The influence of sovereign bond yields on bank lending rates: the pass-through in Europe

Markus Eller,
Thomas Reininger[1]

In the wake of the recent crises, the question arose how to ensure the transmission of monetary policy to the lending rates for loans to private nonbanks, in particular against the background of divergent government bond yield changes. This paper investigates which variables help explain changes of long-term fixed-rate bank lending rates on loans to the private nonfinancial sector in 21 EU countries. We conduct a cross-country panel study and analyze vector error correction models for each country. We find that long-term sovereign bond yields have a significant positive and economically substantial impact on long-term lending rates in most euro area and some non-euro area countries. Our findings lend support to the view that unconventional monetary policy can influence long-term lending rates via its impact on government bond yields. Furthermore, our insights suggest adopting a cautious approach when designing changes to the regulatory treatment of sovereign exposures. To the extent that such changes cause a sustained widening of sovereign yield spreads, the impact on long-term lending rates could entrench real economic divergences between EU countries and in particular within the euro area.

JEL classification: C32, C33, E43, E52, G21
Keywords: sovereign debt crisis, sovereign spread, sovereign credit risk, sovereign yield, government bond yield, bank interest rates, bank lending, lending conditions, long-term financing, bank funding, transmission, interest rate pass-through

In recent years, the sovereign debt crisis in some European countries has had a profound impact on these countries' real economy, causing divergences within the region in general and within the euro area in particular. An important feature of the sovereign debt crisis was the sudden change of market participants' perception of risk in individual EU Member States, which led to sharply rising government bond yields and sovereign risk premia. This altered risk perception sharply reversed the convergence of yields to a very low level that had taken place in the run-up to and the initial years of the euro area.

At the same time, rates on loans to private nonbanks increasingly diverged within the region. To the extent that the rise of sovereign bond yields in some countries has contributed to the increase of lending rates, sovereign debt problems had an impact on the real economy via a channel in addition to those through which fiscal austerity affects real income.

More generally, the question arises to what extent investors and banks differentiate between the sovereign credit risk and the credit risk of private nonbanks of the same country. In other words, does a rise in government bond yields increase the rate on loans to private nonbanks in the same country? Why should we actually expect a change in government bond yields to have an impact on lending rates for loans to private nonbanks?

Traditionally, determinants of lending rates are discussed primarily within the context of the monetary transmission mechanism, focusing on the impact of changes in the key policy rate on money market rates and, hence, on lending rates. However, as suggested by empirical evidence for euro area countries in de Bondt

[1] *Oesterreichische Nationalbank (OeNB), Foreign Research Division, markus.eller@oenb.at and thomas.reininger@oenb.at (corresponding author). Opinions expressed by the authors do not necessarily reflect the official viewpoint of the OeNB or the Eurosystem. The authors would like to thank two anonymous referees, Peter Backé, Jesús Crespo Cuaresma, Dagmar Dichtl, Martin Feldkircher, Florian Huber, Rena Mühldorf and Zoltan Walko for helpful comments and valuable suggestions.*

(2005) or von Borstel et al. (2016) one may expect the impact of monetary policy on lending rates to be considerably weaker for long-term lending rates (that is, lending rates with a long-term interest rate fixation) than for short-term lending rates. By contrast, sovereign bond yields probably have a greater impact on long-term lending rates than on short-term lending rates.

Under this perspective, investigating the impact of sovereign bond yields on long-term fixed lending rates (on new lending and, with a time lag, on the outstanding stock of loans) aims, inter alia, at improving the understanding of potential shortcomings of the monetary transmission mechanism that arise when policymakers rely exclusively on conventional monetary policy using short-term interest rates.

Within the literature on the monetary transmission mechanism (see Beckmann et al., 2013), in addition to the traditional "monetary policy approach," a "cost-of-funds approach" strand has developed to analyze such shortcomings. The term "cost of funds" does not relate primarily to the funding side of the banks, but rather to the maturity-conforming market rate as the opportunity cost of the bank lending rate, that is, the cost of the best foregone investment alternative. Under the cost-of-funds approach, usually a corresponding market rate is chosen according to the highest correlation with the bank retail rate under study (see Sander and Kleimeier, 2004), that is, long-term government bond yields or long-term interest rate swaps are chosen for long-term fixed bank lending rates (e.g. van Leuvensteijn et al., 2013). In practical terms, banks take long-term government bond yields as reference benchmarks for their fixed rates on long-term lending to private nonbanks. In this view, one would expect that sovereign bond yields influence long-term fixed lending rates also "in normal times" – not only in times of sovereign debt problems.

However, in times in which sovereign debt is under severe stress, on the one hand, it may well be that the price-setting behavior of banks changes so that the impact of a rise in the sovereign yield on the lending rate becomes weaker. For instance, banks may not want to raise lending rates above a certain level so as to avoid exposure to riskier borrowers (adverse selection) or to discourage firms from taking excessive risk (moral hazard); see the seminal work by Stiglitz and Weiss (1981). Also, banks may consider some yield movements a temporary phenomenon and may thus be reluctant to follow them as quickly as usual in their price setting.

On the other hand, in times in which sovereign debt is under severe stress, government bond yields may influence lending rates via two additional channels, namely by inducing higher risk premia and by raising banks' funding costs:

First, a strong increase in sovereign risk associated with fears of sovereign default would have an impact on the banking sector in view of the risk of sharply deteriorating general economic conditions (see Bahaj, 2014). If the sovereign of an EU Member State were to default, the economy would fall into a major recession (given the strong role of government in the EU economies) and claims on the productive sector would pay out little. Therefore, banks are likely to raise the premia on lending to firms and households when the probability of sovereign default rises (see Bocola, 2014). Again, however, the upper bound on rates and banks' delayed reaction may restrain the impact of the prospect of sovereign default on risk premia.

Second, a strong increase in sovereign risk can raise the funding costs of banks and thus lead to higher lending rates (if margins are preserved) and lower credit volumes (if credit demand is elastic). There are at least three different ways in which the increase in sovereign risk can affect the refinancing side of banks, in particular of large, systemically important banks of the respective country (see Albertazzi et al., 2014; Bank for International Settlements, 2011; Bocola, 2014; Cantero-Saiz et al., 2014): (1) through the deterioration of (the risk outlook for) banks' assets, including claims on private nonbanks; (2) through the reduction of collateral value, affecting primarily the short-term refinancing of banks; (3) through the correlation between sovereign ratings and bank ratings, as the sovereign rating typically serves as a ceiling and/or because of the presence of explicit or (assumed) implicit state guarantees for (large) banks (see Correa et al., 2014). However, one may doubt that such adverse implications for bank funding (and hence lending rates) of strong increases of government bond yields in times of severely distressed sovereign debt will comprehensively materialize, provided the monetary authorities supply ample liquidity, including in the long-term segment.

Moreover, monetary policy responses may contain the increase of sovereign yields in the first place or may even result in yield declines, which, ceteris paribus, could show up in lower lending rates. More broadly, monetary policy, including unconventional measures, may play a role in determining bank lending rates through the impact on (1) money market liquidity, (2) deposit rates for primary funding and (3) sovereign bond yields. Von Borstel et al. (2016) show that during the sovereign debt crisis in some euro area countries from 2010 to 2013, expansionary monetary policy reduced sovereign risk in peripheral euro area countries and longer-term bank funding risk in both peripheral and core countries, but was not effective in lowering spreads between lending rates and banks' funding costs (Illes et al., 2015, confirm the latter).

In fact, government bond yields are influenced not only by (unconventional) monetary policy, but also by several other factors, including (the outlook for) fiscal policy, international risk aversion, regulatory measures, and the business cycle (see e.g. Maltritz and Molchanov, 2013; Heinz and Sun, 2014).

We note that among the literature on the existing empirical evidence, so far only a few studies have estimated the direct impact of government bond yields on lending rates in Europe. While some of these papers focus on Italian banks only (Albertazzi et al., 2014; Zoli, 2013; Bocola, 2014), there are a few cross-country papers for selected euro area countries (Neri, 2013; Neri and Ropele, 2015; Hristov et al., 2014). The European Central Bank (2013) addressed the issue whether an inclusion of a sovereign risk indicator improved the modeling of the interest rate pass-through of monetary policy decisions in the euro area.

Albertazzi et al. (2014) aim at explaining bank deposit and lending rates by modeling a sovereign risk variable, a monetary policy variable and an economic activity variable, plus lags of the dependent variable, in an autoregressive distributed lags (ARDL) model estimated with ordinary least squares (OLS). They find that the sovereign risk variable significantly affects the cost of credit for firms and households (and exerts a negative effect on loan growth). Zoli (2013) estimates a vector autoregression (VAR) with the bank lending rates on loans to firms the ten-year government bond spread and the average credit default swap (CDS) spread of the five largest Italian banks (as a proxy for bank risk and bank funding costs) as endogenous variables (all in first differences); changes in the three-month EURIBOR are included as an exogenous variable. She finds that the movements in sovereign spreads affect the CDS spreads and are transmitted rapidly to firm lending rates (about 30% to 40% of the increase in sovereign spreads are transmitted to firm lending rates within three months). Bocola (2014) uses a real business cycle model with financial intermediation and the sovereign exposure of banks, taking five-year CDS spreads on Italian government securities as the sovereign risk variable. He finds that the rise in the probability of a sovereign default leads to a rise in the financing premia of firms.

