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# Spreading the word or reducing the term spread? Assessing spillovers from euro area monetary policy

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**Preliminary draft - comments welcome!**

## Abstract

As a consequence of asset purchases by the European Central Bank (ECB), longer-term yields in the euro area decline, and spreads between euro area long-term yields narrow. To assess spillovers of these recent financial developments, we use a Bayesian variant of the global vector autoregressive (BGVAR) model that uses shrinkage priors coupled with stochastic volatility. We find positive and significant spillovers to industrial production in Central, Eastern and Southeastern Europe (CESEE) and other non-euro area EU member states. These effects are transmitted via the financial channel (mainly through interest rates and equity prices) and outweigh costs of appreciation pressure on local currencies vis-à-vis the euro (trade channel). That both shocks yield rather similar results adds narrowing longer-term yields in the euro area as a viable alternative to the policymakers' toolkit. While these results represent general trends, we also find evidence for both cross-country heterogeneity of effects within the euro area and region-specific spillovers thereof.

**Keywords:** Euro area monetary policy, quantitative easing, spillovers

**JEL Codes:** C30, E52, F41, E32.

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## 1 Introduction

Following the global financial crisis in 2007 and the failure of Lehman in 2008, major central banks have considerably lowered their policy rates to stimulate economic growth and consumer price inflation. Since the room for conventional monetary policy quickly eroded and against the background of deflationary pressures and weak economic growth, major central banks switched from traditional interest targeting to other forms of monetary policy. One of these non-conventional monetary policies works through an extension of the central banks' balance sheet by purchasing longer-term securities from the private sector, so-called *Quantitative Easing* (QE, see e.g., [Fawley and Neely, 2013](#), for a detailed overview).

The main domestic transmission channels are the "portfolio balancing" channel and the "asset price channel" (see [Joyce et al., 2012](#), for an excellent summary). In a nutshell, investors who sell bonds to the central bank, are likely to purchase other long-dated assets (e.g., corporate bonds) to restore the original duration of their overall portfolio. This leads to a decline in term spreads (given zero short rates [Baumeister and Benati, 2013](#), see, e.g.,) and ideally to a broad easing of financial conditions in a variety of market segments. Second, the reduction of bond yields should trigger a rise in asset prices ("asset price channel"), which in turn increases consumer wealth and overall aggregate demand. Since the extent of financial deepening within the euro area differs, it seems likely that the within euro area transmission of the policy measure differs. The asymmetric transmission of a conventional monetary policy shock within the euro area has been recently demonstrated by [Georgiadis \(2015\)](#). This implies that to analyze spillovers from euro area monetary policy, it seems essential to use a coherent multi-country framework, that accounts for both heterogeneity of effects within the euro area and spillovers thereof.

[Gambacorta et al. \(2014\)](#) and [Burriel and Galesi \(2016\)](#) follow these lines of arguments and focus on within euro area spillovers. [Gambacorta et al. \(2014\)](#) estimate a structural panel VAR for eight advanced euro area countries to assess the effects of an exogenous increase in central banks' assets. These are pinned down by using a mixture of zero and sign restrictions. The findings in [Gambacorta et al. \(2014\)](#) suggest that an exogenous increase in central bank assets leads to a rise in economic activity and – to a lesser degree - positive effects on prices. Also, these effects are rather homogeneous among euro area countries. [Burriel and Galesi \(2016\)](#) use a wider set of euro area countries, a global vector autoregressive framework that takes cross-country spillovers into account and a similar identification strategy. They find that an exogenous increase in ECBs total assets leads to a significant rise in aggregate output and inflation, a depreciation of the effective exchange rate, an increase in real equity prices and private credit. They also find a significant degree of within-euro area heterogeneity contrasting results of [Gambacorta et al. \(2014\)](#) and conclude that positive spillovers to countries with less fragile banks are largest.

In this paper we assess spillovers from financial market developments induced by recent euro area monetary policy to non-euro area EU member states. Which economies

are more strongly affected from euro area monetary policy, and which are more insulated? On the one hand, the increase in euro area demand is likely to boost economic activity in those countries that share strong trade links with the euro area member states that benefit most from downward pressure on their long-term yields. On the other hand, loose monetary policy in the euro area is expected to put appreciation pressure on euro area's trading partners' currencies, which might mitigate stimulus to economic growth.

Hitherto, there is a small but growing literature examining spillovers from euro area unconventional monetary policy. [Bluwstein and Canova \(2015\)](#) and [Hálová and Horváth \(2015\)](#) assess the effects of euro area unconventional monetary policy for non-euro area EU member states. [Bluwstein and Canova \(2015\)](#) use two-country Bayesian mixed frequency structural vector autoregressions to assess spillovers to non-euro area EU member states. Overall, they find positive but heterogeneous spillovers on output. In line with [Burriel and Galesi \(2016\)](#) the financial channel seems important in transmitting spillovers. [Hálová and Horváth \(2015\)](#) use a panel vector autoregressive framework to either examine a shock to the shadow rate as a measure of unconventional policy ([Wu and Xia, 2016](#)) or to central banks' assets and the reaction of macroeconomic variables in CESEE economies. Corroborating results of [Gambacorta et al. \(2014\)](#) on within-euro area spillovers, they find strong effects on output, while spillovers to prices are rather weak. Last, [Ciarlone and Colabella \(2016\)](#) and [Falagiarda et al. \(2015\)](#) take a different route and conduct event study analyses to investigate announcement effects of the ECB's non-standard measures on financial variables in neighboring countries of the euro area, mainly from CESEE.<sup>1</sup> [Ciarlone and Colabella \(2016\)](#) find that the ECB's asset purchases trigger an appreciation of local currencies against the euro, drive up equity prices and to a lesser extent decrease long term yields in the region. These reactions can be traced back to a surge in portfolio and banking flows to the region as international investors search for higher yields.

We contribute to that young literature by investigating spillovers first, from a reduction in euro area term spreads and secondly, from a narrowing of euro area long-term yields. Both financial market developments could be induced by recent euro area monetary policy, namely large scale asset purchases by the ECB. That these cause a compression of the yield curve in an environment of low interest rates, has been demonstrated by [Baumeister and Benati \(2013\)](#) for the USA and by [Ambler and Rumler \(2016\)](#) for the euro area. The second shock we assess is a reduction in the risk spread - which we define as long-term yields over German long-term yields. This could capture other forms of unconventional monetary policy such as forward guidance as a form to successfully committing to a loose monetary policy and thereby convincing and reducing uncertainty in the markets. We contrast our findings with spillover effects from a reduction in a newly proposed metric that reflects overall monetary policy stance, the effective monetary stimulus (EMS) measure of [Halberstadt and Krippner \(2016\)](#).

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<sup>1</sup>See [Georgiadis and Grab \(2015\)](#) for a study on the impact of the ECBs announcement of the extended asset purchase program on global financial markets.

To analyze spillovers, we use a multi-country framework that is able to fully take into account both, within euro area heterogeneity of monetary policy effects and resulting spillovers from these effects. More specifically, we use a variant of the Bayesian global vector autoregressive (BGVAR) framework put forth in [Crespo Cuaresma et al. \(2016\)](#), and [Feldkircher and Huber \(2016\)](#). The proposed framework features shrinkage priors on the parameters of the model as well as time-varying error variances and is thus a very flexible approach to handle volatile and higher frequency time series. These two features have been shown to be of ample importance to produce accurate estimates and generate well behaved residuals.<sup>2</sup>

Our main results are as follows: First, we find that a reduction in the term or risk spread, leads to an increase in euro area output, consumer prices, equity prices and a depreciation of the euro ([Burriel and Galesi, 2016](#)). That both shocks yield rather similar results adds narrowing longer-term yields in the euro area as a viable alternative to the policymakers’ toolkit. We also find evidence for cross-country heterogeneity within the euro area generalizing the results of [Georgiadis \(2015\)](#). Differences in within-euro area transmission of the shocks lead to different spillovers thereof. More specifically, we find that responses in CESEE economies tend to be more similar to those of euro area core economies, while other non-euro area EU member states seem to follow more closely developments in euro area periphery countries. Second and looking at international effects, we find that both shocks trigger a) an increase in industrial production, brought about by b) a rise in equity prices, which is mitigated by c) an appreciation of local exchange rates vis-à-vis the euro. These results represent general trends in the data. In addition we find region-specific responses, such as a pronounced increase in private credit in CESEE economies, which reflects the regions’ strong financial links to the euro area. More generally, countries with a low GDP per capita ratio, a sound banking sector or few regulations on setting up a new firm benefit more from the expansionary euro area shocks. Our results remain mostly unchanged when euro area effective monetary stimulus, a new monetary policy metric derived from yield curve data, is increased.

The paper is structured as follows. The next section introduces the econometric framework, while [section 3](#) summarizes the data and model specification. [Section 4](#) lays out the strategy to identify term and risk spread shocks and [section 5](#) discusses the results. Finally, [section 6](#) concludes.

## 2 Econometric framework

In this section we turn to the description of the econometric framework. We employ an extension of the traditional GVAR approach put forward by [Pesaran et al. \(2004\)](#) that adopts flexible stochastic volatility specifications. Time variation can be accounted for by either letting coefficients in the model drift, or by allowing residual variances to

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<sup>2</sup>[Huber \(2016\)](#) and [Dovern et al. \(2016\)](#) show that GVARs with shrinkage priors and stochastic volatility perform extraordinarily well in terms of forecasting.

change over time. Several studies ([Sims and Zha, 2006](#); [Primiceri, 2005](#)) find rather limited evidence in favor of time-variation in the autoregressive parameters but recognize the importance to control for heteroscedasticity. Hence, and in light of the present dataset, which is monthly and covers a rather limited time span, we use a stochastic volatility specification within the GVAR framework in order to capture dynamic properties commonly observed in macroeconomic and financial time series.

The first subsection describes the global vector autoregressive model with stochastic volatility in fairly general terms. In the second subsection we briefly discuss the prior setup adopted and the Markov chain Monte Carlo (MCMC) algorithm.

## 2.1 The global vector autoregressive model with stochastic volatility

The GVAR model, originally proposed by [Pesaran et al. \(2004\)](#) builds on a sequence of  $N + 1$  country-specific VAR models that feature a set of weakly exogenous predictors constructed by taking weighted averages of other countries' endogenous variables,

$$x_{it}^* = \sum_{j=0}^N w_{ij} x_{jt}, \quad \text{for } i \in \{0, \dots, N\}, \quad (2.1)$$

with  $w_{ij}$  denoting a set of weights between countries  $i$  and  $j$ , normalized to sum up to unity. In the GVAR literature, these weights are typically assumed to be based on bilateral trade relationships or other measures of economic connectivity. The  $x_{it}^*$  variables are included to approximate the presence of observed or unobserved global factors and serve as a means to control for economic dependencies across countries.

