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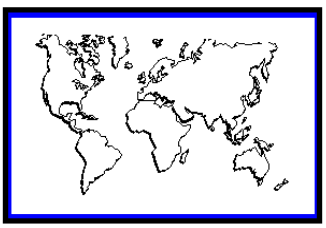

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Inflation, real economic growth and unemployment expectations: An empirical analysis based on the ECB Survey of Professional Forecasters

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Abstract:

Expectations are at the centre of modern macroeconomic theory and policymakers. In this paper, we examine the predictive ability and the consistency properties of macroeconomic expectations using data of the European Central Bank (ECB) Survey of Professional Forecasters (SPF).

Key words: inflation, real economic growth, unemployment, expectations, euro area.

JEL Codes: F31, E31, D84

1. Introduction

Quantifying individual expectations has become a very important topic in economics, both for academic researchers and for policymakers. One of the most relevant advantage of collecting probabilistic expectations is that the quantitative answers can be used to compare predictions across different agents and time, as well as to analyse their consistency.

As the majority of models of exchange rate determination in a context of open economy are based on the assumption of rationality expectations, it is important to analyze how exchange rate expectations are formed. Jongen *et al.* (2008) emphasize the relevance of exchange rate expectations for many issues such as the forward discount puzzle, the heterogeneity of expectations, time-varying risk premium, the rationality of expectations and the accuracy of professional forecasts. Given that the assumption of rational expectations is crucial to evaluate the effectiveness of macroeconomic policies, this paper focuses on the rationality and the predictive accuracy of macroeconomic expectations made by participants in the Survey of Professional Forecasters (SPF) conducted by the European Central Bank (ECB).

Since Muth (1961), there are two conventional ways to test rationality of survey-based expectations: on the one hand, it is needed to analyse the forecast unbiasedness and on the other hand, the orthogonality of forecasts. The first method is related to investigate whether the expected exchange rate is an unbiased predictor of the future spot rate, while the second test assesses whether the panellists incorporate all available information until the moment they are asked about their expectations. It can be possible that the exchange rate expectations are biased, nevertheless this does not necessarily imply that forecasters

form irrational predictions. A rejection of the unbiasedness hypothesis can be rational in the presence of the peso problem, heterogeneous expectations or adaptive learning.

The vast majority of empirical studies finds evidence of irrationality in the exchange rate expectations and show low forecasting ability (see, Dominguez, 1986); Takagi, 1991; Cavaglia *et al.*, 1993; or MacDonald and Marsh, 1994; among others).

Given that most of studies have focused on large advanced countries forecasts, such as the United States (US) and other Group of Seven (G-7) countries (see for instance, Isiklar *et al.*, 2006 or Dovern and Weisser, 2011), Ince and Molodtsova (2015) evaluate the rationality and forecasting accuracy of exchange rate expectations at 3-, 12- and 24-months ahead forecast horizons over the last two decades using a sample of 10 developed and 24 developing countries' currencies. They obtain that survey-based predictions are biased at 3-months ahead forecast horizon for all developed countries and for the vast majority of developing countries. Although this bias is eliminated for 12- and 24-months ahead for developed economies, there is no statistical significance reduction for developing countries. Ince and Molodtsova (2016) conclude that long-term forecasts are more accurate than short-run forecasts. Some papers such as La Porta (1996) or Bergman and Roychowdhury (2008) emphasize the role of cyclicality in the process in which expectations are built. They contend that agents are excessively optimistic in good times and extremely pessimistic in bad times, underestimating long-run mean reversion. In other words, they overestimate the persistence of economic conditions (Baker and Wurgler, 2007). In the same line, Hribar and McInnis (2012) find that stocks prices receive optimistic earnings forecasts when investor's sentiment is high. To determine the average belief form individual agents, it is important to take into account that pro-cyclical optimism in aggregate expectations does not imply that individual predictions are irrational. In fact, Van Nieuwerburgh and Veldkamp (2006) and Patton and Timmermann

(2010) state that even if individual investors were rational, the aggregation of expectations leads to sub-optimal or irrational average beliefs. Using a closed-form general equilibrium model, Marfè (2015) study the investors' expectations of fundamentals with market returns and suggest that the pro-cyclical optimism can explain the persistence of aggregate risk.

Bakhshi *et al.*(2003) also test the rational expectations hypothesis using prediction of fund managers in which respondents are asked to forecast "fixed-event" inflation (i.e, every month panellists are asked about predictions of the annual inflation rate for the same data). In their paper, respondents must predict inflation rate for two years ahead and the following month they offer the new expectation for the same date (at this moment prediction refers to one year and eleven months ahead), and so on. Their findings suggest that forecasts are biased, although Bakhshi *et al.* (2003) stress that this is not itself indicative of irrational expectations. Besides they analyse efficiency in three ways: first, they test whether forecast errors are not correlated with past revisions, finding some evidence of inefficiency; second, they test if forecast revisions are not autocorrelated, obtaining less evidence of inefficiency; and finally, they test if the variance of forecast errors decreases once we are closer to the inflation outturn, indicating that the sample size is too small to be sure about efficiency.

