Exit Strategies, Capital Flight and Speculative Attacks: Europe's Version of the Trilemma

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Exit Strategies, Capital Flight and Speculative Attacks: Europe's Version of the Trilemma*

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Abstract

In the winter 2011/12 a wave of internal capital flight prompted the ECB to abandon its exit strategy and to announce an unprecedented monetary expansion. We analyze this episode in several dimensions: (i) by providing an event-study analysis covering key variables from national central banks' balance sheets, (ii) by rationalizing their patterns in a portfolio balance model of the exchange rate, augmented by institutional characteristics of the TARGET2 system, and (iii) by proposing a theory-based index of exchange market pressure within the euro area. We argue that the euro area entails an inherent policy trilemma that makes it prone to speculative attacks.

JEL Classification: E42; F36; F41; F45.
Keywords: Currency Union; Exchange Market Pressure; Policy Trilemma; Speculative Attack; TARGET2.

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1 Introduction

In small open economies with fixed exchange rates, capital flight often is the root cause of foreign exchange market pressure. The central bank faces the trilemma that it cannot accommodate capital flight with a monetary expansion, while at the same time keeping the exchange rate fixed. At some point countries run out of reserves and a speculative attack breaks the monetary arrangements apart.

The events of the euro crisis have been highly reminiscent of a speculative attack on a fixed exchange rate. In the winter 2011/12, internal capital flight reached its peak when national central banks (NCBs) provided one trillion euros of refinancing credit to banks, thereby accommodating investors' preferences to hold assets in safe countries.[1] This happened at a time when the ECB pursued an exit strategy for the euro area, by raising interest rates and collateral standards. These parallel developments generated severe market tensions and rising break-up expectations in early December 2011, when banks also started using the swap line and borrowed from the ECB in US Dollars.[2] A major policy reversal, including first two tranches of 3-year longer-term refinancing operations (LTROs) and later the promise of unlimited liquidity finally stopped these capital flight dynamics. Christian Noyer, Governor of the Bank of France, interprets the ECB's actions as a "*solid shield against further speculative attacks.*"[3]

The mechanism behind the attack, however, is often not well understood. What are the constraints for NCBs when providing refinancing credit to banks? What is the target of a potential speculative attack from the investors' perspective? What has been the trigger event that caused speculative capital flows within the euro area? Finally, was the attack in 2011/12 successful, or not?

To address these questions, we analyze the institutional characteristics of the euro area with a particular focus on the NCBs in the Eurosystem and the TARGET2 clearing system. We show theoretically that the common central bank of a currency union cannot simultaneously control the monetary base and delegate the implementation of a full-allotment policy to NCBs. At the time of a speculative attack, it is forced to abandon one of the following incompatible objectives: (i) the full-allotment policy, (ii) its monetary target or (iii) the single currency. This result is reminiscent of the well-known *impossible trinity*. In contrast to the literature, however, we focus on policy options within a common currency area, not on individual countries. Financial markets anticipating this predicament will attack the currency union when the ability to accommodate internal capital flight—given a particular monetary target—reaches a critically low level.

From an investor's perspective, we highlight that a flight-to-safety motivation helps to explain capital flight within the euro area.[4] To understand the role of the Eurosystem in the crisis dynamics, it is important to keep in mind that the NCBs' liquidity provision is closely linked to the amount of safe and risky assets available for trading in the markets. The liquidity provision in the crisis countries has absorbed risky assets that were used as collateral when borrowing from NCBs. At the same time, the liquidity absorption of the safe-haven countries has released safe assets from being tied-up as collateral. This way, they became available to be purchased by investors and the price reaction of safe assets to capital flight was less pronounced. A key aspect of the euro crisis is that the amount of risky assets absorbed, and safe assets entering the market, was limited by the ECB's decision to maintain a certain monetary target. We argue that the anticipated increase in the price of safe assets, after the Eurosystem reached a critical limit, contributed to the dynamics of speculative capital flows. In a portfolio balance model of the exchange rate, we show that a strict monetary target for the aggregate euro area, combined with a full-allotment policy for NCBs, eventually creates euro-break-up expectations on the side of investors.

[1] See Sinn and Wollmershäuser (2012), who interpreted the euro crisis as a classical balance of payments crisis, and Tornell (2013), as well as references therein.

[2] See also Cecchetti et al. (2012), who argue that the "Flows of funds suggest that 2012's last leg up in TARGET2 balances reflected something more akin to a currency attack than current account financing or credit reversal."

[3] Speech by Christian Noyer, Governor of the Bank of France and Chairman of the Board of Directors of the Bank for International Settlements, at the Institute of International Finance, Paris, 26 June 2013. The statement was made with special reference to the Outright Monetary Transactions (OMT) program.

[4] This is in line with Caballero et al. (2017), who argue that the perceived violation of the fiscal capacity condition of some euro area countries contributed substantially to a worldwide contraction and supply-shortage of safe assets.

The empirical analysis in this paper consists of two parts. First, we illustrate key macroeconomic variables, as well as indicators from central bank balance sheets in an event-study analysis, centered around the ECB's monetary expansion on December 8, 2011. In particular, we document the patterns of refinancing credit, deposits, reserves, swap lines and TARGET2 balances. We derive a set of stylized facts from this analysis by comparing a group of countries in crisis—Greece, Italy, Ireland, Portugal and Spain (GIIPS)—with a set of countries that have been the recipients of capital flight—Germany, the Netherlands, Finland and Luxembourg (DNFL). We illustrate that the observed patterns in these country groups are strikingly similar to those when comparing, for instance, Mexico and the United States around the Tequila Crisis in 1994/95. Second, based on the theoretical analysis, we construct a new proxy of exchange market pressure in the euro area. We externally verify this index by showing that it correlates with other indexes of break-up risk such as Google searches for break-up or the implied break-up probability from betting platforms.

Finally, based on theory and the empirical analysis, we argue that the ECB's exit strategy in the summer of 2011 can be interpreted as a trigger event for the attack. It added a third policy objective to the earlier decision on full allotment and the overall objective of keeping the single currency intact. The monetary expansion in December 2011 postponed the break-up scenario and the promise of unlimited liquidity in the Outright Monetary Transactions (OMT) Program ultimately forestalled the dynamics. While the attack, from today's perspective, was unsuccessful, the ECB's exit strategy was unsuccessful as well.

The remainder of the paper is organized as follows: The next section describes the behavior of key macroeconomic variables around December 2011. Section 3 provides institutional details of the TARGET2 system and shows how cross-border capital flows affect central bank balance sheets. It derives the European version of the trilemma from a central bank perspective. Section 4 integrates the institutional particularities of the TARGET2 system in a standard portfolio balance model of the exchange rate. The exchange market pressure index for the euro area is presented in Section 5. After discussing the links of our paper to the existing literature in Section 6, the final section provides policy conclusions.

