The potential effectiveness of the ECB's OMT program in restoring monetary transmission[1]

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Abstract

This paper explores the potential effectiveness of the ECB's Outright Monetary Transaction (OMT) program in safeguarding an appropriate monetary policy transmission. As one primary objective of the program is to reduce bank lending rates by conducting sovereign bond purchases on secondary markets, the stability of the relationship between bank lending rates and government bond rates is of major importance. Using vector autoregressive models with time varying parameters (TVP-VAR) we evaluate the stability of this relationship by focusing on the reaction of bank lending rates to movements in yields on government bonds over the period 2003–2014. Our results suggest that the potential success of OMTs in restoring the monetary transmission mechanism is limited as the link between bank lending rates and government bond rates has substantially weakened since mid-2008.

JEL classifications: E42, E43, E44, E58, E63

Key words: European Central Bank, OMT program, time varying parameter vector autoregressive model, interest rate pass–through

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1 Introduction

The European Central Bank (ECB) launched its Outright Monetary Transaction (OMT) program on September 6, 2012 with the objective to safeguard an appropriate monetary policy transmission (European Central Bank, 2012a).[1] Tensions emerged as banks in the euro area became reluctant to decrease their lending rates after mid-2008 despite the vigorous cut in policy rates.[2] OMTs are intended to strengthen the effects of expansionary monetary policy through sovereign bond purchases on secondary markets, which seek to lower bank lending rates by reducing government bond rates.

This paper explores the potential effectiveness of the ECB's OMT program in restoring the monetary transmission mechanism. Using vector autoregressive models with time varying parameters (TVP-VAR) for several euro area periphery countries we examine the reaction of bank lending rates to movements in government bond rates. In the context of the OMT program the strength and stability of the relationship between these interest rates is of major importance. If the relationship would turn out to be weak, the impairment of monetary policy transmission in periphery countries, i.e. the decoupling of bank lending rates from policy rates, could not be countered by lowering government bond rates.

The ECB's OMT program concentrates on sovereign bond markets of

[1] Officially, the ECB states that *"OMTs aim at safeguarding the transmission mechanism in all euro area countries and the singleness of the monetary policy"* (European Central Bank, 2012a, p. 7).

[2] The ECB identified obstacles in the monetary transmission mechanism as the spreads between bank lending rates over money market rates started to increase sharply since the mid-2008 albeit the policy rate on the main refinancing operations was reduced by 410 basis points between July 2008 and June 2014. See Hristov, Hülsewig, and Wollmershäuser (2014), Aristei and Gallo (2012) or Blot and Labondance (2013) for a discussion.

euro area member countries, which face difficulties in issuing government bonds at sustainable interest rates due to tensions that possibly originate from fears of the reversibility of the euro (European Central Bank, 2012b). OMTs are in principle unlimited (Deutsche Bundesbank, 2012), however, a precondition for support will be compliance with a EFSF/ESM program that embeds strict conditionality (Petch, 2013). The program will be concentrated on purchases of government bonds referring to the shorter part of the yield curve, with maturities of between one and three years.[3]

Economic theory underpinning the OMT program is based on the notion that lending rates set by banks are influenced by movements in government bond rates (European Central Bank, 2012a). Thus, bank lending rates in euro area member countries may react sluggishly to a decline in policy rates if domestic sovereign bond yields are elevated or increasing. The link between bank lending rates and government bond rates is explained by the influence of sovereign bond markets on banks' funding conditions (Neri, 2013; Albertazzi, Ropele, Sene, and Signoretti, 2014; European Central Bank, 2012a).[4] First, banks may suffer from write–offs in their balance sheets after a devaluation of sovereign bonds, which possibly deteriorates the capital position. Second, the rating of banks may be downgraded following a reduction in the rating of the sovereign causing an increase of the risk premium on external financing. Third, the collateral base of banks may be damaged due to tensions in sovereign bond markets which limits the access to liquidity. Finally, since savers may regard sovereign bonds as close substitutes for deposits, an

[3]See European Central Bank (2012b) for a survey of the modalities of OMTs.

[4]Blot and Labondance (2013) provide a survey of the cost of funds approach.

increase in sovereign bond rates likely triggers a raise in deposits rates. Consequently, bank lending rates may increase due to distortions in sovereign bond markets that cause raising deposit rates. The OMT program is aimed at removing these effects on the transmission of monetary policy that become relevant once sovereign risk intensifies.

We assess the potential effectiveness of OMTs by considering various euro area periphery countries, i.e. Ireland, Italy, Portugal and Spain, that might be considered possible candidates for the program.[5] For these countries we analyze the reaction of bank lending rates offered to non–financial cooperations with different maturities to shocks in government bond rates over the period 2003–2014 in order to evaluate the stability of the link between these interest rates. Overall, our results suggest that the potential effectiveness of OMTs in safeguarding an appropriate monetary policy transmission is limited. While bank lending rates only adjusted incompletely to changes in government bond rates before the financial crisis that peaked in mid-2008, their responsiveness to movements in sovereign bond rates has weakened substantially thereafter. The average maximum decrease of bank lending rates to a one percentage point drop in sovereign bond interest rates with maturities of 1 to 3 years was 0.30 percentage points (short-term periphery bank lending rates) and 0.47 percentage points (long-term periphery bank lending rates) before 2009, while it was only 0.17 percentage points (short-term periphery bank lending rates) and 0.32 percentage points (long-term periphery bank lending rates) thereafter. This corresponds to a reduction in the maximum

[5]Note that we exclude Greece due to the instability of government bond rate series, which is related to the Greek debt restructuring in March 2012.

interest rate pass-through of 43 % and 31 %, respectively.

Since for policy makers it is important to understand both, the qualitative effects of the impaired interest rate pass-through between bank lending rates and yields on government bonds, as well as its qualitative implications, we perform an out-of-sample policy experiment. We assume that the ECB would have started to conduct OMTs in June 2014 to permanently reduce periphery countries government bond rates to the German level. Our simulation exercise shows that bank lending rates would fall in response to the drop in government bond rates, but owned to the congested interest rate pass-through the decline would be limited. More importantly, we find that strong and continuous monetary policy interventions would be required to significantly decrease periphery government bond rates. Thus, the ECB would become a major creditor of the euro area periphery countries, which potentially threatens the independence of monetary policy.

So far, only a few studies focusing on euro area periphery countries have analyzed the reaction of bank lending rates to changing government bond rates after the outbreak of the financial crisis in mid-2008. Neri (2013) estimates autoregressive distributed lag (ADL) models to explore the responsiveness of bank lending rates to movements in the spreads between the yields on government bonds and the 10-year euro swap rate over the period 2003–2011 by using the seemingly unrelated regression (SUR) method. The spreads are used as indicators for tensions in sovereign debt markets. His findings depart from ours as he reports that the impact on bank lending rates arising from changes in yields on government bonds was negligible until 2008, but became significantly important thereafter. The discrepancy of results can be explained by the different approaches adopted: while we focus on the level of government bond rates, Neri (2013) uses the spreads between the yields on government bonds and the 10–year swap rate, which were close to zero between 2003-2008 before they started to widen substantially.[6]

Zoli (2013) estimates a VAR model for Italy to evaluate the reaction of bank lending rates to sovereign spreads over the period 2006–2012. Her findings suggest that changes in sovereign spreads quickly affect bank lending rates. Albertazzi, Ropele, Sene, and Signoretti (2014) provide similar results. However, a drawback of these studies is the assumption of model parameter stability over time since potential distortions that likely arose during the financial market turmoil in 2008 are neglected. Hristov, Hülsewig, and Wollmershäuser (2014) show that bank lending rates in euro area periphery countries were significantly affected by the systematic increase in the volatility of structural shocks since 2008 and additionally that shocks particularly related to the financial crisis, such as loan supply shocks, became more relevant. The findings of Neri (2013) provide support for this result, at least by showing that the transmission of tensions in sovereign debt markets to bank lending rates has changed over time. Thus, the assumption of parameter stability seems doubtful. Therefore, in this study we employ a time-varying parameter VAR setup that allows us to account for dynamics in the pass–through from bond to loan markets.