There are some papers in which they stress how inflation expectations contribute to the inflation generating process. In particular, Ang *et al.* (2007) and Faust and Wright (2013) emphasize the utility of survey-based measures of inflation predictions and show evidence about how survey forecast tend to perform best when it is compared with different inflation forecasting methods. In the same vein, Gil-Alana *et al.* (2012) claim that survey-based expectations are better to explain the future inflation rate rather than usual time series models. In contrast, Bauer and McCarthy (2015) suggest that financial

markets only provide scarce forward-looking information to predict future information, since market-based inflation forecasts are not more accurate than survey-based forecasts. Given that in the literature there is not consensus about which of both methods outperform, Grothe and Meyler (2015) try to fill this gap analysing market-based and survey-based measures of inflation predictions for the euro area and for the US, concluding that both have a non-negligible predictive power for inflation.

Trying to evaluate whether the accuracy of European Commission forecasts have changed during the Global Financial Crisis with respect to the period before it, González Cabanillas and Terzi (2012) examine six variables: real gross domestic product (GDP) growth, inflation, general government balance, the unemployment rate, current account and total investment. A significant deterioration of the accuracy of year-ahead expectations is detected due to larger forecast errors in the recession year 2009. They suggest the role of the interest-rate assumptions and the assumption of unchanged fiscal policy as the main explanatory variables to explain the observed forecast errors. Heilemann and Stekler (2007) do not find a high improvement in forecasts accuracy when they study the inflation and real GDP growth forecast in Germany during the last ten years.

Since some Asian economies have transitioned from low/middle income to middle/high income, Chen *et al.* (2016) examine whether this progress has contributed to improve forecast performance over the years, concluding that there is no evidence that these predictions have improved over the last years. Chen *et al.* (2016) report large forecast errors for both GDP and inflation series in the most countries and forecasters. In terms of directional changes, GDP growth predictions are found to be more accurate and unbiased for about half of countries and with respect to the hypothesis that forecasters incorporate

new information efficiently, it is rejected for GDP growth expectations with only some marginal evidence for the inflation rate.

In the context of stock prices, Walther and Willis (2012) conclude that market participants' expectations about firm's future payoffs may explain stock mispricing due to the fact that the sentiment effects determine the accuracy of forecasts of short term payoffs. Miwa (2015) shows that long term earning growth expectations are also crucial to stock price evaluations indicating that with sentiment indices it can be controlled an excess of optimism or pessimism in the market and could reduce the irrational effect on asset pricing.

The rest of the paper is organized as follows. Section 2 presents the data used in the analysis. Empirical results are presented in Section 3 and, finally, some concluding remarks are provided in Section 4.

2. Data

The ECB offers forecasts related to different macroeconomic indicators along several time horizons. More specifically, this survey has the advantage of analyzing an integrated macroeconomic perspective since it reflects the expectations about real economic growth, inflation and unemployment rates. In this particular case, the SPF considers the inflation rate as the year on year percentage change of the Harmonised Index of Consumer Prices (HICP); the real GDP is defined as the year on year percentage change of the real GDP using the standardized ESA definition and finally, the unemployment rate refers to the ratio between the number of unemployed with respect to the labour force.

Since 1999 this SPF has been conducted quarterly. This survey collects responses from financial and other institutions from around the European Union. It is usually based on approximately 75 professional forecasters with an average of 60 respondents who participate in each round.

In the ECB SPF there are two types of observations: point forecasts and probability distribution forecasts. In the first case, forecasters are asked to provide a point forecast or a single value with respect to the previous mentioned variables at different horizons time. Sometimes it is convenient to obtain limits between which the true parameter is found with a certain confidence interval. For this reason, in this paper the probability distribution of forecasted outcomes is also considered. In this second case, forecasters are asked to report the probability distribution along a set of intervals for each time horizon. It is needed to emphasize that this set of intervals is different between the previous indicators and is subject to revisions along the survey adapting to different circumstances.

These panellists usually update their forecasts following data releases or other events (such as financial crisis) and some of them confirm that may also update them because of significant shocks. It is also important to mention that large panel assures good data

quality compared to other surveys in which researchers study the behaviour of inflation rates.

Due to the ten-year anniversary of the SPF, the ECB sent to the participants a special questionnaire to analyze whether the forecasts are judgement-based or model-based. In this survey they consider different models such as autoregressive integrated moving average (ARIMA), single equation, vector auto regression (VAR), vector error correction (VEC), factors models, traditional supply and demand-based macro models and dynamic stochastic general equilibrium (DSGE) models.

