OESTERREICHISCHE NATIONALBANK
EUROSYSTEM

WORKING PAPER 198

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Publisher and editor *Oesterreichische Nationalbank*
Otto-Wagner-Platz 3, 1090 Vienna, Austria
PO Box 61, 1011 Vienna, Austria
www.oenb.at
oenb.info@oenb.at
Phone (+43-1) 40420-6666
Fax (+43-1) 40420-046698

DVR 0031577

ISSN 2310-5321 (Print)
ISSN 2310-533X (Online)

Spillovers from Euro Area and U.S. Credit and Demand Shocks: Comparing Emerging Europe on the Basis of a GVAR Model*

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October 17, 2014

Abstract

We examine the international effects of adverse loan supply and aggregate demand shocks originating in the euro area and the U.S.A. For that purpose, we use a global vector autoregressive (GVAR) model and isolate disturbances stemming from loan supply from those of four other macroeconomic shocks by means of sign restrictions. Our general results are as follows: Domestic and international responses of total credit and output to an adverse loan supply shock are substantial. They are more pronounced than the responses to an aggregate demand shock. Under both types of shocks, total credit decreases considerably more strongly than output in the long run, implying a reduction in financial deepening. This deleveraging process is particularly pronounced in the case of loan supply shocks. Taking a regional angle, Central-, Eastern- and Southeastern Europe (CESEE) and even considerably more the Commonwealth of Independent States (CIS) are the most strongly affected regions, and their total credit and output responses are stronger than in the country of shock origin. This is true for both types of structural shocks in the euro area and in the U.S.A. Last, historical decompositions of deviations from trend growth show that for the euro area developments, foreign shocks originating in the U.S.A., the UK and the CESEE and CIS regions feature most prominently, while for the U.S. developments, foreign shocks emanating from the euro area and China play a considerable role.

Keywords: Credit Shock, Global vector autoregressions, Sign restrictions

JEL Codes: C32, F44, E32, O54.

*The views expressed in this paper are not necessarily those of the Oesterreichische Nationalbank (OeNB) and Latvijas Banka. We would like to thank Rudolfs Bems, Konstantins Benkovsvkis, Elona Dushku, Sandra Eickmeier, participants of internal seminars at Latvijas Banka, the OeNB, the Joint Vienna Institute and participants of the 8th SEE Research Workshop of the Albanian National Bank, Tirana, for helpful comments. We are grateful to Kristiana Rozite for the assistance during the internship at the Bank of Latvia. Email address: ludmila.fadejeva@bank.lv, martin.feldkircher@oenb.at and thomas.reininger@oenb.at.

Non-Technical Summary

When the financial crisis erupted in 2008, the global economy witnessed a collapse in trade followed by a sharp contraction of real activity. In its aftermath, financial and economic conditions were characterized by tightened credit, increasing loan loss provisions and a lack of confidence between banks. On the one hand it was argued, that the decrease in new lending was driven by a sharp reduction in the demand for loans. On the other hand, banks were blamed to have tightened credit standards, being overly reluctant to engage in new lending as a part of cleaning their balance sheets. These effects have certainly contributed to the sharp drop in international real activity witnessed since 2008. However, also countries not directly affected by shocks to credit saw their output deteriorate facing adverse aggregate demand shocks for their exports and / or a surge in risk averseness of international investors triggering a kind of "flight to safety" redirection of their investment.

Consequently, in this study we focus on the international effects of an unexpected tightening in credit lending as well as a negative shock to aggregate demand. These shocks are assumed to originate in either the U.S. economy or the euro area, two regions that have been at the core of the financial crisis (the U.S.A.) or at the subsequent sovereign debt crisis (the euro area). From a policy perspective, the distinction between supply driven and demand driven shocks to credit lending and other macroeconomic shocks, such as adverse aggregate demand, is important since they might call for very different responses of monetary and fiscal policy. We extend existing literature on credit spillovers to feature countries from Central, Eastern and Southeastern Europe (CESEE) and the Commonwealth of Independent States (CIS). These countries share strong trade and financial linkages - either in the form of direct cross-border loans to the non-financial sector, wholesale funding or intra-group parent bank funding to the banking sector – with the euro area. Therefore, including these countries in a study to assess adverse shocks to credit supply in the euro area is essential and provides a new angle on the strength and transmission of financial shocks in general and during the crisis.

We find that domestic and international responses of total credit and output to an adverse loan supply shock are substantial. They are more pronounced than the responses to an aggregate demand shock. Under both types of shocks, total credit decreases considerably more strongly than output in the long run, implying a reduction in financial deepening. This deleveraging process is particularly pronounced in the case of loan supply shocks. Taking a regional angle, Central-, Eastern- and Southeastern Europe and even considerably more the Commonwealth of Independent States are the most strongly affected regions, and their total credit and output responses are stronger than in the country of shock origin. Last, historical decompositions of deviations from trend growth show that for the euro area developments, foreign shocks originating in the U.S.A., the UK and the CESEE and CIS regions feature most prominently, while for the U.S. developments, foreign shocks emanating from the euro area and China play a considerable role.

1 Introduction

When the financial crisis erupted in 2008, the global economy witnessed a collapse in trade followed by a sharp contraction of real activity. In its aftermath, financial and economic conditions were characterized by tightened credit, increasing loan loss provisions and a lack of confidence between banks (Busch *et al.*, 2010). On the one hand it was argued, that the decrease in new lending was driven by a sharp reduction in the demand for loans. On the other hand, banks were blamed to have tightened credit standards, being overly reluctant to engage in new lending as a part of cleaning their balance sheets. These effects have certainly contributed to the sharp drop in international real activity witnessed during the period of 2008-2009. However, also countries not directly affected by shocks to credit saw their output deteriorate facing adverse aggregate demand shocks for their exports and / or a surge in risk averseness of international investors triggering a kind of "flight to safety" redirection of their investment (Chudik & Fratzscher, 2011). From a policy perspective, the distinction between supply driven and demand driven shocks to credit lending and other macroeconomic shocks, such as adverse aggregate demand, is important since they might call for very different responses of monetary and fiscal policy (Gambetti & Musso, 2012).

In this paper we investigate *spillovers* from macroeconomic shocks that have their origin in either the U.S. economy or the euro area, two countries that have been at the core of the financial crisis (the U.S.A.) or at the subsequent sovereign debt crisis (the euro area). More specifically, we examine adverse loan supply and aggregate demand shocks and report their effects on output and credit in a range of advanced and emerging economies. For that purpose we use a global vector-autoregressive (GVAR) model that was put forward among others in Pesaran *et al.* (2004), Dees *et al.* (2007b,a), Garrat *et al.* (2006) and extend it to feature total credit and countries from Central, Eastern and Southeastern Europe and the Commonwealth of Independent States. To a different degree, these countries share strong trade and financial linkages - either in the form of direct cross-border loans to the non-financial sector, wholesale funding or intra-group parent bank funding to the banking sector – with the euro area. Including these countries in a study to assess adverse shocks to credit supply in the euro area seems thus essential and provides a new angle on the strength and transmission of financial shocks in general and during the crisis. Finally, our analysis separates loan supply and aggregate demand shocks from other macroeconomic shocks by explicitly controlling also for disturbances from aggregate supply, loan demand and monetary policy. This yields a comprehensive assessment of macroeconomic fluctuations of a broad range of economies with different degrees of financial and trade integration with the world economy.

Our general results are as follows: The following four findings hold true for both the domestic response in the country of shock origin and the spillovers generated from the shock: First, we find strong effects of loan supply shocks on output and total credit. Second, long-run responses to loan supply shocks are more pronounced than those to aggregate demand shocks, despite the same size of on-impact output reaction of 1% according to normalization. Third, we find that under both normalized loan supply shocks and aggregate demand shocks, the decrease in total credit is considerably larger than the decrease in output in the long run, implying a reduction of financial deepening. Fourth, the relative size of long-run decline in total credit compared to output is considerably larger in the case of normalized loan supply shocks than in the case of normalized aggregate demand shocks. Moreover, in both the euro area and the U.S.A., we can give an economic interpretation to their respective domestic shocks according to historical decomposition. All types of structural shocks defined via sign restrictions, and in particular also loan supply shocks and loan demand shocks, are to a considerable extent directly responsible for deviations from trend growth of total credit. By contrast, in the case of output, aggregate supply and demand shocks are directly more relevant than loan supply and loan demand shocks for explaining deviations from trend growth, in particular in the euro area, although the latter types of shocks have probably had an indirect effect by triggering ensuing aggregate supply or demand shocks.

Taking a regional angle, the CESEE region and even considerably more the CIS region are the most strongly affected regions, and their total credit and output responses are stronger than in the country of shock origin. This is true for both types of structural shocks in the euro area and in the U.S.A. The euro area shock impact is more pronounced than the U.S. only in in the short-run. The fast transmission of euro area shocks is in line with tight trade and financial links between these regions. In this vein, historical decompositions of deviations from trend growth show that for the euro area developments, foreign shocks originating in the U.S.A., the UK and the CESEE and CIS regions feature most prominently, while for the U.S. developments, foreign shocks emanating from the euro area and China play a considerable role. Last, comparing the output response across the regions, we find that the responses to euro area loan supply and aggregate demand shocks are larger than the domestic (i.e., own euro area) response only in the CESEE and CIS regions. By contrast, the responses to U.S. loan supply and aggregate demand shocks are larger than the domestic (i.e., own U.S.) response not only in the CESEE and CIS regions, but also in the euro area and in the aggregate of other developed countries, reflecting probably second-round effects from the decline in international activity.

The paper is structured as follows: the next Section summarises the relevant literature, while Section 3 introduces the global VAR (GVAR) model, the data and the model specification. Section 4 presents a set of sign restrictions that we employ to separate loan supply shocks from aggregate demand and supply and a monetary policy shock. Section 5 illustrates the results and Section 6 concludes.

2 Related Literature

In the aftermath of the crisis, heightened interest in the real effects of negative credit shocks was reflected in a vastly growing empirical literature. One strand of the literature employs survey data. In an early and seminal paper, Lown & Morgan (2006) use the U.S. Federal Reserve loan officer opinion survey and treat credit standards as an endogenous variable in a small vector autoregression (VAR). Lown & Morgan (2006) find that fluctuations in commercial credit standards are highly significant in predicting commercial bank loans, output and investment in the trade sector. Furthermore, U.S. credit standards are unaffected by an (unexpected) increase in the federal funds rate, while lending rates rise in parallel with the policy rate. More recently, Ciccarelli *et al.* (2010) use detailed answers from the U.S. and unique euro area bank lending surveys to assess the effect of a monetary policy shock on output and inflation via loan supply and demand (credit channel). They find evidence for an operative credit channel implying that an increase in the policy rate deters the availability of credit and in turn impact output and inflation. While the credit channel tends to amplify the real consequences of monetary policy shocks, Ciccarelli *et al.* (2010) found evidence that during the recent crisis, a reduction of credit supply to firms contributed to the decline in output growth. Bassett *et al.* (2014) construct a unique credit supply indicator from the U.S loan officer opinion survey, which is adjusted for macroeconomic and bank-specific factors that otherwise would affect loan demand. They find that tightening credit supply leads to a substantial decrease in output, a widening in credit spreads and an easing of monetary policy.

A second strand of the literature uses aggregated data and sign restrictions on the impulse response functions to identify loan supply shocks. Busch *et al.* (2010) focus on the recent dynamics of loans to non-financial corporations in Germany. Based on historical shock decompositions they find monetary policy was basically neutral in the period of the outbreak of the global financial crisis and its immediate aftermath. With the beginning of 2008, other non-identified shocks overcompensated the detrimental effect of a negative loan supply shock on loan dynamics. Meeks (2012) investigated credit shocks on the U.S. market for high yield corporate bonds and found that shocks to the credit spread cause immediate and prolonged contractions in output. Furthermore, shocks to the credit market had an adverse effect on output in every recession in the U.S. since 1982. Fornari & Stracca (2012) estimate a panel VAR for 21 advanced economies and assess how shocks emanating from the financial sector impact standard indicators of real activity and financial conditions. Their imposed restrictions on the impulse response functions allow them to isolate this financial shock from an aggregate demand and a monetary policy shock, but fails to attach a more structural interpretation to the financial shock itself. Their results show that financial shocks have a noticeable effect on key macro variables such as output, but that investment reacts most strongly, a fact that is well in line with Peek *et al.* (2003). Furthermore, cross-country differences seem to play a minor role only. Gambetti & Musso (2012) use a time-varying VAR framework allowing for stochastic volatility and analyze the effect of loan supply shocks on output and loan growth in three major economies, the euro area, the U.K. and the U.S.A. They find that loan supply shocks have a significant impact on economic activity, inflation and credit markets and that this effect is varying over time. Especially, during periods of economic slowdown, the contribution of the loan supply shock in explaining movements in output and credit growth is larger. Furthermore, the short-term impact of the loan supply shock on output and credit growth seems to have strengthened in the most recent past. Hristov *et al.* (2012) derive sign restrictions from DSGE models that explicitly allow for a banking sector and feature financial frictions. Based on a panel VAR they find that loan supply shocks in euro area countries are important determinants of growth in loans and real GDP, thereby corroborating the results of Gambetti & Musso (2012). In contrast to Fornari & Stracca (2012), however, the results provided in Hristov *et al.* (2012) reveal important cross-country differences within the euro area as regards the timing and the magnitude of the shocks.