The reminder of the paper is organized as follows. Section 2 outlines our TVP–VAR model setup. We provide an overview of the model framework,

[6]The findings of Neri (2013) are at odds with the view of the ECB, which justifies its OMT program by arguing that government bond markets in general *"are very relevant in determining the financing conditions of banks"* (European Central Bank, 2012a, p. 7).

introduce the data and discuss the model specification strategy. In Section 3 we present our empirical results, which are based on impulse response analysis. In Section 4 we discuss in a counterfactual policy experiment the potential effectiveness of OMTs to reduce bank lending rates. Section 5 summarizes and concludes.

2 TVP–VAR Model Setup

2.1 Model Framework

We use TVP–VAR models for selected euro area periphery countries to explore the reaction of bank lending rates to shocks in government bond rates over time. We refer to Primiceri (2005), Nakajima (2011) and Nakajima, Kasuya, and Watanabe (2011) for a full–fledged discussion of the framework.[7] Using a model with both time–varying coefficient matrices and time–varying covariance matrices of the exogenous shocks has the advantage that the framework is flexible enough to cope with changes in the monetary transmission mechanism as well as with the huge distortions arising from crises, such as the financial crisis that erupted in 2008 and the sovereign debt crisis that started at the beginning of 2010.

[7] Further studies using the same or a very similar approach are Canova and Ciccarelli (2009), Canova and Gambetti (2009), Koop, Leon-Gonzalez, and Strachan (2009), Sa, Towbin, and Wieladek (2011) and D'Agostino, Gambetti, and Giannone (2013) among others.

Consider the reduced form TVP-VAR model:

$$Y_t = C_t + B_{1t}Y_{t-1} + \cdots + B_{kt}Y_{t-k} + u_t, \qquad t = k+1, ..., T, \tag{2.1}$$

where Y_t is a $n \times 1$ vector of endogenous variables, C_t is a $n \times 1$ vector of time varying intercepts, B_{it} are $n \times n$ matrices of time varying coefficients with $i = 1, ..., k$ and k equal to the number of lags, and u_t is a $n \times 1$ vector of possibly correlated residuals.

Let Ω_t denote the covariance matrix of u_t, which can be decomposed as follows:

$$\Omega_t = A_t^{-1}\Sigma_t A_t^{-1\prime},$$

where A_t is a lower triangular matrix

$$A_t = \begin{bmatrix} 1 & 0 & \dots & 0 \\ \alpha_{21,t} & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ \alpha_{n1,t} & \dots & \alpha_{nn-1,t} & 1 \end{bmatrix}$$

and the covariance matrix Σ_t is diagonal

$$\Sigma_t = \begin{bmatrix} \sigma_{1t} & 0 & \dots & 0 \\ 0 & \sigma_{2t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & \sigma_{nt} \end{bmatrix}.$$

Following Primiceri (2005) the structural shock is identified recursively via

$$u_t = A_t^{-1}\Sigma_t^{\frac{1}{2}}\varepsilon_t,$$

and $\mathrm{Var}(\varepsilon_t) = I_n$. The TVP–VAR model (2.1) can be rewritten as:

$$\begin{aligned} Y_t &= X_t' B_t + A_t^{-1}\Sigma_t^{\frac{1}{2}}\varepsilon_t \\ X_t' &= I_n \otimes [1, Y_{t-1}', ..., Y_{t-k}'], \end{aligned} \tag{2.2}$$

where B_t is a stacked vector containing all coefficients of the right hand side of (2.1) and $\otimes$ denotes the Kronecker product. The model parameters are assumed to follow a random walk process (Primiceri, 2005):

$$\begin{aligned} B_t &= B_{t-1} + \nu_t \\ \alpha_t &= \alpha_{t-1} + \zeta_t \\ \log\sigma_t &= \log\sigma_{t-1} + \eta_t, \end{aligned}$$

where α_t denotes a stacked vector of the lower triangular elements in A_t and σ_t is the vector of the diagonal elements in Σ_t. The random–walk specification is used in most studies resorting to the TVP-VAR approach. All innovations in the model are assumed to be jointly normally distributed with variance–

covariance matrix

$$Var([\varepsilon_t \ \nu_t \ \zeta_t \ \eta_t]') = \begin{bmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{bmatrix}.$$

Following Nakajima (2011), we further reduce the parameter space by assuming the covariance matrices Q, S and W to be diagonal.

2.2 Data

We employ monthly data for euro area periphery countries covering the period 2003M1–2014M5. The countries include Ireland, Italy, Portugal and Spain.[8] Since our analysis is aimed at elaborating the reaction of bank lending rates to changes in government bond rates we use a bivariate model $Y_t = [\texttt{GBR}_t \ \texttt{BLR}_t]'$, where $\texttt{GBR}_t$ denotes the government bond rate and $\texttt{BLR}_t$ is the bank lending rate. The government bond rates are monthly averages, calculated from the FTSE Global Government Bond Indices with an average maturity of one to three years. The choice of maturities is related to the modalities of the OMT program according to which only the shorter part of the yield curve, with maturities between one and three years is considered (European Central Bank, 2012b). The series for the government bond rates are taken from Thomson Reuters DataStream. The bank lending rates refer to interest rates on new business loans to non–financial corporations

[8]Recall that we exclude Greece due to instability of government bond rate series, which is related to the Greek debt restructuring in March 2012.

(excluding revolving loans and overdrafts, convenience and extended credit card debt), with a maturity of up to one year (`BLR-1Y`) and over one year (`BLR+1Y`). The series are taken from the ECB's harmonized MFI interest rate statistics.[9]

2.3 Model Specification and Priors

The TVP-VAR model setup leaves various degrees of freedom regarding the exact specification of the lag length considered and the informativeness of the priors for the degree of time-variation in the coefficient matrices and co-variance matrices. This ambiguity makes a thorough model selection process important. The lag length k of each TVP-VAR model is set equal to 2 and is determined using the Schwarz information criterion, that is computed from a constant-parameter model estimated over the entire sample from 2003M1–2014M5. The priors for the diagonal elements of the hyperparameters Q, S and W are assumed to be independently inverse-Gamma distributed while the priors for the initial states of the time varying VAR–parameters, B_0, α_0 and $\log \sigma_0$, are chosen to be normal (see Primiceri, 2005; Nakajima, 2011, among others). In particular, we parameterize the prior distributions as rec-

[9] See Appendix A for further details.

ommended by Primiceri (2005):

$$
\begin{aligned}
B_0 &\sim N(\hat{B}_{OLS}, 4 \cdot V(\hat{B}_{OLS})), \\
\alpha_0 &\sim N(\hat{\alpha}_{OLS}, 4 \cdot V(\hat{\alpha}_{OLS})), \\
\log \sigma_0 &\sim N(\log \hat{\sigma}_{OLS}, I_n \cdot 10), \\
diag(Q) &\sim IG(k_Q^2 \cdot 36 \cdot V(\hat{B}_{OLS}), 36), \\
diag(S) &\sim IG(k_S^2 \cdot 2 \cdot V(\hat{\alpha}_{OLS}), 2), \\
diag(W) &\sim IG(k_W^2, 3 \cdot diag(I_n)),
\end{aligned}
$$

where $\hat{B}_{OLS}$, $\hat{\alpha}_{OLS}$ and $\hat{\sigma}_{OLS}$ are the OLS–estimates of B, A and σ based on a time invariant VAR estimated on a training sample covering the first 36 months of the complete sample. $diag(Q)$, $diag(S)$ and $diag(W)$ denote the vectors containing the diagonal elements of the corresponding matrices. $V(\hat{B}_{OLS})$ and $V(\hat{\alpha}_{OLS})$ are the vectors containing the variances of $\hat{B}_{OLS}$ and $\hat{\alpha}_{OLS}$ obtained from the same OLS estimation. B_0, α_0 and $\log \sigma_0$ and their corresponding variances are used as a starting values in the Carter–Kohn algorithm employed to infer the paths of B_t and α_t and the independence Metropolis–Hastings algorithm used to compute the path of σ_t.[10]

Since our sample is relatively short, the scaling parameters k_Q, k_S and k_W can have non–negligible effects on the estimated time variation in the VAR coefficients. Accordingly, caution is warranted when selecting values for these parameters. Since there are no economic reasons for preferring one (k_Q, k_S, k_W) combination over another, we base our parametrization on a formal

[10] See Appendix B for details. Note, that since we resort to the independence Metropolis-Hastings algorithm, our estimation is immune to the problems described in DelNegro and Primiceri (2013).

statistical criterion. In particular, following Primiceri (2005), we evaluate the marginal likelihood for our TVP-VAR models at each point of the three dimensional grid defined by $k_Q = \{0.01, 0.05, 0.1\}$, $k_S = \{0.01, 0.1, 1\}$ and $k_W = \{0.001, 0.01\}$.[11] We then choose the combination of (k_Q, k_S, k_W) with the highest marginal likelihood.[12] According to this criterion the optimal combination is found at $(k_Q, k_S, k_W) = (0.1, 1, 0.01)$ for each euro area periphery country.