We assume that the dynamics of a set of  $k_i$  endogenous variables in country  $i$  are described by the following VARX( $p, q$ ) model,

$$x_{it} = \sum_{j=1}^p A_{ij} x_{it-j} + \sum_{s=0}^q B_{is} x_{it-s}^* + \varepsilon_{it}, \quad (2.2)$$

with  $A_{ij}$  ( $j = 1, \dots, p$ ) being  $k_i \times k_i$ -dimensional coefficient matrices,  $B_{is}$ , ( $s = 0, \dots, q$ ) are coefficient matrices of dimension  $k_i \times k_i^*$  associated with the weakly-exogenous variables and  $\varepsilon_{it}$  is a normally distributed vector error term with a time-varying variance-covariance matrix  $\Sigma_{it}$ . Following [Cogley and Sargent \(2005\)](#) we can decompose  $\Sigma_{it}$  as follows

$$\Sigma_{it} = U_i H_{it} U_i', \quad (2.3)$$

where  $U_i$  is a  $k_i \times k_i$ -dimensional lower triangular matrix with unit diagonal and off-diagonal elements denoted by  $u_{ij,n}$  ( $j = 2, \dots, k_i; n = 1, \dots, k_i$ ) and  $H_{it}$  is a diagonal matrix with  $H_{it} = \text{diag}(e^{h_{i1,t}}, \dots, e^{h_{ik_i,t}})$ . Hereby we assume that the log-volatilities  $h_{ij,t}$  follow an AR(1) process,

$$h_{ij,t} = \mu_{ij} + \rho_{ij}(h_{ij,t-1} - \mu_{ij}) + \kappa_{ij,t}, \quad (2.4)$$

where  $\kappa_{ij,t}$  denotes a white noise error with variance  $\zeta_{ij}^2$ .

It is straightforward to show that the sequence of  $N + 1$  can be combined to yield a global VAR model,

$$Gx_t = \sum_{n=1}^{\max(p,q)} F_n x_{t-n} + \eta_t. \quad (2.5)$$

Hereby, we let  $x_t = (x'_{0t}, \dots, x'_{Nt})'$  denote a  $k = \sum_{j=0}^N k_j$ -dimensional vector that collects all endogenous variables in the system,  $G$  is a  $k \times k$  matrix of contemporaneous coefficients that are a function of the  $B_{i0}$  matrices and the weights in  $w_{ij}$ . Moreover,  $F_n$  are  $k \times k$  matrices of autoregressive coefficients that are driven by the weights and the estimates of  $A_{ij}$  for all countries and  $\eta_t$  is a  $k$ -dimensional vector white noise process with a block-diagonal matrix  $\Sigma_t = \text{diag}(\Sigma_{0t}, \dots, \Sigma_{Nt})$ . Multiplying with  $G^{-1}$  from the left yields the reduced-form GVAR model that closely resembles a standard VAR model with parametric restrictions imposed through the weights  $w_{ij}$ .

## 2.2 Bayesian estimation and inference

While the GVAR modeling approach imposes parsimony by restricting the coefficients related to other countries' endogenous variables to be driven by economic weights (see Eq. (2.1)), the remaining number of parameters in Eq. (2.2) is still typically higher than the number of available observations. This calls for Bayesian shrinkage priors that effectively deal with this problem by shrinking the parameter space towards some stylized prior model.

Before proceeding to the actual prior implementation it is convenient to rewrite Eq. (2.2) into a standard regression model,

$$x_{it} = C_i z_{it} + \varepsilon_{it}, \quad (2.6)$$

with  $z_{it} = (x'_{it-1}, \dots, x'_{it-p}, x'_{it}, \dots, x'_{it-q})'$  being a  $K_i = k_i p + k_i^* q$ -dimensional vector and  $C_i = (A_{i1}, \dots, A_{ip}, B_{i0}, \dots, B_{iq})$  is a  $k_i \times K_i = k_i p + k_i^* q$  matrix of stacked coefficients.

We follow [Feldkircher and Huber \(2016\)](#) and [Crespo Cuaresma et al. \(2016\)](#) and specify a stochastic search variable selection (SSVS) prior in the spirit of [George and McCulloch \(1993\)](#) and [George et al. \(2008\)](#) on each element of  $c_i = \text{vec}(C_i)$ ,

$$c_{ij} | \delta_{ij} \sim \mathcal{N}(0, \tau_{ij,0}^2) \delta_{ij} + \sim \mathcal{N}(0, \tau_{ij,1}^2) (1 - \delta_{ij}), \quad (2.7)$$

Hereby we assume that the prior on  $c_{ij}$  depends on a Bernoulli distributed random variable  $\delta_{ij}$  that selects the prior scaling parameter  $\tau_{ij,0}^2 \gg \tau_{ij,1}^2$ . Thus, if  $\delta_{ij}$  equals unity, we choose the first Gaussian distribution with mean equal to zero and a rather large variance  $\tau_{ij,0}^2$ . This case imposes little prior information on  $c_{ij}$ , implying that the posterior is strongly driven by the likelihood information. By contrast, if  $\delta_{ij}$  equals zero, the Gaussian prior adopted features a tiny prior variance, strongly pushing the corresponding posterior distribution of  $c_{ij}$  towards zero.<sup>3</sup> On each  $\delta_{ij}$ , we impose a

<sup>3</sup>For both Gaussian components in Eq. (2.7), the prior mean of the first own lag of a given variable/equation is specified to equal unity to mimic features of the Minnesota prior.

Bernoulli prior with

$$\delta_{ij} \sim \text{Bernoulli}(p_{ij}). \quad (2.8)$$

We set  $p_{ij} = \text{Prob}(\delta_{ij} = 1) = 1/2$  for all  $i, j$ . This implies that a priori, all variables are equally likely to enter [Eq. \(2.2\)](#).

Similarly to the prior on the regression coefficients we impose a SSVS prior on the off-diagonal elements of  $U_i$ ,

$$u_{ij,n} | \kappa_{ij,n} \sim \mathcal{N}(0, v_{ij,n0}^2) \kappa_{ij,n} + \mathcal{N}(0, v_{ij,n1}^2) (1 - \kappa_{ij,n}), \quad (2.9)$$

where  $\kappa_{i,j,n}^2$  is again a Bernoulli distributed random quantity that selects the mixture Gaussian component and  $v_{ij,n0}^2, v_{ij,n1}^2$  are prior scalings such that  $v_{ij,n0}^2 \gg v_{ij,n1}^2$ .

Since prior information on inclusion/exclusion of a given covariance parameter is rather scarce, we again adopt a Bernoulli prior with prior inclusion probability set to  $q_{ij,n} = \text{Prob}(\kappa_{ij,n} = 1) = 1/2$ ,

$$\kappa_{ij,n} \sim \text{Bernoulli}(q_{ij,n}). \quad (2.10)$$

We follow [Kastner and Frühwirth-Schnatter \(2014\)](#) and impose a normally distributed prior on  $\mu_{ij} \sim \mathcal{N}(0, v_\mu)$ , a Beta distributed prior on  $\frac{\rho_{ij}+1}{2} \sim \mathcal{B}(a_0, b_0)$  and a Gamma prior on  $\zeta_{ij}^2 \sim \mathcal{G}(1/2, 1/2B_\zeta)$ . This prior setup has several convenient properties that are discussed in length in [Kastner and Frühwirth-Schnatter \(2014\)](#).

Posterior simulation is carried out by sampling from the  $N + 1$  country-specific posterior distributions in parallel. The MCMC algorithm is standard in the literature for VAR models. Specifically, we sample  $C_i$  on an equation-by-equation basis (for details, see [Carriero et al., 2015](#)) from an multivariate normal distribution. The free elements of  $U_i$  can be simulated by noting that the system can be rewritten as a set of  $k_i$  univariate regression models with standard normally distributed errors (see [Cogley and Sargent, 2005](#)). The log-volatilities and the parameters of the state equation [Eq. \(2.4\)](#) are simulated by means of the algorithm stipulated in [Kastner and Frühwirth-Schnatter \(2014\)](#) and implemented in the R package `stochvol` ([Kastner, 2016](#)). Finally, we sample the indicator variables  $\delta_{ij}$  and  $\kappa_{ij,n}$  from their Bernoulli distributed conditional posterior distributions.<sup>4</sup>

Last, we specify the remaining hyperparameters for the prior. More specifically, following [George et al. \(2008\)](#) we set  $\tau_{ij,0}^2 = 3\hat{\sigma}_{ij}^2$  and  $\tau_{ij,1}^2 = 0.1\hat{\sigma}_{ij}^2$ , where  $\hat{\sigma}_{ij}^2$  are the OLS variances associated with  $c_{ij}$ . For the covariance parameters, we simply specify  $v_{ij,n0}^2 = 3$  and  $v_{ij,n1}^2 = 0.1$  for all  $i, j, n$ . For  $\mu_j$  we set  $v_\mu = 10^2$ , leading to a rather uninformative prior on the level of the log-volatility. Finally, for the persistence parameter we set  $a_0 = 25$  and  $b_0 = 5$ , placing significant mass on high persistence regions and  $B_\zeta = 1$ . As noted previously we execute the MCMC algorithm for each country simultaneously and use 20,000 iterations with the first 20,000 being discarded as burn-in.<sup>5</sup>

<sup>4</sup>For further information on the specific posterior moments, see [Feldkircher and Huber \(2016\)](#).

<sup>5</sup>To save computational time and due to storage limits we use a thinning interval to select 2,000 out of the 20,000 posterior draws. From these, we sort out unstable posterior draws which are characterized by large eigenvalues of the companion form of the global model which leads to approximately 1,000 posterior draws upon which the impulse response analysis in [section 5](#) is based.



### 3 Data and country coverage

We use monthly data spanning the period from 2000m10 to 2016m06. We focus on the spillover effects of a reduction in euro area term spreads or narrowing of euro area long-term yields to non-euro area EU member states. To allow for a broad range of potential transmission channels, we try to include a sufficiently large number of variables. More specifically, we collect data on industrial production ( $y$ ), consumer prices ( $p$ ), short- and long-term interest rates ( $i_s$  and  $i_l$ , 3-months and 10-year, respectively), real stock prices ( $eq$ ), private credit ( $pc$ ), house prices ( $hp$ ) and the nominal exchange rate vis-à-vis the euro ( $er$ ). All variables are in levels and data on industrial production and consumer prices are de-seasonalized.

These data are collected for a broad set of countries. More specifically, the euro area countries covered consist of the EA-18 bar the Baltics, Cyprus and Malta due to their relative small role in the asset purchase program. It will prove convenient to distinguish between euro area **core** (Austria, Belgium, Germany, Finland, France, Netherlands and Slovakia) and **periphery** (Ireland, Italy, Portugal, Spain, Greece) countries. Non-euro area EU countries consist mainly of economies from Central, Eastern and Southeastern Europe (**CESEE**), namely the Czech Republic, Hungary, Poland, Bulgaria, Romania, Croatia). We further add to this group two countries that are not members of the European Union, but share close economic ties with both euro area and CESEE economies, namely Russia and Turkey. Other non-euro EA member states include advanced economies (**other non-EA**, Denmark, Great Britain and Sweden). For completeness we also include data on the USA, China, Canada and Japan to control for global factors. That leaves us with a sample of good coverage of the euro area, non-euro area EU-member states and the G-8 industrialized advanced economies.

