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Eurozone or National Inflation Projections: Which Has Greater Impact on Consumer Expectations?

Summary: We compare the dependence of consumer inflation expectations on European Central Bank (ECB) inflation projections with that on national central bank (NCB) projections in four economies: Austria, Belgium, Finland, and Germany. We aim to assess whether the information published by central banks affects consumers, and whether inflation projections published by NCBs are more relevant to consumers than those published for the entire Eurozone. Inflation expectations were obtained from the Business and Consumer Surveys conducted by the Directorate General for Economic and Financial Affairs of the European Commission and quantified using the probabilistic method. The methodology covers: (1) forecast encompassing tests; (2) the Granger causality test; (3) impulse response analysis complemented by (4) forecast error variance decomposition. The results suggest that the ECB outlook constitutes a more important factor in expectation formation. This article adds to the existing literature by comparing the impact of common and national projections on consumer expectations.

Key words: Inflation expectations, Inflation projections, Expectation surveys.

JEL: E52, E58, E61.

Economic actors in the Eurozone form their expectations based on information from national sources or on information published for the entire Eurozone. In the case of inflation, the goal of price stability, established for the entire Eurozone, is considered. However, divergences among European Union (EU) member states have been confirmed empirically (Ernest Gnan, Johannes Langthaler, and Maria T. Valderrama 2011; Jesús Ferreiro et al. 2017). Thus, we would like to address the question of whether European Central Bank (ECB) projections matter more than the projections of national central banks (NCBs). We hypothesise that national forecasts are more relevant for consumers, as they reveal country-specific information. We test whether NCB projections influence expectations more than ECB projections, and *vice versa*.

We are motivated to examine the relationship between forecasts and expectations because there is a limited amount of existing literature on this topic, despite its importance to policymakers. From the ECB standpoint, it is extremely important to influence expectations through ECB actions and information. This need is theory-

consistent. To the best of our knowledge, a study comparing the impact of national forecasts with ECB projections has yet to be published.

The methodology consists of four approaches. Forecast encompassing tests (1) compare the rival forecasts against the information content that could affect expectations. They are followed by a trivariate Granger causality test (2) performed by fitting a trivariate vector autoregressive model (VAR) to the time series. Finally, we trace response functions (3) to a shock, which is a change in ECB or NCB projection and (4) analyse forecast error variance decomposition (FEVD).

The rest of the article is organised as follows: Section 1 contains an overview of the literature; Section 2 presents the data; Section 3 provides a description of the methodology; Section 4 presents the results, with a conclusion to end.

1. Literature Review

Inflation expectations are a crucial aspect of modern monetary policy. Analytical models used by central banks account for inflation expectations, which are included in the New-Keynesian Phillips curve, the IS curve, and the loss function or reaction function. This is in line with monetary theory, which describes cause-effect relationships in the economy (Michael Woodford 2003; Jordi Galí 2008), and implies that the outcome of monetary policy is mainly affected by central banks' ability to shape long-term expectations, rather than by current interest rates. Inflation forecasts should play the main role in shaping inflation expectations in any regime based on inflation targeting (IT). Inflation targeting implemented by central banks may even become inflation forecast targeting (IFT), which some authors consider to be optimal (Lars E. O. Svensson and Woodford 2004). In the face of Eurozone disturbances, appropriate management of inflation expectations seems to be increasingly important and should involve looking for its dynamic sources and drivers. When the central bank operates under zero lower bound (ZLB), and when its policy is shaped by a deflation threat, a forecast that presents interest rates near the floor for a long enough period might help inflation to get back on track (Kevin Clinton et al. 2015).

The most relevant literature refers to the possible impact of central bank forecasts on the inflation expectations of economic actors. Producing and revealing inflation forecasts is an immanent part of fully-fledged IT. Inflation targeting itself should have a considerable impact on expectations formation, as its constitutional features facilitate central banks' impact on expectations, including their anchoring. Such an effect is confirmed by empirical studies (Milan Nedeljković, Nebojša Savić, and Emir Zildžović 2017). Studies on the relationship between inflation forecasts and inflation expectations mostly focus on central bank implementation of the inflation-targeting regime. Such works are related to Svensson's concept of inflation forecast targeting (IFT), in which an inflation forecast is an intermediate target, which is used to anchor inflation expectations on the inflation target in the medium-term (Svensson 1997). The initial concept of Svensson's type of IFT evolved over time towards flexible inflation targeting and endogenisation of interest rates (Svensson 2003), incorporation of expert judgements into forecasting procedures (Svensson 2005), and an extremely transparent approach, meaning the publication of weights attributed to inflation and output gap stabilisation (Svensson 2007). Nowadays, most central banks that implement inflation

targeting are cautious about publishing central paths of interest rates, as the benefits of such decisions are not obvious (see George A. Kahn 2007 for a descriptive analysis of the pros and cons of such publications and Michał Brzoza-Brzezina and Adam Kot 2008 for model-based analysis). The central banks in our sample also produce forecasts under specific assumptions around the interest rate and the exchange rate according to market expectations throughout the whole forecast horizon. Such a forecast is called a projection. Thus, we use "forecasts" to describe general issues and "projections" to refer to forecasts produced by the central banks that we cover.

The most recent literature examines the benefits of IFT in terms of incentive contracts for central bankers, which enhance their possibilities of stabilising expectations: their remuneration depends on inflation forecast precision. As Hans Gersbach and Volker Hahn (2014) find, such contracts enable central bankers to influence inflation expectations more effectively, thus facilitating more successful stabilisation of current inflation. Inflation forecast contracts improve the accuracy of inflation forecasts, but have an adverse effect on output.

The most relevant strand of empirical literature for the purposes of our examination refers directly to an examination of the relationship between central banks' inflation forecasts and the expectations of economic actors. According to many studies, the relationship is related to regime changes. Such changes may be connected to enhanced transparency manifested in the form of inflation forecasts published by central banks. The starting point for such research is that the forecast, once it is revealed, should diminish the dispersion and heterogeneity of the forecasts of private actors. Thus, the forecast becomes a coordinating device for private agents.

A study for Japan conducted by Ippei Fujiwara (2005) is an early example of an investigation of a shift in communication policy, which covers the impact of economic outlooks published by the Bank of Japan on the forecasts of private actors. Qualitative and quantitative evaluations were conducted to find that forecasts published by the Bank of Japan for the past five years affected the forecasts of professional forecasters and reduced their uncertainty.

Andrew Bauer et al. (2006) analysed forecast errors across a large section of forecasters and several macroeconomic variables for the United States, in order to assess the impact of a switch in communication policy on expectations. In 1994, the U.S. Federal Reserve ("the Fed") increased its transparency by launching the publication of statements about the economic outlook. If this enhanced transparency was effective, the expectations of market participants should have been more synchronised in the post-statement period than in the period prior to it. The study proved that they were indeed more synchronised, but analysis of the distribution of forecast errors was not conclusive. The author was cautious in his interpretation of the results, given the fact that the Fed's manner of communication had evolved over the reference period.

Jan Filáček and Branislav Saxa (2012) examined the standard deviations of forecasts made by Czech financial markets analysts and their distance from forecasts published by the Czech National Bank (CNB). They found evidence supporting the coordinating role of inflation forecasts, but not of the gross domestic product (GDP) forecasts. Standard deviations of individual forecasters decreased significantly, since the CNB had improved the transparency of its communications, whereas the distance

of the median of private forecasters decreased for inflation and interest rate forecasts (IRFs). It can be concluded that the degree of coordination depends on the level of general economic uncertainty and the CNB's policy of greater openness; coordination is larger in times of more uncertainty.