This special survey identifies on the one hand that time series models are more common to predict the behaviour of inflation rates and also to form expectations for shorter-term horizons. On the other hand, it is shown that respondents implement more traditional supply and demand-based macroeconomic models for longer-term time horizons and slightly more for the real economic growth rate and unemployment rate.

On average, respondents consider their forecasts to be 40% judgement-based. They emphasize that there is no statistical differences across variables or horizons, except for inflation. The short-run inflation forecasts are predicted using judgement-based around 37%, increasing for longer-time horizons, rather than unemployment and real growth which weight slightly more in its expectations. Furthermore, on average, panellists use judgement-based in higher proportion in order to predict unemployment rate rather than real economic growth rate and there is no significant differences in terms of time horizons.

3. Empirical results

In this section, we successively report our empirical results for inflation rate expectations (3.1), unemployment rate expectations (3.2) and real economic growth rate expectations (3.3).

3.1. Inflation rates

In order to evaluate the forecasting performance of the ECB SPF panel regarding the inflation expectations, we consider the root mean square error (RMSE) and the Theil inequality coefficient. Besides, it has been analyzed how far the mean of the predictions is from the mean of the actual series, how far the variance of the forecast is from the variation of the actual inflation rates and finally, how large is the remaining unsystematic forecasting errors, that is decomposing the RMSE into the bias proportion, the variance and the covariance proportion, respectively.

Table 1 reports the forecast accuracy for different time horizons (3, 6, 9, 12, 15, 18, 21 and 24 months ahead) for the headline and core inflation. Analyzing the headline inflation (Panel A of Table 1), the RMSE is high and increases with the time horizon, mainly from 15 months ahead. In the same vein, Theil's inequality coefficient is far from zero, indicating both indicators that economic agents make errors in their predictions and make it worse as we move away along the time horizon. Regarding the bias proportion, the average of predictions performed is practically the same as the average of the actual series of headline inflation rates observed over the time period since their values are very close to zero. According to the results obtained for the variance proportion, it seems that the panellists are able to replicate the degree of variability of the headline inflation rate the closer they are to the date of the survey ($k = 3, 6$ and 9) , because from 12-months ahead and especially from 15-months ahead begin to adopt higher values. At least up to $k = 12$, most of the bias is concentrated on the covariance proportion, thus indicating that ECB panellists make non-deterministic errors.

Comparing the results of Panels A and B of Table 1, it is evident that respondents are able to predict with more accuracy core inflation than headline inflation, since the values of

both RMSE and Theil inequality coefficient are significantly minors in any time horizon studied. Until k = 12, panellists are able to replicate perfectly both the central position measurement and the degree of variability of the observed series of core inflation (see bias proportion and variance proportion, respectively). This means that errors made when they should predict the behaviour of core inflation rates for the next 3, 6, 9 and 12 months ahead are unsystematic, an opposite situation occurs when they should predict from 15 months ahead in which the errors made are not random (the bias proportion values are reduced but the variance proportion acquires a greater weight in the decomposition of the mean squared forecast error).

All in all, our findings suggest that the predictive ability is much higher for core inflation than for headline inflation. This may be related to the fact that, as in the core inflation the evolution of more volatile prices related to energy products and unprocessed food are not considered, it could be easier for the panellists to make their predictions more accurately.

Table 1: Forecast accuracy

Panel A: Headline inflation					
	RMSE	Theil inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
3-month ahead	0.6481	0.1645	0.0205	0.0067	0.9728
6-month ahead	0.7130	0.1821	0.0212	0.0140	0.9648
9-month ahead	0.6833	0.1740	0.0083	0.0494	0.9422
12-month ahead	0.6930	0.1766	0.0003	0.1848	0.8149
15-month ahead	0.8942	0.2313	0.0008	0.4078	0.5914
18-month ahead	0.9407	0.2448	0.0034	0.3348	0.6618
21-month ahead	0.9036	0.2340	0.0004	0.5164	0.4832
24-month ahead	0.9301	0.2417	0.0007	0.5768	0.4226
Panel B: Core inflation					
	RMSE	Theil inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
3-month ahead	0.4543	0.1372	0.0775	0.1012	0.8213
6-month ahead	0.4460	0.1345	0.0673	0.0810	0.8516
9-month ahead	0.4324	0.1303	0.0392	0.0239	0.9369
12-month ahead	0.4041	0.1215	0.0068	0.0186	0.9746
15-month ahead	0.5266	0.1571	0.0011	0.2427	0.7562
18-month ahead	0.5714	0.1712	0.0043	0.1683	0.8274
21-month ahead	0.5276	0.1574	0.0001	0.3886	0.6113
24-month ahead	0.5502	0.1645	0.0002	0.4757	0.5241

In order to assess whether ECB respondents are predicting more accurately than a random walk, Table 2 shows the results of the percentage of correct predictions about the direction of change in both headline and core inflation. The reason to analyse the accuracy of the direction of changes is because some important papers point out the relevance of doing well for investors and policymakers (see for instance, Altavilla and De Grauwe, 2010 or Bergmeir *et al.*, 2014, among others). In both cases, our results provide sufficient empirical evidence to confirm that the predictions of these economic agents are better than those from a random walk. It should be noted that when the headline inflation is examined, the highest correct prediction percentages are associated to the following time horizons: k = 12, 15 and 18, reaching their maximum in k = 12 (82.35%).

