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Lina Zwick

International Liquidity Shocks and Domestic Loan Supply in the Euro Area

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Universitätsstr. 150, 44801 Bochum, Germany

Technische Universität Dortmund, Department of Economic and Social Sciences
Vogelpothsweg 87, 44227 Dortmund, Germany

Universität Duisburg-Essen, Department of Economics
Universitätsstr. 12, 45117 Essen, Germany

Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI)
Hohenzollernstr. 1-3, 45128 Essen, Germany

Editors

Prof. Dr. Thomas K. Bauer
RUB, Department of Economics, Empirical Economics
Phone: +49 (0) 234/3 22 83 41, e-mail: thomas.bauer@rub.de

Prof. Dr. Wolfgang Leininger
Technische Universität Dortmund, Department of Economic and Social Sciences
Economics – Microeconomics
Phone: +49 (0) 231/7 55-3297, e-mail: W.Leininger@wiso.uni-dortmund.de

Prof. Dr. Volker Clausen
University of Duisburg-Essen, Department of Economics
International Economics
Phone: +49 (0) 201/1 83-3655, e-mail: vclausen@vwl.uni-due.de

Prof. Dr. Roland Döhrn, Prof. Dr. Manuel Frondel, Prof. Dr. Jochen Kluve
RWI, Phone: +49 (0) 201/81 49-213, e-mail: presse@rwi-essen.de

Editorial Office

Sabine Weiler
RWI, Phone: +49 (0) 201/81 49-213, e-mail: sabine.weiler@rwi-essen.de

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Lina Zwick[1]

International Liquidity Shocks and Domestic Loan Supply in the Euro Area

Abstract

After two decades of increased financial market integration, particularly driven by the banking sector, during the recent financial crisis capital flows decreased sharply, and especially banking flows were affected. At the same time loan volume in Euro Area countries slowed down, evoking concerns that domestic banks might have restricted their domestic lending activities due to international liquidity shortages. To probe this explanation, this paper analyzes the macroeconomic effects of adverse international liquidity shocks for eleven Euro Area countries between 2003 and 2013 on a quarterly basis. The international liquidity shocks are identified by applying a panel vector autoregressive (VAR) model with sign restrictions. The analysis reveals no significant decline in loan volume after such a shock. Rather, domestic banks presumably react by withdrawing money from abroad, thereby buffering the impact of the sharp decrease of capital inflows on the domestic economy.

JEL Classification: F32, F34, G21

Keywords: International capital flows; Panel VAR; loan supply restrictions; home bias

June 2015

1 Lina Zwick, RWI and Ruhr-University Bochum. *– I am grateful to Franziska Bremus, Roland Döhrn, Christoph M. Schmidt, Torsten Schmidt and Benjamin Weigert for valuable comments.* *– All correspondence to: Lina Zwick, RWI, Hohenzollernstr. 1-3, 45128 Essen, Germany, e-mail: Lina.Zwick@rwi-essen.de*

1. Introduction

The two decades before the financial crisis witnessed a strong increase in international financial market integration, whereby the banking sector played a predominant role. Undoubtedly, this process was an important element in the strong global growth experienced during this period. But recently the financial crisis revealed the negative implications of highly linked international financial markets: increased vulnerability of countries to international shocks and a higher risk of contagion. Similar to other developed countries strongly involved in the intensification of international financial market integration, Euro Area countries suffered from a withdrawal of capital; especially capital flows involving banks experienced a sharp contraction (Milesi-Ferretti and Tille 2011). The reduction in external liabilities of banks coincided with a slowdown in loan growth in Euro Area countries, leading to concerns that banks might have restricted lending to the private sector due to liquidity shortages.

Against this background this paper analyzes whether an adverse international liquidity shock faced by banks affects domestic lending for eleven Euro Area countries between 2003 and 2013. When analyzing the relation between external funding and domestic loan growth, endogeneity is a highly relevant issue (Feyen et al. 2014). A decrease in capital flows reduces the funding opportunities of banks both with respect to debt securitization and cross-border interbank lending. These lower funding opportunities might lead to a restricted domestic loan supply, and hence a lower loan volume when banks' lending capacities deteriorate. On the other hand, a decrease in capital flows might be the result of a lower loan growth initiated by loan demand. In particular during downturns, firms demand less credit due to lower investment activities leading to less international funding needs of banks. From a policy viewpoint it is crucial to clearly distinguish between demand-side and supply-side explanations. Specifically, European policy makers should place their focus on devising new financing mechanisms, if the supply-side explanations were valid.

The present study accounts to this identification problem by applying a panel vector autoregressive (VAR) model with sign restrictions. A VAR model has the advantage that it avoids endogeneity problems by treating all variables as endogenous. Moreover, the identification of an adverse international funding shock by imposing sign restrictions on the impulse responses allows to distinguishing this shock from other shocks (monetary policy shock, aggregate demand shock, (domestic) loan supply shock). In particular, for disentangling loan demand and supply shocks a structural VAR framework is frequently used in the literature (Hristov et al. 2012, Busch et al. 2010, Helbling et al. 2010). This paper extends this strand of the literature by introducing international capital flows and hence specifying an important channel of loan supply shocks.

In addition, the study adds twofold to the literature on the transmission of international liquidity shocks. First, while many papers within this literature analyze the impact of adverse liquidity shocks in developed countries on emerging markets (Cetorelli and Goldberg 2011, Feyen et al. 2014, Brei 2007, Popov and Udell 2010, Alper and Saglam 2001) or investigate

the experiences of single countries based on microeconomic data (e.g. Iyer et al. 2014 or Buch and Goldberg 2014 for a meta-analysis), and with regard to the role of foreign banks (e.g. Harpedanne de Belleville 2014), this study focuses on lending to the private non-financial sector provided by domestic banks in the Euro Area. In particular these countries had a tough time during the financial crisis facing at least three crises that were interrelated, a banking crisis, a sovereign debt crisis and a growth crisis (Shambaugh 2012, Schmidt and Weigert 2012). Moreover, external financing of firms is essentially bank-based in these countries (ECB 2013). Therefore, it is essential to work out the effects of banks' liquidity shortage in the Euro Area countries themselves.

Furthermore, the present study contributes to this literature by considering a possible home-bias effect within the transmission of international liquidity shocks on domestic lending. Especially in periods of high uncertainty investors shift their portfolios in favor of domestic investments, the so-called home-bias effect. One reason is that in times of increased risk aversion investors prefer domestic investments as their returns are easier to evaluate, and they are generally perceived as less risky (Gianetti and Laeven 2012). Hence, banks still might act as an effective smoothing factor for the domestic economy, although they are restricted in their funding opportunities. In order to include the home-bias effect in the analysis this study builds on net and gross capital flows. While net capital flows, i.e. the difference between inflows and outflows, are relevant from the macroeconomic perspective (Forster et al. 2011), considering inflows and outflows separately (gross terms) facilitates distinguishing between foreign and domestic investors (among others Forbes and Warnock 2012, Calderon and Kubota 2013, Schmidt and Zwick 2014).

