¹⁰

Instead of exploring relationships between the levels of the variables, an alternative approach, which we adopt for the remainder of this section, is to examine the relationship between revisions in inflation expectations and revisions in the values of the underlying assumptions. Since the survey asks for successive forecasts of inflation for several different calendar years in the future, we can compute forecast revisions as the changes in the forecasts for a given target that occurs between two consecutive survey rounds. We consider inflation forecast revisions for one, two and four/five-year ahead horizons. Similarly, we define revisions in assumptions as the changes in the expected values between two consecutive surveys. For oil price and the exchange rate we focus on revisions, expressed as per cent changes, with respect to the values for the current quarter, i.e. the expected value for this quarter compared to the expected value for the one quarter ahead reported in the previous survey. For wage growth we consider revisions with respect to the expected value for the current year.¹¹

In principle, we could also consider revisions in assumptions for longer horizons, e.g. one, two or three quarters ahead – for oil price and exchange rate, or one, two, or four/five years ahead – for wage growth. The main reason why we do not is that data availability becomes a serious problem when we perform analysis at individual level: forecasters do not always respond to all survey questions, and to the extent that they do provide expected values for assumptions, they are far more likely to do so for shorter horizons. Also, as can be seen in Figures A.1 and A.2 in the Appendix, revisions in oil prices and exchange rate assumptions for longer horizons tend to be very highly correlated to revisions in the expected values for the current quarter. Therefore, the additional information content in those revisions with respect to inflation expectations is very limited. At the same time, Figure A.3 in the

^{10.} A possible explanation is that the real price of oil is indicative of global economic activity, in particular aggregate demand, which has implications for inflation. For more details, see Sussman and Zohar (2018) and the references therein.

^{11.} The revision of expected wage growth in the first survey round in a given year is computed relative to the last survey's response for the expected value for the next calendar year.

Appendix shows that revisions of assumptions about wage growth at different horizons are less correlated. We leave the exploration of the implications of this for inflation expectations for future work.

An appealing feature of working with forecast revisions is that they can be explained in terms of new information that becomes available to forecasters after the original forecast was made. If new information about the conditioning variables is deemed relevant for future inflation, this should result in the survey participants revising their earlier forecasts. In what follows we examine to what extent this has been the case for each one of the three conditioning variables. We also try to establish whether there has been a change in the observed relationships before and after 2013. We start by examining the relationship between forecasts and assumptions at the aggregate level, where revisions are computed using the average response across forecasters. Then, we proceed with additional analysis of the same relationships at the level of individual forecasters.



FIGURE 9: Revisions in the oil price assumption and in inflation expectations across surveys

Sources: ECB and authors' calculations.

Note: The shaded areas represents the uncertainty around each regression line (95% confidence interval computed using bootstrap).

Oil price. Figure 9 shows scatter plots of the aggregate revisions in assumptions about oil prices and the revisions in inflation forecasts for one, two, and four/five years ahead. Note that we have significantly fewer observations for the two-year ahead inflation forecasts. As mentioned earlier, this is due to the fact that until 2012 the survey asked for that horizon only twice a year, which leaves us with only one revision per year. Nevertheless, the results clearly suggest a stronger positive relationship for near-term inflation, and is essentially zero for the long-term expectations. This patterns holds both before and after 2013, although, for the shorter-term expectations, the relationship between revisions in forecasts of inflation and oil prices appears to have weakened slightly in the later period.

These results are not surprising because of the well-understood positive pass-through of oil prices into consumer prices, which normally spills over into shorter-term inflation expectations. While this pass-through is complex and involves many factors, including the tax system and structural aspects of the economy, changes in the oil price tend to impact inflation in the same direction, both directly through the impact on consumer energy prices, and indirectly through the impact of energy prices on producer and distribution costs (ECB (2010)). At longer horizons, no meaningful relationship is expected, unless second-round effects extend the impact of the shock to oil prices.¹²

While the relationship between inflation forecasts and oil price revisions is in line with economic intuition, it is important to remember that variables themselves are a result of mechanical aggregation of different individual responses. In general, aggregation may distort or obscure the underlying relationships as well as conceal existing heterogeneity among forecasters. Therefore, next we examine whether and how related these revisions are at the level of individual forecasters. We start by counting the number of forecasters



FIGURE 10: Fraction of forecasters revising the oil price assumption and inflation expectations (for the next calendar year) in the same or in opposite directions in each survey

Sources: ECB and authors' calculations.