In each country model, the set of *domestic* variables is complemented by its *foreign* counterparts denoted by asterisks. Foreign variables are constructed using bilateral trade data and are the main channel in the GVAR framework through which spillovers and feedback is passed on between countries. More specifically, these are based on cross-country bilateral trade flows, averaged over the period from 2000 to 2014, from the World Input Output Database (WIOD).<sup>6</sup> Recently, other weights based on e.g., financial flows have been proposed in the literature (see, e.g., [Eickmeier and Ng, 2015](#)). However, [Feldkircher and Huber \(2016\)](#) present a sensitivity analysis with respect to the choice of weights in Bayesian GVAR specifications and show that trade weights yield a reasonable fit. Basically, we include for all domestic variables their foreign counterparts. There are two exceptions, though. First and to control for exchange rate movements in a broader sense, we include trade weighted exchange rates in euro area countries where no domestic exchange rates (vis-à-vis the euro) exist. The second exception relates to how we model monetary policy in the euro area. Following [Georgiadis \(2015\)](#) we introduce an "ECB" country model where monetary policy is governed by a simple Taylor rule. More specifically, the 3-months Euribor is regressed on purchasing power parity (PPP)

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<sup>6</sup>Data are retrieved from <http://www.wiod.org/home> and described in more detail in [Timmer et al. \(2015\)](#).

weighted averages of output and consumer prices of euro area countries. Euro area short-term interest rates enter then into all (also non-euro area) country models as a weakly exogenous variable. In this sense, the treatment of domestic interest rates is not symmetric among euro area countries on the one hand and the rest of the countries included in the analysis on the other hand.

## 4 Identification

In what follows we look at spillovers from financial developments in the euro area induced by recent monetary policy steps. First we follow the framework of [Baumeister and Benati \(2013\)](#) and assume that large scale purchases of longer-term securities result into a compression of the yield curve in the euro area. That this is indeed the case, has been recently demonstrated among others by [Ambler and Rumler \(2016\)](#). Fig. 1, top panel shows the dynamics of 10-year government bond yields for the euro area, Germany, euro area core and periphery countries.

[INSERT Fig. 1 HERE]

The figure shows how long-term yields increased significantly in the aftermath of the global financial crisis and the euro area debt crisis, especially so for periphery countries. In July 2012, when Mario Draghi, President of the European Central Bank delivered his famous "whatever it takes speech" at the Global Investment Conference in London<sup>7</sup>, however, yields started to decline strongly. Yields also decreased in January 2015 when the ECB announced to start its expanded asset purchase program in March the same year, albeit by a considerably smaller amount probably also since at that time yields have been on a downward trend for already a prolonged period.

We complement the term spread analysis by assessing the effect of a reduction in the risk spread, which we define as the spread of long-term rates in Germany (risk free) over domestic long-term rates. This should give an indication of how important "calming" the markets is compared to the actual purchase of longer-term securities. Fig. 1, bottom panel, illustrates that also a significant decrease in risk spreads was observable in July 2012.

Both shocks are empirically implemented by imposing sign restrictions on the impulse response functions. These are outlined in [Table 1](#) below:

[INSERT Table 1 HERE]

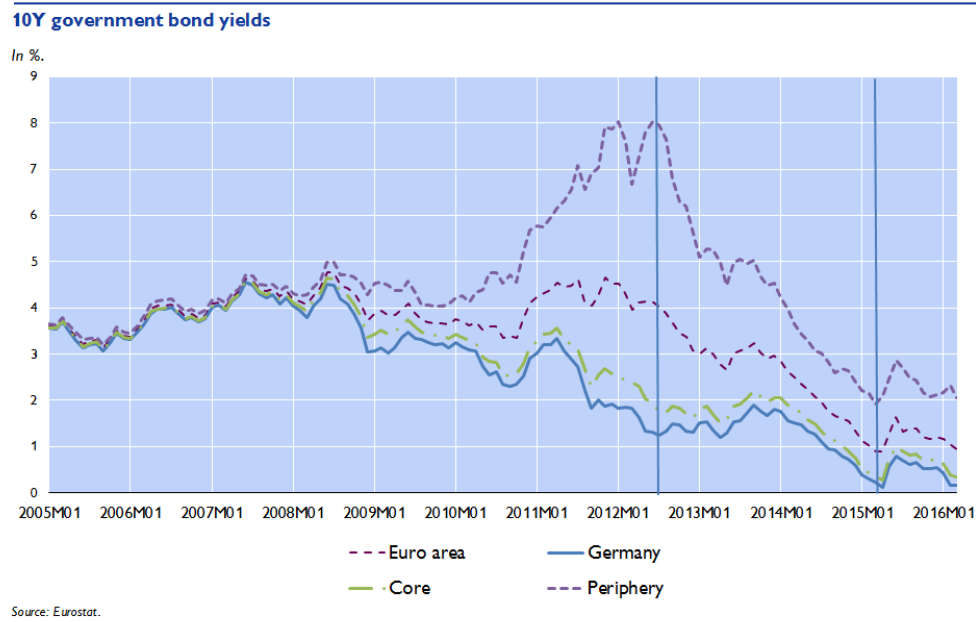
To model spillovers from a shock to the term spread we construct for all countries the difference between long- and short-term interest rates ( $sp$ ). For the second experiment, we construct for all *euro area* countries the spread of long-term interest rates over German long-term rates ( $sp$ ). By construction, this risk spread is not included in the

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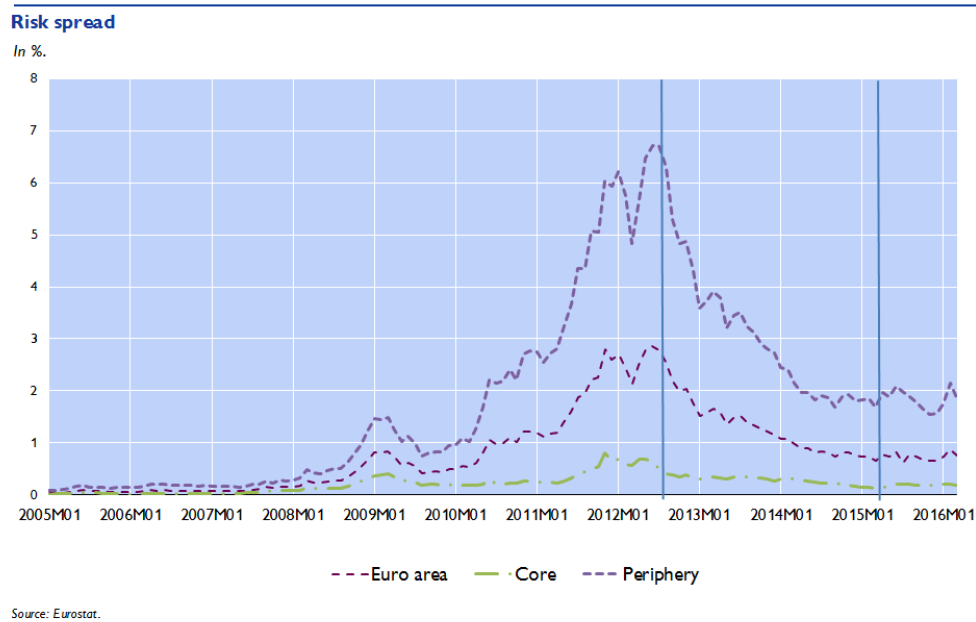
<sup>7</sup>See [Acharya et al. \(2015\)](#) for an empirical assessment of the macroeconomic effects of the "Whatever it takes" speech.

**Fig. 1:** Evolution of 10-year government bond yields and the risk spread

**(a)** 10-year government bond yields



**(b)** Risk spread



*Notes:* The top panel of the plot shows the evolution of 10-year government bond yields, whereas the bottom panel shows movements in the risk spread. The risk spread is defined as the spread of 10-year government bond over German 10-year government bond yields. Core and periphery refer to euro area core and periphery countries as defined in the main text. Purchasing power parities used to calculate regional aggregates. The first vertical bar refers to the "whatever it takes speech" (July 2012), and the second vertical bar to the launch of the extended asset purchase program (March 2015).

**Table 1:** Sign restrictions.

Shock	$sp$	$y$	$p$	$i_s$	$er$	$eq$	$pc$	$hp$
Term spread	↓, (all EA)	↑, ( $\phi$ EA)	↑, ( $\phi$ EA)	-	-	↑	↑	↑
Risk spread	↓, (all EA)	↑, ( $\phi$ EA)	↑, ( $\phi$ EA)	-	-	↑	↑	↑

Notes: The restrictions are imposed as  $\geq / \leq$  and for 3 periods after impact.  $\phi$  indicates that at least half of the countries have to fulfill the sign restrictions in the restricted country group. EA refers to euro area core and periphery countries as defined in the main text.

German country model and also excluded from other non-euro area countries. This implies, that the variable coverage depends on the country block to which a country belongs. For completeness, we have summarized variable coverage for both shocks in [Table A.1](#) in the appendix.

The term spread shock is pinned down by assuming a simultaneous decrease of euro area term spreads. The shock is calibrated to yield a simple average decrease of 100bp in the euro area. The compression of the yield curve – as a consequence of quantitative easing – should increase economic activity ( $y$ ) and prices ( $p$ ). These restrictions basically follow [Baumeister and Benati \(2013\)](#). On top of that, we impose restrictions on financial variables: since the decrease in the term-spread should be driven by a reduction in longer-term yields (given short-term interest rates at the zero lower bound), equity ( $eq$ ) and house prices ( $hp$ ) should pick up. Also, stimulus to economic activity should drive up demand for private credit ( $pc$ ). Note that we have only imposed the restriction on the variable we shock, the term spread, to hold for all euro area economies simultaneously. For the other restrictions, we require only the majority of euro area countries to fulfill the restrictions. By this we allow effects to vary across euro area countries and impose as little structure a priori as possible. That the transmission of both conventional and unconventional monetary policy can be very heterogeneous among euro area countries has been recently demonstrated by [Georgiadis \(2015\)](#) and [Burriel and Galesi \(2016\)](#). In general, note that imposing a large set of restrictions, by exploiting the cross-section of the data, should help pinning down the shock of interest ([Fry and Pagan, 2011](#); [Paustian, 2007](#)). In this sense, the multi-country GVAR framework offers an additional dimension for identification which we are going to exploit.<sup>8</sup> Moreover, note that as we are ultimately interested in international effects of the two shocks, we do not impose any restrictions on variables of countries outside the euro area.

The risk spread shock, implemented by an average decrease euro area risk spreads by 100bp, follows a similar logic as before: calming the markets should increase economic activity and prices for the majority of euro area countries, boosting demand for private credit. At the same time, equity and house prices should pick up.

To mimic the zero lower bound environment, we follow [Baumeister and Benati \(2013\)](#) and zero out the response of euro area interest rates by setting the corresponding

<sup>8</sup>Cross-country sign restrictions have been proposed by [Chudik and Fidora \(2011\)](#) and successfully applied in [Cashin et al. \(2014\)](#) to identify international effects from an oil price shock.

coefficients to zero. That is, we rule out the endogenous response of euro area monetary policy to the term spread shock over the impulse response horizon. We apply the same logic to the risk spread shock, holding the response of German long-term interest rate constant over the impulse response horizon. An alternative to identify the shocks would be by using a recursive ordering. For example, [Walentin \(2014\)](#) examines the effect of QE on macroeconomic quantities through its impact on mortgage spreads in the USA, UK and Sweden. However, in our setting, we want to distinguish a reduction in the term spread that is driven by a decrease of longer term yields given short-rates standing at zero, from a reduction caused by a contractionary monetary policy shock.<sup>9</sup> We accomplish this by requesting output (and prices) to pick up, which would not be straightforward to implement using a recursive ordering.

Last, our results presented in the next section are based on approximately 1,000 posterior draws for each shock. For each draw, we search for 4 rotation matrices that fulfill the sign restrictions outlined in [Table 1](#) and pick the one that minimizes the distance to the median model ([Fry and Pagan, 2011](#)). Credible sets should thus adequately reflect uncertainty about identification.

