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ECB Projections as a Tool for Understanding Policy Decisions

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Abstract
The European Central Bank publishes inflation projections quarterly. This paper aims at establishing whether they influence private forecasts and whether they may be considered as an enhanced means of implementing policy decisions by facilitating private agents' information processing. We provide original evidence that ECB inflation projections do influence private inflation expectations. We also find that ECB projections give information about future ECB rate movements, and that the ECB rate has different effects if complemented or not with the publication of ECB projections. We conclude that ECB projections enable private agents to correctly interpret and predict policy decisions.

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1. Introduction

Private expectations play a central role in macroeconomics because of their importance in determining macroeconomic outcomes. Inflation expectations not only reflect private agents' perceptions about future inflation, they also directly impact actual current and future inflation. Shaping private inflation expectations is thus a key ingredient of the interplay between monetary policy and its outcomes.

Central banks therefore focus increasingly on the management of private expectations through communication and more explicitly for two 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, and 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.

Central bank communication can take different forms: statements, minutes, interviews or speeches (Blinder *et al.*, 2008). We 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 together with 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. In this paper, we abstract from qualitative communication and aim at establishing the effects of ECB inflation projections on private inflation expectations.

To do so, we assess *first* whether ECB inflation projections affect private ones, and we characterize *second* 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, comprising long-term interest rates, ECB inflation projections, the ECB rate and private expectations as measured by the ECB's Survey of Professional Forecasters (SPF), and with a recursive identification scheme to identify ECB inflation projection shocks. They are identified by assuming that policymakers observe immediately the ECB rate, private expectations and long-term interest rates. We focus on two intermediate targets of monetary policy: the long-term interest rates and private inflation

[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.

expectations for which the transmission mechanism is more direct than for the final objectives, inflation and output. We are interested in both the *immediate* influence effect and the *dynamics* of influence to characterize the effects of ECB inflation projections and a VAR model enables to assess the dynamics of a shock in contrast with an event-study or a simple regression that would provide only a 1-period effect. Estimates are robust to various identification assumptions, to the inclusion of output in the VAR, to fixed-horizon forecasts and to another dataset of private forecasts: Consensus Forecasts.

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 Gürkaynak *et al.* (2005a), 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, 2009; Crowe, 2010; and Capistran and Ramos-Francia, 2010). Fujiwara (2005) and Ehrmann *et al.* (2009) 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*. This question matters for two reasons: first, in practice, a central bank which is able to influence private expectations is supposed to make monetary policy implementation more effective. Second, in theory, 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, due to its policymaking role, shapes market expectations. Our contribution to the literature is to provide original evidence on the effects of ECB inflation projections on private inflation expectations and on the mechanism underlying this influencing effect.

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 nearly four times the effect on next year forecasts. SPF current year forecasts overreact to ECB inflation projections and it seems to result from a feedback loop between ECB and private forecasts. In both cases, the maximum effect happens after 2 quarters and vanishes after 3 quarters. The second set of estimates show that first the ECB rate and ECB inflation projections impact similarly SPF next year forecasts. Second, an ECB rate shock has no impact on private forecasts if the effect of ECB inflation projections on private forecasts is artificially shut-off, but has a positive one instead. It suggests that ECB inflation projections may be a tool for reducing the uncertainty on policy decisions and for understanding the appropriate stance of monetary policy. 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 an increase in the ECB rate after two periods. 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.

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 should be used cautionary. ECB projections may thus ensure that private agents are able to 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. Theoretical Framework

This section describes the theoretical framework which motivates our empirical setup. We rely on the imperfect information literature. 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). Following this work, 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. He also suggests that private agents derive their views about future inflation from professional forecasts. It leads them to formulate 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) as well as Mackowiak and Wiederholt (2009) focus on noisy information models: 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). Based on this literature, we assume that average private inflation expectations are given by:

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

where $E_t\pi_{t+h}$ is determined as a linear combination of private agents that stick to 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 this relation 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*:

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

Because of the limited adjustment mechanism of the imperfect information framework in which private agents stick to the same information set for a specific period of time due to sticky information or rational inattention, one would expect that lagged inflation expectations are highly significant. Another alternative of the expectations formation literature is learning[3] and would yield a similar prediction under the condition of inflation inertia (see e.g. Fuhrer and Moore, 1995; Roberts, 1997; and Cogley and Sargent, 2001). 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 based on 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. 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.[4] Finally, ECB inflation projections are published as average annual percentage changes for current and next years.

[3] Including the output gap and the short-term interest rate in the vector X_{t-1} would therefore enable to bridge with the learning literature in which the departure from rational expectations is due to model uncertainty: private agents know the correct model of the economy but do not know the model parameters. They learn about the economy by re-estimating an econometric reduced-form forecasting model updated with incoming new data. Suppose a model with an IS curve with habit formation, a New-Keynesian Phillips curve with indexation and a monetary rule where policy depends on the observed past values of inflation, the output gap and the interest rate. Private agents' expectations formation model is an unrestricted VAR of the variables that appear in the minimum state variable (MSV) solution of the system under rational expectations. See e.g. Evans and Honkapohja (2001), Bullard and Mitra (2002) and Orphanides and Williams (2008). A model of the economy with more state variables would then call for a larger set of variables on which private agents base their expectations.

[4] We have checked that these technical 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.

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 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 makes the identification assumption that the SPF does not respond to the ECB contemporaneously easily justifiable. In the meantime, it means that the ECB has one more month of information. We control for these specific timings with different orderings tested, in particular putting the ECB in a deliberate timing disadvantage. In addition, we also use CF forecasts which include information up to the third month of each quarter to match the ECB information set.

The actual data are taken from the Statistical Data Warehouse from the ECB and are for long-term interest rates the 10-year government bond yields index for the euro area, and for the ECB key interest rate the main refinancing operations interest rate of the ECB. Both are monthly at the origin and we also consider the average of the 3 months of each quarter to construct a quarterly dataset. The overall quarterly dataset starts in 2004.2, ends in 2011.3, and comprises 30 observations (to circumvent this potential issue, the estimation is performed with a small-sample degrees-of-freedom adjustment detailed afterwards). 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 for decomposing ECB inflation projections into mutually orthogonal components with a structural economic interpretation. The identification of an exogenous shock on ECB inflation projections enables to estimate its causal effect on SPF inflation forecasts, and to assess the dynamics of the influencing effect in contrast to an event-study or a simple regression that would provide only a 1-period effect.

Let Z_t represent the (k x 1) vector that contains our k variables of interest at date t. In the benchmark specification, Z_t = [10y rates, SPF inflation, ECB rate, ECB inflation projections]'. 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 therefore combine the exogenous innovation of a given variable to the contemporaneous responses to the other variables. The identification of exogenous innovations to both monetary policy variables goes through the following relation between the reduced-form errors and the exogenous innovation, called the structural errors:

$$e_t = \begin{pmatrix} e_t^{10y\,rates} \\ e_t^{SPF} \\ e_t^{ECB\,rate} \\ e_t^{ECB forecasts} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{10y\,rates} \\ \varepsilon_t^{SPF} \\ \varepsilon_t^{ECB\,rate} \\ \varepsilon_t^{ECB forecasts} \end{pmatrix} \quad (6)$$

The recursive identification assumption postulates that the structural errors are independent and that the A matrix is lower triangular. The covariance between the reduced-form errors is attributed to the structural error of the variable ordered previously in the vector Z_t, and the structural error is uncorrelated to the reduced-form errors of the preceding variables.

