DEUTSCHE BUNDESBANK
EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 24/2019

Capital flows in the euro area and TARGET2 balances

Nikolay Hristov
(CESifo and Deutsche Bundesbank)

Oliver Hülsewig
(CESifo and Munich University of Applied Sciences)

Timo Wollmershäuser
(CESifo and Ifo Institute for Economic Research)

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

Internet http://www.bundesbank.de

ISBN 978–3–95729–601–6 (Printversion)
ISBN 978–3–95729–602–3 (Internetversion)

Non-technical summary

Research Questions

The literature dealing with the episode of substantial widening of TARGET2 balances during the Global Financial Crisis is mainly qualitative in nature and largely focuses on the risks associated with the accumulation of TARGET2 liabilities as well as on distributional aspects from a normative perspective. This paper looks at the TARGET2 episode from a quantitative and purely positive perspective. It explores how the uneven recourse of national banking systems in the euro area to the European Central Bank's unconventional refinancing operations that led to the accumulation of large TARGET2 balances, has contributed to the evolution of aggregate economic activity in important member states of the euro area.

Contribution

This paper looks at the consequences of the capital flow reversals in the euro area between 2008 and 2014. Like in many other episodes of sudden stops, the distressed economies of the euro area had to cope with sharply rising borrowing costs and significant difficulties to tap international capital and money markets. However, unlike the typical sudden stop, the economies of the euro area had access to additional resources to cushion the effects of private capital outflows. In particular, they enjoyed the extraordinarily accommodative provision of liquidity to commercial banks by the European Central Bank as part of its unconventional monetary policy measures. Commercial banks without access to private interbank lending but with sufficient collateral, could obtain from their National Central Bank the liquidity needed to compensate the dry-up of private funding. As the closing of these funding gaps by central bank liquidity was very unevenly distributed across member countries' banking systems, significant and persistent imbalances in the National Central Banks' positions in the Trans-European payment system, known as TARGET2, emerged. Our paper contributes to the literature on the macroeconomic effects of sudden stops and the identification of capital flow shocks. It also adds to the literature that analyzes the distributional effects of monetary policy across countries.

Results

Our main results can be summarized as follows. First, the recourse to the European Central Bank's unconventional monetary policy measures – reflected in the accumulation of TARGET2 balances – has been mainly driven by capital flow shocks. In contrast, cyclical drivers like innovations to aggregate demand or aggregate sup-

ply do not seem to induce statistically significant changes in TARGET2 positions. Second, results from a counterfactual analysis suggest that the uneven recourse of national banking systems to the European Central Bank's unconventional refinancing operations caused real distributional effects across the euro area economies. In particular, due to the ability to accumulate significant TARGET2 positions, distressed euro area member states could avoid deeper recessions. In contrast, if these positions had to be regularly settled by transferring valuable assets, economic activity in the core countries receiving those transfers would have been higher.

Nichttechnische Zusammenfassung

Fragestellung

Der starke Anstieg der TARGET2-Salden im Euroraum nach der globalen Finanzkrise, der unter anderem die über die Mitgliedsländer hinweg sehr ungleiche Inanspruchnahme der unkonventionellen Refinanzierungsgeschäfte der Europäischen Zentralbank reflektiert, wurde in der Literatur bislang vorwiegend qualitativ diskutiert. Die vorliegende Studie hingegen hat einen quantitativen Fokus. Sie untersucht, welchen Einfluss diese ungleiche Inanspruchnahme unkonventioneller Refinanzierungsgeschäfte auf die gesamtwirtschaftliche Aktivität in wichtigen Mitgliedsstaaten des Euroraums hatte.

Beitrag

In dieser Studie werden die Folgen der plötzlichen Umkehr internationaler Kapitalströme (Sudden Stop) im Euroraum zwischen 2008 und 2014 untersucht. Wie bei anderen typischen Sudden Stops auch waren die Krisenländer des Euroraums mit stark steigenden Finanzierungskosten und einem beschränkten Zugang zu den internationalen Geld- und Kapitalmärkten konfrontiert. Im Gegensatz zu einem typischen Sudden Stop hatten die Banken in den Mitgliedstaaten des Euroraums jedoch die Möglichkeit, zusätzliche Finanzierungsquellen in Anspruch zu nehmen, die die Europäische Zentralbank im Rahmen ihrer unkonventionellen geldpolitischen Maßnahmen zur Verfügung stellte. Banken, die über ausreichend Sicherheiten verfügten, erhielten von ihrer nationalen Zentralbank die Liquidität, die notwendig war, um die Finanzierungslücken in ihren Bilanzen zu schließen. Da allerdings die Inanspruchnahme der unkonventionellen Refinanzierungsgeschäfte von Land zu Land sehr ungleich war, bauten sich Ungleichgewichte in den Abrechnungsposten der nationalen Zentralbanken mit dem europäischen Zahlungsverkehrssystem TARGET2 auf. Diese Studie leistet einen Beitrag zu der Literatur, die sich mit den makroökonomischen Folgen eines Sudden Stop und der empirischen Identifikation von unerwarteten internationalen Kapitalbewegungen befasst. Sie trägt auch zu den Arbeiten bei, die sich mit den länderübergreifenden Verteilungseffekten geldpolitischer Maßnahmen befassen.

Ergebnisse

Die Ergebnisse lassen sich wie folgt zusammenfassen. Erstens wurde der Anstieg der TARGET2-Salden überwiegend durch unerwartete Kapitalzu- bzw. Kapitalabflüsse, nicht aber durch aggregierte Angebots- bzw. Nachfrageschocks verursacht. Zweitens deutet unsere Analyse darauf hin, dass die von Land zu Land

unterschiedliche Inanspruchnahme der unkonventionellen Refinanzierungsgeschäfte reale Verteilungseffekte in den Ländern des Euroraums hervorgerufen hat. So hat die Möglichkeit, erhebliche TARGET2-Salden aufzubauen, die Rezession in den Krisenländern abgemildert. Wären hingegen diese Salden regelmäßig durch die Übertragung werthaltiger Vermögenstitel zu begleichen gewesen, so fiele die gesamtwirtschaftliche Aktivität in den Kernländern höher aus.

Deutsche Bundesbank Discussion Paper No 24/2019

Capital flows in the euro area and TARGET2 balances*

Nikolay Hristov† Oliver Hülsewig‡ Timo Wollmershäuser§

March 25, 2019

Abstract

We estimate a panel VAR model for the euro area to quantitatively assess how the uneven recourse of national banking systems in the euro area to the ECB's unconventional refinancing operations that led to the accumulation of large TARGET2 balances, has contributed to the propagation of different types of structural economic shocks as well as to the historical evolution of aggregate economic activity in euro area member countries in the period 2008-2014. Our results suggest that the built-up of TARGET2 balances was mainly driven by capital flow shocks while being barely responsive to other aggregate shocks. Furthermore, on basis of counterfactual experiments we find that the ability to build-up sizable TARGET2 liabilities has contributed substantially to avoid deeper recessions in the distressed euro area member countries like Spain, Italy, Ireland and Portugal, while to a smaller extent depressing aggregate economic activity in core member states, such as Germany, the Netherlands and Finland.

JEL classifications: E42, F32, F41, F45.

Key words: Euro area, TARGET2 balances, capital inflow shocks, panel vector autoregressive model

*This paper reflects the authors' opinion and does not necessarily reflect the views of the Deutsche Bundesbank or the Eurosystem.

†Corresponding author. CESifo and Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main, Germany. Tel.: +49 (0)69 9566 7362. *Email:* <nikolay.hristov@bundesbank.de>

‡CESifo and Munich University of Applied Sciences, Am Stadtpark 20, 81243 Munich, Germany.

§CESifo and Ifo Institute for Economic Research, Poschingerstr. 5, 81679 Munich, Germany.

1 Introduction

During the first five years after the onset of the Global Financial Crisis, several member states of the euro area - Greece, Ireland, Portugal, Spain, Italy and Cyprus - suffered from repeated waves of significant, in some cases even drastic net outflows of foreign private capital. In particular, in a series of run-style sell-offs, also known as the euro crisis, international investors sharply reduced their holdings of debt issued by those countries' governments, banks and other public and private institutions. Like in many other episodes of *sudden stops*, the distressed economies of the euro area had to cope with sharply rising borrowing costs and significant difficulties to tap international capital and money markets. The governments of Greece, Ireland, Portugal were even confronted with a complete exclusion from financial markets and had to rely on voluminous intergovernmental rescue programs.

However, unlike the typical situation, in which a country indebted in foreign currency finds itself during a sudden stop, the banking system of the euro area members had access to additional resources to cushion the effects of private capital outflows. In particular, they enjoyed the extraordinarily accommodative provision of liquidity to commercial banks by the European Central Bank (ECB) as part of its unconventional monetary policy measures.[1] Commercial banks without access to private interbank lending but with sufficient collateral, could obtain refinancing from the Eurosystem which was effectively carried out by their National Central Bank (NCB).[2] In cases where banks lacked collateral, emergency liquidity assistance (ELA) was supplied by NCBs with NCBs being liable. As the closing of these funding gaps by central bank liquidity was very unevenly distributed across member countries' banking systems, significant and persistent imbalances in the NCBs' positions in the Trans-European payment system, known as TARGET2, emerged.[3] TARGET2 liabilities were accumulated in distressed countries where NCBs significantly enlarged their net liquidity provision to commercial banks. By contrast, in countries which were perceived as safe havens, commercial banks were on balance unwilling to lend the excessive liquidity inflows on the interbank market to counterparties in distressed countries and preferred to curtail the refinancing operations

[1] At the core of these measures was the decision of the ECB in 2008 to conduct its liquidity-providing tenders with a fixed-rate, full allotment procedure.

[2] Note that the Eurosystems monetary policy operations are normally implemented through the NCBs. In particular, the ECB coordinates the operations, while the transactions are carried out by the NCBs. See for example: `https://www.ecb.europa.eu/pub/pdf/other/monetarypolicy2011en.pdf`, Chapter 4. For example, a bank with sufficient collateral but unable to roll over its maturing liabilities against a lender from another euro area country, can obtain the amount needed to repay the maturing debt from the Eurosystem. The associated transaction is technically carried out by the corresponding NCB and appears in the latter's balance sheet. Since the debt repayment is associated with a cross-border transfer of reserves, it also leads to an increase in the country's TARGET2 liabilities.

[3] The mechanics of TARGET2 balances are discussed in more detail in Section 2.

with their NCB, whose TARGET2 claims in turn increased. Thus, the widening of TARGET2 balances measures both, differences in the degree to which the national banking systems rely on central bank liquidity (European Central Bank, 2013), and the extent of capital flow reversal during the Global Financial Crisis (Auer, 2014).

There has been a controversial discussion among economists regarding possible consequences for the cross-country distribution of resources and risks or moral hazard effects delaying structural adjustment in distressed countries (see e.g. Bindseil and König, 2012; Bindseil, Cour-Thimann, and König, 2012; Buiter and Rahbari, 2012; Sinn and Wollmershäuser, 2012a,b; Whelan, 2014). On the one hand, proponents argued that in emergency cases, the ECB's unconventional monetary policy enables national commercial banks to obtain liquidity without any implementation lags, which might reduce the likelihood of liquidity crises and by this, a break-up of the monetary union. On the other hand, opponents feared that the build-up of TARGET2 liabilities, which reflects the uneven recourse to the ECB's refinancing operations, might reduce the incentives for structural reforms and serve as an instrument for the mutualization of risks within the euro area. Furthermore, they criticized that the credit provision reflected by TARGET2 is not subject to any democratic legitimation, which is in sharp contrast to the official rescue packages designed by the national governments and the EU.