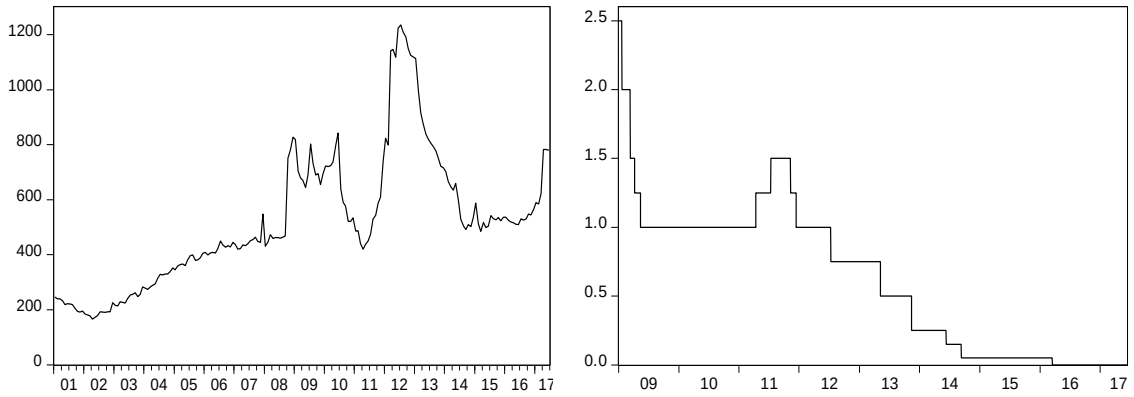
2 Stylized Facts

We start our analysis with the pattern of key macroeconomic variables around December 2011 when the ECB abolished its exit strategy and announced an unprecedented monetary expansion, often referred to as the "Big Bazooka." The collection of graphs extends and complements the work of Sinn and Wollmershäuer (2012), who first described the TARGET2 system and the existence of a balance of payments crisis in Europe in an academic paper[5]. In subsequent sections, these empirical facts will be used as a basis for the theoretical analysis.

Stylized Fact 1: In the beginning of 2011, the ECB followed an exit strategy for the euro area.

At the peak of the financial crisis, in October 2008, the ECB had reacted with a full-allotment policy, which led to an expansion of refinancing credit to private banks by €372 bn. Thereafter, however, it has managed to return aggregate lending back to its original trend growth (see Panel A of Figure 1). This return to trend growth was not only due to a reduced demand for refinancing credit, but rather was a result of a policy reversal of the ECB. Since mid-2009, the ECB had gradually started an exit strategy, which can be seen by the tightening of collateral standards and an increase in the main refinancing rate in the beginning of 2011 (see Panel B of Figure 1). For example, the ECB decided on additional requirements for asset-backed securities to be eligible for use as collateral (November 2009), suspended the use of foreign-currency debt instruments (April 2010), applied higher haircuts (July 2010) and underlined that the ECB is able to "suspend, limit or exclude counterparties' access to monetary policy instruments on the grounds of prudence" and to reject or limit the use of assets submitted as collateral by specific banks (October 2010). Moreover, ECB officials started talking about exit strategies and increased the main refinancing rate from 1.0% in the first quarter of 2011 to 1.5% in the third quarter. By mid-2010, the media widely regarded ECB monetary policy to be in the process of exiting from its exceptional credit provision.

Figure 1: ECB Monetary Expansion and Exit Strategy



(A) Refinancing Credit (B) Refinancing Rate

Notes: Panel A shows the total refinancing credit of the Eurosystem central banks [bn €], Panel B shows the Eurosystem main refinancing rate for fixed-rate tenders [%]. Sources: ECB SDW (Codes: ILM.M.4F.E.A050000.U2.EUR, FM.D.U2.EUR.4F.KR.MRR_FR.LEV).

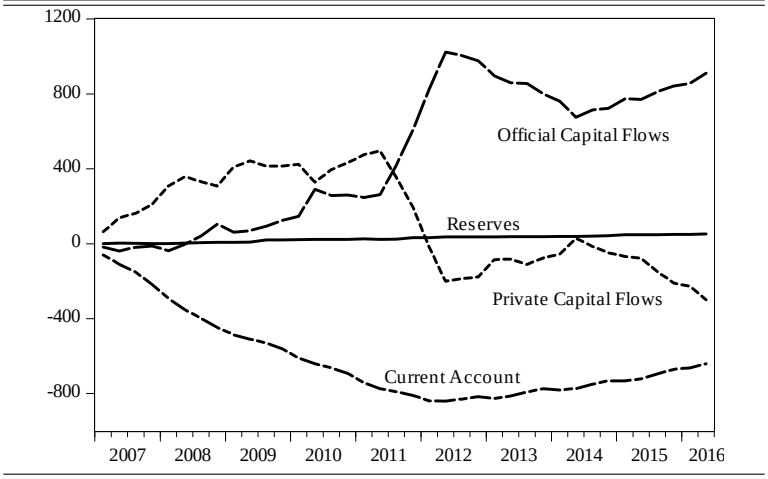
[5] See also Sinn (2014) for a comprehensive overview.

Stylized Fact 2: The ECB's exit strategy was (i) preceeded by large current account deficits and (ii) followed by a sharp reversal in private capital flows.

The second empirical observation is that there has been a continuous process of current account deficits, prior to 2011, in the GIIPS countries. The current account deficit is the "usual suspect" that has been identified as the fundamental cause of balance of payments crises in the literature. In Figure 2, which adds up the current account deficits in the GIIPS, one can clearly see an uninterrupted decline of the cumulative current account balance until 2012, when the process appears to have stabilized at about €760 bn.[6]

The other two dashed lines show how this current account deficit has been financed. Up to 2011, private capital inflows were the largest source of financing. In mid-2011, however, private funding started to fall and fully reversed in the beginning of 2012. Since then, the GIIPS have been characterized by private capital outflows. Instead, public capital flows started to rise. Figure 2 shows official capital flows defined as the sum of all bilateral and multilateral lending, including loans by the European Financial Stability Facility (EFSF), the European Financial Stabilisation Mechanism (EFSM), the European Stability Mechanism (ESM), and intra-Eurosystem liabilities (TARGET2), which have become the largest component of public capital towards the end of the sample.

Figure 2: Balance of Payments of GIIPS Countries



Notes: The figure shows the cumulative current account, the cumulative capital account split into private and public sector, and the change in central banks' reserves. Public-sector entities include the IMF, EFSF, EFSM, ESM, Eurosystem and bilateral lenders. All series in billions of euros. Source: IMF Balance of Payments Statistics.

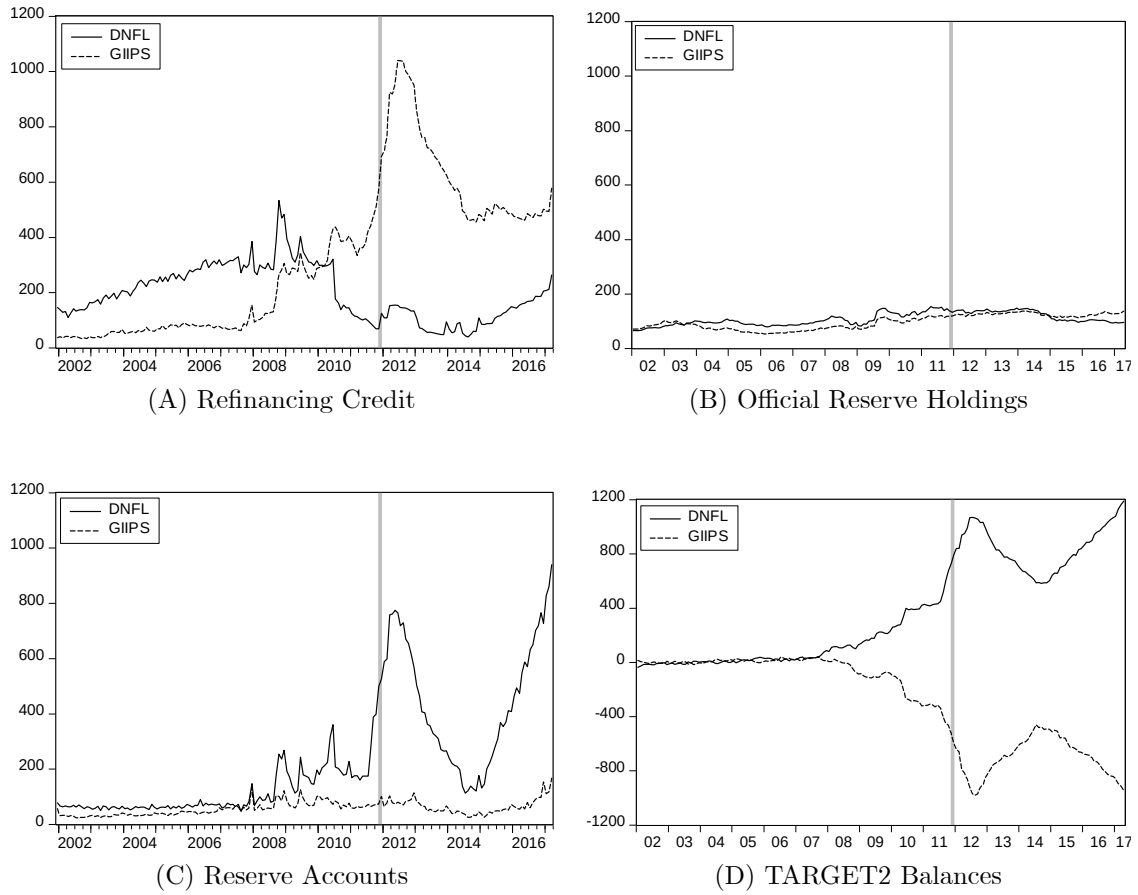
Stylized Fact 3: Monetary aggregates mask asymmetries on NCB balance sheets.