The vector Z_t comprises long-term interest rates, SPF forecasts, the ECB interest rate and ECB projections. In addition to the two monetary policy tools, we focus on two intermediate targets of monetary policy: long-term interest rates and private inflation expectations for four reasons. First, long-term interest rates are the most central variable in the transmission of monetary policy from the central bank interest rate to the real economy, and private inflation expectations are of great importance as they are significant determinants of wage increases and future inflation as well as long-term interest rates. Second, the transmission mechanism to intermediate targets is much more direct than to final objectives. When considering the New-Keynesian Phillips curve and IS equation, private inflation expectations and long-term interest rates are the main determinants of inflation and output, and strongly react to policy shocks (Gürkaynak *et al.*, 2005b). Third, inflation is highly correlated to both ECB and SPF inflation forecasts and would produce multicollinearity. Fourth, because of the small size of the sample, only a limited number of endogenous variables could have been allowed all together. However, since standard monetary VAR usually include output and an inflation variable together, we have tested for robustness purposes an alternative specification with private inflation expectations and real GDP growth.[5]

The recursive identification assumption depends on the ordering of variables in the vector Z_t. Usually, the literature ranks the monetary policy instrument last in the vector of variables and we assume that both ECB variables react contemporaneously to other macro variables. Concerning the relative position of ECB inflation projections and the ECB rate, we assume that ECB inflation projections would react contemporaneously to an exogenous shock on the ECB rate. This implies that the ECB rate should respond with a lag to an exogenous shock to ECB inflation projections. This assumption seems reasonable since first the ECB rate exhibits a strong inertia (Christiano *et al.*, 2008), second, policy decisions are set according to ECB inflation projections, and third, the staff in charge of ECB inflation projections incorporates the most up-to-date policy developments in their exercise. We assume that SPF forecasts respond with a lag to both policy variables. The fact that surveys take time to be collected from panelists and aggregated is a first argument in that direction. A second one refers to Coibion and Gorodnichenko (2010, 2012) and Andrade and LeBihan (2010) who document that private forecasters are subject to rational inattention and sticky information. Hence, this means that the ECB reacts contemporaneously to private expectations, consistently with the

[5] 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 and ECB inflation forecasts. 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.

assumption that the ECB continuously gathers information on private expectations and observes their developments.

This benchmark ordering may however be challenged. One may argue that because ECB inflation projections are staff projections, not policymakers ones, they should not react instantaneously to ECB rate shocks. The ECB rate should thus react contemporaneously to the ECB projections and be ranked last. Moreover, the construction of these staff projections is a lengthy process, potentially more than the SPF. To check the robustness of results, several orderings are tested, including switching the ECB rate and ECB projections, or ranking ECB inflation projections first with then SPF, 10-year interest rates and the ECB rate last, or ranking 10-year interest rates last. Table 1 lists all orderings tested.

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 forecasts beyond past SPF forecasts, ECB rate and long-term interest rates. 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 of 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 increase of SPF forecasts superior to the increase of ECB inflation projections would imply that the ECB has a low credibility for stabilizing inflation and would make its task more difficult.

5.1. Baseline Estimates

Figure 2 plots the impulse response of SPF forecasts to a one-standard-deviation (S.D.) innovation in ECB inflation projections for both current and next years. It causes a significant increase of 0.3 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 much less pronounced (0.1 percentage point) and also disappears after 3 periods. In more general economic terms, these two increases in SPF current and next year forecasts correspond respectively to rises of 2 percentage points and 0.55 percentage point following an increase of 1 percentage point in ECB inflation projections. These maximum effects happen after 2 quarters. While these estimates show that ECB inflation projections are able to influence private expectations, it appears that private forecasters overreact to current year projections, but not to next year projections. Moreover, the variance decomposition of SPF inflation forecasts enables to evaluate the quantitative importance of ECB inflation projections. The "communication channel" explains 29 and 20 percent of the variance of SPF forecasts for current and next years respectively, in comparison to 10 and 19 percent for the ECB rate and 54 and 46 percent for lagged SPF forecasts.

Table 2 presents Granger-causality Wald tests between SPF and ECB inflation projections. The null hypotheses that ECB projections do not Granger-cause SPF forecasts and that SPF forecasts do not Granger-cause ECB projections are both rejected at the 1% level for current year forecasts. For next year forecasts, the pattern is slightly different: the null hypothesis that ECB projections do not Granger-cause SPF forecasts is rejected at the 1% level, whereas the null hypothesis that SPF forecasts do not Granger-cause ECB projections is only rejected at the 10% level. It has to be acknowledged that these tests do not disentangle correlation and causality, and that their power is weak with forward-looking variables. However, given the high correlation between series, it suggests that SPF and ECB current year forecasts influence each other and supports the argument of a feedback loop between forecasts, whereas for next year forecasts, ECB projections influence SPF ones but the opposite is not necessarily true.

5.2. Sensitivity Analysis

We check whether the main result holds with different assumptions to check its robustness. Two series of tests are conducted related to model and estimation specifications, and to the data. First, we provide impulse responses of SPF forecasts to an ECB inflation projection shock with different orderings (see Table 1 and Figure 3.1). As a second test, we estimate a reduced-form VAR with the same variables in the vector Z_t and plot the equivalent impulse response (Figure 3.2). Imposing restrictions on the structure of the variance-covariance matrix enables a causal interpretation of the results. However, estimating a reduced-form VAR allows data to speak without assumptions.

Concerning the data, 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 4.1). Fixed-event forecasts as published by the ECB, SPF and CF might 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), 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.[6] Figure 4.2 plots the response of SPF and CF fixed-horizon forecasts to a shock to ECB fixed-horizon forecasts. Robustness checks illustrate that the main result is indifferent to orderings and confirm the robustness of the baseline result that ECB inflation projections influence private inflation expectations for both current and next year forecasts.

Finally, 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. We then test the influence of the European Commission (EC) macroeconomic forecasts on private forecasts. Figure 5.1 shows the effect of EC forecasts when replacing ECB inflation projections by EC

[6] Fixed-event forecasts might be interpreted as two 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 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.

forecasts in the VAR, while figure 5.2 plots the effect of EC forecasts when EC forecasts replace the 10-year interest rates and then both EC and ECB inflation projections are included in the VAR. The outcome is that EC forecasts do not influence private ones, whereas ECB inflation projections still influence them.

5.3. A Source of Influence: Superior Forecasting Performance

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 extract central bank private information and to produce more accurate forecasts of the economic outlook. Second, ECB projections, independently of forecast accuracy, may convey signals of two types. ECB inflation projections may act as *policy* signals and then be important to understand the appropriate stance of monetary policy (referring to the uncertainty of policy actions, hence facilitating private agents' information processing), to shed light on monetary policy preferences, strategies and objectives. ECB inflation projections may also act as *public* signals which provide a focal point for private agents to coordinate when prices are strategic complements and agents seek to coordinate (Morris and Shin, 2002).

We test the hypothesis that ECB inflation projections are more accurate than private ones with unconditional and conditional comparisons following Romer and Romer (2000). First, we compare the forecast accuracy of the ECB with SPF and CF by calculating their respective Root Mean Square Forecast Errors (RMSFE). We estimate this equation:

$$(Y_{t+h} - ECB_{t,h})^2 - (Y_{t+h} - PF_{t,h})^2 = \alpha + \varepsilon_t \quad (7)$$

where Y_{t+h} is the actual value of inflation, $ECB_{t,h}$ is the central bank forecast made at date t for h horizons later, $PF_{t,h}$ the equivalent for private forecasts, and α is the difference between the RMSFE of both actors. *P-values* for the test that central bank and private RMSFE are significantly different can be obtained by testing the null hypothesis that $\alpha = 0$. Second, we test whether ECB projections possess statistically significant and quantitatively important additional information beyond private forecasts by estimating this equation:

$$Y_{t+h} = \beta_0 + \beta_1 \cdot ECB_{t,h} + \beta_2 \cdot PF_{t,h} + \varepsilon_t \quad (8)$$

Table 3 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 0.20 and 0.19 for SPF and CF. The difference is significant at the 1% level. In addition, the coefficient on ECB projections is close to one and significant while the one of private forecasts is not. 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 is rather a matter of signals than of forecasting performance; while for current year forecasts, influence may stem from a combination of forecasting performance and signaling. This may be a reason for the strong effect of ECB current year projections on private forecasts.

5.3. Discussion

These estimates provide empirical support for the theoretical literature in which monetary policy is about managing private expectations. It is probably also worth noting that two interpretations of the positive influence effect are possible. First, 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 monetary policy intentions. Second, 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.