With respect to the core inflation, respondents generally show a greater capacity to predict whether prices for the next period will rise or fall. In particular, in all the temporal horizons it surpasses the 60% of success rate. As in the case of headline inflation, the most significant success percentages are in k = 15 and 18 (81.25% in both), reaching their

maximum when they need to predict the direction of the inflation rate for the next 6 months ahead (82.35%). The smallest success percentages are the farthest from the present, that is, for k = 21 and 24 (75% in both), reaching their minimum in k = 12 (64.71%).

Table 2: Directional forecast

Panel A: Headline inflation	
3-month ahead	58.82
6-month ahead	70.59
9-month ahead	58.83
12-month ahead	82.35
15-month ahead	75.00
18-month ahead	68.75
21-month ahead	62.50
24-month ahead	62.50
Panel B: Core inflation	
3-month ahead	76.47
6-month ahead	82.35
9-month ahead	76.47
12-month ahead	64.71
15-month ahead	81.25
18-month ahead	81.25
21-month ahead	75.00
24-month ahead	75.00

To check the robustness of the accuracy of the ECB's predictions, we test the hypothesis that the panel forecasts are optimal predictors of future headline and core inflation rates. The rational expectations hypothesis does not imply that the panellist do not make any error in any time horizon but requires that the forecast errors must be unbiased and uncorrelated with any information in which the forecast is conditioned (Clements, 2005). For this reason, in order to verify if these panellists made predictions unbiased and efficient, we consider the following regression of the observed inflation rate at time $t+k$ (π_{t+k}) on the expected rate determined at time t for k periods ahead (π^{e}_{t+k}):

$$\pi_{t+k} = \alpha + \beta\pi^{e}_{t+k} + \varepsilon_{t+k} \qquad (1)$$

Therefore to obtain evidence of rational expectations hypothesis it should result an estimated constant ($\hat{\alpha}$) not significantly different form zero and an estimated coefficient

on the expected inflation rate ($\hat{\beta}$) not significantly different from one. If this hypothesis is not fulfilled, Grant and Thomas (1999) conclude the existence of "weak form of rationality".

Table 3 and Table 4 present the estimation results and the Wald test on the joint hypothesis: $H_0: \hat{\alpha} = 0, \hat{\beta} = 1$ for the headline and core inflation, respectively. Regardless of the time horizon analysed, there is enough empirical evidence to reject this null hypothesis for both headline inflation and core inflation. This shows that the predictions made by panellists are biased and inefficient. This means that the rational expectations hypothesis is not fulfilled, but that the "weak form of rationality" is verified in any time horizon.

Table 3: Forecast optimality (headline inflation)

	3-month ahead	6-month ahead	9-month ahead	12-month ahead
$\hat{\alpha}$	0.6185 (0.0000)	0.7983 (0.0000)	0.8863 (0.0000)	0.9464 (0.0000)
$\hat{\beta}$	0.6616 (0.0000)	0.5591 (0.0000)	0.5627 (0.1611)	0.5619 (0.0000)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000
Wald F-test	114.1240 (0.0000)	143.3383 (0.0000)	141.4985 (0.0000)	136.4759 (0.0000)
No. of observations	1006	899	970	998

Notes: p-values in parenthesis

	15-month ahead	18-month ahead	21-month ahead	24-month ahead
$\hat{\alpha}$	1.4537 (0.0000)	1.7034 (0.0000)	1.7398 (0.0000)	1.7479 (0.0000)
$\hat{\beta}$	0.2279 (0.0000)	0.0701 (0.1445)	0.0743 (0.1177)	0.0567 (0.0000)
Prob(F-statistic)	0.0000	0.1445	0.1177	0.0000
Wald F-test	136.0597 (0.0000)	191.2779 (0.0000)	200.6618 (0.0000)	2471.757 (0.0000)
No. of observations	938	836	889	906

Notes: p-values in parenthesis

Table 4: Forecast optimality (core inflation)

	3-month ahead	6-month ahead	9-month ahead	12-month ahead
$\hat{\alpha}$	0.7810 (0.0000)	0.8196 (0.0000)	0.9057 (0.0000)	0.9460 (0.0000)
$\hat{\beta}$	0.4422 (0.0000)	0.4243 (0.0000)	0.4109 (0.0000)	0.4056 (0.0000)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000