Turning to multicountry studies, Neri (2013) investigates a sample of ten euro area countries in the period January 2003 to August 2012. He aims at explaining the impact of sovereign debt tensions on short-term bank lending rates for new loans (excluding overdrafts) to nonfinancial corporations and to households (for residential mortgages). The explanatory variables are a sovereign risk variable (the ten-year government bond spread), a monetary policy variable (the EONIA rate), a money market credit risk variable (the spread between the three-month EURIBOR and EONIA), a confidence indicator, plus lags of the dependent variable. Neri uses individual country ARDL models estimated with seemingly unrelated regression (SUR). He finds that sovereign debt tensions have had a significant impact on lending rates in the peripheral, but not in the core euro area countries. Neri and Ropele (2015) investigate a sample of 11 euro area countries in the shorter period from January 2007 to December 2012 using a FAVAR (factor-augmented VAR) model. By means of principal component analysis (PCA), they extract common factors from a large set of macroeconomic series, capturing co-movements between country-specific and euro area-wide series. Next, they estimate individual country VAR models using Bayesian methods, with the orthogonalized common factors, a sovereign risk variable (the Greek government bond spread) and a monetary policy variable as endogenous factors and world demand as an exogenous variable. Then, they apply Cholesky ordering, taking first, the latent factors, second, the sovereign risk variable, and finally, the monetary policy rate. They find that credit market conditions for nonfinancial firms and households deteriorate in all peripheral countries in response to a sovereign risk shock. That is, the costs for new loans increase and credit volumes decline, thereafter weighing on economic activity and unemployment in these countries and propagating with some delay through trade and confidence channels to the core economies of the euro area.

Related literature analyzes the impact of sovereign risk on lending volumes (Cantero-Saiz et al., 2014; Popov and van Horen, 2013). Cantero-Saiz et al. conduct a microeconometric study for a sample of 3,125 banks in 12 euro area countries between 1999 and 2012. They use macro variables (the nominal GDP growth rate, the short-term money market rate, government bond yield spreads, the interaction between sovereign risk and the monetary policy rate) and bank-specific characteristics (size, liquidity, capitalization, loan loss provisions), plus lags of the dependent variable to explain bank-level loan supply growth. For this purpose, they build a dynamic panel estimated using two-step system GMM (general method of moments). They find that sovereign risk plays an important role in determining banks' loan supply during monetary policy contractions, in particular in countries with higher sovereign risk premia.

Other related literature addresses the impact of sovereign risk on bank funding costs (Babihuga and Spaltro, 2014; Bank for International Settlements, 2011). The latter paper looks at the factors explaining the spread between fixed-rate bank bond yields at issuance and the swap rate of a similar maturity of 116 banks in 14 advanced economies in 2006 and 2010. It takes sovereign risk (rating, CDS spread), bond characteristics (issue size, maturity, currency, rating), issuer characteristics (rating, CDS spread, size) and market conditions as explanatory variables in a cross-section OLS regression. Its main result is that in 2010, a large part of the spread at bank bond issuance (on average 30%, or 120 basis points) reflected the risk of the sovereign, while in 2006, when investors did not perceive significant risks for either banks or sovereigns, sovereign risk had virtually no effect on the cost of bank funding. Babihuga and Spaltro (2014) look at the marginal funding costs (defined as three-month LIBOR plus the five-year CDS premium) of 52 banks in 14 advanced economies in the period 2001 to 2012. They build a panel ECM (error correction model) and find that an increase in euro area sovereign risk (proxied by a weighted index of sovereign spreads of peripheral euro area countries) is associated with higher bank funding costs.

Against this background, the present paper is to our knowledge the first to systematically investigate the direct impact of long-term government bond yields on *long-term* bank lending rates for new loans to the private nonfinancial sector. It also adds to the literature in that it broadens the sample in particular by covering those EU Member States in Central, Eastern and Southeastern Europe (CESEE) for which sufficient data are available. We combine fixed-effect panel estimates for a larger set of these countries with individual country estimates. At the individual country level, we use VEC (vector error correction) or in some cases VAR models, and for the group estimate, we use an ECM combined with DOLS (dynamic OLS) estimation. There are at least three reasons to start with the panel estimate and not to limit the study to the country-level approach: First, for institutional and political reasons, we wish to have results for the EU, in particular the euro area as a whole. Second, the panel allows us to split the sample into subperiods, which we could not do otherwise because the time series are too short. This gives our paper the additional benefit of distinguishing between two sample periods – a subperiod up to the Great Recession and a subperiod thereafter up to end-2014. Third, in several of the ensuing country models, required normalization for identification constrains the set of explanatory variables in the long-run relationship.

Our main hypotheses are: First, sovereign bond yields have a nonnegligible influence on banks' long-term fixed lending rates on loans to the private sector. (In turn, various factors may determine sovereign bond yields, such as fiscal shocks or unconventional monetary policy.) Second, government bond yields are expected to have at least as much influence on banks' long-term lending rates as the short-term money market rate, and, third, this influence can be identified not only in peripheral euro area economies, but also in the core euro area economies. Fourth, importantly, all these effects are not just a crisis-related phenomenon, but are also present during "normal" times.

This paper is structured as follows: Section 1 describes the variables used in this study, their precise definitions and the length of time series. Section 2 presents the empirical framework, describing the methodological approach and the econometric models that we have implemented. Section 3 provides the results of the estimations of our main models and includes some references to the robustness checks applied. Section 4 contains our conclusions.

1 Data

The EU (ECB/ESCB) provides harmonized interest rate statistics (known as MIR statistics), which contain monthly data on monetary financial institutions' loans to private nonbanks and deposits accepted from private nonbanks in each EU country. These statistics cover monthly data on new business in lending and deposit-taking by sectors, i.e. households and individual enterprises as well as nonfinancial corporations, with the respective national currency being the transaction currency.

For each sector, the new business is distinguished by purpose. Hence, on the deposit side, deposits with an agreed maturity form one major category in each sector. On the lending side, loans other than bank overdrafts are split into consumer credit, loans for house purchases and loans for other purposes in the household sector, whereas they are differentiated by size in the corporate sector.

Moreover, the statistics provide a segmentation by maturity, with the longest maturity being "over 2 years" on the deposit side and "over 5 years" on the lending side.[2] Importantly, in this context, maturity refers not only to the duration of the deposit or loan contract (up to the final repayment), but to the duration of interest rate fixation.

According to our focus on the long-term segment, we constructed time series of the weighted-average annualized agreed deposit rate (in percent) for deposits with a maturity of over two years accepted from private nonbanks (long-term deposit rate, y2depr) and of the weighted-average annualized agreed loan rate (in percent) for loans with a maturity of over five years extended to private nonbanks (long-term lending rate, y5loanr). Here, we used the fact that not only new business prices, but also new business volumes are available.

In volume terms, the share of thus defined long-term deposits in overall deposits with an agreed maturity newly accepted from private nonbanks in 2014 ranged from about 1% in Poland and Sweden to 21% in France, with the euro area average coming to 6.5%. The share of thus defined long-term loans in overall loans (other than bank overdrafts) newly extended to private nonbanks in 2014 ranged from about 1% in Romania and Sweden to 45% in France, with the euro area average standing at 18%.

Obviously, the so constructed long-term lending rate on loans to private nonbanks forms our main variable of interest. The deposit rate for deposits with a maturity of over two years accepted from private nonbanks is one of the explanatory variables.

Basically, these interest rate statistics start with January 2003. However, this does not apply to all current EU countries. Continuous time series for long-term lending and deposit rates vis-à-vis private nonbanks from January 2003 to December 2014 are available for a set of 12 countries, ten of which are currently in the euro area: Germany (DE), France (FR), Austria (AT), the Netherlands (NL), Belgium (BE), Finland (FI), Ireland (IE), Italy (IT), Spain (ES), Portugal

[2] *To be precise, in the case of loans for house purchases by households, this maturity is given in two parts, as "over 5 years and up to 10 years" and "over 10 years."*

(PT), Denmark (DK) and Hungary (HU). For Luxembourg (LU), the time series start in January 2003, but a few monthly data points are missing. For another eight countries, including three current euro area countries, the time series start later but before January 2007, namely Slovenia (SI, May 2005), Slovakia (SK, January 2004), Lithuania (LT, October 2004), Sweden (SE, August 2005), Great Britain (GB, January 2004), the Czech Republic (CZ, January 2004), Poland (PL, January 2005) and Romania (RO, January 2007). Some monthly data are missing in four countries (SI, LT, PL, RO); we substituted the few missing monthly data points by linear interpolation. Sufficiently detailed data were not available for Greece, Cyprus, Malta, Estonia, Latvia, Bulgaria and Croatia. Therefore, our empirical analysis focuses on a total of 21 EU countries.[3]

In addition to the long-term deposit rate, we include the one-month interbank rate (m1ibk) as a proxy for the impact of monetary policy measures (both conventional and unconventional) on money market liquidity at the short end[4] and the ten-year local-currency government bond yield (y10gov) in our basic model. Not only is the maturity of ten years a relatively liquid market segment in general, but it could also match the assumed average of loan maturities "over 5 years" quite well.

Further variables we include for robustness checks are year-on-year inflation rates (Harmonised Index of Consumer Prices – HIPC), and year-on-year growth rates of (seasonal and working-day adjusted) industrial production as a proxy for real activity, which enables us to control for the effects of loan demand as a factor determining the lending rate.