The pattern of monetary aggregates, such as the refinancing credit displayed in Figure 1, has been masking important asymmetries across countries' NCBs. While raising the interest rate and tightening collateral requirements, the ECB has maintained its full-allotment policy, and even reduced collateral standards for some specific countries. Consequently, refinancing credit in some countries kept expanding, even though the aggregate policy was becoming more restrictive.

[6] See also Schnabl and Freitag (2012) for an analysis of intra-Eurosystem imbalances of the current account.

Figure 3 displays the main patterns of NCBs balance sheets for two groups of countries, GIIPS and DNFL. In the upper left quadrant (Panel A), one can see that central bank credit expanded in the GIIPS up to the summer 2012, while it was falling in DNFL. This expansion of credit in the crisis countries with a parallel reduction of credit in other countries coincided with the private capital account reversal, illustrated in Figure 2. As the balance sheet analysis suggests, this process of asymmetric liquidity provision and capital flight has led to large claims and liabilities across NCBs (TARGET2 balances), depicted in Panel D of Figure 3. At the local peak in August 2012, DNFL had accumulated €1056 bn in TARGET2 claims while GIIPS had €1000 bn in liabilities.[7] Unlike in emerging market economies during balance of payments crises, however, official reserve holdings remained largely unchanged (see Panel B).

Figure 3: Asymmetries between Core and Periphery Central Banks



Notes: Shaded area marks December 2011. All series in billions of euros. Sources: IMF International Financial Statistics (Codes: RAFA, FASMBLD, FASAD), Euro Crisis Monitor, authors' calculations.

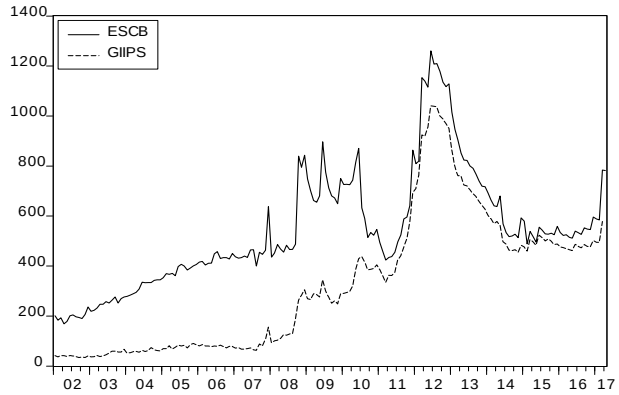
[7] Most recently, since 2015, TARGET2 balances have again been experiencing a rapid increase. In contrast to their earlier rise up to 2012, this increase is largely unrelated to the provision of refinancing credit by NCBs. Instead, the program of Quantitative Easing (QE) is often implemented by asset purchases of NCBs abroad. NCBs in the countries where the assets are purchased credit the money to the seller's reserve account and get a TARGET2 claim in return. The buying NCB gets a TARGET2 liability. Given that this transaction is unrelated to the amount of refinancing credit, this accumulation of claims an liabilities is not subject to the same constraints discussed in our paper, as each additional bond purchased automatically generates the liquidity needed to accommodate the increase in TARGET2 balances.

Interestingly, the increase in TARGET2 balances that started in 2007 was initially not associated with an increase in excess reserves at central banks.[8] Reserve accounts have increased only moderately in both groups of countries, just up to the point where DNFL's refinancing credit was to approach zero. At this point excess reserves in the DNFL jumped sharply upwards while the reserve accounts in the GIIPS remained at their low level (Panel C).

Stylized Fact 4: In 2011, refinancing credit provided by the GIIPS was exceeding its aggregate trend growth in the euro area.

The dual strategy—a monetary contraction in the aggregate with a parallel expansion in some countries—was bound to lead to a conflict eventually. Figure 4 shows that the two developments became incompatible shortly before the ECB abolished its exit strategy. In the summer of 2011, the GIIPS' refinancing credit was nearly as large as the refinancing credit in the euro area as a whole. Any further credit provision in these countries could not have been offset by a reduction in refinancing credit in other countries. Instead, aggregate refinancing credit—and thus the exit strategy of the euro area as a whole—would be affected.

Figure 4: Refinancing Credit – GIIPS vs. Aggregate



Notes: The figure shows the refinancing credit of the central banks of Greece, Ireland, Italy, Portugal and Spain (dashed line) versus the total Eurosystem (solid line), both in billions of euros. Sources: ECB SDW (Codes: ILM.M.4F.E.A050000.U2.EUR, BSI.M....N.N.A20.A.1.U2.1000.Z01.E).

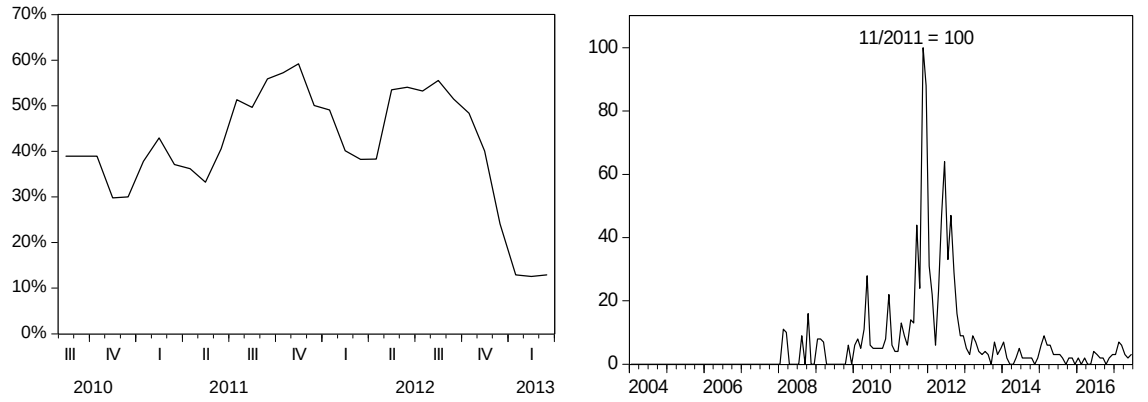
Ex ante, of course, markets could not know how the ECB would react to such a conflict: Would it enforce its exit strategy, or would it accommodate the expansionary path of some of the NCBs by providing liquidity in the aggregate? When the gap between refinancing credit in the GIIPS and the trend growth projection of the aggregate reached a critically low level, there was tension in the markets, which was visible in rising euro break-up expectations.