## 5 Empirical results

In this section we examine the domestic and international effects of a simultaneous compression of euro area single countries' term spreads as well as a simultaneous narrowing of longer-term yields in the euro area. Results are depicted in [Figures 2 to 5](#). In each figure we display the posterior median (in solid blue) along with 68% (dark blue) and 50% (light blue) credible intervals. The use of less stringent credible intervals, such as the 50% set, is not uncommon in highly parametrized models, such as the GVAR framework.<sup>10</sup>

### 5.1 Effects of a compression of the yield curve

Results for the term spread shock are depicted in [Figures 2 and 3](#).

[INSERT [Fig. 2](#) HERE]

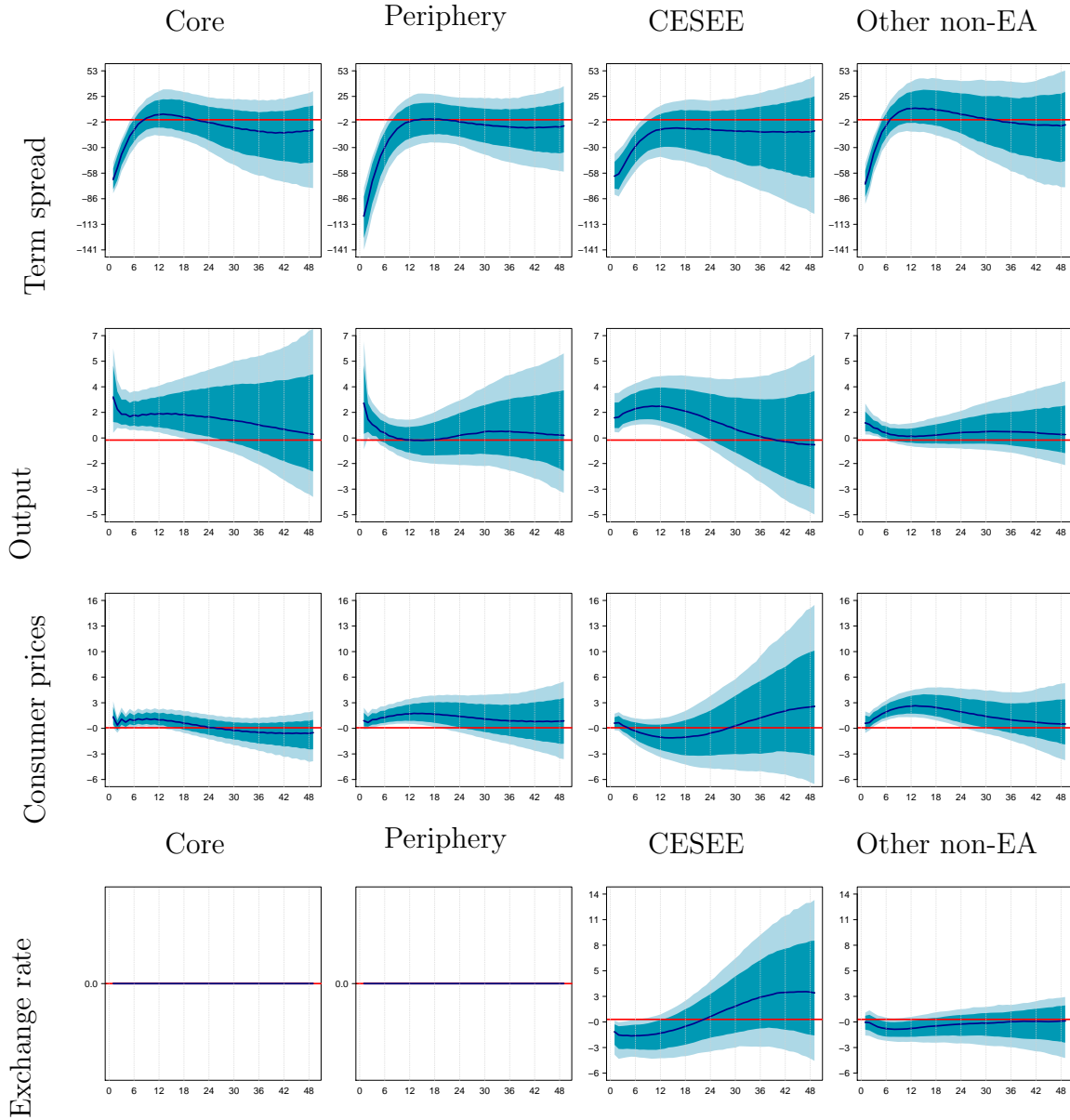
The response of the term spread in the euro area is negative for up to six months, after which the term spread rebounds and credible sets become wide. In both CESEE and other non-euro area EU member states, the immediate decline in term spread is of about the same size as in euro area core countries and thus rather sizable. The reduction in the term spread, brought about by a decline in long-term yields, drives up industrial production in the euro area. While effects are rather persistent in euro

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<sup>9</sup>As pointed out in [Benati and Goodhart \(2008\)](#), an unexpected monetary tightening that lowers inflation, and therefore inflation expectations, causes longer term rates to increase less than short-rates, causing a flattening of the yield curve.

<sup>10</sup>In the context of spillover analysis, see e.g., [Almansour et al. \(2015\)](#) or ?.

**Fig. 2:** Term spread shock - regional results I



*Notes:* The figure shows impulse responses to a simultaneous 100bp reduction in the euro area term spread. Dark blue shaded area denotes 68%, light blue 50% credible sets and the blue solid line the posterior median. Exchange rate refers to nominal exchange rates vis-à-vis the euro (decrease implying a depreciation of the euro). Regional figures are aggregated using purchasing power parities.

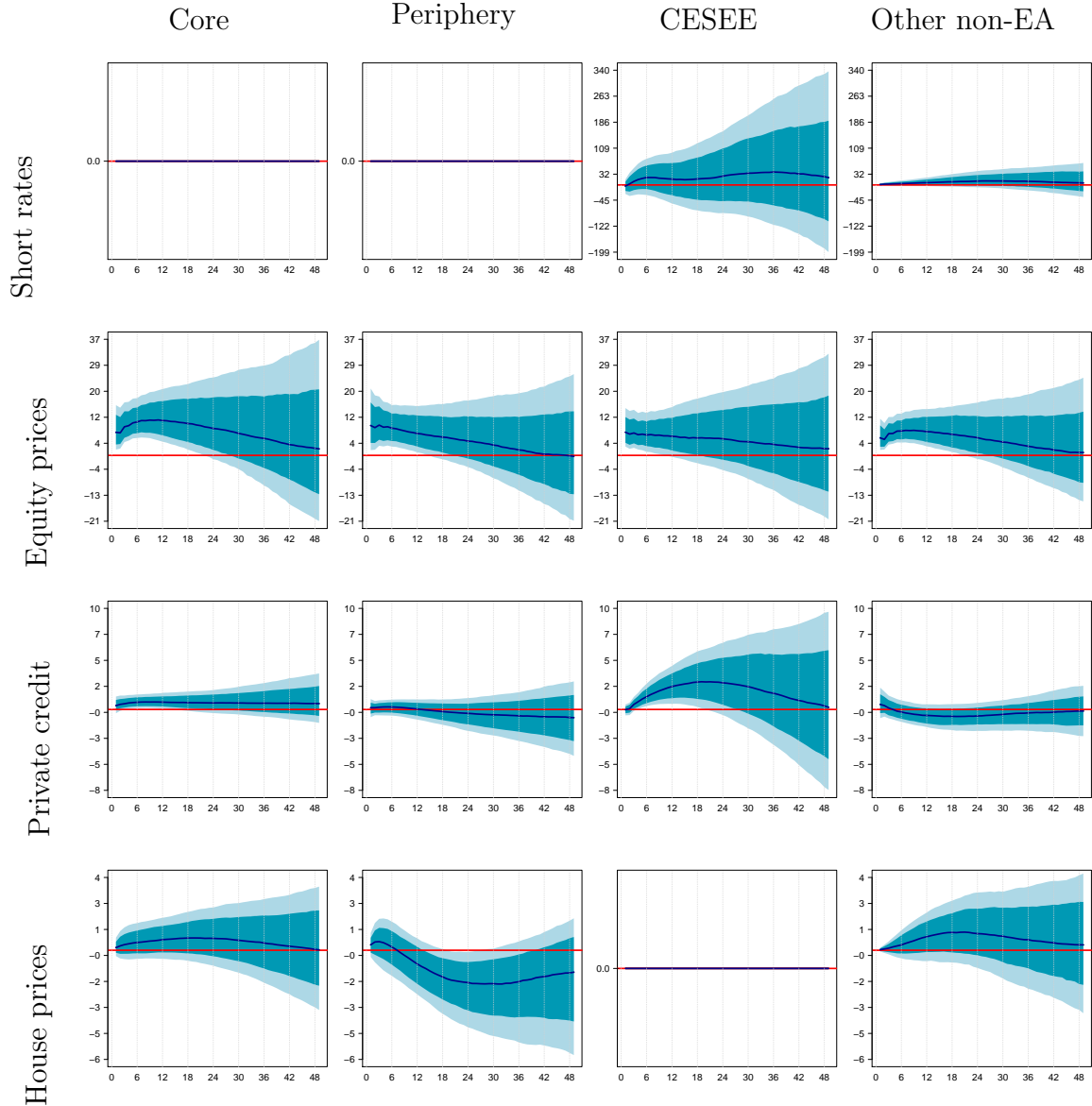
area core countries, they are more short-lived in periphery countries. A heterogeneous transmission of the shock within the euro area – as evidenced for a conventional monetary policy shock in [Georgiadis \(2015\)](#) – might trigger distinct spillovers abroad. More specifically and in terms of output, CESEE economies seem to follow euro area core countries showing rather persistent and positive effects on industrial production. By contrast, other non-euro area EU member states show a more similar pattern to euro area periphery economies with effects being more short-lived.

Next, as economic activity ticks up consumer prices start to grow significantly in all regions but CESEE. Compared to euro area periphery and other non-euro area EU member states, the response of consumer prices is more short-lived in euro area core countries, which might reflect slack in euro area core countries’ price dynamics. Relative to output responses, the reaction of consumer prices are estimated with more uncertainty. This might be driven by the link between asset prices and inflation, which has been recently analyzed by [de Haan and Willem van den End \(2016\)](#). They find that the transmission of financial developments to inflation can be quite long and that overall effects of quantitative easing on inflation can be uncertain, both in timing and direction. Monetary easing in the euro area strengthens CESEE economies’ currencies vis-à-vis the euro. More specifically, domestic exchange rates in CESEE tend to appreciate significantly up to 6 months. Other non-euro area EU member states do not respond immediately with an appreciation of their currency, however, after 6 to 8 months their exchange rates strengthen significantly as well.

[INSERT Fig. 3 HERE]

Next, we look at short-term interest rates. While the response of short-term interest rates in the euro area, determined by the ECB Taylor rule, is by construction zero to mimic the zero lower bound environment, short-rates increase in CESEE and other non-euro area EU member states, but not significantly so. Next, we look at spillovers to financial variables, namely real equity prices, private credit and house prices. [Tobin \(1969\)](#) highlights the importance of equity prices as the link between real and financial sectors of the economy. We expect equity prices to rise due to Keynesian effects that should boost consumption and growth ([Nickel and Vansteenkiste, 2013](#)). In fact and in parallel with the reduction of the term spread, equity prices pick up in the euro area and rather persistently so. International responses show a similar pattern, namely a significant increase in equity prices up to 12 (euro area periphery and CESEE) to 16 (other-non euro area EU member states) months. Responses of private credit are more diverse across the regions: while the rise in economic activity drives up demand for private credit in euro area core countries, there is no significant effect in periphery countries. In line with previous results, spillovers to CESEE economies are strongly determined by domestic responses in euro area core countries. That is, we find pronounced spillovers to private credit in CESEE economies. In fact, responses even outpace those of euro area core countries – a finding that is in line with [Fadejeva et al. \(2017\)](#) who analyze spillovers to credit in response to a range of macroeconomic shocks.