While the literature reviewed above differs with respect to the identification of the loan supply shock and the data employed, it shares the focus on the effect of loan supply shocks on the *domestic* economy. There are only a few papers that bring in a *global* angle. Helbling *et al.* (2011) reveal that credit market shocks shaped the global business cycle during the latest global recession, especially if the shock emanates from the U.S.A. Eickmeier & Ng (2014) extend this further by addressing the question how shocks to credit in four major economies transmit internationally using a global macro model that links single economies by the strength of their bilateral trade and financial ties. In line with Helbling *et al.* (2011), Eickmeier & Ng (2014) find a pivotal role for the U.S.A., in shaping economic conditions in the global economy, while the effect of credit supply shocks emanating from Japan or the euro area are comparably milder. Finally, Eickmeier & Ng (2014) observe a significant flight-to-quality effect which is mirrored in an appreciation of the U.S. dollar vis-a-vis other main currencies.

3 The GVAR Model

The empirical literature on GVAR models has been largely influenced by the work of Hashem M. Pesaran and co-authors (Pesaran *et al.*, 2004; Garrat *et al.*, 2006). In a series of papers, these authors examine the effect of U.S. macroeconomic impulses on selected foreign economies employing agnostic, structural and long-run macroeconomic relations to identify the shocks. (Pesaran *et al.*, 2004; Dees *et al.*, 2007b;a). Recent papers have advanced the literature on GVAR modelling in terms of country coverage (Feldkircher, 2014), Bayesian estimation of the local models (Crespo Cuaresma *et al.*, 2014), the analysis of house price shocks (Cesa-Bianchi, 2013), credit supply shocks (Eickmeier & Ng, 2014), cost-push shocks (Galesi & M. J. Lombardi, 2013), financial stress shocks (Dovern & van Roye, 2014), monetary policy shocks (Feldkircher & Huber, 2014), liquidity shocks during the Great Recession of 2007-2009 (Chudik & Fratzscher, 2011), and for stress-testing of the financial sector (Castrén *et al.*, 2010). For an excellent survey regarding recent applications within the GVAR framework see Chudik & Pesaran (2014).

The GVAR is a compact representation of the world economy designed to model multilateral dependencies among economies across the globe. In principle, a GVAR model comprises *two layers* via which the model is able to capture cross-country spillovers. In the first layer, separate time series models – one per country – are estimated. In the second layer, the country models are stacked to yield a global model that is able to assess the spatial propagation of a shock as well as the dynamics of the associated responses.

The first layer is composed by country-specific local VAR models, enlarged by a set of weakly exogenous and global variables (VARX* model). Assuming that our global economy consists of $N+1$ countries, we estimate a VARX* of the following form for every country $i = 0, ..., N$:[1]

$$x_{it} = a_{i0} + a_{i1}t + \Phi_i x_{i,t-1} + \Lambda_{i0}x_{it}^* + \Lambda_{i1}x_{i,t-1}^* + \pi_{i0}d_t + \pi_{i1}d_{t-1} + \epsilon_{it}. \tag{3.1}$$

Here, x_{it} is a $k_i \times 1$ vector of endogenous variables in country i at time $t \in 1, ..., T$, Φ_i denotes the $k_i \times k_i$ matrix of parameters associated with the lagged endogenous variables and Λ_{ik} are the coefficient matrices of the k_i^* weakly exogenous variables, of dimension $k_i \times k_i^*$. Furthermore, $\epsilon_{it} \sim N(0, \Sigma_i)$ is the standard vector error term, d_t denotes the vector of *strictly exogenous* variables, which are linked to the vector of exogenous variables through the matrices π_{i0} and π_{i1} and t is a deterministic trend component. If $\Lambda_{i0}, \Lambda_{i1}, \pi_0$ and π_1 are composed exclusively by zero elements, the specification boils down to that of a standard VAR model (with a deterministic linear trend if $a_{i1} \neq 0$).

The weakly exogenous or *foreign* variables, x_{it}^*, are constructed as a weighted average of their cross-country counterparts,

$$x_{it}^* := \sum_{j \neq i}^{N} \omega_{ij} x_{jt}, \tag{3.2}$$

where ω_{ij} denotes the weight corresponding to the pair of country i and country j. The weights ω_{ij} reflect economic and financial ties among economies, which are usually proxied using data on bilateral trade weights.[2] The assumption that the x_{it}^* variables are weakly exogenous at the individual level reflects the belief that most countries are small relative to the world economy.

Following Pesaran *et al.* (2004), the country-specific models can be rewritten as

$$A_i z_{it} = a_{i0} + a_{i1}t + B_i z_{it-1} + \pi_{i0}d_t + \pi_{i1}d_{t-1} + \epsilon_{it}, \tag{3.3}$$

where $A_i := (I_{k_i}, \ -\Lambda_{i0})$, $B_i := (\Phi_i, \ -\Lambda_{i1})$ and $z_{it} = (x_{it}', \ x_{it}^{*\prime})'$. By defining a suitable link matrix W_i of dimension $(k_i + k_i^*) \times k$, where $k = \sum_{i=1}^{N} k_i$, we can rewrite z_{it} as $z_{it} = W_i x_t$. x_t denotes the vector that stacks all the endogenous variables of the countries in our sample. Note that this implies that the weakly exogenous variables are endogenous within the system of all equations. Substitution of (3.3) in (3.1) and stacking the different local models leads to the global equation, which is given by

$$\begin{aligned} x_t &= G^{-1}a_0 + G^{-1}a_1 t + G^{-1}Hx_{t-1} + G^{-1}\pi_0 d_t + G^{-1}\pi_1 d_{t-1} + G^{-1}\epsilon_t \\ &= b_0 + b_1 t + Fx_{t-1} + \Gamma_0 d_t + \Gamma_1 d_{t-1} + e_t, \end{aligned} \tag{3.4}$$

where $G = (A_0W_0, \cdots, A_NW_W)'$, $H = (B_0W_0, \cdots, B_NW_W)'$ and a_0, a_1, π_0 and π_1 contain the corresponding stacked vectors containing the parameter vectors of the country-specific

[1] For simplicity, we use a first-order VARX* model for the exposition. The generalization to longer lag structures is straightforward.

[2] See e.g., Eickmeier & Ng (2014), Feldkircher & Huber (2014) for an application using a broad set of different weights.

specifications. The eigenvalues of the matrix F, which is of prime interest for forecasting and impulse response analysis, have to lie within the unit circle in order to ensure stability of Equation 3.4.

3.1 Estimation & Time Series Properties

Following the bulk of the literature we estimate the single country VARX models in error correction form, which allows for cointegration relationships within and between countries. More specifically, in the empirical part we are going to estimate a VARX*(1, 1) model which is re-written in error correction form as follows:

$$\Delta x_{i,t} = c_{i,0} + \alpha_i \beta_i' \left((z_{i,t-1}, d_{t-1}) - \gamma_i(t-1)\right) + \Lambda_{i,0} \Delta x^*_{i,t} + \Delta d_t + \epsilon_{i,t}. \tag{3.5}$$

Here, α_i denotes the $k_i \times r_i$ adjustment or loading matrix, β_i the $(k_i + k_i^*) \times r_i$ matrix of coefficients attached to the long-run equilibrium and r_i the cointegration rank. In case the variables contained in z_t are cointegrating, the long-run matrix $\alpha_i \beta_i'$ will be rank deficient. We follow the convention made in the literature and assume that the foreign variables are 'long-run forcing' for endogenous variables but not vice versa. The single country VARX models are then estimated conditional on the weakly exogenous variables contained in $x^*_{i,t}$ using reduced rank regression. This provides estimates of α_i, β_i, and r_i. The remaining parameters can then be estimated by standard least squares (Eickmeier & Ng, 2014).

We have tested each variable for the presence of a unit root by means of an augmented Dickey-Fuller test. Output, price inflation and interest rates are mostly integrated of order 1, which ensures the appropriateness of the econometric framework pursued in this study. The ADF-test results for total credit, on the other hand, indicates integration of order 2. Furthermore, during the particular time period we cover in this study, there tends to be a significant change in total credit growth after 2009 and consequently the ratio of output and credit. This (crisis-induced) break in the long-term cointegration relationship renders the country models more unstable. Hence, we augment the cointegration equation by a step dummy from 2009Q1 to 2013Q4 (see Table A.2). This structural break dummy accounts for the above mentioned break in the output to credit relationship and helps to stabilize the model.[3] Cointegration rank is tested for by means of a test based on the trace statistic provided in (Smith & Galessi, 2011). The test identifies 2-3 relationships that determine the long-run behavior of the economy for most of the countries. The number of cointegration relations in the country models was further reduced by examining the country-specific persistence profiles of the long-run relationships. The final model specification is presented in Table A.1.

[3]To check the overall robustness of our results, we have also tried to exclude the structural break dummy from the country models. In general, the GVAR still satisfies the eigenvalue conditions of stability. However, impulse response functions regarding total credit where somewhat explosive.

3.2 Data and Model Specification

Our data set contains quarterly observations for 41 countries and 1 regional aggregate, the euro area (EA)[4]. Table 1 presents the country coverage of our sample, which includes emerging economies, advanced economies and the most important oil producers and consumers across the globe.

[Table 1 about here.]

We extend the data set put forward in Feldkircher (2014) with respect to time and variable coverage. Our sample features 76 quarterly observations and spans the period 1995Q1 to 2013Q4. The *domestic* variables that are used in our analysis comprise data on real activity, change in prices, the real exchange rate, and short term interest rates and government bond yields (Dees *et al.*, 2007b;a; Pesaran *et al.*, 2004; 2009; 2007). This data set is extended to feature total credit to the private sector which is based on a new data set provided by the BIS.[5] We further have adjusted for foreign exchange rate movements for countries which credit markets are characterized by large shares of foreign currency denominated credit.[6] The variables used in the model are briefly described in Table 2. Most of the data are available with wide country coverage, with the exception of government yields. Since local capital markets in emerging economies (in particular in Eastern Europe) are still developing, data on interest rates are hardly available for these countries.

[Table 2 about here.]

The euro area and U.S. country models deviate from the rest of the countries in several instances. First, in line with the literature, the oil price is determined within the U.S. country model. We distinguish big oil importer/exporter countries (US, CN, RU, BR, MX, IN, CA and NO) by inclusion of oil variable into the long-run cointegration equation of this countries. For all other countries, the oil price is taken as exogenous. Second, to identify a loan supply shock later on it is essential to include the "price" of total credit besides the aforementioned variables. Consequently we additionally include a composite lending rate in the U.S. and euro area model.

Next, we have to specify the weights that link the single country models. In the early literature on GVARs, weakly exogenous variables have been exclusively constructed based on bilateral trade flows Pesaran *et al.* (2004, 2009), Dees *et al.* (2007a). More recent contributions suggest using trade flows to calculate foreign variables related to the real side of the

[4] The country composition on which the data on the euro area is based changes with time. While historical time series are based on data of the ten original euro area countries, the most recent data are based on 17 countries. The results of our analysis remain qualitatively unchanged if we use a consistent set of 14 euro area member states throughout the sample period instead of the rolling country composition for the data on the euro area, as the relative economic size of these three countries is quite small.

[5] See `http://www.bis.org/statistics/credtopriv.htm` for more details.

[6] More specifically, these are Estonia, Latvia, Lithuania, Slovenia, Slovakia, Czech Republic, Poland, Hungary, Bulgaria, Romania, Croatia, Albania, Ukraine, Russia and Turkey.

economy (e.g., output and inflation) and financial flows for variables related to the financial side of the economy (e.g., interest rates, total credit). We follow Eickmeier & Ng (2014), Feldkircher & Huber (2014) and choose weights based on bilateral trade flows to calculate y^*, Dp^* on the one hand weights based on bilateral banking sector exposure[7] to construct i_s^*, i_l^*, tc^* on the other hand.

Last, and since our data span is rather short, untreated outliers can have a serious impact on the overall stability and the results of the model. We therefore introduce a set of dummy variables in the country-specific specifications to control for outliers. These account for the fact that some countries witnessed extraordinarily high interest rates at the beginning of the sample period (which returned steadily to 'normal' levels) and that some economies (Russia or Argentina, for instance) were exposed to one-off crisis events. We identify the largest deviations from 'normal' times per country and use interaction terms to take care of unusually large historical observations. The exact specification of the country models is provided in the Appendix Table A.2.