[8] This is consistent with Step 2 of capital flight illustrated in Appendix A.

Stylized Fact 5: At the end of 2011, financial tensions were visible in rising break-up expectations.

At the end of 2011, financial markets clearly sensed that the euro area had reached a critical limit, where policies of NCBs and those of the ECB council would become incompatible. This general sense of uncertainty about the euro area as a whole is visible in proxies for euro break-up risk. Panel A of Figure 5, for instance, displays the implied break-up probability from the private betting platform *Intrade*. The probability of a break-up, according to these data, was never as high as in the fourth quarter of 2011, when the implied probability of at least a partial break-up of the euro area reached about 60%. It only substantially declined after the announcement of the OMT program in the third quarter of 2012, where it fell below 10%.[9] Panel B of Figure 5 shows the number of Google searches for "Euro Break-up."[10] The graphs show that these searches were never as high as in November 2011, shortly before the ECB abolished its exit strategy.

Figure 5: Break-up Expectations



(A) Intrade Break-up Expectations (B) Google Searches "Euro Breakup"

Notes: Panel A shows the probability of at least a partial break-up of the euro area as implied by trades on the private betting platform Intrade [%]. Panel B depicts the Google search volumes for the term "euro break-up" [index 11/2011=100]. Sources: Intrade, Google Application Trends.

The markets' realization that the expansionary course of some NCBs would soon no longer be consistent with the ECB exit strategy, has generated a development that is highly reminiscent of a speculative attack within the euro area. The timing of the attack is best illustrated in weekly data on the Euro–USD swap line (Figure 6).

Stylized Fact 6: When banks started using the ECB–FED swap line, the ECB abolished its exit strategy.

Figure 6 shows that, since its reintroduction in December 2007, this swap line was hardly used until early December 2011. To interpret this graph, which shows a sharp spike on December 8, 2011, it is important to be aware of the institutional details and exact timing of monetary policy operations: In order to borrow from the NCBs in regular open market operations or swap lines, private banks need

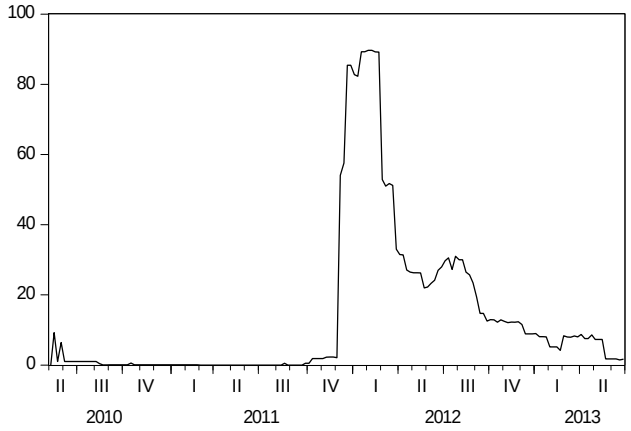
[9] See Steinkamp and Westermann (2014) for an interpretation of this decline in the context of the seniority reversal of the ECB.

[10] The two measures of break-up probability have a correlation coefficient of 0.61.

to place their requests for funding the day before the day of the allotment. Policymakers at the ECB thus knew about the demand for foreign exchange (FX) loans via the swap line the evening before the monetary expansion and the abolishment of the exit strategy was announced. A big jump in FX lending would have been interpreted as a sign of a beginning process of currency substitution, a clear signal of an imminent balance of payments crisis for the euro area as a whole.

To prevent this path of events, the ECB was forced to abandon its exit strategy. On the morning of December 8, the ECB announced that it would flood the markets with liquidity by (a) reducing the minimum reserve requirement, (b) lowering the collateral standards and (c) offering a three-year longer-term refinancing operation (LTRO).

Figure 6: ECB–FED Dollar Liquidity Swap Operations



Note: The figure shows the amount of outstanding swap line credit of the Eurosystem at the US FED [bn. $]. Source: Federal Reserve Bank of New York.

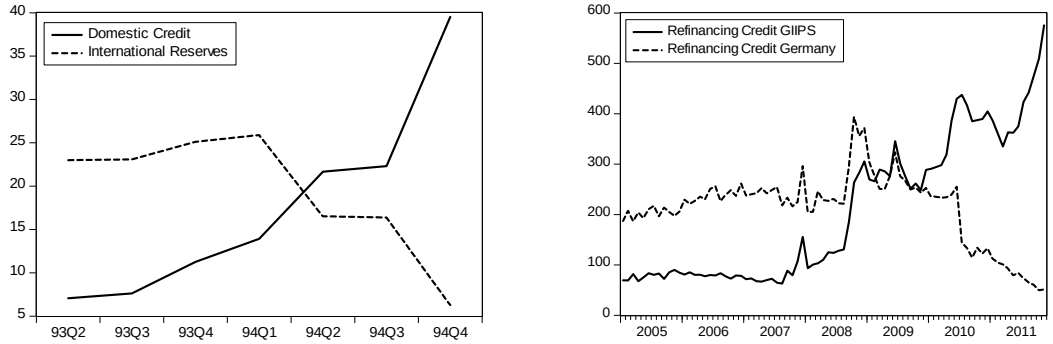
Stylized Fact 7: The patterns in the euro area are reminiscent of those of earlier balance of payments crises.

The patterns in the euro area are highly reminiscent of those in other well-known balance of payments crises. They are, for example, closely analogous to the Mexican crisis of 1994, which had a similar starting point, but a different ending. Panel A of Figure 7 illustrates the Mexican case. In the run-up to the Tequila Crisis in the fall of 1994, the central bank of Mexico expanded the monetary base by buying government bonds and lending to banks against government bonds as collateral. This liquidity, however, was not used for investment in the domestic economy, but rather for capital flight to the United States. Investors simply converted the Mexican peso to US dollars at the fixed exchange rate and purchased US assets. Trying to sustain the fixed exchange rate regime, the central bank of Mexico was forced to run down its international reserves. At some point, when reserves hit a critically low level, a speculative attack set in and forced the central bank to abandon the exchange rate peg (see Sachs et al., 1996).

Similar to Mexico (see Panel B of Figure 7), the GIIPS have been expanding central bank credit against government bonds and other collateral. The liquidity created in this operation was, to a large extent, not used for domestic investment, but rather for capital flight. Unlike Mexico, the GIIPS NCBs did not run down their international reserves. Instead, they accumulated TARGET2 liabilities.

While the dynamics of the two speculative attacks were similar, there are also some differences: First, the euro area did not break apart, but the Mexican peso–US dollar peg did in November 1994. This is because the ECB abolished its exit strategy on December 8, 2011. Second, the crisis countries did not lose their international reserves. Instead, they have accumulated large TARGET2 liabilities and the central banks in DNFL have accumulated TARGET2 claims. The TARGET2 system can—on an abstract level—be interpreted as an unlimited swap line among the members of the Eurosystem.

Figure 7: Comparison Between Mexico 1994 and Euro Area 2011



(A) Tequila Crisis (B) Euro Crisis

Notes: The figure compares the development of domestic credit and international reserves in Mexico (both in billion US dollar) with the refinancing credit in Germany and the GIIPS countries (both in billions of euros). Sources: International Financial Statistics (IFS), Euro Crisis Monitor.