Another study (Michael Ehrmann, Sylvester Eijffinger, and Marcel Fratzscher 2012) was conducted for 12 EU and non-EU countries and was based on data from Consensus Forecasts, including micro data, and the Business and Consumer Surveys conducted by the Directorate General for Economic and Financial Affairs of the European Commission. The study detected the effects of central bank transparency, including forecast publication, on disparities between forecasts made by professionals and non-professionals. However, marginal effects of enhanced transparency declined. The authors were cautious about interpreting their findings in terms of causality.

Paul Hubert (2014) investigated communications from the Fed using the procedure presented by Ehrmann, Eijffinger, and Fratzscher (2012). The goal of Hubert's study was to check whether the inflation forecasts of the Fed diminished the dispersion of the inflation expectations of private agents, represented by data from Consensus Forecasts and the Survey of Professional Forecasters. The study confirms the function of the Fed's forecasts as a coordination device for private forecasts.

The relationship between forecasts produced by central banks and expectations could also be explored in other ways. The most intuitive examination could simply involve analysing correlations between expectations and forecasts and factors determining their strength. Studies of this kind were conducted by Magdalena Szyszko and Karolina Tura (2015) and Szyszko (2017). Such associations have been found for the Czech Republic, Hungary, Poland, and Sweden, but their strength cannot be linked directly to the credibility of central banks, their use of the IFT, or the accuracy of past forecasts.

An alternative, and more advanced, methodological approach to studying the relationship between expectations and forecasts involves the use of models that capture causality. This kind of study was conducted by Hubert (2015a), who analysed data for Canada, Japan, Sweden, Switzerland, and the UK, and found evidence supporting the ability of central banks to influence expectations *via* their forecasts. Hubert examined data from Consensus Forecasts to check whether the level of inflation forecasts made by private agents was affected by the forecasts published by central banks. Since his investigation refers directly to levels of both variables, in contrast to most other studies, Hubert concludes that forecasts do influence the expectations of private agents. To explain the existence of this influence, Hubert assumes that forecasts of central banks are more accurate than private forecasts. This assumption was confirmed only for the Swedish National Bank. Other possible explanations for this influence include the information asymmetry between the central bank and the public or the perception of the forecasts published by central banks as signals of monetary policy intention.

The presence of the relationship between forecasts published by central banks and private forecasts is confirmed in another study by Hubert (2015b), in which data for the US were examined by applying a structured VAR model and shock response analysis. As in the previous study, the author's goal was to determine the sources of this dependence. The forecasts published by the Fed convey information about future

policy actions and, thus, are more valuable from the perspective of private agents than actual interest rate decisions. The dataset used in the study comes from the Survey of Professional Forecasters.

According to another study (Jacek Kotłowski 2015) conducted for Poland, the projections of central banks do not affect either the dispersion or the median of the individual forecasts of professionals. However, the effect can be observed for GDP forecasts. The author tested the dependence using single-equation specifications (separately for inflation and GDP projections) in a linear and non-linear form. The dispersion of professional forecasts or their median is related to forecasts published by the National Bank of Poland and a set of macroeconomic variables.

Consumer expectations and their dependence on the forecasts of central banks were also analysed with the vector error correction model (VECM) (Szyszko and Piotr Płuciennik 2018). Shock response analysis confirmed that consumer expectations in the Czech Republic, Sweden, and the UK react to changes in inflation forecasts. The strength and lag of the reaction varies in each country. Expectations are also affected by changes in other macroeconomic variables.

The potential influence of the inflation forecasts produced by the Central Bank of Chile on the expectations of professionals was examined by Michael Pedersen (2015) who presents evidence suggesting that short-term expectations are influenced by the forecasts, but that this effect is weaker for medium-term expectations. The author estimates a model that accounts for changes in the forecasts of private agents, past differences between private and public forecasts, and some control variables that could affect expectations. This model captures the fact that professionals adjust their predictions to the forecasts of central banks only if they are actually different.

Tomasz Łyziak and Maritta Paloviita (2017) analysed the relationship between consumer inflation expectations in the whole Eurozone and forecasts produced by the ECB in the pre- and post-crisis period. To check whether post-crisis expectations were indeed de-anchored, they were related only to the current Harmonised Index of Consumer Prices (HICP) inflation rate and ECB inflation projections. The authors found that the first factor was much more significant. Nonetheless, the importance of forecasts after the crisis increased, suggesting that they have regained their role as a reference for anchoring expectations. In this study, the question of the relationship between forecasts and expectations is a side issue. However, the study shows that the effect of forecasts on private expectations exists for the Eurozone and varies over time.

To summarise existing findings concerning the relationship between expectations and the forecasts of central banks, we may draw the following conclusions: (1) there are only a few studies that focus on the importance of monetary policy geared towards shaping expectations through forecasts published by central banks; (2) the shortage of literature is mostly due to methodological difficulties. There is no simple and conclusive methodology that could be applied to this kind of data. In the case of the forecasts of central banks, the time series are relatively short and of low quality (i.e. expressed descriptively). Thus, the methodology varies from the simplest to the more sophisticated. Regardless of the methodology, the authors are cautious about possible interpretation of their results; (3) more research is produced to assess the strategies of central banks or the impact of their general transparency on expectations or

their dispersion; (4) previous studies usually find evidence to support the existence of some kind of impact of the forecasts of central banks on private agent expectations. However, results are sometimes ambiguous and authors add numerous caveats to the results. Moreover, there are studies reporting opposite conclusions (more information from central banks means bigger discrepancies between forecasts) (Pierre L. Siklos 2013); (5) most studies deal with forecasts made by professional forecasters. There is no doubt that the group of economic agents that we cover in our study – consumers – has the poorest economic education and limited aptitude for taking in sophisticated economic information, such as forecasts published by a central bank. Consequently, a central bank's forecasts reach households indirectly, through media reports with a certain delay. Such a point of view is in line with Carroll's epidemiological expectations (Christopher D. Carroll 2003). Our focus on households is also justified by recent changes in the way central banks communicate their information, which is not designed for specialists, but for the general public (Carola Binder 2017).

2. Data

Consumer expectations from four economies, Austria (AUS), Belgium (BEL), Finland (FIN), and Germany (DE), and their respective central banks, Oesterreichische Nationalbank (OeNB), National Bank of Belgium (NBB), the Bank of Finland (BoF), and Deutsche Bundesbank (DB), were taken into account. We selected these economies and their central banks as they have belonged to the Eurozone for at least 10 years, have published national forecasts (at least 18 publications), and relevant data about one-year consumer expectations for these countries are available. This is why our sample is limited to four NCBs and the European Central Bank (ECB).

We created a dataset of ECB inflation projections for the Eurozone and national projections published by the NCBs of Austria, Belgium, Finland, and Germany. The time series for each central bank consist of at least 18 projections. The dataset contains values of one-year horizon projections. Descriptive statistics and plots for our data are presented in the Appendix (Table A1 and Figure A1). The values of NCB projections at the one-year horizon were collected from reports of the NCBs (details in Table 1). NCB projections and ECB projections refer to the same inflation measure: HICP rate (percentage change compared to the previous year). The NCB forecasts refer to the national inflation figure, whereas the ECB projection presents inflation for the whole Eurozone. The reference periods for the individual banks are as follows: 2005-2015 for OeNB, 2004-2015 for NBB, 2000-2015 for BoF, and 2007-2015 for DB. The starting point in each case corresponds to the publication of the first forecast.