With regard to the general methodology we use to elaborate on the effectiveness of the OMT program it is important to note that prior specifications that virtually prevent time variation in the estimated parameters, i.e. values of k_i, $i \in \{Q, S, W\}$ close to zero, lead to much lower marginal likelihoods. For example using a specification of $(k_Q, k_S, k_W) = (0.01, 0.01, 0.001)$ reduces the marginal likelihood on average across countries by 8 % for both bank lending maturities. Therefore, a TVP–VAR setup is preferable to a standard constant parameter VAR.

The posterior distributions as well as various statistics of interest are computed by means of a Markov Chain Monte Carlo (MCMC) algorithm described in Appendix B. We choose the number of Markov–Chain samples such that all Markov chains converge according to the Geweke criterion[13] using a burn–in rate of 20 %.

[11] Koop and Korobilis (2010) also suggest using hyperparameters that imply fairly tight priors for Q, S and W.

[12] See Appendix C for details on the computation of the marginal likelihood.

[13] See Geweke (1994) for a description of the statistic.

3 Empirical Results

3.1 Impulse Response Functions

For the euro area periphery countries, Figures 1–4 summarize the impulse responses of bank lending rates to a shock in government bond rates by showing the individual graphs for every horizon ranging from the impact period (horizon 0) to 11 months after the shock. The y–axis measures the deviation of bank lending rates from their steady states in percentage points. The x–axis shows the points of time at which the impulse response functions have been computed. Solid lines display the median response at a particular horizon. The shaded areas show the 16 and 84 percent bounds of the confidence interval derived from the draws of the MCMC algorithm.

Figures 1–4: Bank Lending Rate Responses to a –1 Percentage Point Government Bond Rate Shock

Since for the estimation of our TVP–VAR models a training sample of 36 months and a lag length of two was chosen, the first impulse response functions are obtained for 2006M3. For the computation of impulse responses we use the model parameters estimated for a specific point in time (as shown on the x–axis) and assume that these parameters remain constant over the impulse horizons. In order to isolate changes in the propagation of the shocks from changes in the volatility of the shocks over time, the impulse responses are constructed such that in each month the government bond rate shocks are normalized to -1 percentage point. It should be noted that in our framework we cannot identify the nature of the shock hitting the government bond rate. Until now, the ECB has not applied the OMT program by conducting government bond purchases. Nevertheless, although the government bond shock remains unidentified, the *raison d'être* of the OMT program justifies our assumption that any monetary policy intervention conducted by means of OMTs would lead to an immediate decrease of a country's government bond yield.[14]

Our results show that bank lending rates across euro area periphery countries fall in response to a 1 percentage point drop of government bond rates, however, the overall decline is limited. Moreover, the reaction of bank lending rates exhibits a pronounced time–varying pattern. The decline is strongest in the period up to mid–2008, which for example in the case of Italy amounts to a maximum of 0.4 percentage points for `BLR-1Y` and 0.6 percentage points for `BLR+1Y` three and eight months after the shock. Interestingly, the beginning of the financial crisis in summer 2007 (vertical line I in Figures 1–4), when interbank market credit spreads started to increase and when, as a consequence, the ECB adopted its first quantitative measures by offering a number of additional 3–month–LTROs, hardly affected the transmission of government bond rates to bank lending rates.

At the height of the global financial crisis a quantitatively important change in the interest rate pass–through is observable around September 2008, when the investment bank Lehman Brothers went bankrupt and the ECB started to vigorously cut policy rates and adopted full allotment policy (vertical line II in Figures 1–4). The reaction of bank lending rates across euro

[14] Note that even the announcement of the ECB's OMT program has lead to a drop in periphery government bond rates.

area periphery countries following the -1 percentage point shock of government bond rates became substantially weaker. While the average maximum drop of bank lending rates across all periphery countries was 0.30 percentage points for `BLR-1Y` and 0.47 percentage points for `BLR+1Y` in early 2008, it was only 0.17 percentage points (`BLR-1Y`) and 0.32 percentage points (`BLR+1Y`) in the period thereafter. Thus, the reduction of interest rate pass-through amounted to 43 % (`BLR-1Y`) and 31 % (`BLR+1Y`), respectively.

The burgeoning euro crisis, which gained momentum in May 2010 (vertical line III in Figures 1–4) when government bond spreads of the euro area periphery countries sharply increased and when the ECB launched its Securities Markets Program (i.e. the outright purchase of government bonds from the periphery countries), did not have any notable impact on the link between government bond rates and bank lending rates, which continued to remain weak. The massive interventions of the ECB by the end of 2011, when it provided two long–term refinancing operations with full allotment and a maturity of 3 years each (vertical line IV in Figures 1–4) and the ECB's announcement of the OMT program in the summer of 2012 (vertical line V in Figures 1–4) did not fundamentally change this result. If anything at all, a further decrease in the pass–through can be observed. In sum, the responses of bank lending rates to shocks in government bond rates were significantly weaker since mid–2008 than in the pre-crisis period.

3.2 Discussion

The ECB lists several theoretical arguments suggesting a close link between bank lending rates and government bonds rates (see European Central Bank, 2012a, p.7–11). However, our empirical results for euro area periphery countries show that the relationship between these interest rates is only weak and that therefore the potential effectiveness of the OMT program in safeguarding an appropriate monetary policy transmission is limited. While bank lending rates adjusted only incompletely to changes in government bond rates before the height of the financial crisis in 2008, their responsiveness to movements in yields on government bonds has further weakened substantially thereafter. Related work by de Bondt, Mojon, and Valla (2005), Lorenzo and Marotta (2006) and Marotta (2009), among others, confirm our findings that the interest rate pass–through had already been limited before the outbreak of the crisis.

Identifying the reasons why banks in euro area periphery countries have altered their loan–rate setting behavior in the period after late–2008 is beyond the scope of our analysis, since our empirical model only reflects the correlations between bank lending rates and government bond rates. Nevertheless, one cause might have been that the economies were hit by a sequence of adverse macroeconomic shocks that caused severe recessions. Thus, banks have suffered from a reduction in the average quality of borrowers, which has led to massive write-offs as reflected by the increase in non-performing loans (see Figure 5). Bank capital position deteriorated, while the cost of refinancing increased. Therefore, credit conditions tightened as indicated by the increase in collateral requirements, which in turn might have caused a decoupling of bank lending rates from government bond rates.