Annex 1 provides charts allowing a visual inspection of long-term lending rates, long-term deposit rates and ten-year government bond yields. In most countries, the ten-year sovereign bond yield and the long-term lending rate on loans to private nonbanks seem to exhibit quite a pronounced parallel movement, which in several cases (e.g. the Netherlands or Italy) seems to have become weaker during the most recent years of the period. In some countries, like Ireland, Spain, Portugal and Slovenia, a rather loose initial parallel movement became blurred, partly abruptly disturbed and later, after 2010, restored. By contrast, in a few countries, like in Slovakia, the Czech Republic and Poland, but to a lesser extent also in Great Britain, there seems to be no correlation or only a very weak link between these two time series during the whole time span.

[3] *Throughout this study, countries are listed in the following order: euro area countries that did not have severe sovereign debt problems in 2010/2011; other euro area countries; non-euro area countries that became EU members before 2004; non-euro area countries that joined the EU after 2004.*

[4] *While the choice of the one-month rate incurs some risk premium (generally small) compared to the overnight rate, it tends to be less volatile (on a daily basis). Hence, it is a more stable representative measure of money market liquidity. Besides, most central banks' standard money market operations have a maturity of one or two weeks. More importantly, the difference between the two rates appears to be of secondary importance in relation to our research question to what relative extent long-term bank lending rates are influenced by the price of short-term money market liquidity, long-term deposit rates or long-term government bond yields.*

2 Empirical framework: methodological approach and econometric models

2.1 Panel error correction model

In a first step, we estimate panel models with country fixed effects, focusing on ECMs for the long-term lending rate (LR) as the dependent variable. In the basic variant, we use the long-term deposit rate (DR), the one-month interbank money market rate (MR) and the ten-year government bond yield (GY) as explanatory variables.

We start by building a large panel that includes all 21 EU countries for which sufficiently detailed data are available (see section 2). This large panel (panel 21) is unbalanced, as time series start later than January 2003 for several countries. Next, we build a balanced panel by including all countries with continuous time series starting in January 2003. The panel covers most euro area countries plus Denmark, and we expect these countries to be structurally more similar and thus more suitable for rendering a homogeneous panel.

For both panels, we apply the Pedroni panel cointegration test (with individual intercepts) to find out whether or not any cointegration relationship exists between these variables at all. The Pedroni panel cointegration test is an Engle-Granger-based residual test of the null hypothesis of no cointegration (unit root in the residuals), against the alternative hypothesis with common autoregressive coefficients (within dimension) or individual autoregressive coefficients (between dimension, see group statistics in table 1 on results further below). Pedroni (1999) provides seven statistics for evaluation, i.e., four within-dimension and three between-dimension statistics. We focus on the Augmented Dickey-Fuller (ADF) statistics (both within dimension and between dimension) for two reasons: First, Canning and Pedroni (2004) in a methodologically similar study opt for the same type of statistics. Second, Hlouskova and Wagner (2007) conclude in a comprehensive simulation study on the performance of panel cointegration methods that these statistics show a superior performance, in particular in the case of a relatively short cross section-specific length of time series (T). Additionally, we take into account the other Pedroni test statistics.[5]

In a next step, the relationship between the nonstationary variables found to be cointegrated according to the Pedroni panel cointegration test is recovered by regression equation (1). For this purpose, we perform a dynamic OLS (DOLS) estimate to be on the safe side. Theoretically, a rise in the bank lending rate on new loans to the private nonfinancial sector could lead to (or feed back into) an increase of the government bond yield, as the higher long-term lending rate could weaken the economy and thus cause the fiscal balance to deteriorate, which could in turn result in higher yields on sovereign bonds. One may doubt that this channel works relatively quickly and straightforwardly. Still, the DOLS estimation proposed by Stock and Watson (1993) takes account of such possible endogeneity (reversed causality) among the variables in the form of a simultaneity bias by including both lags and leads of the first differences of the explanatory variables.

[5] *As a caveat, one may caution that more recent modifications of panel cointegration tests take account of the cross-sectional dependence of the errors in the panel model. See Persyn and Westerlund (2008) as well as Banerjee and Carron-I-Silvestre (2015).*

$$\begin{aligned} LR_{it} &= c_i + \beta_1 DR_{it} + \beta_2 MR_{it} + \beta_3 GY_{it} + \\ &+ \sum_{k=0}^{kopt} \eta_{1,k} dDR_{it+k} + \sum_{j=1}^{jopt} \theta_{1,j} dDR_{it-j} + \sum_{k=0}^{kopt} \eta_{2,k} dMR_{it+k} + \\ &+ \sum_{j=1}^{jopt} \theta_{2,j} dMR_{it-j} + \sum_{k=0}^{kopt} \eta_{3,k} dGY_{it+k} + \sum_{j=1}^{jopt} \theta_{3,j} dGY_{it-j} + e_{it} \end{aligned} \tag{1}$$

with e_{it} *~i.i.d.(0,Ω)*, whereby Ω is not necessarily diagonal, and LR for long-term lending rate, DR for long-term deposit rate, MR for short-term money market rate, GY for ten-year government bond yield, and i for the cross-section (country), kopt and jopt for the optimal number of leads and lags, respectively, as chosen by minimizing the Akaike information criterion (AIC).

We include country-specific fixed effects (c_i) in the panel DOLS estimate. To control for heteroscedasticity across the panel, we performed standard error corrections (across cross-sections, across the time dimension and both across cross-sections and time) to derive White-consistent t-statistics. We report the p-values after heteroscedasticity corrections based on White diagonal (time and cross-sectional) standard errors in the table of results. The residuals of this estimate are recovered to form the ECT (error correction term) of the ECM.

Next, we build the ECM for the long-term bank lending rate according to equation (2) by taking all variables in first differences. We include the lagged ECT that was derived from the initial DOLS regression as level-related information. Again, we determine the numbers of leads and lags of the differenced terms by using the Akaike criterion. Finally, the estimated long-run relation (beta vector) and the corresponding adjustment coefficient (alpha) are evaluated.

$$\begin{aligned} dLR_{it} &= \alpha ECT_{it-1} + \\ &+ \sum_{k=0}^{kopt} \delta_{1,k} dDR_{it+k} + \sum_{j=1}^{jopt} \varphi_{1,j} dDR_{it-j} + \sum_{k=0}^{kopt} \delta_{2,k} dMR_{it+k} + \\ &+ \sum_{j=1}^{jopt} \varphi_{2,j} dMR_{it-j} + \sum_{k=0}^{kopt} \delta_{3,k} dGY_{it+k} + \sum_{j=1}^{jopt} \varphi_{3,j} dGY_{it-j} + e_{it} \end{aligned} \tag{2}$$

For performing robustness checks, we enhance this basic variant of the panel ECM by adding euro area inflation and, alternatively, euro area industrial production, and then adding both variables as common control variables. In line with Neri and Ropele (2015), this should allow us to account – at least to some extent – for potential spillovers and the co-movement of variables across the included countries.[6] Moreover, we re-estimate all these panels, including lags of the dependent variable as an additional explanatory variable to account for possible inertia of the time series, with the number of lags again determined by the Akaike criterion.

Further, we re-estimate all these models by replacing the common adjustment coefficient by cross-sectional specific adjustment coefficients. As a post-estimation poolability test, we apply a Wald test on these estimated coefficients. Hence, this

[6] *"Sovereign tensions in one country may spill over to banks in other countries, either through banks' direct exposures to the distressed foreign sovereign, or indirectly, as a result of cross-border interbank exposures or possible contagion across sovereign debt markets." (Bank for International Settlements, 2011, p. 2).*

Wald test is an F-test of the null hypothesis of a homogeneous adjustment parameter across countries.

The panel approach provides the additional advantage that we can evaluate not only the full time period (from January 2003 to December 2014), but also a shorter time period that cannot be evaluated in country-level VECMs (given a considerably smaller number of observations and thus a smaller degree of freedom). In particular, we split the full period into two parts: the first subperiod up to August 2008, that is, the period before the start of the Great Recession, and the post-Lehman subperiod up to end-2014. Interacting the level variables with the two dummies for the first and the second subperiod, respectively, we re-estimate the long-run relationships of these models (following an approach similar to that of Albertazzi et al., 2014). This dummy approach allows us to apply a Wald test to check whether the size of the long-run coefficient, in particular of the government bond yield, is statistically different when we compare these two subperiods.

2.2 Individual country models

As a second step, we estimate models at the individual country level. For each country, we aim at estimating a vector error correction model (VECM) that includes the long-term lending rate (LR), the long-term deposit rate (DR), the 1-month interbank money market rate (MR) and the 10-year government bond yield (GY). To select the appropriate lag length, the log-likelihood ratio (LLR) test statistic, the Akaike information criterion (AIC) and the Schwarz information criterion (SIC) are evaluated. Next, the Johansen cointegration test is applied to find out whether or not any cointegration relationship exists between these variables at all – and if so, how many cointegration relations.

If at least one long-run equilibrium relation is present, we proceed to estimate the VECM (here represented as an example with three lags):

$$\Delta Y_t = \delta_0 + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + (\Pi Y_{t-1}) + \varepsilon_t \qquad (3)$$

where:

$$Y_t = (LR_t, DR_t, MR_t, GY_t)'$$
$$\varepsilon_t = (\varepsilon_{LR,t}, \varepsilon_{DR,t}, \varepsilon_{MR,t}, \varepsilon_{GY,t})'$$
$$\Pi = -(I_4 - \Theta_1 - \Theta_2 - \Theta_3) = \alpha\beta'$$

With Π as the "long-run matrix" of dimension 4 x 4, equal to the product of the "adjustment matrix" alpha (4 x r) and the "matrix of cointegration relationships" beta transposed (r x 4), with r as the number of cointegrating relationships.