Stylized Fact 8: The euro area also reached sensitive political limits.

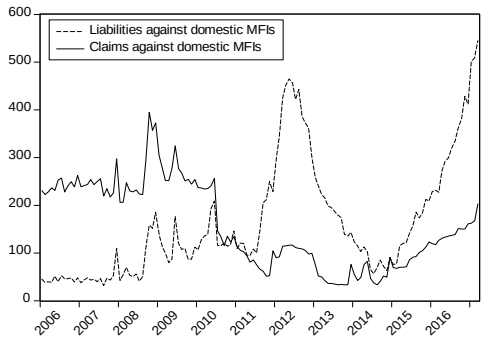
In addition to the conflict between ECB policy for the aggregate euro area and actions of individual NCBs, the euro area also reached sensitive political limits towards the end of 2011. Panel A of Figure 8 shows the claims and liabilities of the German Bundesbank that result from open market operations. As money created in the GIIPS was wire transferred via the TARGET2 system, there was an abundance of liquidity in Germany. As domestic banks stopped borrowing from the Bundesbank, it needed to accept liabilities to financial markets—in form of private banks' reserve deposits—as a byproduct of executing the private wire transfers to Germany. Panel B of Figure 8 shows that the German Bundesbank had become a net borrower vis-à-vis its private banking system at the beginning of 2011. While not constituting a technical limit as long as banks were willing to hold deposits at their central bank, this process clearly might hit a political limit at some point.

An indicator that a political limit had been reached at the Bundesbank is a letter written by the Bundesbank president, Jens Weidmann, to the ECB president, Mario Draghi, on February 29, 2012, where he asks for better collateral standards in the countries in crisis and points towards the enormous TARGET2 balances that had accumulated during the preceding five years. This letter is reminiscent of the famous Emminger Letter—also written by a Bundesbank president and directed to Helmut Schmidt, the chancellor of Germany, in 1978. In this letter, Emminger pointed out the enormous risk of supporting a two-sided fixed exchange rate regime up to an unlimited amount of central bank interventions.[11]

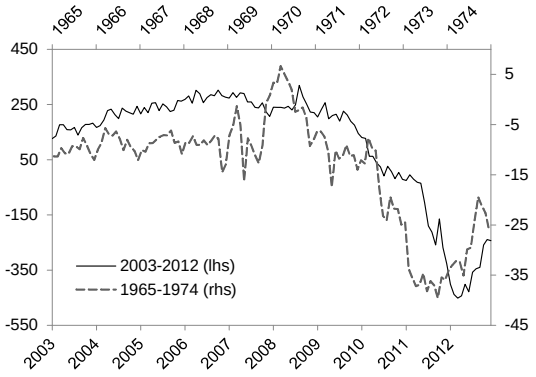
[11] See Marsh (2009).

Schmidt's answer to Emminger was to sign the treaty and—if worst comes to worst—argue that the conditions under which the treaty has been signed have changed and abandon the peg if needed. Translating this to current events would mean that the Bundesbank, at any point, could refer to agreements such as the no-bailout clause, the Maastricht treaty or the prohibition of monetary financing of sovereigns and stop executing TARGET2 transfers if these are deemed to be excessive.

Figure 8: Bundesbank Position Against Domestic Private Banking System



(A) Bundesbank Gross Positions Against Domestic MFIs.



(B) Bundesbank's Net Position Against Domestic MFIs

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Notes: Panel A in billions of euros at current prices, Panel B in billions of German Mark at constant 1990 prices. Sources: Bundesbank, ECB, IFS.

In fact, Sinn and Wollmershäuser (2012) pointed out that the Bretton Woods system had broken apart for a similar reason. In the 1970s, the Bundesbank had become a net borrower with respect to the financial sector. Its net position, shown in Panel B of Figure 8, reached a value of about 80 bn. German Mark or about 5% of GDP. The peak in its net-borrowing position in the most recent episode was, in contrast, nearly 328 bn. German Mark, constituting roughly 14% of GDP in 2012—i.e., three times as large as in 1973. In fact, Panel B of Figure 8 shows that, at a weekly frequency, the time pattern of the net position of the Bundesbank prior to the breakup of the Bretton Woods system in March 1973 was very similar to the one prior to the "Big Bazooka" in December 2011.

3 Europe's Trilemma: A Central Bank Perspective

In the following section, we rationalize the empirical patterns described above from a central bank perspective. To this end, we analyze how capital flight affects the balance sheets of NCBs and the common central bank. This allows us to identify a set of constraints from which Europe's version of the trilemma emerges.

3.1 Central bank balance sheets in a currency union

To illustrate the constraints of the Eurosystem, we consider the following setting: Two countries, Country 1 and Country 2, form a currency union.[12] They establish a common central bank (CCB), which sets monetary policy. Monetary policy operations, however, are undertaken by NCBs. In particular, the provision of central bank money remains in the responsibility of the NCBs in accordance with common monetary policy.

Central bank liabilities consist of money in circulation (M) and deposits of commercial banks on their reserve accounts (D). Refinancing credit (C) and international reserves (R) form the central banks' assets. In practice, other assets including government bonds constitute an additional item on the asset side of central bank balance sheets. For simplicity, we abstain from explicitly including it in this analysis and assume that other assets are held constant.[13] Moreover, we do not consider net worth, which might show up on the liability side as an accounting item.

In addition, this currency union is characterized by the unique feature that NCBs may accumulate liabilities and claims towards each other. These are called TARGET positions (T). The interesting feature of TARGET assets is that they may become negative. They exist in the form of assets and liabilities. In the aggregate over all countries they sum up to zero and thus $T_1 = -T_2$. This is empirically confirmed by the opposed behavior of TARGET2 balances in GIIPS and DNFL countries as shown in Panel D of Figure 3 above. The other asset types—refinancing credit and foreign reserves—in turn, cannot fall below zero (refer to Figure 3 to track the behavior of these asset types in the euro area).[14] The stylized central bank balance sheets of our currency union are shown in Figure 9.

Figure 9: Stylized Central Bank Balance Sheets in a Currency Union

CCB

Assets	Liabilities
C	M
R	D

NCB_1

Assets	Liabilities
C_1	M_1
R_1	D_1
T_1	

NCB_2

Assets	Liabilities
C_2	M_2
R_2	D_2
T_2	

[12] This model may easily be expanded to the case of n countries. Alternatively, Countries 1 and 2 may be interpreted as two groups of countries, with target assets and target liabilities, respectively.

[13] A balance sheet presentation including government bonds may be found in Appendix A.2.

[14] Unconventional monetary policies may allow central banks to hold net domestic liabilities. This presupposes that central banks issue their own securities. By way of example, the issuance of debt certificates by the ECB is one of its instruments for open market operations. To date, however, this tool has not been used. Moreover, legally, the ECB, but not the NCBs, is allowed to issue debt. Similarly, a central bank may have net liabilities in foreign currency. This, however, implies that foreign entities provide credit to the central bank. Examples are central bank swap lines.

The consolidated balance sheet of the currency union corresponds to the sum of the balance sheets of NCBs.[15] Variables without index denote currency union-wide aggregates, e.g. $M = M_1 + M_2$. A bar over a variable denotes fixed values.

Assume for simplicity that both NCBs are of equal size such that each accounts for half of the assets of the consolidated balance sheet. This capital share is determined when the currency union is created. It is fixed over time. The division of the components of the consolidated balance sheet between the NCBs, however, is not predetermined. Theoretically, the entire refinancing credit can move to the balance sheet of one NCB. The accounting identity implies for the currency union that

$$\sum_{i=1}^{2} M_i + \sum_{i=1}^{2} D_i = \sum_{i=1}^{2} C_i + \sum_{i=1}^{2} R_i, \tag{1}$$

where i is a country index.