The variable that we refer to as ECB inflation projection corresponds to *ECB staff macroeconomic projections for the euro area*. Macroeconomic projections offer an outlook for the Eurozone, in particular regarding GDP and inflation. The term *projection* denotes a forecast produced under a specific assumption of interest rates or exchange rates, usually their unchanged level throughout the forecast horizon. Alternatively, the term projection can refer, as in the case of our central banks, to market expectations of the interest rate path and of exchange rate fluctuations. ECB projections are published four times a year: in March, June, September, and December. We use the central projection of HICP over a 12-month horizon to ensure consistency with

Table 1 Description of NCB Inflation Projection Data

NCB	Source	Forecast horizon	Reference period	*N*
OeNB	Monetary Policy and the Economy: Economic Outlook for Austria	2Y	2005-2015	24
NBB	NBB Economic Review, Economic Projections for Belgium	Up to Jun 2014:1Y, since Dec 2014:2Y	2004-2015	26
BoF	Bank of Finland Bulletin: Economic Outlook: Special Issue and Economic Outlook and the Bank of Finland's Macroeconomic Forecast for Finland	2Y	2001-2015	34
DB	Monthly Report: Outlook for the German Economy: Macroeconomic Projections	2Y	Dec 2007-2015	20

Notes: Data on NCB projections were collected from different sources and are presented differently in the relevant documents. A direct reference to the data source is not possible - a novel database was created.

Source: Authors' compilations.

the horizon used in the survey question about inflation expectations, which is 12 months. Since expectations are fixed-horizon forecasts and ECB projections are fixed-event forecasts, we applied the following procedure (Jonas Dovern, Urlich Fritsche, and Jiri Slacalek 2012), which was adjusted to our data to make them comparable:

$$f_{y_t,q_j,y_{t+1}(x)} = \frac{4-j}{4} f_{k_u,y_t,q_j,y_{t+1}}(x) + \frac{4-(4-j)}{4} f_{k_l,y_t,q_j,y_{t+1}}(x). \quad (1)$$

In the expression $f_{k_u,y_t,q_j,y_{t+1}(x)}$ (k_u) denotes the upper interval of the forecast made in year y_t $(t \in N)$, published in quarter j $(j \in (1,2,3,4))$, made for year y_{t+1}, for variable x. In the expression $f_{k_l,y_t,q_j,y_{t+1}(x)}$ (k_l) denotes the lower interval of the forecast made in year y_t $(t \in N)$, published in quarter j $(j \in (1,2,3,4))$, made for year y_{t+1}, for variable x; the expression, $f_{y_t,q_j,y_{t+1}(x)}$ denotes a forecast made in year y_t $(t \in N)$, published in quarter j $(j \in (1,2,3,4))$, made for year y_{t+1}, for variable x. To preserve consistency with the publication schedule of NCB forecasts, we examined only ECB projections published in June and December.

Consumer inflation expectations were quantified using an adjusted version (Roy A. Batchelor and Adrian B. Orr 1988) of the probabilistic method of John A. Carlson and Michael Parkin (1975). Data collected in the household surveys are usually qualitative data, which is also the case with the Business and Consumer Surveys conducted by the Directorate General for Economic and Financial Affairs of the European Commission. Respondents are asked the following question about their inflation expectations: *In comparison with the past 12 months, how do you expect consumer prices to develop in the next 12 months?* Possible answer options include: *They will … increase more rapidly, … increase at the same rate, … increase at a slower rate, … stay about the same, … fall, … don't know* (European Commission 2016). Results of the surveys are published as percentages of respondents who chose a particular option in response to the question about inflation expectations. In the Carlson and Parkin procedure, it is assumed that if the number of respondents is sufficiently large, the expected rate of price changes is normally distributed. The quantification of qualitative responses relies

on the fact that, in replying to the survey question regarding inflation expectations, respondents compare their predictions with the rate of price changes as perceived at the time of the survey (Łyziak 2010). In this case, the two-month lagged inflation figure represents the inflation perception (scaling factor). This information lag is applied as consumers need time to process information. Moreover, the publication of the inflation figure from month t-1, in month t, may post-date the survey on expectations held in month t. The two-month lag guarantees that the consumers are informed of the latest inflation figure. The existence of an information lag is a standard assumption in any examination of consumer expectations, and it is considered when analysing relevant data (see Łyziak and Joanna Mackiewicz-Łyziak 2014).

The probabilistic method also assumes that some sensitivity intervals exist for respondents who choose the answers: prices will *increase at the same rate* and prices *will stay the same*. The assumptions of the probabilistic method – together with the assumption of the expected distribution of inflation rate (usually assumed to be normal) – result in a system of equations that can be used to calculate the expected inflation rate. This procedure is broadly acknowledged and applied in empirical research on expectations (including studies that we refer to in the first section). We present its assumptions graphically, together with equations that constitute the procedure, in the Appendix (Figure A2).

3. Methodology

The first step of the procedure is to examine whether the ECB/NCB projections capture some extra information in shaping consumer expectations, which might have been missed in alternative projections (whether the ECB/NCB projections are able to explain the error of the alternative projections). Following Yock Y. Chong and David F. Hendry's (1986) models, which claim that to congruently represent a data generation process, it must be able to account for the findings of rival models. To address this issue, the "limited information" forecast encompassing tests are performed in the form proposed by Chong and Hendry (1986) and Grayham Mizon and Jean-Francois Richard (1986). The tests are performed on stationary series. The examination includes each country separately. The relevant testing equations are as follow[1]:

$$exp_{t+2} - ECB\ pro = \lambda_{NCB\ pro}\, NCB\ pro + \eta_{1t}, \tag{2}$$

$$exp_{t+2} - NCB\ pro = \lambda_{ECB\ pro}\, ECB\ pro + \eta_{2t}, \tag{3}$$

where: *ECB pro* stands for the ECB's projections, *NCB pro* stands for the NCBs' projections, and *exp* stands for inflation expectations. The significance of the $\lambda_{NCB\ pro}$ or $\lambda_{ECB\ pro}$ coefficient suggests that one projection encompasses the other (Chong and Hendry 1986). For this purpose, a .05 significance level was assumed.

In the next step of the analysis, Granger causality based on VAR models between inflation expectations and projections was tested. Considering Granger causality, we assume that if the forecast Granger-caused expectations (i.e. the fact of taking into account past values of the forecast increases the accuracy of forecasted values of

[1] Only the linear case is considered.

expectations), consumers did incorporate it while forming their expectations. The cause (projection) precedes the effect (private forecasts – expectations). We examined it in both directions. We tested for stationarity of the time series and for the existence of unit roots using the Augmented Dickey-Fueller test (ADF) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. The lag in the VAR models was selected according to the Akaike, Schwartz-Bayesian, and Hannan-Quinn criteria. The same lag was used for all models. Inflation expectations were represented as a linear combination of lagged inflation expectations, and ECB and NCB projections. The VAR(1) specification in the reduced form is given by:

$$\begin{aligned} exp_t &= \alpha_{exp} + \beta_{exp} exp_{t-1} + \beta_{ECBpro} ECBpro_{t-1} + \beta_{NCBpro} NCBpro_{t-1} + \varepsilon_{1t}, \\ ECBpro_t &= \alpha_{ECBpro} + \beta_{ECBpro} ECBpro_{t-1} + \beta_{NCBpro} NCBpro_{t-1} + \beta_{exp} exp_{t-1} + \varepsilon_{2t}, \\ NCBpro_t &= \alpha_{NCBpro} + \beta_{NCBpro} NCBpro_{t-1} + \beta_{ECBpro} ECBpro_{t-1} + \beta_{exp} exp_{t-1} + \varepsilon_{3t}, \end{aligned} \quad (4)$$

where: *exp* denotes the inflation expectations of consumers in each country (variables *AUS exp*, *BEL exp*, *FIN exp*, *DE exp*) and pro denotes the ECB projections (variable *ECB pro*) or NCB projections (variables *OeNB pro*, *NBB pro*, *BoF pro*, *DB pro*). The autocorrelation of the residuals was tested with the use of the Ljung-Box Q test, and normality with the use of the Shapiro-Wilk test (owing to the small data samples).

