Macroeconomic Gain and Pain of ECB Non-standard Monetary Policy*

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February 15, 2016

PRELIMINARY, PLEASE DO NOT CIRCULATE

Abstract

We study the effects and transmission channels of non-standard monetary policy in the euro area using structural vector autoregressions, identified with an external instrument. The instrument is the common component of unexpected variations in euro area sovereign yields vis-à-vis Germany for different maturities on policy announcement days. We find that expansionary monetary surprises are effective in stimulating economic activity, prices and inflation expectations. Shock transmission functions through public and private interest rates, asset prices and credit conditions. The policy innovations, however, also lead to a rise in primary public expenditures, a divergence of relative prices within the union and a widening of internal trade balances.

JEL classification: E52, E58, E63

Keywords: Central banks, policy transmission, fiscal side effects, euro area, internal imbalances, structural VAR.

*We are thankful to Philipp Koenig, Michele Lenza, Morten Ravn and participants of an internal seminar for comments and suggestions. We thank Korbinian Breitrainer for research assistance.

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1 Introduction

Since the onset of the financial crisis in 2007 all major central banks have engaged in unconventional monetary policies, spurring an intense public and academic debate about the costs and benefits of these measures. While ever more rounds of easing have been and are being implemented, there is still scarce evidence on the macroeconomic effectiveness of these policies, and on how they pass-through to the real economy. Even less is known about potential side effects of such policies.

In this paper, we provide new evidence on the macroeconomic effects of unconventional monetary policy in the euro area. Specifically, we study the macroeconomic effectiveness of monetary policy surprises, the underlying transmission channels, and potential side effects on fiscal policy as well as on relative prices and trade balances within the union. We build on Gertler and Karadi (2015) and combine high frequency financial market data with vector autoregressions, identifying the causal effects of monetary policy shocks through an external instrument. The instrument is the common component of unexpected movements in euro area sovereign bond yields vis-à-vis Germany for different maturities on the days of policy announcements.

We find that an unexpected monetary expansion that lowers the average two-year rate on euro area government bonds excluding Germany leads to a significant rise in consumer prices and output, and a significant decline of the unemployment rate. Core consumer prices also increase following the shock, as well as inflation expectations over different horizons. Shock transmission functions through a variety of channels including private and public interest rates, financial market uncertainty and risk aversion, asset prices, and credit conditions. Interestingly, the results for output and prices are qualitatively and quantitatively more in line with the effects of conventional monetary policy shocks (see Christiano et al., 1999) than with some of the available estimates of unconventional monetary surprises (see, for example, Gambacorta et al., 2014).

At the same time, we find several side effects of the monetary policy innovations. While an unexpected monetary expansion leads to an improvement in the overall fiscal balance and reduces the debt/GDP ratio by boosting output and fiscal revenues, it also leads to windfall savings on interest payments and a rise in primary public expenditures excluding investment. Moreover, the heterogeneous impact of the common monetary surprise across member countries generates a divergence of prices and trade balances within the union, as some member countries lose price competitiveness and increase trade deficits versus Germany.

The paper relates to a literature which analyzes the economic consequences of unconventional monetary policies. The literature has adopted two main approaches. On the one hand, many studies use high frequency identification and assess the effects of these policies on asset prices (see, for example, Krishnamurthy and Vissing-Jorgensen, 2011, Gagnon et al., 2011, Wright, 2012, Rogers et al., 2014, Fratzscher et al., 2016).[1] On the other hand, some papers use structural vector autoregressions and quantify the effects of unconventional monetary policy on the macro-economy. The latter contributions identify exogenous policy changes through zero restrictions, sign restrictions, or a combination of both. Ciccarelli et al. (2013) identify innovations to the Eonia, which they take as their measure of the stance of (unconventional) monetary policy. Baumeister and Benati (2013) and Kapetanios et al. (2012) identify structural shocks to the spread between long-term government bond yields and the policy rate to assess the effects of large-scale asset purchases on the economy. Peersman (2011), Gambacorta et al. (2014), Boeckx et al. (2014), and Weale and Wieladek (2015) directly employ information about monetary aggregates and identify structural shocks to central banks' balance sheets. Finally, Darracq-Paries and Santis (2015) focus on specific non-standard measures by the ECB that affect credit supply.

In this paper, we combine both approaches used in the literature, that is, high frequency identification and VAR analysis, by applying the methodology of external instruments (see Stock and Watson, 2012, Mertens and Ravn, 2013). Gertler and Karadi (2015) show how this framework allows embedding high frequency financial market data on monetary policy surprises into structural VAR models, facilitating a joint analysis of the responses of both financial and macroeconomic variables to monetary innovations. In particular, the authors analyze the role of credit spreads in the transmission of (conventional) policy rate shocks to the US economy. Also focusing on the US and using this methodology, but applied to unconventional monetary policy, Rogers et al. (2015) analyze the effects on exchange rates and international risk premia. Different to these papers, we study the macroeconomic effects of unconventional monetary policy in the euro area, the underlying transmission channels, as well as the associated side effects.

The remainder of the paper is structured as follows. In Section 2, we discuss the VAR model and identification strategy. Section 3 contains the main results for the euro area as a whole. Individual country estimates and their implications for

[1] Christensen and Rudebusch (2012) and Hamilton and Wu (2012) use term structure models to evaluate the impact of unconventional monetary policy on yields.

internal (im-)balances follow in Section 4. The last section concludes.

2 The VAR model

2.1 Reduced form model

The reduced form VAR model we use can be written as

$$y_t = c + \Pi(L)y_{t-1} + u_t, \tag{1}$$

where c is a vector of constants, the matrix $\Pi(L)$ in lag polynomials captures the autoregressive part of the model and the vector u_t contains reduced form shocks, with $V(u_t) = \Sigma$. In the baseline specification, the vector y_t of endogenous variables includes the following six variables:

$$y_t = \begin{pmatrix} \text{Two-year rate on euro area government bonds} \\ \text{Stock market volatility} \\ \log(\text{Credit to non-financial firms}) \\ \log(\text{Harmonized index of consumer prices}) \\ \log(\text{Interpolated GDP}) \\ \text{Unemployment rate} \end{pmatrix}.$$

These variables refer to euro area aggregates. The model is estimated on monthly data from 1999M1 to 2015M6, using two lags in the autoregressive component, as suggested by the usual lag length selection criteria.

The two-year rate is our monetary policy indicator, that is, the variable in the structural VAR with exogenous variation coming from the monetary policy innovations. We will use it to scale the policy shock (see below). Compared to the one-year rate or rates for even shorter maturities, the two-year rate is less constrained by the zero lower bound, which it crosses only at the very end of our sample. Moreover, it captures more of non-standard policy innovations influencing expectations over longer horizon, which are a central element of the non-standard policies adopted by the ECB. We compute the two-year yield as a weighted average of sovereign yields of nine euro area countries excluding Germany.[2] We exclude German bonds since they played a particular role as a safe haven asset during the

[2]The countries are Austria, Belgium, Finland, France, Ireland, Italy, Netherlands, Portugal, and Spain.

euro crisis. For other euro area countries it is less clear whether their bonds were regarded as safe havens during this particular period (see, for example, Altavilla et al., 2014 or Fratzscher et al., 2016). Stock market volatility is measured with the VStoxx volatility index, which is based on option prices for stocks of the Euro Stoxx 50. GDP is interpolated from quarterly to monthly frequency with data on industrial production for the euro area using the method of Chow and Lin (1971). Details on the sources and the construction of all variables can be found in Appendix B.

The VAR innovations are assumed to be driven by a non-standard monetary policy shock ϵ_t^m, which we aim to identify as discussed below, and other structural shocks ϵ_t^*, which are related to the u_t through the matrix B^* but are of no interest for the purpose of this paper. As standard in the literature, the VAR residuals are linearly related to the structural shocks as

$$u_t = b^m \epsilon_t^m + B^* \epsilon_t^*. \tag{2}$$

To obtain the impulse vector b^m, which is used to compute impulse responses, we employ the identification strategy of external instruments, following Stock and Watson (2012) and Mertens and Ravn (2013). For this purpose, we need an instrument m_t for the unobserved shock ϵ_t^m such that

$$E(m_t \epsilon_t^m) \neq 0,$$
$$E(m_t \epsilon_t^*) = 0.$$

In words, the instrument is required to be relevant, that is, correlated with the shock of interest, and exogenous, that is, orthogonal to other structural shocks.

2.2 A proxy for monetary policy shocks

We use the following panel regression to compute an instrument m_t for monetary shocks capturing the non-standard policies by the ECB:

$$x_{ijt} = \alpha_i + \beta x_{ijt-1} + \sum_{a=1}^{A} \gamma_a D_{at} + \sum_{n=1}^{N} \delta_n z_{nt} + \eta_{ijt}, \tag{3}$$

where x_{ijt} represents the government bond spread versus Germany of country i on maturity j at time t, D_{at} represents a dummy variable taking value 1 if announcement $a = 1, .., A$ took place at time t, otherwise zero, z_{nt} controls for

the release of macroeconomic news on variable $n = 1, .., N$, α_i are country-specific constants, and η_{ijt} are residuals. We use $A = 32$ monetary policy announcement days. They correspond to when the ECB made explicit or implicit reference, either during regular meetings or other relevant speeches and communication, to at least one of the following three non-standard policy measures: forward guidance, credit easing, or quantitative easing. The choice of events closely follows Wright (2012) and Rogers et al. (2014), updated to the present. The first relevant event for our analysis took place on 22 August, 2007, the last one on 22 January, 2015. The events comprise for instance announcements of long-term refinancing operations (LTROs), the securities market program (SMP), or outright monetary transactions (OMT). A full list of the events is given in Appendix B. Accordingly, each γ_a captures the common variation observed in spreads of the considered countries and maturities on the day in which announcement a occurred. We then transform the estimated vector $(\gamma_1, .., \gamma_A)'$ into a monthly time series m_t by summing the daily γ_a's over the months, and use m_t as the external instrument for identification of a structural monetary policy shock.

To estimate equation (3), we use four countries and three maturities for the yields of each country. In particular, we use yields for Italy, Spain, Portugal and Ireland for maturities two, five and ten years. We chose these countries for several reasons. First, the non-standard measures of the ECB contained in our sample were mainly aimed at affecting yields in these countries, rather than, for instance, in Germany. Second, all four countries were covered by the Securities Market Program.[3] Third, consecutive data on bond yields for the considered maturities is available for all countries throughout the full sample.

We chose these maturities mainly for the following reasons. First, the included market segments are typically more liquid than bonds with longer maturity, in particular of the smaller countries like Ireland and Portugal. Second, yields at shorter maturities hit or are close to the zero lower bound towards the end of the sample, thus not providing sufficient variation. Third, we consider yields at different maturities, instead of focusing on one yield segment only, as the yield curve of the considered countries was inverted at times during the sample period, in particular during the height of the euro area debt crisis when several important non-standard measures were announced. A priori it is therefore unclear which maturities reflect the policy interventions most precisely. Finally, we use spreads

[3]While Greece was also contained in the program, we exclude it from the estimation due to the restructuring of its sovereign bonds in 2010 and because of a lack of data on two- and five-year yields.

instead of levels to isolate unexpected yield changes which are due to non-standard policy measures from those of standard monetary policy. Specifically, using spreads eliminates the effect of key interest rate changes, that are contained in our sample, on the level of the yield curve. We additionally use the impulse response analysis below to check whether interest rates closely tied to the main refinancing rate of the ECB, such as the Euribor or Eurepo, react on impact to the identified structural monetary policy shocks. Since they do not react upon impact, we read this as supporting our interpretation that the shocks reflect non-standard measures.