Figure 5: Stylized Facts

4 Policy Experiment

For policy makers it is important to understand both, the qualitative effects of the impaired pass-through between bank lending rates and government bond rates as well as its quantitative implications. To illustrate the latter, we consider the following counterfactual out–of–sample simulation: we assume that the ECB would have started buying euro area periphery countries government bonds via the OMT program in June 2014, i.e. the month following the end of our sample, in an amount that would lower periphery government bond rates immediately and permanently to the level of the German government bond rate as of May 2014. Therefore, the size of the OMT interventions would have to be chosen such that on impact yields on government bonds decline by 0.26 percentage points in Ireland (reduction of 85%), 0.57 percentage points in Spain (reduction of 92%), 0.71 percentage points in Italy (reduction of 94%) and 0.88 percentage points in Portugal (reduction of 95%) to reach the level of the German government bond rate, which indicates a strong policy intervention. In our TVP-VAR models the size of such interventions is reflected by the shocks that enter the government bond rate equations.[15] We assume that model parameters remain constant at their

[15] Up to now it is not clear whether the ECB, in case the OMT program has to be activated, will predetermine the amounts, the timing and the duration of government bond

May 2014 levels over the simulation horizon.

In our counterfactual simulation we address the following two questions: *First*, how would periphery countries bank lending rates have responded to such an ECB intervention, which successfully lowers government bond rates? *Second*, how large would such an intervention have been by historical standards? Figures 6 and 7 summarize the results by showing the counterfactual paths of bank lending rates and the sequence of shocks in the government bond rate equations of the TVP-VAR models, which are necessary to permanently bring down the periphery yields on government bonds to the level of the German government bond rate.

To answer the *first* question, Figure 6 shows that, as aspired by the ECB, periphery countries bank lending rates would indeed go down in response to a permanent reduction of government bond rates. However, due to the congested pass–through, the reductions induced by OMTs would be small compared to the relatively large and permanent reduction in government bond rates, and the main effects on bank lending rates would occur in the first couple of months.

Figure 6: Simulated Response of Bank lending Rates to an ECB Intervention

To answer the *second* question, Figure 7 shows that strong interventions by means of OMTs would be necessary to permanently bring down periphery countries yields on government bonds to the level of the German government

purchases. We assume that, similar to the Securities Markets Program (SMP) adopted in early 2010, the precise future path of OMTs will remain uncertain. In this case repeated shocks to the government bond rate equation represent a valid approximation of OMTs interventions.

bond rate. The shocks caused by the initial interventions in June 2014 would need to have a size of between -0.4 percentage points (Ireland) and -1.2 percentage points (Portugal) to ensure the required fall of government bond rates. In the months following the initial interventions, continuous intervention shocks of between -0.1 percentage points (Ireland) and -0.5 percentage points (Spain) would have been necessary to maintain periphery countries government bond rates at the level of the German sovereign bond yield.

Figure 7: Simulation of required Government Bond Rate Shocks

One way to assess the magnitude of these interventions is to relate them to the TVP-VAR models average size of the government bond rate shocks observed in the past.[16] The comparison shows that with the exception of Ireland, the initial interventions would have to be two to four times larger than the average size of the shocks in our empirical models. While the subsequent interventions would be smaller in size, the fact that these interventions have to be permanent implies a sizable cumulated intervention volume. Thus, the ECB would become a major creditor of the euro area periphery countries. However, despite such massive interventions bank lending rates would not notably fall. Thus, it seems that the OMT program, if it were activated, would probably not be a sufficient tool to restore the monetary transmission mechanism.

[16]The estimated average national standard deviations are shown in Figure 7 by the dotted horizontal line. Note that the average size of the shock corresponds to its standard deviation which can be derived by simply taking the square root of the estimated volatilities.

5 Conclusion

This paper explored the potential effectiveness of the ECB's OMT program in restoring the monetary transmission mechanism. Using TVP-VAR models for euro area periphery countries we analyzed the response of bank lending rates to movements in government bond rates.

As pointed out by the ECB, the necessity of the OMT program is based on the notion that the transmission of monetary policy in the euro area has been severely impaired due to widely divergent borrowing costs across member countries (European Central Bank, 2012a). A major source of impairment is the fear that one of the euro area periphery countries – or more – could exit the euro, which has driven up the risk premia on sovereign bonds. Since theory suggests that sovereign bond markets play an important role in determining bank lending rates through borrowing costs, the euro area government bond market turmoil might have caused a malfunctioning of monetary policy transmission by adversely affecting bank lending rates. Thus, persistently elevated bank lending rates in euro area periphery countries could be caused by high yields on periphery sovereign bonds. If this was the case, the OMT program would be a sufficient tool for restoring the transmission mechanism of monetary policy.

However, our empirical results cast doubts on the potential effectiveness of the OMT program in safeguarding an appropriate monetary policy transmission as we only find attenuated reactions of bank lending rates in euro area periphery countries to movements in government bond rates. While bank lending rates had already reacted sluggishly to changes in sovereign bond rates before mid-2008, their response has substantially weakened thereafter. Therefore, the theoretical underpinning of the OMT program, i.e. the view that high bank lending rates are primarily caused by high government bond rates, is not supported empirically. Although the announcement of the ECB's OMT program has improved financial conditions for sovereigns in euro area periphery countries, our findings suggest that a significant reduction of bank lending rates is hardly possible by means of government bond purchases.

Future work might focus on two important research questions. First, it would be interesting to identify the reasons why bank lending rates in the euro area periphery countries have decoupled from movements in government bond rates. Possibly the malfunctioning of the monetary transmission mechanism might have been triggered by structural changes in the economies in general or in the banking sector in particular. Detecting the sources of these changes is challenging. Second, it would be interesting to explore the nature of shocks that have particularly hit the euro area periphery countries during the financial crisis. Possibly, idiosyncratic shocks might have caused distortions in the functioning of the monetary transmission mechanism, which might have counteracted the effectiveness of the single monetary policy.

Appendix

A Data

We use monthly data for euro area periphery member countries covering the period 2004M1–2014M5. The set of countries includes Ireland, Italy, Portugal and Spain. The bank lending rates refer to interest rates on new business loans to non–financial corporations (excluding revolving loans and overdrafts, convenience and extended credit card debt), with a maturity of up to one year (`BLR-1Y`) and over one year (`BLR+1Y`). The series are taken from the ECB's harmonized MFI interest rate statistics. The data code is `MIR.M.XX.B.A2A.F.R.A.2240.EUR.N` for the short–term bank lending rates and `MIR.M.XX.B.A2A.K.R.A.2240.EUR.N` for the long–term bank lending rates, where `XX` is the respective country acronym.

The government bond rates are monthly averages, calculated from daily FTSE Global Government Bond Indices with an average maturity of one to three years. The series are taken from the Thompson Reuters DataStream database. We use the series `RGXX1T3(RY)`, where again `XX` denotes the country acronym. For all countries, Figure 8 shows the complete time series that we use for estimation, including the training sample of 36 months.

Figure 8: Euro Area Periphery Countries Time Series

B Markov–Chain Monte–Carlo Algorithm

The parameters of the TVP–VAR models as well as various statistics of interest are estimated by means of a version of the Markov–Chain Monte–Carlo

(MCMC) algorithm. In particular, the *unconditional* posterior distributions of Q, S and W are approximated by draws from their *conditional* posterior distributions, the time paths $\{B_t\}_{t=T_0+1}^{T}$ and $\{\alpha_t\}_{t=T_0+1}^{T}$ are computed by using the Carter–Kohn algorithm while we resort to the independence Metropolis–Hastings approach for inferring the time paths of the stochastic volatilities $\{\log\sigma_t\}_{t=T_0+1}^{T}$, where T and T_0 denote the size of the overall and the training sample respectively. The algorithm includes the following steps:

1. Set priors for Q, S, W, B_0, α_0 and $\log\sigma_0$.

2. Choose starting values for Q, S and W: We use $diag(Q_{start}) = V(\hat{B}_{OLS})$, $diag(S_{start}) = V(\hat{A}_{OLS})$ and $diag(W_{start}) = diag(I_2) * 0.0001$.

3. Choose starting values for the Carter-Kohn algorithm: Following (Primiceri, 2005) we set $B_0 = \hat{B}_{OLS}$, $P_{B,start} = 4 \cdot V(\hat{B}_{OLS})$, $\alpha_0 = \hat{A}_{OLS}$, $P_{A,start} = 4 \cdot V(\hat{A}_{OLS})$, where P_B and P_A denote the covariance matrices of the initial state vectors B_0 and α_0. Note that in our case α_0 is a scalar.