Indeed, while ECB inflation projections are able to influence private forecasts, the strong response of SPF *current year* forecasts puts into question the mechanisms underlying this overreaction of private forecasters and the relevance of the publication of ECB current year projections. A series of hypotheses are put forward. First, the ECB may not be credible in stabilizing inflation, but this is not consistent with its track record since 1999. Second, private forecasts whose forecasting performance is weaker may need to react more strongly to ECB inflation projections to predict future realizations. Third, Granger-causality Wald tests suggest that a feedback loop may be at work for these current year forecasts: ECB inflation projections influence private ones, which in turn influence ECB inflation projections, and so on. Fourth, the combination of the forecasting performance effect and the signaling effect increase the influence ability. Fifth, ECB actions may not be in line with its projections and rising ECB inflation projections without rising interest rates would produce this private agents' overreaction. The purpose of the next section is to characterize the influencing effects of ECB inflation projections and their interaction with the ECB rate.

6. Characterizing ECB Projections' Influencing Effects

Since ECB inflation projections influence SPF forecasts at both horizons, we aim at establishing how signaling works and whether publishing ECB inflation projections may be considered as a way of implementing monetary policy actions by facilitating private agents' information processing. We test three hypotheses: *(a)* an ECB inflation projection shock has the same effects than 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 6 plots impulse responses of SPF forecasts to both ECB rate and ECB inflation projections shocks and for current and next year forecasts. The response of SPF current year forecasts is positive and large after an ECB inflation projections shock and positive and small after an ECB rate shock. At the current year horizon, central banks have no control over inflation due to the transmission lags of monetary policy and it explains this outcome. Responses of SPF next year forecasts are positive and comparable after an ECB inflation projections shock and an ECB rate shock. This outcome 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. This result is indifferent to the identification assumptions of all orderings for both horizons and both ECB variables (see Appendix A.1) except in the case of the SPF *next year* forecasts response to an ECB rate shock for models 4, 5, 6 and 8. They share the feature that ECB projections react with a lag to the ECB rate. The ECB rate has then no effect on SPF forecasts and it supports the argument of a signaling effect of ECB projections.

Figure 7 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 in Bachmann and Sims (2012). We aim at assessing whether the existence and 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.

While an ECB rate shock produces a small increase in private forecasts when ECB inflation projections are taken into account, the same ECB rate shock has no impact on private forecasts if we impose restrictions on ECB inflation projections even though we have shown that the effect of ECB inflation projections on private forecasts is large and sound. This outcome suggests that ECB rate shocks have an effect only if they are complemented with the publication of ECB inflation projections, and hence that ECB inflation projections might be a tool for removing the uncertainty on policy decisions, or for better understanding them by helping private agents to interpret the rationale for interest rate changes.

Figure 8 shows the responses of ECB inflation projections to an ECB rate shock and the opposite, for both current and next year forecasts. ECB rate shocks increase ECB next year projections but not ECB current year projections. This is consistent with the fact that central banks have no control on current inflation due to the transmission lags of monetary policy. An increase in the ECB rate therefore provides a signal that the ECB expects some future inflationary pressures. 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 inflation projections shocks for both current and next year lead to an increase of the ECB rate after two periods. The ECB therefore responds to inflationary pressures, and ECB inflation projections convey a signal on monetary policy intentions. This outcome sheds some light on the hypotheses to explain the overreaction of private agents to current year projections: ECB actions are in line with its communication and the ECB raises its interest rate when it increases its inflation forecasts. Finally, each set of estimates is consistent with the other: ECB rate reacts positively to ECB inflation projections and vice-versa. The ECB rate and ECB inflation projections seem to be complementary and this supports the view that ECB inflation projections are a tool for understanding policy decisions and to predict future ones.[7]

Estimates suggest that ECB inflation projections are a tool for implementing monetary policy by facilitating private agents' information processing. First, the ECB rate and ECB inflation projections impact similarly SPF next year forecasts. Second, an ECB rate shock has no impact on private forecasts if we impose restrictions on ECB inflation projections. It suggests that ECB inflation projections might be a tool for removing the uncertainty or for better understanding policy decisions. It also shed light on the sources of influence of ECB current year projections which convey a signaling effect, in addition to disclosing private information about the inflation outlook to private forecasters. Third, the ECB rate and ECB

[7] The robustness of the outcomes of the three hypotheses is assessed with Consensus Forecasts data. Estimates are presented in the Appendix and Figures A.2 to A.4 display comparable results.

inflation projections are complementary and each one reacts consistently to shocks to the other. Knowing that the ECB rate responds in a certain manner to ECB inflation projections and ECB inflation projections to the ECB rate enables private agents to correctly interpret policy decisions and to predict the future ECB rate evolution.

A pattern in these estimates is that the effects of ECB inflation projections are quick and short, compared to the long-lasting impacts of FOMC forecasts evidenced by Hubert (2013). In addition, it is worth noting that the results are opposed: Fed rate shocks produce the same effects with or without FOMC forecasts, and the Fed rate reacts to FOMC forecasts but not the opposite. Whereas FOMC forecasts seem to signal the future policy path only, ECB inflation projections appears to be a tool for implementing current policy actions and for private agents to understand and predict policy decisions. 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 communication is significantly related to interest rate decisions and helps explaining policy decisions. Moreover, Brand et al. (2010) show that ECB communication 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 communication increases the predictability of the ECB future interest rate decisions. This is in line with the result that ECB inflation projections help understand current decisions and convey a signal on the future ECB rate.

7. Conclusion

This paper examines the effects of publishing ECB inflation projections in two ways. We provide original evidence that ECB inflation projections do influence private ones. It appears that SPF current year forecasts overreact to ECB inflation projections and it seems to result from a feedback loop between ECB and private forecasts. An implication for policymakers is that current year projections should be used cautionary. The second set of estimates supports the view that ECB inflation projections may be a tool for removing the uncertainty or for better understanding policy decisions, 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.

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Table 1 – Orderings used for the structural VAR model

Benchmark VAR	[10y rates, SPF, ECB rate, ECB projections]
Model 2	[10y rates, ECB rate, ECB projections, SPF]
Model 3	[10y rates, ECB rate, SPF, ECB projections]
Model 4	[10y rates, ECB projections, ECB rate, SPF]
Model 5	[10y rates, ECB projections, SPF, ECB rate]
Model 6	[10y rates, SPF, ECB projections, ECB rate]
Model 7	[SPF, ECB rate, ECB projections, 10y rates]
Model 8	[ECB projections, SPF, 10y rates, ECB rate]
Alternative VAR	[Real GDP growth, SPF, ECB rate, ECB projections]

Table 2 - Granger causality Wald tests

Equation	Variable	chi2	df	Prob > chi2
		VAR with SPF_CY		
SPF	ECB	19.175	1	0.000
ECB	SPF	11.571	1	0.001
		VAR with SPF_NY		
SPF	ECB	18.924	1	0.000
ECB	SPF	2.860	1	0.091
		VAR with CF_CY		
CF	ECB	16.185	1	0.000
ECB	CF	10.128	1	0.001
		VAR with CF_NY		
CF	ECB	8.530	1	0.003
ECB	CF	2.245	1	0.134