This literature dealing with the episode of substantial widening of TARGET2 balances during the Global Financial Crisis is mainly qualitative in nature and largely focuses on the risks associated with the accumulation of TARGET2 liabilities as well as on distributional aspects from a normative perspective. While delivering valuable insights and providing interesting impulses for researchers and policy makers, it is, however, widely silent about the quantitative effects of the uneven distribution of liquidity within the Eurosystem (as reflected in the build-up of TARGET2 balances) on real output, inflation, interest rates or real exchange rates. This is where the current paper steps in. It looks at the TARGET2 episode from a quantitative and purely positive perspective. To this end, for the period between the onset of the Global Financial Crisis and 2014 a panel vector autoregressive (VAR) model for the euro area is estimated in order to explore how the uneven recourse of national banking systems in the euro area to the ECB's unconventional refinancing operations that led to the accumulation of large TARGET2 balances at the NCBs, has contributed to the evolution of GDP, long-term interest rates, aggregate prices and international competitiveness in important member states of the euro area.

Our main findings are twofold. First, the results of our impulse response analysis indicate that the recourse to the ECB's unconventional monetary policy measures – reflected in the accumulation of TARGET2 balances – has been mainly driven by capital flow shocks. In contrast, cyclical drivers like innovations to aggregate demand or aggregate supply do not seem to induce statistically significant changes in

TARGET2 positions. Second, our counterfactual experiments indicate that, in the period between 2008 and 2014, the increased liquidity provision by the Eurosystem and thus, the ability to build-up sizable TARGET2 liabilities has contributed substantially to avoid deeper recessions in the distressed euro area member countries Spain, Italy, Ireland and Portugal.[4] In particular, recourse of the national banking systems to the fixed-rate, full-allotment liquidity-providing tenders of their NCBs allowed for more favorable refinancing conditions – as measured by national long-term government bond rates – as well as higher GDP levels. In the counterfactual scenario, in which this liquidity policy is absent or net TARGET2 liabilities have to be regularly settled by transferring valuable assets to NCBs with TARGET2 surpluses, average aggregate output over the period from 2008 to 2014 would have fallen short of its actual level by between 4% and 10% in Ireland, by between 2% and 3% in Spain and by between 2% and 7% in Portugal. In Italy the contribution of the recourse of commercial banks to the ECB's liquidity operations turns out to have been smaller, amounting to an upward shift of GDP by up to 1%. In the core countries, Germany, the Netherlands and Finland, the accumulation of TARGET2 claims contributed unfavorably to aggregate economic activity. However, at the individual country level, the effect turned out to be smaller than in the distressed economies of the euro area. In the counterfactual in which the core economies of the euro area receive assets in the course of TARGET2 settlement, average aggregate output over the period form 2008 to 2014 would have exceeded its actual level by between 1% and 4% in Germany, by between 1% and 2% in the Netherlands and by between 2% and 3% in Finland. In contrast, aggregate output in France was barely affected by the emergence of TARGET2 balances. Note that our counterfactual does not correspond to a tail event like an outright financial crisis in the periphery countries or even a break-up of the monetary union. Although acknowledging that the inability to accumulate sizable TARGET2 positions might trigger such extraordinary events with potentially devastating effects for all member states of the euro area, the linearity of our empirical model precludes an explicit analysis of the highly non-linear dynamics in such emergency cases. By basing the counterfactual experiment on a VAR we rather assume that the aforementioned tail events can be avoided. Accordingly, our results should be viewed as a lower bound for the adverse effects that could have been observed if countries were unable to build-up substantial TARGET2 positions.

The present paper is related to four strands of the literature. First, there is a large body of studies investigating the macroeconomic effects of sudden stops in emerging and advanced economies. Despite using different empirical methodologies

[4]Note that we neglect Greece in our analysis because it obtained external finance merely through financial aid programmes of the euro area member countries since May 2010. External financing through capital markets did not take place while at the same time government bond rates increased tremendously.

and samples, those papers reach the conclusion that sudden stops lead to substantial and persistent drops in real GDP, an improvement in current accounts and a significant real depreciation.[5] Second, more closely related to our work are papers that also resort to structural VAR models with sign restrictions to identify capital flow shocks. In particular, Tillmann (2013) investigates the effects of capital flow reversals on asset markets in emerging Asia while Sa, Towbin, and Wieladek (2014) and Sa and Wieladek (2015) look at the contribution of capital flow shocks to the housing booms in OECD countries and the US, respectively. Zwick (2015) explores the extent to which capital flow shocks were responsible for the protracted contraction of loan supply in the EMU after the outbreak of the Global Financial Crisis. However, the evidence provided by these studies is silent about the quantitative impact of the uneven distribution of central bank liquidity as measured by TARGET2 balances. Third, our paper contributes to a recent approach in the literature that was initiated by Fagan and McNelis (2014). They integrate a stylized TARGET2 system into the small open economy DSGE model of Mendoza (2010) and find that the uneven distribution of central bank liquidity substantially mitigates the adverse effects of a sudden stop on output, consumption and investment. In contrast to Fagan and McNelis (2014), our approach is more agnostic, purely empirical and based on a different methodology, relying on a smaller number of structural assumptions. We view our set-up and results as complementary to those of Fagan and McNelis (2014). Finally, our work is also related to studies by Corsetti and Pesenti (2001), Obstfeld and Rogoff (2002), Tille (2001) and Clarida, Gali, and Gertler (2002), among others, which explore the distributional effects of monetary policy across countries. The findings of these studies show that welfare shifts between open economies can be sizable after a policy-induced currency depreciation depending on certain conditions that affect international price competitiveness such as nominal rigidities or the degree of substitutability of internationally traded goods. We find that the ECB's unconventional monetary policy has also caused distributional effects across countries. While the recessions in the distressed periphery euro area member countries were moderated, economic activity in the core member states of the currency union was dampened.

The reminder of the paper is organized as follows. Section 2 describes the mechanics behind the emergence of TARGET2 balances and their evolution over time. In Section 3, we outline the structural panel VAR model setup and discuss the identification of structural shocks. In Section 4, we present and discuss our results. Finally, Section 5 concludes.

[5]See for example Mendoza (2010), Lane and Milesi-Ferretti (2011) and Barkbu, Eichengreen, and Mody (2012) for reviews of the empirical literature. In addition Schmidt and Zwick (2015) and Zwick (2015) provide recent evidence for the euro area during the financial crisis.

2 The mechanics of TARGET2 balances

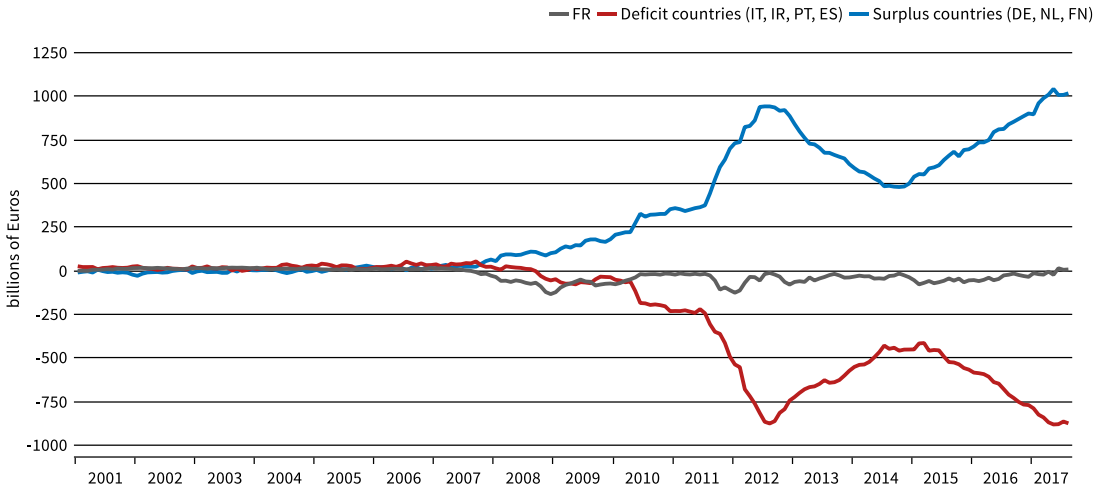
TARGET2 is an acronym that stands for the second generation of the Trans-European Automated Real-time Gross settlement Express Transfer system. It is the Eurosystem's transaction settlement system through which the commercial banks of one country make payments to the commercial banks of another country via their accounts at NCBs. Until 2007 TARGET2 balances of the euro area member countries were virtually zero, implying that the balance of payments associated with private transactions was in equilibrium (see Figure 1). In each country incoming and outgoing payments related to both, current account and financial account transactions canceled out each other.

The situation changed significantly in the course of the Global Financial Crisis and the euro crisis. Until August 2012 Italy, Ireland, Portugal and Spain had accumulated TARGET2 liabilities (i.e. TARGET2 inflows persistently below TARGET2 outflows) totaling 875 billion euros. These liabilities built up because the crisis countries experienced sharp reversals in private capital inflows. In particular, interbank lending came to a standstill, and most of the drop in capital inflows materialized in a decline in cross-border lending of commercial banks (Auer, 2014; Sinn and Wollmershäuser, 2012a). The resulting funding gap in the balance sheets of commercial banks in distressed euro area member states was closed by additional borrowing from these countries' NCBs. With the ECB's decision in 2008 to conduct its liquidity-providing tenders with a fixed-rate, full allotment procedure, NCBs were allowed to satisfy almost any liquidity demand of national commercial banks, against adequate collateral.[6] When providing liquidity, NCBs de facto issued liabilities against the Eurosystem (Bindseil, Cour-Thimann, and König, 2012; Sinn and Wollmershäuser, 2012b; Whelan, 2014). Hence, unlike in the pre-crisis period, the cross-border payments related to the current account deficits that the crisis countries recorded at that time were no longer offset by private net capital inflows (implying an equilibrium in the balance of payments). Rather the resulting funding gap (i.e. the disequilibrium in the balance of payments) was to a substantial extent closed by the accumulation of TARGET2 balances. In the absence of the ECB's extraordinar-

[6]The ECB not only decided to switch to a fixed-rate full allotment policy, but also to provide liquidity to the banking sector at both, increasingly long durations and against a wider range of collateral with lower quality. As a number of commercial banks in particular in Ireland and Greece were not able to provide sufficient or adequate collateral, their NCBs provided short-term emergency loans to these banks (Emergency Liquidity Assistance, or ELA), where collateral requirements were further lowered (see e.g. Whelan, 2012, on the Irish case). Each individual NCB is liable for the ELAs it extends. In addition to the refinancing operations and emergency loans, liquidity was also provided to the banking system through the introduction of two asset purchase programmes (the Covered Bond Purchase Programme since 2009 and the Securities Markets Programme between 2010 and 2012). However, the volume of these programmes was with about 280 billion euros in mid-2012 much less important than that of the refinancing operations, which amounted to 1260 billion euros at that time.

ily accommodative provision of liquidity, the capital flow reversal would have most likely required a sharp contraction of domestic demand and imports to improve the current account position of the crisis countries.

Figure 1: TARGET2 balances of major countries



Source: European Central Bank. Own calculations.