The results indicate that an adverse international liquidity shock does not significantly reduce lending to the private non-financial sector provided by domestic banks, neither using net flows nor employing gross flows. The analysis of gross flows documents, that banks withdraw money from abroad indicating the existence of a home-bias effect. However, since domestic loan volume does not increase the retrenchment of capital by banks obviously only diminishes the negative effects resulting from the sharp decrease in capital inflows, but has no further positive effects on the domestic economy.

The subsequent section provides some background information on international banking with a special focus on the role of Euro area banks, while section 3 presents the empirical approach and the data, and discusses the imposed sign restrictions. Section 4 presents the results and the last section concludes.

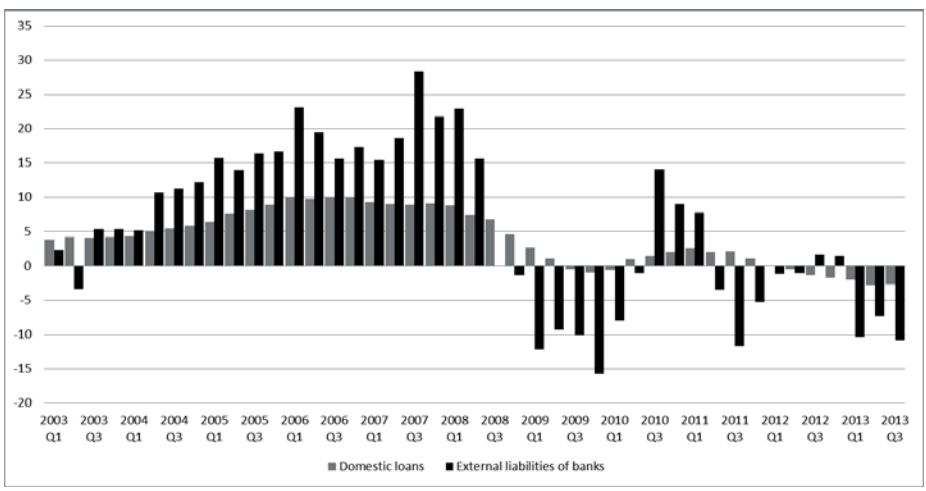
2. International Banking and the role of Euro Area banks

Financial globalization in the years prior to the financial crisis predominantly unfolded in the banking sector. Euro Area banks were particularly active in international banking, as indicated by a high share of foreign assets in their total asset portfolio (Allen et al. 2011). By operating increasingly on the global level, banks took advantage of extended funding sources as well as of opportunities to engage in higher risk sharing. As a result they have

become more robust to domestic funding shocks, while at the same time have been able to better support domestic lending (Allen et al. 2011, Lane and McQuade 2013).

Figure 1 presents the annual percentage change of external liabilities of Euro Area banks both towards banks and non-banks in all BIS-reporting countries and the annual percentage change of loans to the non-financial sector provided by domestic banks in Euro Area countries. It documents the strong increase in international funding of Euro Area banks prior to the financial crisis and indicates a positive correlation between external liabilities of banks and domestic loan volume revealing international funding as an important factor behind the strong credit growth in those countries (Allen et al. 2011). Likewise, Figure 1 shows that the sharp decrease in external liabilities during the recent financial crisis was accompanied by a slowdown in domestic loan volume.

Figure 1: External liabilities and domestic loans of Euro area banks, annual change in %

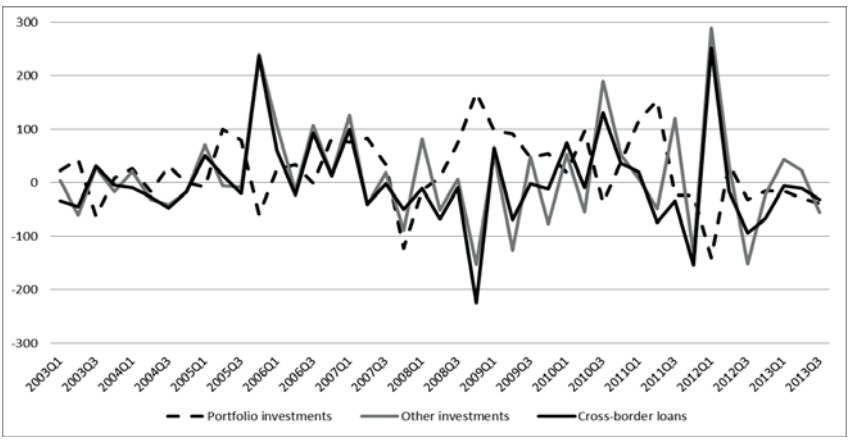


Source: Bank for International Settlements (BIS) Locational Banking Statistics.

Indeed, a high degree of international activity by banks can entail several risks. First, it can lead to a misallocation of resources, if credit is used for less productive sectors, thereby increasing the risk of bubbles, as seen, for example, in the construction sector in Spain before the financial crisis (Allen et al. 2011, Forster et al. 2011). A second risk factor is contagion: while international banking might partly protect the domestic banking sector from domestic funding shocks, it increases the exposure to global shocks (Allen et al. 2011, Forster et al. 2011). Banks exposed to such shocks can severely amplify their impact to the domestic economy, e.g. by restricting loan supply and hence by drying up financing sources of firms (Brei 2007). Generally, contagion effects can work either through the funding side of banks, in case the inter-bank market dries up, or through the asset side of the bank balance sheet, in case of sharp asset price reductions (Allen et al. 2011), both of which have been seen during the recent crisis.

The negative implications of a deeper globalization of Euro Area banks are reflected in the evolution of international capital flows, notably in that of capital flows including banking flows, i.e. portfolio investment flows (among others debt and equity flows of banks) and other investment flows (mainly cross-border banking flows (loans and deposits, but also trade credits as well as currency). These flows dropped sharply during the crisis (Figure 2), with international bank lending constituting the largest pullback (Milesi-Ferretti and Tille 2011).

Figure 2: Net capital flows of Euro area countries, in billions of Euro



Source: IMF Balance of Payments Statistics.

Consequently, an adverse international liquidity shock disturbed the funding sources of Euro Area banks and the question arises what implications this might have had on the real economy. Cetorelli and Goldberg (2011) identify three different channels of international shock transmission when banks are involved. The domestic economy, and in particular domestic lending, can either be affected (i) through a decrease in cross-border lending, (ii) through lower lending by foreign affiliates or (iii) through lower lending by domestic banks that are themselves affected by a decline in the interbank cross-border lending.

