The Financial and Macroeconomic Effects of the OMT Announcements*

Carlo Altavilla,[a] Domenico Giannone,[b] and Michele Lenza[a,c]
[a]European Central Bank
[b]Federal Reserve Bank of New York and CEPR
[c]ECARES-ULB

This paper evaluates the macroeconomic effects of the announcements of the European Central Bank's Outright Monetary Transactions (OMT) program. Using high-frequency data, we find that the OMT announcements decreased the Italian and Spanish two-year government bond yields by about 2 percentage points, while leaving unchanged the bond yields of the same maturity in Germany and France. These results are used to calibrate a scenario in a multi-country model describing the macrofinancial linkages in France, Germany, Italy, and Spain. The scenario analysis suggests that the reduction in bond yields due to the OMT announcements is associated with a significant increase in real activity, credit, and prices in Italy and Spain, with some relatively muted spillovers in France and Germany.

JEL Codes: E47, E58, C54.

1. Introduction

Since the onset of the financial crisis in August 2007, the Eurosystem has engaged in several unconventional monetary policy measures

*We would like to thank Günter Coenen, Stefania D'Amico, Carlo Favero, Philipp Hartman, Geoff Kenny, Tobias Linzert, Roberto Motto, Massimo Rostagno, Frank Smets, Giovanni Vitale, and participants at several seminars for their comments. The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank, the Eurosystem, the Federal Reserve Bank of New York, or the Federal Reserve System. Please address any comments to Carlo Altavilla (carlo.altavilla@ecb.europa.eu), Domenico Giannone (domenico.giannone@ny.frb.org), or Michele Lenza (michele.lenza@ecb.europa.eu).

in order to ensure the correct pass-through of the monetary policy stance to the economy.

In the first phase of the crisis, the non-standard measures were mostly intended to address impairments in the interbank markets. The major concern was to avoid a credit crunch stemming from liquidity and funding problems for banks. In this respect, the introduction of the fixed-rate full-allotment liquidity provision significantly contributed to limit bank funding stress. By accommodating all bids in the liquidity operations, this policy avoided banks' wholesale funding problems related to the freezing of the interbank market. However, with the financial fragmentation associated with the sovereign debt crisis that emerged in 2010, and the resulting concerns of international investors about excessive national debt in several euro-zone countries, the intervention activities have expanded to the secondary sovereign bond markets. Moreover, the initial increase in bond yields in Greece, Ireland, and Portugal subsequently spread to Italy and Spain, which faced a high cost of servicing their debt, arguably higher than would be justified by looking at economic fundamentals (see Hördal and Tristani 2013 for an empirical illustration of this point).

Among other forms of intervention aiming at avoiding impairments in the monetary policy transmission,[1] in the period July to September 2012 the Governing Council of the European Central Bank (ECB) announced the possibility to engage in outright monetary transactions (OMT) in the secondary markets for government bonds. In particular, on July 26, 2012, during a conference in London, President Draghi said that the ECB was ready to do "whatever it takes" to preserve the euro within the limits of its mandate. On August 2, 2012, during the press conference after the Governing Council meeting, President Draghi announced that the "ECB may undertake outright open market operations." Finally, on September 6, 2012, the ECB's Governing Council announced a number of technical features regarding the OMT program. More precisely, the ECB announced that no ex ante quantitative limits would be considered

[1]See, for example, Rivolta (2012), Szczerbowicz (2012), Eser and Schwaab (2013), Falagiarda and Reitz (2013), and Ghysels et al. (2014) for a discussion and an evaluation of unconventional monetary policy and, in particular, of the effects of the Securities Market Programme (SMP).

for the outright transactions in secondary sovereign bond markets, purchases would concentrate on bonds with a remaining maturity of up to three years, and without seniority (pari passu), and bond purchases would be conditional.

After almost two years since its announcement, none of the euro-area countries has activated the OMT. However, asset prices such as bond prices should have, at least in part, incorporated the information publicly available to market participants. Indeed, casual observation suggests that the OMT announcements may have had a significant impact on the financial sector (see, for example, Draghi 2013). In turn, changes in financial prices altered the behavior of private agents, potentially affecting real economic activity. This paper aims to quantify the financial and macroeconomic impact of the OMT *announcements* on four euro-area countries: Germany, France, Italy, and Spain. We conduct our evaluation in two stages.

First, in order to isolate the effects of the announcements on financial prices, we look at daily data on bond yields and conduct an event study along the lines of Altavilla and Giannone's (2014) study on the effects of the Federal Reserve's large-scale asset purchases (LSAPs). The main idea is to assess the effects of the policy announcements through the regression of sovereign bond yields on event dummies (taking value one in the date of the event, the OMT announcements, and zero elsewhere) while, at the same time, controlling for all the other relevant "news" made publicly available in the period under analysis. The "news" is the surprise component of macroeconomic and other relevant releases, i.e., the difference between the data release and the corresponding expectation of market participants (evaluated by looking at 151 categories of releases for the euro area, France, Germany, Italy, and Spain, made available by Bloomberg). We evaluate the impact of the OMT announcements on a measure of the "target" bond yields—assumed here to be the two-year government bond rates—and on ten-year government bond rates. The main outcome of the event study is that the OMT announcements had significant impacts on the bond yields of Italy and Spain—in particular, within the range of maturities indicated by the ECB as the target of the measure: Italian and Spanish two-year bond yields have declined by about 2 percentage points. At the same time, yields at similar maturities for Germany and France were not significantly affected.

Second, we employ a multi-country macroeconomic model in order to assess the macroeconomic impact of the previously estimated changes in bond yields due to the OMT announcements. For each of the four countries in our study, the model includes six variables (real GDP, consumer prices, M3, retail credit, and government bond rates for the two- and ten-year maturity) and also a measure of the ECB policy rate and expected euro-area aggregate bond market volatility. We allow for country heterogeneity, cross-country spillovers in the policy effects, and rich dynamics among countries/variables by adopting a flexible vector autoregressive (VAR) specification. For the estimation of the VAR, we address the high-dimensional data problem (twenty-six variables, five lags, and a quarterly sample starting in 1999:Q1) and use Bayesian shrinkage as suggested in Banbura, Giannone, and Reichlin (2010). In practice, the assessment of the likely macroeconomic effects of the OMT announcements is conducted over a horizon of three years after the announcements by comparing two scenarios, defined as "OMT" and "no-OMT" scenarios. The two scenarios mostly differ in the dynamics of the yield curve which, as we conclude from the event study previously described, were strongly affected by the OMT announcements. In particular, in the OMT scenario, for the whole horizon of three years, we assume that the two-year bond yields in Italy and Spain are about 2 percentage points lower than in the no-OMT scenario, while they are the same in France and Germany. In order to isolate as much as possible the effects of non-standard policy, we also assume that standard monetary policy is the same in the two scenarios. Our evaluation suggests that the OMT announcements are likely to be associated, in the three years following the announcements, with relevant increases in the real economy, consumer prices, and credit in Italy and Spain. France and Germany are only very moderately affected by the OMT announcements. The euro-area bond market volatility is likely to be lower in the OMT scenario than in the no-OMT scenario.