4 Identification of Structural Shocks in the Euro Area and the U.S.A.

The applied literature using GVAR models for counterfactual analysis relies strongly on the concept of generalized impulse response functions to trace out the dispersion of shocks to macroeconomic variables across countries. Generalized impulse response functions, however, fail to attach an economic interpretation to the origins of the shock. In this study we follow Eickmeier & Ng (2014) and go beyond the rather agnostic approach by identifying a negative loan supply shock via restrictions that are imposed on the signs of the impulse response functions directly. This identification, however, applies for the country of shock-origin only (e.g., once the euro area and once the U.S.A.).

More formally, we follow Dees *et al.* (2007b) and identify the shocks locally in the U.S. and the euro area country models. Suppose, the U.S. model is indexed by $i = 0$:

$$x_{0,t} = \psi_{01} x_{0,t-1} + \Lambda_{00} x_{0,t}^* + \Lambda_{01} x_{0,t-1}^* + \epsilon_{0,t}. \tag{4.1}$$

Without loss of generality, we omit the deterministic part of our model. The structural form of the model in Equation 4.2 is given by

$$Q_0 x_{0,t} = \tilde{\psi}_{01} x_{0,t-1} + \tilde{\Lambda}_{00} x_{0,t}^* + \tilde{\Lambda}_{01} x_{0,t-1}^* + \tilde{\epsilon}_{0,t}, \tag{4.2}$$

where $\tilde{\epsilon}_{0,t} \sim \mathcal{N}(0, I_{k_0})$ and $\tilde{\psi}_{01}, \tilde{\Lambda}_{00}$ and $\tilde{\Lambda}_{01}$ denote the structural parameters to be estimated. The relationship between the reduced form in (4.1) and the structural form in Equation 4.2 can be seen by noting that $\psi_{01} = Q_0^{-1}\tilde{\psi}_{01}, \Lambda_{00} = Q_0^{-1}\tilde{\Lambda}_{00}, \Lambda_{01} = Q_0^{-1}\tilde{\Lambda}_{01}$ and $\epsilon_{0,t} = Q_0^{-1}\tilde{\epsilon}_{0,t}$. Thus finding the structural form of the model boils down to finding Q_0.

In what follows we set $Q_0^{-1} = P_0 R_0$ where P_0 is the lower Cholesky factor of $\Sigma_{\epsilon,0}$ and R_0 being a orthonormal $k_0 \times k_0$ matrix chosen by the researcher.[8] The variance-covariance

[7] For more details on how to construct the financial weights see (Backé *et al.*, 2013).

[8] Orthonormality implies that R_0 satisfies $R_0 R_0' = I_{k_0}$.

structure of $\epsilon_{0,t}$ is given by $\Sigma_{\epsilon,0} = P_0^{-1} R_0 R_0' P_0^{-1'}$. In the present application we find R_0 by relying on sign restrictions. That is, we search for an orthonormal rotation matrices until we find a R_0 that fulfills a given set of restrictions on the impulse response functions.

This implies that, conditional on using a suitable rotation matrix R_0, we can back out the structural shocks. To obtain a candidate rotation matrix we draw R_0 using the algorithm outlined in Rubio-Ramírez *et al.* (2010). We then proceed by constructing a $k \times k$ matrix Q, where the first k_0 rows and columns correspond to Q_0.

Formally, Q looks like

$$Q = \begin{pmatrix} Q_0 & 0 & \cdots & 0 \\ 0 & I_{k_1} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & I_{k_N} \end{pmatrix}. \tag{4.3}$$

The corresponding structural form of the global model looks like:

$$QGx_t = \tilde{F} x_{t-1} + \tilde{\epsilon}_t, \tag{4.4}$$

with $\Sigma_{\tilde{\epsilon}} = G^{-1} \Sigma_\epsilon G^{-1'}$ and assuming a block diagonal structure on $\Sigma_{epsilon}$ as proposed in Eickmeier & Ng (2014). To check whether the inclusion of contemporaneous foreign variables in the model helps capture the cross-country correlation, we look at the average pairwise correlation for the first differences of variables and the residual terms of individual country models. The maximum average correlation between first differences of variables is 0.3, and the one between residuals 0.04 correspondingly, therefore the block diagonal structure of error variance-covariance matrix is permissible.

We propose the following constraints to separate loan supply disturbances from other macroeconomic shocks. These are based on modified restrictions proposed by Hristov *et al.* (2012) and Eickmeier & Ng (2014):

[Table 3 about here.]

We distinguish five different types of structural shocks affecting the euro area and the U.S.A.: (i) monetary policy shock, (ii) aggregate supply shock, (iii) aggregate demand shock, (iv) loan demand, and (v) loan supply shock. Separating these additional shocks as opposed to leave them as a residual to the analysis, should help pinning down the loan supply shock more clearly, as increasing the number of restrictions enhances identification of the shock of interest (Paustian, 2007).

Each shock is characterized by a different pattern of restrictions (signs) or non-restrictions on how the shock impacts on endogenous variables, namely output, prices, money market rate, loan rate, lending margin (i.e., spread between loan rate and money market rate), and total credit volume. These signs are established a priori on theoretical grounds, for which we refer to recent literature on structural VARs and its reference to DSGE models (Hristov *et al.*, 2012; Fratzscher *et al.*, 2009; Canova & Paustian, 2011; Gambetti & Musso, 2012; Eickmeier & Ng, 2014). These signs relate to the changes (i.e., first differences) of the variables considered in this study such that e.g., a contractionary monetary policy shock would induce a slowdown in output growth (or even a negative output growth rate) rather than necessarily a decline in output. In this sense our framework imposes rather weak restrictions and lets ample room for the data to speak. Defining these shocks, we followed the principle that they have to distinguish themselves from each other by at least one restriction in order to be mutually exclusive, which is clearly a requirement of the sign restriction approach (Fry & Pagan, 2011).

Restrictions are imposed on impact and on the first quarter, in some cases on the first quarter only. We do not rely on additional longer lag restrictions for defining shocks and discriminating between them. Any restriction on any lag for a specific type of shock would not necessarily help to sufficiently distinguish different types of shocks that have the same restriction on impact in common (Fry & Pagan, 2011). Besides, we note that on-impact responses of a further shock may follow immediately in the next period after a previous shock.

In the following, we briefly summarize the features of the different types of structural shocks, assuming an adverse, i.e., contractionary shock. The *monetary policy shock* is reflected in an increase in the money market rate, transmitted into the lending rate, albeit imperfectly, so that the lending margin decreases. In parallel, output and prices as well as the total credit volume are restricted to decline.

The *aggregate supply shock* is characterized by a decline of output (relative to a base line) and the opposite movement in prices (Hristov *et al.*, 2012). Several authors suggest that the central bank would react by hiking key nominal interest rates (Fratzscher *et al.*, 2009; Canova & Paustian, 2011; Hristov *et al.*, 2012). We refrain from doing so, taking into account varying historical experience and the leeway of central banks to react alternatively by the communication channel to keep inflation expectations firmly anchored. Correspondingly, we do not put a restriction on the loan rate or the lending margin. Concerning total credit volumes, we assume a negative response immediately following the adverse impact on output and costs (prices). This is similar to Gambetti & Musso (2012), Eickmeier & Ng (2014) and Hristov *et al.* (2012), who suggest a closely related movement of output and loans, partly incorporated as an explicit restriction.

The *aggregate demand shock* consists of a decrease in output and prices while the money market rate decreases. Concerning output, we note that we treat an adverse fiscal policy shock as type of an aggregate demand shock. We acknowledge that for a small and open economy, in which foreign demand is a particularly large component of total final demand, an asymmetric aggregate demand shock could have such a strong depreciating effect on the currency that prices may not decrease and the central bank may be reluctant to cut key policy rates, preventing money market rates from decreasing. However, we stress that our five shocks defined here relate to the euro area and the U.S.A., and not to CESEE countries directly. Concerning the loan rate, there are good reasons to argue in favor of a decrease in the loan rate, as the deterioration of investment opportunities will weaken loan demand (and issues of corporate debt securities) and policy rate reductions may be transmitted at least partly. However, we do not impose a restriction on the lending margin. We assume a negative response of loan and, hence, total credit volume, immediately following the adverse impact on output. The decrease in new lending volumes can be driven by the reluctance of banks to lend (given lower collateral value and subdued near-term growth prospects) as well as a reduced demand for credit (as a result of lower income and/or deteriorating sentiment). Hristov *et al.* (2012) and Gambetti & Musso (2012) do not differentiate aggregate demand from a loan demand shock assuming that the former comprises both effects.

However, as shown in the work based on bank-level data for Chile by Calani *et al.* (2010), insights into the behaviour of economic agents during episodes of "credit shrinkage" suggest differentiating to some extent between aggregate demand and *loan demand* development. For example, rising unemployment and expected lower income may lead to postponing consumption, housing purchases and investment, therefore reducing demand for credit later on, as captured by the above-mentioned aggregate demand shock.[9] While the decrease of loan demand is the dominant result of a weakening of aggregate demand, at least after a short delay, it may be also the initial cause of ensuing dampening of aggregate demand, in particular in response to mounting over-indebtedness and emerging difficulties of debt servicing.[10] We distinguish a loan demand shock from an aggregate demand shock by restricting the relative effect of the shocks on real output and total credit on impact. In the case of a loan demand shock, it is assumed that total credit shrinks stronger on-impact than real output, while the opposite is assumed for an aggregate demand shock. Note also that we put no direct restriction on the on-impact response of output to a loan demand shock, as we also have not directly restricted the on-impact response of total credit to an aggregate demand shock.

Finally, the adverse *loan supply shock* consists of an increase in the loan rate and a simultaneous increase in the lending margin (see Eickmeier & Ng, 2014), where we leave it unrestricted whether the money market rate increases less than the loan rate or even decreases. Correspondingly, we put no restriction on the reaction of prices. We find support for this rather cautious approach by the mixed evidence from VAR models with sign restrictions and from DSGE models with financial frictions with respect to the sign restriction on short-term interest rate and on prices (Eickmeier & Ng, 2014; Hristov *et al.*, 2012). Both output and loan and, hence, total credit volume are restricted to decrease. Moreover, we assume that output declines less than the total credit volume, at least on impact, following Eickmeier & Ng (2014).

Table 3 summarizes the sign restrictions for identifying five main types of shocks. Note that these five types of shocks conform to the principle of mutual exclusivity. However, as noted above, real world examples may feature on-impact responses of two structural shocks that follow immediately after each other. Thus, for instance, a loan demand shock in one

[9]However, aggregate demand and loan demand can also work in opposite directions. Given weak aggregate demand (outlook), the unavailability of alternative sources of funding or self-insurance against potential future lack of liquidity by agents, may lead to the expansion of demand for bank loans in the short run (Calani *et al.*, 2010). Moreover, during times of weak aggregate demand, mortgage may be viewed as safe investment, pushing-up loan demand temporarily.

[10]Vice versa, during the period of plummeted housing prices, loan demand may continue to decline, while aggregate demand already starts to grow again.

period may trigger an aggregate demand shock in the next one. Or, a loan supply shock may be followed by an aggregate supply shock.

5 Empirical Results

In this Section we summarize the results of euro area based shocks using structural impulse response functions and historical variance decompositions. To set our results into perspective, we carry out the same exercise for an adverse loan supply shock that emanates from the U.S. economy. We start with presenting impulse responses in the countries of shock origin and then proceed by summarizing the international effects of these spillovers. Structural impulse response analysis is then complemented by a historical decomposition exercise.

5.1 The Domestic Effects of Adverse Loan Supply and Aggregate Demand Shocks in the Euro Area and the U.S.A.

Structural shocks are defined according to the sign restrictions provided in Table 3. We will focus on comparing the effects of a loan supply shock with that of an aggregate demand shock as these two types of shock are generally considered to have been the most relevant ones in the run-up and the aftermath of the global financial and economic crisis 2008/2009.

Figure 1 shows the cumulated structural impulse responses of the respective domestic variables to a loan supply shock in the euro area and the U.S.A., respectively. The impulse response of output is normalised to -1% on impact to facilitate the comparison between the results. As the adverse loan supply shock hits the economy, the lending rate increases and the spread between lending and monetary policy rate widens by definition according to the sign restrictions.

[Figure 1 about here.]