Note: The dots show the fraction of forecasters revising in the same (red) or the opposite (blue) direction in a given survey. The lines connecting them change colour depending on which fraction dominates.

who update their inflation and oil price forecasts in the same or in the opposite direction in each survey. In Figure 10 we show, for revisions in forecasts for the next year's inflation, the fraction of forecasters from each group in the total

^{12.} Second-round effects refer to reactions of wage and price-setters to first-round effects in an attempt to keep real wages and profits unchanged, respectively.

pool of respondents in every survey round.¹³ The results show that, with a few exceptions, more respondents revise their forecasts in the same direction. On average, more that 40% of the forecasters are in that group, while only about 20%, on average, revise inflation and oil price forecasts in the opposite direction. The time-variation of these results is quite evident, and it would be interesting to investigate what the underlying causes might be, and whether similar patterns are found in the case of longer-term expectations. However, these questions are outside the scope of the present article. Instead, here we only examine the empirical distribution of each fraction over the two sample periods – before and after 2013, and for different inflation horizons – one, two, and four/five years ahead.



FIGURE 11: Distributions of the fractions of forecasters revising their oil price assumption and inflation expectations in the same direction (red) or the opposite direction (blue) across all SPF surveys

Sources: ECB and authors' calculations.

Note: The large box represents the interquartile range – the difference between 75th and 25th percentiles (the median is marked with a horizontal line). The smaller boxes represent additional percentiles.

The results are shown in Figure 11, where each distribution is summarised using a box plot. The results for inflation horizon t + 1 show us what we already know from Figure 10 – that in both periods there are far more forecasters who revise oil prices and inflation in the same direction than in the opposite direction. There is also a notable although much less pronounced

^{13.} We count only those respondents who make a revision in their oil price forecasts. Note that some of them keep their inflation forecasts unchanged, which explains why the sum of the "same" and "opposite" fractions in Figure 10 do not always sum up to 1.

difference in the distributions for inflation horizons t + 2 and, even less for t + 5, in the period before 2013, where again we find that a larger number of survey participants revise their oil price and inflation forecasts in the same direction. It is worth remembering that far fewer forecasters make revisions in their longer-term forecasts of inflation, especially for t + 5. Moreover, we have fewer observations after 2013 since that part of the sample is much shorter. Hence, the difference we see in the figure should not be interpreted as evidence for a change in the way forecasts and oil price assumptions are revised in the more recent period.

The above results by themselves do not show that all or even any individual forecasters revise their inflation forecasts in response to revisions in their assumptions about the price of oil. It is possible, that for some survey respondents the two sets of forecasts are unrelated, i.e. inflation forecasts are produced without taking into account the outlook for oil prices. In statistical terms, this would imply that the variables are independent. A simple way to establish if two variables are related, and to determine the sign of the relationship, is to compute correlation coefficients, and check whether they are statistically significant. Therefore, to find out if inflation and oil price forecast revisions are indeed related, we use the individuallevel data to calculate correlation coefficients for each survey participant, and then count the number of those for whom the correlation (positive or negative) is statistically significant. We do this for both sample periods, and



FIGURE 12: Fraction of forecasters for whom revisions in inflation expectations and assumptions about oil prices are statistically significantly correlated

Sources: ECB and authors' calculations.

the results are presented in Figure 12. To allow for a possible non-linearity in the relationship, we consider two rank correlation measures – Spearman, and Kendall- τ , in addition to the standard linear (Pearson) correlation coefficient. Rank correlation measures are better able to capture monotonic relationships,

Note: We use three correlation measures (Pearson, Spearman, and Kendall- τ) and the height of each bar shows the largest fraction obtained.

which may not be linear.¹⁴ In the figure we show only the maximum number of forecasters for whom a significant relationship is detected across the three measures, as a fraction of the number of all forecasters in our sample.¹⁵ The results suggest that for about 40% of the survey participants in each subperiod, new information about oil prices has an impact on their revisions of t + 1inflation forecasts. For all of them the relationship is positive. In the case of two-year ahead and long-term inflation expectations, there is a significant relationship for between 5% and 10% of the forecasters, and the relationship is positive for almost all of them.