A growing amount of research has focused on the financial effects of the non-standard measures implemented in different countries. For the United States, using event-study methodology, Gagnon et al. (2011) found that QE1 decreased the bond rates by 91 basis points (bps). Krishnamurthy and Vissing-Jorgensen (2011) focus on both QE1 and QE2. They estimate that the impact of the first program on the safety premium reduced yields by more than 100 bps, with the second program having a more muted effect (about 20 bps). D'Amico and King (2013), instead, estimate that the effects of Federal Reserve purchases of Treasury securities during QE1 ($300 billion) has produced a decrease in the ten-year Treasury yield of almost 50 basis points. Joyce et al. (2011) suggest that QE measures adopted in the United Kingdom lowered long-term gilt yields by about 100 basis points and that most of the decline was generated by portfolio balance effects. Altavilla and Giannone (2014) find that the overall effect of the non-standard measures implemented in the United States—i.e., QE1, QE2, QE3, and forward guidance—have significantly decreased the long-term interest rate of about 200 bps. Finally, for the euro area, Rivolta (2012), Szczerbowicz (2012), Eser and Schwaab (2013), Falagiarda and Reitz (2013), and Ghysels et al. (2014) show that the Securities Market Programme (SMP) of the Eurosystem was successful at lowering yields relative to a situation of no intervention and at reducing market volatility and improving market functioning.

For the euro area, Lenza, Pill, and Reichlin (2010) estimated the effects of the post-Lehman unconventional liquidity policy by evaluating the elasticity of euro-area unemployment and industrial production to changes in money-market rates in a setup which bears some resemblance to the one in this paper.

In this paper, we carry out an event study to assess the financial effects of the ECB's unconventional policy in order to quantify asset prices changes between the policy and no-policy scenarios using a novel multi-country model. The model presented in the paper also allows for cross-country heterogeneity. The elasticity to changes in the bond yields implied by the estimated macroeconomic effects of the OMT announcements for Italy and Spain lie broadly in the middle of the range of estimates of the effects of LSAP policies in the United States and QE in the United Kingdom. For the United States, Chen, Cúrdia, and Ferrero (2012) provide the lower boundary, while Chung et al. (2012) and Baumeister and Benati (2013) provide the upper boundary. For the United Kingdom, Kapetanios et al. (2012) find that a permanent decrease in the term spread by 100 basis points would imply an increase in the level of GDP that ranges between 0.7 and 2.7 percent. The structure of the paper is the following. Section 2 elaborates on the event-study-based estimation of the impact of

OMT announcements on the yield curve of France, Germany, Italy, and Spain. Section 3 describes the multi-country VAR model and illustrates the macroeconomic impact of the OMT announcements. Section 4 concludes.

2. The Financial Effects of the OMT Announcements

In order to assess the effects of the OMT announcements on the Treasury bond markets in France, Germany, Italy, and Spain, we estimate for each country (in the sample from January 2007 to February 2013) the following equation:

$$\Delta y_t = c + \alpha D_t + \beta News_t + \varepsilon_t. \tag{1}$$

Equation (1) relates the daily changes in the financial variables of interest Δy_t (the changes in the two-year or ten-year bond yields) to a vector of event dummies D_t (i.e., variables with value one in the "event days" and zero elsewhere). Precisely, the dummies take value one in the day of the announcement and the day after, i.e., we assume a two-day event window. Such choice is driven by the consideration that during a period of low liquidity, the prices of bonds may react slowly in response to an announcement. The event dummies reflect the three major events related to the announcement of the OMT and that occurred between July and September 2012. The estimation is carried out by means of standard regression techniques.

We augment the regression estimated in classical event-study analysis by controlling for the main news stemming from economic releases, $News_t$, which could have influenced bond rates (see Altavilla and Giannone 2014 for a more detailed explanation of this method). More in detail, the "controlled" event-study analysis aims at taking into account all macroeconomic news that materialized within each event window and that could have, possibly, influenced the two- and ten-year government bond rates in that particular time window. For this purpose, the analysis uses a real-time data set that captures the information available to market participants at each point in time. In order to address the challenging task of reconstructing the information set of market participants, we use a data set available in Bloomberg. This data set provides, for each economic release at any point in time, the corresponding expectations of a panel of market participants. The expected values are median (consensus) forecasts collected before (up to one day) the official data release. For each of the 151 variables included in table 5, a time series of (standardized) daily news can be computed as the difference between the first-released (real-time) data and its expected value. This time series represents a measure of the news content of all the most relevant releases on economic data in the period under analysis. In fact, if a certain release is perfectly forecasted, then the release cannot be considered as "news" to market participants, and it would hardly affect asset prices. On the contrary, if a certain release is imperfectly forecasted, it contains some "news" for market participants and, hence, is likely to affect asset prices.[2] The estimated α coefficients return the effects of the policy measure. Standard tests can be used to evaluate whether the sum of the coefficients on the event dummies is statistically different from zero. Results are reported in table 1 for two different specifications of equation (1): in the "classical" specification, the alternative news is not included in the regression, while in the "controlled" specification it is included.

OMT announcements have been much more effective in reducing the government bond rates in Italy and Spain than in Germany and France, where bond markets have not significantly reacted to the policy events. The reduction in the two-year bond yields in both Italy and Spain is about 200 bps, while the effects on the ten-year bond rates in both countries are smaller, approximately 100 bps, consistently with the target of the policy measure, which explicitly focuses on the yields of bonds with remaining maturity up to three years. Table 1 also reveals that once the effects of all macroeconomic news are taken into account, the estimated effects of the OMT announcements do not significantly change. This suggests that the announcements are the most relevant news within the event window.

The reliability of event studies rests on the assumption that policy changes are immediately incorporated in prices and that their effects are persistent. These assumptions might not hold, especially in periods of financial turbulence. Another possible shortcoming of high-frequency analysis is the inability of capturing, because of the focus on a narrow time window, possible lagged effects and reversals.

[2]Appendix 1 provides some more details on the macroeconomic news we control for in our exercises.

Table 1. The Effects of OMT Announcements on Sovereign Bond Markets (in basis points)

Country	Maturity	First Announcement		Second Announcement		Third Announcement		Total
		July 26, 2012	**July 27, 2012**	**Aug. 2, 2012**	**Aug. 3, 2012**	**Sept. 6, 2012**	**Sept. 7, 2012**	
Classical								
DE	Two Years	0	1	−2	5	4	1	8
FR	Two Years	−7	−4	2	1	5	1	−4
IT	Two Years	−83	−24	−8	−61	−12	−12	−199***
ES	Two Years	−77	−43	−17	−70	0	−27	−234***
DE	Ten Years	4	7	−8	10	8	3	23*
FR	Ten Years	−7	0	−3	3	1	−3	−9
IT	Ten Years	−40	−12	33	−20	−21	−23	−82***
ES	Ten Years	−42	−24	28	0	−40	−37	−115***
Controlled								
DE	Two Years	0	1	−2	5	1	2	7
FR	Two Years	−6	−5	2	1	2	1	−5
IT	Two Years	−72	−16	−7	−62	−8	−9	−175***
ES	Two Years	−69	−30	−17	−71	2	−23	−209***
DE	Ten Years	6	6	−8	9	7	3	23*
FR	Ten Years	−4	−1	−3	2	4	−2	−4
IT	Ten Years	−33	−10	34	−21	−17	−22	−69***
ES	Ten Years	−37	−14	28	−1	−37	−36	−97***

Notes: The table reports for the days of the OMT announcements and the following days the results of the event study. The last column reports the results of the "classical" and "controlled" event-study analysis as a sum of the change in the days of announcements using a two-day event window. Controlled eventy study refers to the eventy-study regression in equation (1) where the daily changes in each selected asset price are regressed on event dummies and 151 macroeconomic news. *, **, and *** denotes significance of the F-test for abnormal return at 10 percent, 5 percent, and 1 percent, respectively.