The reaction of money market rates and inflation to the loan supply shock was left unrestricted (see Table 3). This explains the opposite sign in the responses of both variables between the euro area and the U.S.A., albeit only initially in the case of short-term interest rates. While inflation, short-term interest rates and lending rates adjust quickly to the new equilibrium, total credit and output contract only gradually, with the latter more prolonged in the euro area than in the U.S.A. In the long-run, the decrease in total credit is considerably larger than the decrease in output in both the euro area (by about 2.5 times) and in the U.S.A. (by about 4.5 times). This means that the loan supply shock results into deleveraging also relative to nominal GDP, i.e., a reduction of financial deepening. The persistent drop in output and total credit is in line with findings of related studies (e.g., Busch *et al.*, 2010). The relative size adjustment is also close to the results of previous studies (e.g., Eickmeier & Ng, 2014).

Figure 2 presents cumulated structural impulse responses of the respective domestic variables to an aggregate demand shock in the euro area and the U.S.A., respectively. Results are depicted in the same fashion as before, with the response of output on impact being normalised to -1%. The response on impact is restricted for all variables, except for total credit. Nevertheless, total credit decreases as well, both in the euro area and in the U.S.A., albeit to a lesser extent than output, conform to one of the identifying assumptions to distinguish aggregate demand shocks from loan supply shocks, namely the initially stronger response of output compared to total credit. Notwithstanding this restriction, the data show that cumulated decline in total credit surpasses the corresponding decline in output after 5 quarters in both the euro area and the U.S.A. This may reflect the (delayed) change in the borrowing behaviour of firms and households as a result of the aggregate demand shock. Over time, all variables respond gradually to the shock in both the euro area and the U.S.A., with the exception of inflation in the U.S.A. The U.S. inflation response is not only quicker, but also stronger in the long-run, in line with lower price stickiness in the U.S.A., compared to the euro area. Total credit shows the most pronounced reaction in both the euro area and the U.S.A. In the long-run, the decrease in total credit is larger than the decrease in output in both the euro area (by about 1.5 times) and in the U.S.A., (by about 2 times).

Comparing the responses to an aggregate demand shock with those to a loan supply shock, we see that the long-run reaction to a loan supply shock is generally larger in the euro area as well as in the U.S.A., for both total credit and output, despite the same size of on-impact output reaction of 1% according to normalization. A further salient feature of our results is that the relative size of long-run decline in total credit compared to output is considerably larger in the case of a loan supply shock than in the case of an aggregate demand shock. This implies that the deleveraging process resulting from a loan supply shock is far more pronounced than that resulting from an aggregate demand shock.

[Figure 2 about here.]

5.2 The International Effects of Adverse Loan Supply and Aggregate Demand Shocks in the Euro Area and the U.S.A.

The empirical literature has established significant spillovers that emanate from the U.S. economy to developed and emerging countries. Helbling *et al.* (2011) reveal that credit market shocks shaped the global business cycle during the latest global recession, especially if the shock emanates from the U.S.A. In line with Helbling *et al.* (2011) Eickmeier & Ng (2014) find a pivotal role for the U.S. economy in shaping global economic conditions, while the effect of credit supply shocks emanating from the euro area are comparably milder.

This Section provides a deeper analysis to the less explored topic of how euro area shocks transmit into total credit and output in the U.S.A. and other regions of the world, including in particular Central, Eastern and Southeastern Europe (CESEE). Moreover, we compare the transmission of structural euro area shocks to that of structural U.S. shocks.

Figures 3 and 4 provide a bird's eye view on the respective strength of international transmission of both loan supply shocks and aggregate demand shocks in the euro area and the U.S.A., respectively, to total credit and output in other regions. Again, the impulse response of output in the country/region of shock origin (i.e., in the euro area and the

U.S.A., respectively) is normalised to 1% on impact to facilitate the comparison between the results. Impulse responses of variables in the other regions are constructed by taking simple averages over the countries in these regions. Alternatively, impulse responses could be weighted by PPP-adjusted GDPs averaged over some period.

[Figure 3 about here.]

[Figure 4 about here.]

We would like to highlight the following salient features of our results: First, the international response of total credit is generally on a far larger scale than that of output. This is true for both types of structural shocks in the euro area and in the U.S.A., and it is similar to what we found for the domestic response in the country/region of shock origin (see subsection 5.1). This means that both types of shocks generally trigger deleveraging processes, with the deleveraging process resulting from a loan supply shock being somewhat more pronounced than that resulting from an aggregate demand shock, again roughly similar to the domestic responses (see subsection 5.1). There are some exceptions to this general finding, in particular the responses of total credit and output in the U.S.A., to a euro area loan supply shock are of the same order of magnitude; the same applies to the responses in the euro area to a U.S. aggregate demand shock.

Second, the international responses to a loan supply shock are generally considerably larger than those to an aggregate demand shock. This is true for both total credit and output in the euro area and in the U.S.A., and it is similar to what we found for the domestic response in the country/region of shock origin (see subsection 5.1).

Third, the CESEE region (including the Baltic countries) and even considerably more the CIS region are the most strongly affected regions, and their total credit and output responses are stronger than in the country/region of shock origin. This is true for both types of structural shocks in the euro area and in the U.S.A. It is interesting that the impact of euro area shocks is only moderately stronger than that of U.S. shocks. The euro area shock impact is stronger than the U.S. one in particular in the short-run. The fast transmission of euro area shocks is in line with tight trade and financial links between these regions. Possible explanations for the above average responses of CESEE and CIS regions are the fact that most CESEE economies are small and open economies and most CIS economies are strongly dependent on commodity exports. Moreover, both regions have a large dependence on foreign capital, via direct cross-border loans to the non-financial sector and via wholesale funding or intra-group parent bank funding to the banking sector. Beyond these structural features, we have to stress that ultimately our model results reflect what is in the data and during the time span under study most countries in this region exhibited the most pronounced credit-boom starting from very low levels and, thus, the strongest bust starting from excessively high boom-levels. So, in this period, the CESEE and CIS regions were not only affected by international shocks emanating from the euro area and the U.S.A., but also by cyclical imbalances for which the adjustment processes were triggered by the effect of international shocks. These adjustment processes compounded the impact of these shocks in our model.

Fourth, comparing the output response across the regions, we find that the response to a euro area structural shock is about equal in size to the domestic (i.e., own euro area) response in the aggregate of other developed countries (i.e., RoW) and larger than the domestic response only in the CESEE and CIS regions. By contrast, the response to an U.S. structural shock is larger than the domestic (i.e., own U.S.) response not only in the CESEE and CIS regions, but also in the euro area and in the aggregate of other developed countries, reflecting probably second-round effects from the decline in international activity. This is particularly so in the case of an U.S. loan supply shock.

5.3 Historical Decomposition of Total Credit and Output by Origin and Structural Interpretation of the Shock

Structural impulse response analysis from the previous Section is complemented by examining historical forecast error variance decompositions. More specifically, we assess how much the structural shocks in the country of origin can explain deviations from trend growth in output and total credit. At the same time we take a regional angle and examine how much shocks to other countries' variables can contribute in explaining historically the data.

Any stationary VAR model can be presented in the moving average (MA) form, therefore time series can be recreated from the estimated matrix of coefficients and error terms. We follow Luetkepohl (2011) in decomposing the GVAR series applying the method proposed by Burbidge & Harrison (1985).

The jth variable at time t can be presented as cumulated sum of impulse responses to K shocks at time t cumulated over time starting from point *z=1*.

$$x_{jt} = \sum_{z=1}^{\infty}(\psi_{j1,z}e_{1,t-z} + ... + \psi_{jK,z}e_{K,t-z}), \tag{5.1}$$

where $\psi_{jk,z}$ is the *(j,k)* element of the MA matrix Ψ_z obtained recursively from the estimated coefficient matrix F from Equation 3.4.

$$\Psi_z = \sum_{j=1}^{z}(\Psi_{z-j}F_j); z = 1, 2, ..., \tag{5.2}$$

where Ψ_0=I of size K.

As shown in Luetkepohl (2011), since researchers possess only limited information about the time series, one can choose any starting point $x_0 = x_{t=0}$ for the decomposition and apply the above formula to evaluate the contribution of the kth shock to the jth component of K variables over the time span z.

$$x_{jt}^{(k)} = \sum_{z=0}^{t-1}(\psi_{jk,z}e_{k,t-z} + ... + f_j^t x_0), \tag{5.3}$$

where f_j is jth row of the estimated coefficient matrix. If the process is stationary the effect of the initial level becomes negligible with time and the obtained series present historical forecast error variance decompositions.

We start investigate the historical decomposition of total credit and real output in the euro area and the U.S.A., over the period from 2003 to 2013 (the year 2000 was used as the starting point of the procedure described in the Equation 5.3). Figures 5 and 6 present deviations from trend growth of the total credit and output series (in quarter-on-quarter terms) explained by shocks. First, we present the decomposition focusing on regional aspects.[11] (see Figure 5 and Figure 6). This allows to investigate which countries' shocks contributed historically to movements in output and total credit in the euro area and the U.S.A. Then, we focus on the country model where the shock originates and assess how much each of the five structural shocks contributed historically to deviations in output and total credit growth.

[Figure 5 about here.]

[Figure 6 about here.]

Figure 5 and Figure 6 present the contribution of shocks to all the variables in the model summed per country/region to the deviations from trend growth in credit and output. In the euro area, up to 2009 negative deviations from trend growth of both credit and output are explained to a large extent by shocks to euro area variables themselves (see Figure 5). In particular the slower development of euro area output than could be predicted from the long term fundamentals constituted a negative shock. By contrast, up to end-2008 when the investment bank Lehman brothers collapsed, positive deviations stemmed to a large extent from shocks to variables of the CESEE region (including the Baltics), Russia and UK. From mid-2006 to mid-2011 (for output) and from mid-2007 to end-2013 (for credit) a large part of negative deviations was accounted for by shocks to U.S. variables. From mid-2011 onwards, shocks to euro area variables contributed increasingly to the negative deviations from trend growth in the case of both output and credit. This corresponds to the impact of the severe sovereign debt and bank crisis that affected several euro area countries at that time.

In the U.S.A., too, up to 2009 negative deviations from trend growth of both credit and output are explained to a considerable extent by shocks to euro area variables (see Figure 6). By contrast, up to end-2005, positive deviations stemmed to a large extent from shocks to U.S. variables themselves. From 2006 to mid-2011, positive deviations originated from shocks to Chinese variables, while up to mid-2011 (for output) and up to end-2013 (for credit) a large part of negative deviations was accounted for by shocks to U.S. variables. From mid-2011 onwards, shocks to U.S. variables contributed to positive deviations, while shocks to euro area and to Chinese variables contributed to negative deviations from trend.

[11] Note that by construction (see Equation 3.1) each country model includes a foreign variable block, which in generally implies a low degree of error terms/shocks correlation between countries. This renders historical decomposition analysis possible within the GVAR framework where cross-country correlation of error terms is typically non-zero.

In the second step, we perform a more structural analysis of the shocks originating in the euro area and the U.S.A., respectively, by applying the orthogonal rotation matrix R to the country specific part of the shocks (see Equation 4.4). Matrix R is country-model specific, which allows us to attach economic interpretations to the euro area shocks part that impact euro area credit and output development (as presented in Figure 5) and to the U.S. shocks part that impact U.S. credit and output (see Figure 6).

[Figure 7 about here.]

Figure 7 presents the contribution of the euro area specific structural shocks defined by the sign restrictions to that part of deviations from trend growth that stemmed from euro area shocks. Looking at the development of total credit first, all five types of structural shocks rendered major contributions to these deviations. Up to end-2006, the negative deviations were caused mainly by aggregate demand shocks and to a lesser extent by aggregate supply shocks. In the run-up to the global financial crisis in 2007 and 2008, loan supply shocks accounted for a sizeable share of the dampening of total credit growth in the euro area, being reinforced by monetary policy shocks in 2008. In 2009, loan demand shocks contributed substantially to the negative deviations from trend growth. From early 2010 to mid-2012, the (delayed) effects of both aggregate demand shocks and loan demand shocks in the euro area aggregate contributed to positive deviations from trend of total credit growth. On the other hand, since 2011, loan supply shocks and increasingly monetary policy shocks contributed to negative deviations of total credit growth from its trend. Monetary policy shocks emerged in the form of large positive error terms that had to be added to the fitted short-term interest rate (corresponding to long-term fundamentals) in order to match the actual level of short-term interest rate. Above all, this shows the effect of the lower zero bound restricting the policy interest rate and the need of further monetary easing by unconventional measures. However, these results do not tell whether this need was adequately covered, as the corresponding equation does only include the short-term interest rate as monetary policy instrument.

Next, looking at the development of output, aggregate supply shocks dominate both positive and negative deviations, followed in size by aggregate demand shocks. Loan supply shocks and monetary policy shocks played a less sizeable role in shaping the deviations of output directly, and these shocks rendered directly mostly negative deviations. Several times, loan supply shocks may have triggered ensuing aggregate supply or demand shocks, for instance in 2008 and 2011. In 2009, aggregate demand shocks led to sizeable negative deviations. Since end-2012, negative deviations dominate, stemming mainly from loan supply shocks and from monetary policy shocks – similar to what we could observe for the negative deviations of total credit growth in that period.