The countries which were perceived as safe havens during the crisis, attracted the reversed capital flows. Until August 2012 Germany, the Netherlands and Finland built up TARGET2 claims (i.e. TARGET2 inflows persistently above TARGET2 outflows) totaling 940 billion euros. As the commercial banks in these countries were on balance unwilling to lend these funds on the interbank market to counterparties in distressed countries, they preferred to curtail the refinancing operations with their NCB and started to deposit their excess reserves at their NCB. As a consequence, excess savings in these countries were transformed from a claim against private foreign debtors to a TARGET2 claim, and hence a claim against the Eurosystem. From an aggregate perspective, the Eurosystem took on the intermediation role that was played by the markets before the outbreak of the crisis (European Central Bank, 2013). It provided more liquidity than needed on aggregate by the banking sector, and at the same time it absorbed the excess liquidity through its deposit facility and fixed-term deposits. Thus, rising TARGET2 balances are an indicator of the persistently uneven distribution of provision and absorption of liquidity across euro area member countries.

After August 2012 TARGET2 balances started to decline towards their pre-crisis levels. The promise of the ECB to do whatever it takes to preserve the euro, marked a turning point of the euro crisis with a remarkable fall of risk premia for public and private securities. Capital outflows from crisis countries started to moderate gradually and commercial banks reduced their reliance on the ECB funding. At the same time the current account balance of the crisis countries was improving

significantly and even turned positive from 2013 on, which reduced the countries' dependency on foreign capital. As a consequence TARGET2 balances decreased until the beginning of 2015.

The renewed surge in TARGET2 balances since 2015 coincides with the beginning of the ECB's outright purchase of euro area government bonds under the Public Sector Purchase Programme (PSPP) in March 2015. According to statements of ECB officials, instead of signaling another balance-of-payments crisis period in the euro area, movements in TARGET2 balances rather reflect the decentralized implementation of the bond purchases (see e.g. Eisenschmidt, Kedan, Schmitz, Adalid, and Papsdorf, 2017). As the majority of bonds is bought from counterparties that are located outside the country of the purchasing NCB, the PSPP involves cross-border payments via TARGET2 with central bank money that was created by the NCB. And since most of these counterparties have accounts at the Deutsche Bundesbank (either because they are located in Germany or, in the case of counterparties from outside the euro area, have historically accessed TARGET2 via the Deutsche Bundesbank), the German TARGET2 claims rise with the government bonds purchased by the NCBs in Italy, Spain and other countries. Meanwhile there are however doubts about this purely mechanical explanation. Dor (2016) and Minenna (2017) show that for Spain and Italy at least part of the increase in TARGET2 liabilities is related to capital outflows by domestic investors. Since the true nature of the current increase in TARGET2 balances is unclear and at least to some extent different from the sudden stop episode of the years 2007 to 2012, we decided to exclude the period from 2015 on from our analysis.

3 Panel-VAR model setup

3.1 Panel VAR

Consider a panel VAR model in reduced form:

$$X_{i,t} = \sum_{j=1}^{p} A_j X_{i,t-j} + c_i + \varepsilon_{i,t}, \tag{3.1}$$

where $X_{i,t}$ is a vector of endogenous variables for country i, A_j is a matrix of autoregressive coefficients for lag j, p is the number of lags, c_i is a vector of country–specific intercepts and $\varepsilon_{i,t}$ is a vector of reduced-form residuals. The vector $X_{i,t}$ consists of six variables

$$X_{i,t} = [y_{i,t} \;\; p_{i,t} \;\; lr_{i,t} \;\; reer_{i,t} \;\; nfl_{i,t} \;\; tgt_{i,t}]', \tag{3.2}$$

where $y_{i,t}$ denotes real GDP, $p_{i,t}$ is the overall price level, measured by the GDP

deflator, $lr_{i,t}$ is the long-term nominal interest rate proxied by the yield on ten-year government bonds, $reer_{i,t}$ is the real effective exchange rate, $nfl_{i,t}$ is the net foreign liability position and $tgt_{i,t}$ is the net stock of TARGET2 liabilities. Real GDP, the price level and the real effective exchange rate are in logs, while the long-term interest rate is expressed in percent. Net foreign liabilities and TARGET2 are measured in percent of nominal GDP. For each variable, we use a pooled set of $M \cdot T$ observations, where M denotes the number of countries and T denotes the number of observations corrected for the number of lags p. The reduced-form residuals $\varepsilon_{i,t}$ are stacked into a vector $\varepsilon_t = [\varepsilon'_{1,t} \dots \varepsilon'_{M,t}]'$, which is normally distributed with mean zero and variance-covariance matrix Σ. c_i comprises individual country dummies that account for possible heterogeneity across the units.

We use quarterly data that are taken from Eurostat, the ECB and the OECD covering the period from 2008Q1 to 2014Q4.[7] We abstain from using post-2014 data since, as it is unclear whether the behavior of the TARGET2 balances in this most recent episode is a mere technical reflection of the ECB's quantitative easing programme (PSPP) or the result of active capital flow reversal as during and around the peak of the European debt crisis.[8] Our panel comprises eight euro area member countries: Spain (ESP), Italy (ITA), Portugal (PRT), Ireland (IRL), Germany (DEU), France (FRA), the Netherlands (NLD) and Finland (FIN).[9] The panel VAR model is estimated with Bayesian methods using a Normal-inverted Wishart prior, 500 draws and a lag order of $p = 2$.

An important issue is whether the VAR model sufficiently describes the unconventional monetary policy of the ECB. In contrast to many other empirical papers we decided to abstain from including variables such as the central bank's balance sheet (see e.g. Gambacorta, Hofmann, and Peersman, 2014). One reason for this is that unlike this literature we do not aim at identifying monetary policy shocks. We rather assume that the ECB's change from conventional to unconventional policy and hence its response to the crisis is reflected in the accumulation of TARGET2 balances. As has been argued in Section 2 TARGET2 is not only used as a indicator for the extent of capital flow reversal during the Global Financial Crisis, but also for the differences in the degree to which the national banking systems have recourse to the ECB's unconventional refinancing operations.

Another important issue is the choice of the empirical model. Estimating a panel VAR model for the euro area with pooled observations has the big advantage that the efficiency of the statistical inference is increased. Since our sample is short, we follow Ciccarelli, Maddaloni, and Peydro (2015) and use a panel of eight euro area

[7] See Appendix 5 for a detailed description of the data.

[8] See Section 2 for a broader discussion.

[9] Recall that we neglect Greece in our analysis because it obtained external finance merely through financial aid programmes of the euro area member countries since May 2010.

member countries.[10] Nevertheless, the approach also exhibits shortcomings, such as the difficulty of modeling interrelationships across individual member countries, and the disregard of cross-country heterogeneity. As regards the first point, since euro area member countries are closely connected with each other by foreign trade, and thus by capital flows, one country's capital outflow might be identical to the inflow enjoyed by another one. In addition, since TARGET2 reflect purely intra-EMU flows, national TARGET2 positions should sum up to zero at the euro-area-wide level. Taking account of these relationships would require to impose cross-country consistency restrictions. However, since our country sample does not reflect the entire euro area we abstract from imposing such restrictions. In this respect, our approach follows studies of Chinn and Prasad (2003), Gruber and Kamin (2007), Beetsma and Giuliodori (2011), Ciccarelli, Maddaloni, and Peydro (2013), Benetrix, Lane, and Shambaugh (2015) or Attinasi and Metelli (2017), among others, which resort to country panels covering a huge fraction - in some cases close to 100% - of current account and/or FDI flows in the world or the euro area. These studies estimate their models with country-specific intercepts but without imposing cross-country restrictions. As regards the second point - disregarding cross-country heterogeneity - we have also estimated a panel VAR model covering only the four distressed economies, i.e. Spain, Italy, Ireland and Portugal to check whether our results are affected by the pooling across core and periphery countries. The results are qualitatively very similar to those delivered by the 8-countries VAR model.[11]

3.2 Identification of structural shocks

Based on the VAR model (3.1) we generate impulse responses of the variables to structural shocks η_t. As in Canova and de Nicolo (2002), Peersman (2005) and Uhlig (2005) the shocks are identified by imposing sign restrictions. The reduced-form residuals ε_t are related to the structural shocks η_t according to $\eta_t = (U\Omega^{1/2}Q)^{-1}\varepsilon_t$, where $U\Omega^{1/2}$ is the Cholesky factor, $\Sigma = U\Omega U'$, of each draw and Q is an orthogonal matrix, $QQ' = I$, generated from a QR decomposition of some random matrix W, which is drawn from an $N(0,1)$ density. For each of the 500 Colesky factors resulting from the Bayesian estimation of the VAR model, the draws of the random matrix W are repeated until a matrix Q is found that generates impulse responses to η_t, which satisfy the sign restrictions.

Our identification of the shocks is set-up according to the following principles.

[10] The length of our sample, $T = 28$, is determined by the period during which TARGET2 balances that were related to capital flight significantly moved. Given this sample size, using aggregate euro area data or individual country data for the estimation of the VAR model might suffer from a small number of degrees of freedom.

[11] The results of the panel VAR model covering only Spain, Italy, Ireland and Portugal are not reported in the following, but are available upon request.

First, in addition to a capital inflow shock we also impose restrictions on two further types of shocks: an aggregate demand and an aggregate supply shock. The restrictions uniquely identify the three shocks, in the sense that the set of sign restrictions imposed is mutually exclusive *ex ante*. Furthermore, the simultaneous identification of the two additional disturbances, besides the capital inflow shock, ensures that the latter indeed captures exogenous shifts in investors' attitude towards a particular country rather than any endogenous reaction of international capital flows to one of the other shocks. Moreover, the literature considers shocks to aggregate supply and aggregate demand to be the most important driving forces of the business cycle. Finally, the restrictions are consistent with what would be suggested by dynamic stochastic general equilibrium (DSGE) models.

3.2.1 Aggregate demand and aggregate supply shocks

For an aggregate demand shock we assume that output and prices move in the same direction. While these restrictions are sufficient to separate the aggregate demand shock from an aggregate supply shock, we need an additional restriction to distinguish it from unexpected capital inflow disturbances. Here we assume that the long-term interest rate falls following a negative aggregate demand shock as the central bank lowers the short-term rate in an attempt to mitigate the effects of the shock.[12] In addition, the decline in aggregate demand is typically associated with a weakening of credit demand which, everything else equal, also exerts downward pressure on long-term rates.[13] Finally, we also assume that the real (effective) exchange rate falls following a negative aggregate demand shock. This restriction can be motivated by acknowledging that a decline in domestic demand is typically associated with a deceleration in inflation and a depreciation of the nominal exchange rate as the central bank seeks to compensate the slack in demand by becoming more expansionary. Both, the reduced domestic price pressure and the reaction of the nominal exchange rate work towards depreciating the economy's real exchange rate and thus improving its international competitiveness.[14] Restrictions on the stock of TARGET2 liabilities are not imposed, implying that the data will determine the sign of their response (see Table 1).

For an aggregate supply shock we assume that output and prices move in the

[12]Note that the restriction on the long-term rate, i.e. to move in the same direction as output and prices, makes the innovation to aggregate demand different from typical monetary policy shocks. The latter are usually associated with nominal interest rates moving in a direction opposite to that of output and prices.

[13]See e.g. Peersman (2005), Fratzscher, Saborowski, and Straub (2009), for similar restrictions in VARs, and Straub and Peersman (2006), and Canova and Paustian (2011), for evidence from standard DSGE models.

[14]See Tillmann (2013), Sa, Towbin, and Wieladek (2014), Sa and Wieladek (2015) for similar sign restrictions in VARs.

opposite direction.[15] In addition, we assume that the real exchange rate appreciates following an adverse aggregate supply shock as, in the face of a more intense upward pressure on production costs, domestic inflation accelerates.[16] The reaction of TARGET2 liabilities is again left unrestricted (see Table 1).

