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The effect of interest rate and communication shocks

on private inflation expectations

Paul Hubert

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Author: Paul Hubert

Affiliations of author: OFCE – Sciences Po

Abstract

The European Central Bank publishes inflation projections quarterly. This paper aims at establishing empirically whether they influence private inflation forecasts and whether they may be considered as an enhanced means of implementing policy decisions by facilitating private agents' information processing. We compare the effect of an ECB inflation projection shock to an ECB interest rate shock. We provide original evidence that ECB inflation projections do influence private inflation expectations positively. We find that ECB projections convey signals about future ECB rate movements. This paper suggests that ECB projections enable private agents to correctly interpret and predict policy decisions.

Contact details: paul.hubert@sciencespo.fr

Address: OFCE – Sciences Po, 69 quai d'Orsay, 75340 Paris cedex 07, France

Tel: +33.(0)1.44.18.54.27

1. Introduction

Private inflation expectations play a central role in macroeconomics because of their importance in determining both current and future inflation. They thus play an important role in shaping short run and long run real interest rates. The management of private inflation expectations is thus a key ingredient of the interplay between monetary policy and its outcomes. The objective of this paper is therefore to first identify interest rate shocks together with central bank communication shocks through a VAR model comprising in addition real GDP, inflation, long-term and Euribor interest rates, an index of financial stability and private expectations, so as to second quantify their impact on one of the intermediate targets of central banks: inflation expectations.

Central banks therefore increasingly use communication to shape private expectations and more explicitly for two main reasons. First, the expectations channel is one of the most subtle channels of monetary policy, because it depends on the private agents' interpretation of interest rate variations.[1] King (2005) summarizes that "because inflation expectations matter to the behavior of the households and firms, the critical aspect of monetary policy is how decisions of the central bank affect those expectations". Policy decisions can be understood in various ways and facilitating private agents' information processing is one reason why central banks complement their actions with communication to the public (see e.g. Adam, 2009, or Baeriswyl and Cornand, 2010). Second, given the delay between policy actions and their real effects, central bank communication provides policymakers with a way to promptly affect private expectations to shorten the transmission lag of monetary policy to inflation, real GDP and long term real interest rates.

This paper aims at establishing the effects of interest rate shocks and one specific type of central bank communication - ECB inflation projections - on private inflation expectations. Indeed, central bank communication can take different forms: statements, minutes, interviews or speeches (Blinder *et al.*, 2008) and we abstract from this qualitative communication to focus on another way for a central bank to communicate to the public: the publication of internal macroeconomic forecasts. Four times per year since 2004, the ECB publishes ECB/Eurosystem staff macroeconomic projections for the euro area in its Monthly Bulletins.[2] This quantitative communication has two advantages: it does not rely on judgmental classifications (content analysis, word counting, etc), and it is possible to assess its quality.

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[1] Private agents may interpret that a decrease in interest rates will lead to higher growth in the future, increasing their confidence to consume and invest. At the opposite, they may interpret that growth is weaker than expected and need the central bank to intervene, decreasing their confidence and then consumption and/or investment.

[2] See ECB (2001) for more details.

We proceed in two steps. First, we assess whether ECB inflation projections affect private ones, and second we characterize whether publishing them may be considered as an enhanced means of implementing monetary policy decisions. Indeed, publishing central bank forecasts may facilitate private agents' information processing and their interpretation of policy decisions, and then make monetary policy more effective. To shed light on this issue, we test the following three hypotheses: *(a)* ECB inflation projections have different effects on private expectations from the ECB rate, *(b)* the publication of ECB inflation projections changes the effects of ECB rate decisions on private inflation expectations, and *(c)* the ECB rate and ECB inflation projections are complementary.

We use a structural VAR model with a Cholesky decomposition to identify interest rate and ECB inflation projection shocks. Our model comprises real GDP, inflation, long-term and Euribor interest rates, an index of financial stability, ECB inflation projections, the ECB rate and private expectations as measured by the ECB's Survey of Professional Forecasters (SPF). Our recursive identification assumptions depend on the timing of events and information flows. Our estimates are robust to fixed-horizon forecasts, to another survey of private forecasts: Consensus Forecasts, and to the inclusion of the European Commission forecasts in the VAR. As we are interested in both the short and long term influence effect as well as in its *dynamics* to characterize how ECB inflation projections may affect private forecasts, a VAR model enables to address this question in contrast with an event-study that would underline this influence effect only for a presumably short time window.

This paper is related to two strands of the existing literature. The first one refers to the signaling role of central bank action or communication. Geraats (2005) shows that publishing central bank forecasts provides reputational signals. Walsh (2007) analyzes the welfare effects of the publication of central bank forecasts and proposes optimal degrees of transparency. Baeriswyl and Cornand (2010) analyze how central bank actions may convey signals and show that central banks may adjust their policy decisions in order to withhold some information. Empirically, this signaling role has been studied in the US by Romer and Romer (2000), who show that ''the Federal Reserve's actions signal its information'' since private agents revise their inflation expectations in response to policy decisions, and by Gürkaynak *et al.* (2005), Ehrmann and Fratzscher (2009) and Brand *et al.* (2010) who provide evidence that both policy actions and statements affect financial markets.

The second one focuses on the effects of central bank communication on private expectations (see e.g. Levin *et al.*, 2004; Gürkaynak *et al.*, 2010; Jansen and De Haan, 2007; Cecchetti and Hakkio, 2010; Crowe, 2010; and Capistran and Ramos-Francia, 2010, Beechey

et al., 2011). Fujiwara (2005) and Ehrmann *et al.* (2009) specifically test whether central bank forecasts or the degree of central bank transparency have an impact on the *dispersion* of private forecasts, but not on their *level*.[3] While the effects of ECB inflation projections on private expectations may appear intuitive, they are still empirically unexplored and our contribution is to provide original evidence for the effects of quantitative central bank communication.

The first set of results shows that an exogenous increase in ECB inflation projections produces a significant positive effect on private forecasts. The effect on current year forecasts is more than twice the effect on next year forecasts. In both cases, the effect vanishes after 3 quarters. The second set of estimates shows that first the ECB rate and ECB inflation projections impact similarly SPF next year forecasts. Second, an ECB rate shock has less impact on private forecasts if the effect of ECB inflation projections on private forecasts is artificially shut-off. It suggests that ECB inflation projections may be a tool for understanding the appropriate stance of monetary policy. At the opposite, the effect of ECB inflation projections on private forecasts does not depend on the ECB rate. Third, the ECB rate and ECB inflation projections are complementary and react consistently to shocks to the other. ECB current and next year projections shocks lead to increases in the ECB rate after two quarters and over 8 quarters respectively. ECB inflation projections thus convey a signal on future policy decisions. This body of evidence suggests that ECB inflation projections enable private agents to correctly interpret policy decisions and to predict the future ECB rate evolution. By way of consequence, ECB inflation projections may help reduce the scope for shocks to long term interest rates (financial shocks)..

Because one expects that policy decisions and published forecasts are consistent one with the other, the latter provide information on the ECB's assessment of the economic outlook and then on future decisions (Svensson, 2001). This is also in line with Issing (2004) stating that ECB inflation projections "are used (...) to inform monetary policy decisions" and that "the information and analysis underlying monetary policy decisions should be shared with the public". Two implications for central bankers are that they may use their projections to complement their policy decisions and remove the uncertainty on how they can be interpreted, but that current year projections might be self-fulfilling (see on this point Morris and Shin, 2005). ECB projections may thus ensure that private agents are able to

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[3] This question also matters theoretically: Bernanke and Woodford (1997) show that a monetary policy influenced by private expectations may lead to indeterminacy, whereas Muto (2011) argues that when private agents follow the central bank, it must respond more strongly to expected inflation to achieve macroeconomic stability. Morris and Shin (2002) suggest that central bank forecasts, through the crowding-out effect of public information on private sources of information, may lead private agents to stop forming their specific information set and to only refer to central bank information. Focusing on the informative value of prices, Amato and Shin (2006) develop a model emphasizing that the central bank may shape market expectations.

understand and predict policy decisions – so improve short-term predictability of policy decisions in the words of Blattner *et al.* (2008).