To check whether the announcements of asset purchases may have had only a temporary impact on asset prices, we increase the size of the event window up to five consecutive days. Table 2 reports the cumulative changes in the two- and ten-year government bond yields as well as for the five-year sovereign credit default swap (CDS) as estimated with both classical and controlled event-study analysis. The results suggest that the impact of the announcements has been very persistent, with no signals of possible rebound in the following days.[3]

3. The Macroeconomic Effects of the OMT Announcements

The OMT announcements contributed to a *statistically* significant reduction in the spreads of long-term bond yields of Italy and Spain with their German counterparts, allowing a more even pass-through of the ECB accommodative monetary policy stance across euro-area countries. In this section, we provide an assessment of the *economic* significance of these effects on the yield-curve spreads, by turning to the evaluation of the likely macroeconomic effects of the OMT.

3.1 Data and Empirical Model

The analysis of the macroeconomic effects associated with the OMT announcements is based on a multi-country model of the macrofinancial linkages in France, Germany, Italy, and Spain. More in detail, for each country, six variables are included (real GDP, Harmonised Index of Consumer Prices (HICP), M3, retail credit, and government bond rates with the remaining maturity of two and ten years). The model also includes, as a measure of the common standard monetary policy actions, the euro-area overnight money-market rate (EONIA) and a measure of expected euro-area bond market volatility.[4] In order to allow for country heterogeneity, cross-country spillovers in the policy effects, and rich dynamics among countries/variables, all

[3] Appendix 2 reports the same results for other asset prices.

[4] Overall, the model includes twenty-six variables, available at the quarterly frequency in the sample 1999:Q1–2014:Q1. For more information on the data, see appendix 3.

Table 2. Asset Price Reactions (in Basis Points) and the Length of the Event Window

	Size of Event Window									
	One Day		**Two Days**		**Three Days**		**Four Days**		**Five Days**	
Variable	**Classical**	**Controlled**	**Classical**	**Controlled**	**Classical**	**Controlled**	**Classical**	**Controlled**	**Classical**	**Controlled**
Two-Year Government Bond										
Germany	1	−3	8	7	2	1	4	0	9	3
France	−1	−2	−4	−5	−8	−9	−8	−12	−7	−11
Italy	−103	−85	−199	175	−190	−159	−154	−130	−190	−172
Spain	−94	−77	−234	209	−325	−296	−286	−267	−291	−278
Ten-Year Government Bond										
Germany	4	7	23	23	23	24	22	23	33	32
France	−8	2	−9	−4	−10	0	−20	−10	−19	−11
Italy	−27	−10	−82	−69	−74	−53	−80	−57	−107	−86
Spain	−53	−39	−115	−97	−158	−139	−144	−129	−145	−133

Note: The table reports the results of the event-study analysis for different sizes of event windows.

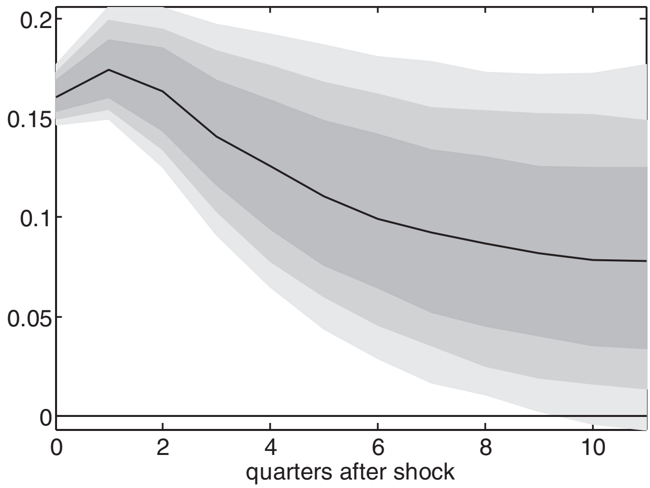
possible interactions among variables/countries are left unrestricted by adopting a flexible vector autoregressive (VAR) specification in (log-)levels and with five lags. For the estimation of the VAR, we address the high-dimensional data problem (twenty-six variables, five lags) and use Bayesian shrinkage as suggested in De Mol, Giannone, and Reichlin (2008) and Banbura, Giannone, and Reichlin (2010). The latter show that if the data are collinear, as is the case for macroeconomic variables, the relevant sample information is not lost when overfitting is controlled for by shrinkage via the imposition of priors on the parameters of the model to be estimated. The hyperparameters controlling for the informativeness of the prior distributions are treated, as suggested in Giannone, Lenza, and Primiceri (2015), as random variables so that we also account for the uncertainty surrounding the prior setup in our evaluation. Appendix 3 at the end sketches the main features of the setup.

3.2 An Illustration of the VAR Dynamics: The Effects of a Standard Monetary Policy Tightening

As a preliminary step, in order to document the ability of our approach to capture the main dynamic interrelationships between the variables, we study the economic developments in the different countries triggered by a tightening of standard monetary policy. More specifically, we estimate the reaction of GDP, consumer prices, credit, M3, the yield curve, and of euro-area aggregate bond market volatility to an exogenous monetary policy shock.

In order to identify the monetary policy shock, we use a recursive identification scheme (see Christiano, Eichenbaum, and Evans 1999 for an extensive discussion and economic interpretation of this type of identification scheme). The overnight money-market rate (EONIA) is assumed to proxy for the monetary policy rate. Our central assumption is that it takes at least one month for a change in the common euro-area monetary policy rate to transmit to real GDP and consumer prices in the four countries under analysis. Credit, M3, and the yield curve in all countries and euro-area bond market volatility, instead, can be affected contemporaneously by the change in the policy rate. Figure 1 shows the dynamics of the policy rate in response to an exogenous tightening of monetary policy.

Figure 1. Response of the Euro-Area Policy Rate to a Monetary Policy Shock

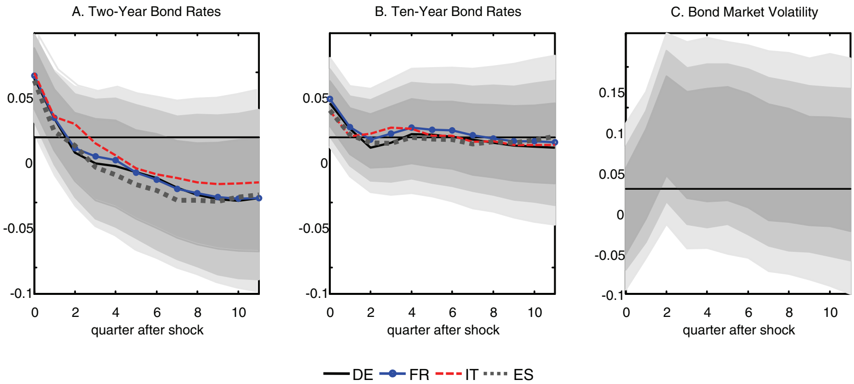


Notes: The figure reports the distribution of impulse responses of the EONIA levels, trimming the quantiles below the sixteenth and above the eighty-fourth. Vertical axis: percentage points. Horizontal axis: quarters after the shock. The black solid line represents the median of the posterior distribution.