[Figure 8 about here.]

We provide the same analysis for the U.S. economy in Figure 8. Looking at the development of total credit first, we note that initially positive deviations stemmed from loan supply shocks (up to early 2005), followed in time by loan demand shocks (up to end-2007). Cheap mortgage loans, systematic misvaluation of assets, and soaring household leverage put the American banking sector under severe stress. However, already from mid-2006 loan supply shocks rendered sizeable negative deviations, followed from end-2006 by aggregate demand shocks and from early 2008 by loan demand shocks. While loan supply shocks and loan demand shocks continued to cause considerable contributions to negative deviations from trend until the end of our sample period, aggregate demand shocks played a vital role in supporting total credit growth by rendering positive deviations from trend from mid-2011 onwards.

Next, looking at the development of output, the pattern of structural shocks contributing to positive and negative shocks is roughly similar, albeit with a less sizeable direct role for the loan supply and demand shock and a more sizeable role for monetary policy shocks. The latter rendered sizeable negative deviations from trend from mid-2011 onwards, largely off-setting positive impact of aggregate demand shocks.

Summarising, in the euro area as well as in the U.S.A., both domestic and foreign shocks account for sizeable shares in explaining deviations from trend growth of total credit and output. For the euro area developments, foreign shocks originating in the U.S.A., the UK and the CESEE and CIS regions feature most prominently, while for the U.S. developments, foreign shocks emanating from the euro area and China play a considerable role.[12] In both the euro area and the U.S.A., we can give an economic interpretation to their respective domestic shocks. All types of structural shocks defined via sign restrictions, and in particular also loan supply shocks and loan demand shocks, are to a considerable extent directly responsible for deviations from trend growth of total credit. By contrast, in the case of output, aggregate supply and demand shocks are directly more relevant than loan supply and loan demand shocks for explaining deviations from trend growth, in particular in the euro area. While loan supply and loan demand shocks had a limited direct impact on output, they emerged quite frequent and several times have probably had an indirect effect by triggering ensuing aggregate supply or demand shocks, for instance in the euro area in 2008 and 2011. Moreover, in 2012-2013, loan supply shocks, loan demand shocks and monetary policy shocks have had not only a direct negative impact on total credit, but also to a lesser, yet indeed considerable extent on output in both the euro area and the U.S.A.

6 Conclusions

In this paper, we use a global VAR model to analyse the domestic effects and the international spillovers of an adverse euro area loan supply shock. To put our results into perspective and against the backdrop of recent historical experiences during the period of the global financial crisis, we furthermore analyse the consequences of a negative aggregate demand shock in more detail. On top of that, the domestic and international effects of both types of shock are examined when the country of origin is not the euro area but the U.S.A.

[12]See Feldkircher & Korhonen (2014) for an in-depth study on China and its economic linkages within the world economy.

Our *general* results are as follows: The following four findings hold true for both the domestic response in the country of shock origin and the spillovers generated from the shock: First and foremost, we find strong effects of loan supply shocks on output and total credit. Regarding the domestic response our results are thus in line with findings of Meeks (2012), Bassett *et al.* (2014) for the U.S.A. and Gambetti & Musso (2012), Hristov *et al.* (2012) for the euro area. Second, comparing loan supply and aggregate demand shocks (in the euro area as well as in the U.S.A.) reveals that long-run responses to loan supply shocks are more pronounced. This is true despite the same size of on-impact output reaction of 1% according to normalization. Third, looking at the response of output and credit separately, we find that for both normalized loan supply shocks and aggregate demand shocks (in the euro area as well as in the U.S.A.), the decrease in total credit is considerably larger than the decrease in output in the long run. This implies that under both types of structural shocks a deleveraging process takes place also relative to nominal GDP, implying a reduction of financial deepening. Fourth, the relative size of long-run decline in total credit compared to output is considerably larger in the case of normalized loan supply shocks than in the case of normalized aggregate demand shocks. This implies that the deleveraging process resulting from a loan supply shock is far more pronounced than that resulting from an aggregate demand shock. Moreover, in both the euro area and the U.S.A., we can give an economic interpretation to their respective domestic shocks according to a historical decomposition. All types of structural shocks defined via sign restrictions, and in particular also loan supply shocks and loan demand shocks, are to a considerable extent directly responsible for deviations from trend growth of total credit. By contrast, in the case of output, aggregate supply and demand shocks are directly more relevant than loan supply and loan demand shocks for explaining deviations from trend growth, in particular in the euro area. While loan supply and loan demand shocks had a limited direct impact on output, they emerged quite frequent and several times have probably had an indirect effect by triggering ensuing aggregate supply or demand shocks, for instance in the euro area in 2008 and 2011. Moreover, in 2012-2013, loan supply shocks, loan demand shocks and monetary policy shocks have had a direct negative impact not only on total credit, but also to a lesser, yet indeed considerable extent on output in both the euro area and the U.S.A., signaling a challenge for monetary policy as well as macro-prudential and supervisory policies.

Taking a *regional angle*, the CESEE region (including the Baltic countries) and mostly even considerably more the CIS region are the most affected regions, and their total credit and output responses are stronger than in the country/region of shock origin. This is true for both types of structural shocks in the euro area and in the U.S.A. It is interesting that the impact of euro area shocks is only moderately stronger than that of U.S. shocks. The euro area shock impact is stronger than the U.S. one only in the short-run. The fast transmission of euro area shocks is in line with tight trade and financial links between these regions. The above average responses of CESEE and CIS regions may be explained partly by structural features, but also by the particularly pronounced boom-bust-cycle during large part of the period here under study. The inter-linkages between the euro area and the CESEE and CIS region has been also evidenced by historical decompositions of deviations from trend growth in output and total credit. For the euro area developments, foreign shocks originating in the U.S.A., the UK and the CESEE and CIS regions feature most prominently, while for U.S. developments, foreign shocks emanating from the euro area and China play a considerable role. Last, comparing the output response across the regions, we find that the responses to euro area loan supply and aggregate demand shocks are about equal in size to the domestic (i.e., own euro area) response in the aggregate of other developed countries and larger than the domestic response only in the CESEE and CIS regions. By contrast, the responses to U.S. loan supply and aggregate demand shocks are larger than the domestic (i.e., own U.S.) response not only in the CESEE and CIS regions, but also in the euro area and in the aggregate of other developed countries, reflecting probably second-round effects from the decline in international activity. This is particularly so in the case of an U.S. loan supply shock.

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Table 1: Country coverage

Emerging Asia (9):	CN, KR, PH, SG, TH, ID, IN, MY, TR
CESEE and Baltics (12):	CZ, HU, PL, SK, SI, BG, RO, HR, AL, LT, LV, EE
CIS (4):	RU, UA, BY, GE
Emerging Latin America (5):	AR, BR, CL, MX, PE
Rest of the World (12):	US, EA, UK, CA, AU, JP, NZ, CH, NO, SE, DK, IS

Abbreviations refer to the two-digit ISO country code.

Table 2: Data description

Variable	Description	Min.	Mean	Max.	Coverage
y	Real GDP, average of 2005=100. Seasonally adjusted, in logarithms.	3.675	4.545	5.400	100%
Δp	Consumer price inflation. CPI seasonally adjusted, in logarithms.	-0.213	0.018	1.215	100%
e	Nominal exchange rate vis-à-vis the U.S. dollar, deflated by national price levels (CPI).	-5.699	-2.404	5.459	100%
i_S	Typically 3-months-market rates, rates per annum.	-0.001	0.092	4.331	97.6%
i_L	Typically government bond yields, rates per annum.	0.006	0.054	0.638	40.5%
tc	Total credit (domestic and cross-border), seasonally adjusted and in logarithms.	-2.575	4.495	7.786	97.6%
EA_{lr}	Composite lending rate for the Euro area, weights based on volumes of credit outstanding.	0.028	0.053	0.098	-
US_{lr}	Composite lending rate for the U.S.A., weights based on volumes of credit outstanding.	0.032	0.060	0.095	-
$poil$	Price of oil, seasonally adjusted, in logarithms.	2.395	3.710	4.753	-
Trade flows	Bilateral data on exports and imports of goods and services, annual data.	-	-	-	-
Banking exposure	Bilateral outstanding assets and liabilities of banking offices located in BIS reporting countries and Russia. Annual data.	-	-	-	-

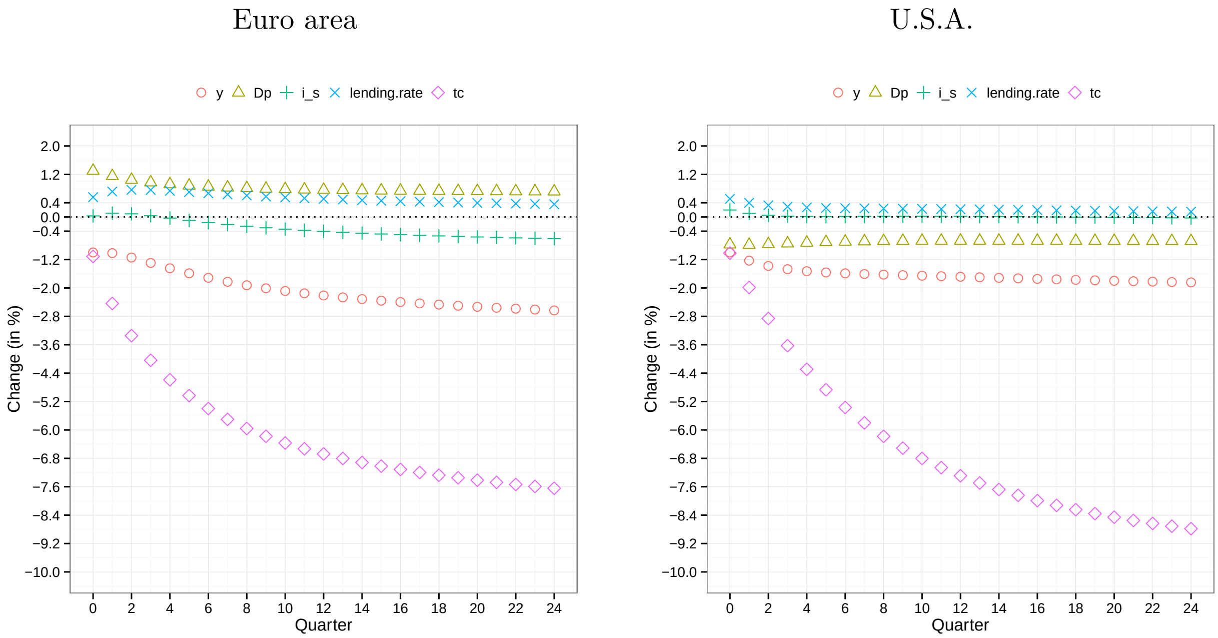
Notes: Summary statistics pooled over countries and time. The coverage refers to the cross-country availability per country, in %. The share of foreign currency denominated loans in total loans for CZ, HU, PL, SI, SK, BG, RO, EE, LT, LV, HR, AL , RU, UA and TR is calculated at constant exchange rates as of end June 2013.

Table 3: Sign restrictions.

