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**Working Paper**

## Anchoring of inflation expectations in the euro area: recent evidence based on survey data

ECB Working Paper, No. 1945

**Provided in Cooperation with:**

European Central Bank (ECB)

*Suggested Citation:* Łyziak, Tomasz; Paloviita, Maritta (2016) : Anchoring of inflation expectations in the euro area: recent evidence based on survey data, ECB Working Paper, No. 1945, ISBN 978-92-899-2193-0, European Central Bank (ECB), Frankfurt a. M., <https://doi.org/10.2866/3439>

This Version is available at:

<https://hdl.handle.net/10419/154378>

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EUROPEAN CENTRAL BANK  
EUROSYSTEM

## Working Paper Series

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Maritta Paloviita

Anchoring of inflation expectations  
in the euro area:  
recent evidence based  
on survey data

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Task force on low inflation  
(LIFT)

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No 1945 / August 2016



**Note:** This Working Paper should not be reported as representing the views of the European Central Bank (ECB). The views expressed are those of the authors and do not necessarily reflect those of the ECB.

### **Task force on low inflation (LIFT)**

This paper presents research conducted within the Task Force on Low Inflation (LIFT). The task force is composed of economists from the European System of Central Banks (ESCB) - i.e. the 29 national central banks of the European Union (EU) and the European Central Bank. The objective of the expert team is to study issues raised by persistently low inflation from both empirical and theoretical modelling perspectives.

The research is carried out in three workstreams:

- 1) Drivers of Low Inflation;
- 2) Inflation Expectations;
- 3) Macroeconomic Effects of Low Inflation.

LIFT is chaired by Matteo Ciccarelli and Chiara Osbat (ECB). Workstream 1 is headed by Elena Bobeica and Marek Jarocinski (ECB) ; workstream 2 by Catherine Jardet (Banque de France) and Arnoud Stevens (National Bank of Belgium); workstream 3 by Caterina Mendicino (ECB), Sergio Santoro (Banca d'Italia) and Alessandro Notarpietro (Banca d'Italia).

The selection and refereeing process for this paper was carried out by the Chairs of the Task Force. Papers were selected based on their quality and on the relevance of the research subject to the aim of the Task Force. The authors of the selected papers were invited to revise their paper to take into consideration feedback received during the preparatory work and the referee's and Editors' comments.

The paper is released to make the research of LIFT generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the ones of the author(s) and do not necessarily reflect those of the ECB, the ESCB, or any of the ESCB National Central Banks.

## **Abstract**

*The paper analyses the anchoring of inflation expectations of professional forecasters and consumers in the euro area. We study anchoring, defined as the central bank's ability to manage expectations, by paying special attention to the impact of the ECB inflation target and ECB inflation projections on inflation expectations. Our analysis indicates that longer-term inflation forecasts have become somewhat more sensitive to shorter-term forecasts and to actual HICP inflation in the post-crisis period. We also find that the ECB inflation projections have recently become more important for short- and medium-term professional forecasts and at the same time the role of the ECB inflation target for those expectations has diminished. Overall, our analysis suggests that in recent years inflation expectations in the euro area have shown some signs of de-anchoring.*

**JEL:** D84, E52, E58

**Keywords:** Inflation expectations, anchoring, survey data, euro area, financial crisis.

## Non-technical summary

This paper examines the anchoring of survey-based measures of inflation expectations in the euro area. We consider inflation expectations of professional forecasters and consumers for 1999Q1-2015Q3. In the case of the professional forecasters, we use one-year ahead, two-years ahead and 4-5-years ahead inflation forecasts from the ECB Survey of Professional Forecasters (SPF), conducted every quarter. In the case of consumers, we use the European Commission Consumer survey, which provides a unique set of harmonised monthly data on 12-months ahead consumer inflation expectations across the EU economies. As the survey question is qualitative, we quantify consumer inflation expectations using the probability approach.

We analyse anchoring of inflation expectations in the EMU period and pay special attention to possible changes in anchoring over the last few years, a period characterized by low inflation, increased economic uncertainty, zero lower bound (ZLB), and unconventional monetary policy measures. First, we examine the responsiveness of inflation expectations to actual inflation and the reaction of longer-term inflation expectations to shorter-term ones. Then, we analyse the anchoring of long-term inflation expectations to the ECB inflation target and extend this analysis to describe the behaviour of short- and medium-term inflation expectations. The novelty of our approach is in assessing the effectiveness of two main communication tools used by the ECB, the inflation target and the ECB inflation projections provided by the Eurosystem-staff or the ECB-staff, in influencing inflation expectations. Finally, we investigate the degree to which implicit anchors for inflation expectations are consistent with the ECB inflation target.

Our analysis suggests that in recent years inflation expectations in the euro area have shown some signs of de-anchoring. Since the onset of the financial crisis, the role of the inflation target for long-term expectations of professional forecasters has not diminished and the implicit anchors for medium- and long-term expectations have remained consistent with the ECB price stability objective. As regards the post-crisis period, however, we find some evidence of increased sensitivity of longer-term inflation forecasts to shorter-term forecasts and to actual HICP inflation. We show that ECB inflation projections have recently become more important for professional forecasters, as they provide benchmarks for their short- and medium-term inflation expectations. At the same time the role of the ECB inflation target for those expectations has diminished.

Continuous analysis of de-anchoring risks is crucial in monetary policy, especially in the current low inflation environment. Monetary policy credibility is built gradually over the years, but we cannot rule out the possibility that it may deteriorate quite rapidly. When analysing anchoring of inflation expectations, we also need to examine when the inflation target is expected to be reached. Risks of de-anchoring are potentially increasing, if the time when the target will be reached has been postponed in economic agents' expectations. Overall, our analysis emphasizes the role of the inflation target and inflation projections in the ECB management of inflation expectations. It also suggests that a more extensive use of forward guidance in monetary policy strategy (e.g. in the form of conditional interest rate path announcements for the next couple of years) can be potentially useful. Possible risks of a de-anchoring of inflation expectations need to be monitored continuously using various measures and methods, including those proposed in this study.

## 1. Introduction

In recent years the euro area has experienced widely differing inflation episodes: relatively stable price developments in the pre-crisis years, highly volatile inflation rates after the Lehman Brothers collapse and currently a very low inflation regime. Long-term inflation expectations obtained from surveys have been relatively stable, but a marginally declining trend has been observed lately. Recent developments raise the question of how the degree of anchoring of inflation expectations has evolved over time, in particular since the onset of the financial crisis.

The concept of anchored inflation expectations results directly from the discussion on the way in which monetary policy operates. The evolution of macroeconomic theory points out that *“the real influence of monetary policy is less the effect of any individual monthly decision on interest rates and more the ability of the framework of policy to condition inflation expectations”* (King, 2005). This means that an analysis of anchoring of inflation expectations – referring to the level and variability of anticipated future inflation and the disagreement among forecasters (Mehrotra and Yetman, 2014) – should test to what extent the framework of monetary policy is able to manage inflation expectations. Anchoring of expectations is therefore closely related to the literature on central bank credibility.<sup>1</sup>

Jochman et al. (2010) have adopted an alternative way to study anchoring of inflation expectations. They have used flexible parametric approach to analyse daily data on inflation compensation derived from the term structure of real and nominal interest rates. More precisely, they have examined the pass-through coefficient, which measures how changes in short-term expectations affect long-term expectations. Inflation expectations are defined to be anchored, if the pass-through coefficient is constant and small. Instead, if the coefficient is close to one, inflation expectations are defined to be unmoored. In the case of contained expectations, the pass-through coefficient is large at (approximately) average levels of short-term inflation expectations, but becomes small as short-term expectations deviate from their average value.

Typically, de-anchoring risks are assessed by focusing solely on long-term expectations, but the responses of long-term inflation expectations to macroeconomic news have also been studied (see for example Beechey et al., 2011). A proper analysis of anchoring of expectations seems to us however more complex. Firstly, it should consider expectations of different groups of economic agents. From the theoretical point of view firms’ expectations of future price developments are probably the most interesting, as they are closely related to price setting behaviour. Due to data availability problems consumer inflation expectations have been used to proxy firms’ expectations<sup>2</sup> (e.g. Coibion and Gorodnichenko, 2015; Friedrich, 2014), but consumer expectations are obviously important also themselves, for understanding decisions related to consumption, saving and wage bargaining. Secondly, the anchoring effects, i.e. the degree to which monetary policy is able to condition inflation expectations, must be analysed at different forecast horizons, not only for the long-term. Also, the sensitivity of longer-term expectations to shorter-term expectations and to actual inflation needs to be examined.

Inflation expectations can be measured directly in two different ways: based on survey data or on financial market data. As Cunningham et al. (2010) point out, both approaches have advantages and

<sup>1</sup> Central bank credibility is understood as the difference between inflation expectations of economic agents and the central bank’s inflation target or forecast (e.g. Faust and Svensson, 2001; Hutchison and Walsh, 1998; Cecchetti and Krause, 2002). Such measures of central bank credibility are consistent with the definitions proposed by Blinder (2000) (*“a central bank is credible if people believe it will do what it says”*) and Cukierman and Meltzer (1986) (*“the absolute value of the difference between policymakers’ plans and the public’s beliefs about those plans”*).

<sup>2</sup> Such an assumption may not necessarily be appropriate. E.g. direct measures of enterprises’ inflation expectations in Poland seem to be formed similarly to financial sector analysts’ inflation expectations and differently from consumer inflation expectations (Łyziak, 2013).

shortcomings. Surveys are useful, since they are addressed to different types of agents (households, enterprises and professional experts) who make price and wage setting decisions. Since surveys have typically been conducted for many decades, they can be used to make comparative analysis from previous inflationary or deflationary episodes. However, surveys usually miss recent changes in inflation expectations (since they are conducted only monthly or quarterly) and those formed among consumers are potentially biased if frequently purchased goods and services are over-weighted in expectations' formation. Also strategic survey responses (for example, participant may have incentives to declare expectations close to the consensus forecasts) and assumptions related to quantification of qualitative survey responses may cause bias to survey-based measures of inflation expectations. Advantages of market-based measures of inflation expectations are related to data frequency (available daily) and a wide range of forecast horizons. In addition, market-based inflation expectations are potentially more accurate than survey-based measures of inflation expectations, since in financial market agents "vote" with real money. However, inflation expectations based on financial market information are potentially biased due to liquidity risk, inflation risk, and institutional distortions. During times of market stress, as experienced after the collapse of Lehman Brothers, a flight to quality may distort nominal yields disproportionately, leading to biases in market based measures of inflation expectations.