Finally, we control for other factors that could influence the daily evolution of spreads by including 139 macroeconomic news variables, following Altavilla et al. (2014). These variables are the surprise component in economic data releases for the euro area as a whole, individual member countries, the U.S. and the U.K. For each variable, we construct a daily time series as the difference between the first-released data and the expected values, the latter corresponding to the median estimate of a panel of experts surveyed by Bloomberg. Details on the variables and their computation can be found in Appendix B.

2.3 Identification of the structural VAR

To identify the effects of a structural non-standard monetary policy shock in the VAR, we build on Stock and Watson (2012) and Mertens and Ravn (2013) and perform the regressions

$$\hat{u}_{jt} = \alpha + \beta_j m_t + \nu_{jt}, \quad j = 1, ..., k, \tag{4}$$

where $\hat{u}_{jt}$ is the estimated VAR reduced form residual corresponding to equation j of model (1) and m_t is the instrument for ϵ_t^m discussed in the previous subsection. The estimates $\hat{\beta}_j$ are inconsistent estimates for the b_j^m elements in equation (2). Nevertheless, the source of such inconsistency is the same across equations, since $\hat{\beta}_j \xrightarrow{p} b_j^m E(\epsilon_t^m m_t)$, implying $\beta \xrightarrow{p} b^m E(\epsilon_t^m m_t)$ (see Olea et al., 2012). Hence, consistent impulse responses can be estimated.

Following Rogers et al. (2015), we improve upon the accuracy of the estimation of the structural VAR model by replacing the estimates $\hat{\beta}_j$ obtained using monthly data with estimates obtained using daily data. We do so for the equations in the VAR that feature a dependent variable available on a daily frequency. The goal is to avoid identifying part of the model on aggregated monthly frequency for variables available at a higher frequency. Moreover, the instrument for the mon-

etary shocks is initially constructed on daily frequency. Specifically, we proceed as follows. Call y_{jt} the j variable entering the model. If y_{jt} is only available on a monthly frequency we identify the corresponding element β_j as discussed above. If instead y_{jt} is available on a daily frequency, we estimate the β_j element corresponding to y_{jt} as the coefficient in the regression $y_{jt} - y_{jt-1} = \tilde{\alpha} + \tilde{\beta}\tilde{m}_t$, where $\tilde{m}_t$ is the instrument on a daily frequency. In the baseline specification, for example, we do so for the first two variables, the two-year rate and the VStoxx.

We find that the instrument m_t computed in the previous section is a strong instrument for our policy indicator. Specifically, the F-statistic in the regression of the two-year rate on the instrument equals 40.39 and the β_j is positive. The high F-statistic suggests that a weak instrument problem is unlikely. Alternative policy indicators that we consider are the five- and ten-year rate on euro area sovereign bonds excluding Germany. The corresponding F-statistics are 40.83 and 34.74. As will be shown below, using the longer-term rates as policy indicators affects the results only marginally, implying slightly stronger effects of the policy surprises on output and prices.

3 Macroeconomic effects in the euro area

We discuss the effects of unconventional monetary policy using estimated impulse responses to a monetary policy innovation. The responses are reported along with their 90 percent confidence bands using bootstrapping methods.[4] The shock is scaled such that it lowers the two-year rate on euro area bonds by 25 basis points.

3.1 Results for the baseline model

The impulse responses of the six variables in the baseline VAR are given in Figure 1. The top left panel shows that the two-year rate drops on impact and is significantly lowered for several months, before overshooting slightly after about one year. The expansionary policy innovation leads to a significant and long-lasting reduction in risk aversion and uncertainty, as measured by the VStoxx. The volume of credit to

[4]We apply a fixed-design wild bootstrap as in Mertens and Ravn (2013) and Gertler and Karadi (2015). This procedure in principle accounts for estimation errors in both stages of the structural VAR estimation (equations 1 and 4). For the variables identified on a daily frequency, however, the bootstrap procedure does not apply in the identification stage. Therefore, no confidence bands regarding the immediate impact are reported for these variables.

non-financial corporations gradually increases and reaches a peak after three years. These responses are associated with a gradual increase in prices and GDP, with output peaking after about 18 months, slightly earlier than prices. The responses of output and inflation are mirrored in the dynamics of the unemployment rate, which bottoms after approximately two years, before returning to the level where it would have been without the monetary innovation. Finally, the overshooting in the two-year rate is consistent with an endogenous response of monetary policy to an increase in the price level.

There are several interesting commonalities and differences between our results and previous estimates of the effects of both conventional and unconventional monetary policy shocks on output and prices. Regarding the relative magnitude of the effects, our results are similar to previous estimates for the US and the euro area, where it is typically found that output reacts more than prices. This is also present in our estimates. Only for the UK there is evidence that the maximum response of both variables is similar in size (see Baumeister and Benati, 2013 and Kapetanios et al., 2012).

Concerning the timing of peak effects, however, our results differ from other studies which focus on unconventional monetary policy but identify policy surprises as shocks to central banks balance sheets (see Gambacorta et al., 2014, Boeckx et al., 2014, or Weale and Wieladek, 2015). In these papers output and prices are found to respond faster, peak earlier, by approximately six to twelve month, and reach their maximum simultaneously. Instead, we find a relatively sluggish response of both variables, peaking only after roughly two years, and with output leading prices. Interestingly, the dynamics implied by our estimates are more similar to the response of the economy to conventional interest rate innovations (see Christiano et al., 1999, or Gertler and Karadi, 2015).

Regarding the effectiveness of monetary policy, our results are likewise more similar to the effects of conventional monetary policy than to the impact of unconventional monetary policy identified as exogenous changes in central banks' balance sheets, although a quantitative comparison with the latter needs to be treated with caution. Gertler and Karadi (2015) find that a shock to the one-year government bond rate of 20 basis points induces a maximum decline of output and prices of approximately 0.5 and 0.1 percent, respectively. Even though the effect on prices is only marginally significant in their case, while it is highly significant in our case, these point estimates are close to ours if we consider a contractionary shock. In contrast, the effects of comparably sized balance sheet shocks are con-

siderably smaller. According to the estimates of Gambacorta et al. (2014), for example, a shock to central bank assets that lowers the VIX by one percentage point on impact has a peak effect on output and prices that is less than half of what we find if we rescale our shock to the two-year rate such that it lowers the VStoxx by one percentage point on impact.

As a final step in this subsection, we evaluate the sensitivity of the results for the benchmark specification to several alterations of the model. First, we check if the results are driven by single outliers in the external instrument by performing an 80% Winsorisation on the instrument. We then identify and estimate the baseline model as before. The impulse responses are given in Figure 13. They are qualitatively and quantitatively similar to the benchmark results based on the uncensored instruments. Second, we include Germany into the computation of the euro area two-year rate. Figure 14 shows that response of the endogenous variables is more pronounced as we keep the scale of the shock unchanged and given that German yields are less sensitive to ECB policy (see also below). Third, instead of the two-year rate we alternatively use the five- and ten-year rate as our policy indicator, respectively. Figure 15 shows that the reaction of the baseline variables is relatively similar across specifications. Intuitively, the effects on the real economy are stronger when yields for longer maturities unexpectedly drop by 25 basis points.

3.2 Prices, inflation expectation and real activity

We next evaluate the effects of a monetary policy surprise on core CPI and several measures of inflation expectations. This is motivated by the fact that the primary mandate of the ECB is to stabilize inflation, and since managing inflation expectations plays a crucial role for actual inflation. As including all of these measures in a single VAR would lead to problems of multi-collineaerity and overparametrization, we instead augment the benchmark six-variable VAR with one additional variable at a time and combine the responses of the marginal variables into one graph. Again, we always calibrate the shock such that it lowers the two-year eurobond rate by 25 basis points.[5]

Figure 2 contains the results. The top left panel shows that core CPI increases gradually and peaks after roughly two years. The increase is both statistically and

[5]Note that the sample may change depending on the marginal variable included. In particular for inflation swap rates data become available only from 2008M9 onwards, which considerably reduces the sample for the VAR estimation.

economically significant. The shape of the response is similar to that of headline CPI but the maximum increase is only about half of the rise in headline CPI. The next two panels show the responses of two monthly survey-based measures of inflation expectations. The first one is a survey among financial market experts conducted by the Centre for European Economic Research (ZEW). The experts are asked for their inflation expectations for the euro area over the next six months. The impulse response shows that, as headline and core CPI increase, the differential between the share of analysts who expect to see a rising inflation rate and the percentage who anticipate a falling inflation rate widens significantly, by about five percentage points five months after the shock. The second measure is a survey among consumers conducted by the European Commission. It also qualitatively assesses inflation expectations over a horizon of twelve months. According to this measure, inflation expectations increase as well, but the rise is not statistically significant.

The remaining five variables in Figure 2 show the responses of financial market based measures of inflation expectations for different maturities, namely euro inflation linked swap rates. All inflation swap rates increase in response to the expansionary policy shock. As to expect, swap rates for shorter maturities increase by more than those for longer maturities and the effects lasts longer. From the impulse response of the five and ten-year swap rates, we compute the five-year, five-year forward swap rate, which has been one of the ECB's preferred measures in recent years. This indicator increases significantly on impact, by about five basis points, and for about two months. All in all, we note that the results for inflation swap rates need to be treated with caution as they are based on a relatively short sample period, which might lead to less precise estimates.

As a final step in evaluating the effectiveness of unconventional monetary policy we replace GDP in the benchmark specification with several alternative measures of economic activity, that are available at the monthly frequency. This exercise also serves as a further robustness check of our benchmark results. Figure 3 reports impulse responses of retail sales, industrial production, car registrations, and new orders. Except for retail sales, all activity measures increase significantly, either on impact or several months after the shock. In addition, the maximum responses all exceed the peak effect of GDP of roughly 0.6 percent As another robustness test, we show the dynamics of the six variables that enter the benchmark specification with the inclusion, one at a time, of the economic activity variables and of those inflation measure which are available for the full sample period as additional

seventh variable in Appendix C. The results for the baseline variables are qualitatively, and often quantitatively, relatively unaffected by the adding the additional variables.

3.3 Financial conditions

We now examine which channels transmit the unconventional monetary policy surprises to prices and economic activity. We start with an analysis of the responses of several bond yields and interest rates to see how different financial market segments are affected by the policy surprises. As before, the responses are computed by adding each variable to the benchmark specification, one at a time. The first two rows of Figure 12 show the effect on synthetic eurobond rates (without Germany) for different maturities, including the two-year rate for comparison, and the term spread. The latter is computed as the difference between the response of the ten- and two-year rate. All rates decline significantly on impact, before returning to their initial level after roughly one year. The decline in the ten-year rate is most persistent. The impact effects are stronger for shorter maturities, however. The response of the term spread, defined as the difference between the ten-year rate and the eurepo, is similar to the dynamics of the ten-year rate as there is hardly any movement in the eurepo.

In comparison, there is a small positive effect on the euribor, which overshoots along with the two-year rate after about one year. The more accentuated response of the euribor is consistent with it referring to unsecured interbank lending, while the eurepo refers to secured interbank lending, and the idea that central bank policy affects risk premia in interbank markets. The insignificant response of the eurepo upon impact supports our identification strategy of using yield spreads vis-à-vis Germany in the first-stage regression, as it shows that the monetary innovations we extract reflect unconventional policy actions orthogonal to key interest rate changes. Finally, we observe a short-lived increase in two-year yields of corporate bonds with AAA rating and a drop for several months in corporate BBB yields. While the latter response is as expected, the former seems to reflect a reduction in safe haven demand as the expansionary policy shock reduces risk aversion and uncertainty in financial markets.