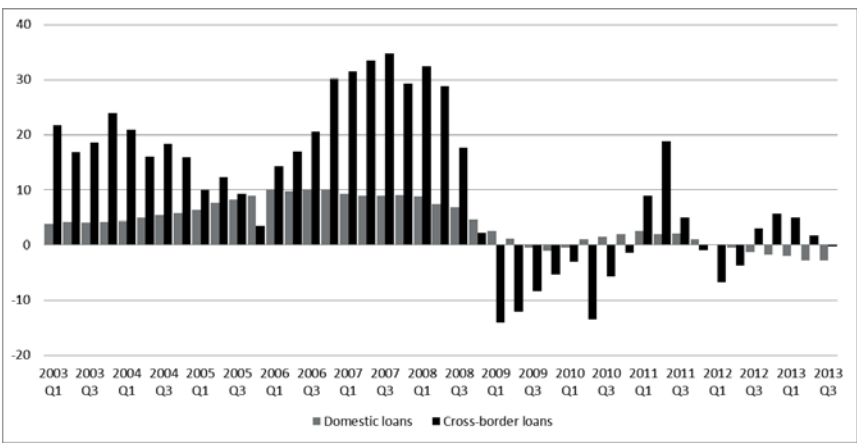
The third channel is of particular importance regarding Euro Area countries since external financing of firms in the Euro Area is essentially bank-based. In particular domestic banks are the major partner in loan business for firms, i.e. accounting for 55% to nearly 90% of loan volume to the private non-financial sector.[1] In contrast, foreign banks play a less vital role than in emerging markets, where they account for 90% of credit volume to the non-bank sector (Allen et al. 2011). Hence, a stable and healthy domestic banking system is crucial for investments of firms and also for economic growth in the Euro Area. Therefore the concerns

[1] For smaller countries like Belgium and – in the aftermath of the crisis – Ireland the share is below 50%. – Calculations are based on data (Long series on credit to the private non-financial sector) provided by the Bank of International Settlements (BIS).

evoked by the simultaneous slowdown and later even decline of domestic loans to the private sector and of external liabilities of banks between 2007 and 2010 came as no surprise. A supply-sided restriction of loan volume, a so-called credit crunch, in response to the liquidity shock might have curbed growth potential that could have been realized if credit had still been flowing unhampered.

However, there are two caveats to these concerns: first, a decline in loan volume does not necessarily reflect restricted supply of credit, but can also be the result of a lower demand for credit. In particular during downturns, firms often demand less credit due to lower investment activities. Hence, for a thorough understanding of the effects that an adverse international liquidity shock has on domestic loan volume via the supply side, supply and demand shocks have to be disentangled. Second, Figure 3 reveals that the decline in cross-border lending was much more pronounced and much sharper than that in domestic loans, which is also found by several studies in the literature (Avdjiev et al. 2012, Cetorelli and Goldberg 2011, Popov and Udell 2010). Gianetti and Laeven (2012) show that a reduction in international banking coincides with a flight home effect, i.e. banks withdraw money from abroad and shift their portfolios in favor of domestic borrowers. Thus, the reduction of banks' international activities might have smoothened domestic lending. Consequently, an adverse international funding shock might, but does not necessarily, lead to a reduction in domestic lending.

Figure 3: Aggregate domestic and cross-border loan growth in Euro area countries, yoy change in %



Source: BIS Locational Banking Statistics and Long series on credit to the private non-financial sector (BIS).

3. Empirical Approach: Panel Vector Autoregression

In order to analyze the macroeconomic effects of an adverse international funding shock on the domestic loan volume, this study applies a vector autoregressive (VAR) model. Such a model avoids endogeneity problems as, in contrast to structural econometric models, the structure of the system does not need to be specified explicitly but is solved within the system. Since the sample period is quite short, this paper follows a panel approach to increase the number of observations making estimation more efficient compared to single country studies. In particular, following Hristov et al. (2012) it employs a VAR in reduced form

$$X_{i,t} = c_i + \sum_{j=1}^{p} A_j X_{i,t-j} + u_{i,t}, \quad (1)$$

where $X_{i,t}$ is a vector that contains the five endogenous variables of interest, i.e. capital flows, domestic loan volume, real GDP, loan rate and money market rate, and c_i is a vector of country-specific intercepts that accounts for heterogeneity across the countries. A_j is a matrix including autoregressive coefficients for lag j, p is the lag length, and $u_{i,t}$ are the reduced-form residuals. The endogenous variables are in pooled form, i.e. there are M*(T-p) observations for each variable where M is the number of countries and T denotes the number of quarters. The residuals are then stacked in a vector that is assumed to be normally-distributed with zero mean and variance-covariance matrix Σ. The model is estimated with Bayesian methods applying a Normal-inverted Wishart prior and a lag length of p=2.[2] From the posterior distribution 500 models are drawn (each model consists of a covariance matrix and the corresponding VAR parameters).

Identification of Shocks

For quantifying the effects of structural shocks, they need to be identified from the residuals of the system. The independence of these shocks is an essential assumption for identification and economic interpretation, since unexplained relations remain if they are correlated (Uhlig 2005). To ensure that shocks are uncorrelated, restrictions have to be imposed on the system.

There are two different approaches in the literature to formulating such restrictions. The first is to set a number of parameters to zero, e.g. by assuming recursivity of the system or that the shock has no long-run effects. The idea of recursivity is that the variables are ordered in an economically sensible way and restrictions on the parameters are imposed in that contemporaneously each variable only affects those further down the ordering. The second approach – that is applied in this paper – imposes sign restrictions on the impulse

[2] Bayesian methods are frequently employed in the VAR literature to solve the problem of over-fitting (Ciccarelli and Rebucci 2003), while a Normal-inverted Wishart prior is considered as reasonable for structural VARs (Canova 2007). The estimation of the Bayesian VAR (BVAR) and the identification of shocks are performed in MATLAB using codes kindly provided by Nikolay Hristov.

response functions that are found in the theoretical or empirical literature to be associated with the respective shock of interest (Fry and Pagan 2011). Imposing restrictions reduces the number of parameters allowing the shocks to be identified. The decision to apply the sign restriction approach is that an economically reasonable ordering of the variables of interest is difficult to establish. Moreover, it allows distinguishing between supply and demand shocks.[3]

In particular, the sign restrictions approach follows two steps: First, from the 500 models resulting from the Bayesian estimation of the VAR model, a base set of structural shocks ε_t is generated by assuming recursivity of the system. It has to be stressed that recursivity is just a technical assumption and need not hold for the system in reality (Fry and Pagan 2011).[4] Technically recursivity can be achieved by applying Cholesky decomposition to the variance-covariance matrix of the residuals $\Sigma_{uu} = PP'$, with a lower triangular matrix P.[5] The structural shocks are then related to the residuals of the system by

$$\varepsilon_t = P^{-1} u_t \tag{2}$$

In a second step, a weighting matrix Q needs to be found that combines these structural shocks in a way that produces impulse response functions satisfying the imposed sign restrictions. In many applications the weighting matrix results from a QR decomposition of a random matrix W with N(0,1) density $W = Q_R R$, where Q_R is an orthogonal matrix ($QQ' = I$) and R is a triangular matrix (Fry and Pagan 2011). By using an orthogonal weighting matrix the Cholesky decomposition can be extended to $\Sigma_{uu} = PQQ'P'$, so that the structural shocks now correspond to the reduced-form residuals by

$$\tilde{\varepsilon}_t = (PQ)^{-1} u_t .^{6} \tag{3}$$

For each of the 500 structural shocks generated in the first step, the draws from the random matrix W are repeated until a weighting matrix Q is found that produces impulse response functions satisfying the sign restrictions. The sign restrictions are imposed for one quarter and have the form of ≤ or ≥.