3.2.2 Capital inflow shocks

A sudden surge in capital flows to a country might be associated with either *pull* or *push* factors. The former mainly reflect domestic demand and supply side shocks which alter a country's relative attractiveness from the perspective of international investors. In contrast, *push* factors are sources of unexpected changes in capital inflows entirely originating abroad. In the following, we define a capital inflow shock as one reflecting a disturbance to the *push* factors while the *pull* side of investment flows from abroad is captured by the endogenous response of the net foreign liability position to the main domestic drivers of the business cycle (disturbances to aggregate demand or aggregate supply).

Open economy general equilibrium models identify various *push*-sources of capital inflow shocks to an individual country. Such shocks might result from different supply, demand or monetary disturbances abroad, which, from the perspective of the country, act as sudden changes in foreign investors' demand for domestic assets. For example, if a country's assets are viewed as safer, a decline in foreigners' risk aversion might trigger a higher inflow of capital from the rest of the world (e.g. as in Sa and Viani, 2013). Likewise, a change in the structure of an important foreign financial markets or the bursting of a bubble there typically changes the amount of resources channeled towards the domestic economy (e.g. Caballero, Farhi, and Gourinchas, 2008). Moreover, any demand-side driven shift in aggregate investment or saving in the rest of the world typically alters the intensity of capital flows to the domestic economy, provided foreigners' portfolios are not subject to a complete home bias (e.g. Caballero and Krishnamurthy, 2009). Finally, fluctuations in capital flows might be triggered by foreign governments regulatory - e.g. macroprudential - interventions or changes in the desired currency and amount of foreign reserves held by monetary authorities abroad (e.g. Favilukis, Kohn, Ludvigson, and Nieuwerburgh, 2013). However, these theories suggest that irrespective of the precise source and/or mechanism leading to the capital inflow shock, its effects on the destination economy's net foreign liability position, nominal and real exchange rate, domestic interest rates and domestic price level are unambiguous.[17]

[15] See again Peersman (2005), Fratzscher, Saborowski, and Straub (2009), for similar restrictions in VARs, and Straub and Peersman (2006), and Canova and Paustian (2011), for evidence from standard DSGE models.

[16] See for example Bems, Dedola, and Smets (2007) for VAR evidence or Glick and Rogoff (1995) for a general equilibrium analysis.

[17] See Caballero, Farhi, and Gourinchas (2008), Caballero and Krishnamurthy (2009), Sa and

The theoretical considerations are supported by several empirical studies. In particular, Warnock and Warnock (2006) and Favilukis, Kohn, Ludvigson, and Nieuwerburgh (2013) and Reinhart and Reinhart (2009) provide results supporting a negative reaction of a country's long-term nominal yields to an unexpected increase in capital flowing from abroad. In addition, the evidence in Reinhart and Reinhart (2009) suggest that, during episodes of *capital flow bonanzas*, a surge in capital inflows accelerates a country's GDP growth and leads to an appreciation of nominal and real exchange rates. In studies focusing on emerging and developing economies, Cardarelli, Elekdag, and Kose (2010), Kim and Yang (2011), Jongwanich and Kohpaiboon (2013) and Kim and Kim (2013) also find a positive relation between surges in capital inflows and domestic GDP, price level and real and/or nominal appreciation.

Based on the theoretical and empirical findings mentioned above, we impose the following sign restrictions to identify a capital inflow shock. The later is associated with an increase in the net foreign liability position (a decrease in the net foreign asset position), non-negative reactions of aggregate output and the price level, a decline in long-term interest rates and a real appreciation. The sudden surge in inflowing foreign capital relaxes credit conditions and thus puts downward pressure on long-term interest rates. The easier access to credit in turn fuels domestic demand and inflation. The reaction of TARGET2 balances is again left unrestricted. Related VAR studies identifying capital inflow shocks based on sign restrictions resort to similar assumptions. In particular, Tillmann (2013) imposes restrictions on the response of the net foreign asset/liability position, the long-term interest rate, the real effective exchange rate and GDP. Sa, Towbin, and Wieladek (2014) and Sa and Wieladek (2015) only impose restrictions on the net foreign asset/liability position, the real exchange rate and the *real* long-term interest rate to identify a capital inflow shock.

Note that the sign restrictions used to identify the adverse capital inflow shock also make it different from contractionary monetary policy disturbances. The latter typically lead to an unexpected rise of the long-term nominal interest rate while having a non-positive effect on output and prices.[18] In addition, adverse monetary shocks are usually associated with an *appreciation* of the real exchange rate.[19]

Viani (2013), Favilukis, Kohn, Ludvigson, and Nieuwerburgh (2013), among others, for a discussion.

[18]The reason why we abstain from identifying a monetary policy shock explicitly within our set of sign restrictions is that in our subsequent counterfactual experiments the monetary policy shock would be country-specific, which, however, is never the case in a monetary union.

[19]The intuition why the real exchange rate appreciates following a contractionary monetary shock is that the increase in the policy rate typically comes along with an appreciation of the nominal exchange rate as foreign investors try to take advantage of the higher domestic short-term rates. The reaction of the nominal exchange rate translates into an appreciation of its real counterpart if the domestic economy and the rest of the world exhibit some degree of nominal price rigidity. For

3.3 Summary of sign restrictions

Table 1 summarizes our sign restrictions to identify the capital inflow shock as well as the shocks to aggregate supply and aggregate demand. The remaining shocks are interpreted as a residual shocks, which capture the remaining variation in the data.

Table 1: Sign Restrictions

	$y_{i,t}$	$p_{i,t}$	$lr_{i,t}$	$reer_{i,t}$	$nfl_{i,t}$	$tgt_{i,t}$
Capital inflow shock	↑	↑	↓	↑	↑	
Aggregate demand shock	↑	↑	↑	↑		
Aggregate supply shock	↑	↓		↓		

Notes: Sign restrictions are imposed for four quarters.

For all variables we set the time period over which the sign restrictions are binding equal to four quarters. This is in line with Peersman (2005), Uhlig (2005), Farrant and Peersman (2006) and Scholl and Uhlig (2008), who assume that the effects of shocks on economic activity can be quite persistent. Assuming that the sign restrictions only hold for two quarters leaves our results qualitatively unchanged. All sign restrictions are imposed as $\leq$ or $\geq$.[20]

4 Empirical results

4.1 Impulse response functions

Figure 2 shows the average reaction of a euro area member country to a capital inflow, aggregate demand and aggregate supply shock. The solid lines denote impulse responses of the six macroeconomic variables. The shaded areas correspond to the 68% posterior credibility bounds. For simplicity, we refer to an impulse response as being *significant* if the zero line lies outside the corresponding credibility bound. The results indicate that sudden capital flow reversals are associated with substantially more persistent reactions of GDP, the GDP deflator and long-term

example, based on various types of approaches, Eichenbaum and Evans (1995), Faust and Rogers (2003), Zettelmeyer (2004), Lee and Chinn (2006), Bems, Dedola, and Smets (2007), Scholl and Uhlig (2008), Forni and Gambetti (2010) provide empirical evidence indicating an appreciation of a country's real effective exchange rate in the case of an adverse domestic monetary shock. Theoretical explanation for this empirical finding is provided by Lane (2001) and Tille (2001) among others.

[20] The estimation of the Bayesian VAR and the identification of the structural shocks is performed in MATLAB, using the codes `bvar.m`, `bvar_chol_impulse.m` and `bvar_sign_ident.m` provided by Fabio Canova (http://www.crei.cat/people/canova/).

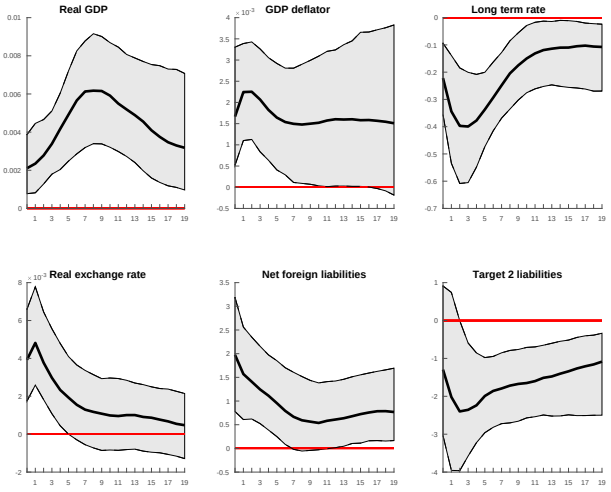
interest rates than disturbances to aggregate demand or aggregate supply. Further, TARGET2 balances react significantly only in the case the economy is hit by a capital flow shock. In particular, an unexpected acceleration of the inflow of capital reduces the necessity to borrow from the Eurosystem which corresponds to a decline in TARGET2 liabilities or an increase in TARGET2 claims, respectively.

Interestingly, sudden shifts in aggregate demand or aggregate supply do not seem to affect the net foreign liability position or the TARGET2 balance significantly. This result suggests that so called domestic *pull* factors are unlikely to have been a driving force behind capital flows in and out of euro area member countries.[21]

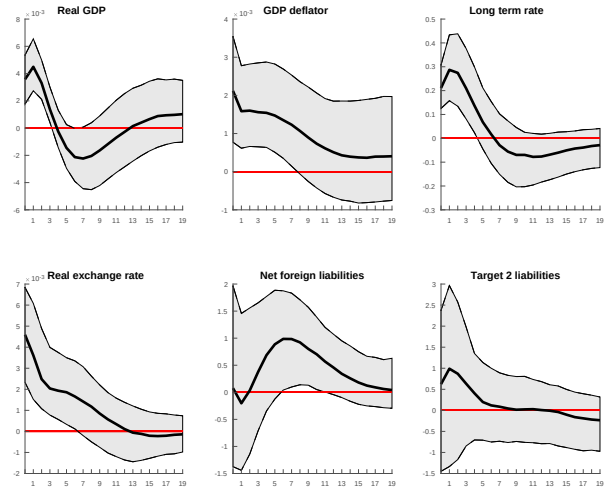
[21] Note that by construction, the capital inflow shock comes along with an increase of net foreign liabilities (see Table 1).

Figure 2: Impulse responses to aggregate shocks. Sample: 2008Q1-2014Q4

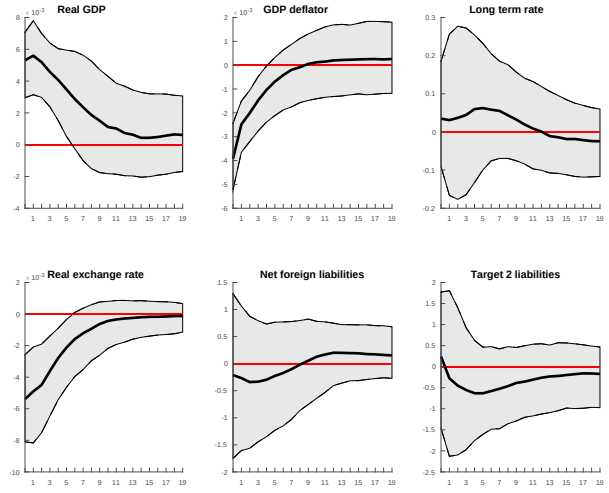
Capital inflow shock



Aggregate demand shock



Aggregate supply shock



Notes: Real GDP, the price level and the real effective exchange rate are in logs. The long-term nominal interest rate is in percent. The net foreign liability position and the TARGET2 liabilities are measured in percentages of nominal GDP. An increase of the NFL or TARGET2 is equivalent to a net accumulation of liabilities. Solid black lines and shaded areas reflect the median response and the 68% credible set.