Figure 5 contains the impact of the policy surprise on other financial asset prices. The top left panel shows the effect on the EUR/USD exchange rate. In line with Rogers et al. (2015), we find that the expansionary shock leads to an appreciation of the euro, which can be rationalized by a reduction in break-up

premia. The effect is relatively small, however. Conversely, there is a strong and long-lasting effect on equity prices. The Euro Stoxx 50 increases by nearly four percent on impact and stays above trend for about two years. Albeit more muted, this behavior is mirrored in the response of corporate CDS spreads, which decline on impact and for roughly one year. On the other hand, the dynamics of CDS spreads of banks and sovereigns are more closely tied to the evolution of sovereign yields. CDS spreads decline for some months, but then overshoot slightly. The last panel shows that ECB policy surprises also have an effect on the price of Brent oil, which significantly increases for roughly one year.

Finally, we investigate how these improvements in financial conditions translate into credit developments. For comparison, we repeat the response of credit volume to non-financial corporations from the baseline specification in Figure 6. The remaining panels show the dynamics of further credit variables that replace this variable in the VAR specification. The figure shows that credit volume to households increases significantly after about six month and for two years. Consistent with previous evidence (Boeckx et al., 2014), the peak in credit to households is earlier than that of credit to non-financial corporations and considerably lower, by a factor of approximately three. In contrast, there is an immediate and long-lasting jump in credit to monetary and financial institutions. Lastly, except for the rate on loans to non-financial corporations, the increase in credit volume is matched by lower credit costs. The consumer credit rate and the house purchase credit rate decline by approximately five basis points several months after the shock and return to trend only slowly. Overall, the results suggest that the transmission of unconventional monetary policy shocks runs through a variety of channels, including interest rates, other asset prices, and credit conditions.

3.4 Fiscal side effects

In this subsection, we assess whether the identified monetary surprises have fiscal side effects. These side effects are often discussed in the public and academic debate with some being more and some less controversial. While, for example, lower government debt ratios that result from unexpected increases in GDP and prices associated with a monetary surprise expansion are hardly regarded as problematic, there are concerns among officials in several countries of the euro area and in the European Commission that windfall savings on interest payments could delay the implementation of structural reforms and be used for additional fiscal outlays. According to their 2013 stability programs, for example, member states on average

planned reductions in the ratios of primary expenditure to GDP of 1.8 percentage points over the coming three years. In the Spring Forecast of 2015, the Commission however expects that the actual reduction is only 0.4 percentage points.

We start with an analysis of the behavior of the overall budget, debt, revenues and expenditures, before we decompose spending dynamics into the responses of different categories. Again, these variables are added to the benchmark specification one by one. Figure 7 shows that, consistent with standard theory, the government balance improves following the surprise monetary stimulus that lowers sovereign yields and raises output and prices. The maximum response occurs after about one year and equals 2.5 billion euro. In terms of 2010 nominal GDP, this number is equivalent to a rise in the monthly balance/GDP ratio of 0.3%. To see how much the unexpected increase in the price level contributes to the improvement in the nominal balance, the next panel shows the response of the real balance. It shows that the response in the real balance is very similar to the response of the nominal one. The following two panels contain the responses of nominal government debt and the debt/GDP ratio. Nominal debt declines significantly several months after the shock. The trough is after two years and the reduction is 40 billion euros. In terms of GDP, the improvement is even larger as output increases, reducing the debt ratio by nearly one percentage point.

The last two panels decompose the dynamics of the overall budget into changes in revenues and expenditures. This separation facilitates a first tentative decomposition of fiscal policy into two dimensions, automatic stabilizers and the systematic response of fiscal policy, and their contribution to the evolution of the overall budget. To obtain an impression of the second dimension, we focus on the expenditure side as automatic stabilizers are typically estimated to be small here (see Fedelino et al., 2009), making a distinction between both dimensions of fiscal policy largely redundant and thereby avoiding potential problems associated with a quantification of the size of automatic stabilizers.

In line with conventional theory of automatic stabilizers (see Van den Noord, 2000), we find that revenues increase as output exceeds trend, contributing to the improvement in the overall budget. A quantitative comparison of the responses of revenues and GDP (see Figure 1) shows that there is nearly a one-to-one relationship between both variables. This number is consistent with official estimates of the elasticity of revenues with respect to the output gap of unity in OECD countries. The response of expenditures, in contrasts, is difficult to reconcile with the theory of automatic stabilizers. The official estimate of the elasticity of ex-

penditures in the euro area is –0.1 (see Girouard and André, 2006), predicting a decline in expenditures when output increases. Moreover, spending is also expected to decline as interest payments are lowered through the monetary surprise expansion. Conflicting with both predictions, the response of expenditures shows a strong, persistent, and mostly significant increase over a horizon of roughly four years. This suggests that spending policy is conducted in a procyclical manner in response to the non-standard monetary policy innovation.

We investigate this preliminary indication further by decomposing expenditures into its subcategories. Figure 8 shows that indeed the monetary expansion leads to a significant reduction of net interest payments which fall for about one year. The unanticipated drop in interest payments in turn is associated with a significant increase in primary expenditures, which closely matches, but exceeds that of total expenditures. A further decomposition shows that the rise in primary expenditures is driven by a persistent and strong increase in both government consumption and public investment. The response of investment is consistent with the decline in public interest rates triggered by the monetary shock, making investment projects more profitable. The response of government consumption suggests that windfall profits from lower interest rates are used to increase intermediate good consumption and compensation of public employees. Social security contributions, on the other hand, tend to fall as output rises and the unemployment rate declines. Albeit not being statistically significant, the decline in social expenditures is consistent with the notion of automatic stabilizers on the spending side working mostly through unemployment benefits, age- and health-related outlays as well as incapacity and sick benefits (see Darby and Melitz, 2008). All in all, the estimates illustrate that the monetary policy shock is not only associated with improvements in the public budget balance and the debt ratio but also with windfall savings which are partly used to increase primary expenditures.

4 Country heterogeneity

In this section, we investigate whether and to which extent euro area member countries respond differently to a common monetary policy surprise which lowers the euro area two-year rate by 25 basis points. To keep the results for the individual countries comparable to those for the euro area, we add the country variables one by one to our benchmark specification. For a focused discussion, we concentrate on the four largest countries Germany, France, Italy and Spain, which together

account for roughly 80% of euro area GDP. We first present the responses of several key monetary variables, such as output and prices, at the country level before we analyze how these dynamics translate into relative price changes and associated movements in trade balances internal to the euro area. Then, we investigate how national fiscal authorities react to monetary innovations.

4.1 Output, (relative) prices, and internal balances

Figure 9 contains the estimated effects of the expansionary monetary policy shock on country-specific two-year rates, stock market indexes, GDP, and CPI. Compared to the benchmark specification for the euro area, we use stock market instead of volatility indexes since the latter are not available for all countries. Nevertheless, equity prices should also reflect investors' risk appetite to some extent. The top row shows a sharp contrast between the response of the two-year rate in Germany and France on the one hand and Italy and Spain on the other hand. While yields increase in the former two countries, they decrease in the latter. The German yield rises by 0.1 percentage points on impact and for roughly six months. The effect on the French yield is a somewhat smaller. In stark contrast, Italian and Spanish yields decline sharply upon impact, by 40 and 60 basis points, respectively, and remain below trend for about one year.

This positive (rather than negative) reaction of German and French yields can be explained by two factors, among others. First, particularly during the height of the euro area debt crisis, government bonds of both countries were seen as a safe haven for financial investors within the euro area investment nexus. As the non-standard policy interventions reduced financial market uncertainty and increased risk appetite, the demand for safe-haven assets declined. Second, several of the policy measures contained in our sample most likely also affected the perceived risk of a break-up of the euro area. They thereby reduced devaluation risks contained in government bond prices of stressed countries, leading investors to re-balance portfolios.

Remarkably, despite the increase in sovereign bond yields, the response of the other variables shows that Germany and France nevertheless profit from the expansionary shock. Equity prices, real GDP, and CPI increase significantly for more than a year, indicating that other channels, such as trade or financial linkages unrelated to sovereign yields, might play a role in transmitting the monetary stimulus to these countries. Nevertheless, the large drop in yields in Spain and Italy leads to relatively stronger increases in equity prices, GDP, and CPI. These dynamics,

while welcome from viewpoint of steering prices at the euro area level, could also have unintended side effects. Specifically, relative price developments within the monetary union could lead to a widening of intra-euro area trade balances, increasing surpluses in Germany and deficits in other countries. We investigate this issue next.

Figure 10 shows the responses of the CPI-difference of France, Italy, and Spain relative to Germany, that is, the CPI based bilateral real exchange rates, together with the dynamics of the respective bilateral trade balances. Save for a small impact decline France, the response of bilateral exchange rates in France and Italy is insignificant. Conversely, relative prices in Spain increase significantly on impact and for more than two years. The maximum response is 0.2 percent after about 18 months. These real exchange rate movements are largely matched by the bilateral trade balances. The response of net imports of France is not distinguishable from zero, while Spanish net imports from Germany increase significantly roughly six months after the shock and reach a peak of more than 100 million. Net imports of Italy also increase, albeit this is not accompanied by a real appreciation. Finally, the impact responses of the trade balances are consistent with the idea that price effects dominate the dynamics in the very short run. While Spain experiences a real appreciation and a drop in nominal net imports, in France a real depreciation is matched with an jump in net imports. Altogether, the results indicate that policies which are aimed at stabilizing aggregate output and prices can have unintended side effects on relative prices and internal trade balances.

4.2 National fiscal policy

In this subsection, we return to the question of how fiscal policy responds to the monetary surprise, but focus on individual member states as fiscal policy is largely determined at the country level. Figure 11 decomposes the dynamics of total expenditures into the responses of the underlying spending components. The top row shows the behavior of net interest payments. Consistent with the responses of sovereign yields to the common monetary shock (see Figure 9), interest payments in Italy and Spain fall, whereas they tend to increase in Germany and France. In Spain the effect is both statistically and economically significant, in Italy it is small, however, and in Germany and France it is not statistically significant.

Regarding the other expenditure components, which are more directly controlled by the national fiscal authorities, we find mostly positive responses in Spain and Italy. Both countries increase government consumption and social benefits.

While they also raise public investment, the effect is not statistically significant. In France, save for a small increase in government consumption, fiscal policy is largely unresponsive, whereas in Germany it appears to be countercyclical with respect to shifts in monetary policy. Overall, the results suggest that some countries use windfall profits from unexpected interest savings to increase public consumption and, to a lesser extent, social benefits.

5 Conclusions

We estimate the macroeconomic effects of unconventional monetary policy in the euro area using a structural VAR, identified with an external instrument. We find that policy interventions are effective in stabilizing the economy and countering risks to financial stability. An expansionary policy shock leads to an increase in prices, output, and inflation expectations. Shock transmission runs through a variety of channels, including interest rates, asset prices, and credit conditions. At the same time, the estimates reveal that primary fiscal expenditures rise following the monetary shocks and that relative prices as well as trade balances within the union diverge. These findings thus entail a note of caution to monetary policy makers that policies which are intended to support the economy can in fact lead to laxer fiscal policy and to an increase of internal imbalances.