After some diagnostic checks (in particular of the autocorrelation of residuals), the estimated long-run relation (beta vector) and the corresponding adjustment coefficients (alpha vector) in the long-term lending rate equation and the government bond yield equation are evaluated.

For countries where we find that there is no long-run equilibrium relation between those four variables, we proceed to estimate the corresponding vector autoregression (VAR) model in levels and in first differences.

$$Y_t = \delta_0 + \Theta_1 Y_{t-1} + \Theta_2 Y_{t-2} + \Theta_3 Y_{t-3} + \varepsilon_t \tag{4a}$$

$$\Delta Y_t = \delta_0 + \Theta_1 \Delta Y_{t-1} + \Theta_2 \Delta Y_{t-2} + \Theta_3 \Delta Y_{t-3} + \varepsilon_t \tag{4b}$$

where:

$$Y_t = (LR_t, DR_t, MR_t, GY_t)'$$
$$\varepsilon_t = (\varepsilon_{LR,t}, \varepsilon_{DR,t}, \varepsilon_{MR,t}, \varepsilon_{GY,t})'$$

Relying on post-estimation diagnostic checks, including in particular tests on the stability of this system, we decide whether to use the VAR in levels or in first differences. We note that the VAR in first differences is equal to the VECM with Π equal to zero. Based on the chosen VAR model, the impact of a shock to the government bond yield on the long-term lending rate is analyzed by means of impulse response functions (IRFs) based on Cholesky ordering by taking first, the bond yield, second, the monetary policy rate, third, the long-term deposit rate and finally, the long-term lending rate. Assigning first place to the long-term bond yield reflects, inter alia, the view that yields often react to changes in inflation expectations no later than monetary policy decisions (reflected in the short-term interbank rate). In addition, we perform a cross-check of the Cholesky-ordered IRFs by means of generalized IRFs (GIRFs). For all these VAR-based IRFs, we establish bootstrapped confidence bands.

For performing robustness checks, we enhance these basic VEC and VAR models by adding inflation and then adding both inflation and industrial production as control variables.

3 Results

3.1 Panel error correction model

In this subsection, we present the results of the FE (fixed-effects) panel ECM estimates. While our large, unbalanced panel contains 21 EU countries, our smaller, balanced panel includes ten countries, namely Germany, France, Austria, the Netherlands, Belgium, Finland, Ireland, Italy, Portugal and Denmark.

The panel cointegration test clearly establishes a significant cointegration relationship for both panel samples on the basis of the ADF statistics (table 1), which are the most relevant ones in the given context of a relatively short cross section-specific length of time series. Moreover, the existence of cointegration (or, more precisely, the rejection of the null of no cointegration) is confirmed even by the two types of rho statistics (within and between). This certainly provides reassuring support, given that Pedroni (2004) concludes in his simulation study: "For example, in very small panels, if the group rho statistic rejects the null of no cointegration, one can be relatively confident of the conclusion because it is slightly undersized and empirically the most conservative of the tests."

Table 1

Cointegration of the long-term lending rate and its explanatory variables

Results of Pedroni panel cointegration tests

	Panel 21	Panel 10
Four cross-section variables: y5loanr, y2depr, m1ibk, y10gov		
	p-value	*p-value*
Panel rho statistic	0.000	0.000
Panel ADF statistic	0.000	0.000
	p-value	*p-value*
Group rho statistic	0.000	0.000
Group ADF statistic	0.000	0.000

Source: Authors' estimations.

Note: Null hypothesis: no cointegration; sample for both panels: January 2003 to December 2014.

Also for the panel ECMs that we use as robustness checks (by including euro area annual inflation and/or the year-on-year change in euro area industrial production as control variables), the ADF statistics and rho statistics of Pedroni cointegration tests reject the null of no cointegration at the 1% level in all cases.

In both panels, the adjustment coefficient for the disequilibrium in levels lagged by one period is statistically highly significant and has a negative sign (table 2). This indicates that preceding changes which bring the difference (in levels) between the long-term loan rate and the explanatory variables out of line with its long-run equilibrium will induce corrective changes such that the long-run equilibrium between these variables remains stable over time. In particular, a shock that has raised the level of the government bond yield in the previous period implies an added factor to the long-term loan rate in the current period.

The size of the adjustment coefficient is around –0.2 and –0.4, respectively, implying five and two to three months, respectively, as the adjustment period. The fact that the adjustment coefficient is higher (in absolute terms) in the balanced panel may indicate that cointegration or adjustment to disequilibria does not exist or is less pronounced in some countries included in the larger but not the smaller panel.

Table 2

Fixed-effects (FE) panel error correction models (ECMs) for the long-term lending rate

Parameter of adjustment to disequilibrium in levels (coefficient of error correction term, ECT)

	Panel 21		Panel 10	
Panel ECM with the number of lags and leads determined by AIC				
Four cross-section variables: y5loanr, y2depr, m1ibk, y10gov				
Number of observations (after sample adjustments)	143		142	
	unbalanced		*balanced*	
Total pool observations	2815		1420	
	coefficient	*p-value*	*coefficient*	*p-value*
ECT (–1)	–0.196	0.000	–0.449	0.000

Source: Authors' estimations.

Note: Sample for both panels: January 2003 to December 2014; AIC: Akaike information criterion.

The (negative) sign and statistical significance do not change if we apply robustness checks, in particular if we include euro area annual inflation and/or the year-on-year change in euro area industrial production as additional explanatory variables or if the ECM includes lags of its dependent variable, which is the first difference of the long-term loan rate.

When including lags of the differenced dependent variable (with the number of lags determined by the Akaike information criterion), the (absolute) size of the adjustment coefficient is clearly lower in both the unbalanced and the balanced panel – it is about half its size in the former and less than half its size in the latter case. Again, in both cases, this result is fairly robust to adding euro area inflation and/or euro area industrial production as control variables, i.e. there is a similar reduction in the size of the adjustment coefficient.

However, the post-estimation Wald test on the cross-sectional specific adjustment coefficients renders a less clear-cut picture for both panels (available from the authors upon request). The results allow for rejecting the null hypothesis of homogeneity of the adjustment parameter across countries not only for the basic four-variable variant of the large and unbalanced panel, but also for the basic variant of the smaller, balanced panel. Yet, this result is not fully robust, as we cannot reject the null (at a high confidence level) under some other variants of these two panel models. Nevertheless, this finding corroborates our agenda to go for individual country models in a second step.

Looking at the panel results for the long-run relation between the long-term loan rate and the explanatory variables, we find a high statistical significance of the government bond yield in explaining the long-term lending rate in both the unbalanced and the balanced panel (table 3). Moreover, we find that the long-term deposit rate and the interbank money market rate are also statistically highly significant in both types of panels.

At the same time, the size of the long-run coefficient of the government bond yield is clearly lower than that of the long-term deposit rate in both panels. By contrast, it is clearly higher than that of the short-term interbank rate in the

Table 3

Long-run fixed-effects (FE) panel cointegration equation for the long-term lending rate

Results of the fixed-effects (FE) panel dynamic OLS (DOLS) equations, with the number of lags and leads determined by AIC

	Panel 21		Panel 10	
Four cross-section variables: y5loanr, y2depr, m1ibk, y10gov				
Number of observations (after sample adjustments)	134		134	
	unbalanced		*balanced*	
Total pool observations	2,626		1,340	
	coefficient	*p-value*	*coefficient*	*p-value*
y2depr	0.665	0.000	0.461	0.000
m1ibk	–0.107	0.001	0.063	0.001
y10gov	0.196	0.000	0.154	0.000

Source: Authors' estimations.

Note: Sample for both panels: January 2003 to December 2014.

balanced panel. The result that the short-term interbank rate even has a negative sign in the unbalanced panel may reflect divergent developments at the short end and the long end of the yield curve and/or (crisis-related) increases in the lending margin in some countries included in the larger but not the smaller panel.

These results – both with respect to statistical significance and to the sign and the approximate size of the coefficients – are robust for both types of panel to including euro area annual inflation and/or the year-on-year change in euro area industrial production as control variables.

Finally, looking at the two subperiods before and after September 2008, the influence of the long-term government bond yield seems to have declined, with its coefficient in the balanced panel declining moderately from 0.225 in the first to 0.145 in the second subperiod. According to the Wald test, we can reject the null of equal government bond yield coefficients across both subperiods at a significance level well below 5%. This may reflect, first, the increased role of funding and funding strains during and after the crisis, as the coefficient of the long-term deposit rate rose moderately (according to a similar Wald test). Second, it may reflect the special development of the euro area government bond markets during the sovereign debt crises of some euro area countries, with the corresponding contagion effects to other euro area countries not having been fully transmitted to the long-term lending rates in these countries.

3.2 Individual country models

Among the 21 countries under study, we find at least one long-run equilibrium relation between the loan rate, the deposit rate, the money market rate and the government bond yield in 15 countries, including 12 euro area countries, in particular in all countries for which longer time series are available, with the exception of Spain (see table 4).

In the corresponding 15 country-level VECMs, the cointegrating vector (beta vector) in which the long-term loan rate was normalized to one shows the government bond yield as statistically significant at the 0.5% level in ten country models and at the 4% level in one further country. In all these cases, the bond yield is also economically relevant. We note that a negative sign of the coefficients of the variables in the cointegrating vector (beta vector) has to be interpreted as implying a positive influence on the dependent variable in level terms (that is, the long-term lending rate). The size of the coefficient ranges from 0.1 in Portugal to 1.1 in Italy, coming to 0.5 and 0.7, respectively, in France and Germany, usually considered core economies.[7] In four countries, namely Luxembourg, Slovenia, Hungary and Romania, the government bond yield does not enter the error correction term (ECT) as statistically significant.