The aim of the study is to analyse anchoring defined as the central bank's ability to manage inflation expectations. We examine whether the degree of anchoring of survey-based inflation expectations of consumers and professional forecasters has varied over time in the euro area. Using aggregated quarterly survey data, we examine how inflation expectations depend on actual inflation, using the approach of Ehrmann (2015), and we also investigate the relationship between longer- and shorter-term inflation expectations. Then we use the Bomfim and Rudebusch (2000) method to analyse the anchoring of long-term inflation expectations to the ECB inflation target and extend this method to describe the behaviour of short- and medium-term inflation expectations.<sup>3</sup> The novelty of our approach is in assessing the effectiveness of two main communication tools used by the ECB, i.e. the inflation target and inflation projections, in influencing inflation expectations. Finally, we use VAR models proposed by Demertzis et al. (2008, 2009) to examine the degree to which implicit anchors for inflation expectations are consistent with the ECB inflation target. Our sample period is 1999Q1-2015Q3, which includes both the financial crisis period and the current low inflation regime. Due to the increased economic uncertainty and unconventional monetary policy measures implemented after the Lehman Brothers collapse, we pay special attention to possible changes in anchoring over the last few years.

The paper is organised in the following way. Our data are described in section 2 and the empirical analysis is presented in section 3. Concluding remarks are provided in section 4.

<sup>3</sup> In the context of our analysis, the short-term forecast horizon is one year and the medium-term forecast horizon is two years. Correspondingly, the long-term forecast horizon is 4-5 years, which is the longest horizon available in the ECB SPF.

## 2. Data

We consider inflation expectations of professional forecasters and consumers for 1999Q1-2015Q3. In the case of the professional forecasters, we use one-year ahead, two-years ahead and 4-5-years ahead inflation forecasts from the ECB Survey of Professional Forecasters (SPF), conducted every quarter.<sup>4</sup> In the case of consumers, we use the European Commission Consumer survey<sup>5</sup>, which provides a unique set of harmonised monthly data on 12-month ahead consumer inflation expectations across the EU economies. As the survey question is qualitative, we follow Łyziak and Mackiewicz-Łyziak (2014) and quantify consumer inflation expectations using the probability approach (Carlson and Parkin, 1975; Batchelor and Orr, 1988).

The ECB inflation target is set at 1.9%, and the ECB views on future price developments are constructed using the Eurosystem-staff or the ECB-staff inflation projections for the current and next calendar years (published every quarter).<sup>6</sup> Using weighted averages (Gerlach, 2007; Dovern et al., 2012), we construct inflation projections one year ahead, which are comparable to the corresponding inflation expectations in the ECB SPF. In order to emphasize the degree of uncertainty attached to inflation projections, the ECB, up to March 2013, published inflation projections in the form of ranges (in our analysis we use midpoints of these ranges). Since June 2013 the midpoints of the ranges for inflation have also been published. Our analysis takes into account publication lags. The ECB SPF survey is conducted in the first month of every quarter, which means that the latest HICP inflation rate available to survey respondents at the time of expectations formation (survey-reply deadline) always refers to the last month of the previous quarter. Correspondingly, the latest ECB projection available at the time when the ECB SPF is conducted is the projection published in the previous quarter.

Figure 1 shows the actual inflation rate (HICP); the average short-term (SPF\_1Y), medium-term (SPF\_2Y) and long-term inflation expectations (SPF\_L) of professional forecasters; and the one-year-ahead inflation expectations of consumers (CONS\_1Y). It also displays the ECB inflation projections for one year ahead. It can be observed that inflation expectations have been more stable than HICP inflation, and the variation in longer-term inflation expectations has been more moderate than in the shorter-term ones. Figure 1 also reveals that short-term consumer inflation expectations have typically been more volatile than the corresponding expectations of professional forecasters. The short-term ECB inflation projections have been more closely related to short-term professional than consumers' expectations (correlation coefficients 0.89 and 0.72 respectively). After 2006, the volatility of actual inflation increased substantially (see Table 1).

[INSERT FIGURE 1 HERE]

[INSERT TABLE 1 HERE]

<sup>4</sup> Data source: <http://www.ecb.europa.eu/stats/prices/indic/forecast/html/index.en.html>. The ECB SPF is described in detail in Bowles et al. (2007). See <http://www.ecb.europa.eu/stats/pdf/spfquestionnaire.pdf?a9c65f6e4b965a8832693dcb0aebff66> for a survey questionnaire in January 2013 and

[http://www.ecb.europa.eu/stats/prices/indic/forecast/shared/files/dataset\\_documentation\\_csv.pdf?76c07dc372dffabc3fec09d8cefbf682](http://www.ecb.europa.eu/stats/prices/indic/forecast/shared/files/dataset_documentation_csv.pdf?76c07dc372dffabc3fec09d8cefbf682) for a description of the ECB SPF data set.

<sup>5</sup> See: European Commission (2006) or European Commission (2007) for a detailed description of the survey.

<sup>6</sup> The ECB inflation projections for the euro area are made four times a year using two different sets of procedures. The projections are performed twice a year by the ECB-staff and the Eurosystem National Central Banks in the context of the Eurosystem Staff Broad Macroeconomic Projection Exercise (BMPE). Twice a year these projections are made by the ECB-staff in the context of the ECB-staff Macroeconomic Projection Exercise (MPE).



The ECB SPF provides not only point forecasts but also information on forecast disagreement and forecast uncertainty. Forecast disagreement refers to standard deviation of point forecasts while using individual probability distributions (histograms) we construct subjective uncertainty series for all the survey respondents.<sup>7</sup> Forecast disagreement reflects polarization of individual views, while average individual uncertainty measures how confident the average survey respondent is in forming expectations. Figure 2 shows the history of forecast disagreement, while Figure 3 presents the average individual uncertainty for professional forecasts one-year-ahead. In addition to the quarterly series, the mean values are displayed for the whole sample and for two sub-periods (the pre-crisis period 1999Q1-2008Q2 and the crisis period 2008Q3-2015Q3).

It can be observed that the financial crisis notably affected forecast disagreement and the average individual uncertainty. Compared to the pre-crisis period, individual point forecasts were temporarily highly divergent after mid-2008 (in the middle of the crisis, both inflation and deflation were anticipated), and other peaks are observed at the beginning of 2012 and 2015. However, in the case of the average individual uncertainty, its higher-than-normal levels have persisted since the beginning of the financial crisis, which suggests that the risks of de-anchoring may have increased lately. The crisis clearly increased the volatility of both variables (see Table 1).

[INSERT FIGURES 2 AND 3 HERE]

### 3. Empirical analysis

Under credible monetary policy possible deviations of inflation from the target are expected to be transitory, i.e. economic agents have a reasonable degree of confidence that after deviating from the monetary policy objective, inflation will return to the target in the long-term and remain there (Anderson and Maule, 2014). A credible central bank is able to anchor long-term inflation expectations, but it can also affect short- and medium-term ones through its decisions and communication, especially through inflation projections. The latter expectations may be more important for wage and price-setting than long-term expectations.<sup>8</sup> Risks of de-anchoring may increase, if economic agents believe that the central bank has become more tolerant of deviations of short- and medium-term inflation from the monetary policy target (even if the monetary policy objective is expected to be reached in the long-run). Increasing risks of de-anchoring may also derive from an increasing sensitivity of longer-term expectations to shorter-term ones and/or to actual inflation, which means that inflationary or deflationary pressures may become self-fulfilling.

<sup>7</sup> In every survey round, survey respondents are asked to report how they assess the probability of the forecasted inflation outcome being within the pre-determined ranges (bins). The average individual uncertainty is defined as the average standard deviation of the individual probability distributions.

<sup>8</sup> Recent estimates of the Phillips curve for the euro area and its economies confirm this observation (see: European Central Bank, 2016).

For the reasons mentioned above, we analyse three aspects of anchoring of inflation expectations in the euro area: the responsiveness of inflation expectations to actual inflation, the reaction of longer-term inflation expectations to shorter-term ones, as well as the impact of the ECB inflation target and projections on inflation expectations. We also assess long-run properties of inflation expectations by estimating their implicit anchors.

### 3.1. Dependence of inflation expectations on actual inflation

If inflation expectations, especially medium- and long-term ones, are firmly anchored, they should not be sensitive to developments in actual inflation. To verify this, we follow Ehrmann (2015) and estimate the following equation:

$$\pi_{t|t+n}^e = \alpha + \beta\pi_{t-1} + \varepsilon_t, \quad (1)$$

where  $\pi_{t|t+n}^e$  refers to the average inflation expectations formed in period  $t$  for the forecast horizon  $t+n$ , and the term  $\pi_{t-1}$  denotes the lagged inflation rate.<sup>9</sup> Equation (1) could be estimated using differences of both variables (see Levin et al., 2004). However, we prefer the level specification proposed by Ehrmann (2015), since inflation in the euro area is persistently low and the ECB is currently targeting inflation from below. It is possible that risks of de-anchoring may strengthen over time, although the inflation rate remains stable.<sup>10</sup> Estimating equation (1) we use either the whole sample or two sub-samples separated by the financial crisis:<sup>11</sup>

$$\pi_{t|t+n}^e = (1 - d^{fc})[\alpha_{pc} + \beta_{pc}\pi_{t-1}] + d^{fc}[\alpha_{fc} + \beta_{fc}\pi_{t-1}] + \varepsilon_t. \quad (2)$$

The crisis dummy  $d^{fc}$  equals 0 up to 2008Q2 and 1 thereafter. Using the Wald test we examine whether the financial crisis has significantly changed the degree of expectations' backward-lookingness. In order to examine possible changes in expectations formation in more detail, we also estimate rolling regressions of equation (1), in which the size of the rolling window is 29 quarters: the sample period in the first rolling regression is 1999Q1-2006Q1, in the last one, it corresponds to the financial crisis period (2008Q3-2015Q3).<sup>12</sup>

Estimation results in Table 2 reveal that inflation expectations are more closely related to the actual inflation rate in the short-run than in the long-run and that the relationship between inflation expectations for one year ahead and actual inflation is stronger for consumers than for professional forecasters, independently of the sample period under consideration. It seems that the financial crisis has somewhat strengthened the impact of current inflation on inflation expectations: the biggest increase in the estimated  $\beta$  coefficient is observed for the short-term consumer expectations (from 0.28 to 0.40). Only for long-term professional forecasts and short-term consumer expectations is the change statistically significant (at the 5 per cent significance level). The relatively high adjusted  $R^2$  statistics for short- and medium-term inflation expectations reflects strong backward-lookingness.

<sup>9</sup> The lagged inflation rate in equation (1) is the latest inflation rate available at the time when expectations were formed, i.e. the HICP inflation rate in the last month of the previous quarter.