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A Figures

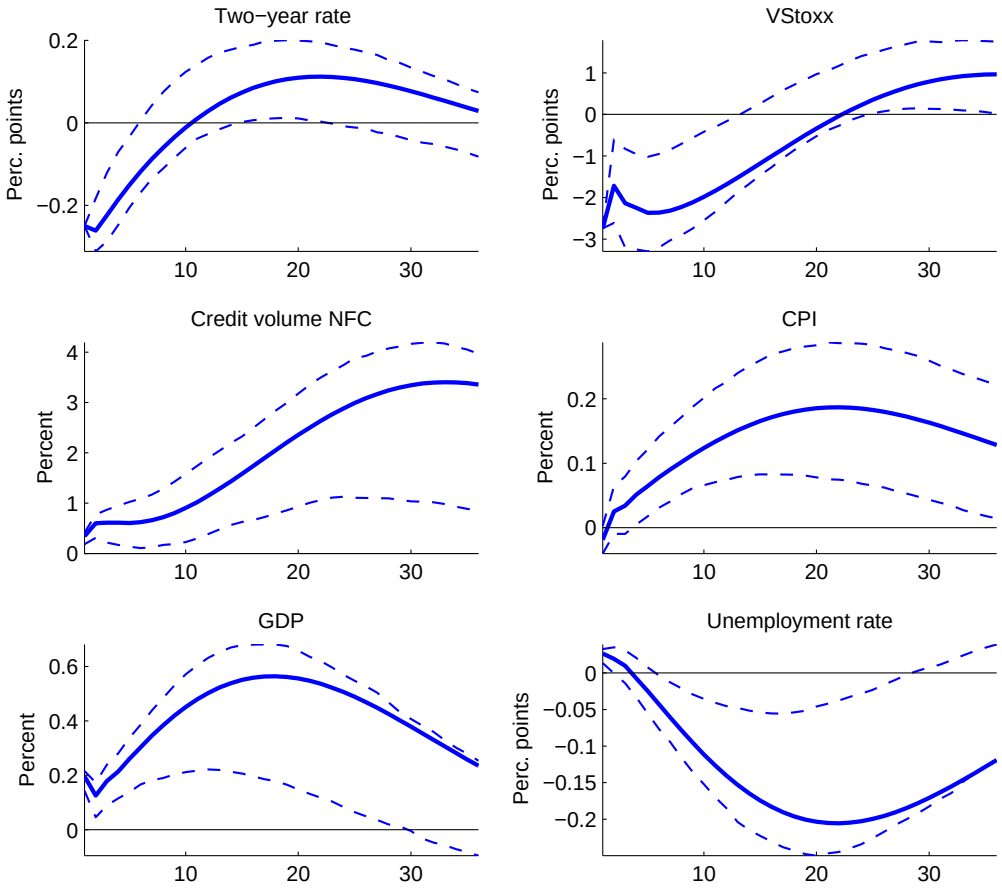

Figure 1: Benchmark estimates for the euro area. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 1999M1 until 2015M6.

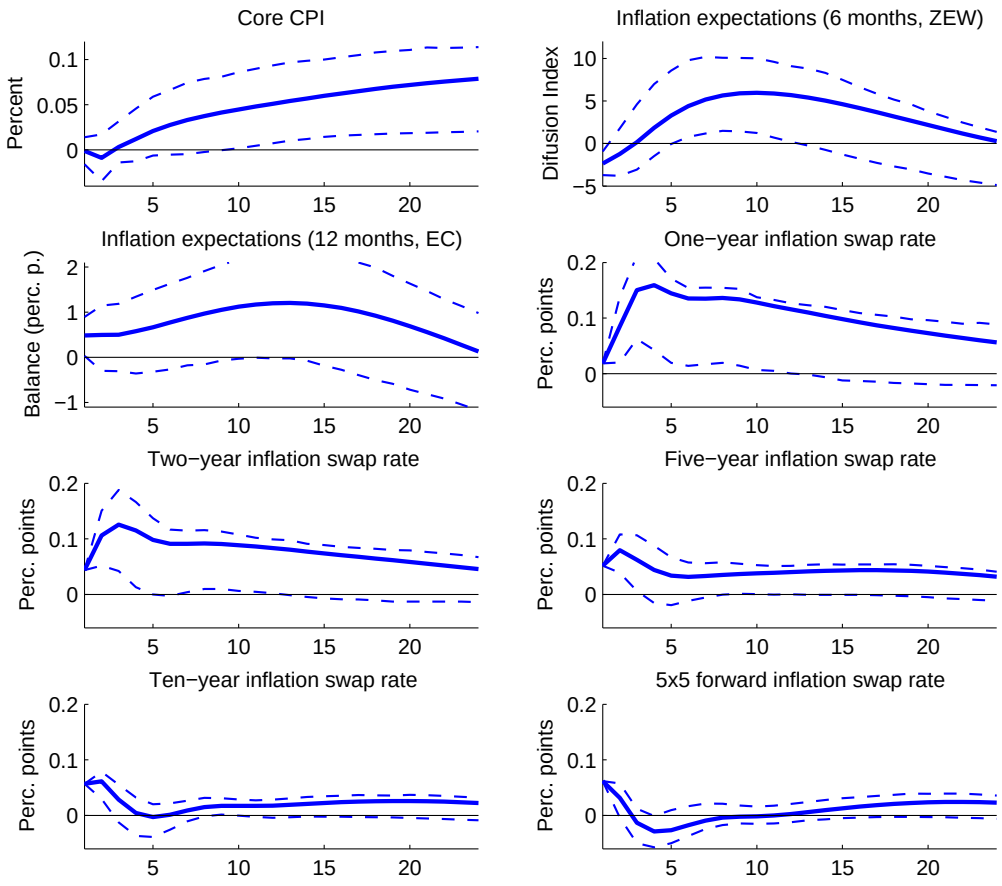

Figure 2: Inflation and inflation expectations. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 1999M1 until 2015M6 for the first three variables and 2008M9 until 2015M6 for the other variables.

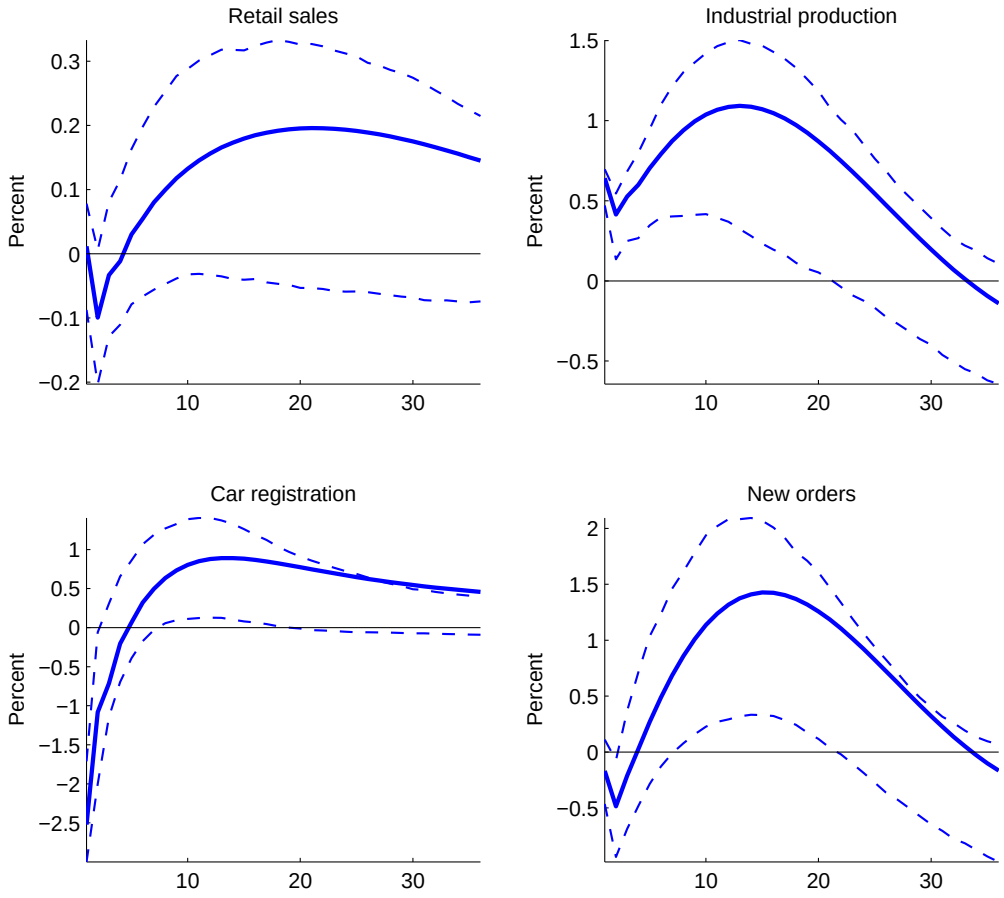

Figure 3: Alternative measures of economic activity. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 1999M1 until 2015M6.

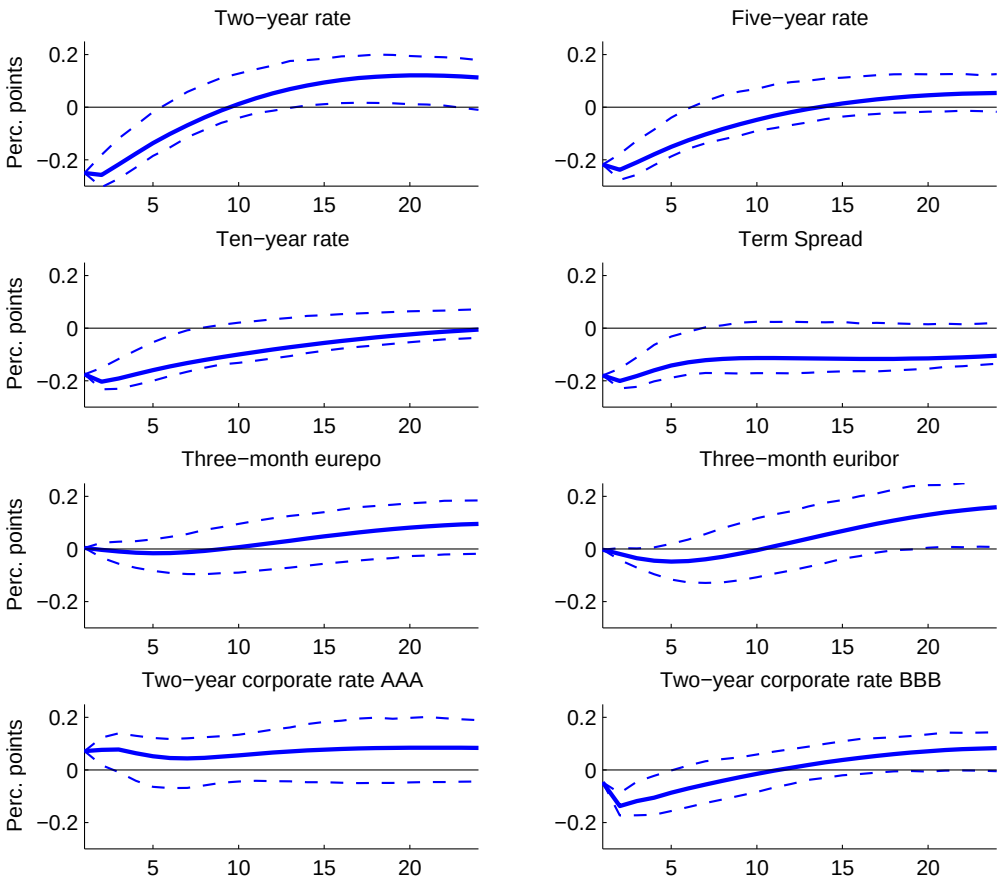

Figure 4: Government bond rates, money market rates, and corporate bond rates. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 2002M4 until 2015M6 for the corporate rates and 1999M1 until 2015M6 for the other variables.