Simulation studies have shown that it is better to identify multiple shocks in order to uncover the correct signs of the impulse response functions (Paustian 2007). Therefore, an aggregate demand shock, a domestic loan supply shock and a monetary policy shock are identified besides the adverse international liquidity shock on which this paper mainly

[3] The decision on which approach to follow in formulating restrictions depends on the specific research question. While the parametric approach is helpful if one is interested in the reaction of several variables to a one-standard deviation shock of a specific variable, the sign restrictions approach identifies a shock and distinguishes it from other possible shocks through the (simultaneous) behavior of the variables of interest.

[4] Changing the order of variables within this step does not change the results of the paper.

[5] For Cholesky decomposition to work the variance-covariance matrix has to be invertible.

[6] Due to the orthogonality of the weighting matrix, the structural shocks generated in this step differ from those of the first step by producing different impulse response functions, albeit the covariance matrix is the same (Fry and Pagan 2011).

focuses on. To be able to differentiate between the shocks, the sign restrictions imposed need to differ in at least one variable.

Median Model

Frequently, the median of all accepted impulse responses is used as a summary statistic in the literature of VAR models with sign restrictions (e.g. Peersman 2005). Fry and Pagan (2011) however argue that since the median is obtained from different accepted models at each horizon, there exists no single model that generates the median impulse responses. This also leads to interpretation problems when computing variance decomposition, since the latter requires that the shocks are generated from the same model in order to have uncorrelated shocks.

This paper addresses the critique by applying the approach of Fry and Pagan (2011). Specifically, they propose using that model of all accepted models for the calculation of the impulse responses that is closest to the median of the impulse responses over a certain horizon and for all identified shocks. In order to find this model, the impulse responses are first standardized by subtracting the median and dividing by the standard deviation. Afterwards the sum of squared differences is calculated over a horizon of 20 quarters and over all identified shocks, and the model with the minimum sum of squared differences is chosen. The study follows the literature (e.g. Busch et al. 2010) by calling this model the median model in the following sections.

Variance decomposition

In order to quantify the effects of the different shocks, in particular the cumulative impact of each shock on the system, forecast error variance decomposition is applied. The idea of variance decomposition is basically to compute the forecast error of the impulse responses and decompose the forecast error variance into proportions of changes in the variable that are created by the respective shock (Enders 2004). Based on the moving average form of the VAR model

$$X_t = \mu + \sum_{j=0}^{\infty} \phi_j \tilde{\varepsilon}_{t-j} \tag{4}$$

where μ is the mean value and ϕ_j denotes the impulse responses resulting from the effects of the respective shocks on the system, the n-step-ahead forecast error would be

$$X_{t+n} - \hat{X}_t(n) = \sum_{j=0}^{n-1} \phi_j \tilde{\varepsilon}_{t+n-j} \,. \tag{5}$$

Since $\sum_{\tilde{\varepsilon}\tilde{\varepsilon}} = E(\tilde{\varepsilon}\tilde{\varepsilon}') = I$, the variance of the forecast error is

$$E\left[\left(x_{t+n}-\hat{x}_t(n)\right)^2\right]=E\left[\left(\sum_{m=1}^{k}\sum_{i=0}^{n-1}\phi_m^i\cdot\tilde{\varepsilon}_{m,t+n-i}\right)^2\right]=\sum_{m=1}^{k}\sum_{i=0}^{n-1}\left(\phi_m^i\right)^2, \quad (6)$$

and hence, the variance is the squared sum over the single shocks (m=1,…,k) as well as over time (i=1,…,n-1). It can be decomposed for each component j of X. From this variance the proportion of each shock's *m* contribution to the variance of each variable j is then computed (Kirchgässner and Wolters 2005) by:

$$share_{jm}^{n}=\frac{\sum_{i=0}^{n-1}(\phi_{jm}^i)^2}{\sum_{s=1}^{k}\sum_{i=0}^{n-1}(\phi_{js}^i)^2}\text{, with m=1,…,k and n=1,2… .} \quad (7)$$

Data

The two variables of particular interest are international capital flows and domestic loan volume. For capital flows gross and net flows of different sub-categories of the financial account are used. In particular, this paper considers total portfolio and other investment flows since these are most likely to influence the funding conditions of banks as they include debt and equity flows (assets and liabilities) of banks as well as bank loans. The data are available from the IMF Balance of Payments Statistics.[7] For domestic loan volume loans extended by domestic banks to the private non-financial sector, provided by the Bank of International Settlements (BIS), are employed. Additionally, real GDP, the money market rate and the loan rate are included since they should also be affected by the shocks analyzed.[8] The data for 11 Euro Area countries is on a quarterly basis.[9] Since loan rate data are available only since 2003, the sample covers the period between the first quarter of 2003 to the third quarter of 2013. All series are linearly de-trended over the sample period; real GDP and domestic loan volume are in logs.

Imposed sign restrictions

The crucial step to identifying the structural shocks within this approach is to impose sign restrictions on the impulse responses. The derivation of these restrictions might rest either on theoretical models or on empirical results. This paper distinguishes between net and gross capital flows, and so does the following discussion of the imposed sign restrictions. With respect to the discussion of gross capital flows it is worth noting that capital outflows are measured in negative terms, so that an increase means that capital is retrenched, while a decrease indicates that domestic investors extend their activities abroad.

[7] In 2012 the IMF introduced the Balance of Payments Manual 6 (BPM6) to his database. Data in BPM6 are available from 2008, while BPM5 contains data until 2008. In order to have the largest sample period possible data is used following the BPM5 classification scheme and is converted backwards (from BPM6 to BPM5) from 2008 on. However, linking portfolio and other investment flows is not critical, because the largest difference between the manuals is in the FDI statistics which is not used here.

[8] See data appendix for more detailed information.

[9] Austria, Belgium, Germany, France, Greece, Ireland, Spain, Italy, Netherlands, Portugal and Finland.

An adverse international funding shock typically comes along with an abrupt reduction in capital flows, in particular in cross-border banking flows, as was observed during the recent financial crisis (Milesi-Ferretti and Tille 2011). Therefore a negative sign is imposed on net capital inflows. When considering gross flows, capital inflows should decrease (similar to net inflows), while (negative) capital outflows are expected to increase since capital inflows and outflows are usually found in the literature to be negatively related (Broner et al. 2013, Schmidt and Zwick 2014).

The scarcity of liquidity leads to higher costs of external funding on the unsecured term money market (Euribor). Specifically, the money market rate is driven by an increased risk banks face on the money market. Heider et al. (2009) find that the occurrence of a negative liquidity shock is associated with an increased counterparty risk, since borrowers' default probabilities rise, and it becomes more difficult to distinguish between safe and risky banks. Furthermore, the money market rate can increase due to a higher funding liquidity risk f lenders, meaning the possibility that these banks are not able to meet their obligations over a certain horizon with immediacy (Drehmann and Nikolaou 2010). Specifically, banks that face such a risk includes the higher refinancing costs associated with it in their current prices they demand, and hence increasing the price on the unsecured term money market (Eisenschmidt and Tapking 2009). Therefore, a positive sign is assumed for the money market rate.