A necessary caveat to the above results is that the number of forecasters, as well as their composition, changes between the two subperiods. In the sample before 2013 we have 59 forecasters, while after 2013 we have 38 forecasters for whom we have enough observations to compute correlations, and test for significance.¹⁶ Also, as already mentioned, some forecasters drop out from the survey, while others have joined only more recently. Thus, the pool of forecasters changes over time. The only conclusion we are able to draw from these results is that for a substantial number of forecasters revisions in oil price expectations appear to have played a role with respect to updates of their t + 1 inflation forecasts, and that the relationship is positive. For very few of them such a relationship also exists in the case of t + 2 and t + 5 expectations.

To summarize, our results show that revisions in oil prices and t + 1 inflation expectations tend to be positively related, which is in line with the expected pass-through from oil prices into consumer prices. Moreover, that relationship does not seem to have changed fundamentally after 2013. The apparent lack of a significant relationship in the case of longer-term expectations is in contrast to what has been documented for inflation expectations extracted from financial instruments, in the more recent period, both in the euro area and in the United States (see for example Elliott *et al.* (2015)). The two types of expectations are not necessarily comparable, however, due to, for instance, very different frequencies of observations (quarterly vs. daily – in the case of market-based expectations), as well as the presences of various premia in market instruments.¹⁷

^{14.} This is similar to what we have done in Figures 10 and 11 where we counted revisions in the same direction and in the opposite direction without regard to the size of revisions.

^{15.} The results are only marginally different if we use any one of the correlation measures. In most cases Spearman and Kendall- τ coefficients give the same answer with respect to significance or lack thereof, while the test for linear correlation tends to show significance in fewer cases.

^{16.} We set, admittedly without any formal justification, the minimum number of observations at 10.

^{17.} For a more detailed explanation of the differences between survey and market-based measures of inflation expectations, see for example Ciccarelli *et al.* (2017).

USD/EUR exchange rate. Figure 13 reports scatter plots of the revisions in aggregate assumptions about the USD/EUR exchange rate and inflation forecasts. To be clear, an increase in the USD/EUR exchange rate implies an appreciation of the euro. Unlike with the aggregate oil price assumptions, there does not appear to be any discernable relationship between the two series. From the regression lines displayed in the plots we can infer a relatively weak positive relationship before 2013, and similarly weak but negative relationship in the later period, in the case of both one and two-year ahead inflation expectations. However, the uncertainty in both cases is very large, and does not rule out a lack of systematic relationship between the variables.



FIGURE 13: Revisions in the exchange rate assumption (USD/EUR) and in inflation expectations across surveys

Sources: ECB and authors' calculations. Note: See the note to Figure 9.

Figure 14 shows the empirical distributions of the fractions of respondents who update their inflation forecasts and exchange rate assumptions in the same or the opposite directions. We see an increase, after 2013, in the fraction of respondents who revise their one-year ahead forecasts in the opposite direction of their exchange rate assumptions. In the earlier part of sample, the two fractions are approximately equal. A similar change is found with respect to the two-year ahead forecasts, for which there are relatively more forecasters revising in the same direction before 2013, but the fraction of those revising in the opposite direction is larger in the more recent period.

In Figure 15, we show the fractions of forecasters for whom revisions in inflation expectations are significantly related to revisions in the assumption about the exchange rate. We see that, in either period, the relationship is significant for very few forecasters. The sample sizes are 58 and 37 before and after 2013, respectively. Therefore the largest number of forecasters in either subperiod – those whose revisions of inflation forecasts for t + 1 are significantly related to exchange rate assumption revisions, is 9, 5 of which



FIGURE 14: Distributions of the fraction of forecasters revising their exchange rate assumption and inflation expectations in the same direction (red) or the opposite (blue) direction across all SPF surveys

Sources: ECB and authors' calculations. Note: See the note to Figure 11.



FIGURE 15: Fraction of forecasters for whom revisions in inflation expectations and assumptions about USD/EUR exchange rate are statistically significantly correlated

Sources: ECB and authors' calculations. Note: See the note to Figure 12.

show positive relationship, and the other 4 - a negative one. After 2013, the sign is negative in all cases, but the number of forecasters showing a significant relationship is even smaller – between 2 (for inflation in t + 2) and 4 (for inflation in t + 5).