Trivariate Granger causality tests based on the VAR models for each central bank were performed under the null hypothesis that ECB or NCB projections do not Granger-cause consumers' inflation expectations in the four Eurozone countries. The effect of ECB (NCB) projections on inflation expectations was investigated conditionally on NCB (ECB) projections to determine whether the ECB projections influence expectations beyond the influence of NCB projections, and *vice versa*. If inflation expectations (forecasts) were Granger-caused by forecasts (expectations), then past values of projections (expectations) should contain information that would help predict inflation expectations (projections) above and beyond the information contained in past values of inflation expectations (inflation projections) alone (Clive W. J. Granger 1969, 1980). To check the robustness of the results, impulse response functions were generated on the basis of the VAR system. The IRFs of expectations were based on the Cholesky decomposition for orthogonalising the projection shocks under recursive causal ordering. Expectations' lagged values were ordered at the first place, as expectations are smoothed over time, that is, current expectations are driven by their past values. To capture the conditional effect of the specific projections on the expectations, we assumed that ECB projections are more exogenous than NCB projections and deployed in the IRFs the following base ordering: ECB projections, NCB projections. To determine the sensitivity of base ordering results, we compared them with the alternative ordering results (alternative ordering: (1) the expectations; (2) NCB projections; (3) ECB projections). Finally, we examined FEVD. Forecast error variance decomposition displayed interactions of expectations and other variables and the evolution of such a relation over time. It could be discussed in terms of variability of a dependent variable that is explained by its own variance. Additionally, FEVD captures which of the independent variables is "stronger" in explaining the variability in the dependent variables over time. It helps to determine the proportion of variation of the dependent variable explained by each of the independent variables. The forecast error variance

decompositions from the trivariate VARs are shown on stacked bar graphs. The IRFs and FEVD results for alternative ordering are presented in the Appendix (Figures A3 and A4).

As the sample is quite small, we decided not to use subsamples (e.g. to account for the pre-crisis and post-crisis context). All the estimations were performed for the entire country-specific sample.

4. Results and Their Interpretation

Forecast encompassing test (Table 2) results suggest that ECB projections outperform national projections for all economies: they capture additional information missed by alternative projection. It does not work the other way round, except for NBB projections that also bring additional information for expectations in comparison to ECB projections. By comparing the projections that we use in our examination, we can conclude that consumers, if able to evaluate the usefulness of projections within this framework, are more likely to focus on ECB projections than on national projections. The exception is the case of Belgium, where both projections bear additional information in comparison to the alternative version.

Table 2 Limited Information Forecast Encompassing Test

Variable	$\lambda_{ECB\ pro}$	$\lambda_{NCB\ pro}$
AUS exp(t + 2) - ECB pro		0.35[0.17]
AUS exp(t + 2) - OeNB pro	0.56* [0.16]	
BEL exp(t + 2) - ECB pro		0.57* [0.21]
BEL exp(t + 2) - NBB pro	0.75*[0.22]	
FIN exp(t + 2) - ECB pro		0.2[0.21]
FIN exp(t + 2) - BoF pro	0.66*[0.29]	
DE exp(t + 2) - ECB pro		0.07 [0.15]
DE exp(t + 2) - DB pro	0.39*[0.14]	

Notes: * significant at the .05 level. Standard errors in brackets. Tests of stationarity: Appendix, Table A3. Tests for residual homoscedasticity, autocorrelation and normality, see Appendix, Table A2.

Source: Authors' calculations.

VAR lag selections are presented in Table A5 (Appendix), their specifications are in Table A6 (Appendix), and tests for the autocorrelation and normality of residuals are in Table A7 (Appendix). The Granger causality test confirms that NCB projections do not Granger-cause the inflation expectations of the consumers of the member states in question. However, for Belgium, Finland and Germany, the ECB projections do Granger-cause expectations (Table 3). This means that past values of projections (here, the casual series) may contain information that increases the predictive power of inflation expectations compared with the situation in which they are formulated only on the basis of past expectations. It is a special sense of causality, but it still means that the dependence exists. Implicitly, it shows that consumers consider the ECB projections upon forming expectations. We also reported a lack of inverse causality – expectations

affecting forecasts – thus confirming the results obtained by other authors (Hubert 2015a).

Table 3 Granger Causality Test Results

Country	Data	Granger causality	VAR model	Test value	*p*-value
AUS	2005-2015	*OeNB pro* $\rightarrow^{G}$ *AUS exp*	VAR(1)*	1.04	.32
		ECB pro $\rightarrow^{G}$ *AUS exp*		1.92	.18
BEL	2004-2015	*NBB pro* $\rightarrow^{G}$ *BEL exp*	VAR(1)*	3	.11
		ECB pro $\rightarrow^{G}$ *BEL exp***		20.23	<.001
FIN	2001-2015	*BoF pro* $\rightarrow^{G}$ *FIN exp*	VAR(1)*	2.46	.13
		ECB pro $\rightarrow^{G}$ *FIN exp***		7.52	.01
DE	2007-2015	*DB pro* $\rightarrow^{G}$ *DE exp*	VAR(1)*	0.12	.74
		ECB pro $\rightarrow^{G}$ *DE exp***		4.31	.06

Notes: For all *NCB exp* $\rightarrow^{G}$ *ECB pro/NCB pro* the hypothesis assuming the lack of Granger causality is not rejected at the .1 significance level. Results are available upon request. * lag length selected according to the AIC, BIC and HQC criterion. ** hypothesis assuming the lack of Granger causality rejected at the .1 significance level.

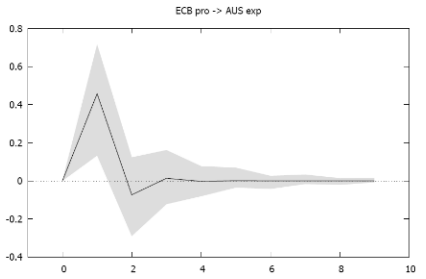
Source: Authors' calculations.

We also produced trivariate VAR-based impulse response functions, as the Granger causality test itself does not capture the strength of causality and the persistence of relation, if it exists. Tracking the impulse response provides room for a more prolonged analysis. As estimated models differ substantially, it is expected that the differences in shock responses exist as well. Figure 1 presents trivariate VAR IRFs of expectations on ECB/NCB projection shocks. Ordering of variables is as follows: *exp*, *ECB pro*, *NCB pro*.

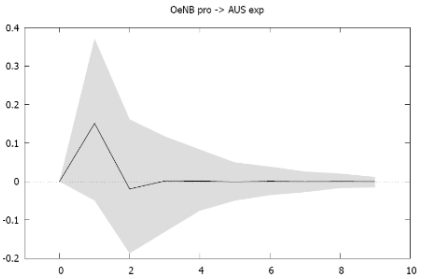
Impulse response functions are statistically significant only for the ECB projections, and the shock (which constitutes a one standard deviation change of inflation projection) persists mostly from about one to two periods ahead (up to one year). The effect of the shock on expectations is strongest after about six months. The lagged reaction of expectations is consistent with the theory-consumers need time to process economic news. The strength of shock response varies across member states from about 0.3 for Finland and Germany, 0.4 for Belgium, to 0.5 for Austria. In all of the cases, a higher projection of inflation shock, increases expectations of future inflation outcomes. The results generated by VAR systems suggest that consumers assess the ECB projections as accurate and react accordingly to the shock.