Table 3 - Forecasting Accuracy

Unconditional Comparisons - RMSFE

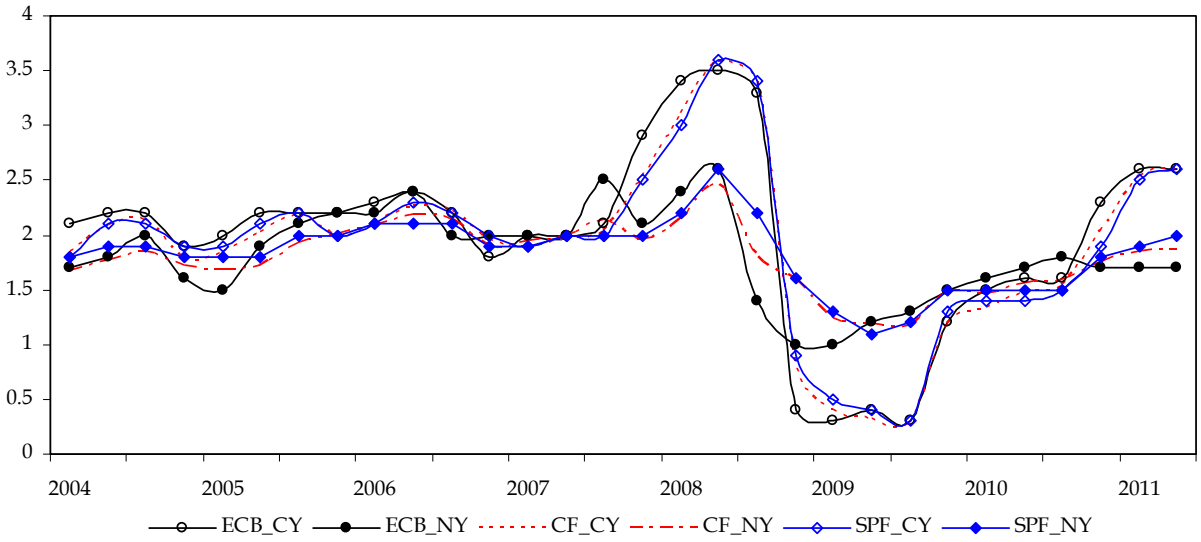
	Current Year		*Next Year*	
ECB	0.12		0.75	
SPF	0.20		0.74	
CF		0.19		0.73
α	-0.08**	-0.07***	0.01	0.01
se	(0.03)	(0.02)	(0.03)	(0.03)

Conditional Comparisons - Regressions

	Current Year				*Next Year*			
	coef.	se	coef.	se	coef.	se	coef.	se
ECB	1.07***	(0.22)	1.20***	(0.25)	1.21**	(0.49)	0.96	(0.86)
SPF	-0.10	(0.23)			-1.81**	(0.85)		
CF			-0.24	(0.26)			-1.26	(1.21)
Constant	0.09	(0.08)	0.09	(0.08)	3.09**	(1.18)	2.45**	(1.09)

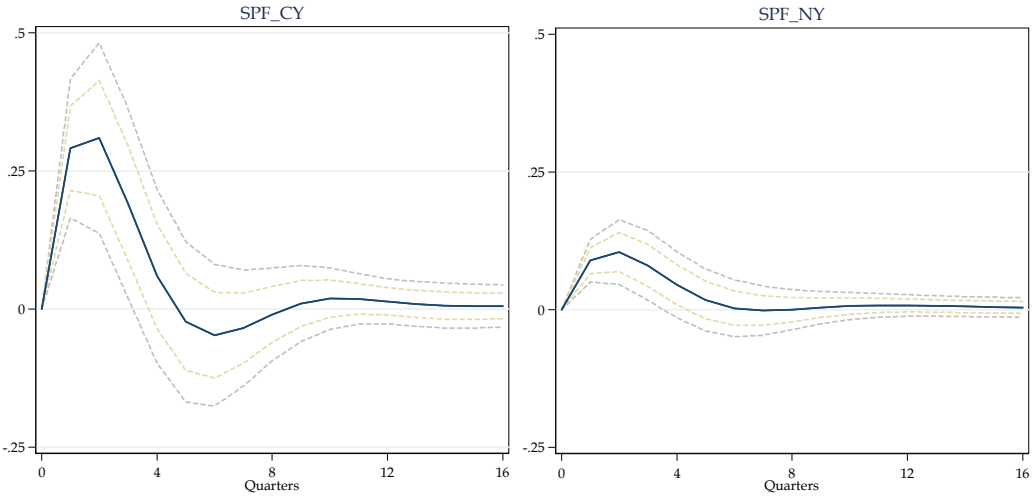
We test the null hypothesis that central bank errors and private agents' errors are equal. α is the difference between ECB's and SPF's or CF's RMSFE. Conditional comparisons are estimated with OLS. Robust standard errors are computed correcting for serial correlation according to the Newey-West HAC method. The truncation lag is equal to the maximum forecast horizon, so lag = 8. *** and ** denotes significance at the 1% and 5% 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.

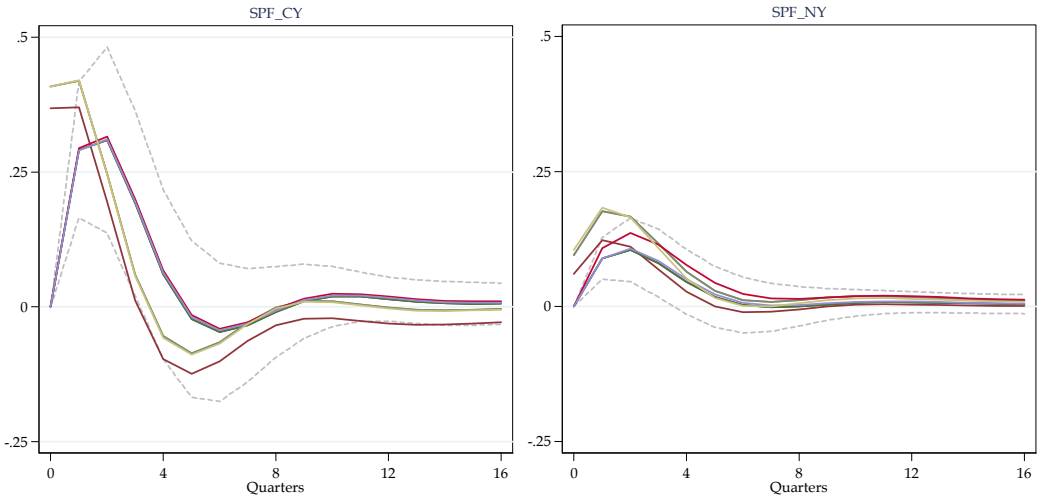
Figure 2 – Response to an ECB inflation projections shock



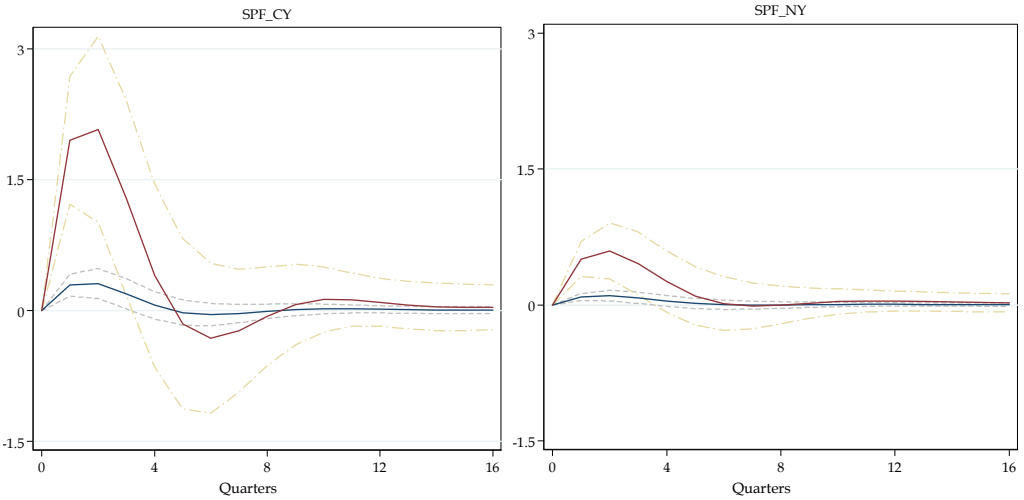
Note: Estimates based on the benchmark VAR with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 68% and 90% confidence intervals. The impulse response corresponds to the percentage point change in SPF forecasts, in response to a one-S.D. innovation in the ECB inflation projection. On the left hand side, the VAR comprises ECB and SPF forecasts of current year, while on the right hand side, it includes next year forecasts.