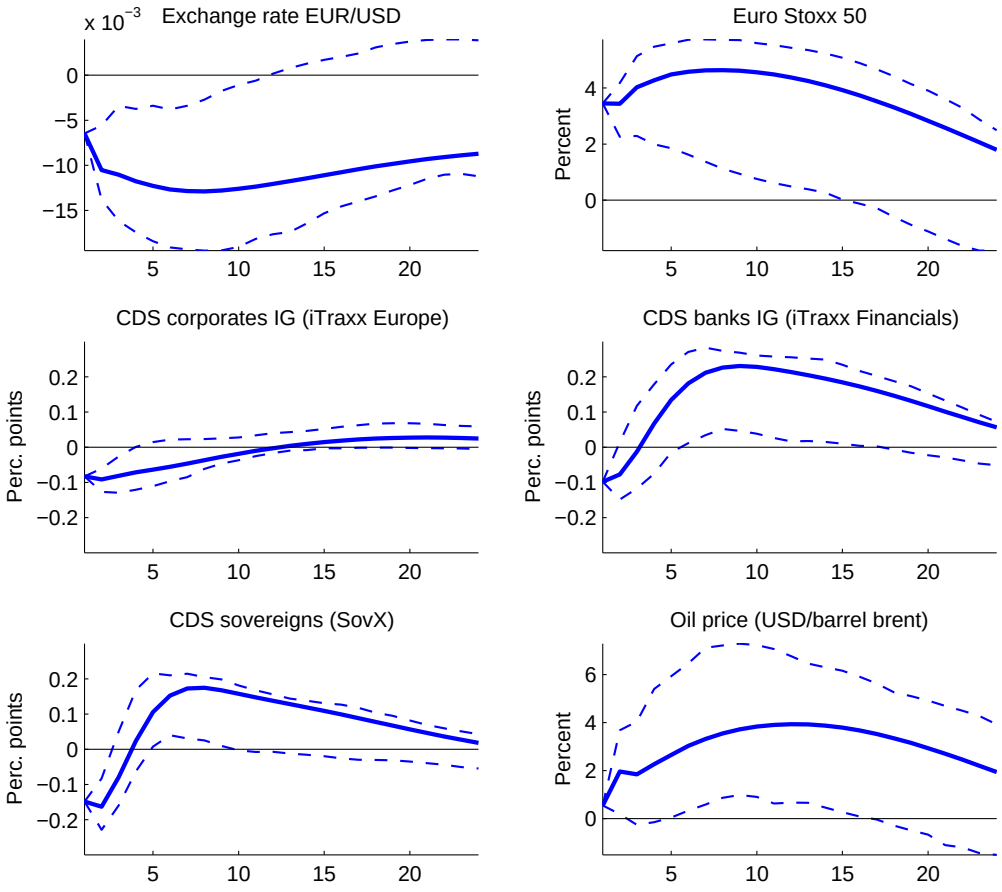

Figure 5: Other financial variables. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 2003M1 until 2015M6 for the CDS on banks and sovereigns, 2005M4 until 2015M6 for the CDS on corporates, and 1999M1 until 2015M6 for the other variables.

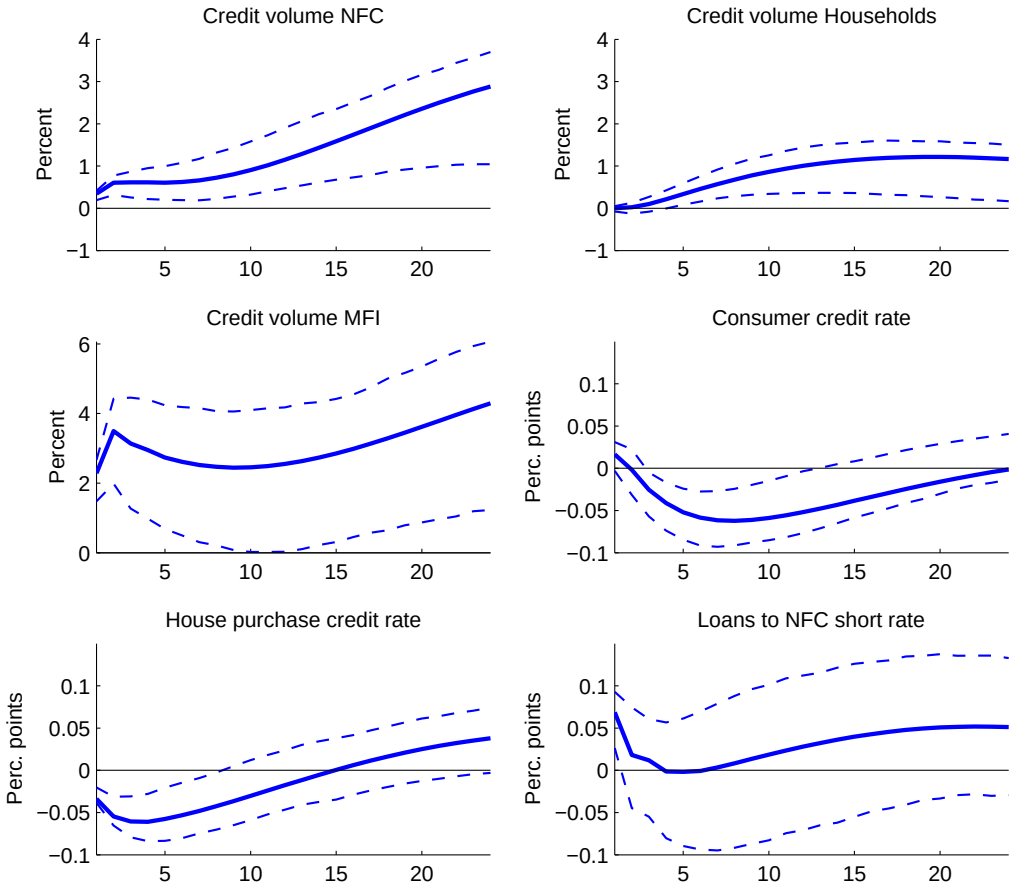

Figure 6: Credit volume and credit rates. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 2003M1 until 2015M6 for the house purchase rate, 2000M1 until 2015M6 for the other rates, and 1999M1 until 2015M6 for the credit volumes.

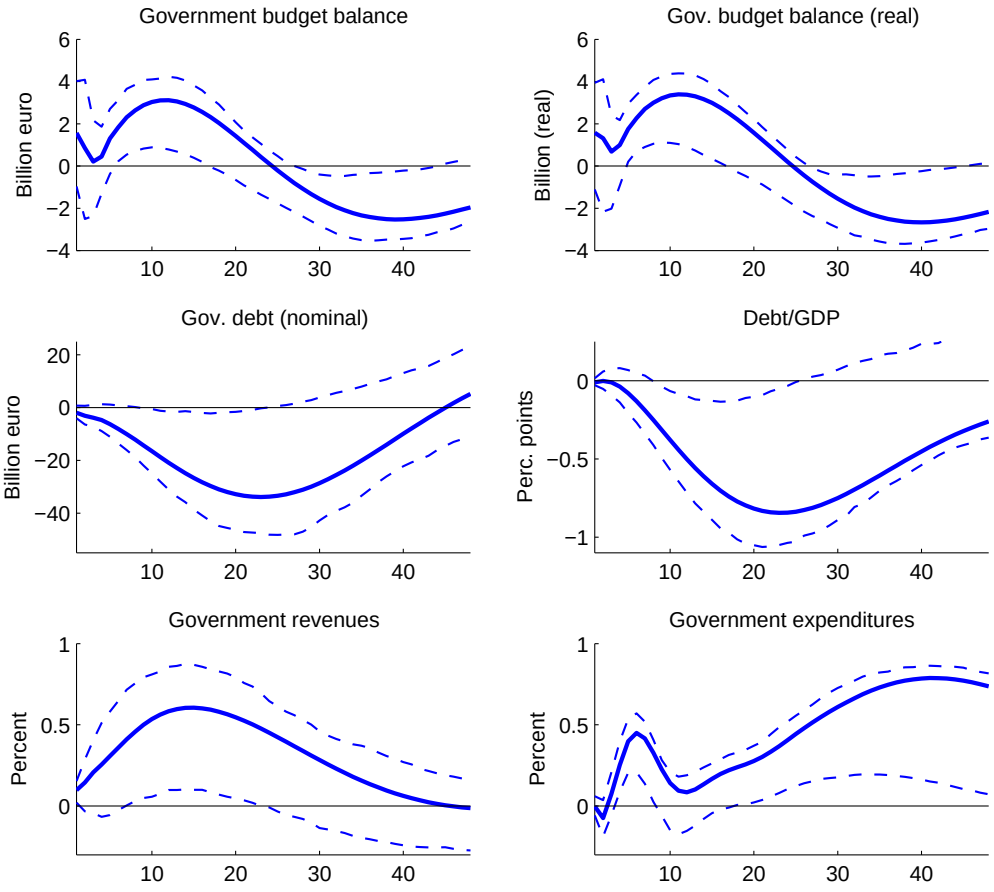

Figure 7: Government budget balance and debt. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 2003M1 until 2015M6 for the budget balance and debt, 2000M1 until 2015M6 for debt/GDP, and 2000M3 until 2015M6 for revenues and expenditures.

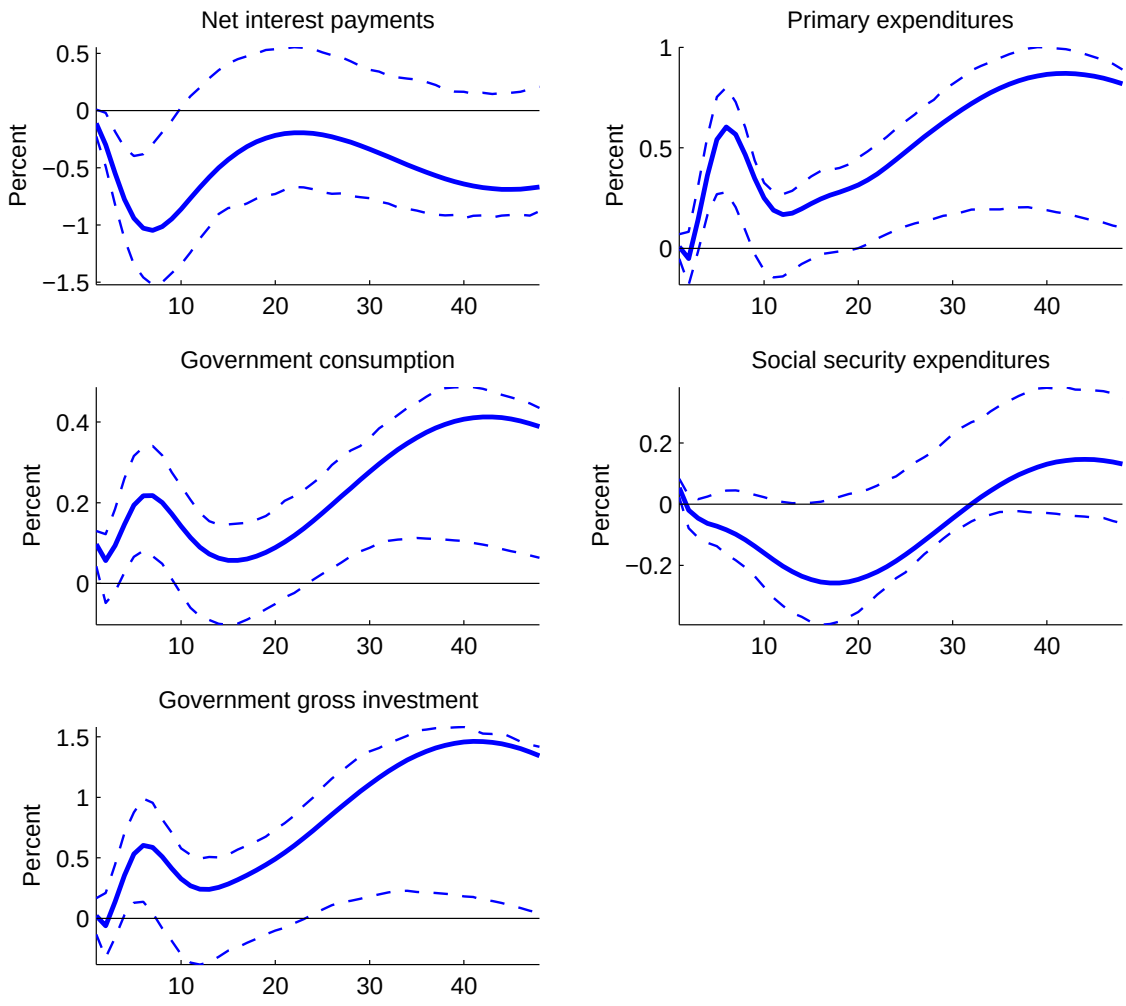

Figure 8: Government expenditure by category. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 2002M3 until 2015M6.