On impact, the policy rate increases by about 16 basis points; it peaks one quarter after the shock and then gradually decreases. Figure 2 reports the reaction of the long-term interest rates (panels A and B) and a measure of euro-area bond market volatility (panel C) to the monetary policy tightening. We report the distribution of impulse responses for the euro area (computed, in panels A and B, as the GDP weighted average of the country responses) and the median of the individual country responses.

The bond rates increase on impact and then tend to quickly revert to pre-tightening levels. These results imply that a 1 percent increase in the EONIA rate leads, on impact, to an increase of about 40 and 30 basis points in the two- and ten-year bond yields, respectively. The results are broadly in line with previous studies on the effects of a federal funds rate shock on long-term bond yields. Kuttner (2001), for example, found similar values for the response of the two- and ten-year bond yields: an increase of 61 and 32 basis

Figure 2. Response of the Yield Curve and Bond Market Volatility to a Monetary Policy Shock



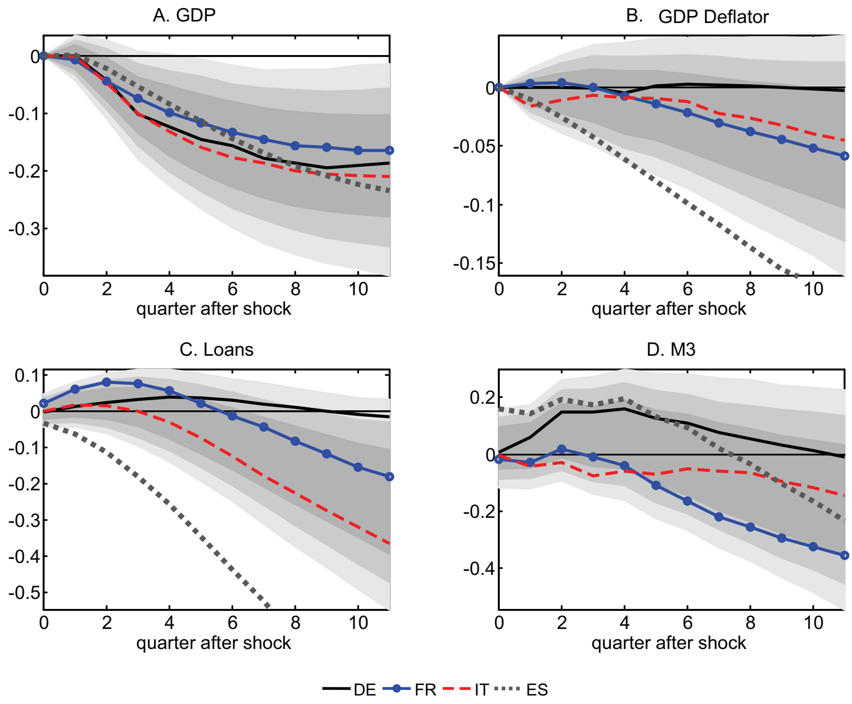
Notes: The figure reports the distribution of impulse responses of the levels of the variables in the euro area (GDP weighted average of the four countries in panels A and B), trimming the quantiles below the sixteenth and above the eighty-fourth. The four lines in panels A and B refer to the median responses in each of the four countries. Vertical axis: percentage points. Horizontal axis: quarters after the shock.

points, respectively, for a 1-percentage-point rise in the federal funds rate. Cochrane and Piazzesi (2002) found a larger reaction to the federal funds target: a 1 percent unexpected target change affects ten-year Treasury yields by 52 bps. Remarkably, the response of the yield curve to a tightening in the stance of standard euro-area-wide monetary policy is quite homogenous across countries. Hence, standard monetary policy tools may not be able to address the issue of heterogeneous yield-curve developments that arose during the euro-area sovereign crisis. Standard monetary policy also does not seem to be able to significantly affect euro-area bond market volatility.

Figure 3 reports the responses of the other variables in the model, expressed in log-levels: GDP (panel A), the GDP deflator (panel B), loans (to firms and households, panel C), and M3 (panel D).

Again, the shaded area represents the distribution of impulse responses in the euro area (computed as the GDP weighted average of the country responses), while the four lines represent, respectively, the median responses in the four countries.

Figure 3. Response of Macroeconomic Variables to a Monetary Policy Shock



Notes: The figure reports the distribution of impulse responses of the log-levels of the variables in the euro area (GDP weighted average of the four countries, in all panels), trimming the quantiles below the sixteenth and above the eighty-fourth. The four lines in all panels refer to the median responses in each of the four countries. Vertical axis: percentage points. Horizontal axis: quarters after the shock.

As expected, real GDP decreases in all countries in response to a tightening of the ECB monetary policy. Real GDP reaches its trough after about two years in all countries, with similar path and size of the reaction across countries. Consumer prices exhibit more cross-country heterogeneity, dropping in Italy, Spain, and France, while German prices are unaffected by the monetary policy tightening. Credit markets exhibit a more relevant extent of cross-country heterogeneity compared with real activity and prices. For example, Spain exhibits the most substantial drop in credit, while in Germany, Italy, and France loans initially increase (implying that aggregate loans also increase) before starting to drop after about one year (see den Haan, Sumner, and Yamashiro 2007 and Giannone, Lenza, and Reichlin 2012 for a similar result in the United States and the euro area, and possible interpretations).

Finally, M3, on impact, increases on average across countries. This apparent "lack of liquidity effect" is not surprising, and it is explained by the fact that M3 dynamics are dominated by those of short-term monetary assets (time deposits, marketable instruments) whose return is very sensitive to the policy rate. Hence, a tightening makes these assets more attractive than alternative investment options (see Giannone, Lenza, and Reichlin 2012 for an extensive discussion of this fact).

3.3 The Evaluation of the OMT Effects

The evaluation of OMT effects is made by comparing two scenarios, defined as the no-OMT and the OMT scenarios.[5] The counterfactual analysis is performed starting from 2012:Q3 (i.e., when the OMT has been announced) with a projection horizon of three years, and is constructed as follows. The model is estimated over the sample 1999:Q1–2012:Q3. The no-OMT scenario is simply given by the unconditional forecast of the VAR model for the following three years. The OMT scenario, instead, has the features summarized in table 3.

In particular, *relative to the no-OMT scenario paths*, the OMT announcements are assumed to decrease the two-year bond rates in Italy and Spain over the entire three-year projection horizon (by 1.75 and 2.09 percent in Italy and Spain, respectively, as estimated in the "controlled" event study). The two-year bond rates in France and Germany are left unchanged (i.e., equal to no-OMT values).