Figure 3 – Robustness to the estimation method
– Response to an ECB inflation projections shock

3.1 – Various orderings



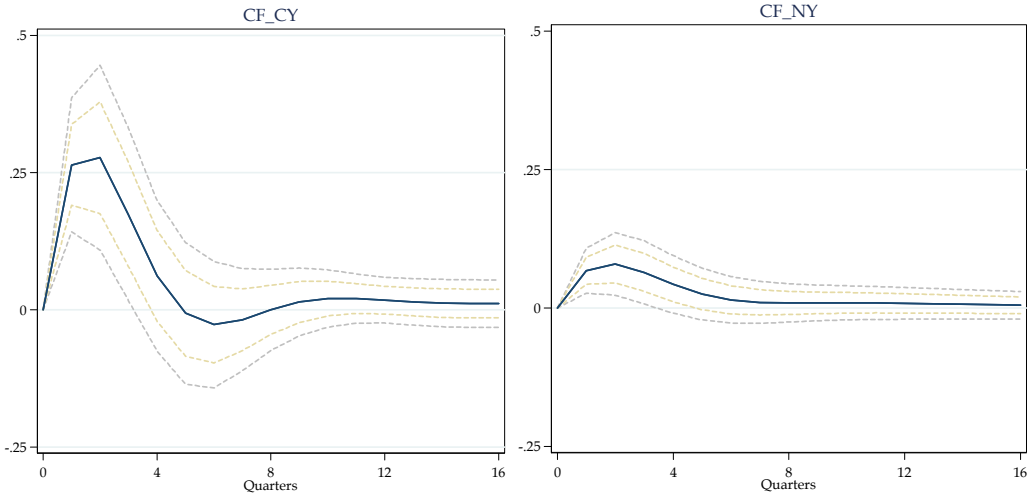
3.2 – Structural vs. Reduced-form VAR



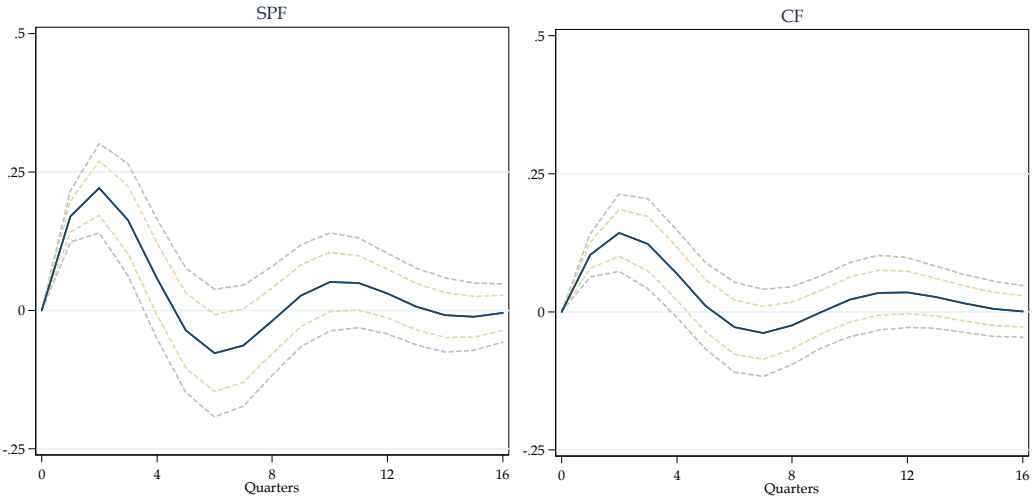
Note: On the first row, estimates are based on the benchmark VAR and models 2-7 with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 90% confidence intervals. The blue line is for benchmark VAR, maroon for model 2, green for model 3, orange for model 4, grey for model 5, red for model 6, purple for model 7 and gold for model 8. 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. On the second row, estimates are based on the benchmark structural VAR (blue line) with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 90% confidence intervals. The red line represents the SPF response based on the reduced-form VAR and the dash-dotted lines the associated 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 ECB inflation projection.

Figure 4 – Robustness to data – Response to an ECB inflation projections shock

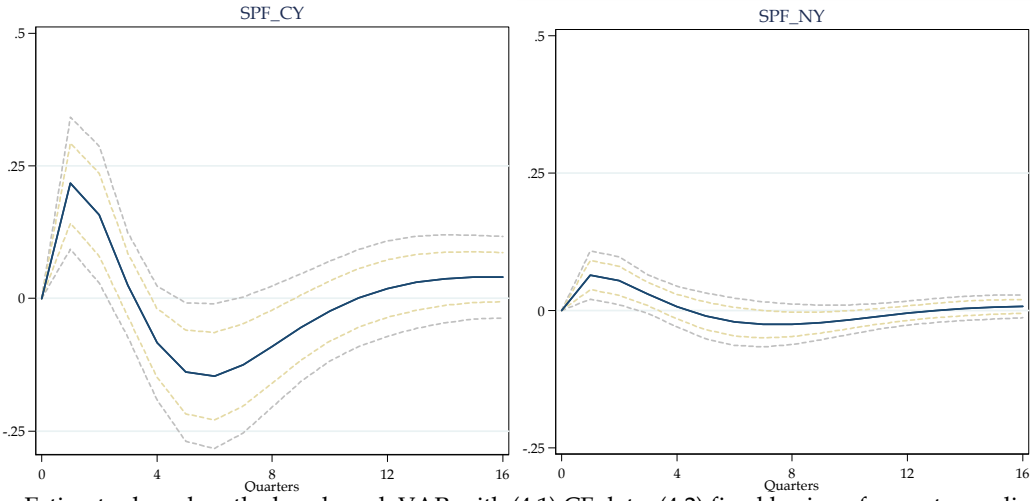
4.1 – CF data



4.2 – Fixed-horizon forecasts



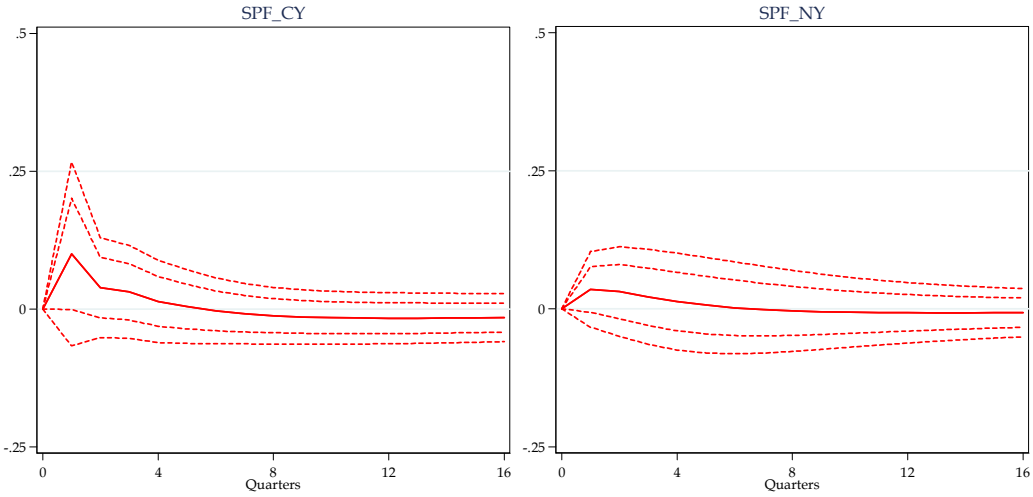
4.3 – Replacing 10-y rates by GDP growth in the VAR



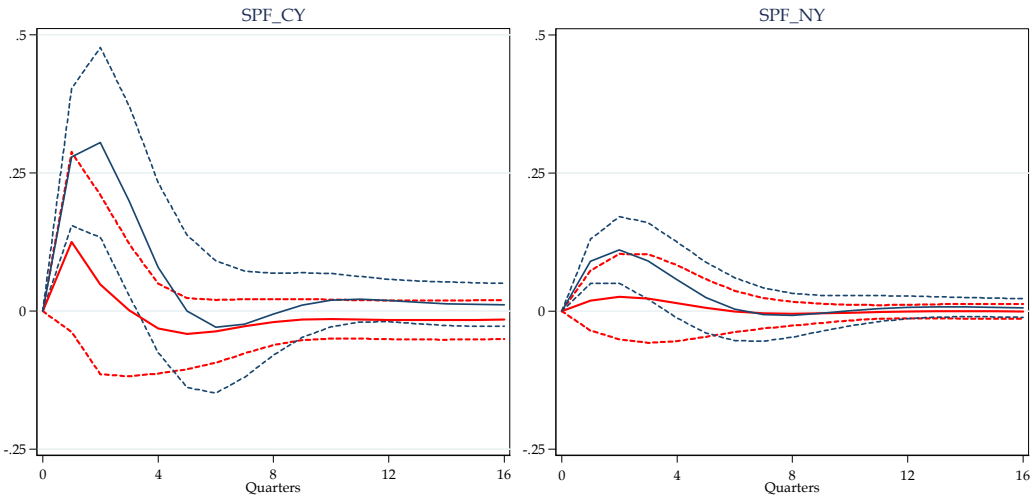
Note: Estimates based on the benchmark VAR with (4.1) CF data, (4.2) fixed horizon forecasts as a linear combination of current and next years forecasts for SPF, ECB and CF data, and (4.3) replacing 10-y rates by GDP growth, with a small-sample degrees-of-freedom adjustment. The dotted lines represent 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 ECB inflation projection.