A strong reduction in cross-border banking flows and an increase in the cost of refinancing tighten the credit capacity of banks and hence could have a negative impact on the domestic loan volume, also indicated by several papers in the literature for emerging markets (Cetorelli and Goldberg 2011, Feyen et al 2014, Brei 2007). However, the possible existence of a home-bias effect, i.e. a shift of banks' portfolio towards domestic borrowers, would indicate that either nothing happens to the domestic loan supply or that it even increases since banks prefer investing domestically during periods of high uncertainty (Gianetti and Laeven 2012). Therefore, the sign of the response of the domestic loan volume is not restricted. Similarly, the signs of the response of the loan rate and the real GDP growth rate are not restricted as it is not clear whether banks fully transmit the liquidity shock to the domestic economy or whether they are able to smooth the effects of the shock.

In order to ensure that the impulse responses satisfying these restrictions reflect indeed changes in the macroeconomic variables due to an adverse international funding shock, three other shocks are identified. These shocks are common in the literature, in particular this paper follows Hristov et al. (2012) who give an overview on the sign restrictions employed in the empirical literature based on theoretical models. The paper extends these restrictions with respect to international capital flows.

Firstly, it is important to distinguish the international funding shock from a domestic loan supply shock, e.g. due to higher capital requirements, as both shocks work through the supply-side of the loan market on the real economy. A domestic loan supply shock is found in the literature to move loan volume and loan rate in opposite directions (Busch et al. 2010,

Helbling et al. 2010) – in contrast to an aggregate demand shock where loan volume and loan rate should change in the same direction. Moreover, an adverse loan supply shock has a negative impact on real output. The money market rate should decrease because banks probably need less capital from the money market when restricting lending to the domestic private sector. Generally, it is found in the literature that banks react to higher capital requirements by reducing lending to increase the capital ratio (VanHoose 2007).[10] With respect to capital flows the signs of the impulse responses are not restricted as the reaction of both net and gross flows is not clear.

Besides shocks that work through the supply side of the loan market on the real economy, demand-side factors are an important source of macroeconomic fluctuations. Changes in the macroeconomic variables can be driven by the demand-side, when firms demand less credit during times of crises due to lower investment activities. This needs to be distinguished from changes in response to (international) supply-side factors. An adverse aggregate demand shock would move loan volume and loan rate in the same direction, as with a lower demand for loans the loan rate is expected to decrease (Hristov et al. 2012). This lower demand for loans leads to reduced refinancing needs of banks. Consequently, banks should demand less on the money market decreasing the money market rate. Likewise, a strong decrease in aggregate demand would come along with a reduction in net capital flows.

And finally, a contractionary monetary policy shock would affect the variables of interest as follows. It would result in an unanticipated increase of the money market rate, while it is found in the literature to have negative effects on real GDP (Hristov et al. 2012, Canova and De Nicolo 2002). With respect to international capital flows a positive sign is imposed on the impulse responses since net capital inflows should increase after the central bank has raised interest rates due to higher expected yields. The latter restriction distinguishes the monetary policy shock from an international funding shock. With regard to gross flows, inflows and outflows should both increase due to yield expectations (Kumhof 2004, for the reverse case see Bremus and Fratzscher 2014). A summary of the imposed sign restrictions is given in Tables 1 and 2.

Table 1: Imposed sign restrictions (net flows)

	Capital Inflows	Real GDP	Money market rate	Loan volume	Loan rate
International funding shock	-		+		
Loan supply shock		-	-	-	+
Aggregate demand shock	-	-	-	-	-
Monetary policy shock	+	-	+		+

Notes: Restrictions are imposed for one quarter. + means an increase in the respective variable, - represents a decrease.

[10] Another argument in the literature for a negative sign of the response of the money market rate is the reaction of the central bank (Hristov et al. 2012). Busch et al. (2010) impose the sign restriction for the money market rate with a lag of two quarters bearing in mind that identifying a loan supply shock and implementing policy responses takes some time.

Table 2: Imposed sign restrictions (gross flows)

	Capital Outflows	Capital Inflows	Real GDP	Money market rate	Loan volume	Loan rate
International funding shock	+	-		+		
Loan supply shock			-	-	-	+
Aggregate demand shock		-	-	-	-	-
Monetary policy shock	+	+	-	+		+

Notes: Restrictions are imposed for one quarter. + means an increase in the respective variable, - represents a decrease.

4. Results

Impulse Response Functions

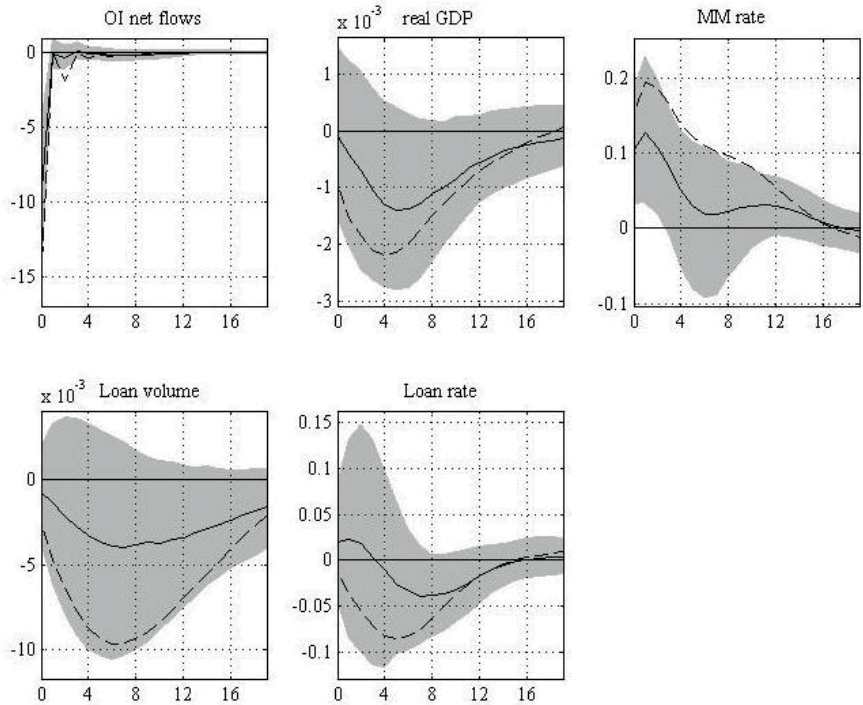
Figures 4 and 5 present the impulse responses to an international liquidity shock for net and gross capital flows respectively for a horizon of 20 quarters.[11] The solid line denotes the median of the impulse responses, while the dashed line reflects the median model, i.e. that model whose distance to the median is the smallest regarding all identified shocks. The figures reveal that the median model deviates for some variables from the median of the impulse responses indicating that it indeed makes a difference on which model the analysis is based on as proposed by Fry and Pagan (2011). However, generally both models follow a similar pattern. In addition, the deviations – with minor exceptions – remain in the 68% confidence intervals of the median of the impulse responses, so that the qualitative conclusions drawn do not differ.

Figure 4 shows that net other investment flows, i.e. cross-border banking flows, initially decrease following an international liquidity shock; afterwards their response becomes insignificant and converts to zero. Thus, capital flows react short and sharply, which reflects the high volatility of these flows. The money market rate increases significantly during the first two quarters after the shock, reflecting that banks have to pay higher returns to be funded on the money market. However, these higher refinancing costs are not passed through to the private sector. Although the loan rate increases directly after the shock occurs, the response is not statistically significant.[12] This is in line with the responses of real GDP and loan volume. Both variables decline directly after the shock, however the response is statistically insignificant. At a first glance, this seems counterintuitive as banks suffer obviously from liquidity shortage and higher refinancing costs but this tightening is not passed through to the private sector.