Shock	y	Δp	i_s	lending rate	tc	lending rate - i_s
Monetary Policy	$\downarrow$	$\downarrow$	$\uparrow$	-	$\downarrow$	$\downarrow$
Aggregate Supply	$\downarrow$, $y > tc$	$\uparrow$	-	-	$\underline{\downarrow}$	-
Aggregate Demand	$\downarrow$, $y > tc$	$\downarrow$	$\downarrow$	$\downarrow$	$\underline{\downarrow}$	-
Loan Demand	$\underline{\downarrow}$	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$, $tc > y$	-
Loan Supply	$\underline{\downarrow}$	-	-	$\uparrow$	$\downarrow$, $tc > y$	$\uparrow$

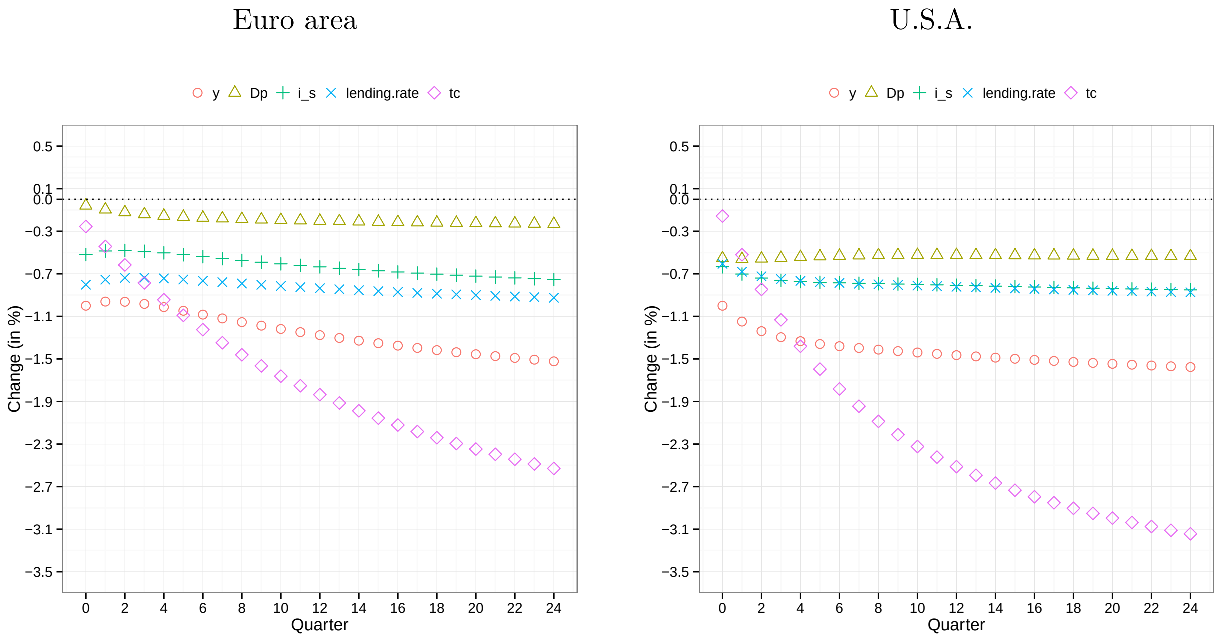
Notes: The restrictions are imposed as $\geq$ / $\leq$ and on the growth rates of the variables in the table. In general, restrictions are imposed on impact and on the first quarter. Underlined arrows reflect an exception to this in the sense that the restriction is imposed on the first quarter only.

Figure 1: Euro Area and U.S. Domestic Responses to Adverse Loan Supply Shocks in the euro area and the U.S.A., respectively.



Notes: The shocks are normalized such that on impact real output falls by 1%. In cumulated percentage changes.

Figure 2: Euro Area and U.S. Domestic Responses to Adverse Aggregate Demand Shocks in the euro area and the U.S.A., respectively.

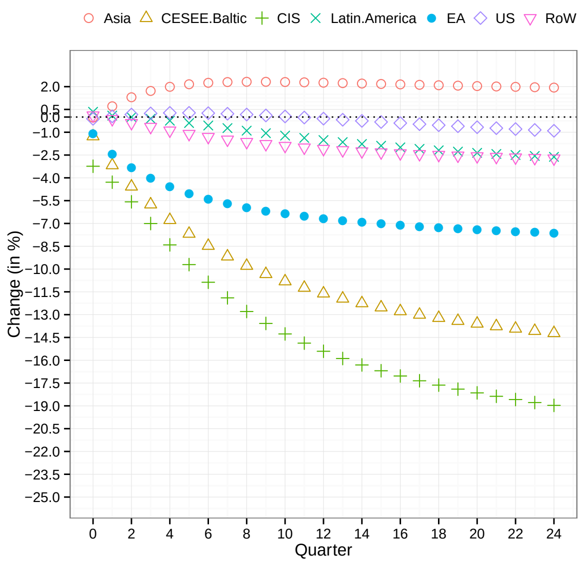


Notes: The shocks are normalized such that on impact real output falls by 1%. In cumulated percentage changes.

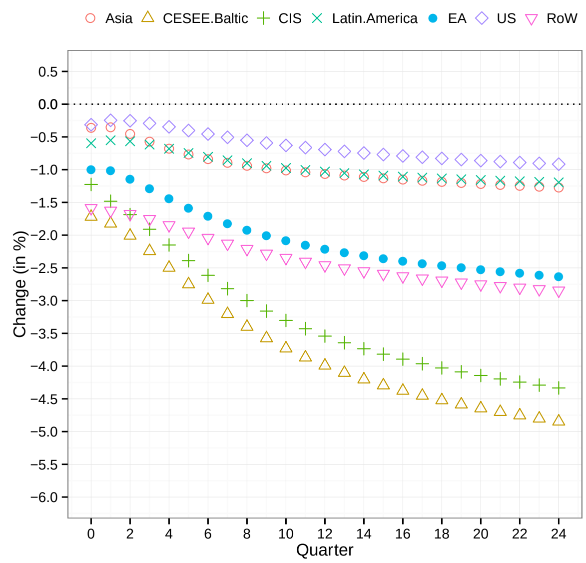
Figure 3: Response of Total Credit and Output to an Adverse Loan Supply Shock in the euro area and in the U.S.A.

(a) Euro area

Total Credit

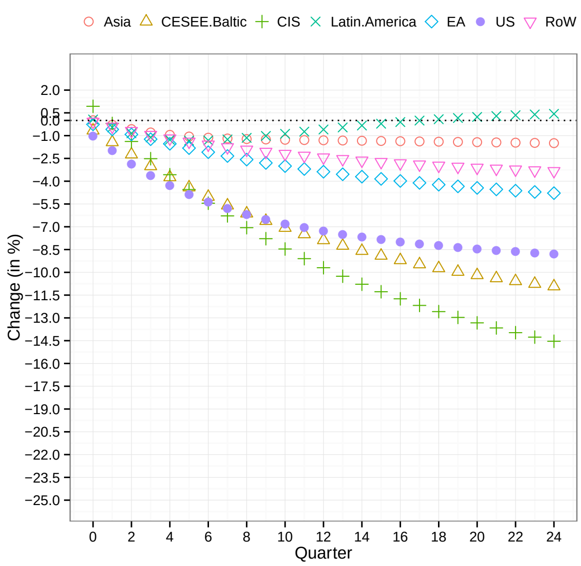


Output

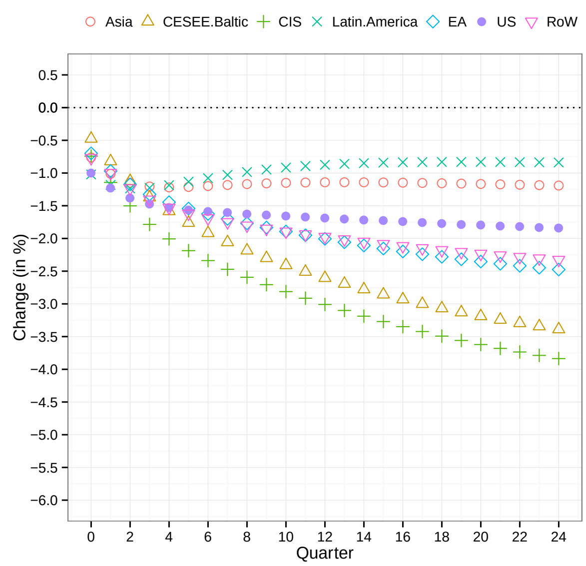


(b) U.S.A.

Total Credit



Output

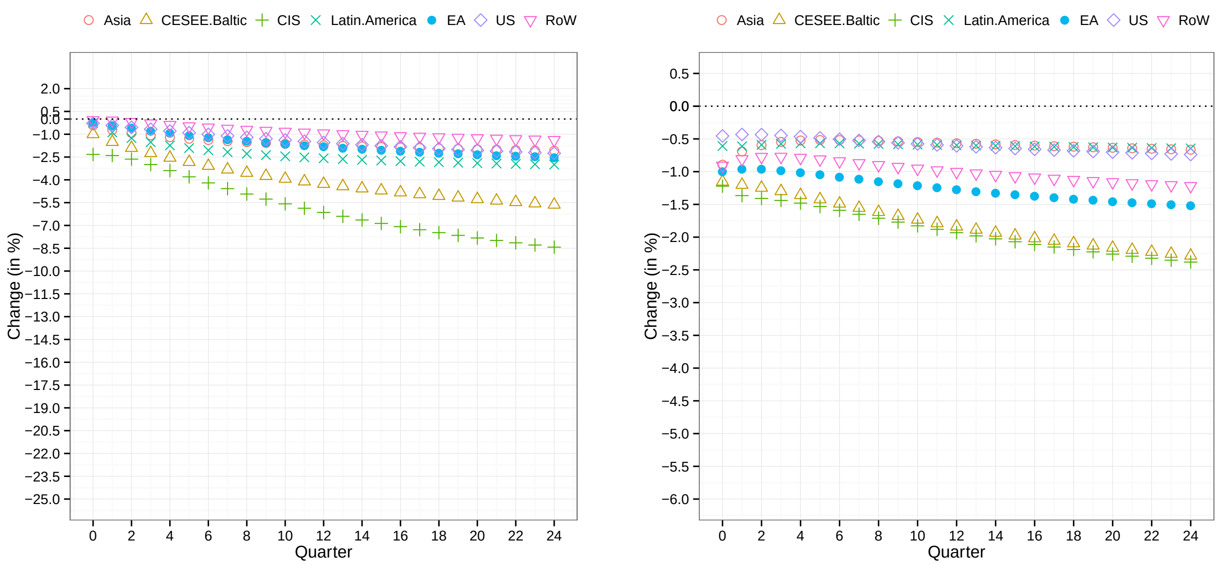


(c) *Notes: Country aggregates are defined as in Table 1 except the rest of the world group (RoW). Here Iceland is excluded since otherwise only developed countries feature in the group. Domestic responses of the euro area and the U.S.A., in bold.*

Figure 4: Response of Total Credit and Output to an Adverse Aggregate Demand Shock in the euro area and in the U.S.A.