**Fig. 3:** Term spread shock - regional results II



*Notes:* The figure shows impulse responses to a simultaneous 100bp reduction in the euro area term spread. Dark blue shaded area denotes 68%, light blue 50% credible sets and the blue solid line the posterior median. Regional figures are aggregated using purchasing power parities.



The strong responses of credit might reflect the particularly high degree of financial integration between the regions. By contrast, non-euro area EU member states show again responses that are similar to that of euro area periphery countries, namely an immediate increase in private credit which is accompanied by wide credible sets. Last, we look at the impact of the term spread shock on international house prices. As yields decrease, investors might re-allocate capital into the housing sector driving up real estate prices. In the short-run, this holds true throughout the regions but effects are not precisely estimated. In euro area periphery countries, the initial increase is offset by a significant decline over the medium-term. For CESEE economies, no data on house prices are available.

Summing up, we find that a reduction in euro area term spreads positively and persistently affects industrial output in euro area core, CESEE and other non-euro area EU economies. This finding is in line with [Hálová and Horváth \(2015\)](#) for CESEE, and [Gambacorta et al. \(2014\)](#) for euro area core countries. In euro area periphery countries, effects are positive but not precisely estimated. Spillovers transmit via both, the trade and the financial channel as we see a depreciation of the euro on the one hand and a decline in term spreads triggering a rise in equity prices on the other hand. The latter might indicate that wealth effects play an important additional role in providing stimulus to output growth. Reactions of other financial variables is region-specific. For CESEE economies, there is a strong and pronounced increase in private credit, probably driven by a surge in cross-border banking flows to the region ([Ciarlone and Colabella, 2016](#)), while for other non-euro area EU member states, house prices seem to play an important role at least in the short-run.

## 5.2 How far does "whatever it takes" take you?

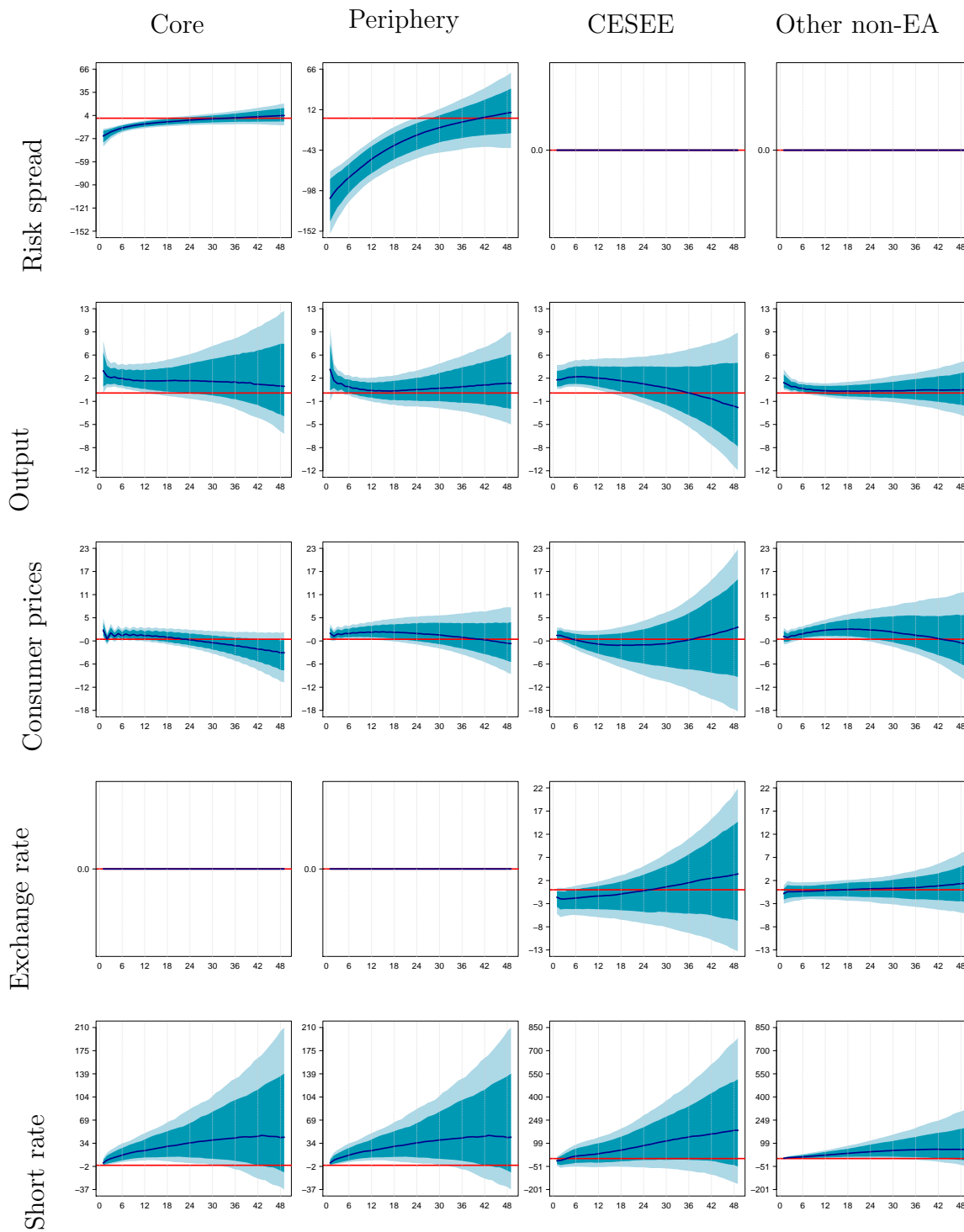
In this section we contrast the results of the term spread shock with effects of a reduction in the risk spread. We define the risk spread as the difference between a euro area member states' long-term interest rate and long-term interest rates in Germany. A credible commitment to provide stimulus for an extended period of time might reduce cross-country long-term interest rate spreads. In the spirit of the term spread shock framework, we zero out the response of the German long-term interest rate. The results are depicted in Figures 4 and 5.

[INSERT Fig. 4 HERE]

[INSERT Fig. 5 HERE]

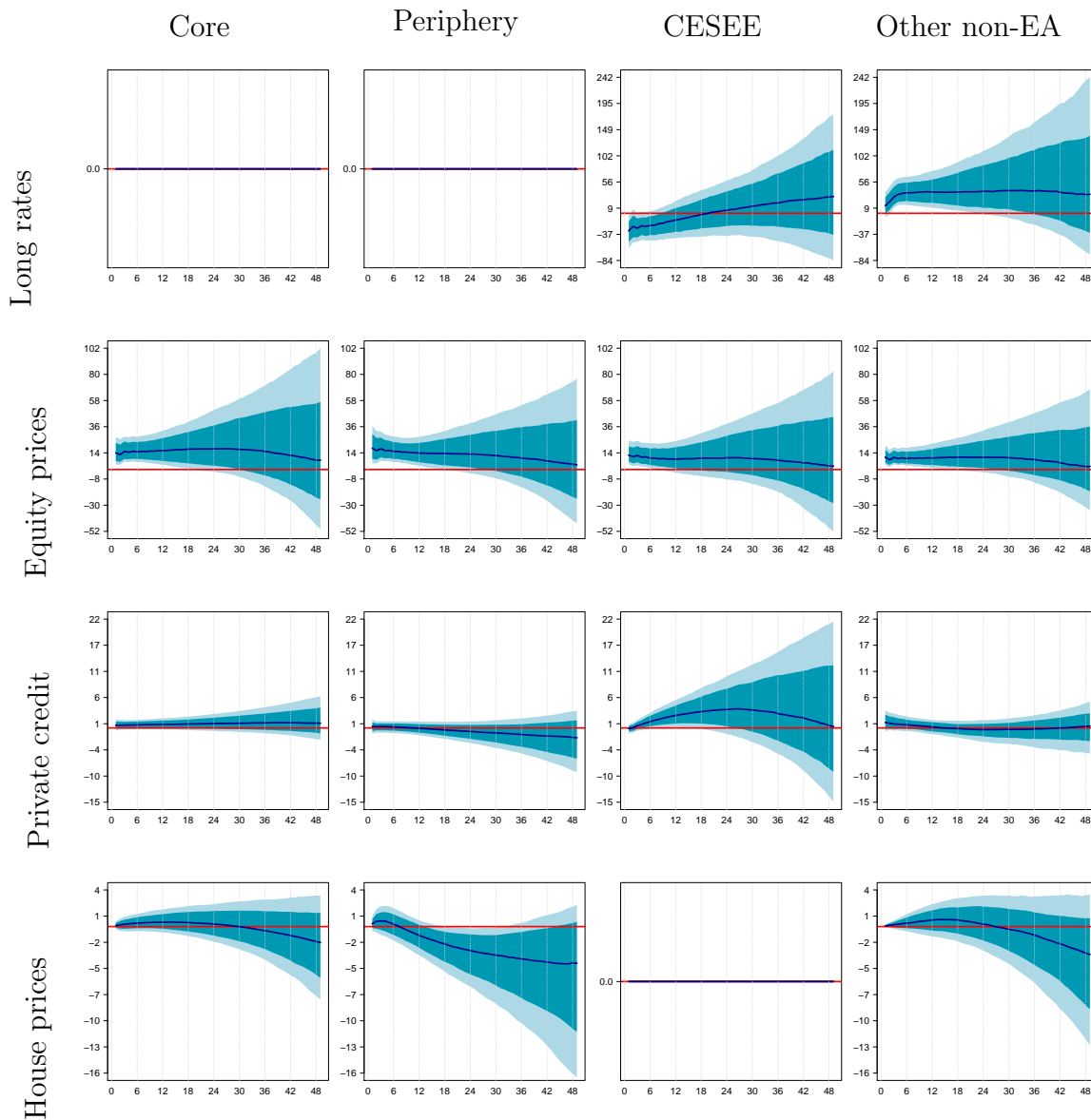
A reduction in the risk spread increases industrial production in all four regions, with more persistent responses in euro area core and CESEE economies and more short-lived reactions in periphery and other non-euro area economies. Consumer prices pick up but only significantly so in euro area periphery and other non-euro area EU member states. Corroborating previous results of the term spread shock, we find an appreciation of other currencies against the euro, but responses are accompanied by

**Fig. 4:** Risk spread shock - regional results I



*Notes:* The figure shows impulse responses to a simultaneous 100bp reduction in the euro area risk spread. Dark blue shaded area denotes 68%, light blue 50% credible sets and the blue solid line the posterior median. Exchange rate refers to nominal exchange rates vis-à-vis the euro (decrease implying a depreciation of the euro). Regional figures are aggregated using purchasing power parities.