Wald F-test	1126.802 (0.0000)	950.7270 (0.0000)	671.1242 (0.0000)	412.6461 (0.0000)
No. of observations	1006	899	970	998

Notes: p-values in parenthesis

	15-month ahead	18-month ahead	21-month ahead	24-month ahead
$\hat{\alpha}$	1.2460 (0.0000)	1.4024 (0.0000)	1.4159 (0.0000)	1.5881 (0.0000)
$\hat{\beta}$	0.2276 (0.0000)	0.1257 (0.0000)	0.1371 (0.0000)	0.0274 (0.0012)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0012
Wald F-test	361.5924 (0.0000)	467.0063 (0.0000)	434.2251 (0.0000)	6872.099 (0.0000)
No. of observations	938	836	889	906

Notes: p-values in parenthesis

To ensure that the expectations are rational one necessary requirement is the consistency, but is weaker than rationality, the reason is that in this case is not required that the prediction process match the stochastic process generating the actual series. Following Froot and Ito (1989), consistency of expectations built at the same moment in time dominate if we obtain the same result when we compare the expectation about the inflation rate for the entire time period with the expectations about inflation rate changes during shorter time periods.

We assume the same model used by Frankel and Froot (1987a, b) and Frenkel *et al.* (2012) in which the panellists build their expectations using an extrapolative model which can, in its simplest form, be expressed as a distributed lag function with one lag:

$$E_{t,i}(\pi_{t+k}) - \pi_t = \alpha_k + \beta_k(\pi_{t-1} - \pi_t) + \varepsilon_{t,i} \qquad (2)$$

where π_t and $E_{t,i}(\pi_{t+k})$ denote, respectively, the unemployment rate at t and the expected unemployment rate for $t+k$ of forecaster i at time t. Subscript k denotes the forecast horizon and ε the error term.

Taking into account that in each quarter respondents are asked about the predictions of two different time periods, the first one is considered as the short term and the second time horizon as the long term. In particular, in the first quarter, they are inquired about the headline and core inflation rate for the next 12 and 24 months, whereby k = 12 is considered the prediction for the short term and k = 24 the prediction for the long term. In the second quarter, the expectations for 9 (short term) and 21 months ahead (long term) are analyzed. Finally, in the third and fourth quarters they are asked for 6 and 18 months and for 3 and 15 months, respectively. Examining the estimated betas related to Table 5, it is observed that all those associated with the short term (3, 6, 9 and 12) are statistically significant and positive, reflecting that the panellists present stabilizing expectations in the short term. Continuing with the headline inflation, except for β_{15} and β_{24} that are negative and positive respectively but not significant even getting rid of the constant, in general it can be concluded that the estimated betas in the long run are positive, indicating therefore that in the long run respondents form expectations that are also stabilising. By this way, short-term expectations are consistent with long-term expectations.

Analysing the core inflation (Table 6), except for β_{12}, that it is not significant, all short-term estimated betas are statistically significant and positive, implying that short-term expectations are stabilizing. Likewise, the long-term expectations are also stabilizing (with the exception of β_{15}), for this reason we can conclude that both predictions are consistent.

Table 5: Expectation formation (headline inflation)

	3-month ahead	6-month ahead	9-month ahead	12-month ahead
$\hat{\alpha}$	-0.0083 (0.5329)	-0.0373 (0.0143)	-0.1611 (0.0000)	-0.2321 (0.0000)
$\hat{\beta}$	0.8499 (0.0000)	1.2830 (0.0000)	0.4689 (0.0000)	0.7824 (0.0000)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000
No. of observations	1006	899	970	998

Notes: p-values in parenthesis

	15-month ahead	18-month ahead	21-month ahead	24-month ahead
$\hat{\alpha}$	-0.2270 (0.0000)	-0.2438 (0.0000)	-0.2879 (0.0000)	0.0595 (0.4531)
$\hat{\beta}$	-0.1601 (0.1798)	1.8851 (0.0000)	0.2187 (0.0155)	0.3836 (0.1711)
Prob(F-statistic)	0.1798	0.0000	0.0155	0.1711
No. of observations	938	836	889	906

Notes: p-values in parenthesis

Table 6: Expectation formation (core inflation)

	3-month ahead	6-month ahead	9-month ahead	12-month ahead
$\hat{\alpha}$	0.2537 (0.0000)	0.2309 (0.0000)	0.1120 (0.0000)	0.0342 (0.1501)
$\hat{\beta}$	0.4241 (0.0107)	0.5929 (0.0125)	0.4606 (0.0000)	0.1810 (0.1671)
Prob(F-statistic)	0.0107	0.0125	0.0000	0.1671
No. of observations	1006	899	970	998