In order to further isolate the change in bond rates as mostly related to the OMT announcements, two further assumptions are also made. First, macroeconomic variables in all countries (real activity and prices) are not allowed to change at the time of the "OMT shock" compared with the no-OMT scenario (though they

[5]Lenza, Pill, and Reichlin (2010), Giannone et al. (2012), and Kapetanios et al. (2012) apply a similar methodology for the study of the effects of the ECB liquidity policy and the quantitative easing policy in the United Kingdom.

Table 3. Assumption for the OMT and the No-OMT Scenarios

Assumption A: Shift in the Path of Bond Yields
Italy and Spain: Two-year bond rates decrease over the entire three-year projection horizon (by 1.75 and 2.09 percent in Italy and Spain, respectively).
Germany and France: Impose the same path between OMT and non-OMT scenario.
Assumption B: OMT Only Driver of Changes in Yields
Real activity and prices in all countries are not allowed to change at the time of the OMT announcement (GDP and price changes are set to zero on impact).
Assumption C: Path of Monetary Policy
Impose the same path between OMT and non-OMT scenario.

Notes: The table reports the assumptions used in the conditional forecasting exercise to retrieve the OMT and no-OMT scenarios. The length of the projection horizon used in the analysis is three years.

are allowed to change subsequently). Second, in order to exclude that the differences between the OMT and no-OMT scenarios are related to different paths of standard monetary policy (characterized by the path of the short-term interest rate), we assume that the latter is the same in both scenarios.

Our measure of the effects associated with the OMT announcements is given by the difference of the path for the variables in the OMT and the no-OMT scenarios. Notice that, given that results are computed in terms of deviations in the OMT from the no-OMT scenarios in a linear VAR model, this assessment is independent of the path assumed for the no-OMT scenario.[6] Table 4 reports, for the country/variables pairs (columns 1 and 2) both (i) the median

[6]In order to assess the reaction of the variables in the scenarios, the Kalman-filter-based algorithm described in Banbura, Giannone, and Lenza (2015) is adopted. The algorithm extracts the most likely combination of shocks that, given past regularities, could have generated the scenario paths. All the scenarios assume that the structure of the economy (reflected in the estimated coefficients) and the nature and the relative importance of different shocks (reflected in the estimated covariance matrix of the shocks) remain the same as in the estimation sample.

Table 4. The Macroeconomic Effects Associated with the OMT Announcements

	Variables	Effect	Probability of Positive Effect
Germany	GDP	0.34	0.60
	Price	0.28	0.67
	Loans	1.08	0.90
France	GDP	0.46	0.64
	Price	0.28	0.68
	Loans	1.38	0.22
Italy	GDP	1.50	0.81
	Price	1.21	0.86
	Loans	3.58	0.82
Spain	GDP	2.01	0.80
	Price	0.74	0.65
	Loans	2.31	0.75

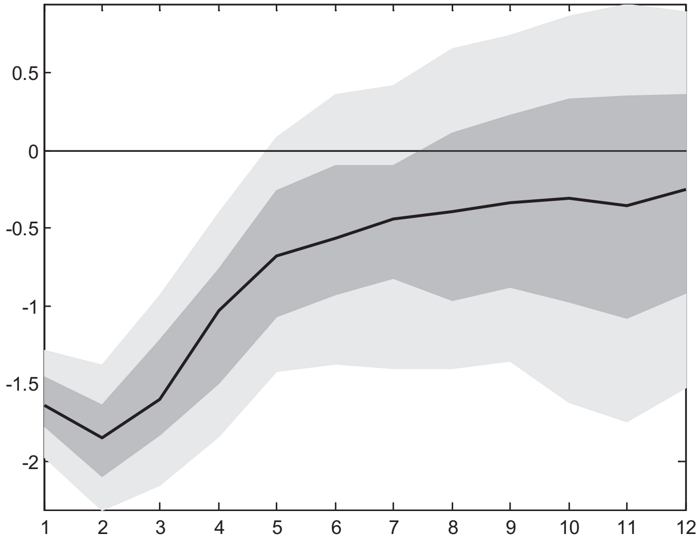
Notes: The table reports the effects associated with the OMT announcements in terms of percentage deviations in the OMT scenario relative to the no-OMT secnario at the end of the three-year projection horizon. The last column reports the probability that the effects are positive.

results (column 3) and (ii) the probability (column 4) that the effects are positive, both evaluated three years after the announcement.

The general outcome of the analysis is that the OMT announcements are very likely to be associated with positive and quite sizable effects on real activity, loans, and consumer prices in Italy and Spain. The size of the effects of GDP and prices is broadly in line with those estimated for the quantitative easing policies in the United States and the United Kingdom.[7] The evidence reported in table 3 points

[7]The elasticity implied in the estimates of the macroeconomic effects of the OMT announcements for Italy and Spain lie broadly in the middle of the range of estimates of the effects of LSAP policies in the United States and QE in the United Kingdom. For the United States, Chen, Cúrdia, and Ferrero (2012) provide the lower boundary, while Chung et al. (2012) and Baumeister and Benati (2013) provide the upper boundary. For the United Kingdom, Kapetanios et al. (2012) find that a permanent decrease in the term spread by 100 basis points would imply an increase in the level of GDP which ranges between 0.7 and 2.7 percent.

Figure 4. The Effects on Bond Market Volatility Associated with the OMT Announcements



Notes: The figure reports the distribution of the responses of bond market volatility (trimming the quantiles lower than the fifth and higher than the ninety-fifth). The black solid line represents the median of the posterior distribution. Vertical axis: percentage points. Horizontal axis: quarters after the shock.

to moderate (positive) spillovers on the real activity in France, and even smaller in Germany.

Figure 4 provides some additional evidence on the effects of the OMT announcements on bond market volatility. The OMT announcements are shown to reduce expected bond market volatility, a measure of uncertainty in the euro-area bond market, by about 1.5 percentage points. Given the definition of the volatility index, the latter result implies a reduction of 35 basis points in the standard deviation of following-month expected euro-area bond rates. This result is in contrast with the insignificant response of bond market volatility found for the effects of standard monetary policy.

4. Conclusions

The announcements that the Eurosystem might engage (under specific conditions) in outright monetary transactions had a sizable impact on financial markets in a period where monetary policy transmission was particularly impaired because of high redenomination risks perceived by market participants. We have found that such announcements have led to a decrease by about 200 basis points in the two-year government bond rates in Italy and Spain, while leaving German and French yields of bonds of comparable maturities largely unaffected.

Evaluating the impact on the real economy of the financial market effects through the lens of a multi-country BVAR model for the largest euro-area countries, we found that the announcements have statistically significant and economically relevant effects on credit and, in general, on economic growth in Italy and Spain with some relatively limited spillovers in France and Germany.

Over the last months, declining levels of interest rate on sovereign bonds, improving financial market conditions, and a decreasing dependency of the euro-area banking system on Eurosystem refinancing have signaled the gradual return to a phase of a normalization in the euro-area financial markets. Our findings attribute part of these improvements to the announcements of the OMT program.