The rest of the paper is organized as follows. Section 2 presents the theoretical framework, section 3 data and section 4 our structural VAR model. In sections 4 and 5, we investigate whether ECB projections influence private ones and characterize the influencing effects of ECB projections. Section 6 concludes.

2. Framework

This section describes the theoretical framework which motivates our empirical setup. We rely on the imperfect information literature, for which Coibion and Gorodnichenko (2010, 2012) and Andrade and LeBihan (2013) provide empirical support. In the sticky information approach of Mankiw and Reis (2002), private agents do not update their expectations at each period as they face costs of absorbing and processing information. However, private agents can observe anything perfectly and if they update their information set, they gain full information rational expectations (RE). Carroll (2003) suggests that professional forecasts spread epidemiologically to other private agents, and shows that professional forecasters pay attention to news and form their forecasts with the last information available to them. Both contributions can be described through these equations respectively:

$$E_t\pi_{t+h} = \lambda\ RE_t\pi_{t+h} + (1 - \lambda)\ E_{t-1}\pi_{t+h} \quad (1)$$
$$E_t\pi_{t+h} = \lambda\ SPF_t\pi_{t+h} + (1 - \lambda)\ E_{t-1}\pi_{t+h} \quad (2)$$

where $E_t\pi_{t+h}$ are private inflation expectations for horizon h, RE_t the RE forecast, and SPF_t the professional forecast. Private expectations are represented as a linear combination of lagged private expectations and either a rational or boundedly rational forecast.

Sims (2003) focuses on rational inattention: the observed inertial reaction of private agents arises from the inability to pay attention to all the noisy information available although people update continuously. It is an optimal choice for private agents – internalizing their information processing capacity constraints – to remain inattentive to some part of the available information because incorporating all signals is impossible (Moscarini, 2004). The average private inflation expectation is:

$$E_t\pi_{t+h} = \alpha + \beta_1 E_{t-1}\pi_{t+h} + \beta_2 X_t + \varepsilon_t \quad (3)$$

where $E_t\pi_{t+h}$ is determined as a linear combination of private agents that do not update the average inflation expectations of the previous period ($E_{t-1}\pi_{t+h}$) and of a fraction that updates inflation expectations based on up-to-date information about the current state of the economy summarized by the vector X_t. This reduced-form equation might also be interpreted as private agents have an initial belief about the future inflation rate (their past

inflation expectations) at the beginning of each period, and during each period, they incorporate some relevant - but potentially noisy - information about future inflation.

Taking equation (3) to the data requires an identifying assumption. Since timing of information is paramount in this framework and because the data generating process of current variables makes it inconsistent to include them in the information set of the current period, we assume that private agents form their current expectations based on the information set X_{t-1} including variables up to the previous period t-1:

$$E_t \pi_{t+h} = \alpha + \beta_1 E_{t-1}\pi_{t+h} + \beta_2 X_{t-1} + \varepsilon_t \quad (4)$$

To bring together the different strands of the expectations formation literature, the vector X_t might include a rational forecast, a "newspaper" forecast, a professional forecast, the central bank interest rate, and/or other variables that might affect future inflation. We aim at investigating the effects of ECB inflation projections on private inflation forecasts through a VAR model in which the equation for private inflation forecasts is equivalent to equation (4).

3. Data

The ECB/Eurosystem staff macroeconomic projections for the euro area are produced biannually since December 2000, and quarterly since June 2004 with a special emphasis on their disclosure to the public.[4] We focus on projections starting from this latter date for frequency consistency with private forecasts. They are usually published during the first week of March, June, September and December and are published as ranges, which equal twice the historical mean absolute projection error to reflect uncertainty. We use the midpoint of the range as the figure for ECB projections (Romer and Romer, 2000). The underlying scenarios for interest rates and commodity prices were that they remain constant over the projection horizon until 2006Q1; since 2006Q2 they are based on market expectations derived from future rates.[5] Finally, ECB inflation projections are published as average annual percentage changes for current and next years.

Private forecasts come from two different sources: the ECB's Survey of Professional Forecasters (SPF) and Consensus Forecasts (CF). The SPF is a quarterly survey of expectations for the rates of inflation, real GDP growth and unemployment in the euro area. Participants are experts affiliated with financial or non- financial institutions in the

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[4] In March and September, they are produced by ECB staff while in June and December by Eurosystem staff.

[5] We have checked that these assumptions for constructing ECB projections have no impact on the results. Although it should matter whether one assumes constant interest rates or market-expected interest rates, whole sample or post-2006Q2 estimates provide similar effects. Results are available upon request.

European Union. SPF forecasts are produced in February, May, August and November. HICP and real GDP growth are measured as average annual percentage change for current and next years. The CF is a monthly survey with an average of 30 institutional respondents for about fifteen macroeconomic variables including HICP and real GDP for the euro area, measured as average annual percentage change for current and next years. We consider the average of the 3 months of each quarter to build a quarterly dataset.

Matching these data sets raises an issue about the timing of forecasts publication. SPF forecasts are always published one month before ECB projections. This supports the identification assumption that SPF forecasts do not respond to the ECB contemporaneously. In the meantime, it means that the ECB has one more month of information. We control for this issue when using CF forecasts which include information up to the third month of each quarter to match the ECB information set.

The 10-year government bond yields index for the euro area, the Euribor 3-month, the CISS (Composite Indicator of Systemic Stress, overall index), the main refinancing operations interest rate of the ECB, the HICP (overall index), and the real GDP (Gross Domestic Product at market price, chain linked) are the actual data taken from the Statistical Data Warehouse of the ECB. Monthly variables are averaged over the 3 months of each quarter to construct a quarterly dataset. Our dataset starts in 2004Q2, ends in 2013Q2, and comprises 37 observations. Table 1 summarizes the descriptive statistics of the dataset and Figure 1 plots the ECB, SPF and CF inflation forecasts for current and next years.

4. The Empirical Model

We use a structural VAR model using a Cholesky decomposition to generate ECB inflation projection shocks. This method enables to assess the dynamics of influence and its potential long-lasting effect in contrast to an event-study. Let Z_t = [Real GDP, CPI, SPF, ECB projections, ECB rate, 10y rates, Euribor, CISS]′ represent the (k x 1) vector that contains our k variables of interest at date t. The vector Z_t comprises the main variables likely to matter for the question addressed: real GDP, inflation, the ECB interest rate, long-term interest rates, the Euribor interest rate and the CISS index, in addition to SPF forecasts and ECB projections, therefore minimizing the scope for an omitted variable bias.[6] The relevant information set that the private sector receives and uses to form inflation expectations is likely to be captured by these variables. Beyond the usual 3 variables in monetary VAR, Euribor and long-term interest rates shed light on the transmission of monetary policy from

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[6] The possibility for this potential bias is reduced by the inclusion in the VAR of the two forecast variables capturing expected inflation, which in addition enables to take account for the price puzzle (see Castelnuovo and Surico, 2010).