Notes: p-values in parenthesis

	15-month ahead	18-month ahead	21-month ahead	24-month ahead
$\hat{\alpha}$	0.1119 (0.0000)	0.0977 (0.0010)	0.0537 (0.0211)	0.2849 (0.0004)
$\hat{\beta}$	-0.5835 (0.0020)	0.5668 (0.0310)	0.3560 (0.0012)	1.5783 (0.0003)
Prob(F-statistic)	0.0020	0.0310	0.0012	0.0003
No. of observations	938	836	889	906

Notes: p-values in parenthesis

3.2. Unemployment rates

Regarding the expectations on unemployment rates, Table 7 offers some statistical tests to evaluate how well ECB respondents form their predictions. As can be seen, they are more accurate than those for the inflation rates, at least until to k = 9, since the RMSE presents lower values. From k = 15, this indicator begins to experience a slight increase in relative terms. According to Theil inequality coefficient, with estimated values so close to zero, the panellists do not make such serious errors. Given the disaggregation of the RMSE, both the bias proportion and the variance proportion show very small values, thus reflecting that the mean and variance of the predictions carried out by the panellists do not differ from the mean and variance of the actually observed unemployment rates. Since

most of the error committed by analysts lies in the covariance proportion, the observed deviation between the prediction and the true value of the series is random.

Table 7: Forecast accuracy

Unemployment					
	RMSE	Theil inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
3-month ahead	0.4773	0.0247	0.0046	0.0865	0.9089
6-month ahead	0.5237	0.0271	0.0052	0.0937	0.9011
9-month ahead	0.6256	0.0324	0.0048	0.0624	0.9328
12-month ahead	0.7848	0.0407	0.0048	0.0382	0.9570
15-month ahead	0.9763	0.0506	0.0052	0.0201	0.9747
18-month ahead	1.2002	0.0622	0.0090	0.0417	0.9494
21-month ahead	1.2524	0.0650	0.0078	0.0217	0.9705
24-month ahead	1.2852	0.0667	0.0067	0.0097	0.9835

As the time horizon increases, the percentage of success with respect to the direction of changes in the unemployment rate increases, reaching a 50% for 15 and 18 months ahead (with the exception of k=21), in fact its maximum is around 56% for the 24 months ahead predictions.

Table 8: Directional forecast

Unemployment	
3-month ahead	35.29
6-month ahead	41.18
9-month ahead	41.18
12-month ahead	47.06
15-month ahead	50.00
18-month ahead	50.00
21-month ahead	43.75
24-month ahead	56.25

In order to test if the predictions carried out by this group of analysts are optimal predictors of the future unemployment rate of the euro area, it is contrasted if the predictions are unbiased and efficient through the following equation:

$$u_{t+k} = \alpha + \beta u^{e}_{t+k} + \varepsilon_{t+k} \qquad (3)$$

From Table 9 one can draw the conclusion that predictions are biased and inefficient, since the null hypothesis is rejected in all time horizons studied, thus rejecting the hypothesis of rational expectations and accepting the "weak form of rationality ".

Table 9: Forecast optimality (unemployment)

	3-month ahead	6-month ahead	9-month ahead	12-month ahead
$\hat{\alpha}$	1.9233 (0.0000)	2.2819 (0.0000)	2.5217 (0.0000)	3.0494 (0.0000)
$\hat{\beta}$	0.8094 (0.0000)	0.7688 (0.0000)	0.7415 (0.0000)	0.6845 (0.0000)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000
Wald F-test	172.9623 (0.0000)	181.2481 (0.0000)	169.7855 (0.0000)	178.4941 (0.0000)
No. of observations	957	879	941	972

Notes: p-values in parenthesis

	15-month ahead	18-month ahead	21-month ahead	24-month ahead
$\hat{\alpha}$	3.5444 (0.0000)	4.8344 (0.0000)	4.9220 (0.0000)	5.2206 (0.0000)
$\hat{\beta}$	0.6447 (0.0000)	0.5106 (0.0000)	0.4991 (0.0000)	0.4674 (0.0000)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000
Wald F-test	173.6603 (0.0000)	284.0449 (0.0000)	258.2844 (0.0000)	253.5828 (0.0000)
No. of observations	901	822	873	886

Notes: p-values in parenthesis

As in the previous section, here we assume that unemployment forecasters build their expectations by using the following extrapolative model:

$$E_{t,i}(u_{t+k}) - u_t = \alpha_k + \beta_k(u_{t-1} - u_t) + \varepsilon_{t,i} \qquad (4)$$

where u_t and $E_{t,i}(u_{t+k})$ denote, respectively, the unemployment rate at t and the expected unemployment rate for $t+k$ of forecaster i at time t. Subscript k denotes the forecast horizon and ε the error term.