Let us assume that monetary policy is determined by the common central bank, which targets the evolution of the monetary base defined as $M0 = M + D$.[16] This assumption is consistent with Stylized Fact 1, which shows that the ECB was following an exit strategy for the euro area in its entirety. By implication, union-wide central bank assets are constant. Although NCBs maintain their full-allotment policy, the balance sheet of the common central bank cannot be extended in the aggregate.

Assets consist of reserves and refinancing credit. For simplification, we assume that NCBs hold their reserve levels constant because they are not allowed to intervene in the foreign exchange market without approval of the common central bank.[17] By implication, union-wide supply of refinancing credit is constant.

Proposition 1 ***(Balance sheet constraint in a consolidated currency union)***
For $M0 = \overline{M0}$ and $R = \overline{R}$, it follows from equation (1) that $C = \overline{C}$.

Let us turn to the individual NCBs' balance sheets. The balance sheet constraint (1) augmented by intra currency union TARGET claims and liabilities implies for each NCB:

$$M0_i = C_i + \overline{R}_i + T_i. \tag{2}$$

This identity shows that an increase in refinancing credit, C_i, must be balanced by a decrease (liability) of T_i assets or an increase in the monetary base $M0_i$. Remember that the NCBs' monetary base may increase or decrease; the constraint of a constant monetary base only applies to the monetary union as a whole.

Proposition 2 ***(Balance sheet constraint for individual members of the currency union)***
If in a monetary union with NCBs (1) $M0 = \overline{M0}$ and (2) $R_i = \overline{R_i}$, then $\Delta C_1 = -\Delta C_2$.

Proof. Given that $T_1 = -T_2$, (2) can be rewritten for Country 1 as

$$M0_1 = C_1 + R_1 - T_2.$$

Aggregating over both countries, one gets

$$\overline{M0} = C_1 + C_2 + \overline{R}. \tag{3}$$

■

[15] In practice, NCBs might transfer capital to the common central bank. From an accounting perspective, however, it makes no difference whether the common central bank is endowed with its own capital, whether its capital enters as a liability towards the NCBs or whether its own balance sheet is empty. In any case, the union-wide central bank balance sheet is not affected by the distribution of intra-Eurosystem claims and liabilities.

[16] Provided that the money multiplier is stable, this is in line with a policy of money targeting where the central bank's target is a money aggregate like $M1, M2$ or $M3$. The ECB, for instance, monitors developments of $M3$ and its components as part of its two-pillar strategy of monetary policy.

[17] See "Guideline of the ECB, 23 October 2003 for participating Member States' transactions with their foreign exchange working balances pursuant to Article 31.3 of the Statute of the ESCB and of the ECB (ECB/2003/12)."

To hold the union-wide monetary base constant, any increase ΔC_1 has to be offset by an equal decrease ΔC_2. This means that an increase in refinancing credit in one country is offset by an equal decrease in refinancing credit in the union's remaining countries.[18] We call this mechanism *reserve constraint* because of its similarity to the flow of reserves between central banks outside a monetary union in the face of a balance of payments deficit.

Corollary 1 *If the amount of aggregate refinancing credit is constant and finite, refinancing credit provided by an individual NCB cannot grow indefinitely.*

TARGET balances thus can be expressed as the difference between monetary base and refinancing credit:

$$T_i = M0_i - C_i - \overline{R}_i. \tag{4}$$

While, legally, there exists no upper or lower limit to TARGET balances, TARGET liabilities are constrained by the other central bank's ability to accumulate TARGET assets.

Proposition 3 ***(TARGET constraint)***
If the common central bank follows an exit strategy for the entire monetary union ($M0 = \overline{M0}$), there exists an upper limit for TARGET balances, given by

$$T^{\max} = \overline{M0} - \overline{R}_i. \tag{5}$$

Proof. The formula can be derived from equation (4) after setting $M0_i = M0_1 + M0_2 = \overline{M0}$ and $C_2 = 0$. ■

TARGET balances may not exceed the aggregate monetary base minus reserves of the NCB with TARGET claims. This limit is reached when refinancing credit of the NCB with a positive TARGET position has fallen to zero. Except reserves, all assets of the NCB with TARGET claims have been transformed into TARGET claims.

3.2 Imbalances

In the following sections, we examine under which conditions the TARGET constraint might become binding. To this end, we consider two possible scenarios: (i) a current account deficit in Country 1 (foreign country) with respect to Country 2 (home country), which is not financed by private capital flows and (ii) capital flight from Country 1 to Country 2. Both transactions imply that foreign agents exchange foreign central bank money for home central bank money as described in Appendix A. With respect to central bank accounting, both transactions are identical: They increase refinancing credit of NCB_1 in exchange for growing liabilities of NCB_1 towards NCB_2. These scenarios correspond to the developments in the euro area as described in Stylized Fact 2.

3.2.1 Imbalances without currency union

To highlight the particularities of a currency union, we first describe the effects for countries that supply their own money. A cross-border transaction from Country 1 to Country 2 implies that NCB_1 loses reserves and its balance sheet contracts (see Figure 7 of the stylized facts for an illustration of the fall in international reserves in Mexico during the Tequila Crisis). Sterilization via the provision of refinancing credit allows NCB_1 to restore the balance sheet total and to keep the amount of central

[18] It is worth noting that we abstract from the presence of other assets on the central bank balance sheets. In practice, these may provide some additional leeway: To hold the monetary base constant, central banks may offset an increase in refinancing credit by a sale of other assets (e.g. government bonds) instead of reducing refinancing credit in the other country. However, once all other assets were sold, the limits as described above apply. Moreover, NCB_2 may issue debt certificates when $C_2 = 0$. This, however, would be an unconventional policy and has to be announced well in advance to impede an attack. If speculators question the sustainability of the central bank balance sheet, the announcement itself might provoke an attack. In theory, deposits of commercial banks on their reserve accounts provide an alternative source to fund cross-border transactions without affecting the monetary base.

bank money constant. The NCB_2's balance sheet is affected by opposed transactions: The net inflow of money increases its reserves and its liabilities to the banking sector. The increase in central bank money can be sterilized through a reduction in refinancing credit.

Note that, for both NCBs, the transaction changes the supply of central bank money in the first place. Sterilization allows the balance sheet length to remain constant and the transactions materialize as an accounting exchange on the asset side. The maximum amount of sterilization, however, is limited: When NCB_2's assets are entirely held in the form of foreign exchange, further inflows of reserves cannot be sterilized. Comparably, the external resources of NCB_1 are limited. When NCB_1 has lost all reserves, cross-border payments can no longer be financed.

3.2.2 Imbalances in a currency union

Central bank balance sheet accounting perspective

In a currency union, the same net capital flows affect central bank balance sheets in the following way: Since we only consider transactions within the currency union, the aggregate balance sheet of the system of central banks remains unchanged. The foreign central bank increases refinancing credit and accumulates liabilities with respect to the home central bank (TARGET liabilities increase). Note that the TARGET position basically assumes the function played by reserves of an individual central bank operating outside a currency union: While an independent central bank runs down its reserves to finance a balance of payments deficit, a NCB operating in a currency union accumulates liabilities towards other member central banks. The home central bank registers opposing effects: Its refinancing credit decreases while its TARGET assets increase. These similarities between reserves in a fixed exchange rate system and refinancing credit in a currency union are described for the case of Mexico and the euro area in Stylized Fact 7.