For those country-level VECMs for which more than one cointegrating vectors are found, one or more of the other explanatory variables are missing for identification purposes. This drawback (compared to the long-run relation in the panel model) prevents a systematic comparison of these variables across all countries.

In all country-level VECMs, the coefficient of the ECT (adjustment coefficient) is statistically significant in the loan rate equation, mostly at the 0.5% level,

[7] *All these coefficients indicate a positive long-run influence on the dependent variable, but enter the long-run equation (beta vector) with a negative sign, as shown in table 4.*

except in Hungary (at 2%) and Romania (only at 7%). Moreover, this element of the alpha vector has the appropriate negative sign in all cases. The speed of adjustment varies between less than one quarter and more than three quarters of a year. The corresponding country-specific adjustment coefficients range from 0.11 in France to 0.78 in Finland. We note that the size of the adjustment coefficient in

Table 4

Country VECMs with four endogenous variables

	Number of cointegrating vectors (rank of VECM)	Adjustment coefficient (alpha vector) of first cointegrating vector in y5loanr equation	First cointegrating vector (beta vector) with coefficient of y5 loanr normalized to 1				
			y5loanr	y2depr	m1ibk	y10gov	Constant
		Coefficients and corresponding p-values (if < 0.10)					
DE	1	–0.520	1.0	–0.1	–0.0	–0.7	–2.0
		0.00		0.08		0.00	0.00
FR	1	–0.112	1.0	0.2	–0.2	–0.5	–2.7
		0.00		0.06	0.00	0.00	0.00
AT	1	–0.576	1.0	–0.1	–0.1	–0.4	–2.4
		0.00				0.00	0.00
NL	2	–0.130	1.0	0.0	0.0	–0.5	–3.1
		0.00				0.00	0.00
BE	2	–0.144	1.0	–0.0	–0.1	–0.7	–1.8
		0.00			0.03	0.00	0.00
LU	2	–0.760	1.0	0.0	–0.6	–0.1	–2.6
		0.000			0.00		0.00
FI	2	–0.780	1.0	–0.0	–0.3	–0.3	–2.3
		0.00			0.00	0.00	0.00
IE	2	–0.406	1.0	0.0	–0.2	–0.2	–3.7
		0.00			0.01	0.01	
IT	2	–0.295	1.0	0.0	0.0	–1.1	–1.0
		0.00				0.00	
ES	0						
PT	2	–0.699	1.0	0.0	0.0	–0.1	–8.5
		0.00				0.04	0.00
SI	1	–0.764	1.0	–0.5	–0.3	0.0	–4.5
		0.00		0.00	0.00		0.00
SK	0						
LT	2	–0.540	1.0	0.0	0.3	–0.6	–4.4
		0.00			0.01	0.00	0.00
DK	1	–0.247	1.0	–1.0	0.4	–0.8	–1.4
		0.00		0.00	0.00	0.00	0.00
SE	0						
GB	0						
CZ	0						
PL	0						
HU	1	–0.061	1.0	–22.9	11.1	–1.7	21.6
		0.02		0.00	0.00		
RO	1	–0.037	1.0	3.4	–3.5	0.6	–14.1
		0.07		0.00	0.00		0.00

Source: Authors' estimations.

Note: y5loanr: average fixed rate for loans to private nonbanks with a maturity equal to or above 5 years; y2depr: average fixed rate for deposits from private nonbanks with a maturity equal to or above 2 years; m1ibk: one-month interbank money market rate; y10gov: yield-to-maturity of government bond with maturity of 10 years.

the small panel was roughly in the middle of this range, and that these country models confirm the lack of homogeneity of the adjustment parameter across countries, as evidenced by the Wald test described above.

In contrast to the loan rate equation, the corresponding adjustment coefficient in the government bond yield equation is generally not statistically significant even at the 10% level. Only in two cases does it show up as significant at the 2% or 4% level, respectively. It follows that the correction of any disequilibrium between the long-term lending rate and the government bond yield generally runs via the adjustment of the lending rate only, and that a sufficiently quick and strong feedback loop from long-term lending rates to long-term government bond yields does not seem to be in place. We note that although we tackled any possibly existing endogeneity bias by using DOLS estimates in the panel approach, these country-level results provide some ex post justification for applying the simpler panel ECM (with the long-term loan rate as the dependent variable) instead of a panel VECM, as these results indicate that reversed causality (and thus the issue of endogenous regressors) is likely to be limited.

The robustness check performed by adding control variables (annual inflation only, or both annual inflation and the annual growth of industrial production) causes a few substantial changes for some countries. In particular, in Hungary, the cointegrating vector (which includes an insignificant bond yield in the basic model) vanishes; that is, it is not statistically significant. By contrast, in three of the six countries where the basic model has no long-run relation, namely in Spain, Sweden and Poland, a cointegrating vector emerges in the broader of these two model variants and includes a significant government bond yield in the case of Spain and Sweden. Otherwise, the established results remain largely unchanged. In particular, both the adjustment parameter and the government bond yield in the long-run equation remain statistically significant and economically relevant in all 11 countries for which we had such a result in the basic model (with the exception of Belgium with respect to the significance of the yield, but only in the narrower of the two model variants). Moreover, the coefficient of the government bond yield is even larger in the broader model variant used for the robustness check than in the basic variant in most of these countries. Besides, cointegration remains in place, together with a government bond yield that remains insignificant, in the remaining three countries (Luxembourg, Slovenia, Romania) out of the 15 countries that showed at least one cointegrating vector under the basic variant.[8]

VAR models are estimated for those six countries that do not show a long-run equilibrium relation between the four time series of the basic model (loan rate, deposit rate, money market rate and government bond yield), namely Spain, Slovenia, Sweden, Great Britain, the Czech Republic and Poland.

Checking the stability condition of the VAR models in levels and in first differences, respectively, post-estimation diagnostics show that in the former case, the modulus of at least one eigenvalue is rather close to one in each of these countries. In addition to this finding, we consider a model in first differences as better comparable with the VECMs. Hence, we opt for the VAR in first differences.

[8] *The detailed results of all robustness checks for both the individual country models and the panel error correction model are available from the authors on request.*

Looking at the corresponding cumulative orthogonalized IRFs for the effect of a shock to the change in the government bond yield on the change in the long-term lending rate (see chart A2), we find a positive response that appears to be statistically significant (as judged by the bootstrapped 95% confidence bands) in two of these six countries, namely in Sweden and Poland. In the other four countries (Spain, Slovakia, Great Britain and the Czech Republic), the effect is close to zero or statistically not significantly different from zero. These results are confirmed also when using GIRFs instead of Cholesky-ordered IRFs. Moreover, the robustness check by adding the aforementioned control variables produces only marginal changes of these results.

Overall, the country-specific results show quite a strong role for the government bond yield in influencing the long-term lending rate in countries for which longer time series are available, including most euro area countries. Most countries for which we find a rather limited role of the government bond yield in influencing the long-term lending rate are CESEE countries. While among these countries only Hungary has longer time series, the length of the time series is probably only one factor for this finding. Other factors probably relate to structural features of the banking sector in CESEE countries, like foreign ownership of a large part of the banking sector or foreign currency lending, which could render the domestic local currency bond yield of the sovereign a less relevant benchmark.

4 Conclusions

To our knowledge, this paper is the first to systematically investigate the direct impact of long-term government bond yields on long-term fixed-rate bank lending rates for new loans to the private nonfinancial sector in a large sample of European countries.

On the basis of our analysis of two cross-country panel samples and of 21 individual EU countries, we conclude that long-term sovereign bond yields have a significant positive and substantial impact on long-term fixed-rate bank lending rates on loans to the private nonfinancial sector in most euro area countries and in some non-euro area countries, e.g. Denmark and Sweden. In particular, long-term sovereign bond yields play an important role not only in peripheral euro area countries, but also in core euro area economies. For example, in the long run, an increase of the government bond yield by 100 basis points leads to a rise in the long-term lending rate by 50 basis points in France, 70 basis points in Germany and about 100 basis points in Italy.

Most countries for which we find a rather limited influence of the long-term government bond yield on the long-term lending rate are CESEE countries. Apart from the generally shorter length of the time series, some structural features of the banking sector in CESEE countries may help explain this result, in particular foreign ownership of a large part of the banking sector and/or foreign currency lending, which could render the domestic local currency bond yield of the sovereign a less relevant benchmark.

Based on the panel study, we find that in most euro area countries and in some non-euro area countries, the strong influence of government bond yields on these lending rates was not just a crisis-related or post-crisis phenomenon, but rather was present already before the start of the Great Recession in 2008.

Indeed, long-term sovereign bond yields were economically more relevant for long-term fixed-rate bank lending rates than the short-term money market rate in the full period to end-2014 as well as in both subperiods before and after September 2008.

In terms of their relevance for policy, our findings lend support to the view that unconventional monetary policy measures that have – inter alia – a more direct impact on sovereign bond yields also exert a significant influence on the long-term lending rates via this yield channel.