<sup>10</sup> Ciccarelli et al. (2015) have analysed the effects of the unconventional monetary policy measures on U.S. long-term inflation expectations using the first-difference specification. Also in Jochmann et al. (2010) the analysis of anchoring in the U.S. financial market data is based on the first-difference specification.

<sup>11</sup> Lehman Brothers collapsed in September 2008.

<sup>12</sup> Changes of anchoring could also be analysed using regime switching models, which are based on sudden changes of anchoring. However, these models are not necessarily suitable for analysis of anchoring, since it is more likely that central bank credibility and anchoring of inflation expectations vary gradually over time.

[INSERT TABLE 2 HERE]

The  $\beta$  coefficients and corresponding confidence bounds from rolling regressions, dated at the end of every sample (Figure 4), show that the impact of current inflation on professional inflation expectations decreased quite clearly before 2008, but increased thereafter until 2009. The reaction of consumer expectations to actual inflation was slightly different in the beginning of the sample: fairly steadily increasing  $\beta$  coefficients are estimated before 2009. After 2009 the response of expectations to actual inflation remained quite stable in all cases, but after the end of 2013 steadily increasing coefficients are obtained for professionals expectations at all forecast horizons. But around the end of the sample, marginally decreasing  $\beta$  coefficients are obtained for consumer expectations.<sup>13</sup>

Rolling regressions indicate that the current low inflation regime has strengthened the effect of actual inflation on expectations to maximum levels, since in all cases the largest  $\beta$  coefficients are obtained at the end of the sample. On the other hand, the estimated  $\beta$  parameters increase in size after mid-2013, i.e. after the rolling period 2006Q2-2013Q2. This coincides with increased volatility of actual inflation (see Figure 1), which led to more dispersed inflation expectations and increased inflation uncertainty (see Figures 2 and 3). The confidence bounds reveal that only after mid-2012 did the response of long-term expectations to actual price development become statistically significant.<sup>14</sup>

[INSERT FIGURE 4 HERE]

Our finding of a recently strengthened impact of actual inflation on inflation expectations is in line with Ehrmann (2015), who has compared the dependence of inflation expectations on past inflation in inflation targeting countries and non-inflation targeting countries. Using inflation expectations provided by Consensus Economics, he finds that with low and persistently low inflation, inflation expectations are more dependent on lagged inflation.

### 3.2. Dependence of longer-term inflation expectations on shorter-term inflation expectations

Firmly anchored inflation expectations should be insensitive to developments in shorter-term inflation expectations. Anchoring risks of this kind can be assessed by estimating the following equation:

$$\pi_{t|t+n}^e = \alpha + \gamma\pi_{t|t+m}^e + \varepsilon_t, \quad (3)$$

where  $\pi_{t|t+n}^e$  refers to the average longer-term inflation expectations formed in period  $t$  for the forecast horizon  $t+n$  and  $\pi_{t|t+m}^e$  denotes the average shorter-term inflation expectations formed in period  $t$  for

<sup>13</sup> This results may be due to the fact that since mid-2013 inflation perceived by consumers, quantified on the basis of EC survey data and used as a scaling factor in quantifying inflation expectations, has been consistently above the current HICP inflation. The average inflation perception – quantified in line with Mackiewicz-Lyziak and Lyziak (2014) method – was approx. 1.5% in 2013Q3-2015Q1, while the average current HICP inflation in the corresponding period was almost 50% lower (0.8%). Such an inflation perception gap may be related to the fact that consumers attach a relatively small weight to price reductions (Kurri, 2006), so in an environment of low inflation their perceptions exceed official measures of price dynamics.

<sup>14</sup> Somewhat more volatile  $\beta$  parameters are obtained if the size of the rolling window is reduced (available upon request).

the forecast horizon  $t+m$ . By including the crisis dummy in equation (3), we obtain separate coefficients for the pre-crisis and crisis periods:

$$\pi_{t|t+n}^e = (1 - d^{fc})[\alpha_{pc} + \gamma_{pc}\pi_{t|t+m}^e] + d^{fc}[\alpha_{fc} + \gamma_{fc}\pi_{t|t+m}^e] + \varepsilon_t. \quad (4)$$

We use equations (3) and (4) to examine how long-term professional forecasts respond to short- and medium-term expectations, and how medium-term expectations are affected by short-term expectations. In addition rolling estimations are also conducted.

Table 3 suggests that the recent crisis has substantially changed the impact of short-term inflation expectations on the long-term ones. The estimated  $\gamma$  coefficient is three times as high (0.17) in the crisis period as in the pre-crisis period (0.06), and according to the Wald test this increase is statistically significant at the 10 per cent level.

[INSERT TABLE 3 HERE]

Figure 5 displays rolling regression results for equation (3) – again, the size of the rolling window is 29 quarters and the estimated  $\gamma$  coefficients and corresponding confidence bounds are dated at the end of each sample. It occurs that the response of long-term expectations to short- and medium-term ones increased up to 2008, but thereafter the estimated coefficients decreased until 2009. From 2010 to mid-2013 the impact of short- and medium-term expectations on the long-term ones was relatively weak and stable, but clearly larger parameters are obtained again after mid-2013 (very high  $\gamma$  coefficients are estimated at the end of the sample compared to the earlier history). During this period the response of medium-term expectations to short-term ones also increased steadily (also in this case the maximum estimated  $\gamma$ -values come at the end of the sample). It is worth noting that in both cases the estimated  $\gamma$  parameters for long-term inflation expectations have been significantly positive since the beginning of 2014. Overall, all these rolling regressions indicate that the risks of de-anchoring have increased slightly in the most recent period.<sup>15</sup>

[INSERT FIGURE 5 HERE]

### **3.3. Anchoring of inflation expectations to the ECB inflation target and the ECB inflation projections**

In this section we examine how the ECB inflation target and the ECB inflation projections affect the evolution of inflation expectations. Figures 6 and 7 present absolute deviations of inflation expectations from the ECB inflation target and ECB inflation projections, comparing them with absolute deviations of inflation expectations from the current HICP inflation. In this way we try to assess which of the potential benchmarks attracts inflation expectations of both groups of economic agents at different forecast horizons and how this has changed in the financial crisis period.

<sup>15</sup> The estimation results are qualitatively unchanged, if the size of the rolling window is reduced by few quarters (available upon request).

[INSERT FIGURES 6-7 HERE]

Scatter graphs suggest that in the case of professional forecasters ECB communication matters very much in attracting short-, medium- and long-term inflation forecasts. We observe that absolute deviations of those forecasts from current HICP inflation are much bigger than the respective deviations from the ECB inflation target or projections. This holds for both the pre-crisis sample and the financial crisis sample.

In the financial crisis period short-term inflation expectations of consumers and professional forecasters period display bigger and more diversified deviations from the ECB inflation target relative to the pre-crisis period, although deviations of those expectations from the ECB inflation projections have not been seriously affected. The same conclusion applies in the case of medium-term SPF forecasts, whose deviations from the ECB inflation target and projections have become only slightly larger than in the pre-crisis period. These effects, combined with relatively stable deviations of long-term SPF forecasts from the ECB inflation target, suggest that the management of expectations by the ECB is quite effective and has not deteriorated recently.

Next, we use formal analysis to examine the above results in more detail. We consider central bank credibility using the Bomfim and Rudebusch (2000) approach, in which inflation expectations ( $\pi_{t|t+n}^e$ ) are modelled as a weighted average of the lagged inflation rate ( $\pi_{t-1}$ ) and the inflation target ( $\pi_{t+n}^{tar}$ ):

$$\pi_{t|t+n}^e = \lambda^{tar} \pi_{t+n}^{tar} + (1 - \lambda^{tar}) \pi_{t-1} + \varepsilon_t. \quad (5)$$

In equation (5) the weight of the inflation target ( $\lambda^{tar}$ ) measures the degree of central bank credibility. This approach has been applied by Łyziak (2013) to Polish data and by Rosenblatt-Wisch and Scheufele (2015) to Swiss data. Demertzis et al. (2009) has used the same method in analysing several inflation targeting countries (including the euro area).

In testing central bank credibility, long-term expectations should be considered. Estimating equation (5) with short-term or medium-term inflation expectations as the dependent variable, we extend the benchmark specification to include the second communication tool used by central banks nowadays, i.e. their inflation projections ( $\pi_{t+n}^{for}$ ):

$$\pi_{t|t+n}^e = \lambda^{tar} \pi_{t+n}^{tar} + \lambda^{for} \pi_{t+n}^{for} + (1 - \lambda^{tar} - \lambda^{for}) \pi_{t-1} + \varepsilon_t. \quad (6)$$

This is in line with the analysis of Anderson and Maule (2014), who assess the anchoring of short-term inflation expectations in the UK, treating inflation projections of the Bank of England as the benchmark for such expectations. Such an extension can be especially useful in periods when current inflation is far from the target and central bank inflation projections provide the public with the path for achieving the target. In the case of equation (6), the degree of anchoring of inflation expectations, understood as the ability of monetary policymakers to manage inflation expectations (King, 2005), can be measured as the sum of the weights of the central bank target and the forecast ( $\lambda^{tar} + \lambda^{for}$ ).

Due to the fact that short-term ECB inflation projections are significantly affected by current HICP inflation (base effect), which may include multicollinearity of regressors<sup>16</sup>, we estimated the above

<sup>16</sup> Correlation coefficient between 1-year-ahead ECB inflation projections and current HICP inflation is 0.76, while in the case of 2-year-ahead projections it is reduced to 0.26.

equation using the nested estimation procedure (Feng-Jenj, 2008). This approach is based on the OLS method and estimates different parameters of independent variables sequentially. Constructing the base model, the independent variable having the highest correlation with the dependent variable is used. In subsequent steps, residuals from the model are regressed on the independent variable displaying the highest correlations with them. The variables eliminated while constructing the base models for short-term inflation expectations, i.e. current HICP inflation in the case of SPF forecasts and the ECB inflation target in the case of consumer inflation expectations, do not appear to be significant in the nested models and so are eliminated from analysis. In the final specification short-term inflation expectations of professional forecasters depend only on the ECB inflation target and projections; for consumers, they depend on current HICP inflation and the ECB inflation projections.<sup>17</sup>

Possible changes in anchoring over time are examined by comparing estimated parameters in different sub-samples and by estimating rolling regressions. When using the financial crisis dummy  $d^{fc}$ , the estimated equation takes the following form:

$$\begin{aligned} \pi_{t|t+n}^e = & (1 - d^{fc})[\lambda_{pc}^{tar} \pi_{t+n}^{tar} + \lambda_{pc}^{for} \pi_{t+n}^{for} + (1 - \lambda_{pc}^{tar} - \lambda_{pc}^{for})\pi_{t-1}] + \\ & + d^{fc} [\lambda_{fc}^{tar} \pi_{t+n}^{tar} + \lambda_{fc}^{for} \pi_{t+n}^{for} + (1 - \lambda_{fc}^{tar} - \lambda_{fc}^{for})\pi_{t-1}] + \varepsilon_t. \end{aligned} \quad (7)$$

In the case of the long-term SPF inflation forecast, we estimate the original Bomfim and Rudebusch (2000) specification (5) and its version with the financial crisis dummy, since the ECB projections with analogous horizon are not available:

$$\pi_{t|t+n}^e = (1 - d^{fc})[\lambda_{pc}^{tar} \pi_{t+n}^{tar} + (1 - \lambda_{pc}^{tar})\pi_{t-1}] + d^{fc} [\lambda_{fc}^{tar} \pi_{t+n}^{tar} + (1 - \lambda_{fc}^{tar})\pi_{t-1}] + \varepsilon_t. \quad (8)$$

Table 4 shows the results of the estimation of equation (6) and (7) using SPF inflation forecasts at 1- and 2-year forecast horizons and consumer inflation expectations one year ahead. For 2-year-ahead SPF inflation forecast, we estimate also equations (5) and (8) (4<sup>th</sup> column in Table 4). In the case of long-term SPF forecasts we estimate only equations (5) and (8), due to the fact that the ECB projections for corresponding horizons are not available.