The ordering of the variables only matters for the results to a limited extent (see Figure A3 in the Appendix). When we considered the order of variables: *exp*, *NCB pro*, *ECB pro*, the ECB projection shock is reflected in the expectations for three member states (except for Austria). Additionally, statistically significant responses appear for two national projection shocks, in the cases of Austria and Belgium.

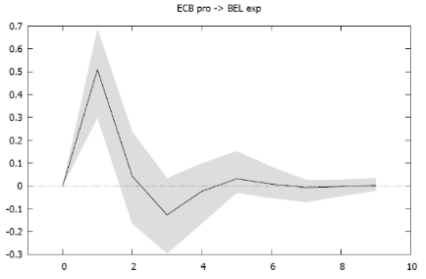
Finally, we provide the forecast error variance decomposition for expectations for our base ordering (Figure 2). This displays that interactions between expectations and other variables are quite stable over time. For each case, expectations explain the



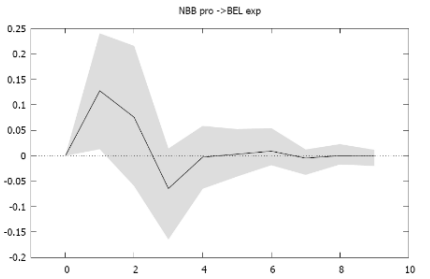
IRF: *ECB pro* on AUS *exp*



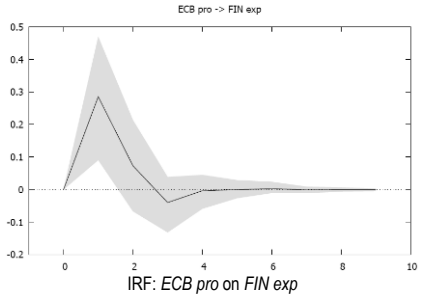
IRF: *OeNB pro* on AUS *exp*



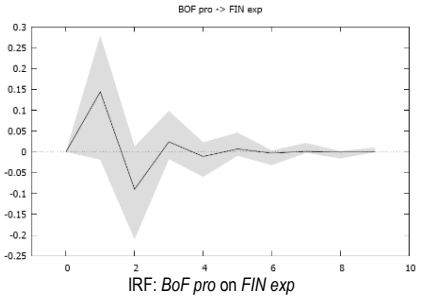
IRF: *ECB pro* on BEL *exp*



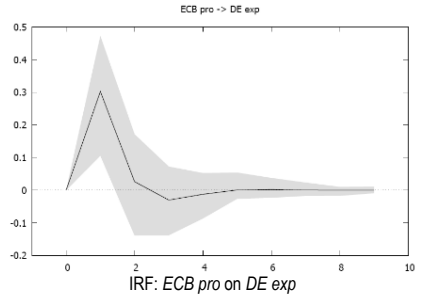
IRF: *NBB pro* on BEL *exp*



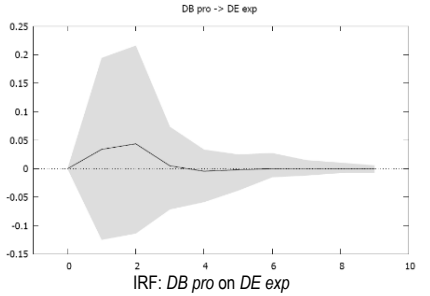
IRF: *ECB pro* on *FIN exp*



IRF: *BoF pro* on *FIN exp*



IRF: *ECB pro* on *DE exp*

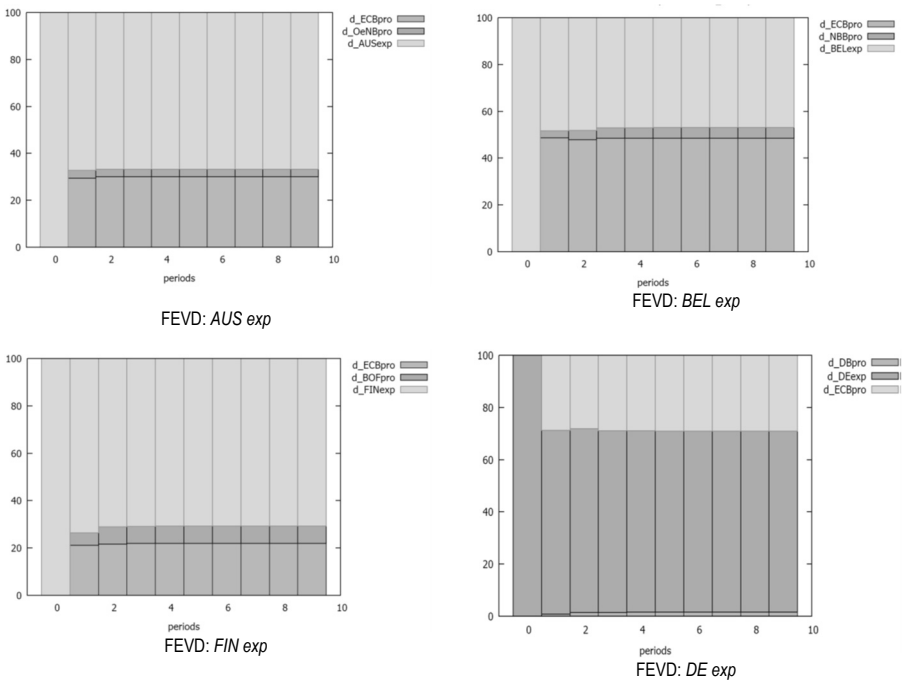


IRF: *DB pro* on *DE exp*

Notes: Trivariate: IRFs of *exp*; ECB/NCB projection shocks; Ordering: *exp*, *ECB pro*, *NCB pro*.

Source: Authors' elaboration.

Figure 1 Impulse Response Reactions



Source: Authors' elaboration.

Figure 2 Forecast Error Variance Decomposition

majority of the forecast error variance. The ECB projections are the second variable responsible for the volatility of expectations. The NCB projections are a minor factor causing their variability. Again, the ECB information is important. The FEVD are also provided for alternative ordering of the variables: *exp*, *ECB pro*, *NCB pro* (see Figure A4 in the Appendix).

The results of our analysis are summarised in Table 4. The results suggest that consumers in the chosen member states rely more on ECB forecasts. This is reflected by the results of the forecast encompassing tests (showing that ECB projections reveal additional information in all of the cases) and Granger causality tests (showing that expectations are more accurate if the ECB projection is incorporated into their formation process). Simulations results, including tracing expectations response to the shock also suggested that consumers, when aware of both projection results, tend to react to the ECB information. Moreover, FEVD provides the conclusion that the ECB projection highlighted more of the forecast errors variability.

A possible summary is that forward-looking announcements at the European level matter more than national announcements. Consumers seem to consider that the actual policymaker to be located in Frankfurt. The ECB projections are publicised with higher frequency than national projections, they prevail in terms of information content, and deliver information that could possibly improve expectations accuracy. They are more important, despite the fact that they do not describe the outlook of the national economy, but rather of the Eurozone.

Table 4 Results Summary

		AUS	BEL	FIN	DE
Forecast encopassing tests	NCB information prevails	no	yes	no	no
	ECB information content prevails	yes	yes	yes	yes
Granger causality *NCB pro* $\rightarrow^{G}$ *exp*		no	no	no	no
Granger causality *ECB pro* $\rightarrow^{G}$ *exp*		no	yes	yes	yes
IRF *NCB pro* $\rightarrow^{G}$ *exp*		no	no	no	no
IRF *ECB pro* $\rightarrow^{G}$ *exp*		yes	yes	yes	yes
FEVD: projection explaining more of expectations variability		ECB	ECB	ECB	ECB

Source: Authors' elaboration.