the central bank interest rate to the real economy, while the CISS enables to capture financial instability.[7] The regression of Z_t on its own lags p produces the reduced-form VAR errors e_t:

$$Z_t = \alpha + \sum_{i=1}^{p} \beta_i Z_{t-i} + e_t \quad (5)$$

The reduced-form errors comprise the contemporaneous effects of each variable on the others and combine the exogenous innovation of a given variable to the contemporaneous responses to the other variables. The recursive identification assumption postulates that the structural errors are independent, and the identification of exogenous innovations to ECB inflation projections relates reduced-form errors and structural errors through the following lower triangular matrix:

$$
e_t =
\begin{pmatrix}
e_t^{Real\,GDP} \\
e_t^{CPI} \\
e_t^{SPF} \\
e_t^{ECB\,projections} \\
e_t^{ECB\,rate} \\
e_t^{10y\,rates} \\
e_t^{Euribor} \\
e_t^{CISS}
\end{pmatrix}
=
\begin{bmatrix}
a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\
a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 & 0 \\
a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 & 0 \\
a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 & 0 \\
a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 & 0 \\
a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & 0 \\
a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88}
\end{bmatrix}
\begin{pmatrix}
\varepsilon_t^{Real\,GDP} \\
\varepsilon_t^{CPI} \\
\varepsilon_t^{SPF} \\
\varepsilon_t^{ECB\,projections} \\
\varepsilon_t^{ECB\,rate} \\
\varepsilon_t^{10y\,rates} \\
\varepsilon_t^{Euribor} \\
\varepsilon_t^{CISS}
\end{pmatrix}
\quad (6)
$$

This means that the covariance between the reduced-form errors is attributed to the structural error of the variable ordered previously in Z_t, and that the structural error is uncorrelated to the reduced-form errors of the preceding variables. The recursive identification assumption therefore depends on the ordering of the variables in the vector Z_t.

Our recursive identification assumptions determining the ordering of variables in the vector Z_t depend on the timing of events and information flows, which seems the more reasonable and natural way to order these variables. As usual in the literature, both macro variables –

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[7] Having two variables of private expectations, for inflation and output, would make the identification scheme more complicated as there would be no ways to disentangle the two expectations in a Choleski ordering. Moreover, one may argue that the ECB projections shock captures some omitted variable bias, e.g. ECB's private information which is orthogonal to other variables. This argument reasonably applies to all 3-variable monetary VAR and the present VAR goes one step beyond by including private inflation forecasts, 10-year rates, the Euribor, and the CISS. Second, whether ECB inflation projections contain ECB's private information does not alter the assessment of the effect of ECB inflation projections (as soon as the ECB discloses them to the public) on private forecasts if the omitted variable is ECB's private information.

real GDP and inflation – are ordered first, as they react to other variables with lags. At the opposite end of the vector Z_t, market variables – 10-year rates, Euribor and CISS – react contemporaneously to shifts in any other variables. We assume that financial instability reacts the fastest, then short-term rates, more prone to be affected by economic news, and then long-term rates. In the middle of the vector, we are left with the ECB rate, ECB projections and SPF forecasts. According to the timeline described below, SPF cannot react contemporaneously to innovations in ECB projections and are ordered before. Finally, the ECB projections are staff projections realized to serve as an input for ECB policy meetings providing an assessment of the future economic outlook. One may therefore reasonably assume that the ECB rate and policy decisions are set according to ECB inflation projections, so that the ECB rate reacts contemporaneously to innovations in ECB projections. Assuming that SPF forecasts respond with a lag to ECB and market variables is consistent with Coibion and Gorodnichenko (2010, 2012) and Andrade and LeBihan (2013) who document that private forecasters may be subject to rational inattention and sticky information, and with the idea that central banks continuously watch and gather information on private expectations.

Timeline of events			
	Quarter		
	Month 1	Month 2	Month 3
Publication		SPF	
			ECB

The structural VAR analysis is performed with 1 lag and with a small sample estimator, because the number of observations is small. The variance-covariance matrix is estimated with a small-sample degrees-of-freedom adjustment: the small-sample divisor used is *1/(T-m)* instead of the maximum likelihood divisor *1/T*, *T* being the sample size and *m* the average number of parameters in each of the equations. Since small samples produce greater standard errors, the potential bias would lean against the tested hypothesis that ECB inflation projections influence private ones. Significant estimates would thus be all the more so convincing. We also checked the eigenvalue stability condition of our VAR estimates. All eigenvalues lie inside the unit circle, so it satisfies the stability condition.

5. Do ECB Projections Influence Private Forecasts?

We test the hypothesis that an exogenous ECB inflation projections shock has a positive effect on SPF inflation forecasts. We expect that an increase in ECB inflation projections leads to an increase in SPF forecasts with an elasticity comprised between zero and one. Indeed, a decrease in SPF forecasts after a positive ECB inflation projections shock would imply that the ECB is exceptionally credible and policy actions are not necessary, or that the

ECB is not credible at all. At the opposite, an overreaction – defined as an increase in SPF forecasts superior to the increase in ECB inflation projections – would imply that the ECB has a low credibility for stabilizing inflation, would make its task more difficult, and would therefore not justify the publication of ECB projections.

5.1. Baseline Estimates

Based on two different VAR estimations in which both SPF forecasts and ECB projections are either for the current year or the next year horizon, Figure 2 plots the impulse response of SPF forecasts to a one-standard-deviation (S.D.) innovation in ECB inflation projections. It causes a significant increase of 0.12 percentage point in SPF current year forecasts which disappears after 3 periods. It also causes a significant increase in SPF next year forecasts, which is less pronounced (0.5 percentage point) and disappears after 2 periods. In more general economic terms, these two increases in SPF current and next year forecasts correspond respectively to rises of 0.99 and 0.31 percentage point following an increase of 1 percentage point in ECB inflation projections. These estimates show that ECB inflation projections are able to influence private expectations.

Moreover, the variance decomposition of SPF inflation forecasts enables to evaluate the quantitative importance of ECB inflation projections. The publication of ECB inflation projections explains 5 and 12 percent of the variance of SPF forecasts for current and next years respectively, in comparison to 3 percent for the ECB rate in the two cases, 21 and 29 percent for lagged SPF forecasts, 43 and 33 percent for inflation, and 17 and 12 percent for real GDP.

5.2. Sensitivity Analysis

We check whether the main result holds with different assumptions. First, we replace SPF forecasts by CF forecasts, another survey of private expectations, and plot the impulse response of CF forecasts after an ECB inflation projection shock (Figure 3.1). Fixed-event forecasts as published by the ECB, SPF and CF may have seasonal effects as the forecasting horizon decreases quarter after quarter. One might suppose that the effects of ECB inflation projections on private ones are stronger in the beginning of each year and smaller at the end when much more information is known on actual variables. Following Dovern *et al.* (2012) stressing that "fixed-horizon forecasts are preferable", we then construct one-year-ahead fixed-horizon forecasts as a weighted average of fixed-event forecasts, the weights being the number of quarters forecasted in both the current and next years.[8] Figure 3.2 plots

[8] Fixed-event forecasts across each year might be interpreted as different variables because they are based on different information sets and horizons. One might thus consider that this variable is not being drawn from the same stochastic process and introduce

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the response of SPF and CF fixed-horizon forecasts to a shock to ECB fixed-horizon forecasts. Though the response of CF current year forecasts is only significant with 1 standard error bands, robustness checks confirm the main result that ECB inflation projections influence private inflation expectations for both current and next year forecasts. More particularly, the fixed-horizon estimates, correcting for decreasing horizons, show a very pronounced effect of ECB projections on both surveys of private forecasts.

Moreover, one might argue that because forecasts are strongly correlated, forecasts produced by any other institutions would produce the same effect on private forecasts. A more economic-based argument would be that any institutions which publish forecasts generate public information disclosed to private agents and might become a focal point (see Morris and Shin, 2002). We then test the influence of the European Commission (EC) inflation forecasts on private forecasts. Figure 4.1 shows the effect of EC forecasts when replacing ECB inflation projections by EC forecasts in the vector Z_t, while figure 4.2 plots the effect of EC forecasts when both EC and ECB inflation projections are included together in the vector Z_t. EC forecasts do not influence private ones, whereas ECB inflation projections still influence them.