The differences are striking: Outside a currency union, capital outflows contract the central bank balance sheet and central bank money is destroyed. Capital inflows create central bank money. Within a currency union, neither capital inflows nor capital outflows affect the amount of central bank money. That is, the effects of capital flows on the provision of central bank money are automatically sterilized.

However, analogously to the case of independent central banks, the capacity to sterilize within a monetary union is limited. Sterilization implies that domestic assets decrease in the country with capital inflows. When $C_2 = 0$, TARGET balances reach their upper limit (see equation (5)) and further capital inflows cannot be sterilized. The increase in reserves is replaced by an increase in claims towards the other central bank. In other words, while outside a currency union assets are transferred between central banks, within a union this transaction is replaced by a claim on the assets of the other central bank.[19]

There exists also an analogy with central bank swap lines, which have been institutionalized during the recent financial crisis (see Stylized Fact 6). While a swap line allows the central bank to transfer money without tapping its stock of reserves, TARGET liabilities allow money transactions without transfer of securities. As such, the TARGET assets of the home central bank can be interpreted as a swap line provided to the foreign central bank.

[19] While the described system of TARGET claims and liabilities corresponds to the practice in the Eurosystem, net capital flows within the US Federal Reserve System induce de facto movements of bonds between districts' Federal Reserve Banks. Liabilities are settled once a year by the transfer of gold certificates.

Balance of payments accounting perspective

The implications of TARGET balances can alternatively be illustrated by the balance of payments identity, which can be expressed for country i as

$$CA_i - KA_i = 0. \tag{6}$$

where CA is the balance of the current account and KA denotes the balance of capital and financial account.[20] KA may be split in changes in the net foreign asset position of the central bank (KA^{CB}) and changes in the net foreign asset position of the rest of the economy (KA^{PR}). The net foreign asset position of the central bank may change due to changes in international reserves, changes in TARGET balances and changes in other central bank assets (ΔOCB). Hence, equation (6) can alternatively be expressed as

$$CA_i - KA_i^{PR} = \Delta R_i + \Delta T_i + \Delta OCB_i.$$

This expression shows the following: First, any deficit in the current-cum-financial account can be financed through the sale of reserves by the central bank. This is the policy of exchange rate defense through foreign exchange market interventions. Second, in a currency union, the TARGET settlement system provides additional flexibility to finance imbalances within the union. To finance a deficit, NCBs can accumulate liabilities towards other member central banks. This can be considered as an alternative way to defend the fixed exchange rate system between members.[21]

Proposition 4 ***(Refinancing credit's role as reserves)***

If the common central bank follows an aggregate exit strategy ($M0 = \overline{M0}$), the ability to finance balance of payments deficits within the currency union is restricted by the availability of refinancing credit in the surplus country.

Proof. For given liabilities, NCB_2 can only further increase T_2 if C_2 falls. Hence, the balance of payments identity of Country 1 reads

$$CA_1 - KA_1^{PR} = \Delta R_1 + \Delta C_2 + \Delta OCB_1.$$

■

As such, refinancing credit of the home central bank assumes the same role as international reserves do for a central bank issuing its own currency: They fall until they reach a lower bound. Payments can only be settled until $C_2 = 0$.

Implications

The TARGET system has two implications: In the short run, it provides flexibility. It buffers imbalances within a currency union. NCBs provide liquidity to each other without affecting their international reserves. In the long run, however, TARGET positions reach a limit very much alike international reserves may be exhausted. TARGET liabilities reach their limit when refinancing credit in the partner country has fallen to zero. Net transactions from Country 1 to Country 2 may no longer be feasible. As a corollary of Proposition 1, rational agents anticipate that the system of central banks can choose between three scenarios.

[20] According to the IMF's definition, financial transactions are recorded either in the financial or capital account. For simplicity, we aggregate both accounts and refer to them as financial account in the rest of the paper.

[21] Sinn and Wollmershäuser (2012, p. 488) also show that the balance of payments identity of euro countries is augmented by the TARGET position and state that "the increase of a country's Target liability over one year, i.e. its Target deficit, equals the sum of (private and public) net capital exports and the current account deficit vis-à-vis other euro countries."

Corollary 2 *Persistent balance of payments deficits vis-à-vis other countries of a currency union will eventually require one of the following policy responses:*
(i) Transactions from Country 1 to Country 2 are no longer executed,
(ii) the currency union collapses, or
(iii) the common central bank pursues an expansionary monetary policy and the common currency depreciates with respect to the rest of the world.

Corollary 2 illustrates Europe's version of the trilemma. One of three potential policy goals must be waived. In scenario (i) the unidirectional suspension of transactions from Country 1 to Country 2 lowers the value of deposits in Country 1 relative to those in Country 2. The market exchange rate deviates from the officially fixed rate. If the currency union breaks up (scenario ii) the exchange rate of Country 1 depreciates relative to Country 2 and restores the equilibrium in the balance of payments. Since the sterilized expansion of TARGET balances is no longer feasible, in scenario (iii) the common central bank relaxes this constraint by an expansionary monetary policy. M, the interest rate and the price level rise. Real money balances drop. The currency depreciates with respect to the rest of the world.

Anticipation of scenarios (i) and (ii) may induce speculative capital flight to Country 2, while the best ex-ante response to scenario (iii) is to move funds outside of the currency union. The insights of the literature on speculative attacks on fixed exchange rate systems apply (see Flood and Garber, 1984; Krugman, 1979; Obstfeld, 1994). The nature of the attack depends on speculators' expectations about the currency union's endogenous response to the tensions: The speculative attack may be directed either on the TARGET system or on the entire currency union. It depends on whether scenarios (i) and (ii) or scenario (iii) are the expected policy response. While the expected policy response affects the nature of the attack, its timing is independent of whether capital is reallocated within the union or whether it flows outside.

4 Europe's Trilemma: An Investor's Perspective

While the previous sections used central bank balance sheets to illustrate Europe's policy trilemma, the following portfolio balance model focuses on the behavior of international investors.[22] We show that, depending on the size of capital flight, the central bank may be left with two incompatible policy objectives of either preventing a surge of break-up expectations or keeping money supply fixed. Investors' uncertainty of how the central bank would respond to such a predicament make the currency union vulnerable to speculative attacks.

4.1 Basic model setup

In our model, a representative international investor chooses between three types of assets to optimize his portfolio in a given period: Bonds (B), deposits (excess reserves) at the NCB (D), and money (M). Bonds and deposits are country specific,[23] whereas there is only one form of cash, independent of the country of issue (common currency). The volume of bonds is expressed in terms of the nominal bond value. The market value of a bond is a multiple P of its nominal value. Variables referring to the foreign country are denoted with asterisks. The international investor is meant to reflect the aggregate of wealth owners living in either of the two countries that constitute a currency union.

The investor chooses to allocate his portfolio subject to a wealth constraint. The net worth (W) of today's portfolio is

$$W = B^* \frac{P^*}{\bar{e}} + \frac{D^*}{\bar{e}} + M + BP + D. \tag{7}$$

[22] Our formulation is close to the model of Sinn and Westermann (2005), albeit with adaptations to account for the fact that we analyze a currency union, not a flexible exchange rate regime.

[23] We model investors and commercial banks as one entity for simplicity.

The nominal exchange rate (e) is the price of home currency in terms of foreign currency. It is fixed at unity in the currency union of our model, $\bar{e} = 1$. The expected exchange rate at the end of the period, $\widetilde{e}$, however, may deviate from its fixed value.