[INSERT TABLE 4 HERE]

Our whole sample results in Table 4 suggest that the formation of inflation expectations by consumers versus professional forecasters differs significantly. Consumers in the euro area seem to be strongly backward-looking. Their short-term inflation expectations react mainly to current inflation developments, but they are also affected – to a smaller extent – by the ECB inflation projections. On the other hand, central bank communication is important for expectations of professional forecasters.<sup>18</sup> Even

<sup>17</sup> Alternatively, to avoid multicollinearity of regressors, we adjusted the measure of ECB inflation projections one year ahead for changes in actual HICP inflation by replacing it with the residuals from the equation in which ECB inflation forecasts are regressed on lagged HICP inflation. We are aware of problems with this approach (e.g. Baltagi, 2008, pp. 272-273); therefore we prefer using the nested regression method. However, it should be pointed out that in residualizing ECB inflation projections it occurs that the factors eliminated in nested models have some importance in explaining developments of short-term inflation expectations. On the other hand, if we estimate separate models with each of the collinear factors (i.e. inflation projection and current HICP inflation) and then derive their weights by minimizing the sum of residuals (in absolute terms), it occurs that for both measures of short-term expectations only one of two collinear variables is needed, which confirms the results based on nested models.

<sup>18</sup> Our results are consistent with Hubert (2015), who shows that ECB rate and ECB inflation projection shocks impact SPF forecasts.

at the short-term horizon, current inflation developments affect SPF forecasts only via ECB inflation projections, independently of the period under consideration.

Central bank inflation projections also exert influence on 2-year-ahead SPF forecasts, although at this horizon the weight of the inflation target is twice the weight of inflation projections. However, ignoring them in the model significantly worsens its statistical fit; so even at this horizon the extended specification of the Bomfim and Rudebusch (2000)-type equation is preferred. The ECB inflation target plays the key role in the formation of long-term inflation forecasts by professional experts, indicating a high degree of central bank credibility. It is important to note that credibility has not deteriorated during the financial crisis period.

The impact of the ECB inflation target on short- and medium-term SPF forecasts has diminished since the collapse of Lehman Brothers, but at the same time the impact of the ECB inflation projections has become larger.<sup>19</sup> This suggests that in an environment of elevated macroeconomic uncertainty, ECB views on future inflation have become more important for setting the path of short- and medium-term inflation expectations by professional forecasters, compensating for a diminished importance of the ECB inflation target.

The crisis seems not to have significantly affected the formation of consumer expectations. It seems that the relative role of ECB inflation projections has become slightly less important for consumers since the collapse of Lehman Brothers, but according to the Wald test, the changes in estimated coefficients are not statistically significant.

Rolling regression estimates of equation (5)/(6), shown in Figures 8-11, reveal the evolution of short-, medium- and long-term expectations formation over time in a more detailed manner, providing more conclusive results.<sup>20</sup> The way, in which consumers and SPF experts form their short-term inflation forecasts is determined by different factors.<sup>21</sup> Consumers seem to pay attention mainly to current HICP developments and – to smaller extent – to the ECB inflation projections, while in the case of professional forecasters both communication tools of the ECB play role, while current HICP indices are not statistically significant. The formation of consumer inflation expectations has been stable over time. In the case of short-term SPF forecasts the weights of the ECB inflation target and projections were equal to each other till 2014, while recently the role of the ECB inflation target has decreased, while the weight of the ECB inflation projections has increased, making the latter factor more important than the former. In the case of medium-term SPF forecasts since 2008 the weight of the ECB inflation target has been gradually decreasing, while for long-term SPF forecasts it has been rather stable.<sup>22</sup> At the same time current HICP inflation has become statistically significant in explaining medium-term SPF inflation forecasts; however, the importance of the ECB inflation projections has increased much more considerably – from approx. 4% in 2007 to 10% in 2008 and to 35-40% in 2013-2015. It confirms the previous findings on the importance of central bank communication and suggests that with both major communication tools at its disposal, i.e. with the inflation target and inflation projections, the ECB is still able to manage short- and medium-term inflation expectations of professional forecasters. At the same time the ability of the ECB to influence short-term consumer inflation expectations with the means of inflation projections has not been constrained since the beginning of the financial crisis.

<sup>19</sup> For medium-term SPF forecasts, this effect is on the edge of statistical significance.

<sup>20</sup> The estimation results are qualitatively unchanged, if the size of the rolling window is reduced by few quarters (available upon request).

<sup>21</sup> Rolling estimates for short-term inflation expectations were performed using nested models.

<sup>22</sup> A slightly decreasing role of the ECB inflation target in affecting long-term SPF forecasts in this period may be related to the increase in average individual uncertainty that started in the second half of 2007 (see Figure 3).

[INSERT FIGURES 8-11 HERE]

Summing up, our results indicate that the crisis has had some effects on inflation expectations. In particular, short- and medium-term inflation expectations of professional forecasters have become less tightly anchored to the ECB inflation target, but more tightly anchored to the ECB inflation projections. On the other hand, in the current low inflation regime the credibility of the ECB has not eroded, as suggested by a stable weight of the ECB inflation target in affecting long-term inflation expectations of professional forecasters.

### 3.4. Estimating anchors for inflation expectations

In this section we follow the approach proposed by Demertzis et al. (2008, 2009) and derive anchors for inflation expectations. In the Bomfim and Rudebusch (2000) approach it is assumed that the inflation anchor is given by the inflation target. Moreover, in equation (5), used to estimate credibility of the inflation target, inflation expectations do not depend on their own past behaviour. As shown by Demertzis et al. (2008), this assumption is systematically rejected. The use of bivariate VAR model, containing actual inflation and long-term inflation expectations, offers therefore a more general way to assess anchoring of inflation expectations. It takes also into consideration that inflation and inflation expectations are intrinsically related. The prior in this approach is that credible monetary policy implies that expectations are de-coupled from inflation (low correlation) and are anchored to an implicit target, estimated on the basis of the VAR model. By checking its consistency with the official inflation target Demertzis et al. (2008) draw conclusions regarding central bank credibility.

Following Demertzis et al. (2008) we estimate VAR(p) models of the form:

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \dots + \alpha_p\pi_{t-p} + b_1\pi_{t-1|t+n-1}^e + \dots + b_p\pi_{t-p|t+n-p}^e + \varepsilon_{1t} \quad (9a)$$

$$\pi_{t|t+n}^e = c_0 + c_1\pi_{t-1} + \dots + c_p\pi_{t-p} + d_1\pi_{t-1|t+n-1}^e + \dots + d_p\pi_{t-p|t+n-p}^e + \varepsilon_{2t} \quad (9b)$$

for which the long-run solution is:

$$\pi = \frac{\alpha_0}{1-\alpha_1-\dots-\alpha_p} + \frac{b_1+\dots+b_p}{1-\alpha_1-\dots-\alpha_p}\pi^e \quad (10)$$

$$\pi^e = \frac{c_0}{1-d_1-\dots-d_p} + \frac{c_1+\dots+c_p}{1-d_1-\dots-d_p}\pi \quad (11)$$

Equation (11) is similar to the Bomfim and Rudebusch (2000) specification (5) and interpreted from this point of view it implies that:

$$\lambda\pi^* = \frac{c_0}{1-d_1-\dots-d_p} \quad (12)$$

$$1 - \lambda = \frac{c_1+\dots+c_p}{1-d_1-\dots-d_p} \quad (13)$$



where  $\pi^*$  denotes the implicit anchor for inflation expectations of private sector agents, which is not necessarily equal to the inflation target. The solution to equations (12) and (13) takes the form:

$$\lambda = 1 - \frac{c_1 + \dots + c_p}{1 - d_1 - \dots - d_p} \quad (14)$$

$$\pi^* = \frac{c_0}{1 - d_1 - \dots - d_p - c_1 - \dots - c_p} \quad (15)$$

In estimations, the selection of lags is based on the information criteria and the assessment of autocorrelation of residuals. The optimal number of lags is 2 (3) for the VAR model with SPF expectations (consumer expectations).

Table 5 presents estimated anchors of inflation expectations and their weights in the formation of inflation expectations. The results indicate that the implicit anchors for the short- and medium-term inflation expectations under consideration have decreased during the financial crisis period, although in the case of medium-term expectations of professional forecasters the effect seems relatively small, and the anchor is still broadly consistent with the ECB inflation target. The weights of implicit anchors have also decreased, suggesting increased importance of current inflation, but to a relatively small extent in the case of SPF forecasts, especially for 2-year-ahead forecasts. It is interesting to note that in the case of long-term SPF forecasts the anchor has increased slightly in the recent period, as has its weight, but it is still consistent with the ECB inflation target. Therefore in summary we note that from this analytical perspective there are no signs of de-anchoring of long-term inflation expectations.

We can conclude that the results based on VAR models are consistent with our earlier findings, suggesting that, as regards medium- and long-term inflation expectations, the financial crisis and low inflation environment have not led to a significant reduction in their degree of anchoring.

[INSERT TABLE 5 HERE]

Finally, we use the Demertzis et al. (2009) approach to continue our earlier analysis of the dependence of inflation expectations on actual inflation. In this case the VAR models described above are estimated separately for the pre-crisis and financial crisis periods.