From the point of view of the ECB, the synchronisation of national expectations would be of added value. The ECB is the entity that is most interested in having influential information. Due to the fact that our sample includes a very turbulent period for all European economies, the impact of projections may be modified to some extent by the effect of the crisis.

One other remark should be made on the general cross-country differences between the impact of forecasts on expectations in our sample. They are in line with the literature on the heterogeneity of expectations across the Eurozone countries, which was confirmed in the empirical analysis of various inflation expectation proxies (Gnan, Langthaler, and Valderrama 2011; Ricardo Gimeno and Eva Ortega 2016). Cross-country heterogeneity also involves the learning rule of the formation of expectations, which was confirmed by Anke Weber (2007) and Christina Strobach and Carin van der Cruijsen (2015).

The forecasts of the central bank may provide information that will shape consumer expectations. Although the rationale for such consumer behaviour is beyond the scope of this study, its general results, which confirm the existence of the relationship between forecasts and expectations is in line with the previous findings reported in the literature.

5. Concluding Remarks

In January 2004, for the first time, the Fed's ordinary statement stating that "policy accommodation can be maintained for a considerable period" was replaced by the following: "the Committee believes it can be patient in removing its policy accommodation". This declaration was interpreted by financial markets as an announcement of policy tightening, which came sooner than expected and triggered an extremely large reaction in the financial markets. Since then, perceiving monetary policy actions as changes in interest rates would be missing the whole story (Refet S. Gürkaynak, Brian Sack, and Eric T. Swanson 2005). Signalling future monetary policy actions is, therefore, a crucial function of policy-making. It has evolved over time towards greater transparency, including signalling intensions explicitly, publishing inflation outlooks, forecasts or even forecasted interest rate paths. A sound theoretical background concerning such increased transparency, implemented by the central bank, opens the field

for an empirical examination of the relationship between forecasts and expectations, which we undertook in this study.

Our intention was to find dependence between ECB projections or forecasts published by NCBs and inflation expectations reported in a survey by consumers from four relatively stable European economies: Austria, Belgium, Finland, and Germany. The results suggest that inflation expectations of consumers in four Eurozone countries are Granger-caused by forecasts for the whole Eurozone. Moreover, projections produced by the ECB affect expectations, traced by impulse response analysis, and describe more of their variability, captured by FEVD. The results are not in line with our starting assumption; we expected to find national forecasts more informative and influential, as they deliver a country-specific outlook. However, our result is good news for the ECB, which aims to shape the expectations of economic agents.

We realise that our study could be extended by including some other variables in the analysis. Nonetheless, the study provides a contribution to the literature on the relationship between forecasts and expectations, particularly those of consumers. Given the fact that central banks have recently started to address their communication to a broader audience (households, non-economists), while most of the existing research tends to focus on professionals (Binder 2017), it can be expected that the question of the effectiveness of information communicated through forecasts will attract increasing amounts of attention from researchers. Moreover, an important issue considered in our study, but not in the preceding examinations of the forecasts, expectations dependence, is the comparison of the relation between the projections of national banks and the ECB and consumer expectations.

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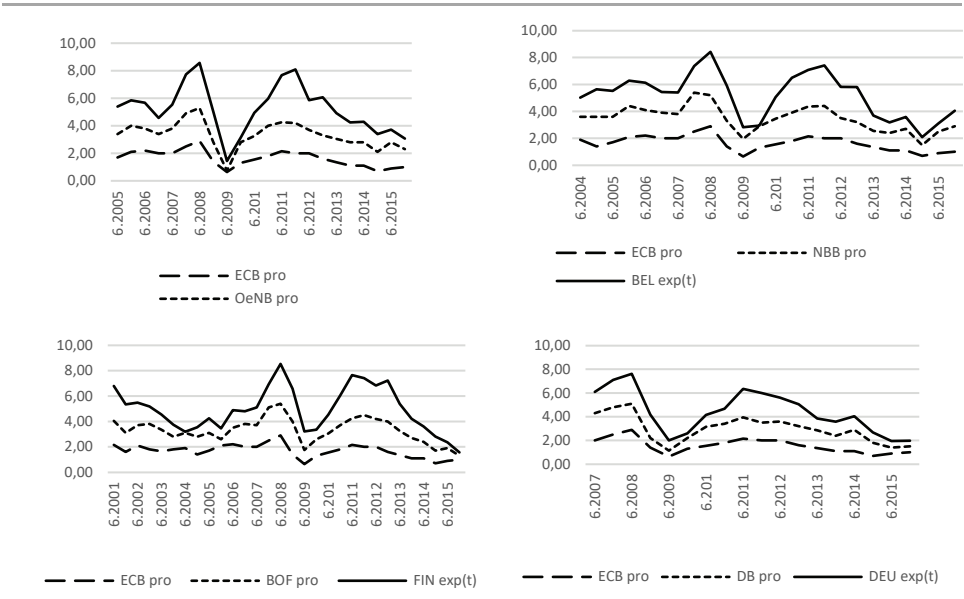
Appendix

Table A1 Descriptive Statistics of the Sample and Plots of Data

Variable	N	Mean	Median	Minimum	Maximum	Std. dev.	Coef. var.	Skewness	Ex. Kurtosis
ECB pro		1.64	1.65	0.65	2.9	0.59	0.36	0.11	-0.64
OeNB pro	22	1.7	1.7	0.1	2.4	0.47	0.28	-1.48	4.05
AUS exp	22	1.89	1.86	0.34	3.89	0.91	0.48	0.46	-0.31
ECB pro	24	1.64	1.65	0.65	2.9	0.57	0.35	0.1	-0.51
NBB pro	24	1.825	1.9	0.8	2.9	0.449	0.246	0.04	0.36
BEL exp	24	1.71	1.744	0.04	3.22	0.844	0.49	-0.06	-0.86
ECB pro	30	1.68	1.75	0.65	2.9	0.52	0.31	-0.08	-0.21
BoF pro	30	1.62	1.6	0.3	2.6	0.59	0.36	-0.14	-0.4
FIN exp	30	1.64	1.43	0.08	3.4	0.9	0.55	0.39	-0.83
ECB pro	18	1.56	1.48	0.65	2.9	0.62	0.4	0.44	-0.52
DB pro	18	1. 41	1.55	0.5	2.3	0.59	0.42	-0.18	-0.94
DE exp	18	1.45	1.23	0.4	2.52	0.72	0.5	0.13	-1.37

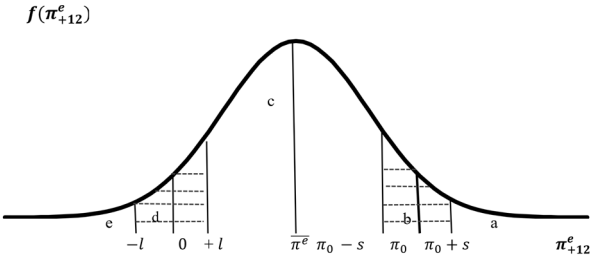
Notes: Statistics for the ECB *pro* are repeated, as the number of observations varies according to the length of the national sample. The same notations as those in the body of the text are used.

Source: Authors' calculations.



Source: Authors' calculations.

Figure A1 Time Series Evolution over Time



Source: Authors' elaboration based on Łyziak (2010).