Appendix 1. Event-Study Analysis, List of Macroeconomic Releases

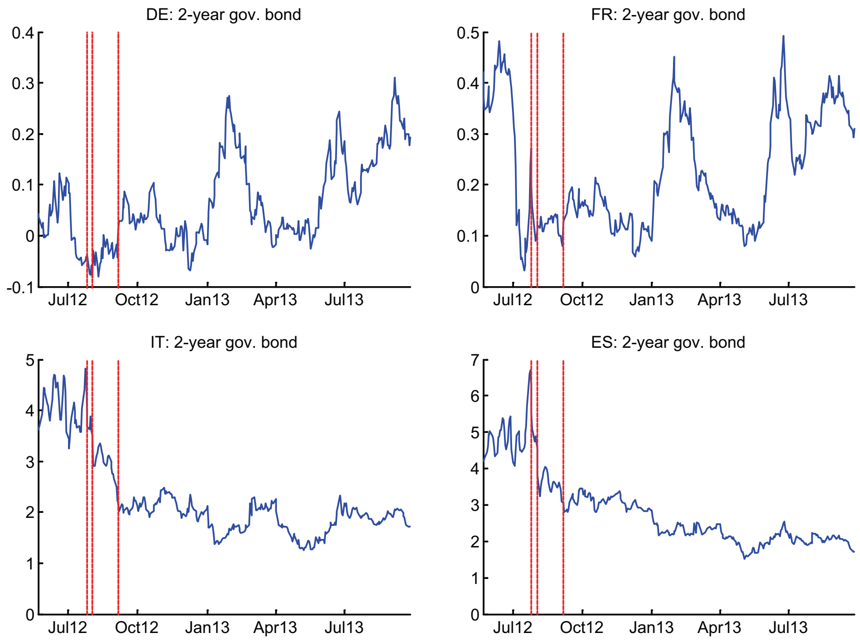
Table 5 reports the entire set of macroeconomic variables used in the high-frequency analysis to identify the effect of the OMT announcements on the government bond yield in Germany, France, Italy, and Spain.

Table 5. Macroeconomic Variables included in the Analysis

Euro Area	France	Germany	Italy	Spain
Business Climate Ind.	Bank of France Bus. Sentiment	Budget (% of GDP)	Budget Balance (Year-to-Date)	Adj. Real Ret. Sales (YoY)
ECB Interest Rates	Business Confidence Indicator	Capital Investment	Business Confidence	CPI (MoM)
Current Account SA	Central Govt. Balance (Euros)	Construction Investment	Consumer Conf. Ind. sa	CPI (YoY)
Consumer Conf.	Consumer Confidence Indicator	CPI (MoM)	CPI (NIC incl. tobacco, MoM)	CPI (Core Index) (MoM)
CPI – Core (YoY)	CPI (MoM)	CPI (YoY)	CPI (NIC incl. tobacco, YoY)	CPI (Core Index (YoY)
CPI Estimate (YoY)	CPI (YoY)	Current Account (Euro)	Deficit to GDP	CPI (EU Harm.) (MoM)
Current Account nsa	Consumer Spending (MoM)	Domestic Demand	Government Spending	CPI (EU Harm.) (YoY)
Economic Conf.	Consumer Spending (YoY)	Exports	Hourly Wages (MoM)	GDP (Constant SA) (QoQ)
GDP s.a (QoQ)	CPI	Exports SA (MoM)	Hourly Wages (YoY)	GDP (Constant SA) (YoY)
GDP s.a. (YoY)	CPI	Factory Orders MoM (sa)	Imports	House Price Index (QoQ)
Govt. Debt/GDP Ratio	CPI Ex. Tobacco Index	Factory Orders YoY (nsa)	Industrial Orders n.s.a. (YoY)	House Price Index (YoY)
Govt. Expend. (QoQ)	France Retail PMI	GDP nsa (YoY)	Industrial Orders s.a. (MoM)	Ind. Output WDA (YoY)
Gross Fix Cap. (QoQ)	GDP (QoQ)	GDP s.a. (QoQ)	Ind. Prod. nsa (YoY)	PPI (MoM)
Household Cons. (QoQ)	GDP (YoY)	GDP wda (YoY)	Ind. Prod. sa (MoM)	PPI (YoY)
Ind. Prod. sa (MoM)	Housing Perm. 3M YoY% Chg.	GfK Cons. Conf. Survey	Ind. Prod. wda (YoY)	Real Ret. Sales (YoY)
Ind. Prod. wda (YoY)	Housing Starts 3M YoY% Chg.	Government Spending	Ind. Sales n.s.a. (YoY)	Cons. Confidence
Indust. Conf.	ILO Mainland Unempl. Rate	IFO – Business Climate	Ind. Sales s.a. (MoM)	Trade Balance (Mln. Euros)
Labor Costs (YoY)	ILO Unemployment Rate	Import Price Index (MoM)	PMI Manufacturing	Unempl. MoM Net (000s)
M3 s.a. (YoY)	Imports (QoQ)	Import Price Index (YoY)	PMI Services	Unemp. Rate (Survey)
M3 s.a. 3 mth ave.	Ind. Prod. (MoM)	Imports	PPI (MoM)	
PPI (MoM)	Ind. Prod. (YoY)	Imports SA (MoM)	PPI (YoY)	
PPI (YoY)	Mainland Unemp. Chg. (000s)	Ind. Prod. YoY (nsa wda)	Private Consumption	
Ret. Sales (MoM)	Manuf. Prod. (MoM)	Ind. Prod. (YoY)	Retail Sales (YoY)	
Ret. Sales (YoY)	Manuf. Prod. (YoY)	Ind. Prod. MoM (sa)	Retail Sales s.a. (MoM)	
Services Conf.	Non-Farm Payrolls (QoQ)	PMI Manufacturing	Retailers' Confid. General	
Trade Balance	Own-Company Prod. Outlook	PMI Services	Total Investments	
Trade Balance sa	PMI Manufacturing	Private Consumption	Trade Balance (Total) (Euros)	
Unempl. Rate	PMI Services	Producer Prices (MoM)	Trade Balance Eu (Euros)	
Ind. New Ord. NSA (YoY)	PPI (MoM)	Producer Prices (YoY)	Trade Balance Non-Eu (Euros)	
Ind. New Ord. SA (MoM)	PPI (YoY)	Retail Sales (MoM)	Unempl. Rate	
PMI Composite	Production Outlook Indicator	Retail Sales (YoY)	Unempl. Rate (s.a.)	
PMI Manuf.	Total Jobseekers	Trade Balance	Unempl. Rate (SA)	
PMI Services	Trade Balance (Euros)	Unempl. Chg. (000s)		
ZEW Survey (Econ. Sent.)	Wages (QoQ)	Unempl. Rate (s.a.)		

Note: The table reports the macroeconomic variables used in the high-frequency analysis.

Figure 5. Two-Year Bond Rate: Daily Frequency



Notes: The figure reports the interest rates on the two-year government bond in Germany (DE), France (FR), Italy (IT), and Spain (ES) during the sample period of the event-study analysis, i.e., from May 2012 to September 2013. Vertical gridlines indicate the OMT announcement days, i.e., July 26, August 2, and September 6, 2012.