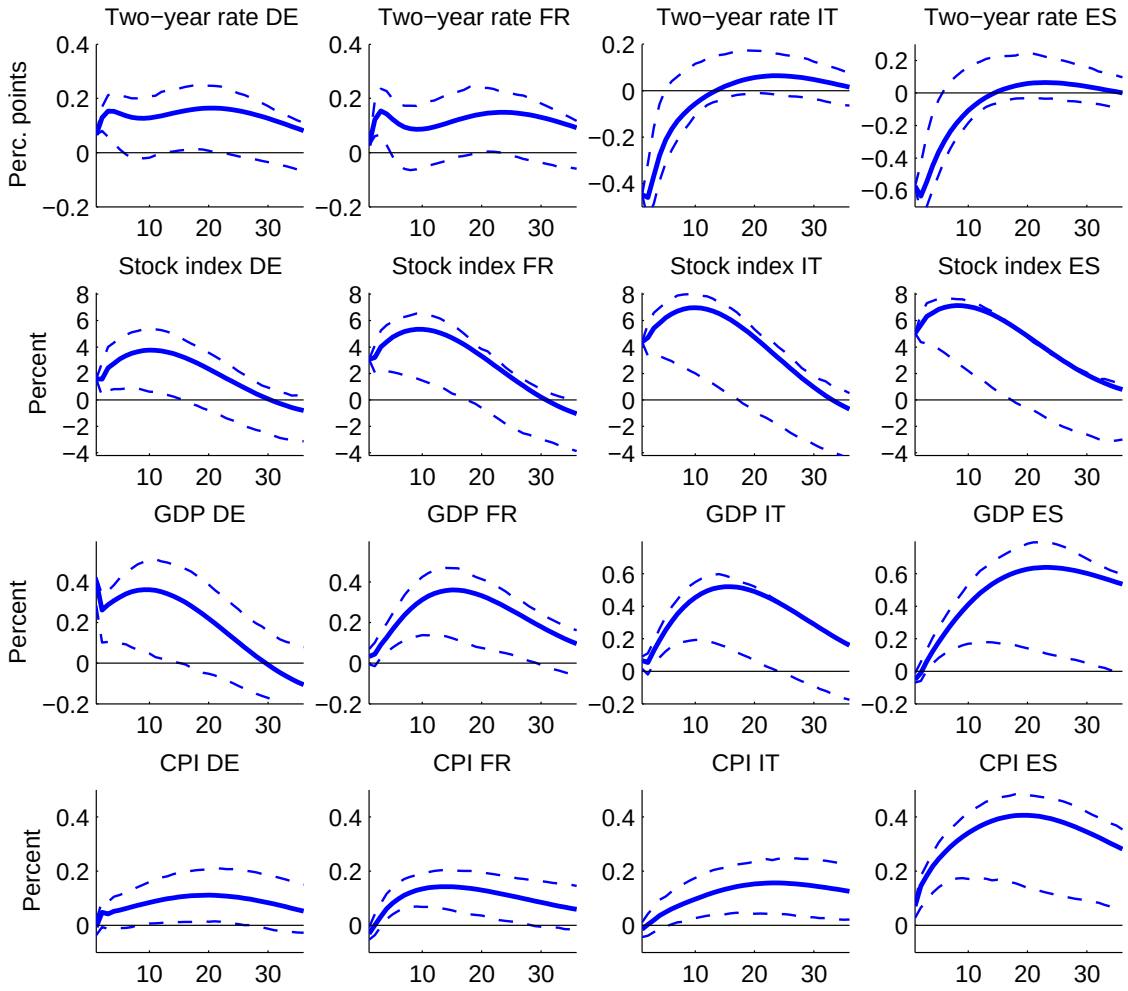

Figure 9: Baseline results for country level. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected country-specific variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 2000M1 until 2015M for the stock indices and 1999M1 until 2015M6 for the other variables.

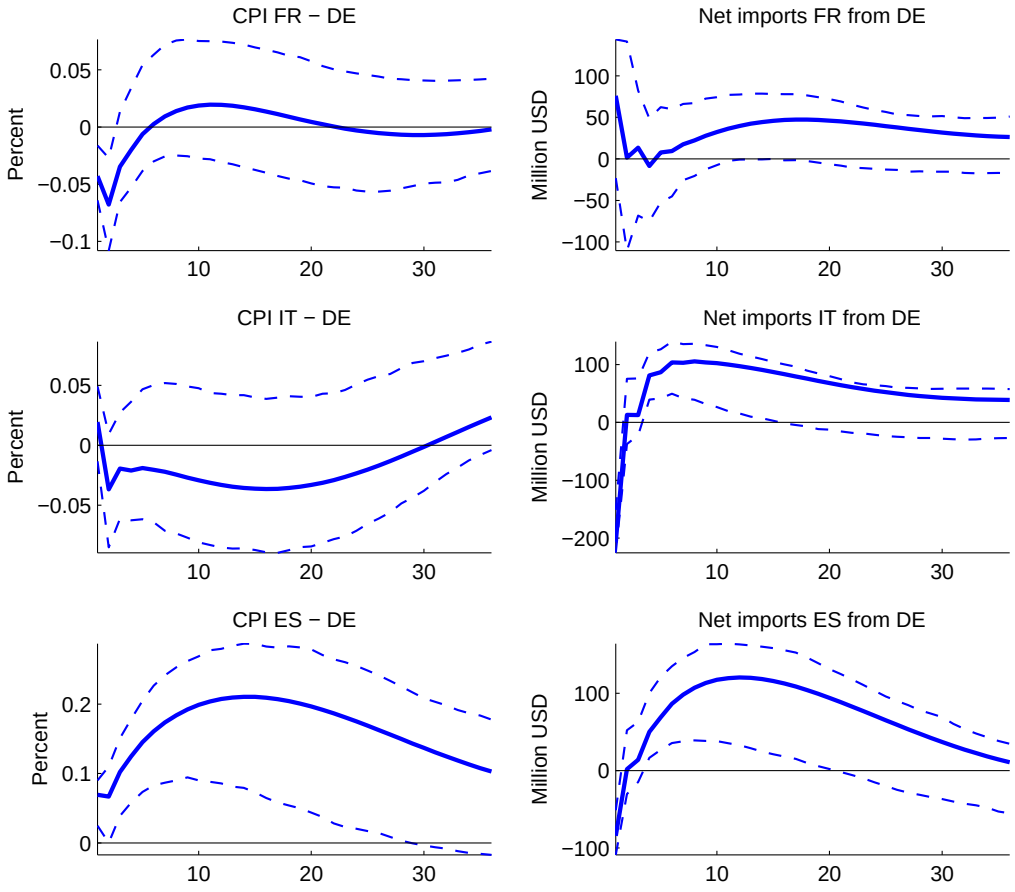

Figure 10: Bilateral real exchange rates and trade balances. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected country-specific variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 2001M1 until 2015M6 for the net imports and 1999M1 until 2015M6 for the CPI differences.

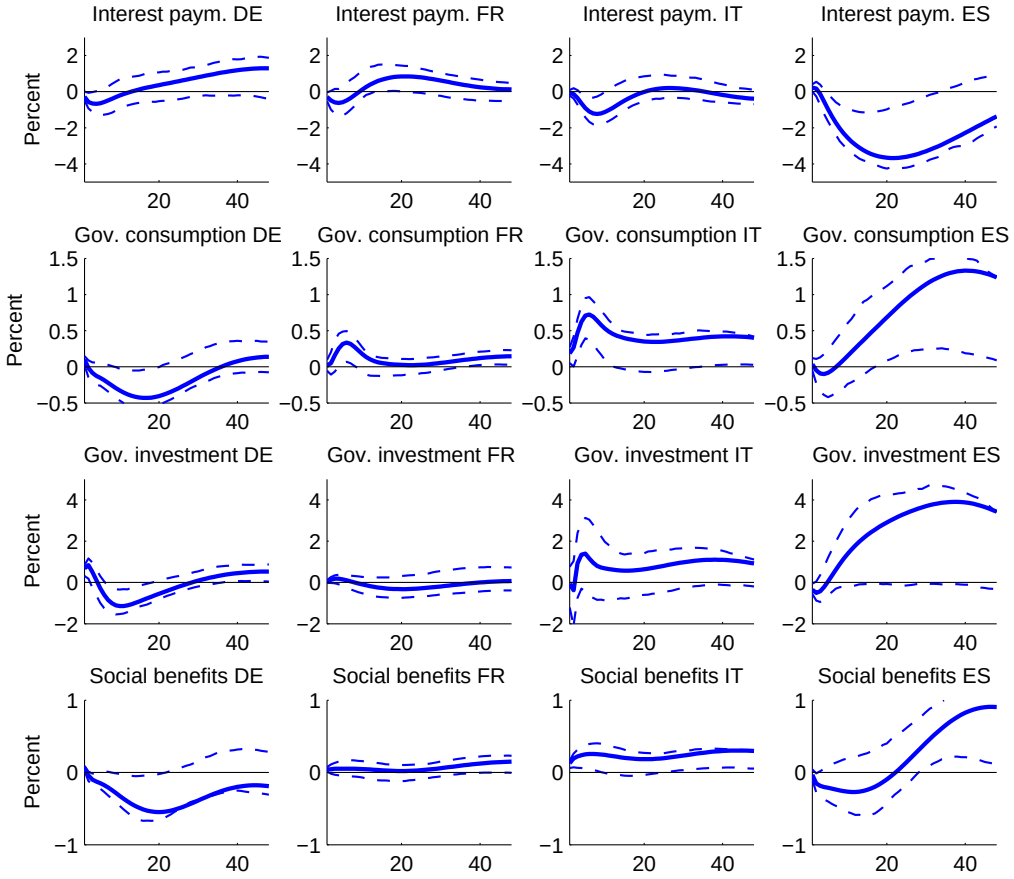

Figure 11: National government expenditures. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected country-specific government expenditure components to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 2002M3 until 2015M6 for the German variables, 2000M3 until 2015M6 (interest payments) or 1999M1 until 2015M6 (consumption, investments, benefits) for the other countries.