4.2 Counterfactual historical evolution

4.2.1 Counterfactual I

We assess the quantitative importance of the ECB's extraordinarily accommodative provision of liquidity by constructing a counterfactual scenario in which this policy is shut off. The counterfactual simulates the development of the euro area economies without the ability to accumulate sizable TARGET2 balances, conditional on the assumption that the absence of the ECB's extraordinarily accommodative provision of liquidity is not causing an outright economic collapse in individual member states or the entire euro area. In particular, due to the linearity of the empirical model, our analysis is limited to the point that we cannot construct a counterfactual in which the inability to build up large TARGET2 positions causes a tail event that is related to massive turmoil in periphery countries' financial markets or even a disintegration of the euro area. Alternatively, our counterfactual might be interpreted as a scenario that simulates the effects on the euro area economies with access to the TARGET2 system, however under the assumption that the TARGET2 balances are settled on a regular - e.g. yearly - basis. In this scenario, NCBs with TARGET2 surpluses receive assets from NCBs with TARGET2 deficits. However, this assumes that the NCBs with TARGET2 liabilities hold enough assets.

Technically, we follow Sims (1998), Sims and Zha (2006a, 2006b) and Pesaran and Smith (2016) among others and choose the paths of the fifth and sixth shock in the model, such that TARGET2 balances are equal to zero and, at the same time, the counterfactual evolution of the net foreign liabilities corresponds to private capital flows only, i.e.

$$\widetilde{nfl}_{i,t} = nfl_{i,t} - tgt_{i,t}. \tag{4.1}$$

The paths of the remaining shocks are identical to their estimated actual historical values. The difference between the actual and counterfactual evolution of an endogenous variable is then an estimate of the *ex post* effect of shutting-off the ability to accumulate TARGET2 balances by assuming that the ECB's liquidity provision through unconventional monetary policy measures would have not taken place.[22]

[22] See Bernanke, Gertler, and Watson (1997) or Sims (1998), among others for a discussion on the use of counterfactuals. In our case, the *ex post* deviation between the actual and the counterfactual evolution of the endogenous variables $X_{i,t}$ in period t, $d^{ep}_{i,t}$, is given by $d^{ep}_{i,t} = E_{t-1}(X_{i,t}|\eta_{i,1t},...,\eta_{i,6t}) - E_{t-1}(X_{i,t}|\widetilde{tgt}_{i,t},\widetilde{nfl}_{i,t},\eta_{i,1t},...,\eta_{i,4t})$, where $\widetilde{tgt}_{i,t}$ and $\widetilde{nfl}_{i,t}$ are the values of TARGET2 balances and net foreign liabilities according to our counterfactual assumption, $[\eta_{i,1t},...,\eta_{i,6t}]$ is the vector of actual structural shocks, $[\eta_{i,1t},...,\eta_{i,4t}]$ is the vector of actual values of the subset of structural shocks that are not determined endogenously in accordance with our counterfactual. In contrast, if we abstain from conditioning on the actual values of the free shocks and rather construct the difference between the sequence of unconditional one-step-ahead forecasts and the corresponding sequence of forecasts conditional on the values of TARGET2

However, note that in the counterfactual channeling funds across countries through TARGET2 is always possible.

The results of our counterfactual analysis are shown in Figure 3, where red lines correspond to the actual series while the blue lines are the medians of the counterfactuals. For Spain, Ireland and Portugal, the inability to excessively borrow from their NCB and hence to build up TARGET2 liabilities would have implied substantially lower GDP and price levels, higher long-term interest rates and thus more unfavorable financing conditions and a tendency for a faster and/or more pronounced depreciation of the real exchange rate. The effects were particularly strong in the periods characterized by substantial private capital outflows and corresponding sharp increases in national TARGET2 liabilities. Around the first peak of the European debt crisis, i.e. in the second half of 2011 and in 2012, the actual level of Spanish GDP would have been about 8% lower than actually observed. Ireland would have experienced a persistently weaker aggregate economic activity, both in the early stages of the crisis (2008-2009) as well as more recently in 2011. In particular, in both phases, Irish GDP would have been around 12% lower than actually observed. Portugal would have been confronted with a similarly persistent, albeit less pronounced (around 7%) loss of GDP. In contrast, the effects of shutting-off the access to the ECB's unconventional liquidity provision in Italy seem to be much more muted. In particular, the counterfactual level of GDP is slightly lower (by about 2%) than its actual level around 2011/2012 as Italian TARGET2 liabilities increased sharply; in 2013 and 2014 GDP would have been slightly higher. These two phases almost offset each other in terms of cumulative GDP losses. The average GDP loss, computed as the mean percentage deviation between the actual and the counterfactual GDP level over the period from 2008 through 2014, would have amounted to 1.5% in Spain, 2.3% in Portugal and 3.8% in Ireland. In addition, the GDP deflator, the effective real exchange rate and the long-term interest rate in Italy would have been barely different from those actually observed. The reason for the weak contribution of the availability of the extraordinary liquidity provision to the Italian business cycle most likely results from the relatively limited magnitude of the increase in net foreign liabilities and TARGET2 liabilities, if measured as a percentage of GDP. In particular, Italian net foreign liabilities have never exceeded 25% of GDP while, even at the first peak of the European debt crisis (2011/2012), the corresponding TARGET2 position barely reached 20% of aggregate output. In contrast, the ratio of net foreign liabilities to GDP amounted to more than 90% in

balances and net foreign liabilities, we would end up with the *ex ante* contribution $d_t^{i,ea}$ of the TARGET2 channel: $d_t^{i,ea} = E_{t-1}(X_{i,t}) - E_{t-1}(X_{i,t}|\widetilde{tgt}_{i,t}, \widetilde{nfl}_{i,t})$ (see Pesaran and Smith (2016) for an application).

Spain, around 120% in Portugal and more than 200% in Ireland. The corresponding ratios of TARGET2 liabilities to GDP reached 40% in Spain and Portugal and almost 100% in Ireland.

The counterfactuals for the core countries in our sample, i.e. Germany, France, the Netherlands and Finland, are shown in Figure 4. Our results suggest that the level of aggregate economic activity would have been higher without the build-up of large TARGET2 claims. In this scenario core countries' GDP is stimulated by a stronger fall in long-term interest rates. In particular, the drop of real interest rates is more pronounced due to the higher price dynamics, which reinforces the easing of refinancing conditions. These favourable effects seem to overcompensate the drag on GDP put by the stronger real appreciation. Overall, the absolute effects on core countries' output in the counterfactual are substantially smaller than those in the periphery economies. The level of aggregate output in Germany, the Netherlands and Finland would have been depressed by about 4%, 4% and 7%, respectively, around the peak of the euro crisis. The counterfactual for France is rather close to the actual evolution, which likely stems from its relatively small TARGET2-to-GDP ratio. The average GDP gain, measured as the mean percentage deviation between actual and counterfactual GDP over the period between 2008 and 2014, would have been 1.2% in Germany and the Netherlands and 1.5% in Finland. France would on average even have experienced a small GDP loss of about 0.5%.

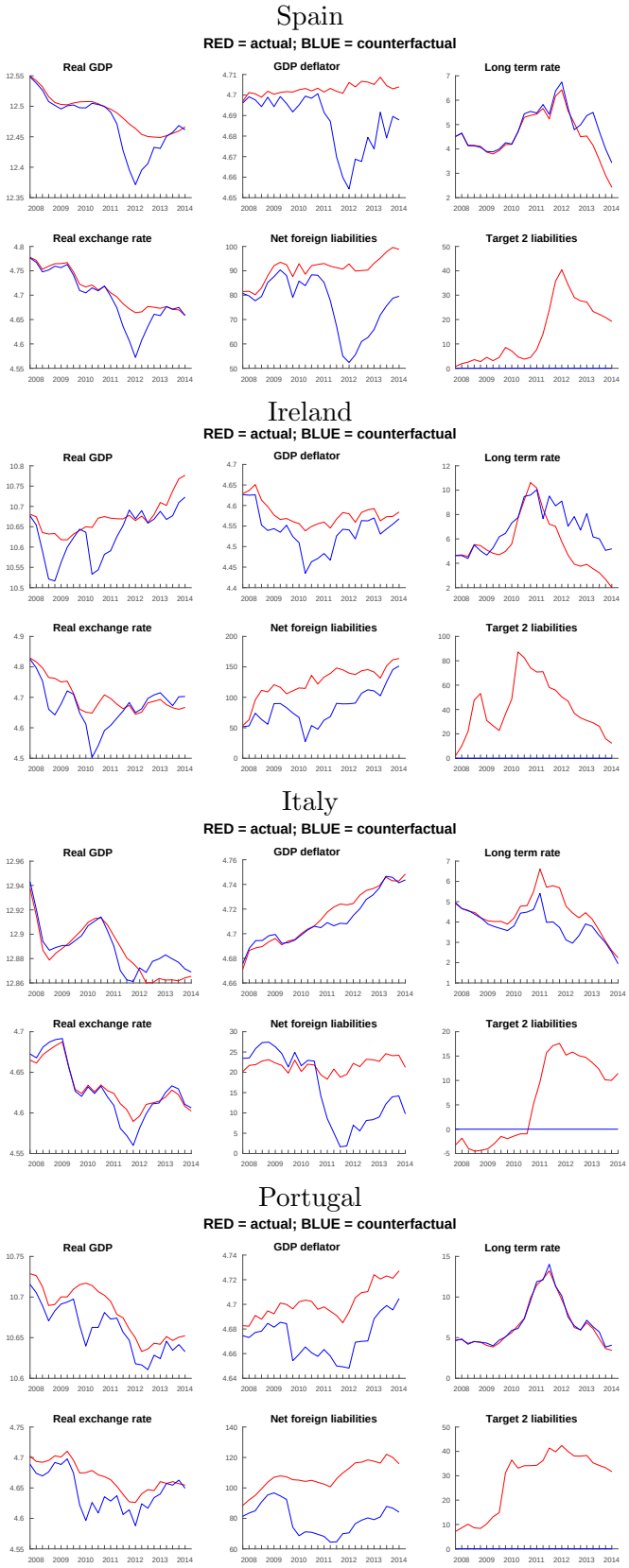
Clearly, as most counterfactuals carried out in the literature, our analysis could be challenged through the lens of the *Lucas critique*. However, as emphasized by Sims (1998), as long as the counterfactual scenario can be considered element of agents (subjective) distributional beliefs regarding the relevant economic parameters, the scenario itself does not necessarily represent a structural change. It should be rather viewed as a draw from the *unchanged* parameter distributions underlying the structure of the economy. In such a case, a counterfactual analysis is substantially less prone to the *Lucas critique* (Sims, 1998; Leeper and Zha, 2003).[23] In fact,

[23] As Sims (1998) points out, the *Lucas critique* of econometric policy evaluation (Lucas, 1976) can be summarized in terms of two relevant versions: First, according to the *Lucas critique* using a stochastic model that explicitly models the dynamics of expectations formation to evaluate changes in the policy rule as if they could be made permanent, while leaving expectations formation dynamics unchanged, is misleading (Sims, 1998, p. 153). Second, the *Lucas critique* states that conditioning on policy instruments or other stochastic variables exhibiting variations lying outside their relevant historical distributions can be misleading as it is implausible that the public would view such variations as the realizations of a fixed probability law, e.g. for policy behavior (Sims, 1998, p. 154). Akin to Sims (1998) our counterfactual analysis is not subject to the first version of the *Lucas critique*, because our model contains no explicit dynamics of expectations formation. The second version of the Lucas critique applies but, given Sims' arguments, without a noteworthy severity. See also the discussion in Bernanke, Gertler, and Watson (1997), Leeper and Zha (2003) and Pesaran and Smith (2016).

to construct our counterfactual, we need sequences of fairly unsystematic shocks that only rarely exceed their estimated two standard deviations.[24] Accordingly, we believe that the problems giving rise to the *Lucas critique* do not bias our results in a substantial way.