Impulse responses of inflation expectations to inflationary shocks (Figure 12) indicate that, compared to the pre-crisis years, some de-anchoring (understood now in terms of increasing impact of inflationary shocks on inflation expectations) occurred in the financial crisis period. Moreover, the responses of SPF forecasts to inflation shocks have become statistically significant since the Lehman Brothers collapse, even as regards the long-term SPF forecasts. At the same time, the response of consumer inflation expectations has become more pronounced in the financial crisis period. Interestingly, the responses of short-term consumer and professional expectations to inflationary shocks follow a similar path, but in the case of consumer expectations the reaction is stronger in both sub-periods.

[INSERT FIGURE 12 HERE]

## 4. Conclusions

Credible central banks can manage private agents' inflation expectations – especially by announcing inflation targets and publishing inflation projections – and thereby affect their wage and price behaviour. If longer-term inflation expectations are in line with the price stability objective, they respond neither to shorter-term inflation expectations nor to actual inflation or other macroeconomic news.

In this study we examined the anchoring of professional and consumer inflation expectations in the euro area since the beginning of 1999. Our analysis covers the pre-crisis years as well as the recent financial crisis period and current low inflation regime. Using aggregated survey data for different forecast horizons, our analysis is based on three different approaches: dependence of inflation expectations on actual inflation and shorter-term expectations, credibility of monetary policy (Bomfim and Rudebusch 2000 method) and VAR analysis proposed by Demertzis et al. (2008, 2009). Consistently with our preferred definition of anchoring of inflation expectations, understood as the ability of central bank to manage them (King, 2005), we focused on the impact of the inflation target and the Eurosystem-staff or the ECB-staff inflation projections on inflation expectations. We also analysed possible variations of anchoring of inflation expectations over time and calculated implicit anchors for expectations.

Our analysis suggests that in recent years, a period characterized by low inflation, increased economic uncertainty, zero lower bound (ZLB) and unconventional monetary policy measures, inflation expectations display some signs of de-anchoring. We provide evidence of increased sensitivity of longer-term SPF inflation forecasts to shorter-term ones and to current HICP inflation in the post-crisis period. At the same time, less weight has been given to the inflation target in the formation of those expectations. However, our analysis also suggests that the ECB projections, which play a central role in ECB communication strategy, have recently become more important for professional forecasters, as they provide benchmarks for their short- and medium-term inflation expectations.

Continuous analysis of de-anchoring risks is crucial in monetary policy, especially in the current low inflation environment. Monetary policy credibility is built gradually over the years, but we cannot rule out the possibility that it may deteriorate quite rapidly – as Orphanides (2015) has pointed out, “*Inflation expectations are well anchored until they are not*”. When analysing anchoring of inflation expectations, we also need to examine when the inflation target is expected to be reached. Risks of de-anchoring are potentially increasing, if the time when the target will be reached has been postponed in economic agents' expectations. Overall, our analysis emphasizes the role of the inflation target and inflation projections in ECB management of inflation expectations. It also suggests that a more extensive use of forward guidance in monetary policy strategy (e.g. in the form of conditional interest rate path announcements for the next couple of years) can be potentially useful. Possible risks of a de-anchoring of inflation expectations need to be monitored continuously using various measures and methods, including those proposed in this study.

## References

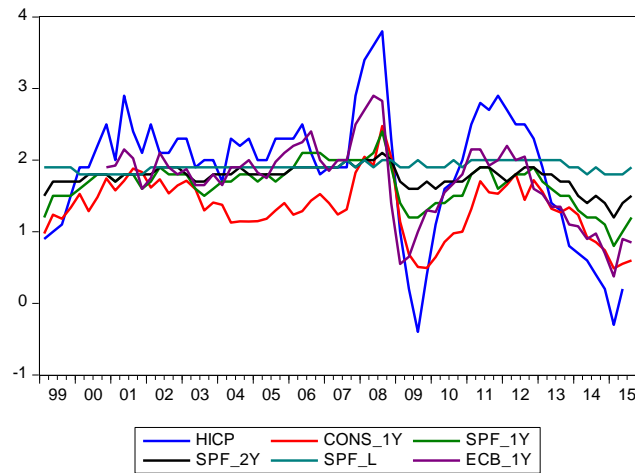
- Anderson G., Maule B. (2014), *Assessing the risk to inflation from inflation expectations*, The Bank of England Quarterly Bulletin Q2.
- Baltagi B. H. (2008), *A Companion to Theoretical Econometrics*, Wiley-Blackwell.
- Batchelor R. A., Orr A. B. (1988), *Inflation expectations revisited*, *Economica*, New Series, 55(219), 317-331.

- Beechey M. J., Johansen B. K. and Levin A.T. (2011), *Are long-run inflation expectations anchored more firmly in the Euro area than in the United States*, *American Economic Journal: Macroeconomics*, 3(2), 104-129.
- Blinder A. S. (2000), *Central-Bank Credibility: Why Do We Care? How Do We Build It?*, *The American Economic Review*, 90(5), 1421-1431.
- Bomfim A., Rudebusch G. (2000), *Opportunistic and deliberate disinflation under imperfect credibility*, *Journal of Money, Credit and Banking*, 32, 707-721.
- Bowles C., Friz R., Genre V., Kenny G., Meyler A. and Rautanen, T. (2007), *The ECB Survey of Professional Forecasters: A Review after Eight Years' Experience*, ECB Occasional Paper 58.
- Carlson J. A., Parkin M. (1975), *Inflation expectations*, *Economica*, 42, 123-138.
- Cecchetti S. G., Krause S. (2002), *Central bank structure, policy efficiency, and macroeconomic performance: exploring empirical relationships*, *Federal Reserve Bank of St. Louis Review*, 84, 47-60.
- Ciccarelli, M., García, J.A. and C. Montes-Galdón, 2015, *Unconventional Monetary Policy and the anchoring of inflation expectations*, ECB, mimeo.
- Coibion O., Gorodnichenko Y. (2015), *Is the Phillips Curve Alive and Well after All? Inflation Expectations and the Missing Disinflation*, *American Economic Journal: Macroeconomics*, 7(1), 197-232.
- Cukierman A. and Meltzer (1986), *A theory of ambiguity, credibility, and inflation under discretion and asymmetric information*, *Econometrica*, 54(5), 1099-1128.
- Cunningham R., Desroches B., Santor E. (2010), *Inflation expectations and the conduct of monetary policy: a review of recent evidence and experience*, *Bank of Canada Review*, Spring 2010, 13-25.
- Demertzis M., Marcellino M., Viegi N. (2008), *A measure of credibility: tracking US monetary developments*, Discussion Paper No. 7036, Centre for Economic Policy Research.
- Demertzis M., Marcellino M., Viegi N. (2009), *Anchors for inflation expectations*, DNB Working Paper, 229.
- Dovern, J., Fritsch, U. and Slacalek, J. (2012) *Disagreement among Forecaster in G7 Countries*, *The Review of Economics and Statistics*, 94(4), 1081-1096.
- Ehrmann, M. (2015) *Targeting Inflation from Below – How Do Inflation Expectations Behave?* *International Journal of Central Banking*, 11(4), 213-249.
- European Central Bank (2016), *Task Force on Low Inflation Report*, ECB Occasional Paper Series, forthcoming.
- European Commission (2006), *The joint harmonized EU programme of business and consumer surveys*, *European Economy, Special Report*, 5/2006.
- European Commission (2007), *The joint harmonized EU programme of business and consumer surveys. User guide*, Directorate-General for Economic and Financial Affairs, European Commission.
- Faust J., Svensson L. E. O. (2001), *Transparency and credibility: monetary policy with unobservable goals*, *International Economic Review*, 42(2), 369-397.
- Feng-Jenq L. (2006), *Solving multicollinearity in the process of fitting regression model using the nested estimate procedure*, *Quality & Quantity*, 42, 417-426.
- Friedrich C. (2014), *Global inflation dynamics in the post-crisis period: what explains the twin puzzle?*, Bank of Canada Working Paper, 36.
- Gábel P. (2010), *Household inflation expectations and inflation dynamics*, MNB Working Paper, 2010/12.
- Gerlach S. (2007), *Interest rate setting by the ECB: words and deeds*, *International Journal of Central Banking*, 3, 1-46.
- Hubert P. (2015), *ECB projections as a tool for understanding policy decisions*, *Journal of Forecasting*, 34, 574–587.

- Hutchison M. M., Walsh C. E. (1998), *The output-inflation tradeoff and central bank reform: Evidence from New Zealand*, *The Economic Journal*, 108, 703-725.
- Jochmann, M., Koop, G., and S. Potter, 2010, *Modelling the dynamics of inflation compensation*, *Journal of Empirical Finance* 17 (1), 157-167.
- King, M. (2005), *Monetary policy: practice ahead of theory*, Mais Lecture.
- Kurri S. (2006), *Why does consumers' perceived inflation differ so much from actual inflation?*, *Bank of Finland Bulletin*, 80(3), 75-82, Bank of Finland.
- Levin, A. T., Natalucci, F. and Piger, J. (2004), *The Macroeconomic Effects of Inflation Targeting*, *The Federal Reserve Bank of St. Louis Review* 86(4), 51-80.
- Łyziak T. (2013), *Formation of inflation expectations by different economic agents. The case of Poland*, *Eastern European Economics*, 51(6), 5-33.
- Łyziak T., Mackiewicz-Łyziak J. (2014), *Do consumers in Europe anticipate future inflation? Has it changed since the beginning of the financial crisis?*, *Eastern European Economics*, 52(3), 5-32.
- Mehrotra A., Yetman J. (2014), *Decaying expectations: what inflation forecasts tell us about the anchoring of inflation expectations*, *BIS Working Papers*, 464, Bank for International Settlements.
- Orphanides, A. (2015), *Fear of liftoff: uncertainty, rules, and discretion in monetary policy normalization*, *Federal Reserve Bank of St. Louis Review*, 97(3), 173-96.
- Rosenblatt-Wisch R., Scheufele R. (2015), *Quantification and characteristics of household inflation expectations in Switzerland*, *Applied Economics*, <http://dx.doi.org/10.1080/00036846.2015.1008773>.

## Figures and tables

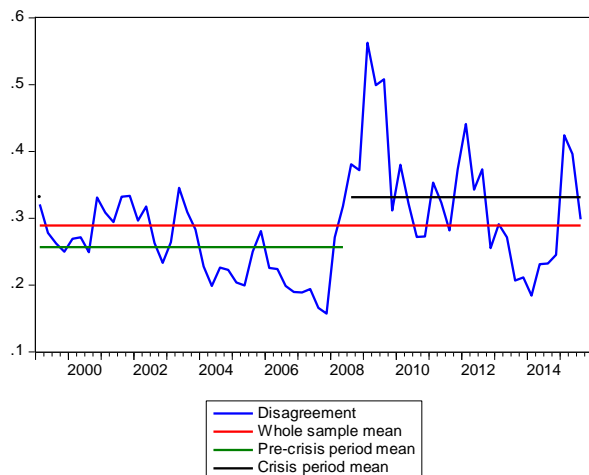
**Figure 1.** Inflation expectations and ECB projections



*Note:* 1Y (2Y) refers to expectations one year ahead (two years ahead). L denotes long-term expectations. Inflation expectations are dated at the time when the survey was conducted.