5.3. Sources of Influence: the Forecasting Performance Hypothesis

The influence of ECB inflation projections on private forecasts may stem from two intertwined sources: first, ECB projections may have lower forecast errors than private forecasts and are used by private agents to produce more accurate forecasts of the economic outlook. Second, ECB projections, independently of forecast accuracy, may convey policy signals. We test the hypothesis that ECB inflation projections are more accurate than private ones in two ways. First, we test for equal forecast accuracy based on the Diebold and Mariano (1995)'s test. Second, we proceed to conditional comparisons through forecast encompassing regressions of the actual variable on both central bank and private forecasts, with no constant and parameters constrained to add up to one as described by West (2006), Clements and Harvey (2009).

Table 2 presents both comparisons of forecast accuracy. For the current year horizon, the ECB has more accurate projections than private forecasts: its RMSFE is 0.12 and respectively 0.22 and 0.20 for SPF and CF, and the coefficient on ECB projections is close to

heteroscedasticity in the estimation process and calls for controlling that the implicit constant variance assumption does not bias the estimation. Another advantage of fixed-horizon forecasts to check the robustness of the fixed-event estimates is that there is a break in the forecasts series for Q1 as the current year Q1 forecast estimate the underlying variable for the subsequent year compared to the preceding Q4 forecast. One argument to overcome the effect of this break is that we are interested in the signaling content of the projections which is not calendar-year based, and not in their actual accuracy. In other words, if the ECB discloses a policy signal, it should move both current and next year projections together.

one while the one of private forecasts is not significant. For next year forecasts, the overall forecasting performance is weak and there is no significant difference between the ECB and private forecasters. These outcomes suggest that for next year forecasts, the influence of ECB projections may be a matter of signals rather than of forecasting performance; while for current year forecasts, influence may stem from a combination of forecasting performance and signaling.

5.3. Discussion

These estimates provide empirical support for the wide literature in which the management of private inflation expectations is the main task of monetary policy and central banks aim at steering private inflation expectations. It is also worth noting that two interpretations of the positive influence effect are possible. First, one may argue that the ECB creates self-fulfilling prophecies by communicating on inflation. By influencing private inflation expectations which are the main determinants of future realized inflation, the ECB somewhat partly set the future inflation rate. Second, the ECB may expect an increase in inflation and communicates on it. If the ECB is credible, private agents will expect a rise in the ECB rate and then forecast a smaller than communicated increase in inflation. The ECB would have succeeded to partly prevent the increase in inflation by signaling inflationary pressures and its future monetary policy intentions.

6. Characterizing ECB Projections' Influencing Effects

This section aims at establishing the signaling content of ECB projections and whether publishing ECB inflation projections may be considered as a way of better implementing monetary policy actions by facilitating private agents' information processing. We test three hypotheses: *(a)* an ECB inflation projection shock has the same effects as an ECB rate shock, *(b)* the publication of ECB inflation projections changes the effects of an ECB rate shock on private forecasts, and *(c)* an ECB rate shock has an impact on ECB inflation projections and vice-versa.

First, we test the hypothesis that ECB projections and the ECB rate produce similar effects on private forecasts. Figure 5 plots impulse responses of SPF forecasts to both ECB rate and ECB inflation projections shocks and for current and next year forecasts. At both horizons, the response of SPF current year forecasts is positive and comparable after both an ECB inflation projections shock and an ECB rate shock. This suggests that the ECB rate and ECB inflation projections - and their respective signals - are not interpreted very differently by private agents as they produce similar effects on SPF forecasts; especially at

the current year horizon when central banks have no control over inflation due to the transmission lags of monetary policy and so the ECB rate should have no effect on inflation.

Figure 6.1 presents the effects of an ECB rate shock on SPF forecasts when artificially shutting-off the communication channel by imposing restrictions on the ECB projections coefficient in the SPF forecasts equation as thought by Bachmann and Sims (2012). We aim at assessing whether the publication of ECB projections affect the interpretation of ECB rate shocks by private agents. If ECB inflation projections were a tool for facilitating private agents' information processing and for helping private agents to interpret interest rate changes, then shutting-off the effect of ECB inflation projections should make the responses of private expectations to the ECB rate different and would then provide an estimate of the effect of policymakers' forecasts. An interpretation of the question "Do ECB projections matter in the transmission of ECB rate shocks?" would be to restrict the coefficients of the underlying VAR in such a way as to force the response of SPF forecasts to ECB projections to be zero, and then compare the restricted impulse responses with the unrestricted ones. A necessary condition for SPF forecasts to not react to ECB projections at any horizon is that SPF forecasts are ordered before ECB projections in the vector of endogenous variables, so that it does not react on impact. This plus restricting the AR coefficients on lagged ECB projections in the SPF forecasts equation to zero is sufficient for imposing that SPF forecasts does not react to ECB projections at any horizon. These restrictions are implemented by estimating the VAR model using seemingly unrelated regressions.

The increase in private forecasts after an ECB rate shock if we impose restrictions on ECB inflation projections is smaller than the equivalent response when ECB inflation projections are taken into account. This outcome suggests that ECB rate shocks have a more pronounced effect if they are complemented with the publication of ECB inflation projections, and hence that ECB inflation projections may help private agents interpreting interest rate changes.

A complementary test to assess the effects and content of ECB inflation projections is to look at the impact of ECB inflation projections on private inflation forecasts when imposing a restriction on the ECB rate to artificially shut-off the effect of the ECB rate on private forecasts. Figure 6.2 shows that the influencing effect of ECB inflation projections remains significant without the ECB rate, though is smaller in the current year horizon case. It therefore appears that the effect of communication is not dependent on past and current policy decisions.

Figure 7 shows the responses of ECB inflation projections to an ECB rate shock and the opposite, for both current and next year forecasts. It also shows Euribor responses to an ECB projection shock. ECB rate shocks increase ECB current year projections but not, or marginally, ECB next year projections. An increase in the ECB rate therefore provides a signal that the ECB expects some future inflationary pressures within the year, not further ahead. This seems reasonable and enables to understand the way the ECB is setting its interest rate and the reasons underlying its policy decisions. Consistently, ECB current year projections shocks lead to an increase in the ECB rate in the next three quarters, while ECB next year projections shocks lead to a larger increase in the ECB rate over the next eight quarters. ECB inflation projections thus convey a signal on monetary policy intentions. The fact that the Euribor rate responds in a similar way to ECB inflation projections suggest that the signal reaches private agents and that they anticipate a tighter policy. ECB inflation projections and the ECB rate seem complementary and these estimates support the view that ECB inflation projections help to understand policy decisions and to predict future ones.

To sum up, both ECB rate and ECB inflation projection shocks impact SPF forecasts and seem to send a signal from the ECB about future inflation. Second, an ECB rate shock has less impact on private forecasts if we impose restrictions on ECB inflation projections. It suggests that ECB inflation projections convey extra information for better understanding policy decisions. Third, the ECB rate and ECB inflation projections are complementary and each one reacts consistently to shocks to the other. Knowing that ECB inflation projections responds in a certain manner to ECB rate shocks and the ECB rate to ECB inflation projection shocks enables private agents to correctly interpret policy decisions and to predict future ones.

This interpretation is consistent with Gerlach (2007), Heinemann and Ullrich (2007), Rosa and Verga (2007), and Jansen and De Haan (2009) who find that ECB *qualitative* communication – measured by constructed indicators – is significantly related to interest rate decisions and helps explaining policy decisions. Moreover, Brand et al. (2010) show that ECB *qualitative* communication – the Introductory Statement and following questions and answers after each Governing Council meeting – may lead to substantial revisions in policy expectations and exert a significant impact on long-term interest rates, while Sturm and De Haan (2011) find that ECB *qualitative* communication – also measured by five indicators that are all based on the ECB President's Introductory Statement – increases the predictability of the ECB future interest rate decisions. This is consistent with the result that ECB inflation projections help understand current decisions and convey a signal on the future ECB rate and suggests that the Introductory Statement and ECB inflation projections may be two complementary tools for ECB communication.