**Fig. 5:** Risk spread shock - regional results II



*Notes:* The figure shows impulse responses to a simultaneous 100bp reduction in the euro area risk spread. Dark blue shaded area denotes 68%, light blue 50% credible sets and the blue solid line the posterior median. Regional figures are aggregated using purchasing power parities.

slightly larger credible sets compared to results of the term spread shock. The analysis of the risk spread allows to examine the endogenous response of euro area short-term interest rates (which were held constant at zero in the term spread exercise). The Taylor rule indicates a rise in interest rates in response to re-newed economic activity and price growth. Short-term interest rates follow the rate increase in the euro area but only significantly so in other non-euro area EU member states. Interestingly, the pass-through to long-term rates works differently in CESEE and other-non euro area EU member states: While long-term yields decrease in CESEE - probably through a surge in capital inflows – long-term yields increase in other non-euro area EU member states. Next, and in line with the term spread shock, equity prices increase throughout the regions and private credit picks up markedly in CESEE. House prices increase in all regions where data are available in the short-run, but estimates are surrounded with uncertainty. In euro area periphery countries, however, there is a significant negative rebound of house prices in the medium term.

Summing up, we find that effects of a reduction in the risk spread leads to qualitatively very similar results compared to that of the term spread shock. Output and consumer prices increase in most regions, the euro depreciates and equity prices pick up. The analysis of the risk spread allows to examine in more detail spillovers to short- and long-term interest rates. Here, we find that international short-term rates follow the rate increase in the euro area. Interestingly, international long-term interest rates respond differently in CESEE and other non-euro area EU member states: while they decrease in the former, they increase in the latter. The decrease in long-term interest rates in CESEE implies that international portfolio re-balancing takes place triggering a strong inflow of financial flows to the CESEE region corroborating results of [Ciarlone and Colabella \(2016\)](#). The fact that most variables respond in a similar way as to the term spread shock, indicates that a narrowing of long-term yields in the euro area might serve as a valuable alternative to a more direct approach of monetary policy, which aims at reducing term spreads.

### 5.3 Do effects vary across countries?

In [Fig. 3](#) we assess in more detail the cross-country variation of spillovers. In other words, which CESEE and other non-euro area EU-member states are more strongly affected, which ones are more insulated from the shock. To that end we show peak / trough effects of the spillovers with accompanying 50% credible sets. We focus on peak / trough effects in response to the term spread shock. Results of the risk spread shock are very similar and provided in the annex in [Fig. A.1](#).

[INSERT [Fig. 6](#) HERE]

There are some salient features emerging from the data: Peak effects on industrial production and consumer prices are significant for mostly all economies. In terms of output, Hungary, Turkey and Romania benefit most from the economic expansion in the euro area, whereas consumer prices pick up most markedly in Russia. Currencies

that strengthen most against the euro comprise the Polish zloty and the Turkish lira, both currencies which also showed large swings historically. By contrast, in Denmark and Croatia, both countries that pursue a form of fixed exchange rate regime against the euro, effects are rather small. In response to the term spread shock, short-term rates tend to increase but to a varying degree. Rate increases are most pronounced in Turkey, Romania and Russia. Next, we find negative and sizable peak effects of term spreads for CESEE economies implicitly corroborating findings of [Falagiarda et al. \(2015\)](#) and [Ciarlone and Colabella \(2016\)](#). Peak effects of equity prices are most pronounced for Turkey and more advanced economies, namely Denmark and Sweden on the one hand and the Czech Republic and Poland on the other hand. Spillovers to private credit are sizable in Turkey and Russia, followed by peak effects for the Czech Republic and Poland. While in Turkey and Russia, domestic growth was historically fueled by a surge in lending resulting in a strong credit to output link, the increase in the Czech Republic and Poland might be more related to the close financial ties these two economies share with euro area core countries. Peak effects of house prices are most pronounced in Denmark but are estimated with a considerable degree of uncertainty. Note though that since credible sets of the estimated peak / trough effects frequently overlap across countries, cross-country differences should be interpreted with care.

To explore the differences in peak / trough responses in a more systematic way, we follow [Burriel and Galesi \(2016\)](#). They relate median peak responses of an unconventional monetary policy shock to GDP per capita, the unemployment rate, the soundness of the banking system as measured by capital to assets, and the ease of doing business index of the World bank. Using simple correlation analysis shows that spillovers to output and equity prices are stronger in either poorer countries or in those where an entrepreneur faces less regulatory requirements to start the operation of a firm (correlations of about 0.3 to 0.4). We also find a positive correlation with banks' capital to asset ratio implying that spillovers are larger to countries with sound banking systems ([Boeckx et al., 2014](#); [Burriel and Galesi, 2016](#)).

Summing up, we find that countries that have historically witnessed boom-bust periods on the one hand or those who are strongly integrated with the euro area on the other hand, show most pronounced responses when euro area spreads ease. A simple correlation exercise suggests that spillovers to output and equity prices are higher for comparably poorer countries or in countries where starting a new business is simple. Spillovers from the term spread shock are also larger in countries with a sound banking system since they are less constrained by a reduction in long-term interest rates.

#### 5.4 Effects of an increase in effective monetary stimulus

In this section we compare our results to spillovers from a conventional monetary policy shock. To this end we employ a new monetary policy metric that is derived from yield curve data and equally well represents the overall monetary policy stance during "normal" and zero-lower bound periods.

A lot of research has been recently devoted to so-called shadow short rates (SSRs) as a proxy for the overall monetary policy stance (see, e.g., for the United States [Wu and Xia, 2016](#); [Francis et al., 2014](#)). SSRs are estimated quantities often derived from shadow/lower bound term structure model. The advantage of SSRs is that they are not constrained by the zero lower bound as opposed to nominal short term rates and thus can always be used to assess the monetary policy stance. Albeit appealing, the use of SSRs as a monetary policy metric has been frequently debated. For example, [Francis et al. \(2014\)](#) raises several short-comings, namely that SSRs are unobserved quantities (during zero lower bound periods) and not directly influenced by macroeconomic quantities. The latter fact is in stark contrast to short-term nominal rates, the standard monetary policy metric.

To overcome these difficulties, [Halberstadt and Krippner \(2016\)](#) propose a new metric, the effective monetary stimulus (EMS). We use the model-free version of the EMS, which amounts to the difference of natural long-term interest rates and observed long-term forward rates. Note the EMS' components are directly observable and the future path of interest rates is directly shaped by macroeconomic quantities. Also [Halberstadt and Krippner \(2016\)](#) show that the EMS provides plausible judgment during non-zero lower bound periods. The EMS is displayed in [Fig. 7](#) below.

[INSERT [Fig. 7](#) HERE]

In what follows we contrast estimated spillover effects of the term and risk spread shocks by international effects of an easing of the EMS in the euro area by 100bp.

[INSERT [Fig. 8](#) HERE]

In [Fig. 8](#) we see that short-term rates decrease in parallel with euro area EMS in other-non euro area EU member states. Responses for the CESEE region, by contrast, are accompanied by large credible sets. An easing of the EMS triggers an increase in euro area core countries' output. This effect, however, sets in with a delay of about 6 months. Interestingly, there is a negative response of industrial output in euro area periphery countries, which fades out when output picks up in core countries. Note that for both, the term and risk spread shock, and as a direct consequence of the related variances, the initial response of both spreads is larger in euro area periphery compared to euro area core countries. This is in contrast to a shock to the EMS (or the policy rate) which is assumed to be the same for all euro area countries. Taken at face value, this finding might imply that in order to boost growth in periphery countries the initial stimulus must be sizable and probably larger relative to core countries. CESEE economies show a pronounced and persistent increase in industrial output. The fact that we find positive spillovers to output without any restrictions imposed is a strong finding that emerges solely from the data. Next, we look at consumer prices. Here, we find a positive impact in the whole euro area and other non-euro area EU member states. Compared to responses to the term and risk spread, the reaction of consumer prices to the EMS shock is much smoother. In CESEE countries, consumer prices

tend to decrease to sustain external competitiveness in the medium-term emphasizing the importance that exports play in the regions' growth model. Monetary easing in the euro area pushes pressure on trading partners' currencies. Compared to results of the term spread and risk spread shocks, effects on international currencies seem more pronounced when easing comes from the EMS.

[INSERT Fig. 9 HERE]

In line with our previous results, the financial channel plays an important role in spreading the shock internationally. Long-term rates decrease throughout all regions. While spillovers to CESEE and other non-euro area EU member states are persistently negative (up to 12 months), we see a significant significant re-bounce of long-term rates in the medium term in euro area core and periphery countries. Easing of the euro area's monetary policy stance triggers a pick up in equity prices throughout all regions which lasts about 40 months. The euro area expansion drives up private credit in the euro area and markedly so in the CESEE region – a finding that is in line with our previous results on the term and risk spread. By contrast, easing of the EMS induces negative spillovers to private credit in other non-euro area EU member states. Last, we again find a negative medium-term response of house prices in euro area periphery countries.

Summing up we find that spillovers from an easing of euro area monetary policy yield in most instances qualitatively similar results to international effects of term spread and risk spread shocks. Mostly, responses are more pronounced and credible sets larger when using the EMS as the monetary policy metric. For consumer prices, we find much smoother and more tightly estimated responses compared to the term and risk spread shock. Since the effect of asset purchases on consumer prices seems ambiguous in the literature (de Haan and Willem van den End, 2016), their precisely estimated responses indicate that the EMS resembles a broader monetary policy metric as opposed to term and risk spread shocks.

## 6 Closing remarks

Since the global financial crisis, the ECB has implemented several non-standard measures.<sup>11</sup> The latest of these measures constitute buying large amounts of securities issued by euro area governments, agencies and EU institutions, asset-backed securities and covered bonds driving down longer-term yields. Not only the actual purchase of these securities can alter interest rates. Also the successful commitment of the ECB to follow a certain policy path can influence financial markets. In this paper we use a novel econometric approach that uses shrinkage priors coupled with stochastic volatility to assess spillovers from most recent euro area monetary policy actions. To that end, we examine the effects of a 100bp reduction in the euro area term spread as well

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<sup>11</sup>See, e.g., the studies by Giannone et al. (2012) and Lenza et al. (2010) that examine the early non-standard measures of the ECB that targeted liquidity provisioning and stability of the banking system. These studies find in general, that the ECB measures were quite effective.

as a reduction of the risk spread, that is defined by the spread of euro area member states' long-term government bond yield over German long term yields. As a further robustness exercise, we contrast these results with an analysis of an increase of effective monetary stimulus, a monetary policy metric derived from yield curve data that has been recently proposed in [Halberstadt and Krippner \(2016\)](#).

Looking at *within-euro area effects* of the term and risk spread first, our results are well in line with the recent literature on quantitative easing. A reduction in the term or risk spread, leads to an increase in output and prices ([Gambacorta et al., 2014](#)), a depreciation of the euro and drives up equity prices and private credit ([Burriel and Galesi, 2016](#)). The fact that effects of the term spread shock are very similar to those of the risk spread shock, indicates that a narrowing of long-term yields in the euro area might serve as a valuable alternative to reducing longer-term yields generally. We also find a lot of heterogeneity of within-euro area effects generalizing the findings of [Georgiadis \(2015\)](#) regarding the transmission of conventional monetary policy. For example, house prices respond differently in euro area core and periphery countries and more generally the impulse to stimulate economic growth in euro area periphery countries has to be rather sizable. That our model is capable of reproducing salient features of the established literature adds confidence to our econometric framework and the overall identification strategy.