Focusing on the highly significant estimated betas in the short run it can be seen a positive estimated sign (Table 10), indicating that, given an increase in the unemployment rate in the period prior to the survey, panellists expect an opposite effect for the next period (t +

k), in which they consider that a reduction in the unemployment rate will occur, thus showing stabilizing expectations. Nevertheless, with the exception of β_{24}, the remainder estimated betas for the long term that are significant show a negative estimated sign in their estimations. From this result it can be concluded that if analysts observe an increase in the unemployment rate at the time before the survey, they will expect that this pattern to be maintained for the next period for which they are asked, thus maintaining expectations destabilizing. In other words, short-term expectations are not consistent with long-term predictions.

Table 10: Expectation formation (unemployment)

	3-month ahead	6-month ahead	9-month ahead	12-month ahead
$\hat{\alpha}$	-0.1355 (0.0000)	-0.0813 (0.0000)	-0.0911 (0.0000)	-0.0625 (0.0018)
$\hat{\beta}$	2.7822 (0.0000)	1.2217 (0.0000)	0.1557 (0.3207)	-0.0117 (0.6765)
Prob(F-statistic)	0.0000	0.0000	0.3207	0.6765
No. of observations	957	879	941	912

Notes: p-values in parenthesis

	15-month ahead	18-month ahead	21-month ahead	24-month ahead
$\hat{\alpha}$	-0.1628 (0.0000)	-0.1916 (0.0000)	-0.2408 (0.0000)	-0.2208 (0.0000)
$\hat{\beta}$	-1.1161 (0.0000)	-0.5577 (0.1433)	-1.7508 (0.0000)	0.2057 (0.0000)
Prob(F-statistic)	0.0000)	0.1433	0.0000	0.0000
No. of observations	901	822	873	886

Notes: p-values in parenthesis

3.3. Real economic growth rates

As for the expectations on real GDP growth, examining Table 11 we notice that, although the RMSE is high, unlike inflation rates or the unemployment rate decreases as we move forward in the time horizon, especially this decline is highly noticeable from 15 months ahead. In this case, the Theil inequality coefficient acts as a complementary indicator to the results obtained previously, since the predictive ability of the respondents improves

from k = 9 and much more significantly from k = 15. Analysts make high errors by trying to identify the central position measure of the future real growth rate up to 12 months ahead, but from k = 15 the values of this indicator are again close to zero. In general, the covariance proportion is also high from k = 15 showing that they make nondeterministic errors when they are asked about the predictions for 15, 18, 21 and 24 months ahead.

Table 11: Forecast accuracy

Real economic growth					
	RMSE	Theil inequality coefficient	Bias proportion	Variance proportion	Covariance proportion
3-month ahead	1.2748	0.4473	0.5457	0.0571	0.3971
6-month ahead	1.2606	0.4399	0.5708	0.0689	0.3603
9-month ahead	1.1005	0.3665	0.4537	0.1070	0.4393
12-month ahead	0.8585	0.2692	0.2583	0.1169	0.6248
15-month ahead	0.4833	0.1410	0.0636	0.0510	0.8853
18-month ahead	0.4295	0.1247	0.0272	0.0056	0.9673
21-month ahead	0.3964	0.1149	0.0101	0.0034	0.9865
24-month ahead	0.4116	0.1194	0.0010	0.0720	0.9270

As the time horizon increases, it can be seen a higher percentage of success in the predictions associated with the direction of expected changes in the variable of interest. From k = 12, the percentage of success is greater than 80%, showing that their predictions are much more accurate than the random walk. The highest success percentages correspond to the predictions for 9 and 21 months ahead (with 94.12% and 93.75%, respectively).

Table 12: Directional forecast

Real economic growth	
3-month ahead	70.59
6-month ahead	76.47
9-month ahead	94.12
12-month ahead	88.24
15-month ahead	81.25
18-month ahead	81.25
21-month ahead	93.75
24-month ahead	81.25

Besides we assess the hypothesis that the panel forecasts are optimal predictors of future real economic growth rates from:

$$\rho_{t+k} = \alpha + \beta\rho^{e}_{t+k} + \varepsilon_{t+k} \qquad (5)$$

The joint hypothesis in which the estimated constant is zero and the estimated coefficient of the expected real growth rate for the time horizon to be studied is one is clearly rejected in all cases, being able to affirm that the predictions are biased and inefficient. In this way there is enough empirical evidence to assure the "weak form of rationality" of the predictions made by the ECB's panellists.