7. Conclusion

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This paper examines the effects of publishing ECB inflation projections in two ways. We provide original evidence that ECB inflation projections influence private ones. The second set of estimates supports the view that ECB inflation projections may be a tool for better understanding policy decisions help private agents' information processing, and that ECB inflation projections convey a signal on future policy decisions. This body of evidence suggests that ECB inflation projections enable private agents to correctly interpret and predict policy decisions. Making further progress on modeling the central bank management of private expectations is likely to require assessing the relationships between quantitative and qualitative communication and their relative effects on the formation of private expectations.

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Table 1 - Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
SPF_CY	37	1.97	0.71	0.30	3.60
SPF_NY	37	1.82	0.29	1.10	2.60
CF_CY	37	1.97	0.74	0.28	3.58
CF_NY	37	1.78	0.28	1.17	2.46
SPF	37	1.85	0.41	0.90	2.85
CF	37	1.83	0.41	0.82	2.74
ECB_CY	37	2.03	0.78	0.30	3.50
ECB_NY	37	1.78	0.39	1.00	2.60
ECB rate	37	2.02	1.17	0.58	4.25
10y rate	37	3.86	0.54	2.22	4.61
Euribor	37	2.15	1.49	0.20	4.98
CPI	37	2.10	0.86	-0.37	3.80
Real GDP	37	0.88	2.37	-5.46	3.81

SPF and CF variables are constructed one-year-ahead fixed-horizon forecasts as a weighted average of current year and next year fixed-event forecasts.

Table 2 - Forecasting Performance

|	SPF		CF	
	(1)	(2)	(3)	(4)
	y_{CY}	y_{NY}	y_{CY}	y_{NY}
	CY	**NY**	**CY**	**NY**
ECB	1.21***	1.10*	1.31***	0.63
	[0.15]	[0.61]	[0.18]	[0.82]
SPF or CF	-0.21	-0.10	-0.31*	0.37
	[0.15]	[0.61]	[0.18]	[0.82]
N	35	31	35	31
Diebold-Mariano forecast comparison, MAFE criterion				
u_{ECB}	0.12	0.78	0.12	0.78
u_{PS}	0.22	0.78	0.20	0.78
$u_{PS}-u_{CB}$	-0.10	0.00	-0.08	0.00
DM-stat	-3.40	-0.04	-4.43	-0.05
p-value	0.00	0.97	0.00	0.96

The table shows the DM-stat and its related p-value from a standard Diebold-Mariano (1995) test of equal Mean Absolute Forecast Errors (MAFE) and conditional comparisons through forecast encompassing regressions of the actual variable y on both central bank (ECB) and private sector (PS) forecasts, with no constant and sum of parameters constrained to one. u_i is the MAFE of forecasters i. ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Figure 1 – Inflation Forecasts Data
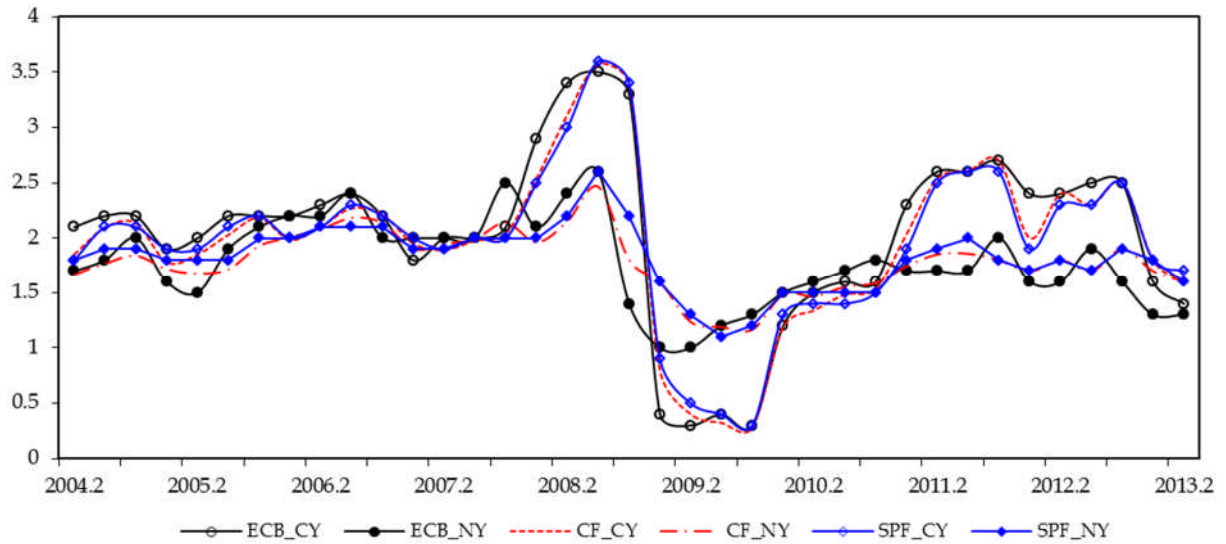
Note: Forecasts are average annual percentage changes. The y-axis is in percent. CY and NY stand for current year and next year forecasts, while ECB, CF and SPF are for European Central Bank, Consensus Forecasts and Survey of Professional Forecasters respectively.
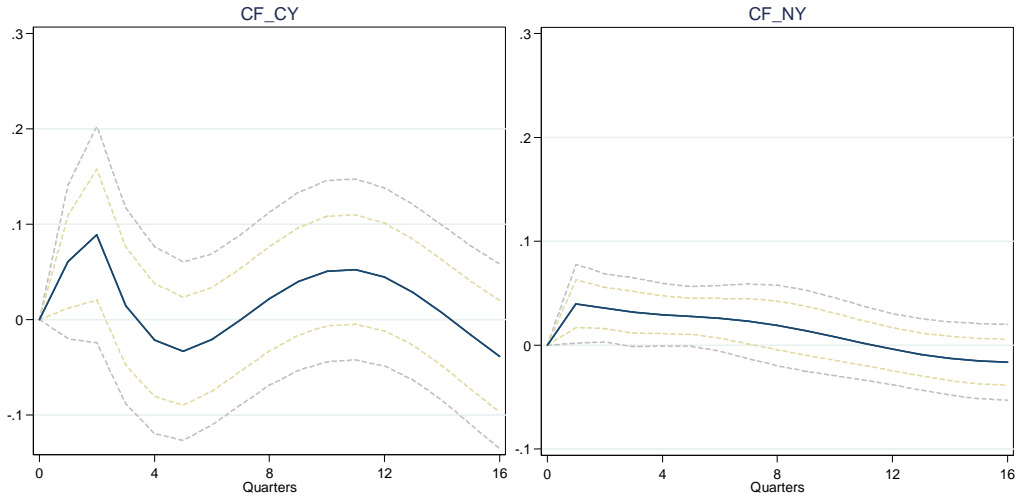
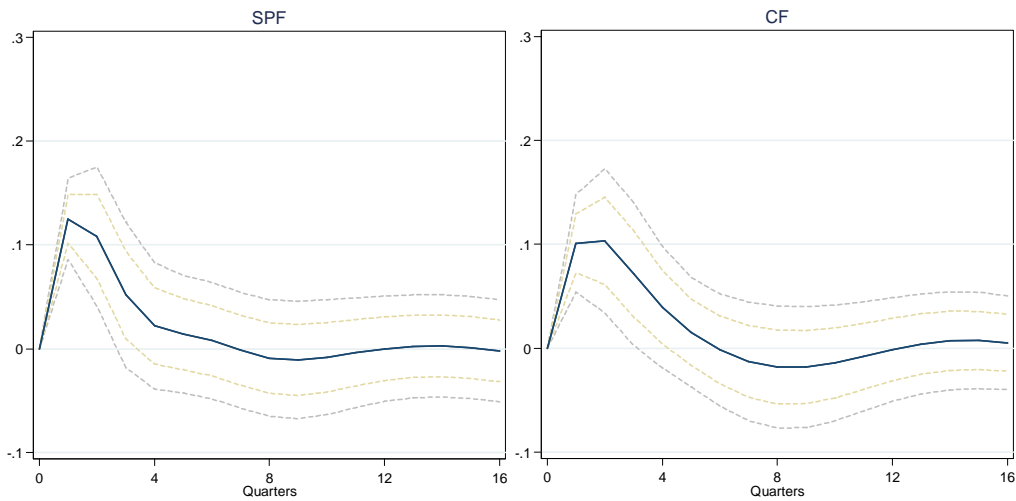## Figure 2 – Response to an ECB inflation projections shock
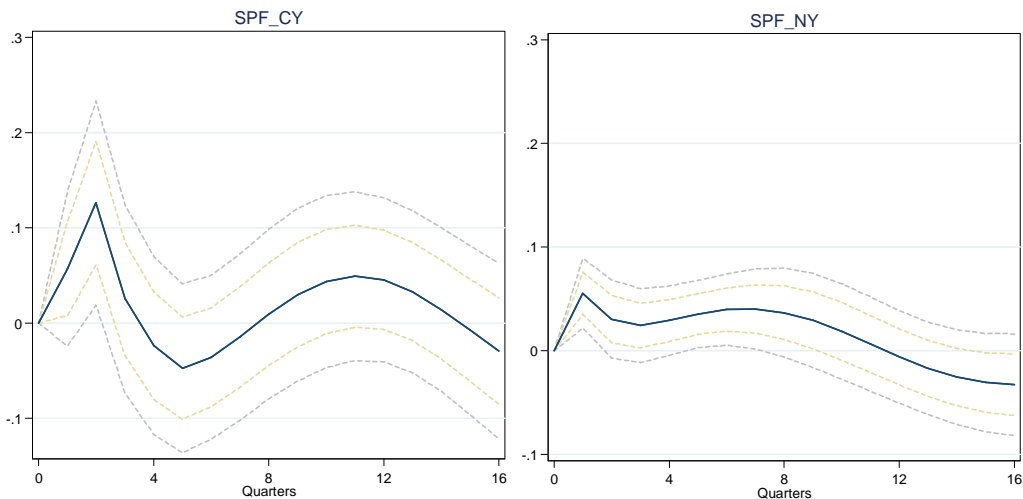
Note: Estimates based on the benchmark VAR with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 68% and 90% confidence intervals. The impulse response corresponds to the percentage point change in SPF forecasts, in response to a one-S.D. innovation in ECB inflation projections. On the left hand side, the VAR comprises ECB and SPF current year projections, while on the right hand side, it includes next year projections.