Appendix 2. Daily and Intradaily Effects of the Announcements

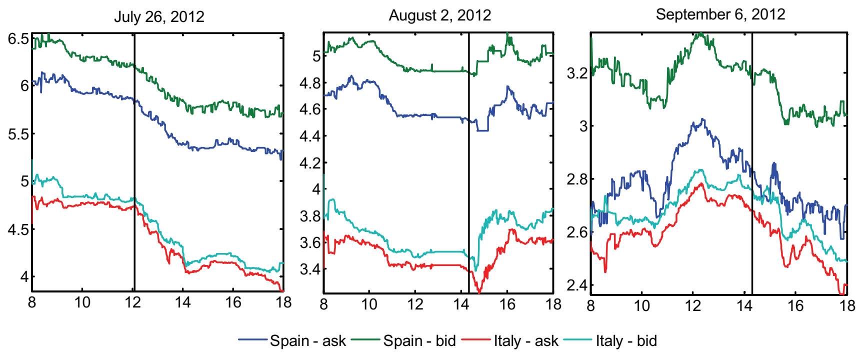
Figure 5 reports the interest rates on the two-year government bond in Germany (DE), France (FR), Italy (IT), and Spain (ES) during the sample period of the event-study analysis, i.e., from May 2012 to September 2013. Vertical gridlines indicate the announcement days.

Changing the size of the event window might be interpreted as a test for possible reversal and lagged effects. In line with the results presented in table 2, the estimated reaction of five-year sovereign CDS in the four selected economies, and the euro-area bond market volatility and stock market volatility to the OMT announcements, are not influenced by the length of the event window (see table 6).

Table 6. Asset Price Reactions (in Basis Points) and the Length of the Event Window

	Size of Event Window									
	One Day		Two Days		Three Days		Four Days		Five Days	
Variable	Classical	Controlled	Classical	Controlled	Classical	Controlled	Classical	Controlled	Classical	Controlled
Five-Year CDS										
Germany	−5	−1	−16	−13	−21	−19	−20	−21	−23	−24
France	−9	−5	−35	−32	−41	−36	−43	−41	−51	−50
Italy	−41	−33	−154	−144	−154	−142	−163	−153	−175	−169
Spain	−40	−33	−156	−148	−178	−169	−177	−172	−202	−201
Euro Area: Bond Volatility	−1.2	−1.3	−1.0	−1.2	0.0	−0.1	0.5	0.1	0.1	−0.1
Euro Area: Stock Volatility	−5.3	−5.0	−9.8	−9.7	−5.9	−4.8	−5.9	−5.9	−6.6	−6.1

Figure 6. Intraday Bid and Ask of Two-Year Bond during the Days of OMT Announcements



Notes: The figure reports the value of the bid and ask two-year bond rates in Italy and Spain during the day of the three OMT-related announcements. Horizontal axis: trading hours. The vertical lines indicate the time when Mr. Draghi started to talk in London on July 26 (12:09) and on August 2 and September 6 (14:30).

Figure 6 reports the time patterns of the two-year bond bid and ask rates for Italy and Spain during the trading hours of the first OMT announcement. As depicted in the figure, these rates significantly drop after the announcement (the vertical line in the graph). This further corroborates that the announcement was the dominant event during that day.

Appendix 3. The Multi-Country VAR Model

Let y_t be an n-dimensional vector of variables; the general equation of a VAR is

$$y_t = c + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t$$
$$\varepsilon_t - N(0, \Sigma),$$

where $A_1 \ldots A_2$ are $n \times n$ matrices of coefficients, p $(= 5)$ the number of lags, and ε_t is an n-dimensional vectorial white noise.

Table 7 reports the definition and data transformations of the n $(= 26)$ variables we include in the VAR model. We estimate our

Table 7. VAR Variables Definition

Country	Variable	Transformation
France (FR)	Real GDP	4*Log-levels
	HICP	4*Log-levels
	M3	4*Log-levels
	Retail Loans	4*Log-levels
	Two-Year Bond Rates	Raw
	Ten-Year Bond Rates	Raw
Germany (DE)	Real GDP	4*Log-levels
	HICP	4*Log-levels
	M3	4*Log-levels
	Retail Loans	4*Log-levels
	Two-Year Bond Rates	Raw
	Ten-Year Bond Rates	Raw
Italy (IT)	Real GDP	4*Log-levels
	HICP	4*Log-levels
	M3	4*Log-levels
	Retail Loans	4*Log-levels
	Two-Year Bond Rates	Raw
	Ten-Year Bond Rates	Raw
Spain (ES)	Real GDP	4*Log-levels
	HICP	4*Log-levels
	M3	4*Log-levels
	Retail Loans	4*Log-levels
	Two-Year Bond Rates	Raw
	Ten-Year Bond Rates	Raw
Euro Area (EA)	EONIA (overnight money-market rate)	Raw
	Bond Volatility	Raw

model in (log-)levels. The data are quarterly and are available in the sample 1999:Q1–2012:Q4.

Retail credit is the sum of total credit to households and non-financial corporations. The implied bond volatility for the euro area is constructed by averaging the (end-of-period) implied volatility on call and put options of the Eurex Generic 1st "RX" Future.

This future contract is based on long-term notional debt securities issued by the German federal government with a term of 8.5–10.5 years.

Estimation and Conditional Forecasts

The large cross-section of variables (twenty-six) and number of lags (five), coupled with the relatively small sample, implies that classical maximum-likelihood techniques would provide unreliable estimates.

Hence, for the estimation of the VAR, we address the high-dimensional data problem by adopting Bayesian shrinkage as suggested in De Mol, Giannone, and Reichlin (2008) and Banbura, Giannone, and Reichlin (2010). The latter show that if the data are collinear, as is the case for macroeconomic variables, the relevant sample information is not lost when overfitting is controlled for by shrinkage via the imposition of priors on the parameters of the model to be estimated.

More precisely, in this paper we consider conjugate priors belonging to the normal/inverse-Wishart family where the prior for the covariance matrix of the residuals Σ is inverse-Wishart and the prior for the autoregressive coefficients is normal.

For the prior on the covariance matrix of the errors, Σ, we set the degrees of freedom equal to $n+2$, which is the minimum value that guarantees the existence of the prior mean, which we set as $E[\Sigma] = \Psi$, where Ψ is diagonal.

The baseline prior on the model coefficients is a version of the so-called Minnesota prior (see Litterman 1979). This prior is centered on the assumption that each variable follows an independent random-walk process, possibly with drift, which is a parsimonious yet "reasonable approximation of the behaviour of an economic variable."

The prior moments for the VAR coefficients are as follows:

$$E[(A)_{ij}|\Sigma,\lambda,\Psi] = \begin{cases} 1 & \text{if } i=j \text{ and } s=1 \\ 0 & \text{otherwise} \end{cases}$$

$$\text{cov}((A_s)_{ij},(A_r)_{hm}|\Sigma,\lambda,\Psi) = \begin{cases} \lambda^2 \frac{1}{s^2}\frac{\Sigma_{ih}}{\psi_j} & \text{if } m=j \text{ and } r=s \\ 0 & \text{otherwise} \end{cases}$$

Notice that the variance of this prior is lower for the coefficients associated with more distant lags, and that coefficients associated with the same variable and lag in different equations are allowed to be correlated. Finally, the key hyperparameter is λ—it controls the scale of all the variances and covariances, and effectively determines the overall tightness of this prior. The terms $\frac{\Sigma_{ih}}{\psi_j}$ account for the relative scale of the variables. The prior for the intercept, c, is non-informative (a very high prior variance).