Figure A2 Carlson and Parkin Probabilistic Approach

The starting set of equations of the Carlson and Parkin procedure is presented below. Notations: $(-l, l)$ – sensitivity interval around zero (*prices will stay the same*); $(\pi_0 - s, \pi_0 + s)$ – sensitivity interval around scaling factor (*prices will increase at the same rate*); π^e_{+12} – expected rate of inflation; $f(\pi^e_{+12})$ – density function of expected inflation; $\overline{\pi^e}$ – expected rate of inflation; a, b, c, d, e – percentage of responders choosing one of the survey's responses: from the most positive (*prices will increase more rapidly*) to the most negative (*prices will fall*). The equations are rearranged according to the type of distribution; here, normal distribution of expectations is assumed. The assumptions of the Carlson and Parking method are shown in the figure above.

$$a = P(\pi^e_t > \pi_{0t} + s_t) = 1 - F_t(\pi_{0t} + s_t)$$
$$b = P(\pi_{0t} - s_t < \pi^e_t + < \pi_{0t} + s_t) = F_t(\pi_{0t} + s_t) - F_t(\pi_{0t} - s_t)$$
$$c = P(l_t < \pi^e_t < \pi_{0t} - s_t) = F_t(\pi_{0t} - s_t) - F_t(l_t)$$
$$d = P(-l_t < \pi^e_t < l_t) = F_t(l_t) - F_t(-l_t)$$
$$e = P(\pi^e_t < -l_t) = F_t(-l_t)$$

Table A2 Normality Tests of Time Series

Variable	Doornik-Hansen test		Shapiro-Wilk test		Lilliefors test		Jarque'a-Bera test	
	Test value	*p*-value	Test value	*p*-value	Test value	*p*-value	Test value	*p*-value
ECB pro	0.38	0.825	0.98	.743	0.09	.67	0.09	.956
OeNB pro	11.13	0.004	0.84	.002	0.18	.07	23.18	.001
NBB pro	2.56	0.277	0.98	.847	0.14	.23	0.14	.934
BOF pro	0.16	0.919	0.97	.596	0.08	.92	0.29	.862
DB pro	0.48	0.785	0.92	.159	0.17	.17	0.77	.68
AUS exp	2.59	0.274	0.96	.358	0.12	.33	2.13	.345
BEL exp	0.15	0.924	0.98	.847	0.11	.52	0.64	.726
FIN exp	2.02	0.363	0.96	.277	0.16	.05	1.46	.482
DE exp	1.84	0.398	0.95	.205	0.14	.15	1.52	.467

Source: Authors' calculations.

Table A3 ADF and KPSS Tests Results

Variable	I	ADF test		KPSS test	
		Test value	*p*-value	Test value	*p*-value
ECB pro	I(0)	-2.39	.15	0.53	.04
	I(1)	-4.48	<.001	0.063	>.1
OeNB pro	I(0)	-3.65	.005	0.05	>.1
AUS exp	I(0)	-2.78	.061	0.12	>.1
AUS exp(t + 2) - ECB pro	I(0)	-2.61	.01	0.91	<.1
	I(1)	-5.38	<.001	0.051	>.1
AUS exp(t + 2) - OeNB pro	I(0)	-2.31	.02	0.22	>.1
ECB pro	I(0)	-2.49	.11	0.49	.045
	I(1)	-4.72	<.001	0.049	>.1
NBB pro	I(0)	-2.97	.052	0.46	.05
	I(1)	-6.27	<.001	0.06	>.1
BEL exp	I(0)	-3.29	.015	0.21	>.1
BEL exp(t + 2) - ECB pro	I(0)	-3.37	.001	0.29	>.1
BEL exp(t + 2) - NBB pro	I(0)	-2.25	.03	0.25	>.1
ECB pro	I(0)	-2.39	.15	0.53	.04
ECB pro	I(1)	-5.27	<.001	0.0039	>.1
BOF pro	I(0)	-1.15	.22	0.21	>.1
	I(1)	-5.55	<.001	0.13	>.1
FIN exp	I(0)	-1.5	.12	0.17	>.1
	I(1)	-4.31	.002	0.11	>.1
FIN exp(t + 2) - ECB pro	I(0)	-2.13	.03	1.06	<.01
	I(1)	-6.37	<.001	0.1	>.1
FIN exp(t + 2) - BOF pro	I(0)	-4.71	<.001	0.31	>.1
ECB pro	I(0)	-2.72	.06	0.41	.08
	I(1)	-4.25	<.001	0.052	>.1
DE exp	I(0)	-2.73	.06	0.29	>.1
DB pro	I(0)	-2.96	.03	0.26	>.1
DE exp(t + 2) - ECB pro	I(0)	-2.61	.01	0.41	.07
	I(1)	-6.08	<.001	0.05	>.1
DE exp(t + 2) - DB pro	I(0)	-2.75	.009	0.25	>.1

Notes: The test included a constant term. Lag length for the ADF test was 1.

Source: Authors' calculations.

Table A4 Limited Information Forecast Encompassing Test-Residuals Testing

Equation	Ljung-Box Q test		Doornik-Hansen test		White test	
	Test value	*p*-value	Test value	*p*-value	Test value	*p*-value
AUS exp(t + 2) - ECB pro	2.1	.35	1.86	.39	1.22	.54
AUS exp(t + 2) - NCB pro	4.34	.11	0.59	.74	0.78	.67
BEL exp(t + 2) - ECB pro	4.53	.11	3.86	.14	0.64	.72
BEL exp(t + 2) - NCB pro	2.43	.29	0.67	.72	1.76	.41
FIN exp (t + 2) - ECB pro	4.53	.11	3.86	.14	0.64	.73
FIN exp (t + 2) - BOF pro	7.16	.12	0.51	.77	0.96	.62
DE exp(t + 2) - ECB pro	5.63	.06	3.16	.21	2.17	.34
DE exp(t + 2) - NCB pro	3.53	.16	3.22	.19	1.88	.39

Source: Authors' calculations.

Table A5 VAR Lag Selection

Model variables	Lag	AIC	BIC	HQC
ECB pro, *OeNB pro* and *AUS exp*	1	4.66	5.26*	4.76*
	2	4.62*	5.66	4.8
ECB pro, *NBB pro* and *BEL exp*	1	3.74*	4.33*	3.86*
	2	4.11	5.16	4.34
ECB pro, *BOF pro* and *FIN exp*	1	4.33*	4.91*	4.5*
	2	4.39	5.4	4.69
ECB pro, *DB pro* and *DE exp*	1	3.97*	4.54*	3.97*
	2	4.03	5.03	4.03

Source: Authors' calculations.

Table A6 VAR Model Specifications

VAR	Model	Equation	exp_{t-1}	$ECBpro_{t-1}$	$NCBpro_{t-1}$	R^2	F	P
VAR(1)	*BEL exp*, *NBB pro* and *ECB pro*	Equation (1) *BEL exp*	-0.24 [0.16]	1.18*** [0.26]	0.43* [0.25]	0.63	10.34	<.001
		Equation (2) *ECB pro*	-0.22 [0.14]	0.09 [0.22]	0.43* [0.22]	0.24	1.89	.16
		Equation (3) *NBB pro*	-0.14 [0.15]	0.36 [0.24]	-0.36 [0.23]	0.21	1.55	.23
VAR(1)	*FIN exp*, *BOF pro* and *ECB pro*	Equation (1) *FIN exp*	-0.11 [0.19]	0.7** [0.25]	0.37 [0.24]	0.34	4.08	.02
		Equation (2) *ECB pro*	-0.07 [0.15]	0.08 [0.21]	-0.01 [0.2]	0.03	0.24	.86
		Equation (3) *BOF pro*	0.15 [0.15]	0.59** [0.2]	-0.32 [0.19]	0.34	4.18	.02
VAR(1)	*DE exp*, *DB pro* and *ECB pro*	Equation (1) *DE exp*	-0.1 [0.24]	0.69* [0.33]	0.11 [0.33]	0.49	3.9	.04
		Equation (2) *ECB pro*	-0.15 [0.31]	0.07 [0.43]	0.19 [0.42]	0.05	0.2	.9
		Equation (3) *DB pro*	-0.27 [0.29]	-0.004 [0.40]	0.24 [0.4]	0.09	0.4	.75