Figure 3 – Robustness Tests

### 3.1 – CF data

3.2 – Fixed-horizon forecasts

Note: Estimates based on the benchmark VAR with (3.1) CF data, and (3.2) fixed horizon forecasts as a linear combination of current and next years forecasts for SPF, ECB and CF data, with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 68% and 90% confidence intervals. The impulse response corresponds to the percentage point change in SPF or CF forecasts, in response to a one-S.D. innovation in ECB inflation projections.

Figure 4 – Introducing European Commission Forecasts

4.1 Response to an EC Forecasts shock –
### when replacing ECB inflation projections by EC Forecasts in the benchmark VAR
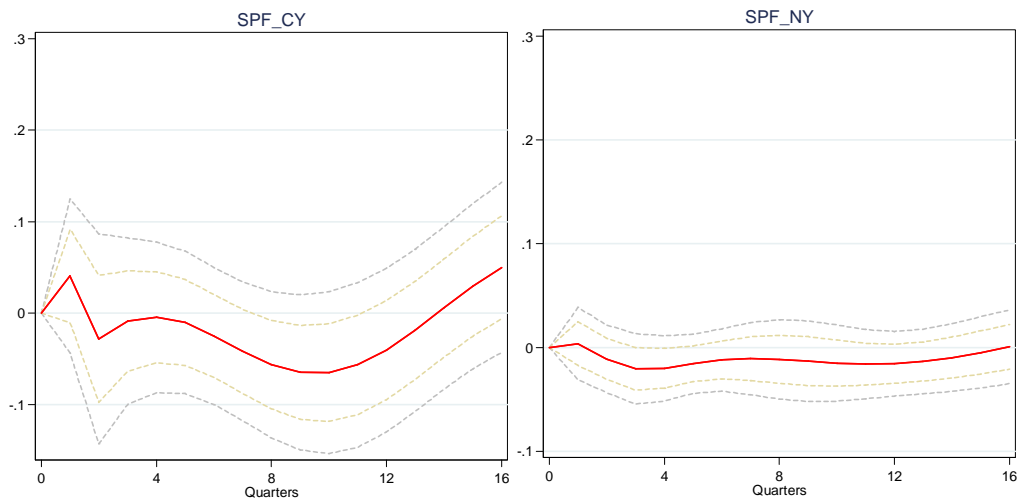
4.2 Response to both EC Forecasts and ECB inflation projections shocks –
when introducing EC forecasts additionally in the benchmark VAR
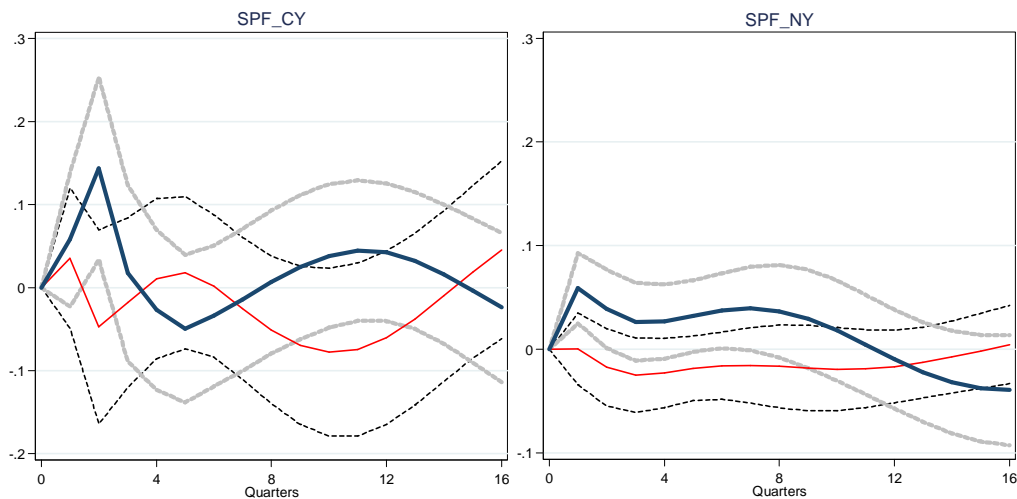
Note: On the first row, estimates are based on the benchmark VAR when replacing ECB projections by EC ones in the vector Z_t, with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 68% and 90% confidence intervals. The impulse response corresponds to the percentage point change in SPF forecasts, in response to a one-S.D. innovation in the EC forecast. On the second row, estimates are based on the benchmark VAR when including EC forecasts together with ECB projections in the vector Z_t, with a small-sample degrees-of-freedom adjustment. The thin red (thick blue) solid and dotted lines represent the estimated responses in SPF forecasts following an EC (ECB) forecasts shock, and the 90% confidence interval.