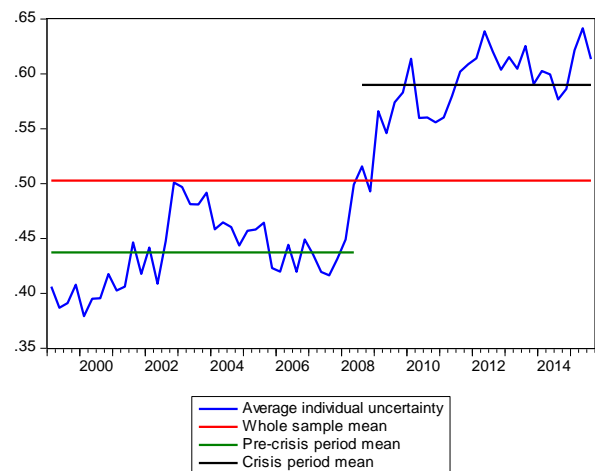
*Source:* Eurostat, ECB, own calculations based on European Commission data.

**Figure 2.** Forecast disagreement (standard deviation of point forecasts) for professional inflation forecasts one year ahead



*Source:* own calculations based on ECB data.

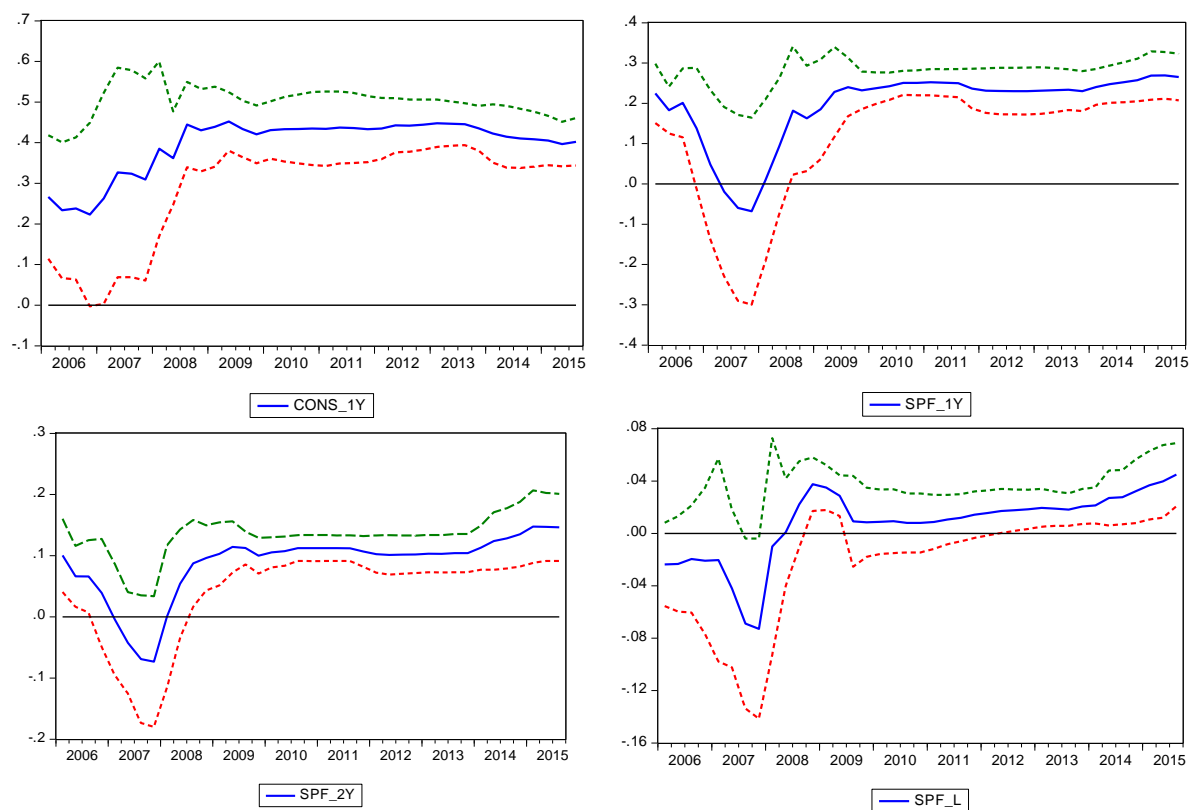
**Figure 3.** Average individual uncertainty for professional inflation forecasts one year ahead



*Note:* The average individual uncertainty is defined as the average standard deviation of the individual probability distributions.

*Source:* own calculations based on ECB data.

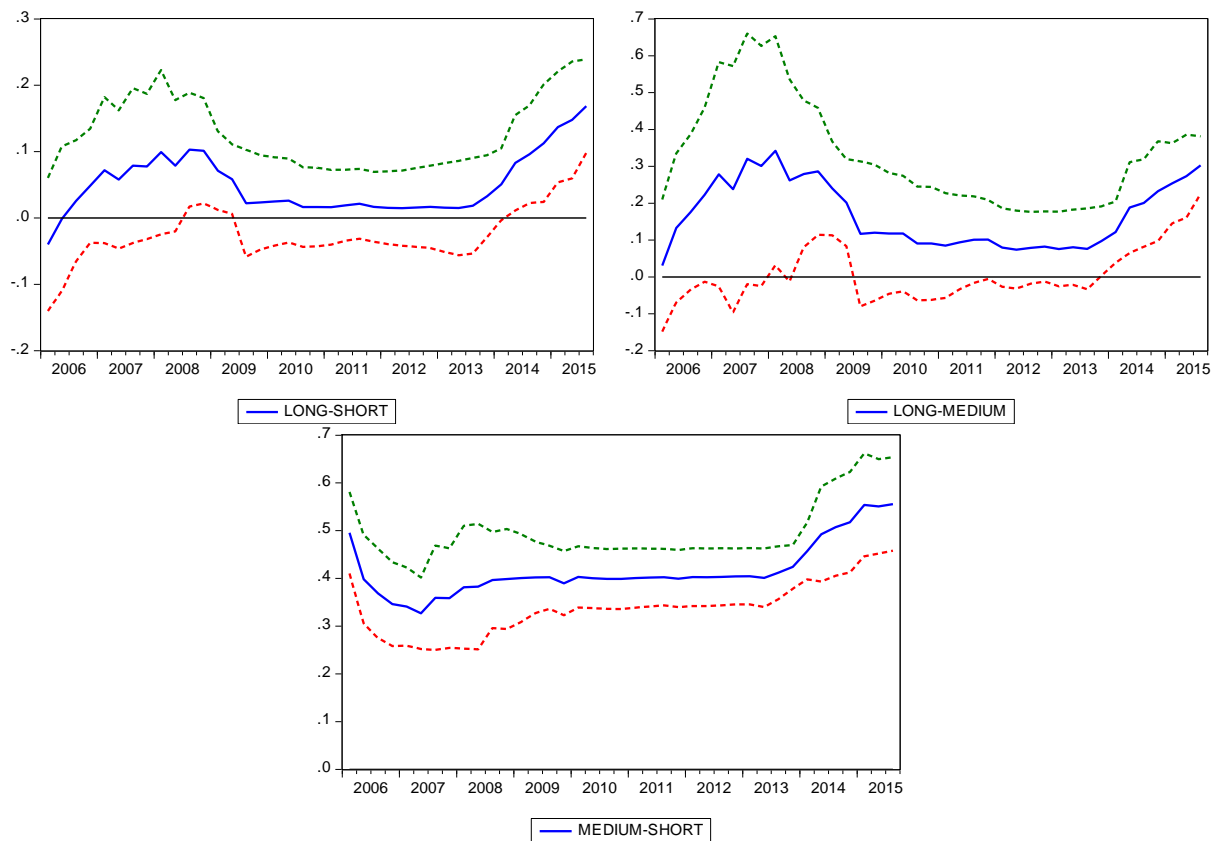
**Figure 4.** Dependence of inflation expectations on actual inflation, rolling estimates



*Note:* 1Y (2Y) refers to expectations one year ahead (two years ahead). L denotes long-term expectations. Rolling estimates with lower and upper bounds dated at the end of each sample (ordinary least squares, Newey-West HAC standard errors).

*Source:* own calculations.

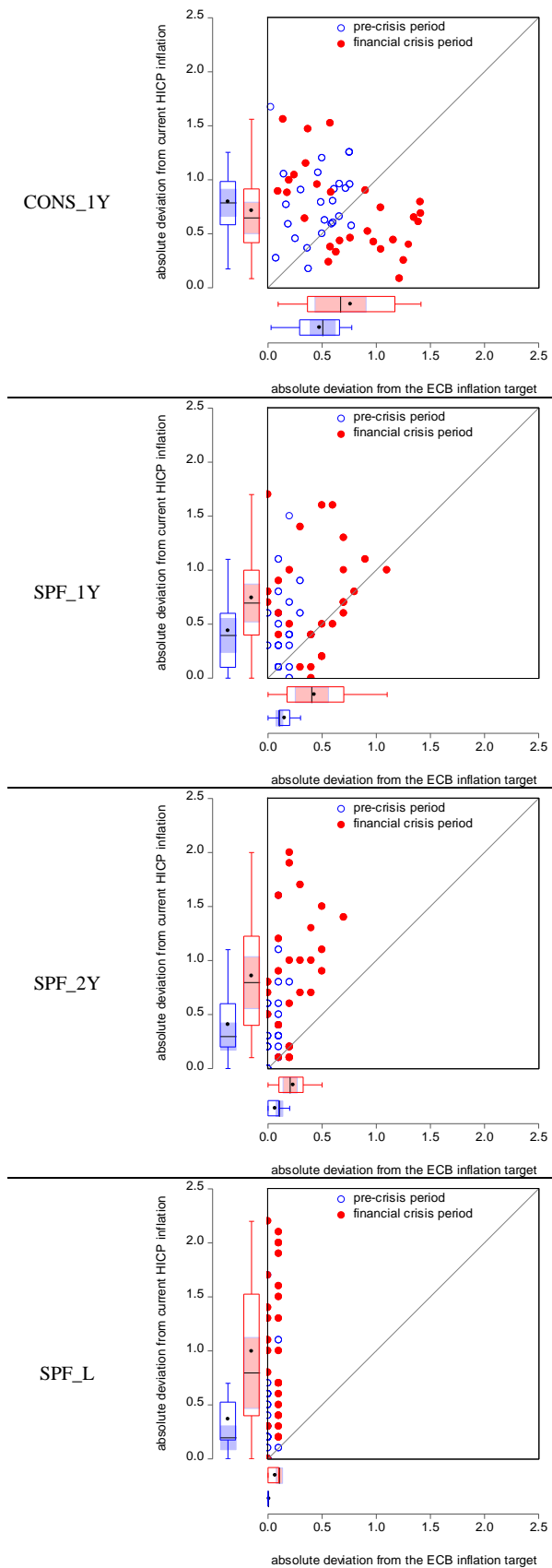
**Figure 5.** Dependence of longer-term inflation expectations on shorter-term ones, rolling estimates



*Note:* LONG-SHORT (LONG-MEDIUM) measures the impact of short-term (medium-term) inflation expectations on long-term expectations. Correspondingly, the impact of short-term expectations on medium-term expectations is denoted by MEDIUM-SHORT. Rolling estimates with lower and upper bounds dated at the end of each sample (ordinary least squares, Newey-West HAC standard errors).