B Data and sources

Table 1: Data construction and sources

Variable	Construction and source
Sovereign bond yields	Yield to redemption of sovereign bonds. Source: Datastream.
Euro area sovereign bond yields without Germany	Synthetic yields for euro area bonds are computed as weighted averages of nine individual countries: Austria, Belgium, Finland, France, Ireland, Italy, Netherlands, Portugal, and Spain. The weights are taken from euro area Benchmark Bond Yields in Datastream.
Stock market volatility	VStoxx option implied volatility. Source: Datastream.
Credit measures	Credit to non-financial firms, households, and monetary financial institutions. Source: ECB data warehouse. Seasonally adjusted with X-ARIMA-13.
Consumer price indices	Source: Datastream.
Real GDP and Industrial Production	Source: Datastream. Monthly IP series are seasonally adjusted with X-ARIMA-13. Quarterly GDP is interpolated using the series on IP and the method of Chow and Lin (1971).
Unemployment Rates	Source: Eurostat.
Inflation Expectations	Source of survey data: Centre for European Economic Research (ZEW), Germany, and European Commission. Source of inflation swaps: Datastream.
Real activity indicators	Retail sales, new car registrations, and new orders in manufacturing. Source: Datastream.
Other financial market variables	Eurepo, Euribor, EUR/USD spot exchange rate, Euro Stoxx 50, national stock price indices, CDS for sovereigns (SovX), corporates (iTraxx Europe), and banks (iTraxx Financials), yields of corporate bond indices with 2yr maturity and ratings AAA and BBB. Source: Datastream.
Oil Price	Price of Brent Crude Oil in US dollar. Source: Datastream.
Surprise component in economic data releases	Difference between the first-released data and the expected value (median expectation of a panel of experts surveyed by Bloomberg). The difference is divided by the standard deviation of the expectations. Source: Bloomberg. Variables from the following countries are included (see Table 2 for details): Euro Area, Germany, France, Italy, Spain, UK, and US.
Credit Rates	Source: ECB / Datastream. Cons. Credit: Personal Lending Rates, New Loans, Consumer Credit (Excluding Bank Overdrafts), 1-5 Years. House purchases: Personal Lending Rates, New Loans, House Purchases (Excluding Bank Overdrafts), 10 Years +. Loans to NFC (short): Prime Rates, New Loans, 1 Million Euro +, Excluding Bank Overdrafts, 1-5 Years.
Government budget balance / debt	Monthly euro area aggregated budget balance from Datastream. Seasonally adjusted with X-ARIMA-12. Converted to real terms using euro area CPI. Series on debt is obtained by cumulating the monthly balances.
Government debt-to-GDP	Quarterly debt-to-GDP for ten individual countries (Aus., Bel., Fin., Fra., Ger., Ire., Ita., Net., Por., and Spa.), aggregated using GDP weights. Source: Datastream. Seasonally adjusted with X-ARIMA-12 and linearly interpolated to monthly frequency.
Government revenues and expenditures (total and in detail)	Source: Eurostat (Consumption: intermediate consumption plus compensation of employees, social security expenditure: social benefits and social transfers in kind, gross investment: capital expenditure). Euro area aggregates based on data for ten individual countries: Aus., Bel., Fin., Fra., Ger., Ire., Ita., Net., Por., and Spa. Quarterly data is seasonally adjusted with X-ARIMA-12/13 and then linearly interpolated to the monthly frequency. Converted to real terms using CPIs.
Net imports	Imports minus exports vis-a-vis Germany. Source: German Federal Statistical Office (Destatis). Seasonally adjusted with X-ARIMA-13.

Table 2: List of included economic data releases

Euro area	**France**	**Germany**	**US**
EC Bus. Climate Ind.	CPI YoY	CPI YoY	CPI YoY NSA
Current Account Net WDA SA	CPI MoM	CPI MoM	CPI Ex. Fd. & En. YoY NSA
EC Cons. Conf. Ind.	Cons. Conf. Ind.	Manu. Ord. YoY NSA	Pers. Cons. Exp. CPI YoY SA
CPI YoY	Bus. Conf. Ind. (Manu.)	Manu. Ord. MoM SA	CPI MoM SA
CPI MoM	Prod. Outlook Ind.	Trade Balance Val. Exp. MoM SA	Un. of Michigan Cons. Conf. Ind.
BOP Current Account Net NSA	Bus. Sent. Ind.	Trade Balance Val. Imp. MoM SA	Gov. Budget Balance
New Orders (Manu.) YoY	Cons. Spending MoM	Trade Balance EUR NSA	Cons. Spend. GR MoM SA
Gr. Fx. Capital Formation QoQ	CPI ex Tobacco	Retail Sales NSA YoY	Markit Manu. PMI SA
EC Serv. Conf. Ind.	real GDP QoQ	Retail Sales SWDA MoM	Ind. Prod. MoM SA
Markit Comp. PMI SA	real GDP YoY	Prod. Prices MoM	Core PPI
Markit Serv. PMI SA	ML & OS Unemployment Rate	Ind. Prod. YoY NSA WDA	PPI - Fin. Goods
Retail Sales Vol. YoY WDA	Markit Manu. PMI SA	Ind. Prod.n MoM SA	In. Jobless Claims SA
Retail Sales Vol. MoM SA	Markit Serv. PMI SA	Ind. Prod. YoY SA	Housing Starts/Permits
ZEW Exp. of Econ. Growth (Econ. Sent.)	PPI MoM	Unem. Rate SA	Diff. between Exp. and Imp.
Trade Bal. with non EZ Countries	PPI YoY	Unem. Change SA	GDP QoQ SAAR
M3 Money Supply 3 M. Mov. Avg.	Jobseekers Total SA	Ifo Pan Bus. Climate	PPI Fin. Goods SA MoM%
PPI Industry Ex Constr.YoY	Trade Balance EUR	Ifo Pan Bus. Expectations	Cap. Util.n % of Tot. Cap.
PPI Industry Ex Constr. MoM	Manu. Prod. MoM SA	Current Account EUR	Bus. Inventories MoM SA
Unem. Rate	Own-Comp. Prod. Outlook	Import Price Index MoM	Avg. Hourly Earnings YoY% SA
GDP SA QoQ (real SA)		Markit Manu. PMI SA	Avg. Hourly Earnings MoM% SA
		GDP Priv.Cons. QoQ	Constr. Spend. Total MoM SA
		GDP Gr. Fx. Capital Inv. QoQ	Dur. Goods New Orders Ind. MoM SA
		GDP Inv. in Const. QoQ	Conf. Board Leading Ind. MoM
			Prod. Output ph Nonfarm Bus. Sec. QoQ SA
			Unit Labor Costs Nonfarm Bus. Sec. QoQ % SAAR
Italy	**UK**	**Spain**	Retail Sales SA MoM % Change
CPI NIC Incl Tbc. YoY NSA	CPI Ex En. Fd. Alc.l & Tbc. YoY	CPI YoY	Personal Income MoM SA
CPI NIC Incl Tbc. MoM NSA	GDP YoY	CPI Core YoY	Nonfarm Payrolls Total MoM SA
Cons. Conf. Ind. SA	GDP MoM	PPI MoM	
Bus. Conf. Manu. Sector	Retail Sales Ex Auto. Fuel YoY SA	Trade Balance EUR	
Hourly Wages MoM SA	Retail Sales Ex Auto. Fuel MoM SA	Reg. Unem. Level MoM Net Change	
Ind. Orders YoY NSA	PPI Manu.Prod. YoY NSA	Avg Labor Costs per Worker YoY	
Ind. Orders MoM SA	PPI Manu. Prod. MoM NSA	PMI Manu. SA	
Ind. Prod. YoY WDA	PPI Input Prices MoM NSA		
Ind. Prod. MoM SA	PPI Input Prices YoY NSA		
Ind. Prod. YoY	Ind. Prod. YoY SA		
Ind. Sales YoY	Unem. Rate SA (Change)		
Ind. Sales MoM SA	Markit/CIPS Const. PMI SA		
Manu. PMI SA	Markit/CIPS Serv PMI SA		
Serv. PMI SA	Govt. Budget Balance		
PPI Manu. MoM	Priv. Cons. QoQ		
PPI Manu. YoY	House Price Ind. MoM SA		
PPI Manu. YoY	Cons. Conf. Ind.		
Priv. Cons. QoQ SA WDA	Gov. Spending QoQ		
Retail Sales MoM SA			
Retail Sales YoY			
Trade Balance Total			
Unem. Rate SA			
Real GDP YoY SA WDA			
Trade Balance Non EU NSA			

Table 3: List of included ECB Monetary Policy Announcements

Date	Policy Announcement
22.08.2007	Supplementary liquidity-providing longer-term refinancing operation (LTRO) with a maturity of three months
28.03.2008	LTROs with a maturity of six months
29.09.2008	Special term refinancing operation
08.10.2008	Fixed rate tender procedure with full allotment on the main refinancing operation(MROs)
15.10.2008	List of assets eligible as collateral in Eurosystem credit operations extended
07.05.2009	LTROs with a maturity of one year
04.06.2009	Details on Purchase program for covered bonds (CBPP)
03.12.2009	Phasing out of 6-month LTROs, indexation of new one year LTROs
04.03.2010	Phasing out of 3-month LTROs, indexation of six month LTROs
10.05.2010	Securities Markets Program (SMP)
28.07.2010	Risk control measures in collateral framework reviewed
03.03.2011	Further LTROs
09.06.2011	MROs as fixed rate tender procedures with full allotment (FRFA) for as long as necessary, at least until October 2011
04.08.2011	Further LTROs with a maturity of three and six months
08.08.2011	ECB will actively implement its Securities Market Program
06.10.2011	New covered bond purchase program (CBPP2)
08.12.2011	Two additional LTROs with a maturity of three months
21.12.2011	Results of first three year LTRO
09.02.2012	ECB's Governing Council approves eligibility criteria for additional credit claims
28.02.2012	Results of second three year LTRO
06.06.2012	FRFA on MROs as long as necessary, and at least until January 2013
26.07.2012	'Whatever it takes...' speech of ECB President Mario Draghi in London
02.08.2012	Outright Monetary Transactions program (OMT)
06.09.2012	Technical features of OMT
06.12.2012	FRFA on MROs as long as necessary, and at least until July 2013
22.03.2013	Collateral rule changes for some uncovered government guaranteed bank bonds
02.05.2013	FRFA on MROs as long as necessary, and at least until July 2014
04.07.2013	Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time (open-ended forward guidance)
08.11.2013	FRFA on MROs as long as necessary, and at least until July 2015
05.06.2014	Targeted longer-term refinancing operations (TLTROs)
03.07.2014	Details on TLTROs published
22.01.2015	Expanded asset purchase program