[11] The impulse responses of the other shocks are provided in the Appendix.

[12] Here the median model deviates from the median of all impulse responses as it directly decreases. However, as the impulse response is in the 68%-interval, the effect should also be insignificant so that the qualitative interpretation does not change.

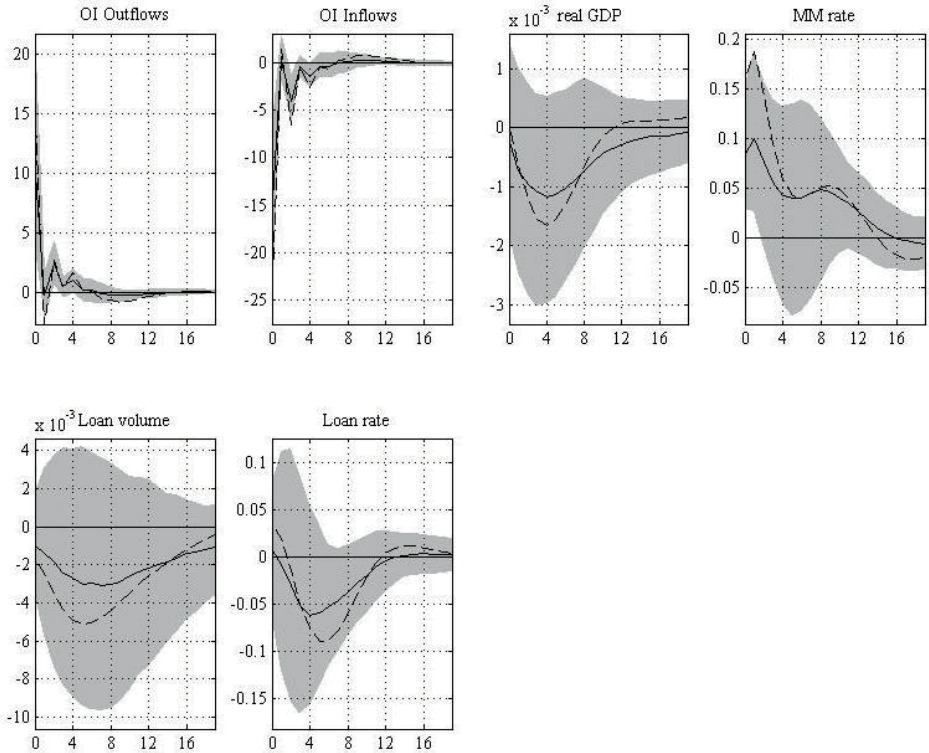
Figure 4: Impulse responses to an international liquidity shock (net flows)



Notes: The solid line reflects the median of the impulse responses, while the dashed line denotes the impulse responses of the median model. The shaded areas are the 68% confidence intervals around the median of the impulse responses. As the median is computed from all impulse responses that satisfy the sign restrictions, the confidence interval reflects not only sampling uncertainty but also modeling uncertainty due to non-uniqueness of identified shocks.

The impulse response functions to an international liquidity shock when considering gross flows (Figure 5) reveal a possible explanation. While capital inflows initially decrease following an adverse international liquidity shock, capital outflows increase significantly. The other variables react quite similarly to the shock compared to the analysis with net capital flows. The increase in (negative) capital outflows indicates that banks withdraw money from abroad that they might invest domestically, as for example in loans. However, loan volume decreases similarly to the analysis with net capital flows, albeit insignificantly. Therefore, the retrenchment of capital outflows by domestic banks does not increase loan supply at home but probably only diminishes the negative effects from the drop in capital inflows. Thus, the results partly support the so-called home-bias effect, where banks shift their portfolios in favor of domestic investments (Gianetti and Laeven 2012).

Figure 5: Impulse responses to an international liquidity shock (gross flows)



Notes: The solid line reflects the median of the impulse responses, while the dashed line denotes the impulse responses of the median model. The shaded areas are the 68% confidence intervals. As the median is computed from all impulse responses that satisfy the sign restrictions, the confidence interval reflects not only sampling uncertainty but also modeling uncertainty due to non-uniqueness of identified shocks and is therefore larger than in other estimations.

With regard to the recent financial crisis these results are in line with the observed evolution of domestic and cross-border loans (section 2) documenting that cross-border loans decreased much more than domestic loans. Besides the smoothening of the domestic loan market by banks shifting investments to their home markets, large interventions by the ECB probably also contributed to cushioning the negative effects of the liquidity squeeze experienced by banks during this period. The results of both analyses (net and gross flows) are robust to changes in the capital flow variable. In particular, the model was also estimated by employing portfolio investment flows, for which the impulse responses to an

international funding shock, based on gross capital flows, are presented in Figure 7 of the Appendix.[13]

Variance decomposition

In order to quantify the importance of the different shocks, this study additionally employs forecast error variance decomposition (FEVD). Table 3 presents the proportion that each shock contributes to the forecast error variance for each variable over a five-year forecast horizon. The FEVD is based on the median model in order to assure that the shocks are uncorrelated (Fry and Pagan 2011) and on the analysis of gross capital flows.[14] In the last column the shares of the single shocks are aggregated. The aggregated share ranges between 80 and 99%, except for changes in capital outflows that is explained by less than 50%, and hence the identified shocks generally explain large parts of the variation of the variables.

Real macroeconomic fluctuations are essentially driven by monetary policy and aggregate demand shocks, accounting together for around 80% of the variation of real GDP. While the FEVD increases with the time horizon for a monetary policy shock, the aggregate demand shock has its highest contribution in the first two years. The same pattern is observed with respect to changes in loan volume. In particular, loan supply and aggregate demand shocks contribute to changes in this variable at the beginning of the forecast horizon, while monetary policy shocks affect changes in loan volume strongly after the first two years. An adverse international liquidity shock also contributes to changes in loan volume, albeit to a slightly lower extent than the other shocks.

The adverse international funding shock rather contributes to changes in the money market rate. Additionally, this shock especially explains a large part of the variation of capital flows; regarding both types of flows (inflows and outflows), between 26% and 56% of changes in these variables are explained by this shock. Changes in capital inflows and outflows are also strongly affected by aggregate demand shocks, albeit to a lower extent. In both cases the contribution to changes in capital inflows is higher than to those in capital outflows indicating that foreign investors might react stronger to shocks than domestic investors. In contrast, loan supply and monetary policy shocks play a minor role in explaining changes in these variables.

[13] The impulse response to the other identified shocks and those based on net capital flows are available from the author upon request.

[14] The results of the FEVD based on the analysis of net capital flows are provided by the author on request.