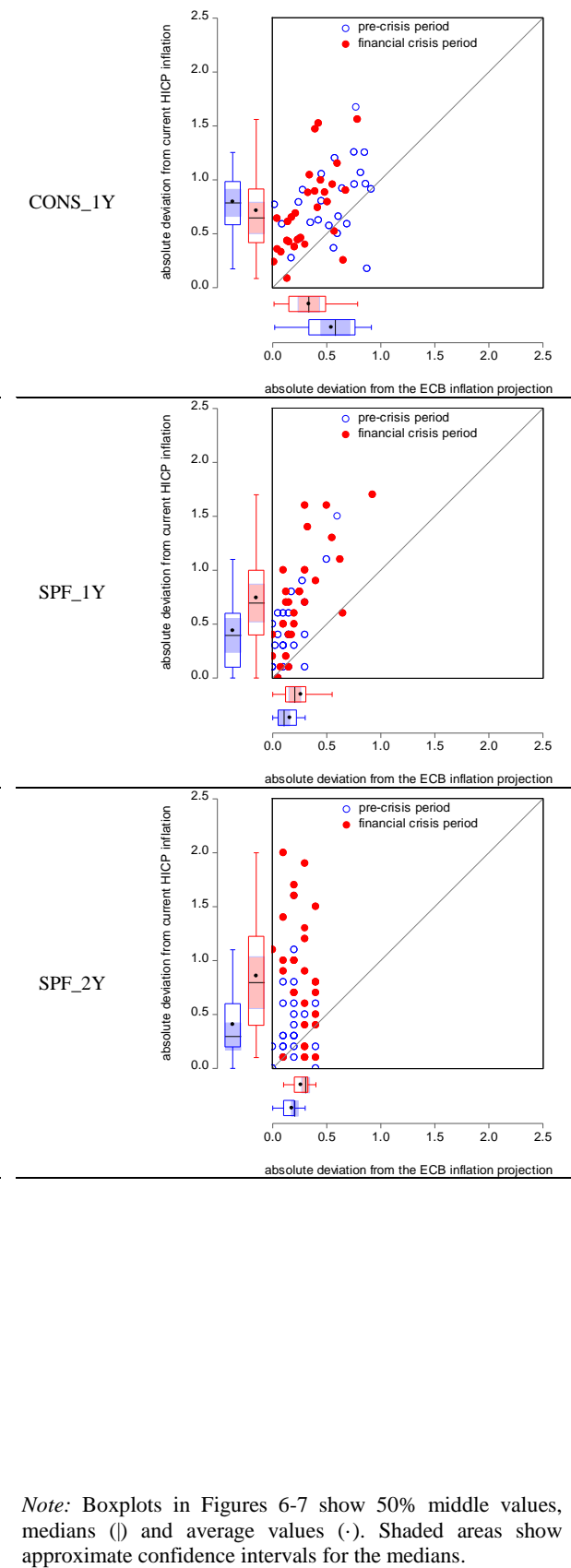
*Source:* own calculations.

**Figure 6.** Absolute deviations of expectations from ECB inflation target vs. absolute deviations from current HICP inflation



Source: own calculations.

**Figure 7.** Absolute deviations of expectations from ECB inflation projections vs. absolute deviations from current HICP inflation

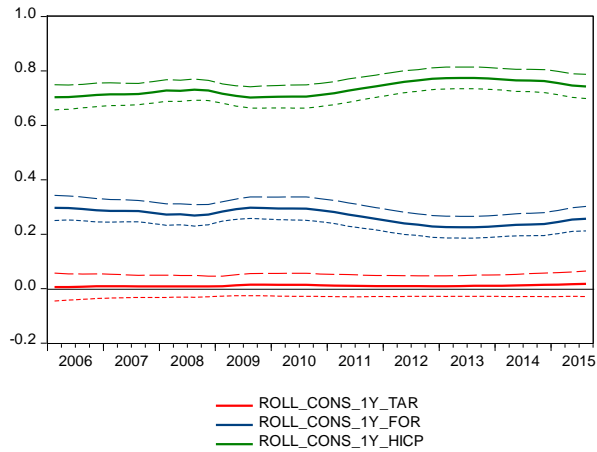


Source: own calculations.

Note: Boxplots in Figures 6-7 show 50% middle values, medians (|) and average values (·). Shaded areas show approximate confidence intervals for the medians.

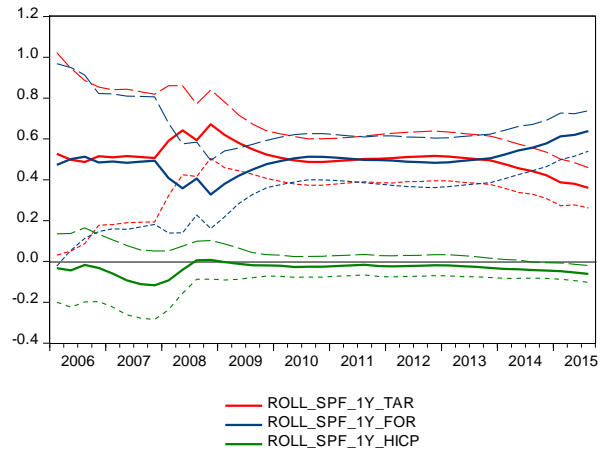


**Figure 8.** Weights of current HICP, ECB inflation target and projections, rolling regressions, 1-year-ahead consumer expectations



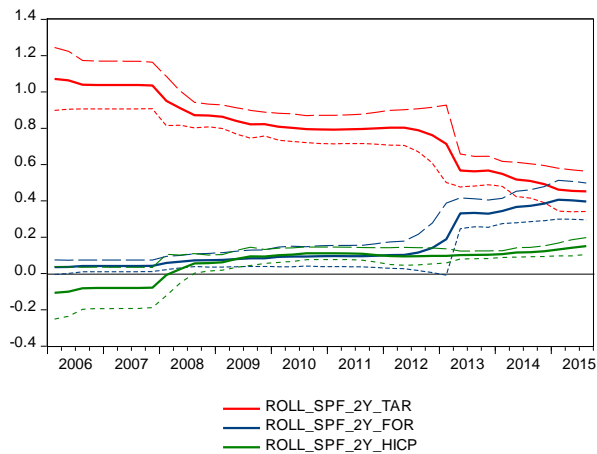
Source: own calculations.

**Figure 9.** Weights of current HICP, ECB inflation target and projections, rolling regressions, 1-year-ahead SPF forecasts



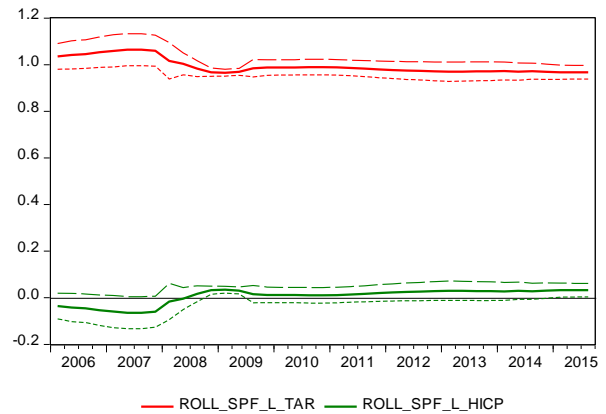
Source: own calculations.

**Figure 10.** Weights of current HICP, ECB inflation target and projections, rolling regressions, 2-year-ahead SPF forecasts



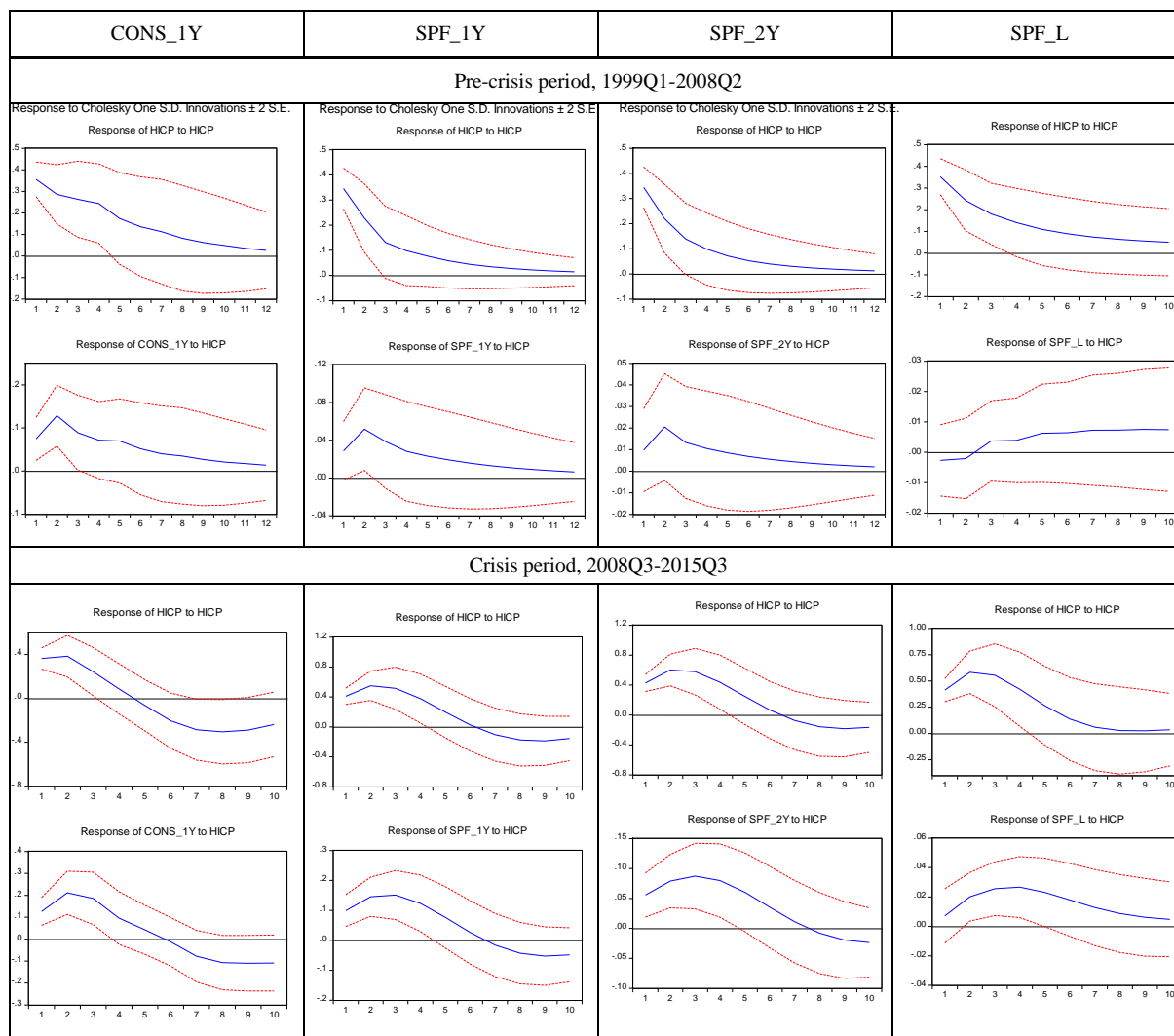
Source: own calculations.