Figure 5 – Introducing European Commission Forecasts

5.1 Response to an EC Forecasts shock – when replacing ECB inflation projections by EC Forecasts in the benchmark VAR

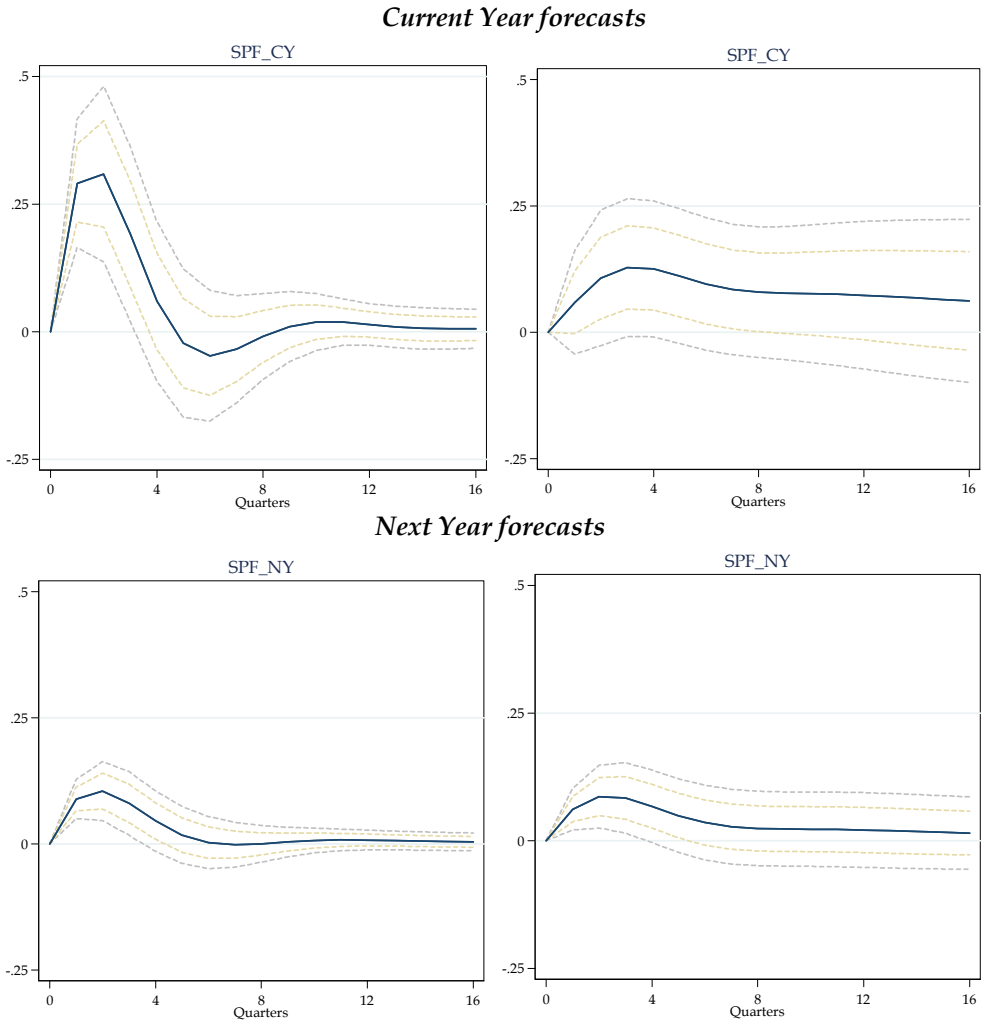


5.2 Response to both EC Forecasts and ECB inflation projections shocks – when replacing 10-y rates by EC forecasts in the benchmark VAR



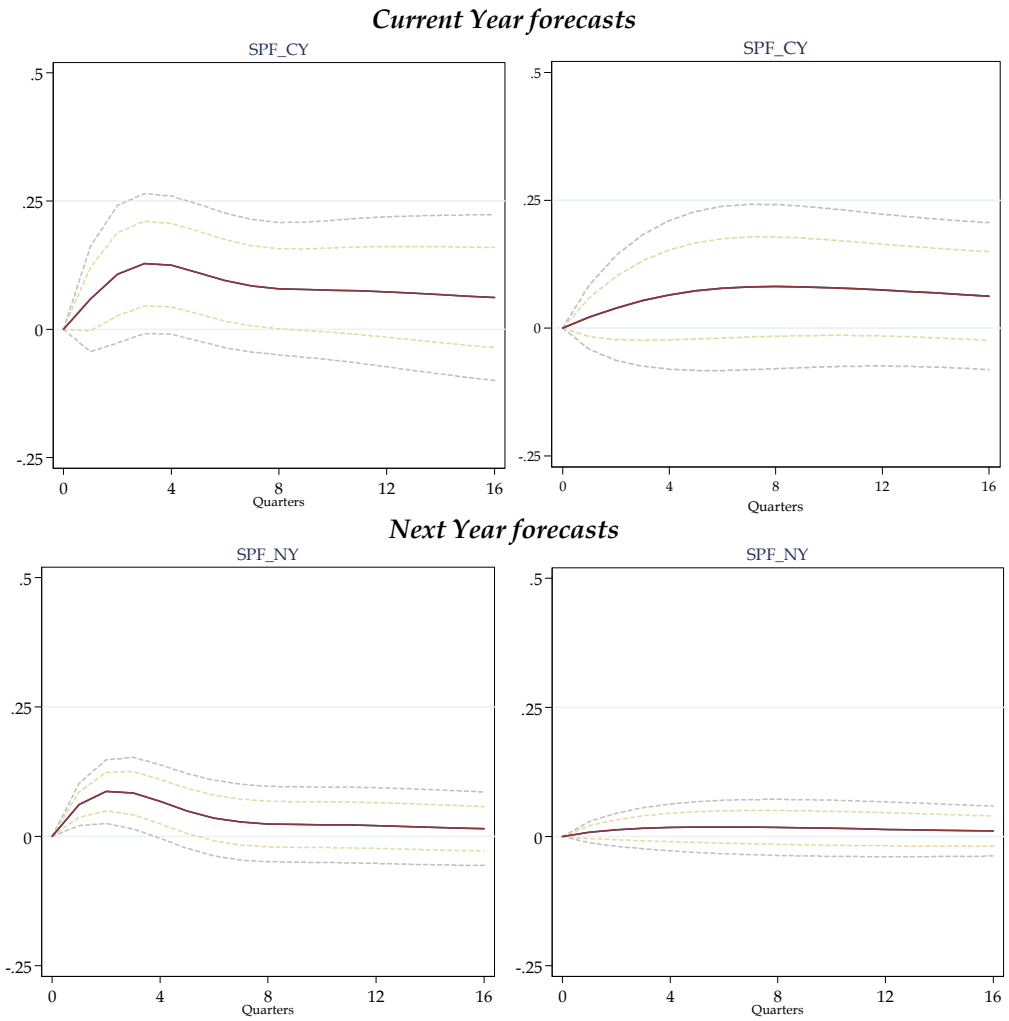
Note: On the first row, estimates are based on the benchmark VAR when replacing ECB inflation projections by EC ones, with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 68% and 90% confidence intervals. The impulse response corresponds to the percentage point change in 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 replacing 10-y rates by EC forecasts, with a small-sample degrees-of-freedom adjustment. The thick red (thin blue) solid and dotted lines represent the estimated responses from an EC (ECB) forecasts shock and the 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 ECB and EC forecasts.