Furthermore, we consider these insights as important for the design of rules that should provide a stable regulatory framework over the economic and financial cycle for all countries. In particular, our findings suggest a cautious approach when designing changes to the regulatory treatment of sovereign exposures. To the extent that such changes cause a sustained widening of sovereign yield spreads ceteris paribus, the impact of yields on long-term lending rates could entrench real economic divergences between EU countries and in particular within the euro area.

References

Albertazzi, U., T. Ropele, G. Sene and F. M. Signoretti. 2014. The impact of the sovereign debt crisis on the activity of Italian banks. In: Journal of Banking and Finance 46. 387–402.

Babihuga, R. and M. Spaltro. 2014. Bank Funding Costs for International Banks. IMF Working Paper No. 14/71.

Bahaj, S. A. 2014. Systemic Sovereign Risk: Macroeconomic Implications in the Euro Area. OeNB Working Paper No. 191.

Banerjee, A. and J. L. Carrion-i-Silvestre. 2015. Cointegration in Panel Data with Structural Breaks and Cross-Section Dependence. In: Journal of Applied Econometrics 30(1). 1–23.

Bank for International Settlements. 2011. The impact of sovereign credit risk on bank funding conditions. Committee on the Global Financial System Paper No. 43.

Beckmann, J., A. Belke and F. Verheyen. 2013. Interest Rate Pass-Through in the EMU – New Evidence from Nonlinear Cointegration Techniques for Fully Harmonized Data. In: Journal of International Money and Finance 37. 1–24.

Bocola, L. 2014. The Pass-Through of Sovereign Risk. University of Pennsylvania. Mimeo.

Canning, D. and P. Pedroni. 2004. The Effect of Infrastructure on Long-Run Economic Growth. Department of Economics Working Papers 2004-04. Department of Economics. Williams College.

Cantero-Saiz, M., S. Sanfilippo-Azofra, B. Torre-Olmo and C. López-Gutiérrez. 2014. Sovereign risk and the bank lending channel in Europe. In: Journal of International Money and Finance 47(C). 1–20.

Correa, R., K. Lee, H. Sapriza and G. A. Suárez. 2014. Sovereign Credit Risk, Banks' Government Support, and Bank Stock Returns Around the World. In: Journal of Money, Credit and Banking 46(S1). 93–121.

de Bondt, G. 2005. Interest Rate Pass-Through: Empirical Results for the Euro Area. German Economic Review 6(1). 37–78.

European Central Bank. 2013. Assessing the Retail Bank Interest Rate Pass-Through in the Euro Area at Times of Financial Fragmentation. In: ECB Monthly Bulletin. August. 75–91.

Heinz, F. F. and Y. Sun. 2014. Sovereign CDS Spreads in Europe – The Role of Global Risk Aversion, Economic Fundamentals, Liquidity, and Spillovers. IMF Working Paper No. 14/17.

Hlouskova, J. and M. Wagner. 2007. The Performance of Panel Cointegration Methods. Results from a Large Scale Simulation Study. In: Economics Series 201. Institute for Advanced Studies.

Hristov, N., O. Hülsewig, T. Siemsen and T. Wollmershäuser 2014. Smells Like Fiscal Policy? Assessing the Potential Effectiveness of the ECB's OMT Program. CESifo Working Paper No. 4628.

Illes, A., M. J. Lombardi and P. Mizen. 2015. Why did bank lending rates diverge from policy rates after the financial crisis? BIS Working Paper No. 486 February 2015.

Maltritz, D. and A. Molchanov. 2013. Analyzing determinants of bond yield spreads with Bayesian Model Averaging. In: Journal of Banking and Finance 37(12). 5257–5284.

Neri, S. 2013. The impact of the sovereign debt crisis on bank lending rates in the euro area. Banca d'Italia Occasional Paper No. 170. June.

Neri, S. and T. Ropele. 2015. The macroeconomic effects of the sovereign debt crisis in the euro area. Banca d'Italia Working Paper No. 1007. March.

Persyn, D. and J. Westerlund. 2008. Error-correction-based cointegration tests for panel data. In: The Stata Journal 8(2). 232–241.

Pedroni, P. 1999. Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. Oxford Bulletin of Economics and Statistics. Department of Economics. University of Oxford 6(10). Special 1. 653–673.

Pedroni, P. 2004. Panel Cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the ppp hypothesis. In: Econometric Theory 20. 597–625.

Popov, A. and N. Van Horen. 2013. The impact of sovereign debt exposure on bank lending: Evidence from the European debt crisis. DNB Working Paper No. 382.

Sander, H. and S. Kleimeier. 2004. Convergence in Euro-Zone Retail Banking? What Interest Rate Pass-Through Tells Us About Monetary Policy Transmission, Competition and Integration. In: Journal of International Money and Finance 23(3), 461–492.

Stiglitz, J. E. and A. Weiss. 1981. Credit Rationing in Markets with Imperfect Information. In: The American Economic Review 71(3). 393–410.

Stock, J. H. and M. Watson. 1993. A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems. Econometrica 61(4). 783–820.

van Leuvensteijn, M., C. Kok-Sørensen, J. Bikker and A. van Rixtel. 2013. Impact of bank competition on the interest rate pass-through in the euro area. In: Applied Economics 7(48). 1359–1380.

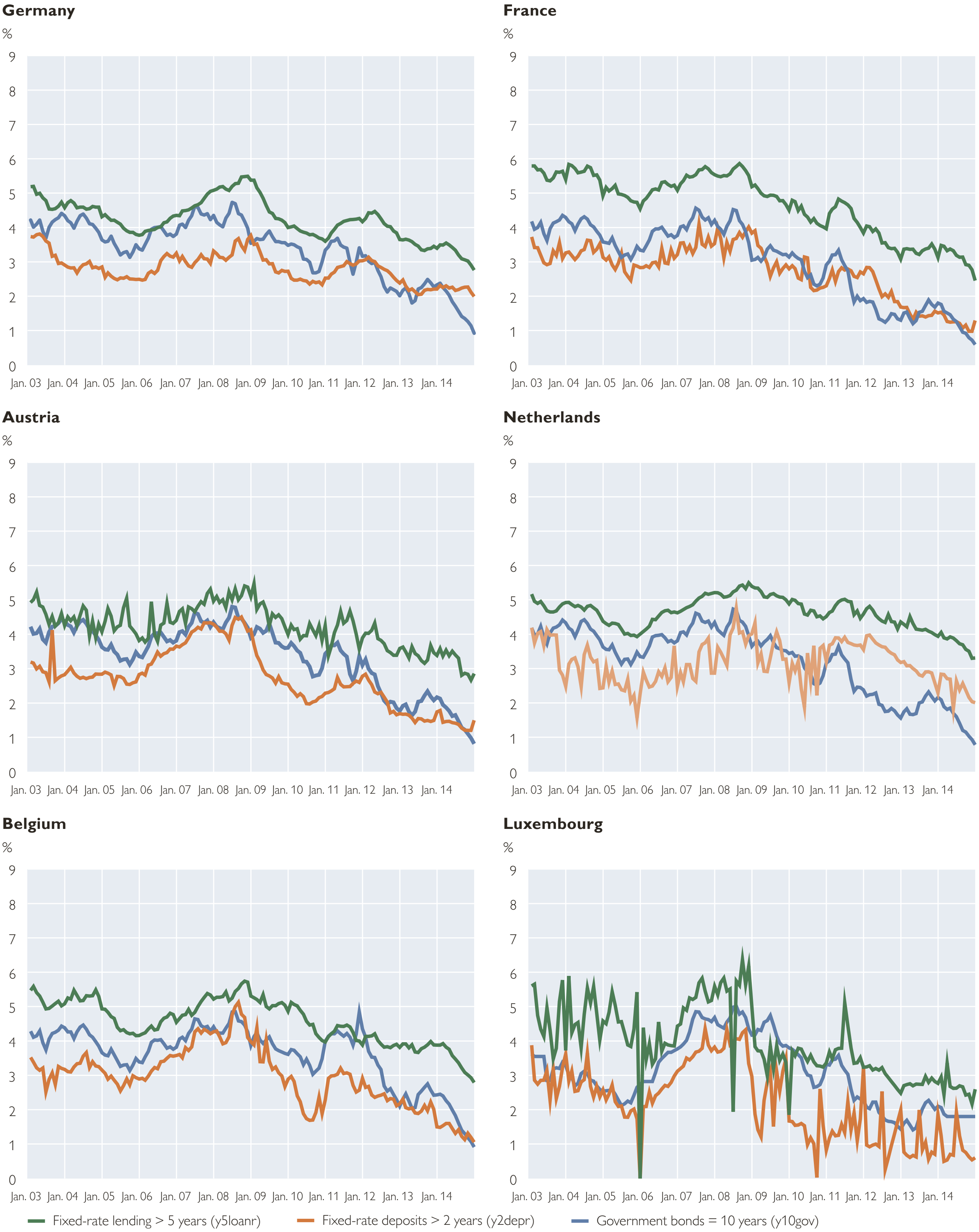
von Borstel, J., S. Eickmeier and L. Krippner. 2016. The interest rate pass-through in the euro area during the sovereign debt crisis. In: Journal of International Money and Finance. Forthcoming.

Zoli, E. 2013. Italian Sovereign Spreads: Their Determinants and Pass-through to Bank Funding Costs and Lending Conditions. IMF Working Paper No. 13/84.