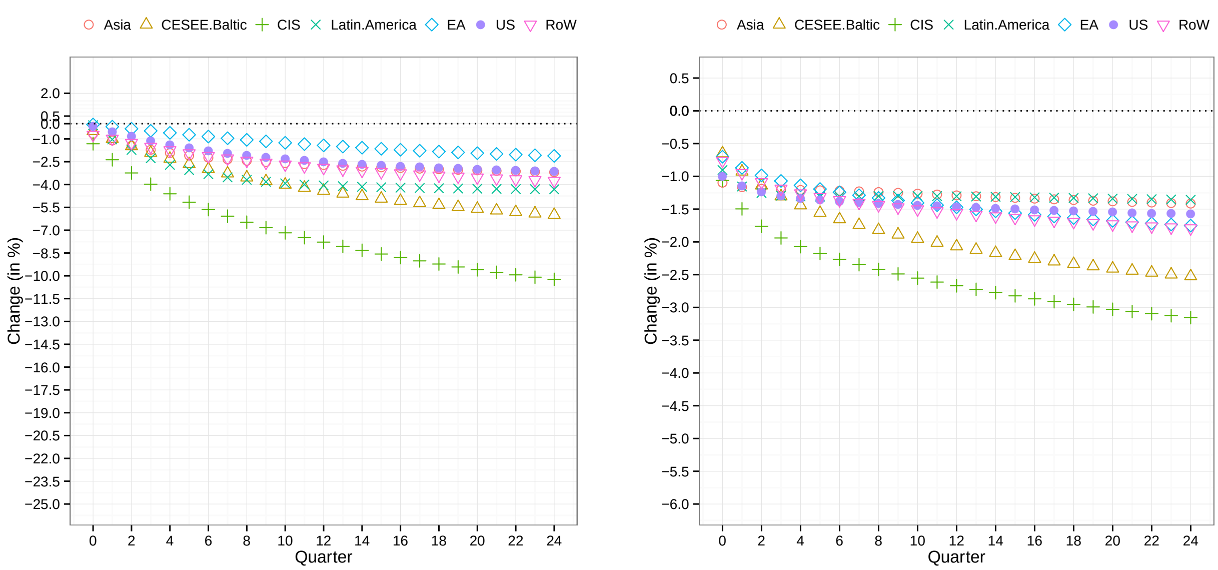
(a) Euro area

Total Credit | Output



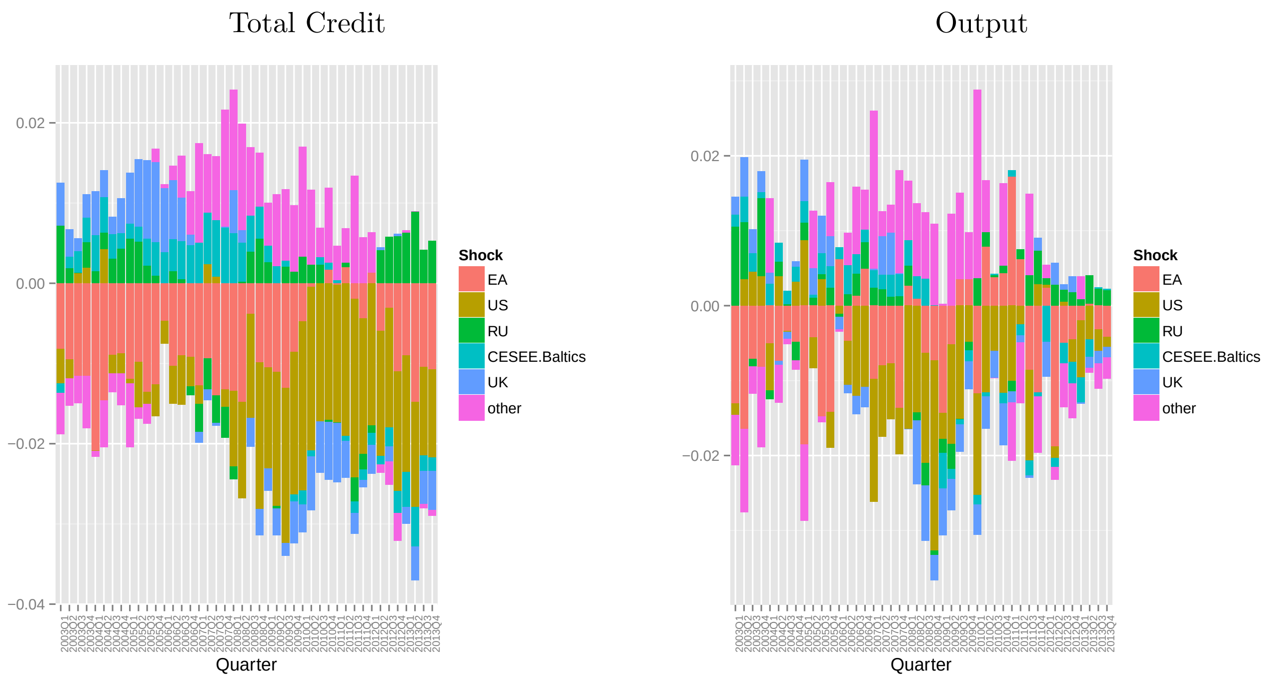
(b) U.S.A.

Total Credit | Output



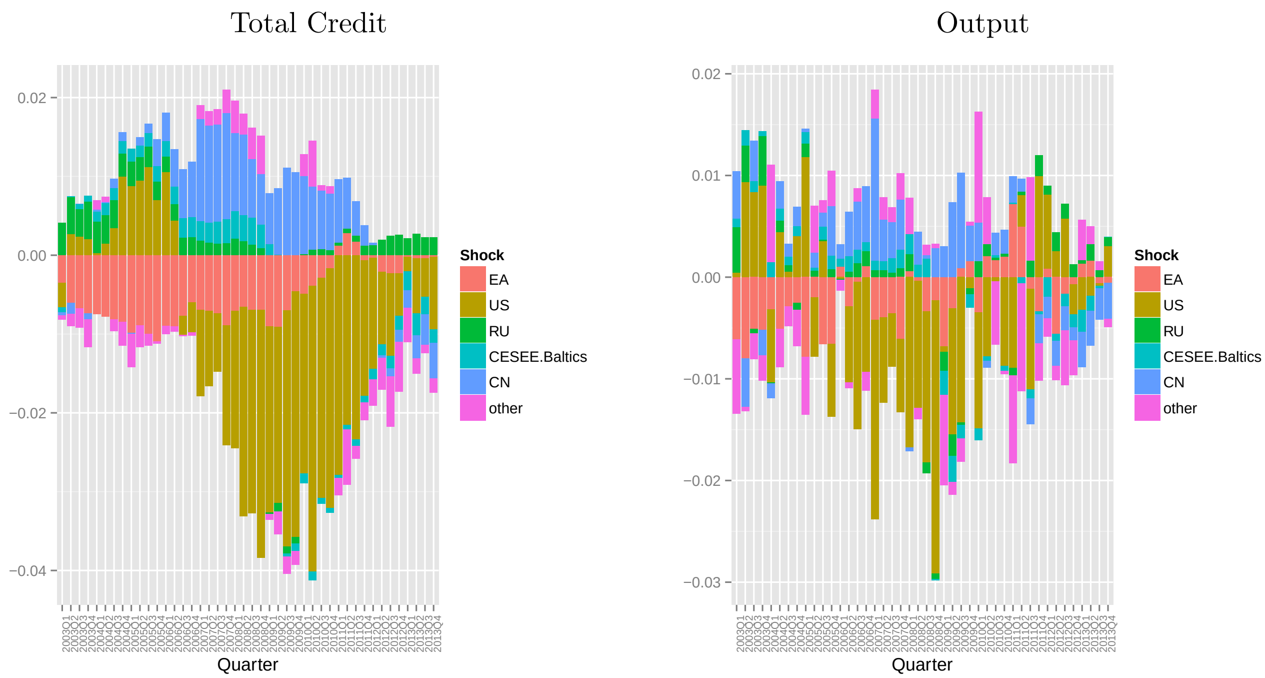
(c) *Notes: Country aggregates are defined as in Table 1 except the rest of the world group (RoW). Here Iceland is excluded since otherwise only developed countries feature in the group. Domestic responses of the euro area and the U.S.A., in bold.*

Figure 5: Historical decomposition of total Credit and output in the euro area by country of shock origin



Notes: The left-hand (right-hand) side panel of the graph shows the contribution of shocks per region explaining deviations from trend growth in total credit (output).

Figure 6: Historical decomposition of total Credit and output in the U.S.A. by country of shocks origin

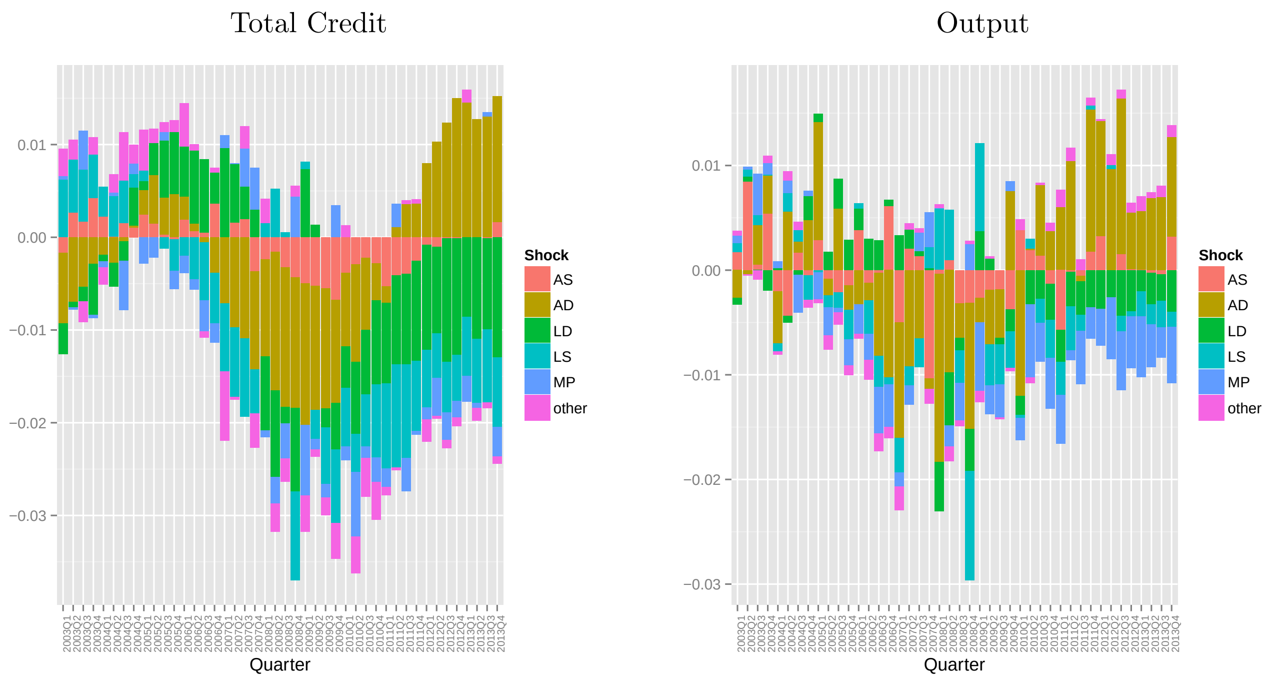


Notes: The left-hand (right-hand) side panel of the graph shows the contribution of shocks per region explaining deviations from trend growth in total credit (output).

Figure 7: Structural interpretation to EA shock part in historical decomposition of EA total credit and output

Notes: The left-hand (right-hand) side panel of the graph shows the contribution of structural shocks in the euro area explaining deviations from trend growth in euro area total credit (output).

Figure 8: Economic interpretation to U.S. shock part in historical decomposition of U.S. total credit and output



Notes: The left-hand (right-hand) side panel of the graph shows the contribution of structural shocks in the U.S.A., explaining deviations from trend growth in U.S. total credit (output).

Appendix A Appendix

Table A.1: Specification of the country models- Domestic and Foreign Variables

Countries	Domestic Variables	Foreign Variables	Deterministic component	Cointegration rank
EA	y, Δp, e, tc, i_s, lr/i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
US	y, Δp, tc, i_s, lr/i_l, $poil$	y^*, Δp^*, e^*	5*	1
UK	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
JP	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
CN	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{***}$	3	1
CZ	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
HU	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
PL	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
SI	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
SK	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
BG	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
RO	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
EE	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
LT	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
LV	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
HR	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
AL	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
RU	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{***}$	5*	1
UA	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
BY	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
GE	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
AR	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
BR	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{***}$	3	2
CL	y, Δp, e	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
MX	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{***}$	3	1
PE	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
KR	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*	3	2
PH	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
SG	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
TH	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
IN	y, Δp, e, tc	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{***}$	3	1
ID	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
MY	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	4	1
AU	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	5*	1
NZ	y, Δp, e, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
TR	y, Δp, e, tc, i_s	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
CA	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{***}$	5*	2
CH	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
NO	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{***}$	3	1
SE	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
DK	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1
IS	y, Δp, e, tc, i_s, i_l	y^*, Δp^*, $tc*$, i_s^*, i_l^*, $poil^{**}$	3	1

Notes: The table represents the general specification and variable cross-country variable coverage of our GVAR model. Throughout the paper we have used 1 lag for endogenous, weakly exogenous and strictly exogenous variables only. Deterministic components: 3 - intercept, 4 - intercept and trend 5* - intercept and structural break dummy for the period 2009Q1-2013Q4. Poil*** - indicates that oil was included into the long-run cointegration equation of the country model.