VAR(1)	*AUS exp*, *OeNB pro* and *ECB pro*	Equation (1) *AUS Exp*	-0.29 [0.23]	0.79 [0.57]	0.49 [0.48]	0.38	3.2	.04
		Equation (2) *ECB pro*	-0.01 [0.15]	-0.11 [0.38]	0.28 [0.32]	0.06	0.34	.79
		Equation (3) *OeNB pro*	-0.05 [0.19]	0.37 [0.47]	-0.29 [0.39]	0.04	0.24	.86

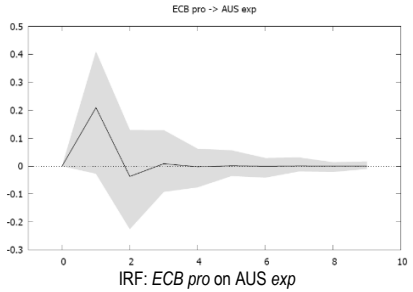
Notes: Constant not reported. Significant at level: **** .001, *** .01, ** .05, * .1. Standard errors in brackets.

Source: Authors' calculations.

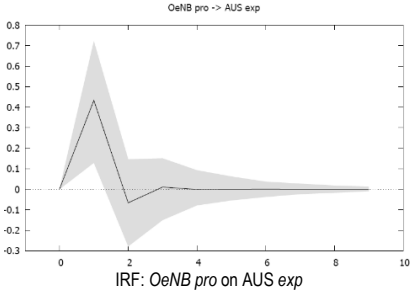
Table A7 Residuals' Tests of VAR Models

VAR	Model	Rao F Test		Doornik-Hansen	
		Test value	*p*-value	Test value	*p*-vale
VAR(1)	*AUS exp, OeNB pro* and *ECB pro*	0.85	.57	8.06	.23
VAR(1)	*BEL exp*, *NBB pro* and *ECB pro*	0.65	.74	3.15	.78
VAR(1)	*FIN exp*, *BOF pro* and *ECB pro*	1.22	.31	13.27	.04
VAR(1)	*DE exp, DB pro* and *ECB pro*	0.74	.67	7.92	.24

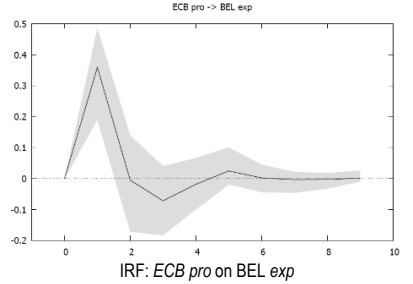
Source: Authors' calculations.



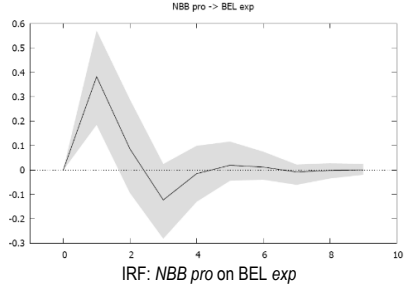
IRF: *ECB pro* on AUS *exp*



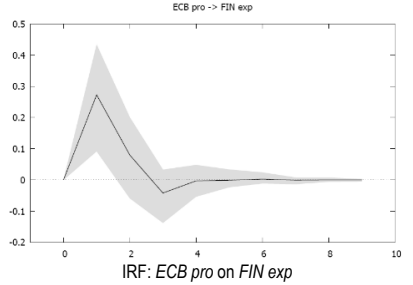
IRF: *OeNB pro* on AUS *exp*



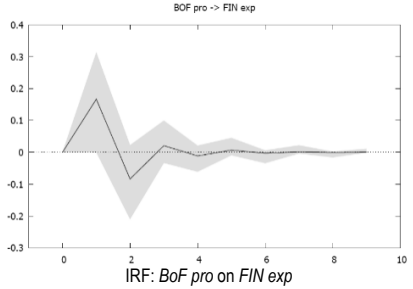
IRF: *ECB pro* on BEL *exp*



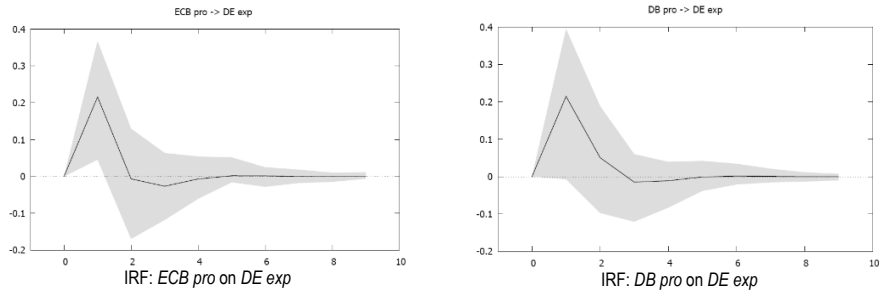
IRF: *NBB pro* on BEL *exp*



IRF: *ECB pro* on *FIN exp*



IRF: *BoF pro* on *FIN exp*

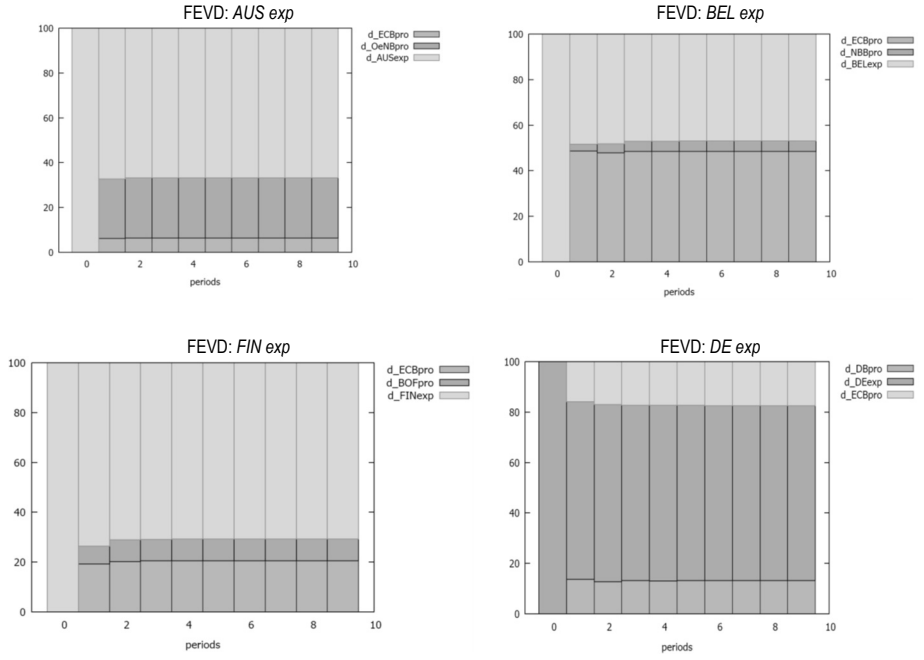


IRF: *ECB pro* on *DE exp* IRF: *DB pro* on *DE exp*

Notes: Trivariate: IRFs of *exp*; ECB/NCB projection shocks; Ordering: *exp, NCB pro, ECB pro.*

Source: Authors' elaboration.

Figure A3 Impulse Response Functions: An Alternative Ordering of: *exp*, *NCB pro*, *ECB pro*



Source: Authors' elaboration.

Figure A4 Forecast Variance Decomposition Errors: An Alternative Ordering of: *exp*, *NCB pro*, *ECB pro*