The finding that USD/EUR exchange rate assumptions do not seem to have much of an impact on the inflation expectations for the large majority of SPF participants might be puzzling. From a theoretical point of view, a depreciation of the euro, i.e. a decrease in the USD/EUR rate, is expected to lead to higher inflation. The effect can be both direct – from the impact on the import prices of final consumer goods, or indirect – stemming from higher production costs, and other real channels, which again cause upward pressure on consumer prices (ECB (2016)). One possible explanation is that the limited set of observations we have does not allow us to detect a role for the exchange rate assumption even though they do play an important role with respect to inflation forecasts. Dividing the sample into two parts exacerbates this problem as it further limits the number of observations used to test for significance. However, our main result does not change when we redo the analysis using the full sample – again at most around 10%, i.e 6 or 7 forecasters, show a significant relationship, and for the majority of them the relationship is positive, i.e. the opposite of what would be implied by theory.

Wage growth. Lastly, we explore the relationship between revisions in inflation expectations and the forecasters' assumptions about wage growth. A scatter plot of the two variables, in terms of averages across forecasters, is shown in Figure 16. There is no apparent association before 2013, and a relatively strong positive relationship, including for long-term expectations, after that. There is also some suggestion of a negative relationship for two-year ahead expectations before 2013. However, this result should be discounted due to the very few observations in that sample.



FIGURE 16: Revisions in the wage growth assumption and in inflation expectations across surveys

Sources: ECB and authors' calculations. Note: See the note to Figure 9.

The individual-level data, shown in Figure 17, appears consistent with the aggregate-level result: after 2013, there are substantially more forecasters who revise expectations about wage growth and inflation in the same direction





FIGURE 17: Distributions of the fraction of forecasters revising their wage growth assumption and inflation expectations in the same direction (red) or the opposite (blue) direction across all SPF surveys

Sources: ECB and authors' calculations. Note: See the note to Figure 11.

Figure 18 shows the fraction of forecasters for whom we find a significant correlation between the revisions in inflation and wage growth expectations. The number of forecasters in the two subperiods – before and after 2013, is 35 and 24 respectively.¹⁸ Similar to the results for the exchange rate, relatively few forecasters appear to revise their inflation expectations taking into account new information about wage growth. There is no substantial difference in the results before and after 2013: a relatively larger number of forecasters show a significant relationship for revisions in t + 1 inflation – 4 respondents in the first, and 6 in the second period, for 1 of which the relationship is negative. In both subperiods, there are also a few forecasters (4 in the first and 2 in the second) whose revisions in long-term inflation expectations are related to changes in the assumptions about wage growth. These results do not change in any significant way if we use the full sample.

A positive relationship, like the one that appears to be relatively more prevalent in our results, is what one would expect from economic theory. Wages are an important part of firms' cost structure, and are thus tied to

^{18.} Questions about wage growth assumptions only started being asked in 2004Q3. This is the main reason why we have a smaller number of forecasters here compared to the oil price or exchange rate assumptions, for which we have data since 2002Q1.

their pricing decisions. Households also take into account the expected price dynamics when negotiating wages. Of course, neither of these arguments suggests that there is a causal link, and it is a very challenging task to establish such a relationship empirically.



FIGURE 18: Fraction of forecasters for whom revisions in inflation expectations and assumptions about the wage growth are statistically significantly correlated

Sources: ECB and authors' calculations. Note: See the note to Figure 12.

The role of shocks to current inflation

As already mentioned earlier, current developments in realised inflation have tended to be accompanied by changes in shorter-term inflation expectations. This is easily explained by the fact that shocks to inflation normally have a persistent effect, which takes some time to fade away. At the same time, if medium and longer-term expectations are well-anchored, deviations of inflation from the central bank's objective should be transitory, and inflation should gradually converge to the central bank's objective. Therefore, a useful metric to assess the central bank's ability to anchor inflation expectation is to assess whether there is no significant association between revisions in short-term inflation expectations and revisions in long-term ones (for a more thorough discussion of this see Bowles *et al.* (2007) and Castelnuovo *et al.* (2003)).

In this section we examine the relationship between short and long-term inflation expectations, and again compare the period before and after 2013. In particular, we are interested in understanding whether the fears of a deanchoring that emerged around 2013 and may have prompted additional policy actions by the ECB, can be justified or explained on the basis of developments in SPF expectations.

In Figure 19 we plot revisions in the average value of inflation expectations for the current year and revisions in average long-term inflation expectation across all surveys. For the period before 2013, there is a weak positive



association between the two variables. After 2013, the association appears to have remained unchanged, but is surrounded by even more uncertainty.