4. Set priors for the Metropolis-Hastings algorithm (used to infer the path of σ_t): We resort to $\log\sigma_0 \sim N(\bar{\mu}, \bar{\sigma})$ with $\bar{\mu} = \log\hat{\sigma}_{OLS}$ and $\bar{\sigma} = diag(I_n) \cdot 10$.

5. Specify a starting value for the time path $\{\alpha_t\}_{t=T_0+1}^{T}$: We set $\alpha_{t,start} = \hat{A}_{OLS}$ for all $t = T_0 + 1, ..., T$.

6. Specify a starting value for the time path of $\{\sigma_t\}_{t=T_0+1}^{T}$: We set $\sigma_{1,t,start} = u^2_{1,OLS}$ and $\sigma_{2,t,start} = u^2_{2,OLS}$ for all $t = T_0 + 1, ..., T$, where $u^2_{1,OLS}$ and

$u^2_{2,OLS}$ are the OLS estimates of the variances of the reduced form residuals based on the training sample.

7. Set $Q = Q_{start}$, $S = S_{start}$, $W = W_{start}$, $\alpha_t = \alpha_{t,start}$ and $\log\sigma_t = \log\sigma_{t,start}$.

8. Conditional on Q, α_t and $\log\sigma_t$ draw a new time path $\{B_t\}^T_{t=T_0+1}$ by using the Carter-Kohn algorithm.

9. Given the draw for the time path $\{B_t\}^T_{t=T_0+1}$ calculate the corresponding draw for the time path of the vector of residuals $\nu_t = B_t - B_{t-1}$, for $t = T_0+1, ..., T$.

10. Conditional on the draw for $\{\nu_t\}^T_{t=T_0+1} = \bar{\nu}$ draw the ith diagonal element of the diagonal matrix $\tilde{Q}$ from the inverse Gamma distribution with scaling parameter equal to the ith element of $(diag(\bar{\nu}'\bar{\nu}) + k^2_Q \cdot T_0 \cdot V(\hat{B}_{OLS}))/2$ and degrees of freedom $(T_0 + T - T_0)/2$. If Q is allowed to be non-diagonal, draw $\tilde{Q}$ from the inverse Wishart distribution with scaling matrix $\bar{\nu}'\bar{\nu}_t + k^2_Q \cdot T_0 \cdot V(\hat{B}_{OLS})$ and degrees of freedom $T_0 + T - T_0$.

11. Conditional on S, $\{\log\sigma_t\}^T_{t=T_0+1}$ and the new draw $\{B_t\}^T_{t=T_0+1}$ draw a new time path $\{\alpha_t\}^T_{t=T_0+1}$ using the Carter-Kohn algorithm.

12. Given the new draw for $\{\alpha_t\}^T_{t=T_0+1}$ calculate the corresponding draw for the residuals $\zeta_t = \alpha_t - \alpha_{t-1}$ for $t = T_0+1, ..., T$.

13. Conditional on the draw for $\{\zeta_t\}^T_{t=T-0+1} = \bar{\zeta}$ draw the $\tilde{S}$ from the inverse Gamma distribution with scaling parameter $(\bar{\zeta}'\bar{\zeta} + k^2_S \cdot 2 \cdot V(\hat{A}_{OLS}))/2$

and degrees of freedom $(T - T_0 - 1)/2$. Note that in our case α_t is a scalar.

14. Conditional on the draws for $\{B_t\}_{t=T-0+1}^{T}$ and $\{\alpha_t\}_{t=T-0+1}^{T}$ calculate a new draw for the structural residuals $\epsilon_t = A_t u_t$, for $t = T_0 + 1, ..., T$.

15. Conditional on W and the draw $\{\epsilon_t\}_{t=T_0+1}^{T}$ use the independence Metropolis-Hastings algorithm (with parameters $\bar{\mu}$ and $\bar{\sigma}$) to derive a new draw for $\{\sigma_t\}_{t=T_0+1}^{T}$. Note that, since the two structural residuals in our model, $\epsilon_{1,t}$ and $\epsilon_{2,t}$ are mutually uncorrelated, the corresponding paths of the variances $\{\sigma_{1,t}\}_{t=T_0+1}^{T}$ ($\{\sigma_{2,t}\}_{t=T_0+1}^{T}$) are computed based on $\{\epsilon_{1,t}\}_{t=T_0+1}^{T}$ ($\{\epsilon_{2,t}\}_{t=T_0+1}^{T}$) only.

16. Given the new draw for $\{\sigma_t\}_{t=T_0+1}^{T}$ compute $\eta_t = \log \sigma_i - \log \sigma_{i,t-1}$, for $t = T_0 + 1, ..., T$. Given $\{\eta_t\}_{t=T_0+1}^{T} = \bar{\eta}$ draw the ith diagonal element of the diagonal matrix $\tilde{W}$ from the inverse Gamma distribution with scaling parameter equal to the ith element of $\frac{diag(\bar{\eta}'\bar{\eta})+k_W^2 \cdot 3}{2}$ and degrees of freedom $(T - T_0)/2$.

17. Set $Q = \tilde{Q}$, $S = \tilde{S}$ and $W = \tilde{W}$.

18. Repeat steps 8 through 17 X times. Discard the *burn-in* draws. The remaining draws are used to compute the statistics of interest.

C Marginal Likelihood

Let $\theta = (Q, S, W)$, $\vartheta = (\{B_t\}_{t=T_0+1}^{T}, \{\alpha_t\}_{t=T_0+1}^{T}, \{\sigma_t\}_{t=T_0+1}^{T})$ and $Y = \{Y_t\}_{t=T_0+1}^{T}$. The marginal likelihood for our model $F(Y)$ is defined as the integral

$$F(Y) = \int f(Y \mid \theta; \vartheta)\pi(\theta)d\theta,$$

where $f(Y \mid \theta; \vartheta)$ denotes the likelihood function of the model while $\pi(\theta)$ denotes the joint prior density of the parameters. Accordingly, the marginal likelihood corresponds to the posterior distribution with the parameters integrated out. Since for our TVP–VAR the above integral can not be evaluated analytically, we follow Nakajima (2011) and approximate it by the method suggested by Gelfand and Dey (1994):

$$\frac{1}{F(Y)} \approx \frac{1}{N_{draws}} \cdot \sum_{j=1}^{N_{draws}} \frac{\phi(\theta_j)}{f(Y \mid \theta_j; \vartheta_j)\pi(\theta_j)},$$

where N_{draws} is the number of MCMC draws, θ_j denotes the jth draw of θ and $\phi(\theta_j)$ is the probability density function of the truncated normal distribution recommended by Geweke (1994). In particular

$$\phi(\theta_j) = \frac{1}{(1-\tau)(2\pi)^{\frac{K}{2}}} |\Upsilon|^{-\frac{1}{2}} \exp\Big[-\frac{1}{2}(\theta_j - \bar{\theta})'\Upsilon^{-1}(\theta_j - \bar{\theta})\Big] \cdot \mathbb{I},$$

where $\bar{\theta}$ is the posterior mean and Υ the posterior covariance matrix of the parameter vector θ. K is the number of elements in θ. $\mathbb{I}$ denotes the indicator function taking the value of one if

$$(\theta_j - \bar{\theta})'\Upsilon^{-1}(\theta_j - \bar{\theta}) \leq \chi^2_\tau(K)$$

and zero otherwise. $\chi^2_\tau(K)$ denotes the τ^{th} percentile of the inverse χ^2-distribution with K degrees of freedom. Following Nakajima (2011) we set $\tau = 0.99$.