Our main results on the *international effects* of a reduction in euro area term spreads or a narrowing of euro area long-term yields are as follows: First, both shocks drive up industrial production in CESEE and other non-euro area EU member states corroborating findings of [Bluwstein and Canova \(2015\)](#) and [Hálová and Horváth \(2015\)](#). We do find also positive effects to consumer prices in other non-euro area EU member states. By contrast, there is no evidence for a significant increase in consumer prices in CESEE, which is in line with results of [Hálová and Horváth \(2015\)](#) who find rather weak price effects for that region. Also, it might reflect the fact that in some countries prices decrease in order to sustain external competitiveness emphasizing the important role that exports play in the regions' growth model.

Second, both shocks *transmit* through the trade channel (via an appreciation of local currencies vis-à-vis the euro) and the financial channel. The latter one is defined in a broad way covering interest rates on the one hand and a range of financial variables on the other hand. For example, international term spreads are driven down as investors re-allocate capital as a consequence of smaller yields in the euro area. Also, in response to the risk spread shock, long term yields fall in CESEE revealing evidence for international portfolio re-balancing towards that region. We find especially strong evidence for equity prices playing an important role in the transmission of euro area term and risk spread shocks. They increase throughout all regions implying that wealth effects are crucial in providing stimulus to the economy (see also [Nickel and Vansteenkiste, 2013](#); ?, for the case of a fiscal shock). As a consequence of strong financial ties between CESEE and the euro area, we find sizable spillovers to private credit. This result corroborates findings of [Ciarlone and Colabella \(2016\)](#) who demonstrate an increase in cross-border banking flows and portfolio flows to CESEE in response to asset purchase announcements of the



ECB. A strong general responsiveness of credit in CESEE has also been demonstrated in [Fadejeva et al. \(2017\)](#). Taken at face value, this implies that policies to absorb foreign shocks have to account for the financial channel.

Last, we also observe a certain degree of *cross-country heterogeneity* in international effects. To a certain degree this heterogeneity might be driven by how the shocks transmit within the euro area. More specifically, we find that responses of CESEE economies often tend to mirror those in euro area core countries, while other non-euro area EU member states frequently show similar responses to euro area periphery countries. Looking at differences in peak / trough responses reveals most pronounced spillovers to countries that have historically witnessed boom-bust periods on the one hand or those who are strongly integrated with the euro area on the other hand. A simple correlation analysis reveals that spillovers to output and equity prices are higher for poorer countries and in countries where starting a new business is simple. Spillovers from the term spread shock are also larger in countries with a sound banking system since they are less constrained by a reduction in long-term interest rates ([Burriel and Galesi, 2016](#)).

Our results remain qualitatively unchanged when we resort to a new metric of monetary policy, the effective monetary policy stimulus of [Halberstadt and Krippner \(2016\)](#), which ensures that the identified channels are also operational when resorting to a broader measure of monetary policy.

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## Appendix A Additional results

**Table A.1:** Summary of model specification

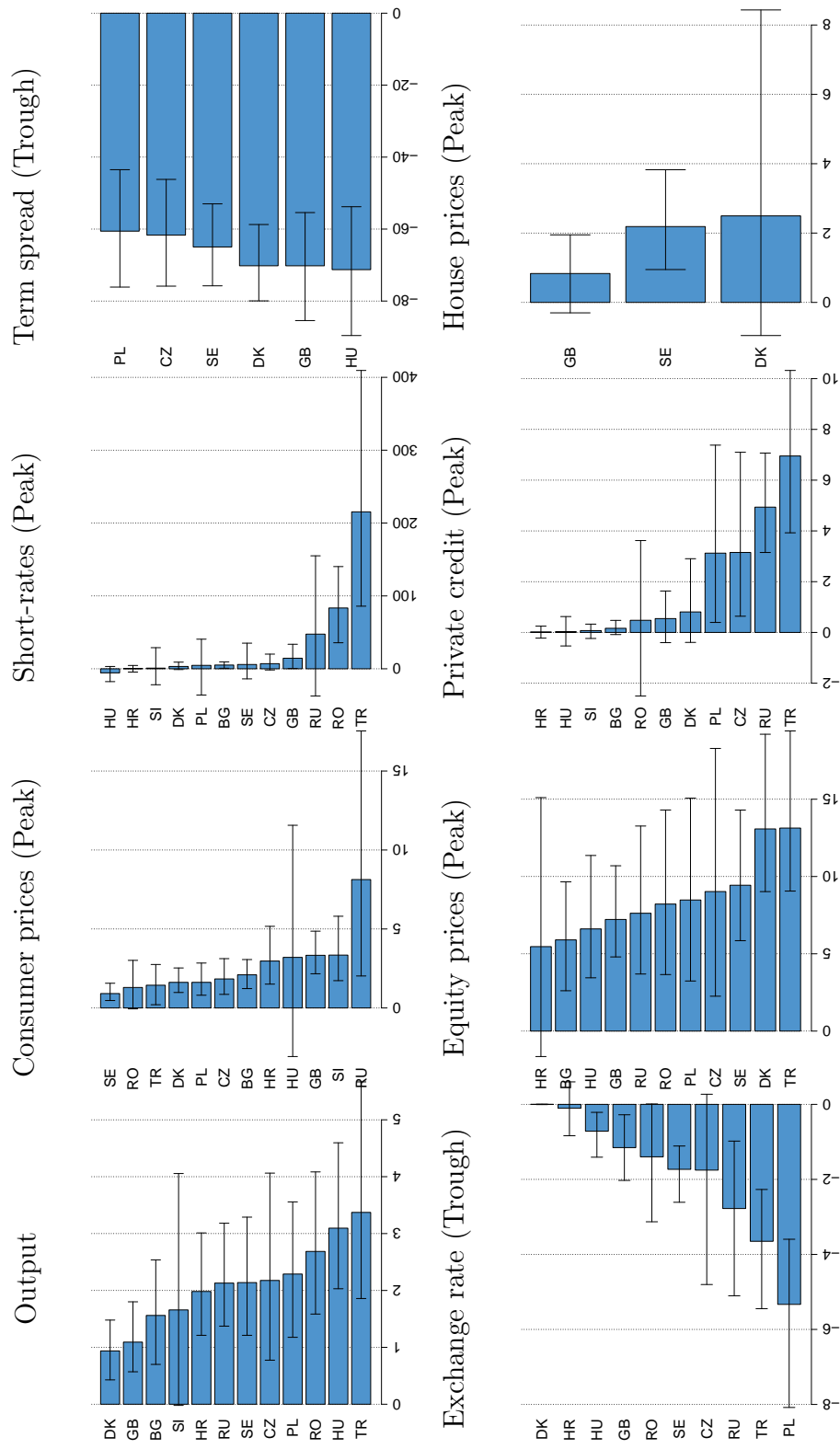
Term spread shock																					
Country	$y$	$p$	$i_s$	$i_{EA}$	$i_l$	$sp$	$er$	$eq$	$hp$	$pc$	$y^*$	$p^*$	$i_s^*$	$i_{EA}^{**}$	$i_l^*$	$sp^*$	$er^*$	$eq^*$	$hp^*$	$pc^*$	
EA (excl., DE)	✓	✓	-	-	-	✓	-	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
DE	✓	✓	-	-	-	✓	-	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓
ECB	-	-	-	✓	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-
Non-EA	✓	✓	✓	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	-	-	✓	✓	✓

Risk spread shock																					
Country	$y$	$p$	$i_s$	$i_{EA}$	$i_l$	$sp$	$er$	$eq$	$hp$	$pc$	$y^*$	$p^*$	$i_s^*$	$i_{EA}^{**}$	$i_l^*$	$sp^*$	$er^*$	$eq^*$	$hp^*$	$pc^*$	
EA (excl., DE)	✓	✓	-	-	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DE	✓	✓	-	-	✓	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ECB	-	-	-	✓	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-	-
Non-EA	✓	✓	✓	-	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓

**Notes:** In the upper panel, "sp" denotes the term spread, while in the lower panel the risk spread.  $y^*$  and  $p^*$  refer to purchasing power parity euro area country averages. Note that not all variables are available for all countries covered in the analysis. This relates typically to financial variables, for which coverage of CESEE countries is limited.

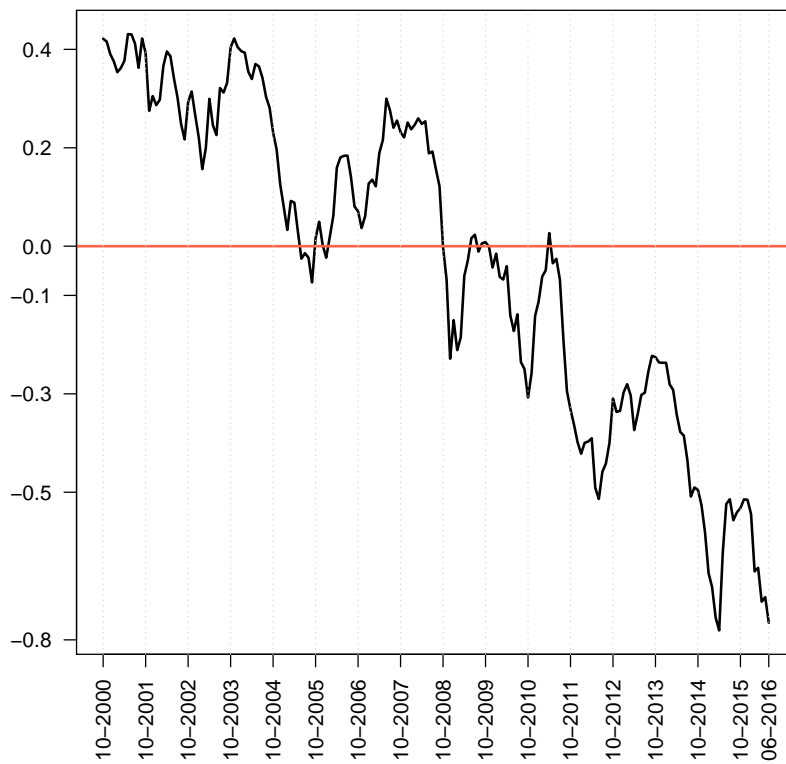
**Fig. 6:** Peak / trough effects of spillovers (term spread shock)



The bar plots show peak / trough effects with the whiskers denoting 50% credible intervals. A decrease of the exchange rate response implies an appreciation of the local currency against the euro.