Figure 6 – Hypothesis 1 - Response to an ECB inflation projections shock (left column) and to an ECB rate shock (right column)



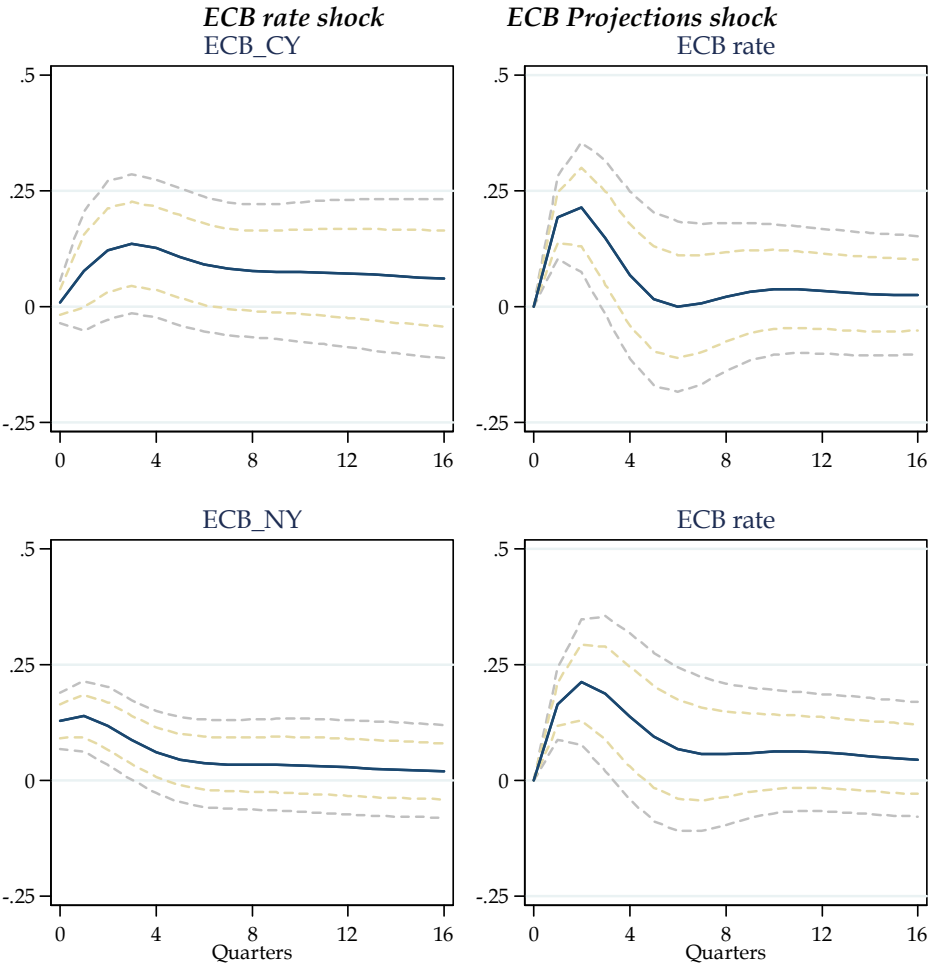
Note: Estimates based on the benchmark VAR with a small-sample degrees-of-freedom adjustment. The gold and grey dotted lines represent the 68% and 90% confidence intervals respectively. The impulse response corresponds to the percentage point change in 10-year interest rates and SPF forecasts, in response to a one-S.D. innovation in the ECB inflation projection or the ECB rate.

Figure 7 – Hypothesis 2 - Response to an ECB rate shock
Without restrictions (left column) / With restrictions (right column)
to artificially shut-off the ECB forecasts channel



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 10-year interest rates and SPF forecasts, in response to a one-S.D. innovation in the ECB rate.

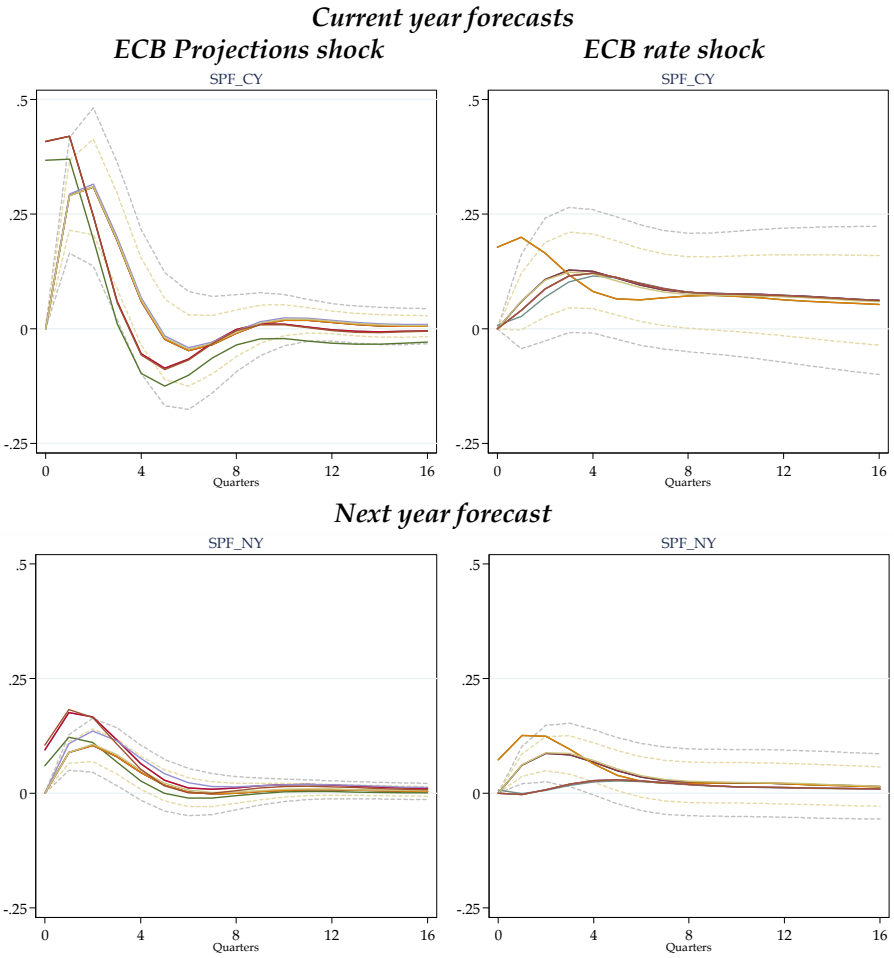
Figure 8 – Hypothesis 3 - Response of ECB inflation projections and the ECB rate to an ECB inflation projections or ECB rate shock



Note: The first line displays the responses of ECB inflation projections and the ECB rate to both monetary shocks in the case of the benchmark VAR with current year forecasts. The second line displays the equivalent responses in the case of the benchmark 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.