Table 3: Forecast Error Variance Decomposition (FEVD) in percent, gross flows

	Year	International Liquidity Shock	Loan Supply Shock	Monetary Policy Shock	Aggregate Demand Shock	Sum of Shocks
Capital Outflows	1	27.1	2.5	3.8	12.9	46.3
	2	26.9	3.4	4.5	13.7	48.4
	3	26.6	3.8	4.6	14.3	49.3
	4	26.6	3.8	4.6	14.3	49.4
	5	26.6	3.9	4.6	14.3	49.4
Capital Inflows	1	56.0	1.6	4.0	26.9	88.5
	2	54.7	2.9	4.7	26.9	89.1
	3	53.6	3.7	4.9	27.1	89.3
	4	53.6	3.7	5.0	27.1	89.4
	5	53.6	3.8	5.0	27.1	89.4
real GDP	1	2.5	0.7	38.0	55.9	97.1
	2	8.0	5.6	50.4	33.3	97.4
	3	7.2	9.7	56.3	23.1	96.3
	4	6.6	9.8	58.6	20.8	95.8
	5	6.4	9.6	59.3	20.3	95.6
MM rate	1	36.9	24.6	11.4	8.0	80.8
	2	26.2	29.5	8.4	15.8	79.8
	3	22.4	27.7	7.9	25.5	83.5
	4	22.1	26.8	9.8	25.2	84.0
	5	21.9	26.5	10.4	25.4	84.2
Loan Volume	1	15.7	35.7	5.4	34.4	91.3
	2	19.9	30.2	20.6	27.4	98.1
	3	18.9	26.4	32.1	20.4	97.9
	4	17.0	23.5	38.9	17.7	97.1
	5	15.7	22.0	42.7	16.3	96.6
Loan Rate	1	2.1	39.7	6.7	51.3	99.8
	2	5.8	32.2	3.9	58.0	99.9
	3	9.1	30.2	5.9	54.3	99.5
	4	9.0	30.2	7.2	52.9	99.3
	5	9.1	30.1	7.4	52.7	99.3

5. Summary and Conclusion

This paper has analyzed whether an adverse international liquidity shock that reduces banks' funding opportunities influences domestic loan supply for 11 Euro Area countries between 2003 and 2013. In particular during the recent crisis a reduction of banks' external liabilities came along with a slowdown in domestic loan growth in Euro Area countries evoking concerns that domestic banks might have restricted their lending to the private non-financial sector.

By applying a panel VAR model with sign restrictions the paper aimed at identifying an international liquidity shock that works through the supply-side of the loan market while at the same time distinguishing it from other shocks that influence macroeconomic variables. In particular, a domestic loan supply shock, a contractionary monetary policy shock and an aggregate demand shock were additionally identified imposing sign restrictions on the impulse response functions. For the analysis portfolio investment flows and other investment flows were used since they include banking flows, and hence are most likely to affect domestic loan supply.

The results indicate that between 2003 and 2013 international liquidity shocks did not significantly influence domestic loan volume, although domestic banks obviously experienced a liquidity shortage. While this seems counterintuitive, the analysis using gross flows offers a possible explanation: capital inflows sharply decrease, but (negative) outflows increase, and hence banks retrench capital. Gianetti and Laeven (2012) show, that in times of increased uncertainty banks shift their portfolio towards domestic borrowers, since they classify domestic investments as less risky. However, the results support the thesis of such a home-bias effect only partly since domestic lending does not increase. Rather domestic banks obviously diminish the possible negative effects of a sharp drop in capital inflows.

Although these are good news from the domestic economy's point of view, the withdrawal from the international financial markets by banks lead to a higher fragmentation of international banking that might increase borrowing costs also in Euro Area countries. In particular firms in peripheral countries of the Euro Area country suffered recently from worse financing conditions than for example in Germany (German Council of Economic Experts 2013).

In order to avoid supply-side restrictions of both domestic and cross-border lending due to funding problems of banks, regulatory rules should be implemented to strengthen the capital basis of banks but also to foster external financing of firms through the capital market. Thus, a deeper financial integration, both in the banking sector and on the capital markets, should be enhanced, while at the same time implementing a Euro Area wide regulation framework. To some extent this has already been implemented within the framework of a Banking Union of the European Union.

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Data Appendix

GDP is the gross domestic product in billions of national currency, chain-linked with reference year 2005 and seasonally adjusted as well as adjusted by working days, provided by Eurostat. The series for Greece was not available until the current edge and was therefore taken from feri (data provider). The Greek GDP has the same characteristics with the exception that it is not working day adjusted.

Loan volume is the volume of loans provided by domestic banks to the private sector in billions of Euro and is adjusted for breaks. The series is made available by the Bank of International Settlements (BIS).

Money market rate is the three-month Euribor provided by Eurostat.

Loan rate is the interest rate, made available by the ECB.

Capital Flows includes different capital flows depending on the respective model. All series are in billions of national currency and are taken from the Balance of Payments Statistics (BoP) from the IMF. In order to extent the sample period, data from the actual systematic (Balance of Payments Manual 6 (BPM6)) and from the former systematic (BPM5) were linked. As there are no big changes between the different systematics for the capital flow series analyzed, linking the data is not critical with respect to structural breaks. All series are expressed in BPM5 systematic, i.e. the asset values are in negative terms. In particular, assets and liabilities of the following capital flows are used:

1. Portfolio investment flows, total
2. Other investment flows, total
3. Other investment flows, loans of banks

Appendix

Figure 1: Impulse responses to a monetary policy shock, net flows

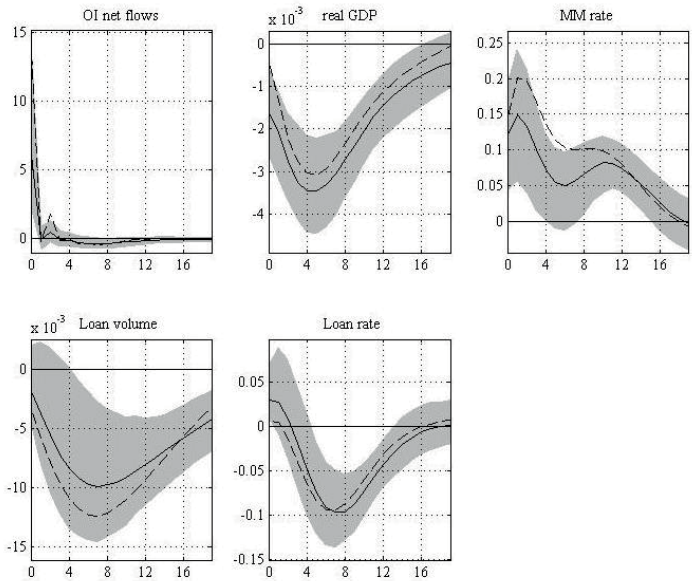

Figure 2: Impulse responses to a domestic loan supply shock, net flows

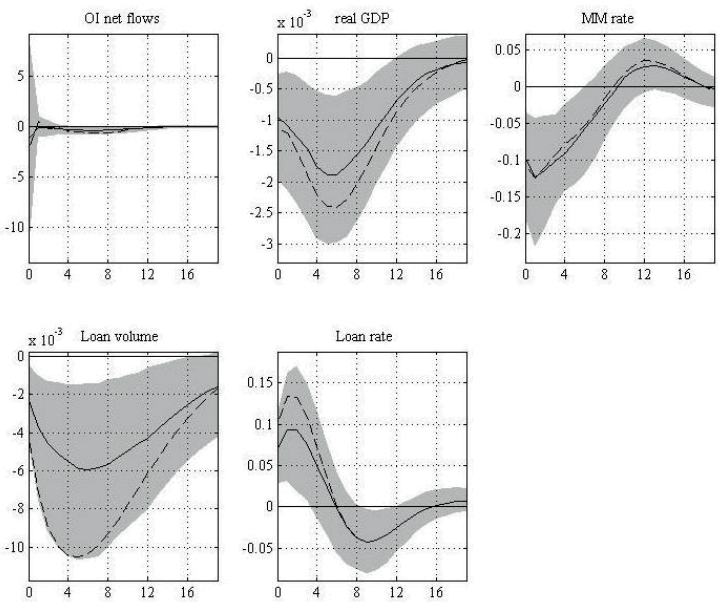

Figure 3: Impulse responses to an aggregate demand shock, net flows

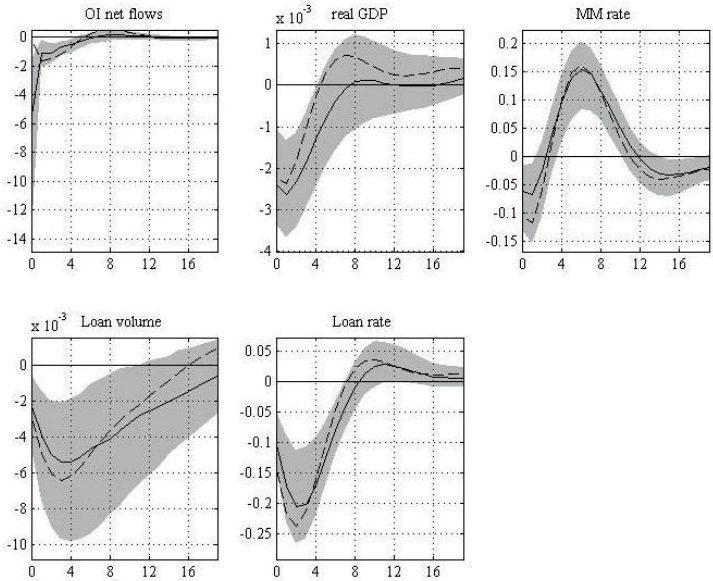

Figure 4: Impulse responses to a monetary policy shock, gross flows

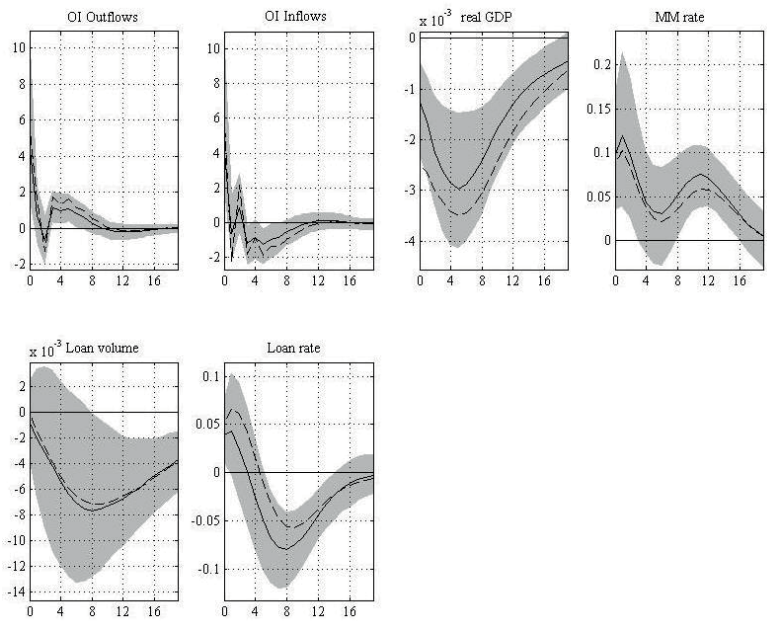

Figure 5: Impulse responses to a domestic loan supply shock, gross flows

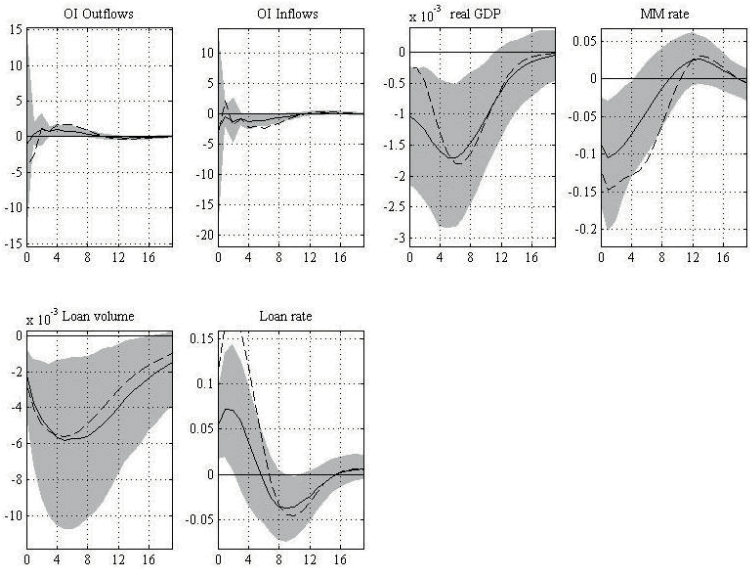

Figure 6: Impulse responses to an aggregate demand shock, gross flows

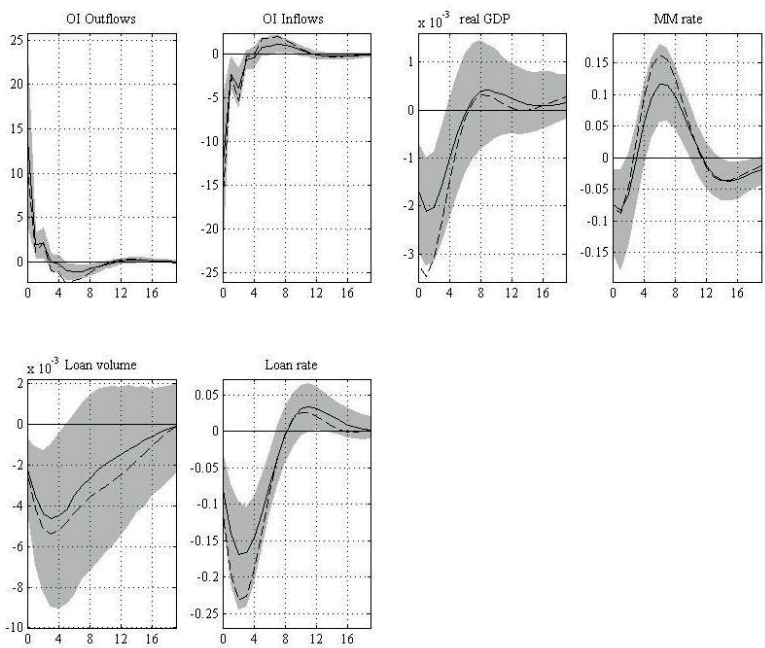

Figure 7: Impulses to an international liquidity shock, portfolio investment flows