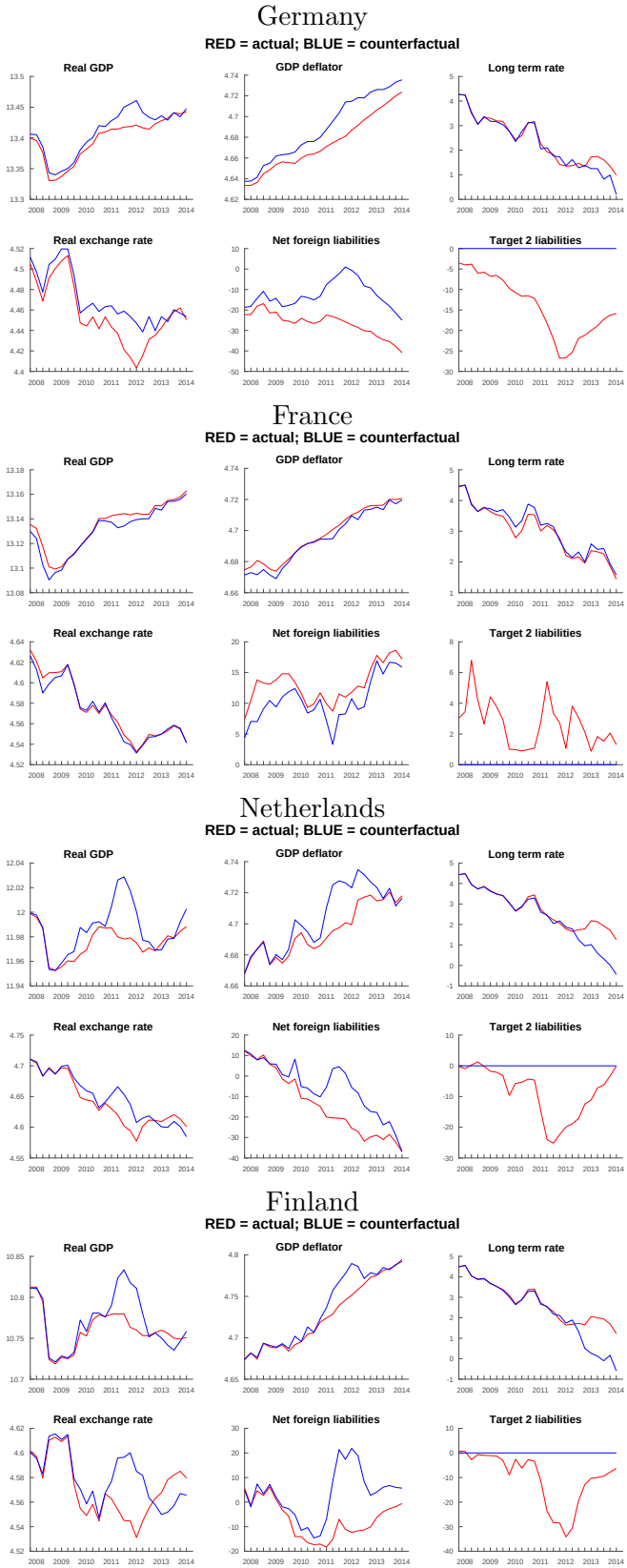
[24]The shock sequences are available upon request.

Figure 3: Actual and counterfactual evolution of macroeconomic aggregates in distressed countries



Notes: The graphs plot the actual and counterfactual (median) evolution of the macroeconomic aggregates over the period 2008Q1-2014Q4. Actuals are represented by red color, counterfactuals in blue. The counterfactuals are constructed by setting the 4th and 5th shock in the VAR to the values implying TARGET2 balances equal to zero and an evolution of the NFL reflecting only private capital flows. Real GDP, the price level and the real effective exchange rate are in logs. The long-term rate is in percent. The net foreign liability position and the TARGET2 liabilities are measured as percentages of nominal GDP.

Figure 4: Actual and counterfactual evolution of macroeconomic aggregates in core countries



Notes: The graphs plot the actual and counterfactual (median) evolution of the macroeconomic aggregates over the period 2008Q1-2014Q4. Actuals are represented by red color, counterfactuals in blue. The counterfactuals are constructed by setting the 4th and 5th shock in the VAR to the values implying TARGET2 balances equal to zero and an evolution of the NFL reflecting only private capital flows. Real GDP, the price level and the real effective exchange rate are in logs. The long-term rate is in percent. The net foreign liability position and the TARGET2 liabilities are measured as percentages of nominal GDP.

4.2.2 Counterfactual II: Alternative specification

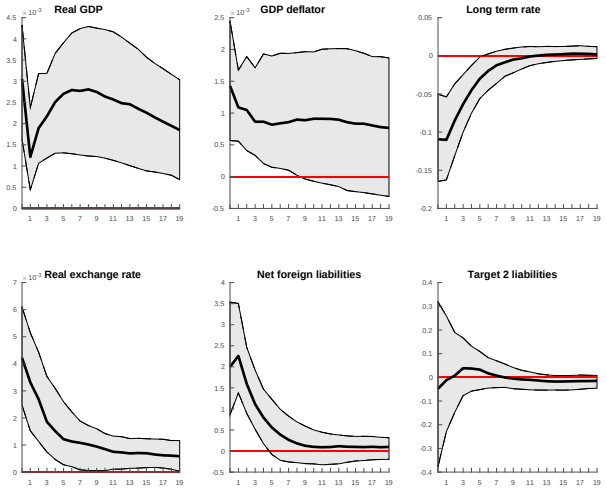
For an alternative specification of the counterfactual we follow the approach described by Sims and Zha (2006b) and set the coefficients in the TARGET2 equation to their means estimated over the pre-crisis sample, i.e. 2001Q1-2007Q4. In addition, we choose one of the structural shocks such that the counterfactual evolution of net foreign liabilities corresponds to private capital flows only as in equation (4.1). The rationale for viewing this approach (at least partly) immune to the *Lucas critique* is similar to that underlying the counterfactual spelled out in Section 4.2.1. In particular, if a subset of the actual coefficients in a VAR are replaced by values which lie within certain bounds of the corresponding (posterior) distributions, the counterfactual coefficients and the associated scenario deviate from the baseline ones only *modestly* in the sense of Leeper and Zha (2003). In such a case, the counterfactual does not necessarily represent a structural change but rather one possible draw from the *unchanged* parameter distributions underlying the structure of the economy.[25] Indeed, the pre-crisis values of the coefficients in the TARGET2 equation of our VAR lie within the 95% credibility bounds of the post-crisis distributions of the same parameters. Accordingly, we view the coefficient restriction imposed as a *modest* change.

A necessary preliminary step is to estimate the model over the years preceding the outbreak of the Global Financial Crisis. The results are again summarized by impulse response functions to the three structural shocks discussed in Section 3.2 and identified as in Table 1. Figure 5 displays the impulse responses. As can be seen, in contrast to the period after 2008, the structural shocks do not induce statistically significant changes in the TARGET2 liabilities. This is barely surprising since the latter were almost time invariant over the period 2001-2007 (see also Figure 1).

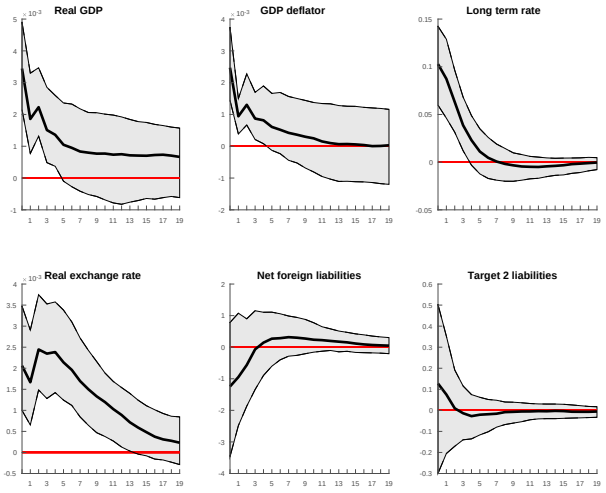
[25] See Sims and Zha (2006b) for a detailed discussion and several applications.

Figure 5: Impulse responses to aggregate shocks. Sample: 2001Q1-2007Q4

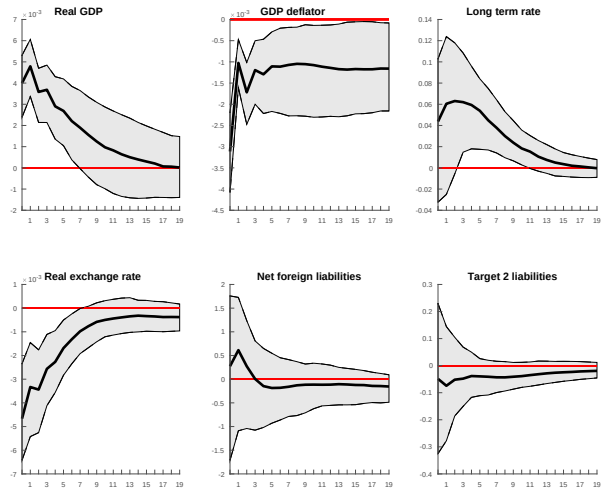
Capital inflow shock



Aggregate demand shock



Aggregate supply shock



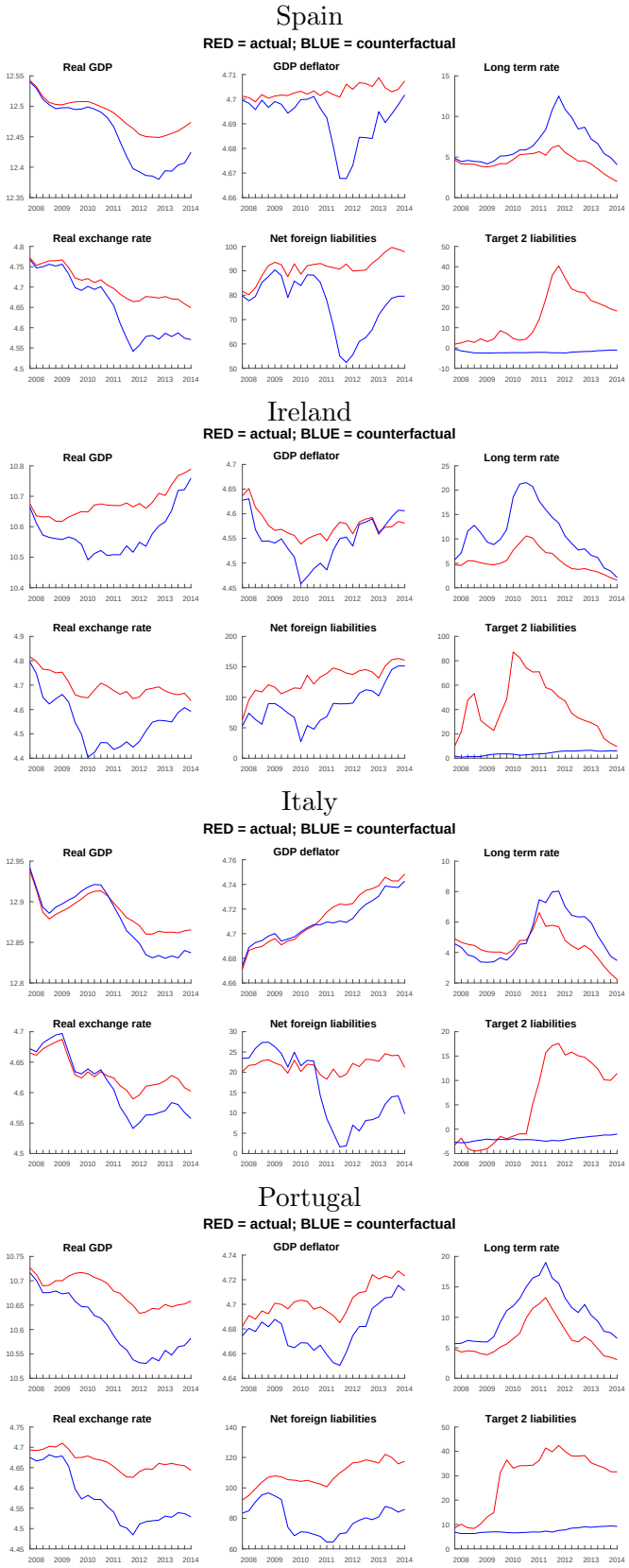
Notes: Real GDP, the price level and the real effective exchange rate are in logs. The long-term nominal interest rate is in percent. The net foreign liability position and the TARGET2 liabilities are measured as percentages of nominal GDP. An increase of the NFL or TARGET2 is equivalent to a net accumulation of liabilities. Solid black lines and shaded areas reflect the median response and the 68% credible set.