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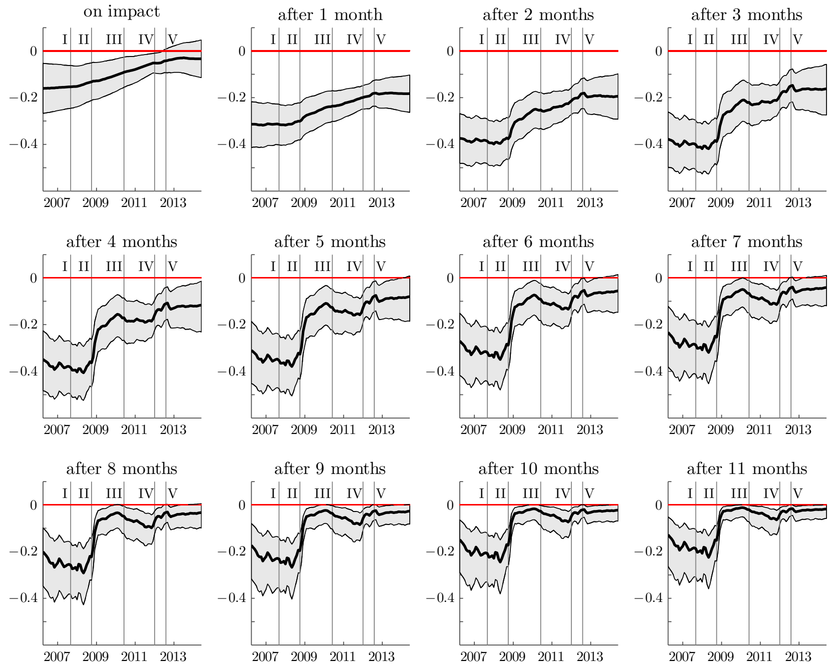
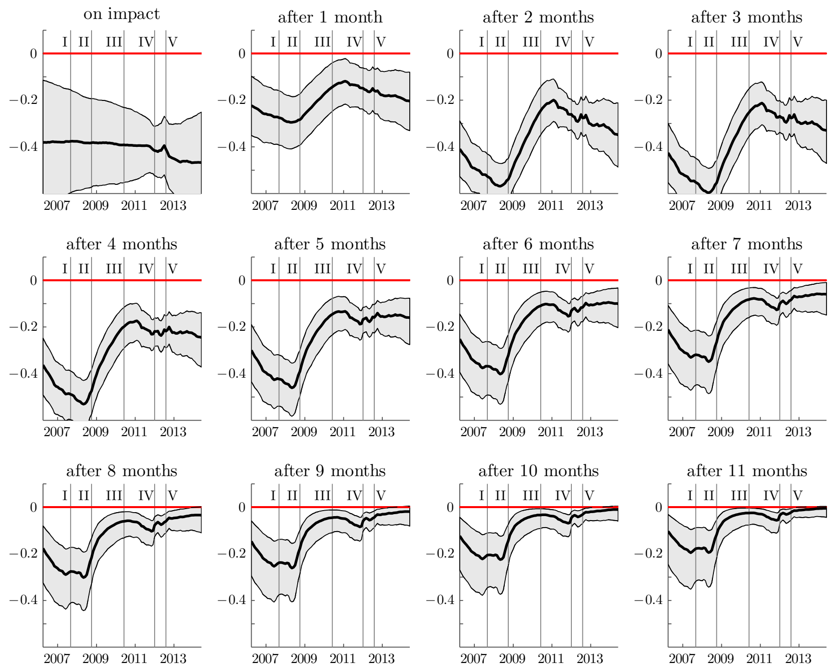
Figure 1: Response of Italian bank lending rates

Response of `BLR-1Y` to a –1 Percentage Point Government Bond Rate Shock



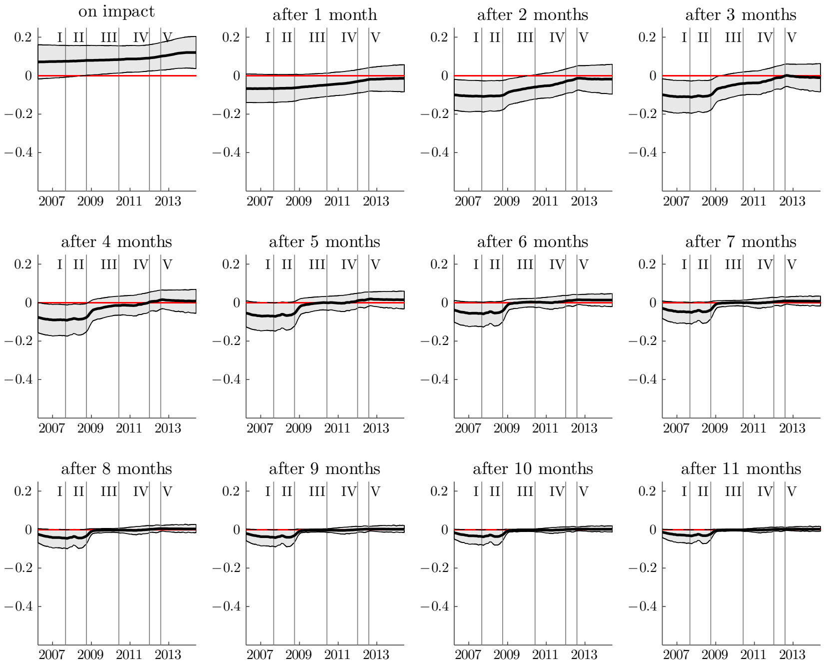
Response of `BLR+1Y` to a –1 Percentage Point Government Bond Rate Shock



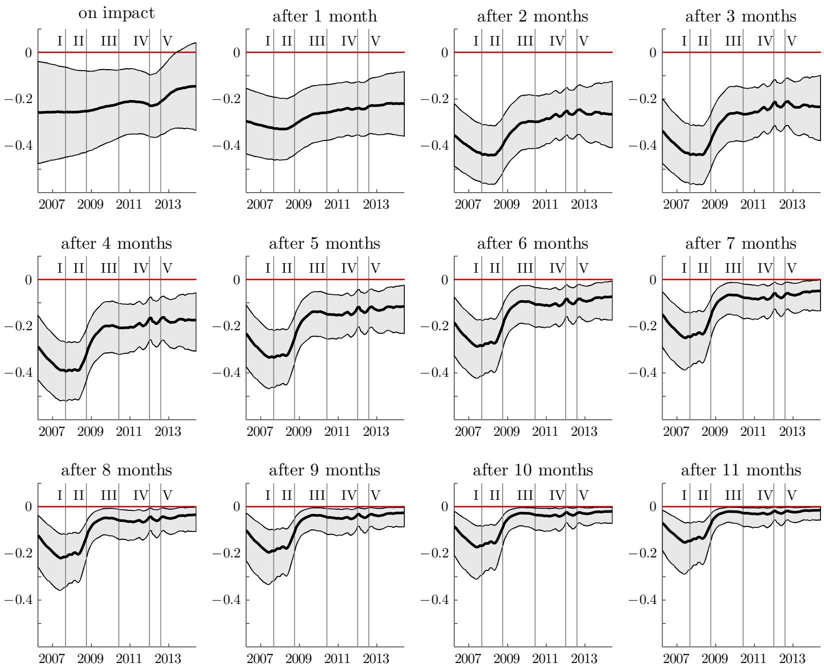
Notes: The graph plots the time–varying median response of bank lending rates (as percentage point deviation from the steady state) to a –1 percentage point shock of the government bond rate equation over the 12 months following the shock.