Annex

Chart A1

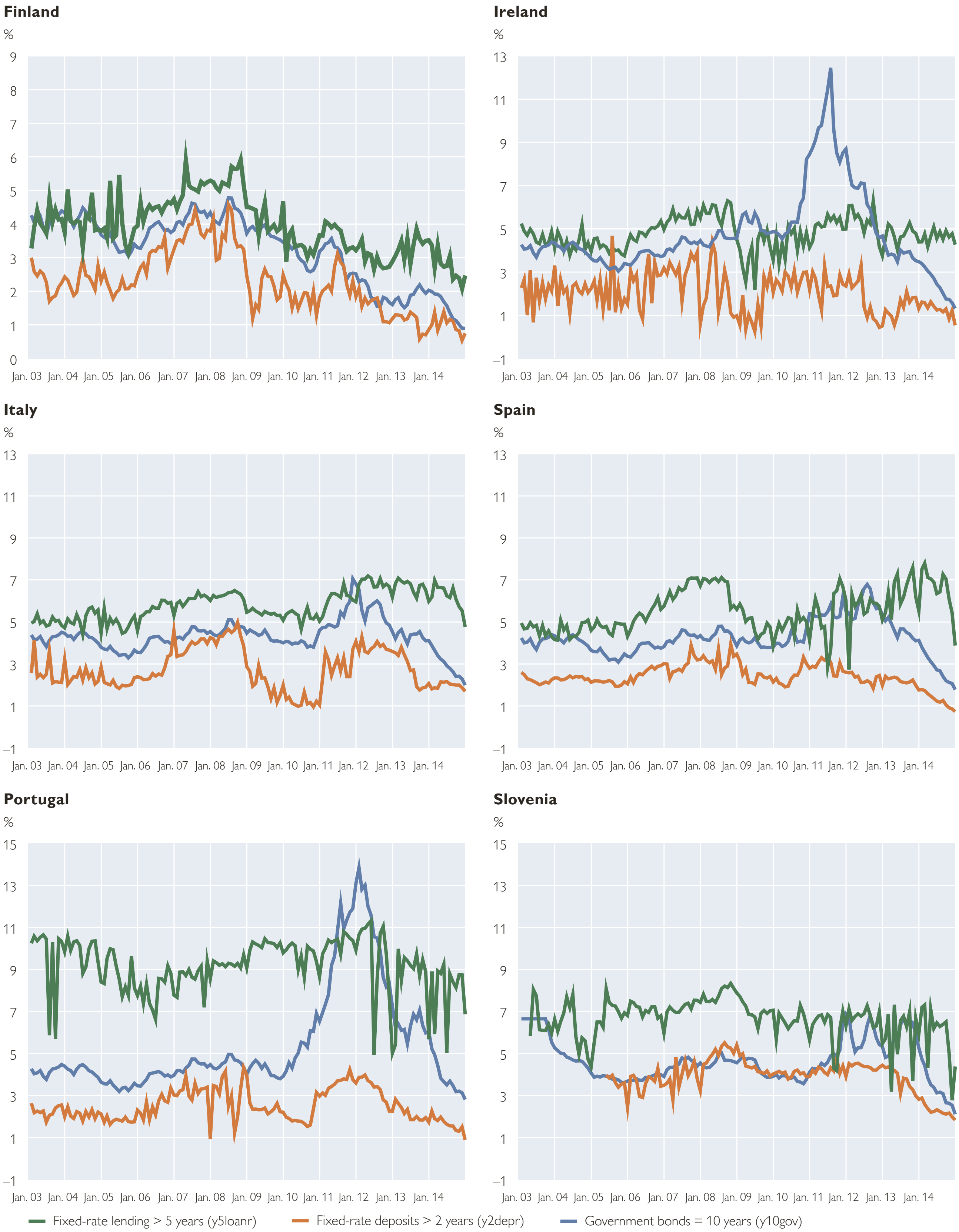
Long-term lending rate, long-term deposit rate and ten-year government bond yield



Source: ECB, authors' calculations.

Chart A1 continued

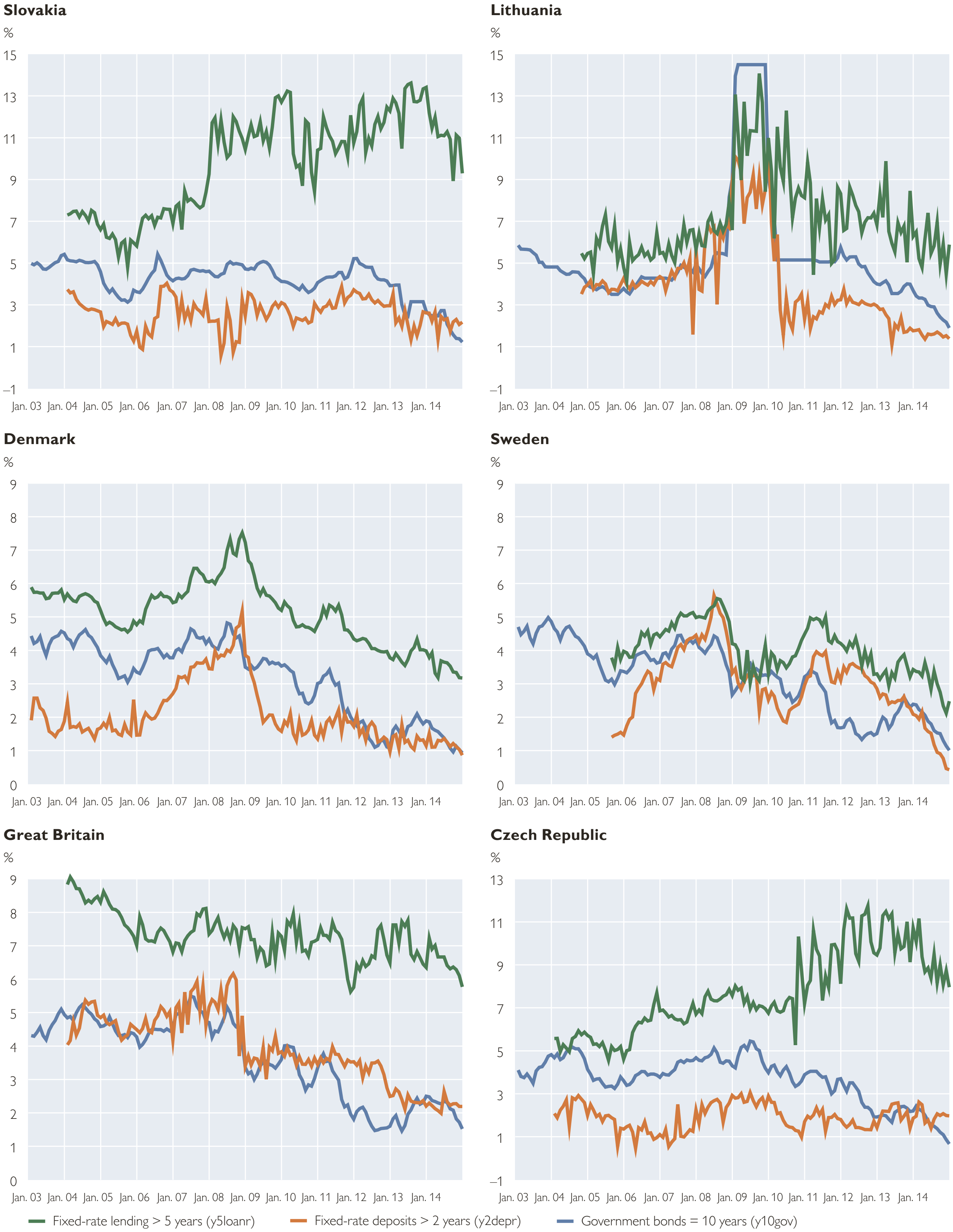
Long-term lending rate, long-term deposit rate and ten-year government bond yield



Source: ECB, authors' calculations.