For each distressed country, Figure 6 displays the evolution of the six endogenous model variables along their respective actual (red) as well as the counterfactual (blue) paths. The figure reveals a qualitatively similar picture as that presented in Section 4.2.1. Again, switching-off the access to the ECB's unconventional liquidity provision and thus, restricting the build-up of TARGET2 balances, would have induced much stronger adverse effects in Spain, Ireland and Portugal while being associated with still unfavorable but relatively more muted contribution to economic activity in Italy. However, in contrast to the analysis presented in Section 4.2.1, now the counterfactual effects are substantially stronger. In particular, GDP would have persistently fallen short of its actual level by about 18% in Ireland, 11% in Portugal, 10% in Spain and 4% in Italy, since the first eruptions associated with the euro crisis in 2010. Correspondingly, in each country, the long-term interest rates would have been way higher, while the price level and the real exchange rate would have been markedly lower than actually observed. The average GDP losses over the time span 2008-2014 would have been 9.6% in Ireland, 7.3% in Portugal, 3.1% in Spain and 1% in Italy.

For the core countries Figure 7 shows that the quantitative contributions of the ability to build-up sizable TARGET2 claims might have been stronger than those presented in Section 4.2.1 and shown in Figure 4. In the counterfactual GDP would have exceeded its actually observed level since 2010 by up to 6% in Germany and the Netherlands and by up to 5% in Finland. The average GDP gains over the crisis sample 2008-2014 would have been around 3.5% in Germany, 2.3% in the Netherlands and 2.7% in Finland. In contrast, France would have experienced a small GDP loss in the counterfactual of slightly less than 1%.

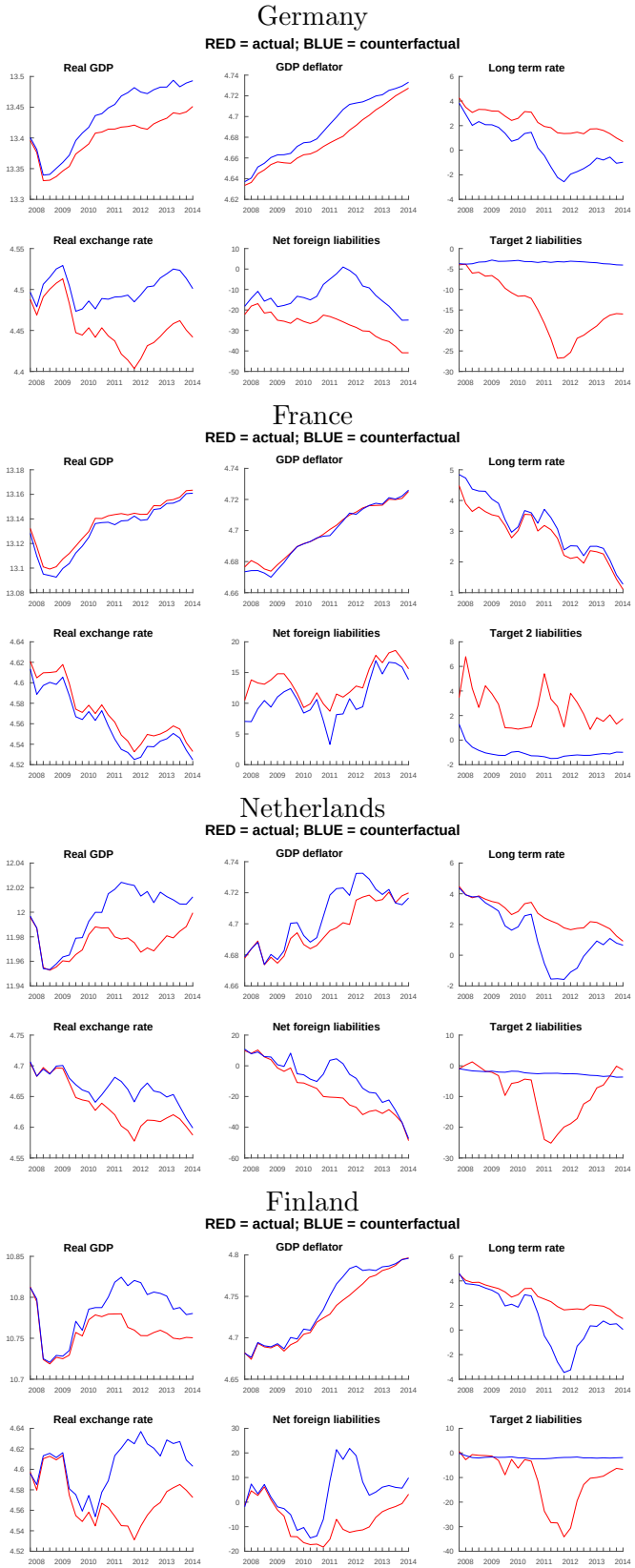
The quantitatively different importance assigned to the ECB's unconventional liquidity provision by the two types of counterfactual analyses (Figures 6 and 7 in comparison with Figures 3 and 4) is barely surprising. As discussed by Sims and Zha (2006b), counterfactuals based on sequences of structural white noise shocks, which are of modest magnitude in order not to exceed certain distributional bounds, typically generate relatively small and short-lived deviations between the counterfactual and the actual evolution of the endogenous variables in a VAR. In contrast, imposing counterfactuals constructed by restricting a subset of the VAR coefficients tend to be associated with a larger contribution of the channel under consideration.

Figure 6: Actual and counterfactual evolution of macroeconomic aggregates in distressed countries



Notes: The graphs plot the actual and counterfactual (median) evolution of the macroeconomic aggregates over the period 2008Q1-2014Q4. Actuals are represented by red color, counterfactuals in blue. The counterfactuals are constructed by setting the coefficients in the equations for TARGET2 and NFL to their estimated means based on the pre-crisis sample, i.e. 2001Q1-2007Q4. Real GDP, the price level and the real effective exchange rate are in logs. The long-term rate is in percent. The net foreign liability position and the TARGET2 liabilities are measured as percentages of nominal GDP.

Figure 7: Actual and counterfactual evolution of macroeconomic aggregates in core countries



Notes: The graphs plot the actual and counterfactual (median) evolution of the macroeconomic aggregates over the period 2008Q1-2014Q4. Actuals are represented by red color, counterfactuals in blue. The counterfactuals are constructed by setting the coefficients in the equations for TARGET2 and NFL to their estimated means based on the pre-crisis sample, i.e. 2001Q1-2007Q4. Real GDP, the price level and the real effective exchange rate are in logs. The long-term rate is in percent. The net foreign liability position and the TARGET2 liabilities are measured as percentages of nominal GDP.

4.3 Robustness checks

We ran a number of robustness checks along several dimensions of the VAR.[26] In sum, our results are qualitatively unaffected and subject to only marginal quantitative changes if we vary the lag length p of the VAR between 2 and 6, if we impose the sign restrictions over a shorter horizon, i.e. only 2 or 3 quarters and if we reduce the number of identified structural shocks beyond the capital inflow shock. Finally, within both, the set-up of Section 4.2.1 and that of Section 4.2.2 we varied the subset of structural shocks that are determined endogenously to satisfy the counterfactual assumptions. The quantitative effects turned to be very small.

5 Conclusion

This paper explores how the uneven recourse of national banking systems in the euro area to the ECB's unconventional refinancing operations that led to the accumulation of large TARGET2 balances at the NCBs, has contributed to the evolution of GDP, long-term interest rates, aggregate prices and international competitiveness in important member states of the euro area. For the period between the onset of the Global Financial Crisis and 2014 we estimate a structural panel VAR model and identify the structural shocks by means of sign restrictions.

Our main findings are as follows. First, the results of our impulse response analysis indicate that the recourse to the ECB's unconventional monetary policy measures – reflected in the accumulation of TARGET2 balances – has been mainly driven by capital flow shocks. In contrast, cyclical drivers like innovations to aggregate demand or aggregate supply do not seem to induce statistically significant changes in TARGET2 positions. Second, our counterfactual experiments indicate that, in the period between 2008 and 2014, the increased liquidity provision by the Eurosystem and thus, the ability to build-up sizable TARGET2 liabilities has contributed substantially to avoid deeper recessions in the distressed euro area member countries Spain, Italy, Ireland and Portugal. In particular, recourse of the national banking systems to the fixed-rate, full-allotment liquidity-providing tenders of their NCBs allowed for more favorable refinancing conditions – as measured by national long-term government bond rates – as well as higher GDP levels. In the core countries, Germany, the Netherlands and Finland, the accumulation of TARGET2 claims contributed unfavorably to aggregate economic activity. However, at the individual country level, the effect turned out to be smaller than in the distressed economies of the euro area. Aggregate output in France was barely affected by the emergence of

[26] The results are available upon request.

TARGET2 balances. These findings are based on the assumption that the absence of the ability of periphery countries to accumulate TARGET2 liabilities would not have caused massive distortions. In this case our results point towards a distributional effect of ECB's extraordinary liquidity measures shifting real resources from Germany, the Netherlands and Finland towards Spain, Ireland, Portugal and to a more limited extent Italy.

References

Attinasi, M. G., and L. Metelli (2017): "Is fiscal consolidation self-defeating? A panel-VAR analysis for the Euro area countries," *Journal of International Money and Finance*, 74(C), 147–164.

Auer, R. A. (2014): "What drives TARGET2 balances? Evidence from a panel analysis," *Economic Policy*, 29(77), 139–197.

Barkbu, B., B. Eichengreen, and A. Mody (2012): "Financial crises and the multilateral response: What the historical record shows," *Journal of International Economics*, 88(2), 422–435.

Beetsma, R., and M. Giuliodori (2011): "The Effects of government purchases shocks: review and estimates for the EU," *Economic Journal*, 121(550), 4–32.

Bems, R., L. Dedola, and F. Smets (2007): "US imbalances: The role of technology and policy," *Journal of International Money and Finance*, 26(4), 523–545.

Benetrix, A. S., P. R. Lane, and J. C. Shambaugh (2015): "International currency exposures, valuation effects and the global financial crisis," *Journal of International Economics*, 96(S1), 98–109.

Bernanke, B. S., M. Gertler, and M. Watson (1997): "Systematic monetary policy and the effects of oil price shocks," *Brookings Papers on Economic Activity*, 28(1), 91–157.