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Figure 5 – Hypothesis 1 - SPF Forecast Responses to an ECB inflation projections shock (left column) and to an ECB rate shock (right column)
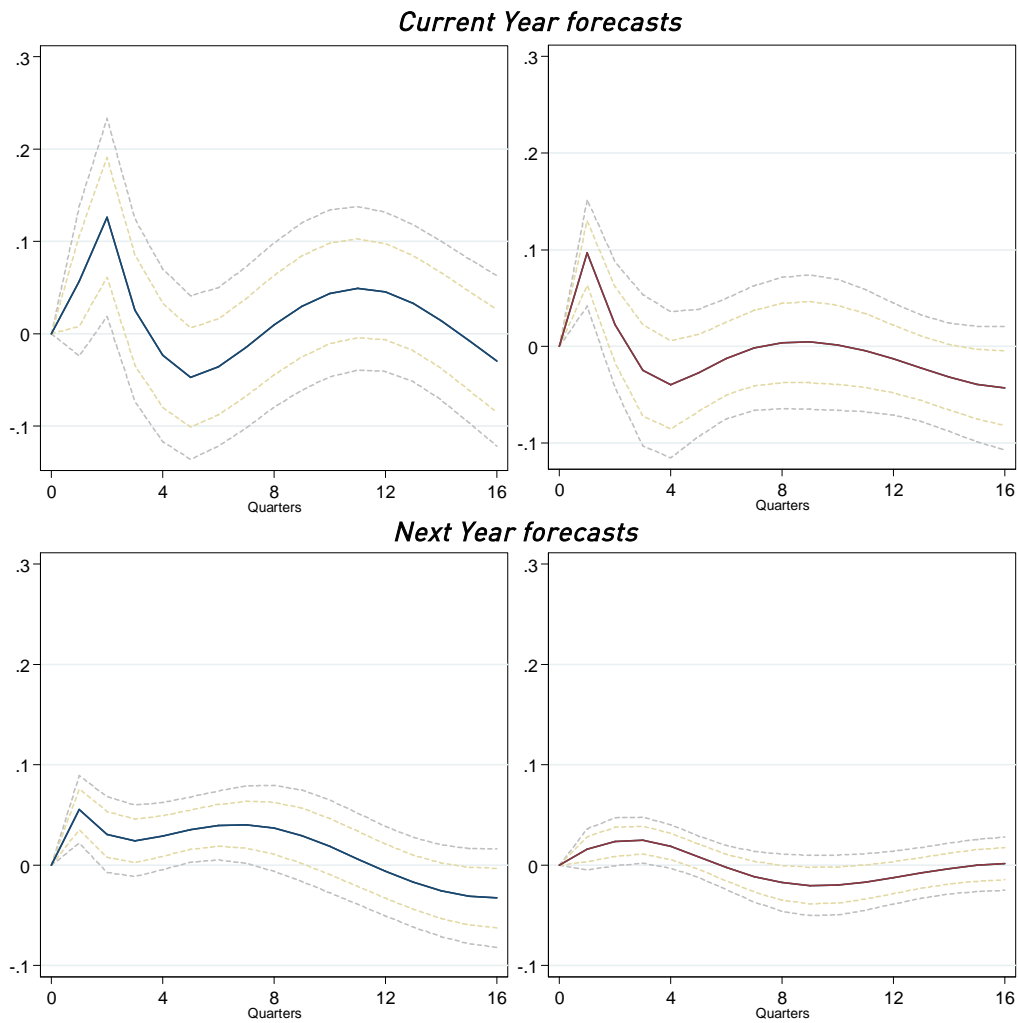
Current Year forecasts

Next Year forecasts

Note: Estimates based on the benchmark VAR with a small-sample degrees-of-freedom adjustment. The gold and grey dotted lines represent the 68% and 90% confidence intervals respectively. The impulse response corresponds to the percentage point change in SPF forecasts, in response to a one-S.D. innovation in the ECB inflation projection (left panel) or in the ECB rate (right panel).

Figure 6.1 – Hypothesis 2 - SPF Forecast Response
to an ECB rate shock
without restrictions (left column) / with restrictions (right column)
to artificially shut-off the ECB forecasts channel
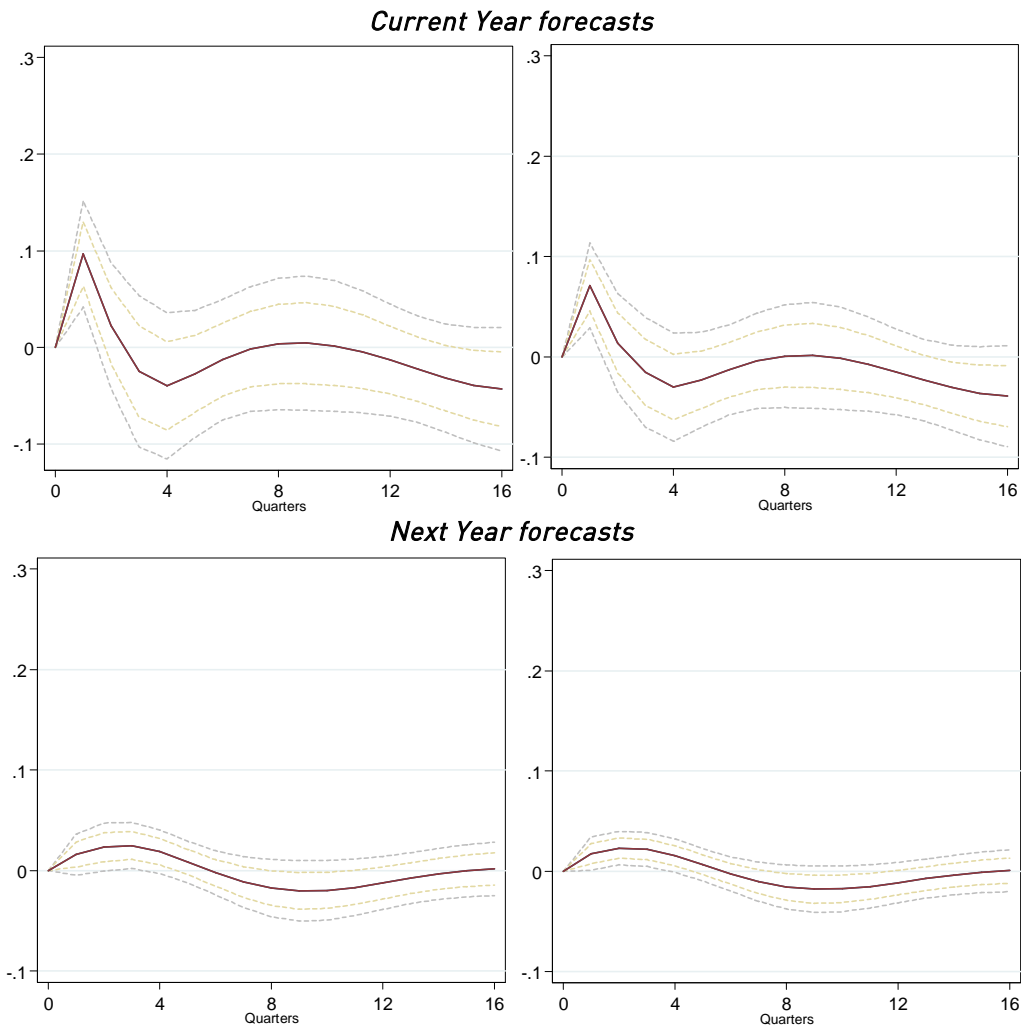
Current Year forecasts

Next Year forecasts

Note: Estimates based on the benchmark VAR with or without restrictions on the ECB projections coefficient in the SPF forecasts equation, with a small-sample degrees-of-freedom adjustment. The gold and grey dotted lines represent the 68% and 90% confidence intervals respectively. The impulse response corresponds to the percentage point change in SPF forecasts, in response to a one-S.D. innovation in the ECB rate.