Figure 2: Response of Spanish bank lending rates

Response of `BLR-1Y` to a –1 Percentage Point Government Bond Rate Shock



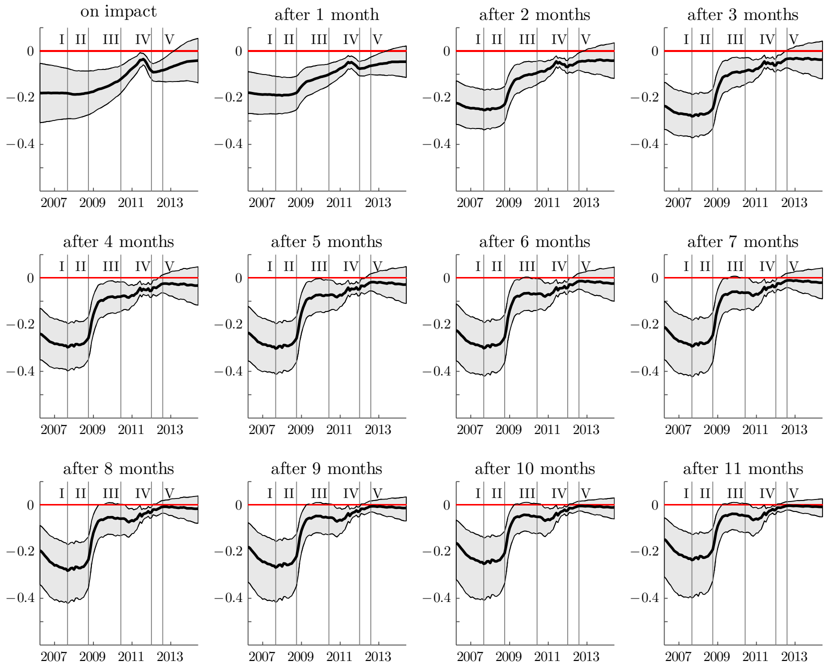
Response of `BLR+1Y` to a –1 Percentage Point Government Bond Rate Shock



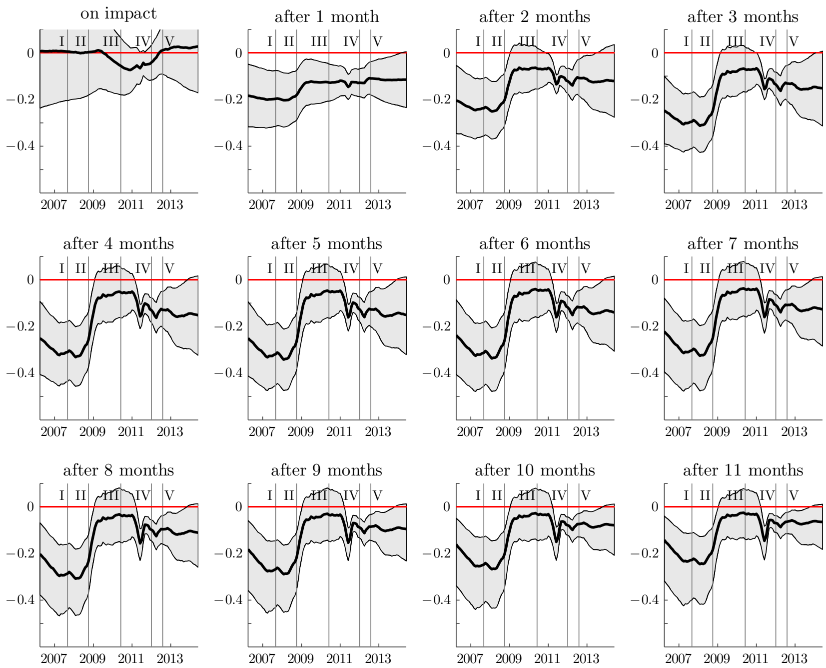
Notes: The graph plots the time–varying median response of bank lending rates (as percentage point deviation from the steady state) to a –1 percentage point shock of the government bond rate equation over the 12 months following the shock.

Figure 3: Response of Irish bank lending rates

Response of `BLR-1Y` to a –1 Percentage Point Government Bond Rate Shock



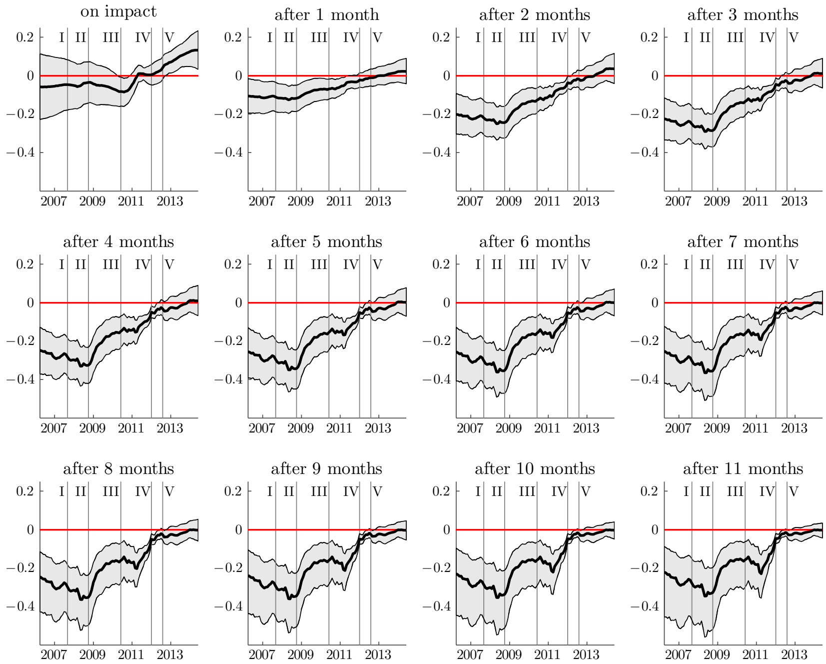
Response of `BLR+1Y` to a –1 Percentage Point Government Bond Rate Shock



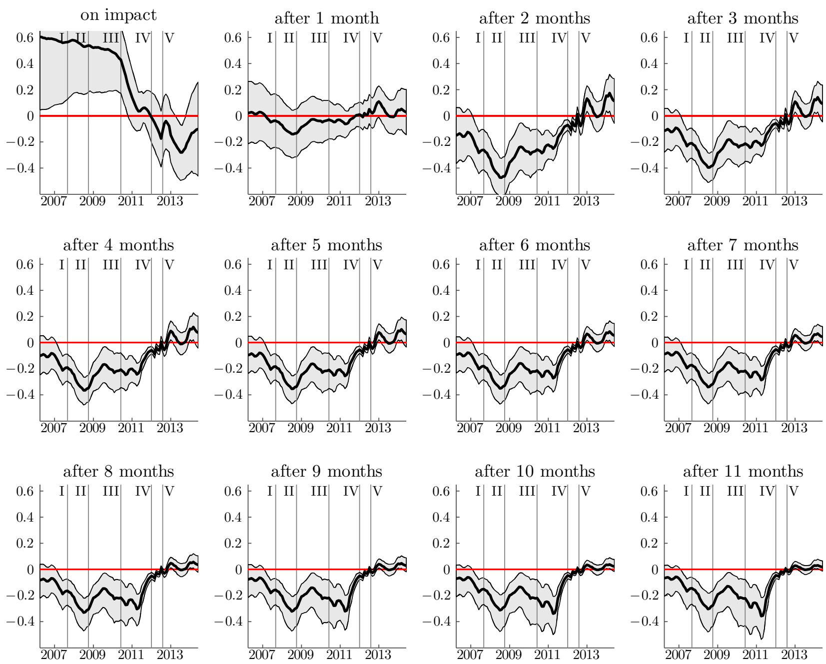
Notes: The graph plots the time–varying median response of bank lending rates (as percentage point deviation from the steady state) to a –1 percentage point shock of the government bond rate equation over the 12 months following the shock.