Bindseil, U., P. Cour-Thimann, and P. König (2012): "Target2 and cross-border interbank payments during the financial crisis," *CESifo Forum*, 13(SPECIALIS), 83–92.

Bindseil, U., and P. J. König (2012): "TARGET2 and the European sovereign debt crisis," *Credit and Capital Markets*, 45(2), 135–174.

Buiter, W. H., and E. Rahbari (2012): "Target2 Redux: The simple accountancy and slightly more complex economics of Bundesbank loss exposure through the Eurosystem," CEPR Discussion Papers 9211, C.E.P.R. Discussion Papers.

Caballero, R. J., E. Farhi, and P.-O. Gourinchas (2008): "An equilibrium model of 'global imbalances' and low interest rates," *American Economic Review*, 98(1), 358–93.

Caballero, R. J., and A. Krishnamurthy (2009): "Global imbalances and financial fragility," *American Economic Review*, 99(2), 584–88.

Canova, F., and G. de Nicolo (2002): "Monetary disturbances matter for business fluctuations in the G-7," *Journal of Monetary Economics*, 49, 1131–1159.

Canova, F., and M. Paustian (2011): "Business cycle measurement with some theory," *Journal of Monetary Economics*, 58(4), 345–361.

Cardarelli, R., S. Elekdag, and M. A. Kose (2010): "Capital inflows: Macroeconomic implications and policy responses," *Economic Systems*, 34(4), 333–356.

Chinn, M. D., and E. S. Prasad (2003): "Medium-term determinants of current accounts in industrial and developing countries: an empirical exploration," *Journal of International Economics*, 59(1), 47–76.

Ciccarelli, M., A. Maddaloni, and J.-L. Peydro (2013): "Heterogeneous transmission mechanism: monetary policy and financial fragility in the euro area," Working Paper Series 1527, European Central Bank.

Ciccarelli, M., A. Maddaloni, and J. L. Peydro (2015): "Trusting the bankers: A new look at the credit channel of monetary policy," *Review of Economic Dynamics*, 18(4), 979–1002.

Clarida, R., J. Gali, and M. Gertler (2002): "A simple framework for international monetary policy analysis," *Journal of Monetary Economics*, 49(5), 879–904.

Corsetti, G., and P. Pesenti (2001): "Welfare and macroeconomic interdependence," *The Quarterly Journal of Economics*, 116(2), 421–445.

Dor, E. (2016): "Explaining the surge of TARGET2 liabilities in Italy: Less simple than the ECB's narrative," Working paper, IESEG School of Management.

Eichenbaum, M., and C. L. Evans (1995): "Some empirical evidence on the effects of shocks to monetary policy on exchange rates," *The Quarterly Journal of Economics*, 110(4), 975–1009.

Eisenschmidt, J., D. Kedan, M. Schmitz, R. Adalid, and P. Papsdorf (2017): "The Eurosystem's asset purchase programme and TARGET balances," Occasional Paper Series 196, European Central Bank.

European Central Bank (2013): "TARGET balances and monetary policy operations," *Monthly Bulletin*, May, 103–114.

Fagan, G., and P. McNelis (2014): "TARGET Balances and Macroeconomic Adjustment to Sudden Stops in the Euro Area," The Institute for International Integration Studies Discussion Paper Series 465, IIIS.

Farrant, K., and G. Peersman (2006): "Is the exchange rate a shock absorber or a source of shocks? New empirical evidence," *Journal of Money, Credit and Banking*, 38(4), 939–961.

Faust, J., and J. H. Rogers (2003): "Monetary policy's role in exchange rate behavior," *Journal of Monetary Economics*, 50(7), 1403–1424.

Favilukis, J., D. Kohn, S. C. Ludvigson, and S. V. Nieuwerburgh (2013): "International capital flows and house prices: Theory and evidence," in *Housing and the Financial Crisis*, NBER Chapters, pp. 235–299. National Bureau of Economic Research, Inc.

Forni, M., and L. Gambetti (2010): "The dynamic effects of monetary policy: A structural factor model approach," *Journal of Monetary Economics*, 57(2), 203–216.

Fratzscher, M., C. Saborowski, and R. Straub (2009): "Monetary policy shocks and portfolio choice," Working Paper Series 1122, European Central Bank.

Gambacorta, L., B. Hofmann, and G. Peersman (2014): "The effectiveness of unconventional monetary policy at the zero lower bound: A cross-country analysis," *Journal of Money, Credit and Banking*, 46(4), 615–642.

Glick, R., and K. Rogoff (1995): "Global versus country-specific productivity shocks and the current account," *Journal of Monetary Economics*, 35(1), 159–192.

Gruber, J. W., and S. B. Kamin (2007): "Explaining the global pattern of current account imbalances," *Journal of International Money and Finance*, 26(4), 500–522.

Jongwanich, J., and A. Kohpaiboon (2013): "Capital flows and real exchange rates in emerging Asian countries," *Journal of Asian Economics*, 24(C), 138–146.

Kim, S., and S. H. Kim (2013): "International capital flows, boom-bust cycles, and business cycle synchronization in the asia pacific region," *Contemporary Economic Policy*, 31(1), 191–211.

Kim, S., and D. Yang (2011): "The impact of capital inflows on asset prices in emerging asian economies: Is too much money chasing too little good?," *Open Economies Review*, 22(2), 293–315.

Lane, P. R. (2001): "The new open economy macroeconomics: a survey," *Journal of International Economics*, 54(2), 235–266.

Lane, P. R., and G. M. Milesi-Ferretti (2011): "The cross-country incidence of the global crisis," *IMF Economic Review*, 59(1), 77–110.

Lee, J., and M. D. Chinn (2006): "Current account and real exchange rate dynamics in the G7 countries," *Journal of International Money and Finance*, 25(2), 257–274.

Leeper, E. M., and T. Zha (2003): "Modest policy interventions," *Journal of Monetary Economics*, 50(8), 1673–1700.

Lucas, R. J. (1976): "Econometric policy evaluation: A critique," *Carnegie-Rochester Conference Series on Public Policy*, 1(1), 19–46.

Mendoza, E. G. (2010): "Sudden stops, financial crises, and leverage," *American Economic Review*, 100(5), 1941–1966.

Minenna, M. (2017): "The ECB's story on TARGET2 doesn't add up," Guest post, FT Alphaville.

Obstfeld, M., and K. Rogoff (2002): "Global implications of self-oriented national monetary rules," *The Quarterly Journal of Economics*, 117(2), 503–535.

Peersman, G. (2005): "What caused the early millennium slowdown? Evidence based on vector autoregressions," *Journal of Applied Econometrics*, 20(2), 185–207.

Pesaran, H., and R. P. Smith (2016): "Counterfactual analysis in macroeconometrics: An empirical investigation into the effects of quantitative easing," *Research in Economics*, 70(2), 262–280.

Reinhart, C., and V. Reinhart (2009): "Capital flow bonanzas: An encompassing view of the past and present," in *NBER International Seminar on Macroeconomics 2008*, NBER Chapters, pp. 9–62. National Bureau of Economic Research, Inc.

Sa, F., P. Towbin, and T. Wieladek (2014): "Capital inflows, financial structure and housing booms," *Journal of the European Economic Association*, 12(2), 522–546.

Sa, F., and F. Viani (2013): "Shifts in portfolio preferences of international investors: An application to sovereign wealth funds," *Review of International Economics*, 21(5), 868–885.

Sa, F., and T. Wieladek (2015): "Capital inflows and the U.S. housing boom," *Journal of Money, Credit and Banking*, 47(S1), 221–256.

Schmidt, T., and L. Zwick (2015): "Uncertainty and episodes of extreme capital flows in the Euro Area," *Economic Modelling*, 48(C), 343–356.

Scholl, A., and H. Uhlig (2008): "New evidence on the puzzles: Results from agnostic identification on monetary policy and exchange rates," *Journal of International Economics*, 76(1), 1–13.

Sims, C. A. (1998): "Role of interest rate policy in the generation and propagation of business cycles: what has changed since the '30s?," *Conference Series ; [Proceedings]*, 42(Jun), 121–175.

Sims, C. A., and T. Zha (2006a): "Does monetary policy generate recessions?," *Macroeconomic Dynamics*, 10(02), 231–272.

——— (2006b): "Were there regime switches in U.S. monetary policy?," *American Economic Review*, 96(1), 54–81.

Sinn, H.-W., and T. Wollmershäuser (2012a): "Target balances and the German financial account in light of the European balance-of-payments crisis," CESifo Working Paper Series 4051, CESifo Group Munich.

——— (2012b): "Target loans, current account balances and capital flows: the ECB's rescue facility," *International Tax and Public Finance*, 19(4), 468–508.

Straub, R., and G. Peersman (2006): "Putting the New Keynesian model to a test," IMF Working Papers 06/135, International Monetary Fund.

Tille, C. (2001): "The role of consumption substitutability in the international transmission of monetary shocks," *Journal of International Economics*, 53(2), 421–444.

Tillmann, P. (2013): "Capital inflows and asset prices: Evidence from emerging Asia," *Journal of Banking and Finance*, 37(3), 717–729.

Uhlig, H. (2005): "What are the effects of monetary policy on output? Results from an agnostic identifcation procedure," *Journal of Monetary Economics*, 52, 381–419.

Warnock, F. E., and V. C. Warnock (2006): "International capital flows and U.S. interest rates," *Journal of International Money and Finance*, 28, 903–919.

Whelan, K. (2012): "ELA, promissory notes and all that: The fiscal costs of anglo irish bank," *The Economic and Social Review*, 43(4), 653–673.

——— (2014): "TARGET2 and central bank balance sheets," *Economic Policy*, 29(77), 79–137.

Zettelmeyer, J. (2004): "The impact of monetary policy on the exchange rate: evidence from three small open economies," *Journal of Monetary Economics*, 51(3), 635–652.

Zwick, L. (2015): "International liquidity shocks and domestic loan supply in the euro area," Ruhr Economic Papers 564, RWI - Leibniz-Institut für Wirtschaftsforschung, Ruhr-University Bochum, TU Dortmund University, University of Duisburg-Essen.

Appendix

Data

The series for real GDP, the GDP deflator and the long-term nominal interest rate are taken from the database of the OECD. Real GDP refers to seasonally adjusted quarterly gross domestic product in Euros and at constant prices. The GDP deflator is the related price index, which is set equal to 100 in 2010. The long-term nominal interest rate is measured in per cent p.a. and proxied by the quarterly average yield of ten year government bonds.

The real effective exchange rate is the quarterly harmonised competitiveness indicator of the ECB. It is calculated as weighted average of the nominal exchange rate of the euro area member countries vis-à-vis the 19 most important trading partners of the euro area and the other euro area member countries and is deflated by GDP deflators. The weights are based on bilateral data on trade in manufactured goods. The real effective exchange rate is a seasonally-adjusted index, which is equal to 100 in 1999Q1.

The net foreign liabilities are calculated as balance between all financial liabilities and assets of an economy's residents vis-à-vis the rest of the world, valued at market prices at the end of the quarter and divided by the annualised nominal GDP of this quarter. The series are taken from the Eurostat database (Tables on EU policy, Macroeconomic imbalance procedure indicators, International investment position). Missing data for Ireland (2001) and the Netherlands (2001 and 2002) was taken from a discontinued earlier version of Eurostat's balance of payments statistics (which was calculated according to the fifth edition of the IMF's Balance of Payments and International Investment Position Manual).

The TARGET2 (net) liabilities represent total TARGET2 liabilities netted against total TARGET2 claims. The quarterly value is calculated from the average value of the NCB's TARGET2 liability in the third month of each quarter, divided by the annualised nominal GDP of this quarter. The series are taken from the ECB database.