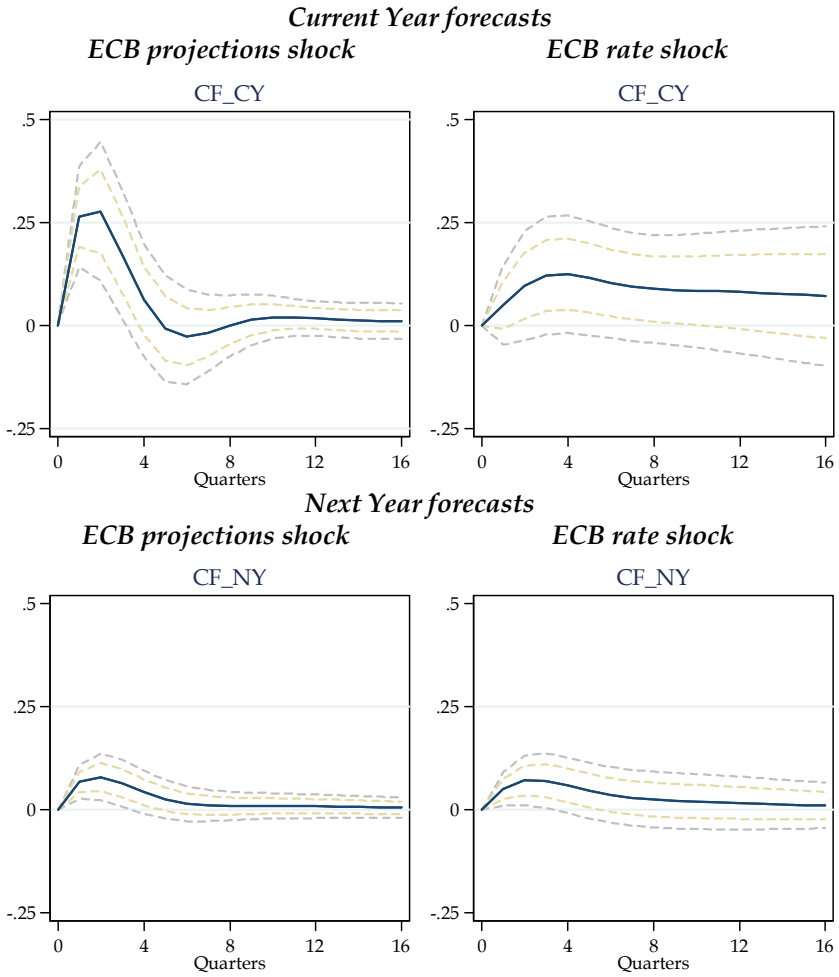
APPENDIX

Figure A.1 – Response to both monetary shocks – Various orderings



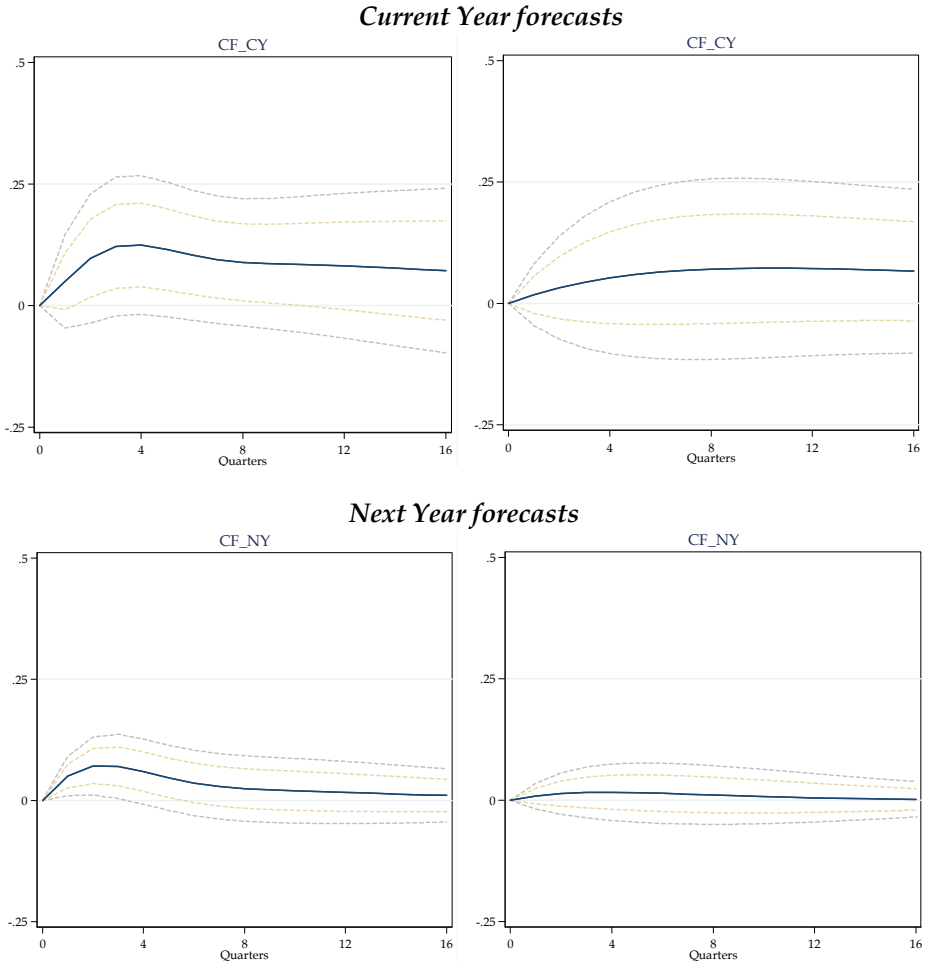
Note: The blue line is for benchmark VAR, green for model 2, orange for model 3, grey for model 4, red for model 5, purple for model 6, gold for model 7 and maroon for model 8, all with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 90% confidence intervals. The impulse response corresponds to the percentage point change in 10-year interest rates and SPF forecasts, in response to a one-S.D. innovation in the ECB inflation projection and rate.

Figure A.2 – CF data – Hypothesis 1 - Response to an ECB inflation projections shock and to an ECB rate shock



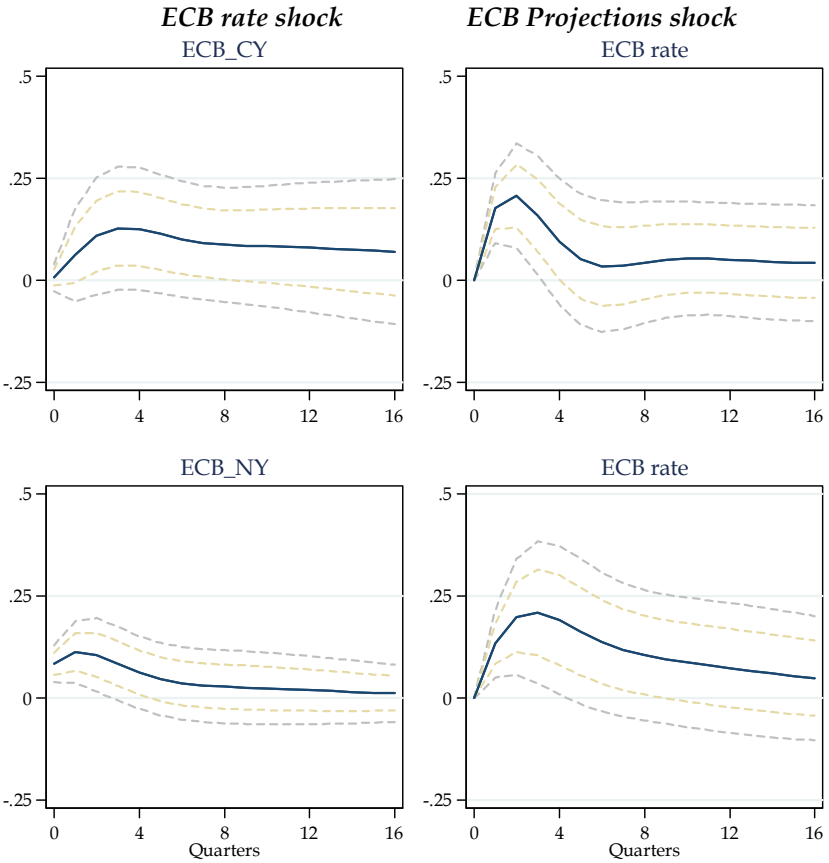
Note: Estimates based on the benchmark VAR with CF data, with a small-sample degrees-of-freedom adjustment. The dotted lines represent the 68% and 90% confidence intervals. The impulse response corresponds to the percentage point change in 10-year interest rates and SPF forecasts, in response to a one-S.D. innovation in ECB inflation projections and the ECB rate.

Figure A.3 – CF data – Hypothesis 2 - Response to an ECB rate shock Without restrictions (left column) / With restrictions (right column) to artificially shut-off the ECB forecasts channel



Note: Estimates based on the benchmark VAR with CF data when artificially shutting-off the effect of ECB inflation projections in the CF forecasts equation, and 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 10-year interest rates and SPF forecasts, in response to a one-S.D. innovation in the ECB rate.

Figure A.4 – CF data – 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 and the ECB rate to both monetary shocks in the case of the benchmark VAR with current year forecasts. The second line displays the equivalent responses in the case of the benchmark 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.