Table 13: Forecast optimality (real economic growth)

	3-month ahead	6-month ahead	9-month ahead	12-month ahead
$\hat{\alpha}$	1.3971 (0.0000)	1.3807 (0.0000)	1.3324 (0.0000)	1.1559 (0.0000)
$\hat{\beta}$	0.1698 (0.0000)	0.1863 (0.0000)	0.2253 (0.0000)	0.3150 (0.0000)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000
Wald F-test	3143.732 (0.0000)	3286.728 (0.0000)	2410.687 (0.0000)	1070.901 (0.0000)
No. of observations	1007	902	975	999

Notes: p-values in parenthesis

	15-month ahead	18-month ahead	21-month ahead	24-month ahead
$\hat{\alpha}$	1.0337 (0.0000)	0.9312 (0.0000)	0.9476 (0.0000)	0.9529 (0.0000)
$\hat{\beta}$	0.4055 (0.0000)	0.4100 (0.0000)	0.3913 (0.0000)	0.3755 (0.0000)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000
Wald F-test	658.1890 (0.0000)	533.8908 (0.0000)	590.0444 (0.0000)	588.9679 (0.0000)
No. of observations	942	839	905	904

Notes: p-values in parenthesis

As in the previous section, here we assume that real economic growth forecasters build their expectations by using the following extrapolative model:

$$E_{t,i}(\rho_{t+k}) - \rho_t = \alpha_k + \beta_k(\rho_{t-1} - \rho_t) + \varepsilon_{t,i} \qquad (6)$$

where ρ_t and $E_{t,i}(\rho_{t+k})$ denote, respectively, the real economic growth rate at t and the expected real economic growth rate for $t+k$ of forecaster i at time t. Subscript k denotes the forecast horizon and ε the error term.

The results of Table 14 suggest that there is not enough empirical evidence to allow us to reject the null hypothesis that short-term predictions are consistent with long-term predictions. Specifically, on the one hand, the estimated betas associated with the short term (3, 6, 9 and 12 months ahead) are strongly significant and negative (with the exception of β_9), which means that panelists construct destabilizing expectations. On the other hand, analyzing the long-term estimated sign for excellence reveals that

expectations are destabilizing. In this way, there is consistency between the short- and long-term predictions.

Table 14: Expectation formation (real economic growth)

	3-month ahead	6-month ahead	9-month ahead	12-month ahead
$\hat{\alpha}$	-0.5672 (0.0000)	-0.5793 (0.0000)	-0.6189 (0.0000)	-0.2958 (0.0000)
$\hat{\beta}$	-2.0297 (0.0000)	-2.6437 (0.0000)	-1.5561 (0.0000)	1.9166 (0.0000)
Prob(F-statistic)	0.0000	0.0000	0.0000	0.0000
No. of observations	887	793	864	889

Notes: p-values in parenthesis

	15-month ahead	18-month ahead	21-month ahead	24-month ahead
$\hat{\alpha}$	-0.1551 (0.0000)	0.0162 (0.6393)	0.0359 (0.2808)	0.1752 (0.0000)
$\hat{\beta}$	-0.4171 (0.0179)	0.0286 (0.8097)	-0.7152 (0.0000)	1.3267 (0.0000)
Prob(F-statistic)	0.0179	0.8097	0.0000	0.0000
No. of observations	829	735	801	801

Notes: p-values in parenthesis

4. Concluding remarks

Understanding how agents form expectations is at the centre of macroeconomic modelling. In this paper, we have contributed to the literature investigating the predictive ability and consistency properties of macroeconomic expectations using the Survey of Professional Forecasters conducted by the European central bank, offering further evidence on the explanatory power of expectations on inflation, unemployment rate and real economic growth, directly observed from survey data.

Our results suggest that with respect to the headline inflation, both the RMSE and the Theil's inequality coefficient indicate that economic agents make errors in their predictions and make it worse as we move away along the time horizon. At least up to k=12, most of the bias is concentrated on the covariance proportion, thus indicating that

ECB panellists make non-deterministic errors. We notice that respondents are able to predict with more accuracy core inflation than headline inflation. In both cases, our results provide sufficient empirical evidence to confirm that the predictions of these economic agents are better than those from a random walk. Rational expectations hypothesis is not fulfilled, but that the "weak form of rationality" is verified in any time horizon. Analysing consistency of expectations, it is obtained that short-term expectations are consistent with long-term predictions.

Regarding the expectations on unemployment rates, ECB participants form their predictions more accurate than those for the inflation rates, at least until to k=9. It is reflected that the mean and variance of the expectations carried out by the panellists do not differ from the mean and variance of the actually observed unemployment rates. In this case, predictions are biased and inefficient. In addition, there is enough empirical evidence to allow us to reject the null hypothesis that short-term predictions are consistent with long-term expectations.

As for the expectations on real GDP growth, unlike inflation rates or the unemployment rates, the RMSE decreases as we move forward in the time horizon, especially this decline is highly noticeable from 15 months ahead. In general panellists make non-deterministic errors when they are asked about the predictions for 15, 18, 21 and 24 months ahead. In this particular case, there is enough empirical evidence to assure the "weak form of rationality" of the predictions made by the ECB's respondents. Besides short-term expectations are consistent with long-term predictions.

Future research exploring the channels through which economic development affects ECB participants' forecast performances would be very beneficial.

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