**Figure 11.** Weights of current HICP and ECB inflation target, rolling regressions, long-term SPF forecasts



Source: own calculations.

**Figure 12.** Impulse responses of inflation expectations to HICP inflation shocks



*Note:* Impulse responses are based on the bivariate VAR model used in section 3.4 of this paper. Inflation expectations shocks are identified assuming that due to publication lags expectations do not respond to contemporaneous information on actual inflation. 1Y (2Y) refers to expectations one year ahead (two years ahead). L denotes long-term expectations.

*Source:* own calculations.

**Table 1.** Basic statistics: actual inflation, forecast disagreement and average individual uncertainty of ECB SPF inflation forecasts one year ahead

	HICP	Disagreement	Uncertainty
Whole sample, 1999Q1-2015Q3			
Mean	1.9	0.29	0.50
Maximum	3.8	0.56	0.64
Minimum	-0.4	0.16	0.38
Std. dev.	0.9	0.08	0.08
Observations	66	67	67
Pre-crisis period, 1999Q1-2008Q2			
Mean	2.1	0.26	0.44
Maximum	3.6	0.35	0.50
Minimum	0.9	0.16	0.38
Std. dev.	0.5	0.05	0.03
Observations	38	38	38
Crisis period, 2008Q3-2015Q3			
Mean	1.5	0.33	0.59
Maximum	3.8	0.56	0.64
Minimum	-0.4	0.18	0.49
Std. dev.	1.1	0.09	0.04
Observations	28	29	29

*Note:* Disagreement refers to standard deviation of point forecasts and Uncertainty to the average individual uncertainty, which is defined as the average standard deviation of the individual probability distributions.

*Source:* own calculations.

**Table 2.** Dependence of inflation expectations on the actual inflation rate

	Whole sample – eq. (1)		Whole sample with the crisis dummy – eq. (2)			
	$\beta$	R <sup>2</sup> adj.	$\beta_{pc}$	$\beta_{fc}$	R <sup>2</sup> adj.	H <sub>0</sub> : $\beta_{pc} = \beta_{fc}$ : F-statistic [p-values]
CONS, 1y	0.382*** (12.45)	0.754	0.278*** (5.24)	0.402*** (13.90)	0.778	5.167 [0.026]
SPF, 1y	0.276*** (10.71)	0.712	0.217*** (4.23)	0.265*** (9.24)	0.757	0.671 [0.416]
SPF, 2y	0.147*** (6.09)	0.676	0.108*** (3.79)	0.146*** (5.37)	0.707	0.970 [0.328]
SPF, L	0.023* (1.93)	0.102	-0.003 (-0.17)	0.045*** (3.75)	0.448	4.645 [0.035]

*Note:* 1Y (2Y) refers to expectations one year ahead (two years ahead). L denotes long-term expectations. Ordinary least squares with Newey-West HAC standard errors. Numbers in parentheses below estimated coefficients are t-Statistic. \*\*\* denotes significance level at 99 per cent; \*\* denotes significance level at 95 per cent; \* denotes significance level 90 per cent.

*Source:* own calculations.

**Table 3.** Dependence of longer-term inflation expectations on shorter-term inflation expectations

Dependent variable [explanatory variable]	Whole sample – eq. (3)		Whole sample with the crisis dummy – eq. (4)			
	$\gamma$	R <sup>2</sup> adj.	$\gamma_{pc}$	$\gamma_{fc}$	R <sup>2</sup> adj.	H <sub>0</sub> : $\gamma_{pc} = \gamma_{fc}$ : F-statistic [p-values]
SPF_L [SPF_1Y]	0.067 ** (2.36)	0.094	0.057 (1.32)	0.168*** (4.80)	0.508	3.579 [0.063]
SPF_L [SPF_2Y]	0.168*** (5.03)	0.175	0.188 (1.61)	0.303*** (7.79)	0.574	0.821 [0.368]
SPF_2Y [SPF_1Y]	0.513*** (11.73)	0.886	0.448*** (8.86)	0.556*** (11.41)	0.894	2.156 [0.147]

*Note:* 1Y (2Y) refers to expectations one year ahead (two years ahead). L denotes long-term expectations. Ordinary least squares with Newey-West HAC standard errors. Numbers in parentheses below estimated coefficients are t-Statistic. \*\*\* denotes significance level at 99 per cent; \*\* denotes significance level at 95 per cent; \* denotes significance level 90 per cent.

*Source:* own calculations.

**Table 4.** Impact of current HICP inflation, ECB inflation target and projections on inflation expectations

	CONS_1Y eq.(6), eq.(7)	SPF_1Y eq.(6), eq.(7)	SPF_2Y eq.(6), eq.(7)	SPF_2Y eq.(5), eq.(8)	SPF_L eq.(5), eq.(8)
Whole sample, 2002Q2-2015Q3					
$\lambda^{tar}$	-	0.39*** (5.6)	0.58*** (8.96)	0.84*** (37.4)	0.97*** (68.7)
$\lambda^{for}$	0.23*** (5.48)	0.61	0.27*** (4.3)	x	x
$\lambda^{HICP}$	0.72*** (29.3)	-	0.15	0.16	0.03
R <sup>2</sup> adj.	0.79	0.69	0.54	0.18	0.08
Pre-crisis period, 1999Q1-2008Q2					
$\lambda_{pc}^{tar}$	-	0.61*** (4.9)	0.67*** (7.1)	1.00*** (18.2)	0.98*** (46.9)
$\lambda_{pc}^{for}$	0.41*** (8.7)	0.39	0.28*** (3.8)	x	x
$\lambda_{pc}^{HICP}$	0.59	-	0.05	0.00	0.02
Crisis period, 2008Q3-2015Q3					
$\lambda_{fc}^{tar}$	-	0.36*** (5.6)	0.45*** (11.8)	0.82*** (36.4)	0.97*** (114.4)
$\lambda_{fc}^{for}$	0.29*** (3.2)	0.64	0.40*** (10.1)	x	x
$\lambda_{fc}^{HICP}$	0.71	-	0.15	0.00	0.03
R <sup>2</sup> adj.	0.91	0.71	0.78	0.18	0.07
Wald test (F-statistic and probability.)					
$H_0: \lambda_{pc}^{tar} = \lambda_{fc}^{tar}$	-	3.82 [0.06]	4.60 [0.04]	10.41 [0.00]	0.47 [0.50]
$H_0: \lambda_{pc}^{for} = \lambda_{fc}^{for}$	1.36 [0.25]	3.82 [0.06]	2.05 [0.16]	x	x
$H_0: \lambda_{pc}^{HICP} = \lambda_{fc}^{HICP}$	1.36 [0.25]	-	7.16 [0.01]	10.41 [0.00]	0.47 [0.50]

Notes: 1Y (2Y) refers to expectations one year ahead (two years ahead). L denotes long-term expectations. Ordinary least squares with Newey-West HAC standard errors. Numbers in parentheses below estimated coefficients are t-Statistic. \*\*\* denotes significance level at 99 per cent; \*\* denotes significance level at 95 per cent; \* denotes significance level 90 per cent.

In the case of short-term expectations the equation is estimated using the nested estimation procedure (Feng-Jenq, 2008). It is due to the fact that short-term ECB inflation projections are highly correlated with the current HICP inflation, leading to multicollinearity of regressors. This procedure is based on the OLS method and estimates different parameters of independent variables sequentially. Constructing the base model, the independent variable having the highest correlation with the dependent variable is used. In subsequent steps, residuals from the model are regressed on the independent variable displaying the highest correlations with them.

Source: own calculations.

**Table 5.** Implicit anchors ( $\pi^*$ ) and their weights in the formation of inflation expectations ( $\lambda$ )

		Pre-crisis period	Crisis period
CONS, 1y	$\pi^*$	<b>1.34</b>	<b>0.84</b>
	$\lambda$	0.80	0.54
SPF, 1y	$\pi^*$	<b>1.83</b>	<b>1.51</b>
	$\lambda$	0.90	0.76
SPF, 2y	$\pi^*$	<b>1.84</b>	<b>1.70</b>
	$\lambda$	0.95	0.87
SPF, L	$\pi^*$	<b>1.88</b>	<b>1.96</b>
	$\lambda$	0.88	0.94

*Note:* The implicit anchors and their weights in the formation of inflation expectations are estimated on the basis of bivariate VAR model, in line with the approach proposed by Demertzis et al. (2008, 2009) and presented in section 3.4 of this paper. 1Y (2Y) refers to expectations one year ahead (two years ahead). L denotes long-term expectations.

*Source:* own calculations.

### Acknowledgements

We would like to thank an anonymous Referee and Seppo Honkapohja for helpful comments. Useful comments received from the members of the ESCB Low Inflation Task Force and the participants of the 17th EBES Conference (Venice, October 2015) are also gratefully acknowledged. Finally, we want to thank Jari Hännikäinen for constructive comments in XXXVIII Annual Meeting of the Finnish Economic Association in Pori (February 2016). The views expressed in this paper are not necessarily those of the European Central Bank, Narodowy Bank Polski or the Bank of Finland.

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ISSN                    1725-2806 (online)  
ISBN                    978-92-899-2193-0  
DOI                      10.2866/3439  
EU catalogue No      QB-AR-16-062-EN-N