We complement the prior with an additional prior to implement a so-called inexact differencing of the data. More precisely, rewrite the VAR equation in an error-correction form:

$$y_t = c + (A_1 + \cdots + A_p - I_n)y_{t-1} + B_1\Delta y_{t-1} + \cdots + B_p\Delta y_{t-p} + \varepsilon_t,$$

where $B_s = -A_{s+1} - \cdots - A_p$.

A VAR in first differences implies the restriction $\Pi = 0$. We follow Doan, Litterman, and Sims (1984) and set a prior centered at 1 for the sum of coefficients on own lags for each variable, and at 0 for the sum of coefficients on other variables' lags. This prior also introduces correlation among the coefficients on each variable in each equation. The tightness of this additional prior is controlled by the hyperparameter μ. As μ goes to infinity, the prior becomes diffuse, while as it goes to 0, we approach the case of exact differencing, which implies the presence of a unit root in each equation.

Summing up, the setting of these priors depends on the hyperparameters λ, μ, and Ψ, which reflect the informativeness of the prior distributions for the model coefficients. These parameters have been usually set on the basis of subjective considerations or rules of thumb. We instead closely follow the theoretically grounded approach proposed by Giannone, Lenza, and Primiceri (2015). This involves treating the hyperparameters as additional parameters, in the spirit of hierarchical modeling. As hyperpriors (i.e., prior distributions for the hyperparameters), we use proper but almost flat distributions. In this setup, the marginal likelihood evaluated at the posterior mode of the hyperparameters is close to its maximum.

In order to compute conditional forecasts in our relatively large VAR, we use the Kalman-filter-based algorithm described in Banbura, Giannone, and Lenza (2015).

References

Altavilla, C., and D. Giannone. 2014. "The Effectiveness of Non-standard Monetary Policy Measures: Evidence from Survey Data." CEPR Discussion Paper No. 10001.

Banbura, M., D. Giannone, and M. Lenza. 2015. "Conditional Forecasts and Scenario Analysis with Vector Autoregressions for Large Cross-Sections." *International Journal of Forecasting* 31 (3): 739–56.

Banbura, M., D. Giannone, and L. Reichlin. 2010. "Large Bayesian Vector Auto Regressions." *Journal of Applied Econometrics* 25 (1): 71–92.

Baumeister, C., and L. Benati. 2013. "Unconventional Monetary Policy and the Great Recession: Estimating the Macroeconomic Effects of a Spread Compression at the Zero Lower Bound." *International Journal of Central Banking* 9 (2, June): 165–212.

Carter, C., and P. Kohn. 1994. "On Gibbs Sampling for State Space Models." *Biometrika* 81 (3): 541–53.

Chen, H., V. Cúrdia, and A. Ferrero. 2012. "The Macroeconomic Effects of Large-Scale Asset Purchase Programmes." *Economic Journal* 122 (564): F289–F315.

Christiano, L. J., M. Eichenbaum, and C. L. Evans. 1999. "Monetary Policy Shocks: What Have We Learned and to What End?" In *Handbook of Macroeconomics*, Vol. 1A, ed. J. B. Taylor and M. Woodford, 65–148 (chapter 2). Elsevier.

Chung, H., J.-P. Laforte, D. Reifschneider, and J. C. Williams. 2012. "Have We Underestimated the Likelihood and Severity of Zero Lower Bound Events?" *Journal of Money, Credit and Banking* 44 (s1): 47–82.

Cochrane, J. H., and M. Piazzesi. 2002. "The Fed and Interest Rates: A High-Frequency Identification." *American Economic Review* 92 (2): 90–95.

D'Amico, S., and T. King. 2013. "Flow and Stock Effects of Large-Scale Treasury Purchases: Evidence on the Importance of Local Supply." *Journal of Financial Economics* 108 (2): 425–48.

De Mol, C., D. Giannone, and L. Reichlin. 2008. "Forecasting Using a Large Number of Predictors: Is Bayesian Shrinkage a Valid Alternative to Principal Components?" *Journal of Econometrics* 146 (2): 318–28.

den Haan, W. J., S. W. Sumner, and G. M. Yamashiro. 2007. "Bank Loan Portfolios and the Monetary Transmission Mechanism." *Journal of Monetary Economics* 54 (3): 904–24.

Doan, T., R. Litterman, and C. A. Sims. 1984. "Forecasting and Conditional Projection Using Realistic Prior Distributions." *Econometric Reviews* 3 (1): 1–100.

Draghi, M. 2013. "Strengthening Financial Resilience." Speech by Mario Draghi at the 2013 International Monetary Conference, Shanghai, June 3.

Eser, F., and B. Schwaab. 2013. "Assessing Asset Purchases within the ECB's Securities Markets Programme." ECB Working Paper No. 1587.

Falagiarda, M., and S. Reitz. 2013. "Announcements of ECB Unconventional Programs: Implications for the Sovereign Risk of Italy." Working Paper No. 1866, Kiel Institute for the World Economy.

Gagnon, J., R. Raskin, J. Remache, and B. Sack. 2011. "The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases." *International Journal of Central Banking* 7 (1, March): 3–43.

Ghysels, E., J. Idier, S. Manganelli, and O. Vergote. 2014. "A High Frequency Assessment of the ECB Securities Markets Programme." ECB Working Paper No. 1642.

Giannone, D., M. Lenza, H. Pill, and L. Reichlin. 2012. "The ECB and the Interbank Market." *Economic Journal* 122 (564): F467–F486.

Giannone, D., M. Lenza, and G. Primiceri. 2015. "Prior Selection for Vector Autoregressions." *Review of Economics and Statistics* 97 (2): 436–51.

Giannone, D., M. Lenza, and L. Reichlin. 2012. "Money, Credit, Monetary Policy and the Business Cycle in the Euro Area." CEPR Discussion Paper No. 8944.

Hördal, P., and O. Tristani. 2013. "Macro Factors and Sovereign Bond Spreads: A Quadratic No-Arbitrage Model." Mimeo, European Central Bank.

Joyce, M., A. Lasaosa, I. Stevens, and M. Tong. 2011. "The Financial Market Impact of Quantitative Easing." *International Journal of Central Banking* 7 (3, September): 113–61.

Kapetanios, G., H. Mumtaz, I. Stevens, and K. Theodoridis. 2012. "Assessing the Economy-wide Effects of Quantitative Easing." *Economic Journal* 122 (564): F316–F347.

Krishnamurthy, A., and A. Vissing-Jorgensen. 2011. "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy." *Brookings Papers on Economic Activity* 2: 215–87.

Kuttner, K. N. 2001. "Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market." *Journal of Monetary Economics* 47 (3): 523–44.

Lenza, M., H. Pill, and L. Reichlin. 2010. "Monetary Policy in Exceptional Times." *Economic Policy* 25 (62): 295–339.

Litterman, R. B. 1979. "Techniques of Forecasting Using Vector Autoregressions." Working Paper No. 115, Federal Reserve Bank of Minneapolis.

Rivolta, G. 2012. "An Event Study Analysis of ECB Unconventional Monetary Policy." Mimeo, University of Milan.

Szczerbowicz, U. 2012. "The ECB Unconventional Monetary Policies: Have They Lowered Market Borrowing Costs for Banks and Governments?" Working Paper No. 2012-36, CEPII Research Center.