Table A.2: Specification of the country models- Dummy Variables

Countries	Dummy Variables
EA	-
US	$tc \times \mathrm{usD}_{(99Q4,12Q4)}$, $\mathrm{usD}_{(99Q4,12Q4)}$
UK	-
JP	$e \times \mathrm{jpD}_{(98Q4)}$, $\mathrm{jpD}_{(98Q4)}$
CN	$tc \times \mathrm{cnD}_{(01Q1)}$, $\mathrm{cnD}_{(01Q1)}$, $i_s \times \mathrm{cnD}_{(96Q1-Q2,08Q4)}$, $\mathrm{cnD}_{(96Q1-Q2,08Q4)}$
CZ	$i_s \times \mathrm{czD}_{(97Q2)}$, $\mathrm{czD}_{(97Q2)}$, $tc \times \mathrm{czD}_{(01Q3)}$, $\mathrm{czD}_{(01Q3)}$
HU	-
PL	$i_s \times \mathrm{plD}_{(96Q4-97Q1,98Q2-Q3)}$, $\mathrm{plD}_{(96Q4-97Q1,98Q2-Q3)}$
	$y \times \mathrm{plD}_{(95Q3,97Q4,96Q4-97Q1)}$,$\mathrm{plD}_{(96Q4-97Q1,98Q2-98Q3)}$
	$y \times \mathrm{plD}_{(95Q3,97Q4,96Q4-97Q1)}$,$\mathrm{plD}_{(95Q3,97Q4,96Q4-97Q1)}$
	$e \times \mathrm{plD}_{(08Q4)}$, $\mathrm{plD}_{(08Q4)}$
SI	$i_s \times \mathrm{siD}_{(96Q2-Q3)}$,$\mathrm{siD}_{(96Q2-Q3)}$, $cd \times \mathrm{siD}_{(00Q1,01Q1-Q3)}$,$\mathrm{siD}_{(00Q1,01Q1-Q3)}$
SK	$Dp \times$ 99Q3, skD_{99Q3}, $tc \times$ 97Q1,skD_{97Q1}, $i_s \times \mathrm{skD}_{(95Q3,98Q1-Q2,98Q4,09Q1)}$, $\mathrm{skD}_{95Q3,98Q1-Q2,98Q4,00Q1}$
	$y \times \mathrm{skD}_{(98Q4,07Q4-08Q1,09Q1)}$, $\mathrm{skD}_{98Q4,07Q4-08Q1,09Q1}$
BG	$i_s \times \mathrm{bgD}_{(95Q4-97Q3)}$, $\mathrm{bgD}_{(95Q4-97Q3)}$, $Dp \times \mathrm{bgD}_{(95Q4-97Q3,98Q1-Q2)}$, $\mathrm{bgD}_{(95Q4-97Q3,98Q1-Q2)}$
	$tc \times \mathrm{bgD}_{(95Q4,96Q2-Q3,97Q1,97Q4-98Q1)}$, $\mathrm{bgD}_{(95Q4,96Q2-Q3,97Q1,97Q4-98Q1)}$, $e \times \mathrm{bgD}_{(96Q1,96Q4)}$,$\mathrm{bgD}_{(96Q1,96Q4)}$
RO	$i_s \times \mathrm{roD}_{(97Q1-Q3)}$, $e \times \mathrm{roD}_{(97Q1-Q3)}$,$\mathrm{roD}_{(97Q1-Q3)}$, $Dp \times \mathrm{roD}_{(96Q1,97Q1-97Q3)}$
	$\mathrm{roD}_{(96Q4-97Q3,98Q1,98Q4-99Q2)}$
EE	$i_s \times \mathrm{eeD}_{(97Q4,98Q4-99Q1)}$, $\mathrm{eeD}_{(97Q4,98Q4-99Q1)}$, $y \times \mathrm{eeD}_{(08Q4)}$, $\mathrm{eeD}_{(08Q4)}$
	$Dp \times \mathrm{eeD}_{(95Q4,96Q2-Q3,97Q2)}$, $\mathrm{eeD}_{(95Q4,96Q2-Q3,97Q2)}$, $tc \times \mathrm{eeD}_{(95Q4,96Q4)}$, $\mathrm{eeD}_{(95Q4,96Q4)}$
LT	$i_s \times \mathrm{ltD}_{(96Q3-97Q1,00Q1)}$,$\mathrm{ltD}_{(96Q3-97Q1,00Q1)}$
	$Dp \times \mathrm{ltD}_{(95Q4-96Q1,96Q3)}$,$\mathrm{ltD}_{(95Q4-96Q1,96Q3)}$, $y \times \mathrm{ltD}_{(09Q1)}$,$\mathrm{ltD}_{(09Q1)}$
LV	$i_s \times \mathrm{lvD}_{(98Q4,09Q1-Q2)}$, $\mathrm{lvD}_{(98Q4,09Q1-Q2)}$, $Dp \times \mathrm{lvD}_{(95Q4)}$, $\mathrm{lvD}_{(95Q4)}$
	$tc \times \mathrm{lvD}_{(95Q4,96Q4)}$, $\mathrm{lvD}_{(95Q4,96Q4)}$, $y \times \mathrm{lvD}_{(08Q3,09Q1-Q2)}$, $\mathrm{lvD}_{(08Q3,09Q1-Q2)}$
HR	$i_s \times \mathrm{hrD}_{(95Q4-96Q3)}$, $\mathrm{hrD}_{(95Q4-96Q3)}$, $tc \times \mathrm{hrD}_{(96Q4-97Q1,97Q4,99Q2)}$, $\mathrm{hrD}_{(96Q4-97Q1,97Q4,99Q2)}$
	$y \times \mathrm{hrD}_{(97Q1,98Q1,98Q4)}$, $\mathrm{hrD}_{(97Q1,98Q1,98Q4)}$
AL	$i_s \times \mathrm{alD}_{(96Q2,97Q1-Q2,98Q3)}$, $\mathrm{alD}_{(96Q2,97Q1-Q2,98Q3)}$, $y \times \mathrm{alD}_{(97Q1,98Q1)}$, $\mathrm{alD}_{(97Q1,98Q1)}$
	$tc \times \mathrm{alD}_{(97Q1,00Q3-Q4,01Q3-Q4)}$, $\mathrm{alD}_{(97Q1,00Q3-Q4,01Q3-Q4)}$, $Dp \times \mathrm{alD}_{(96Q3,97Q2-Q3)}$, $\mathrm{alD}_{(96Q3,97Q2-Q3)}$
RU	$i_s \times \mathrm{ruD}_{(98Q3)}$, $tc \times \mathrm{ruD}_{(98Q3)}$, $\mathrm{ruD}_{(98Q3)}$, $Dp \times \mathrm{ruD}_{(96Q1,98Q3-99Q1)}$, $\mathrm{ruD}_{(96Q1,98Q3-99Q1)}$
UA	$i_s \times \mathrm{uaD}_{(98Q3,99Q3-00Q1)}$, $\mathrm{uaD}_{(98Q3,99Q3-00Q1)}$, $Dp \times \mathrm{uaD}_{(96Q1)}$, $\mathrm{uaD}_{(96Q1)}$, $tc \times \mathrm{uaD}_{(98Q3)}$
BY	$i_s \times \mathrm{byD}_{(96Q1)}$, $\mathrm{byD}_{(96Q1,97Q1)}$, $Dp \times \mathrm{byD}_{(96Q1,97Q1)}$, $tc \times \mathrm{byD}_{(97Q1,98Q4,00Q1)}$, $\mathrm{byD}_{(97Q1,98Q4,00Q1)}$
	$e \times \mathrm{byD}_{(98Q1,99Q4-00Q1)}$, $\mathrm{byD}_{(98Q1,99Q4-00Q1)}$
GE	$i_s \times \mathrm{geD}_{(98Q4-99Q1)}$, $\mathrm{geD}_{(98Q4-99Q1)}$, $Dp \times \mathrm{geD}_{(95Q4)}$, $\mathrm{geD}_{(95Q4)}$, $tc \times \mathrm{geD}_{(96Q2)}$, $\mathrm{geD}_{(96Q2)}$
AR	$i_s \times \mathrm{arD}_{(01Q4-02Q1,02Q4)}$, $\mathrm{arD}_{(01Q4-02Q1,02Q4)}$, $Dp \times \mathrm{arD}_{(02Q1)}$,$\mathrm{arD}_{(02Q1)}$, $tc \times \mathrm{arD}_{(01Q1,02Q1)}$,$\mathrm{arD}_{(01Q1,02Q1)}$
	$e \times \mathrm{arD}_{(02Q1-Q2)}$, $\mathrm{arD}_{(02Q1-Q2)}$
BR	$i_s \times \mathrm{brD}_{(97Q4-98Q2,98Q4,99Q2)}$, $\mathrm{brD}_{(97Q4-98Q2,98Q4,99Q2)}$, $Dp \times \mathrm{brD}_{(96Q1,03Q2)}$, $\mathrm{brD}_{(96Q1,03Q2)}$
	$tc \times \mathrm{brD}_{(00Q1)}$, $\mathrm{brD}_{(00Q1)}$
CL	-
MX	$Dp \times \mathrm{mxD}_{(96Q1-96Q2)}$, $\mathrm{mxD}_{(96Q1-96Q2)}$, $i_s \times \mathrm{mxD}_{(95Q4-96Q1,98Q3,99Q2)}$, $\mathrm{mxD}_{(95Q4-96Q1,98Q3,99Q2)}$
PE	$i_s \times \mathrm{peD}_{(98Q3-Q4)}$, $\mathrm{peD}_{(98Q3-Q4)}$
KR	$tc \times \mathrm{krD}_{(97Q1,97Q4,98Q4,99Q1-Q2)}$, $\mathrm{krD}_{(97Q1,97Q4,98Q4,99Q1-Q2)}$, $e \times \mathrm{krD}_{(97Q4-98Q1)}$, $\mathrm{krD}_{(97Q4-98Q1)}$
	$i_s \times \mathrm{krD}_{(97Q4-98Q1)}$
PH	$Dp \times \mathrm{phD}_{(99Q2,00Q1-Q2)}$, $\mathrm{phD}_{(99Q2,00Q1-Q2)}$, $tc \times \mathrm{phD}_{(96Q4-97Q3,01Q4)}$, $\mathrm{phD}_{(96Q4-97Q3,01Q4)}$
	$i_s \times \mathrm{phD}_{(95Q4,97Q3,98Q1)}$, $\mathrm{phD}_{(95Q4,97Q3,98Q1)}$
SG	-
TH	$i_s \times \mathrm{thD}_{(96Q3,97Q3,98Q3)}$, $\mathrm{thD}_{(96Q3,97Q3,98Q3)}$, $e \times \mathrm{thD}_{(97Q3,98Q2)}$, $y \times \mathrm{thD}_{(11Q4-12Q1,12Q4)}$, $\mathrm{thD}_{(11Q4-12Q1,12Q4)}$
IN	$Dp \times \mathrm{inD}_{(98Q1,99Q1)}$, $\mathrm{inD}_{(98Q1,99Q1)}$
ID	$i_s \times \mathrm{idD}_{(97Q3)}$, $e \times \mathrm{idD}_{(97Q3)}$,$Dp \times \mathrm{idD}_{(97Q4-98Q1)}$ $\mathrm{idD}_{(97Q4-98Q1)}$,$e \times \mathrm{idD}_{(98Q1,98Q4)}$, $e \times \mathrm{idD}_{(98Q1,98Q4)}$
MY	$tc \times \mathrm{myD}_{(95Q2-97Q4)}$, $\mathrm{eD}_{(95Q2-97Q4)}$, $Dp \times \mathrm{myD}_{(08Q4)}$, $\mathrm{eD}_{(08Q4)}$
AU	$Dp \times \mathrm{auD}_{(00Q3-Q4)}$, $\mathrm{auD}_{(00Q3-Q4)}$, $i_s \times \mathrm{auD}_{(08Q4)}$, $\mathrm{auD}_{(08Q4)}$, $tc \times \mathrm{auD}_{(01Q2)}$, $\mathrm{auD}_{(01Q2)}$
NZ	$i_s \times \mathrm{nzD}_{(98Q1,98Q3)}$, $\mathrm{nzD}_{(98Q1,98Q3)}$, $y \times \mathrm{nzD}_{(96Q1-Q3)}$, $\mathrm{nzD}_{(96Q1-Q3)}$, $Dp \times \mathrm{nzD}_{(10Q4,11Q4)}$, $\mathrm{nzD}_{(10Q4,11Q4)}$
TR	$i_s \times \mathrm{trD}_{(00Q1,00Q4)}$, $\mathrm{trD}_{(00Q1,00Q4)}$, $Dp \times \mathrm{trD}_{(01Q2,02Q3)}$, $\mathrm{trD}_{(01Q2,02Q3)}$, $tc \times \mathrm{trD}_{(08Q4)}$, $\mathrm{trD}_{(08Q4)}$
CA	-
CH	-
NO	$i_s \times \mathrm{noD}_{(98Q3)}$, $\mathrm{noD}_{(98Q3)}$, $Dp \times \mathrm{noD}_{(03Q2)}$, $\mathrm{noD}_{(03Q2)}$
SE	-
DK	$Dp \times \mathrm{dkD}_{(07Q4)}$, $\mathrm{dkD}_{(07Q4)}$, $tc \times \mathrm{dkD}_{(01Q4-02Q1)}$, $\mathrm{dkD}_{(01Q4-02Q1)}$
IS	$i_s \times \mathrm{isD}_{(01Q4,02Q1-Q2)}$, $\mathrm{isD}_{(01Q4,02Q1-Q2)}$, $tc \times \mathrm{isD}_{(08Q4)}$, $\mathrm{isD}_{(08Q4)}$

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Call for Applications: Visiting Research Program

The Oesterreichische Nationalbank (OeNB) invites applications from external researchers for participation in a Visiting Research Program established by the OeNB's Economic Analysis and Research Department. The purpose of this program is to enhance cooperation with members of academic and research institutions (preferably post-doc) who work in the fields of macroeconomics, international economics or financial economics and/or with a regional focus on Central, Eastern and Southeastern Europe.

The OeNB offers a stimulating and professional research environment in close proximity to the policymaking process. Visiting researchers are expected to collaborate with the OeNB's research staff on a prespecified topic and to participate actively in the department's internal seminars and other research activities. They will be provided with accommodation on demand and will, as a rule, have access to the department's computer resources. Their research output may be published in one of the department's publication outlets or as an OeNB Working Paper. Research visits should ideally last between 3 and 6 months, but timing is flexible.

Applications (in English) should include

- a curriculum vitae,
- a research proposal that motivates and clearly describes the envisaged research project,
- an indication of the period envisaged for the research visit, and
- information on previous scientific work.

Applications for 2014 should be e-mailed to *eva.gehringer-wasserbauer@oenb.at* by November 1, 2014.

Applicants will be notified of the jury's decision by mid-December. The following round of applications will close on May 1, 2015.