FIGURE 19: Revisions in inflation expectations for the current year and for the long term across surveys

Sources: ECB and authors' calculations. Note: See the note to Figure 9.

Individual-level data also suggest a relatively limited association between short and long-term expectations. In Figure 20 we can see that the distribution of the fraction of forecasters revising in the same direction shifted towards slightly higher values after 2013, while that for forecasters revising in the opposite direction shifted to somewhat lower values. Yet, in general the share of forecasters revising short and long-term expectations in the same direction remained at relatively low levels.

It is worth highlighting that relatively few survey respondents revise their point forecasts for long-term inflation in any given survey. This is why the sum of the fractions of "same" and "opposite" is typically much less than 1. Moreover, it is possible that even when forecasters make changes in their long term inflation forecasts, the changes are not related to their revisions of the short-term inflation forecast. We report, in Figure 21, the fraction of forecasters for whom we find such a relationship. In the period before 2013 there are 7 forecasters, in a sample of 59, i.e. about 12%, with statistically significant correlation coefficients. For all but one of them the relationship is positive. After 2013, our sample has only 36 forecasters with enough observations, and a significant positive relationship is found for 5 of them, while for 1 the relationship is negative.

The fact that over the last years long-term expectations have remained in the range of 1.8% to 2.0% – a range broadly consistent with the ECB' objective –, despite the strong volatility of HICP inflation outcomes and



FIGURE 20: Distributions of the fraction of forecasters revising their inflation expectations for the current year and for the long term in the same direction (red) or the opposite (blue) direction across all SPF surveys

Sources: ECB and authors' calculations. Note: See the note to Figure 11.



FIGURE 21: Fraction of forecasters for whom revisions in short and long-term inflation expectations are statistically significantly correlated

Sources: ECB and authors' calculations. Note: See the note to Figure 12.

shorter-term expectations, and the fact that the ECB's objective continues to be referred by survey participants as the main factor informing long-term expectations (ECB (2019)) also suggest that SPF expectations remain relatively anchored. Notwithstanding, some researchers have found empirical evidence of spillovers from short to long-term inflation expectations in the current period of low inflation, especially when using inflation expectations extracted from financial market instruments (see for example Antunes (2015)). In particular, Łyziak and Paloviita (2017) use SPF data and find that longer-term inflation expectations have become more sensitive to shorter-term ones after the crisis. A major difference relative to our approach is that the relationship is investigated using the level of expectations, and not revisions.

Concluding remarks

The SPF conducted by the ECB is an important source of information about inflation expectations in the euro area. In this article we provided an overview of the results of the survey, and illustrated some of the ways in which it is used to inform us about the evolution of expectations over time and the professional forecasters' assessment of risks and uncertainty around the expected path of inflation. We also examined the role of assumptions about future values of variables included in the survey - the price of oil, USD/EUR exchange rate, and wage growth, have played in driving the dynamics of inflation expectations. Our results suggest that updates in the value of only one of these variables - the price of oil, appear to have had a significant impact on the revisions of shorter-term inflation expectations throughout the sample period. The manifestation of such an impact at the aggregate level, as well as the absence of a significant effect from revisions in the other two variables, is due to differences at the level of individual forecasters. A significantly larger number of them appear to update their outlook for inflation when new information about the price of oil becomes available, compared to those who do that due to news about the exchange rate or wage growth. Further, we do not find significant differences in these results before and after 2013.

Our findings, however, should be interpreted with caution: the available data for individual-level responses is quite sparse, due to changing composition of the pool of forecasters, and intermittent lack of responses to survey questions, in particular regarding assumptions. It is, therefore, conceivable that our failure to find a significant role of exchange rate and wage growth revisions on inflation is due not to absence of underlying relationships, but to insufficient number of observations for us to detect it.

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Appendix: Additional Figures

 $\label{eq:FIGURE} FIGURE \ A.1: Revisions in aggregate expectations about oil prices for different horizons$

Sources: ECB and authors' calculations.

Note: The plots on the diagonal show Gaussian kernel density estimates of the distribution of the revisions in the expected price of oil for a given horizon.



FIGURE A.2: Revisions in aggregate expectations about USD/EUR exchange rate for different horizons

Sources: ECB and authors' calculations. Note: See note to Figure A.1.



FIGURE A.3: Revisions in aggregate expectations about wage growth for different horizons

Sources: ECB and authors' calculations. Note: See note to Figure A.1.