Figure 4: Response of Portuguese bank lending rates

Response of `BLR-1Y` to a –1 Percentage Point Government Bond Rate Shock

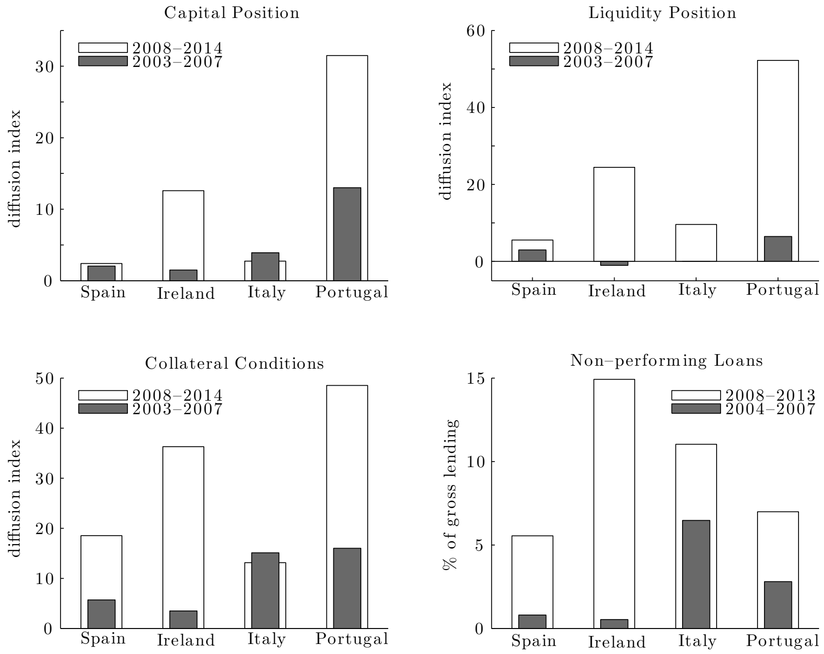


Response of `BLR+1Y` to a –1 Percentage Point Government Bond Rate Shock



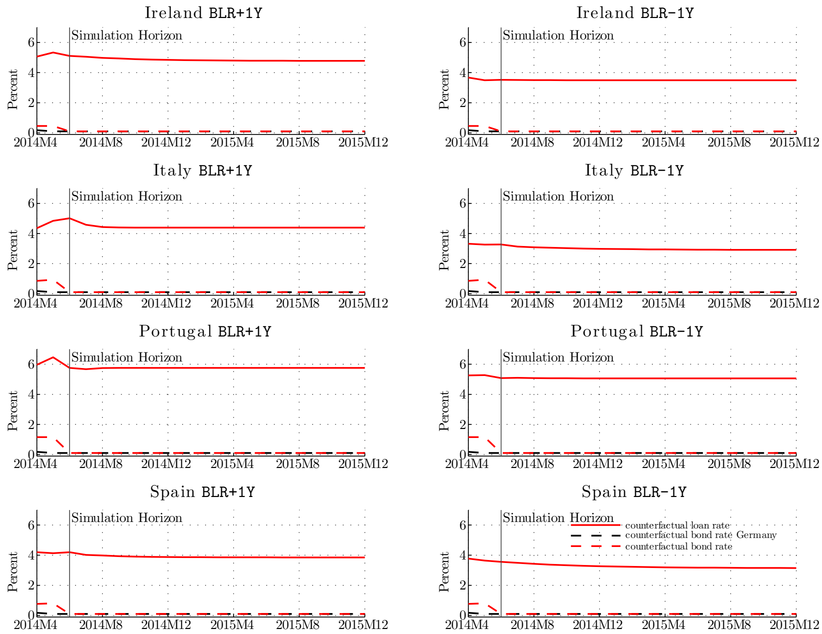
Notes: The graph plots the time–varying median response of bank lending rates (as percentage point deviation from the steady state) to a –1 percentage point shock of the government bond rate equation over the 12 months following the shock.

Figure 5: Some Stylized Facts



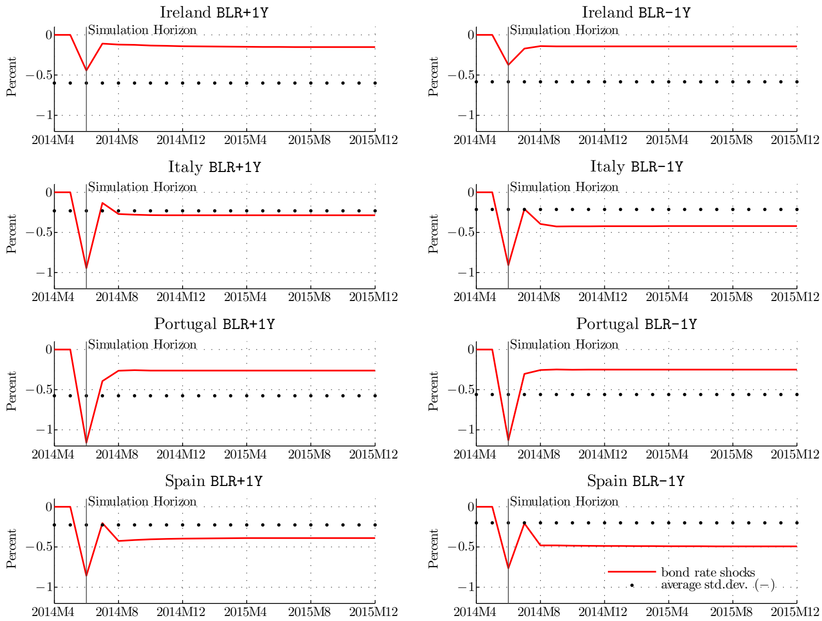
Notes: Source: European Central Bank, Bank Lending Survey (BLS) and World Bank, World Development Indicators (WDI). Capital Position: answer to question 2.A.1 (BLS). Liquidity Position: unbalanced average of answers to questions 2.A.2 and 2.A.3 (BLS). Collateral Conditions: unbalanced average of answers to questions 2.B.3 and 3.B.3 (BLS). Non–performing loans as fraction of total gross lending (WDI).

Figure 6: Simulation of an ECB Intervention



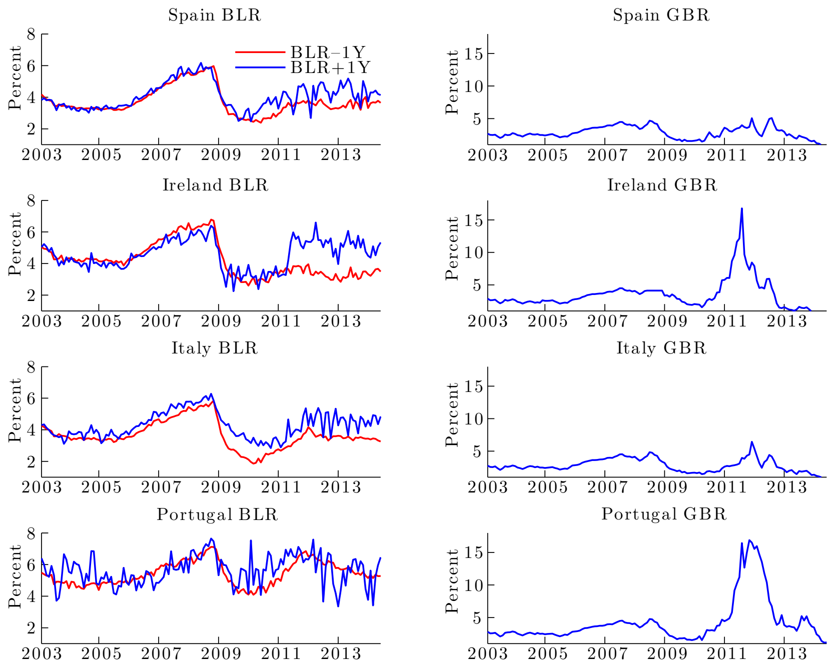
Notes: The simulation uses the estimated coefficients of the TVP-VAR models for 2014M5. In the counterfactual, the ECB pushes the periphery bond rates (dashed red line) instantaneously and permanently to the level of the German bond yield (dashed black line), which was observed in 2014M5. The solid red line shows the counterfactual bank lending rate path.

Figure 7: Simulation of required Government Bond Yield Shocks



Notes: The simulation uses the estimated coefficients of the TVP-VAR models for 2014M5. In the counterfactual, the ECB pushes the periphery bond rates instantaneously and permanently to the level of the German bond yield, which was observed in 2014M5. The dotted line indicates the average standard deviation of the estimated government bond yield shocks between 2006M3 and 2014M5.

Figure 8: Euro Area Periphery Countries Time Series



Notes: Source: European Central Bank and FTSE Global Government Bond Indices