C Additional material not for publication

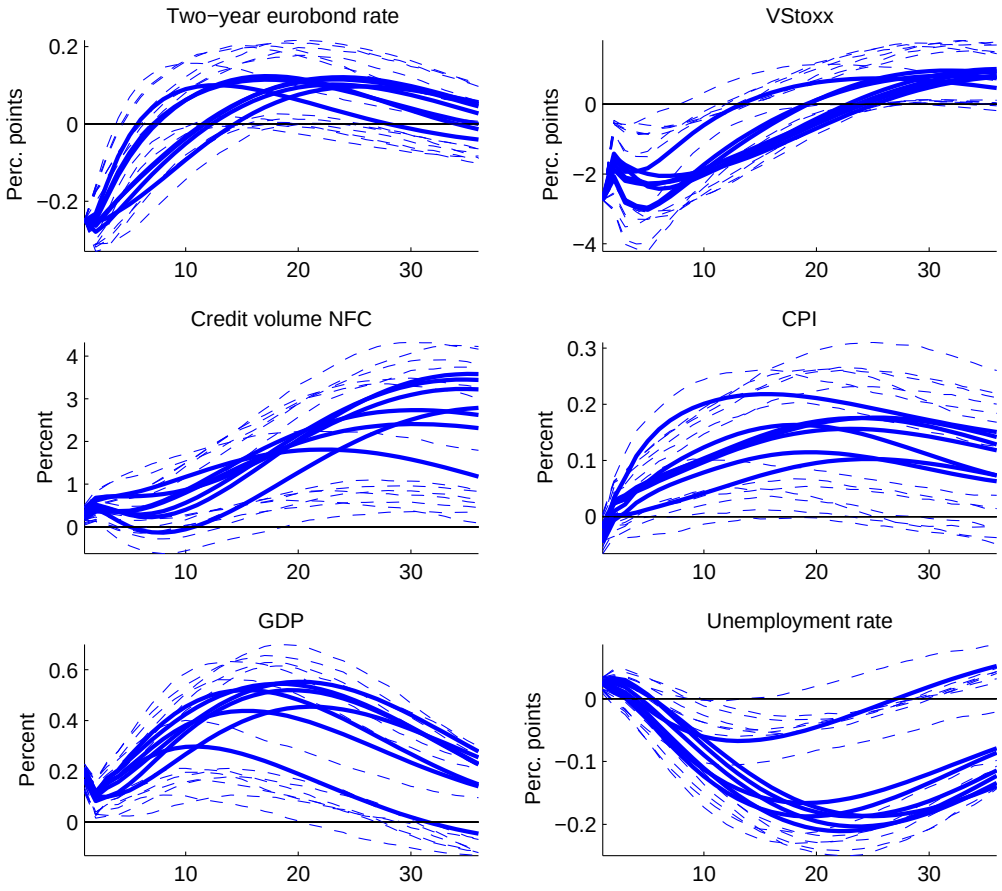

Figure 12: Robustness of benchmark variables to including additional variables. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of the benchmark variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points when including additional variables, one at a time, to the benchmark VAR. The sample is 1999M1 until 2015M6.

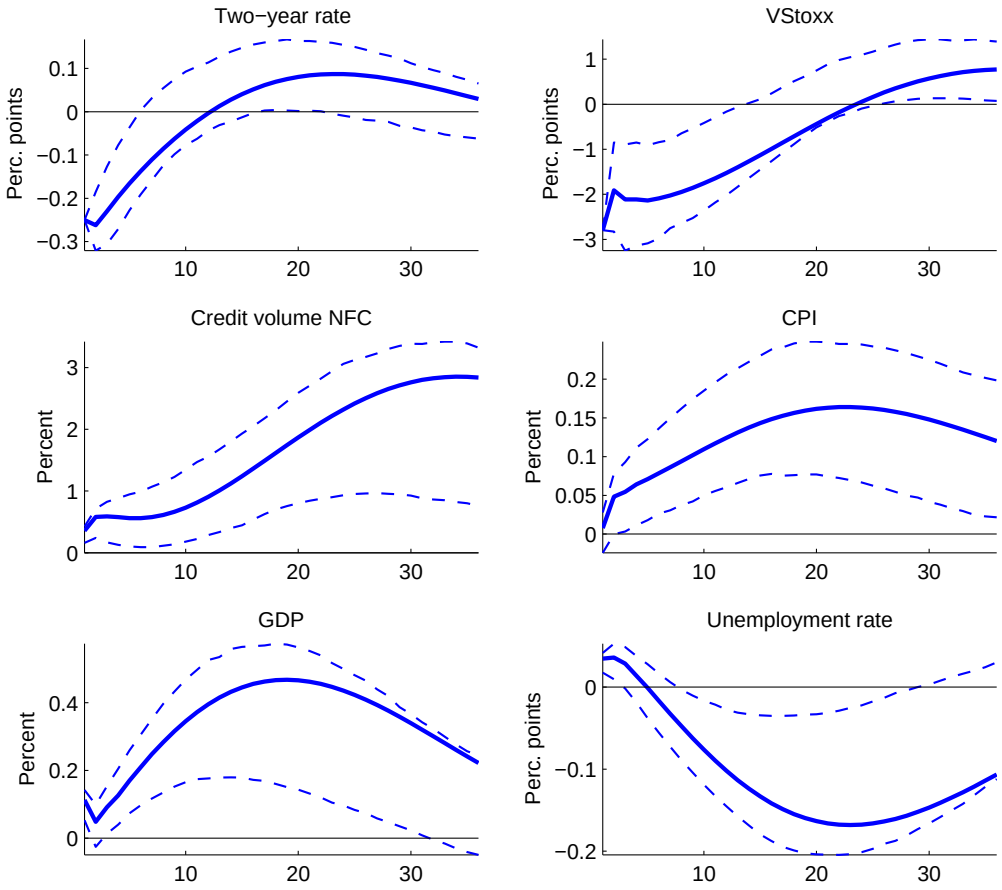

Figure 13: Robustness of benchmark specification to a 80% Windsorization of the external instrument. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 1999M1 until 2015M6.

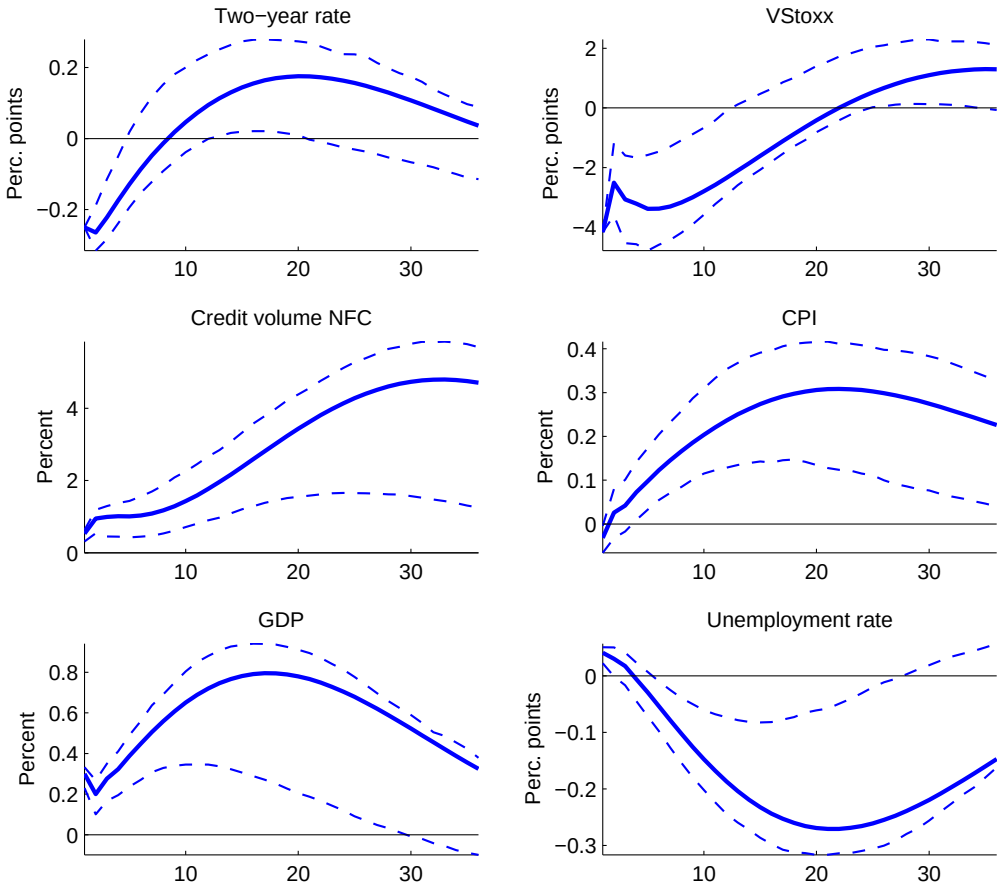

Figure 14: Robustness of benchmark specification to including German bond yields in the computation of the euro area average two-year yield. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers the two-year rate on eurobonds by 25 basis points. The sample is 1999M1 until 2015M6.

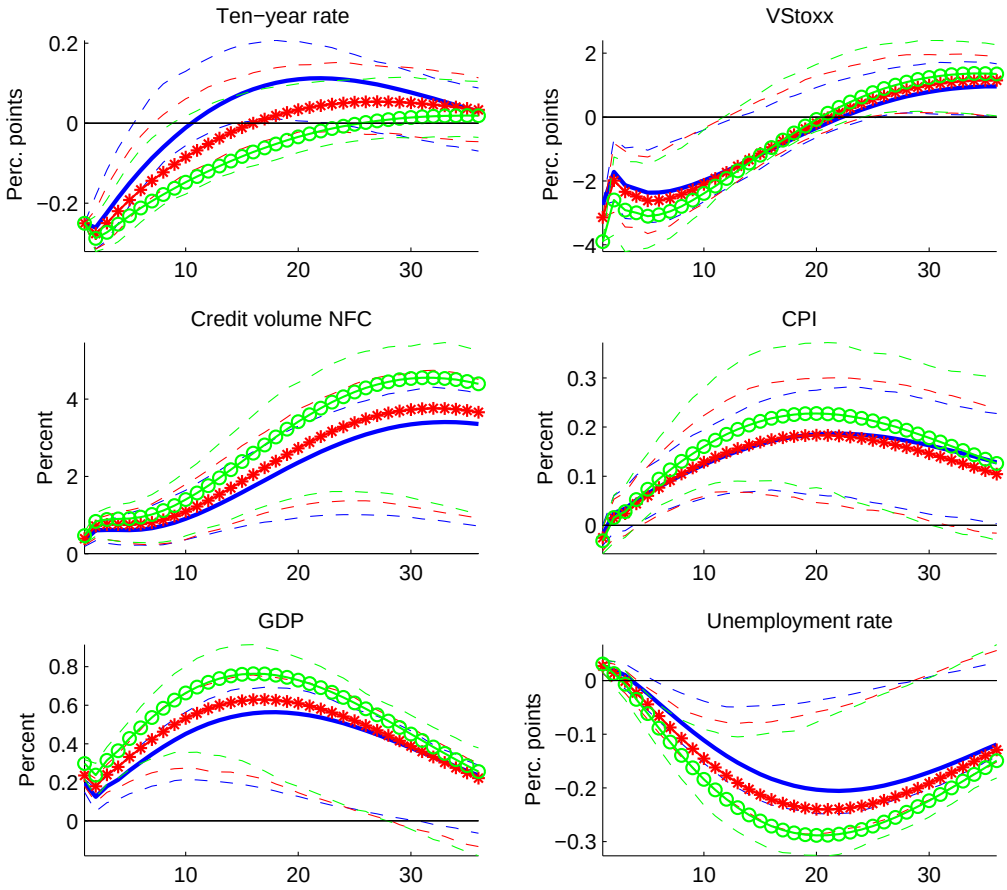

Figure 15: Robustness of benchmark specification using eurobonds of different maturities as policy instrument. *Note:* The figure shows the estimated impulse responses, along with their 90 percent confidence bands obtained using 500 bootstrap replications, of selected euro area variables to a monetary policy shock that lowers either the two-year rate (blue lines), the five-year rate (red lines, Asterisk) or the ten-year rate (green lines, Circles) on eurobonds by 25 basis points. The sample is 1999M1 until 2015M6.