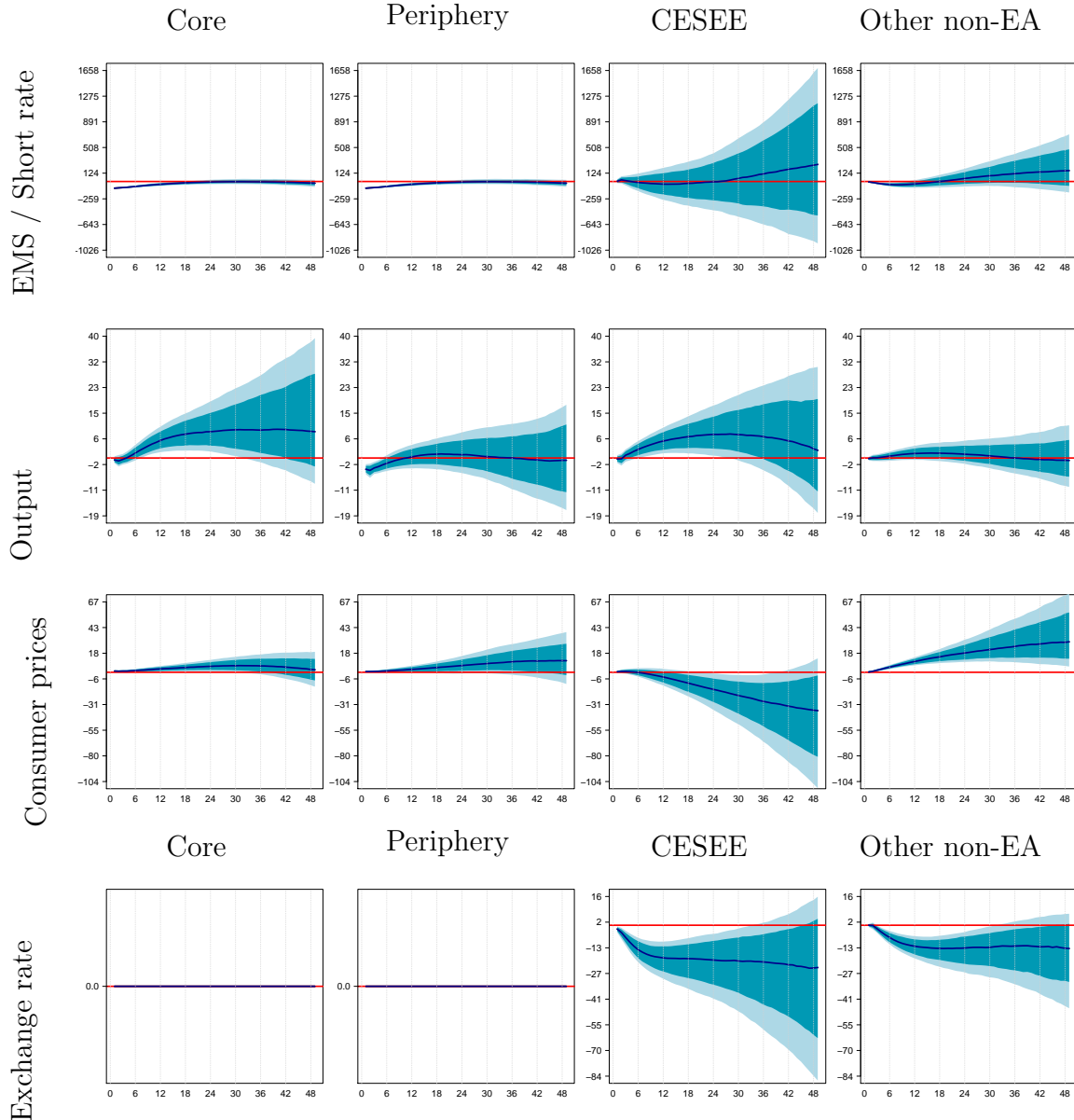


**Fig. 7:** Effective monetary stimulus (EMS)



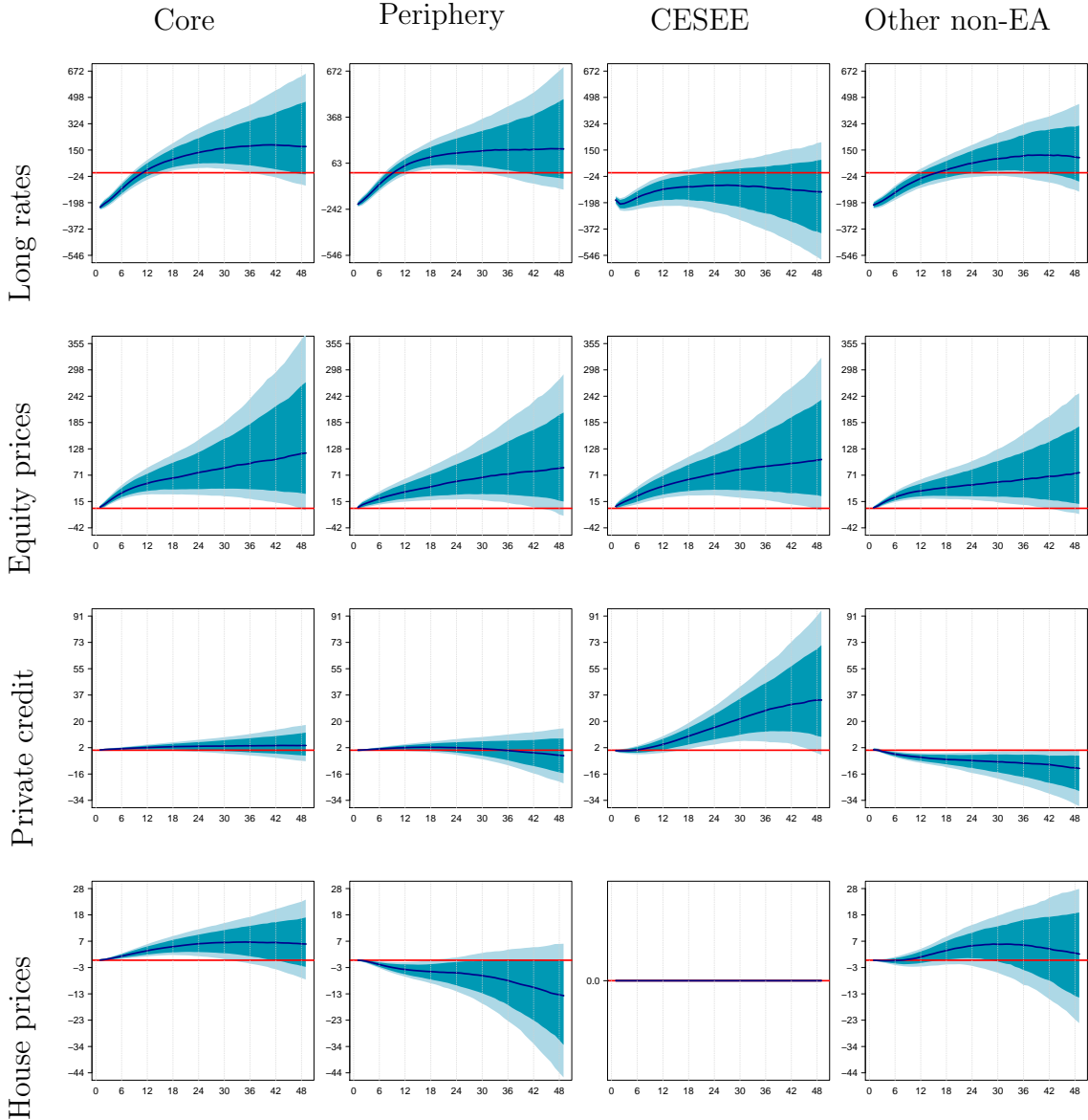
*Notes:* The effective monetary stimulus measure is derived as the difference between the nominal natural interest rate and 30 years forward rates and refers to the model-free variant proposed in [Halberstadt and Krippner \(2016\)](#).

**Fig. 8: EMS shock - regional results I**



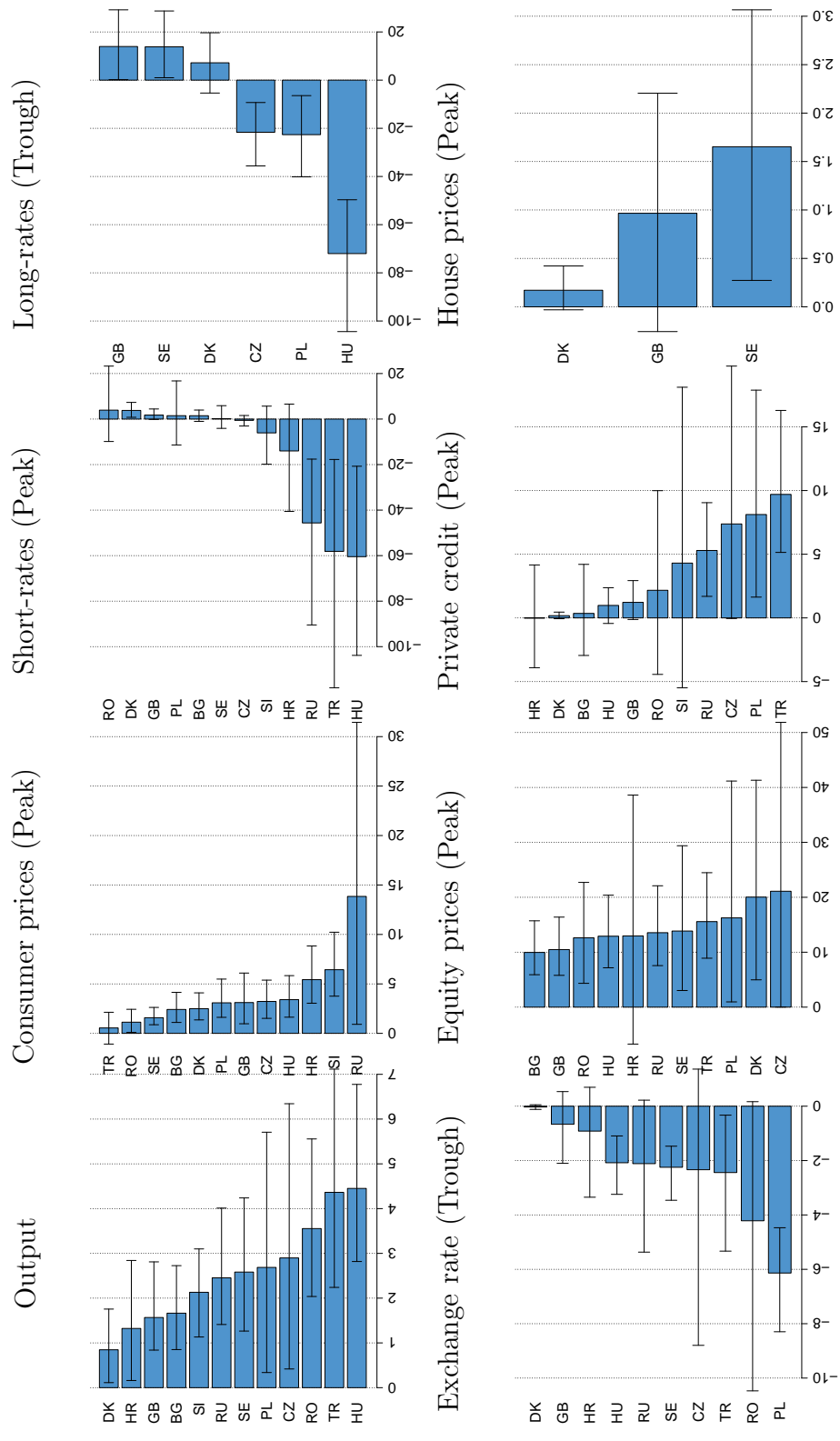
*Notes:* The figure shows impulse responses to a simultaneous 100bp reduction in the effective monetary stimulus measure for the euro area. Dark blue shaded area denotes 68%, light blue 50% credible sets and the blue solid line the posterior median. Exchange rate refers to nominal exchange rates vis-à-vis the euro (decrease implying a depreciation of the euro). Regional figures are aggregate using purchasing power parities.

**Fig. 9: EMS shock - regional results II**



*Notes:* The figure shows impulse responses to a simultaneous 100bp reduction in the effective monetary stimulus measure in the euro area. Dark blue shaded area denotes 68%, light blue 50% credible sets and the blue solid line the posterior median. Regional figures are aggregate using purchasing power parities.

**Fig. A.1:** Peak / trough effects of spillovers (risk spread shock)



The bar plots show peak / trough effects with the whiskers denoting 50% credible intervals. A decrease of the exchange rate response implies an appreciation of the local currency against the euro.