Chart A1 continued

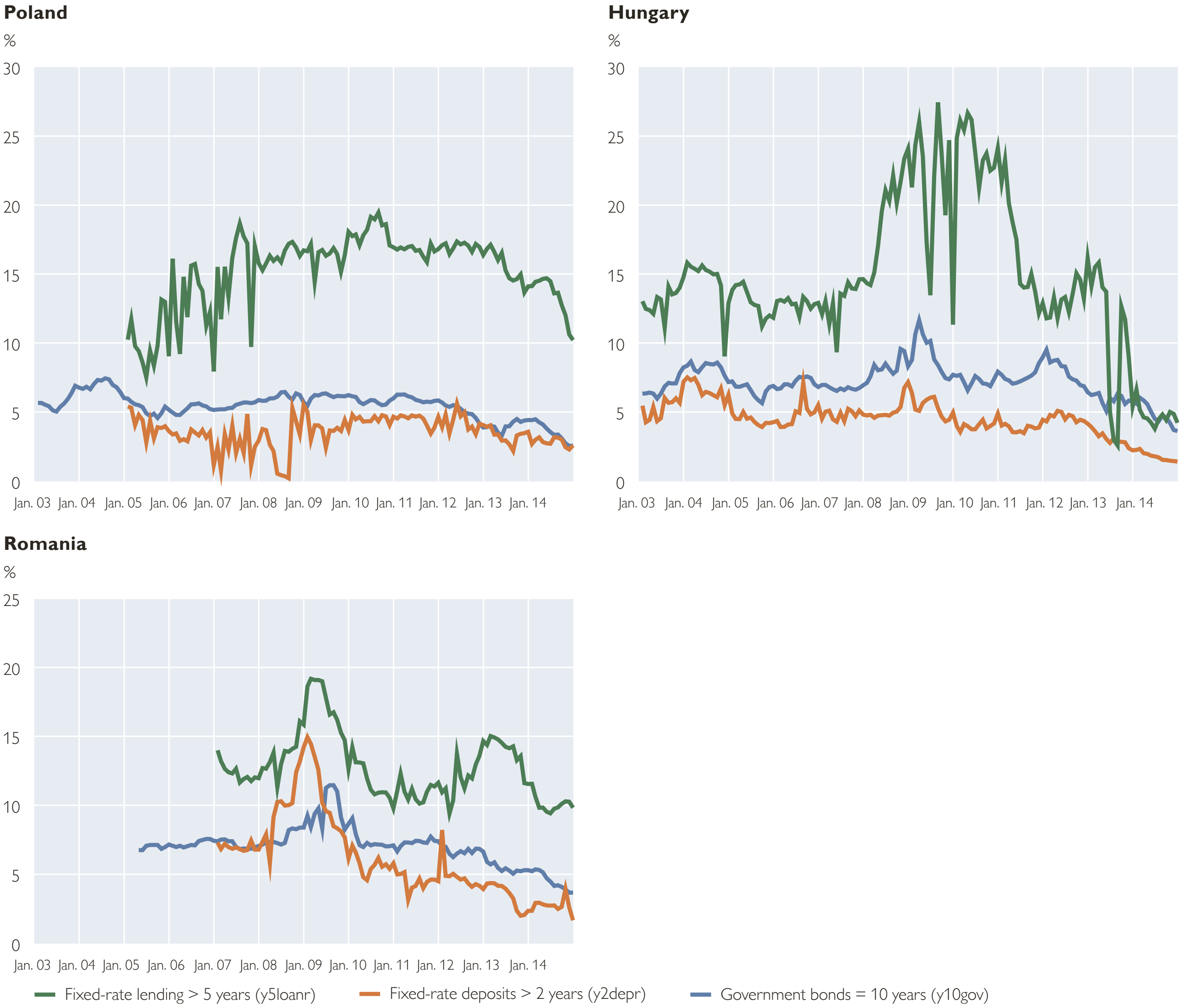
Long-term lending rate, long-term deposit rate and ten-year government bond yield



Source: ECB, authors' calculations.

Chart A1 continued

Long-term lending rate, long-term deposit rate and ten-year government bond yield



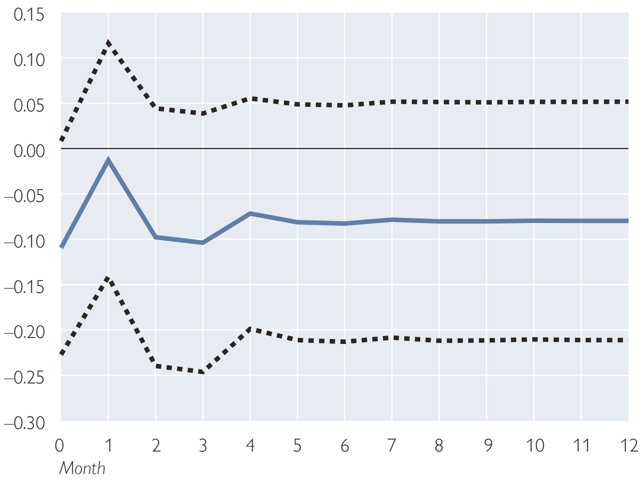
Source: ECB, authors' calculations.

Chart A2

Response of the long-term lending rate to an impulse from the ten-year government bond yield

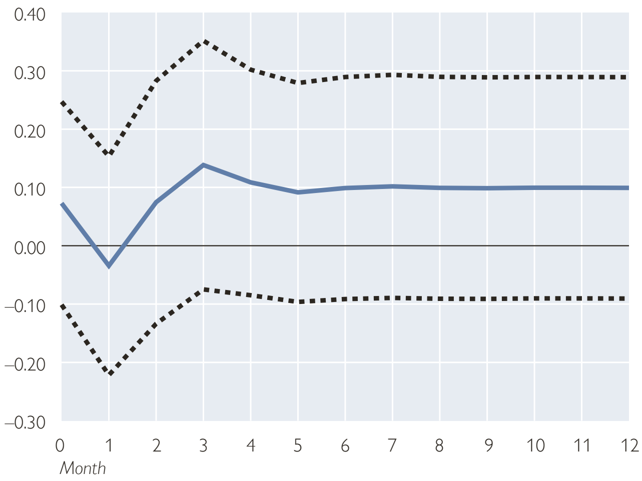
Spain

Cumulative orthogonalized impulse response function (COIRF) with 95% confidence interval (CI) from a VAR model in first differences



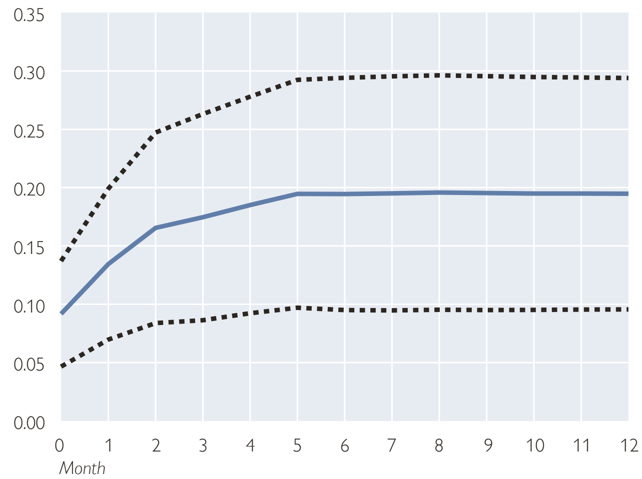
Slovakia

Cumulative orthogonalized impulse response function (COIRF) with 95% confidence interval (CI) from a VAR model in first differences



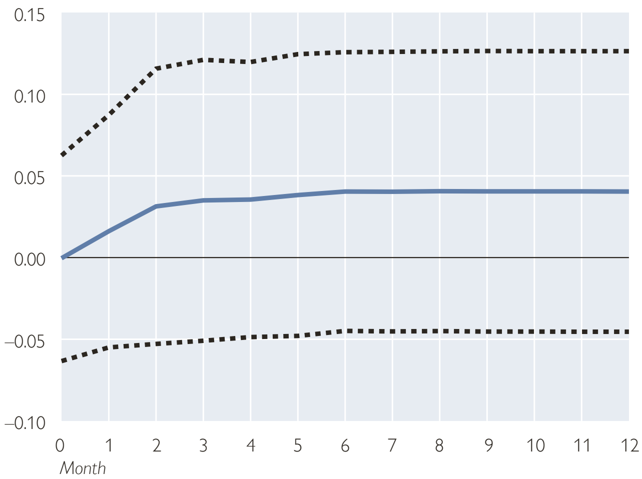
Sweden

Cumulative orthogonalized impulse response function (COIRF) with 95% confidence interval (CI) from a VAR model in first differences



Great Britain

Cumulative orthogonalized impulse response function (COIRF) with 95% confidence interval (CI) from a VAR model in first differences



COIRF ▪▪▪ Lower bound ▪▪▪ Upper bound

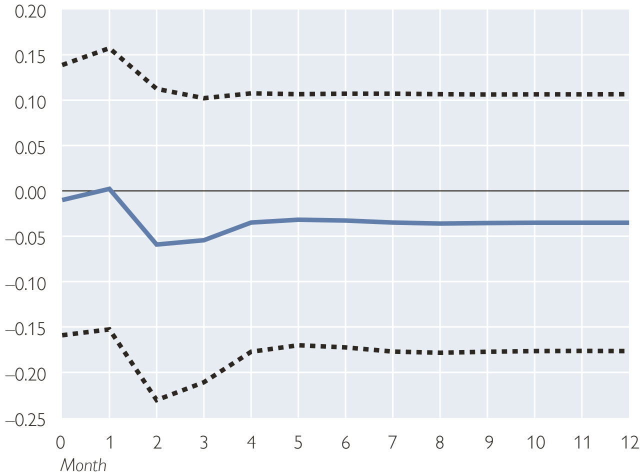
Source: Authors' own estimations based on STATA.

Chart A2 continued

Response of the long-term lending rate to an impulse from the ten-year government bond yield

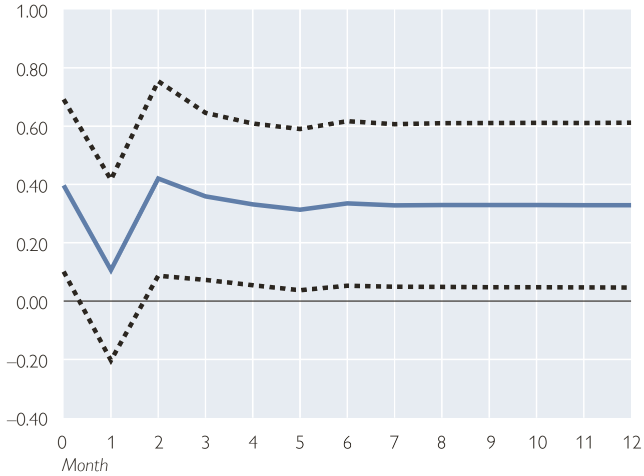
Czech Republic

Cumulative orthogonalized impulse response function (COIRF) with 95% confidence interval (CI) from a VAR model in first differences



Poland

Cumulative orthogonalized impulse response function (COIRF) with 95% confidence interval (CI) from a VAR model in first differences



COIRF   Lower bound   Upper bound

Source: Authors' own estimations based on STATA.