Figure 6.2 – Hypothesis 2 – SPF Forecast Responses
to an ECB inflation projection shock
without restrictions (left column) / with restrictions (right column)
to artificially shut-off the ECB rate channel

Current Year forecasts

Next Year forecasts
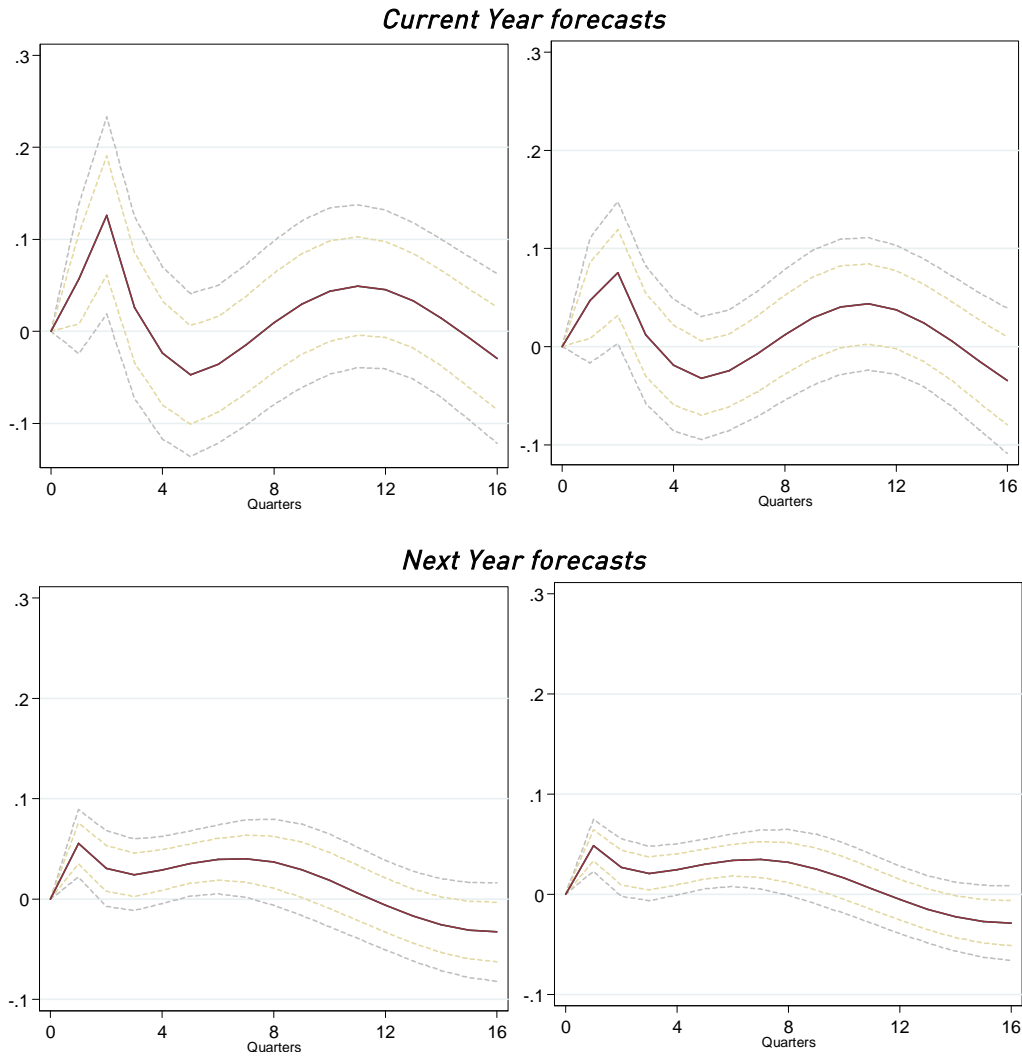
Note: Estimates based on the benchmark VAR with or without restrictions on the ECB rate coefficient in the SPF forecasts equation, with a small-sample degrees-of-freedom adjustment. The gold and grey dotted lines represent the 68% and 90% confidence intervals respectively. The impulse response corresponds to the percentage point change in SPF forecasts, in response to a one-S.D. innovation in ECB projections.

Figure 7 – Hypothesis 3 - Response of ECB inflation projections and the ECB rate to an ECB inflation projections or ECB rate shock
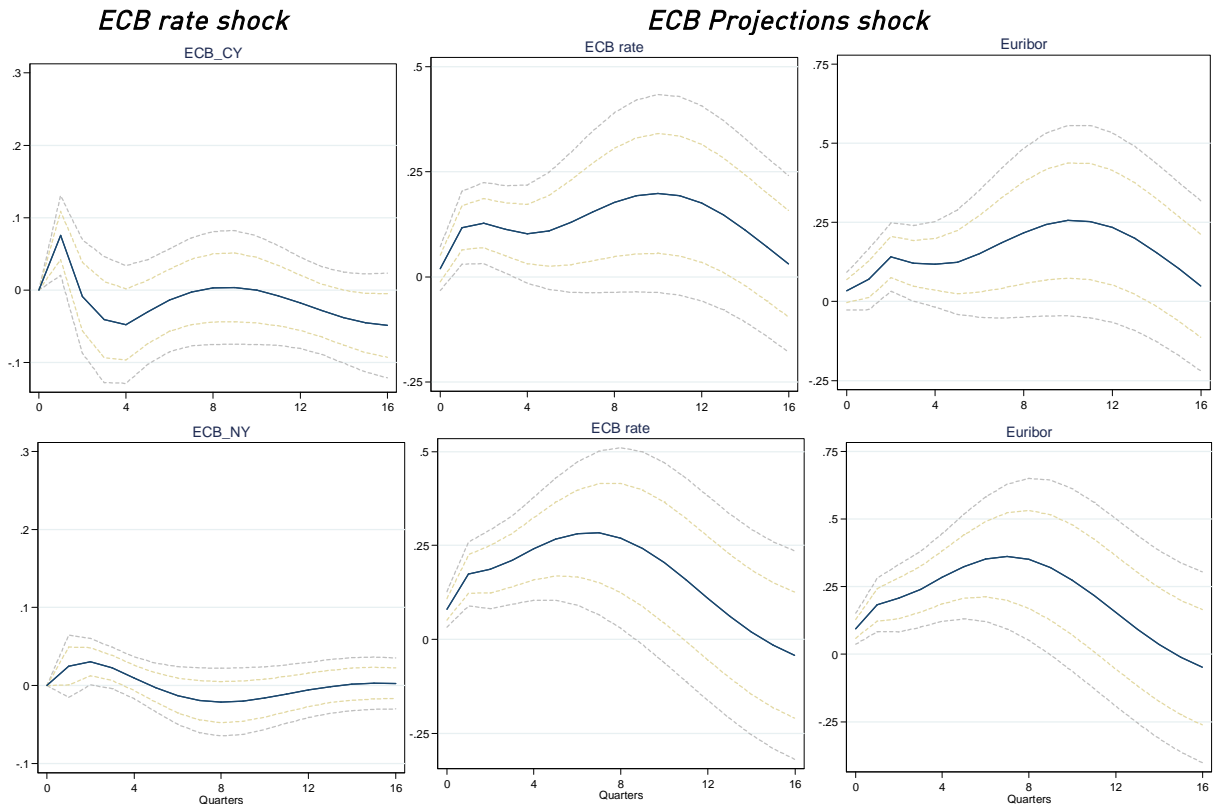
Note: The first line displays the responses of ECB inflation projections to an ECB rate shock and responses of the ECB and Euribor rates to an ECB projection shock in the case of the VAR with current year forecasts. The second line displays the equivalent responses in the case of the VAR with next year forecasts. Both are estimated with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 68% and 90% confidence intervals.