Our investor's utility function depends on the end-of-period wealth and a liquidity service:

$$U\left(\sigma^* \frac{B^* \widetilde{P}^*}{\widetilde{e}}, \beta^* \frac{D^*}{\widetilde{e}}, \mu M, \sigma B \widetilde{P}, \beta D\right). \tag{8}$$

The exogenous liquidity parameters, σ^*, β^*, μ, σ, β, capture all sorts of considerations other than pecuniary return (e.g., risk preferences, differences in liquidity, and transaction costs). Tildes mark expected values. For simplicity, we do not impose a specific functional form on the utility function other than it being increasing in its parameters, strictly concave and additively separable.

The investor maximizes the following Lagrangian with respect to the volumes of each asset class:

$$\begin{aligned} L = {} & B^* \frac{1}{\widetilde{e}} \left(\widetilde{P^*} + r^*\right) + D^* \frac{1}{\widetilde{e}} \left(1 + i^*\right) + M + B \left(\widetilde{P} + r\right) + D \left(1 + i\right) \\ & + U\left(\sigma^* B^* \frac{\widetilde{P}^*}{\widetilde{e}}, \beta^* \frac{D^*}{\widetilde{e}}, \mu M, \sigma B \widetilde{P}, \beta D\right) \\ & + \lambda \left(W - B^* P^* - D^* - M - BP - D\right). \end{aligned} \tag{9}$$

The first line captures the end-of-period wealth in terms of domestic currency, with r and i denoting the yield on bonds and the interest rate paid on the deposit holdings, respectively. The second line shows the utility derived from the liquidity service, and the third line accounts for the investor's budget constraint.

From the first-order conditions, we derive the following marginal conditions:

$$\frac{1}{\widetilde{e}} \frac{\widetilde{P^*} \left(1 + \sigma^* U_{B^*}\right) + r^*}{P^*} = \lambda \tag{10}$$

$$\frac{1}{\widetilde{e}} \left(1 + i^* + \beta^* U_{D^*}\right) = \lambda \tag{11}$$

$$1 + U_M = \lambda \tag{12}$$

$$\frac{\widetilde{P} \left(1 + r + \sigma U_B\right)}{P} = \lambda \tag{13}$$

$$1 + i + \beta U_D = \lambda \tag{14}$$

The Lagrangian multiplier, λ, reflects a common yardstick. The marginal utility derived from each asset ought to be the same in optimum. We do not explicitly solve for all variables of the model. Most important insights can be derived by performing comparative statics and by simply inspecting the relevant equations.

4.2 Flight-to-safety with a passive central bank

As a first step, we assume the central bank to be completely passive. For example, the central bank does not conduct any open market operations or lend against collateral. Thus, the stocks of risky and safe bonds in the economy are fixed in the short term ($B = \bar{B}$, $B^* = \bar{B}^*$). The central bank holds the stock of money constant ($M = \bar{M}$) and the common yardstick, λ, is determined by equation (12).

While deposits are freely transferable across countries, their sum $D + D^*$ is also fixed because wealth is constant and there are no other types of investment available.

We now ask how our investor's optimal portfolio changes when his preferences change. More specifically, we consider the effect of a negative shock in the preference for (risky) foreign bonds and a positive shock in the preference for (safe) home bonds. This decrease in σ^* with a joint increase in σ may represent a flight-to-safety motivation.[24]

Only equations (10) and (13) are affected. The change in preferences simply changes the return of both bonds. With the supply of bonds being fixed, a decreased preference for foreign bonds has to be accommodated by an increase in their return, r^*/P^*. On the other hand, an increase in the preference for home bonds translates into a decreased return, r/P.[25] No further portfolio adjustments are needed to maintain the portfolio equilibrium. Particularly, neither the exchange rate nor money supply change. For example, from equation (11) follows that the expected exchange rate does not change because the yardstick, λ, is constant and all other variables are unaffected by the shock considered. In this setting the investor cannot engage in capital flight, as quantities are fixed. The returns simply adjust to a point where he is content with holding the assets that he has.

4.3 Flight-to-safety with an active central bank

Next, we consider the case of an active central bank such as the European System of Central Banks after introducing a full-allotment policy. Investors are able to borrow against collateral at the NCB. They will be credited the nominal value of these bonds to their deposit facility in return:[26] $\Delta D = -\Delta B$ and $\Delta D^* = -\Delta B^*$.[27] By implication, the stocks of each type of asset become flexible.

In the case of an active central bank, it is useful to distinguish between two magnitudes of shocks, which correspond to two different phases of capital flight during the euro crisis.

4.3.1 Phase I

In Phase I, we consider the same shock as before—a decrease in σ^* with a joint increase in σ. If we assume that money supply is constant, λ is determined by equation (12) and is constant across all marginal conditions. Pledging foreign bonds as collateral at the NCB reduces the supply of foreign bonds available to trade in the markets. Consequently, their marginal utility, U_{B^*}, increases. The investor gets credited deposits at the foreign central bank in return, which decreases the marginal utility of such deposits, U_{D^*}. From equation (11) and (14) it is evident that the investor will find it optimal to reallocate his portfolio:

$$\frac{1}{\widetilde{e}}\left(1 + i^* + \beta^* U_{D^*}\right) = 1 + i + \beta U_D. \tag{15}$$

To satisfy this condition, a transfer of deposits from the foreign NCB to the home NCB takes place and frees up collateral, which had previously been pledged at the home NCB: B rises. The increase in the stock of home bonds, B, in turn, decreases their marginal utility, U_B. This process continues until equation (15) is fulfilled. With the common interest rate fixed, this implies in equilibrium that all deposits return to their original levels. They are transferred to the home country and invested in home bonds.

[24] See also Westermann (2012, 2014) and Appendix A.

[25] This may either mean a change of prices or coupons or a combination of both. For the purpose of clarity of our argument, we simply attribute any change in the return of bonds to price changes. That is, we assume fixed-coupon bonds. This does not alter any of the results.

[26] Drechsler et al. (2016) and Steinkamp et al. (2017) document that NCBs in the euro area applied substantially lower haircuts compared to private markets throughout the crisis.

[27] Similar to open market operations of the US FED, bonds could alternatively be sold to the central bank. It only matters that bonds (i) can be used to create central bank liquidity in the size of the market value of the bonds and (ii) are not available to be traded in the market any more.

4.3.2 Phase II

The type of capital flight described in Phase I cannot go on indefinitely. While the full-allotment policy ensures that arbitrarily large amounts of bonds can be absorbed by the NCB in the foreign country ($\Delta D^* = -\Delta B^*$), the amount of bonds provided indirectly by the home NCB is limited. At some point, no collateral is freed up because refinancing credit at the receiving country's central bank has already been run down to zero.[28] In other words, we need to assume the stock of home bonds to be fixed at $B = \bar{B}$.

Again, following a (large) preference change, investors will pledge the bonds as collateral for refinancing credit at the foreign central bank at their nominal value. Therefore, B^* decreases accompanied by a rise in D^*. But there is no corresponding increase in B that would absorb the additional deposits created. In this case, there are two possible equilibrium portfolios. The central bank can either (i) let expectations about a currency break-up rise: $\widetilde{e}$ falls below unity.[29] (ii) Stop its full-allotment policy or (iii) abandon its monetary target.

First, when the central bank sticks to its monetary target, as well as the full-allotment policy, break-up expectations arise. As $M = \bar{M}$, λ is constant according to equation (12). To satisfy equation (14), D must be constant as well. The effect on the expected exchange rate can be derived from equation (11) after solving for $\widetilde{e}$:

$$\widetilde{e} = \frac{(1 + i^* + \beta^* U_{D^*})}{\lambda} \tag{16}$$

The marginal utility, U_{D^*}, decreases because D^* increases. However, the new liquidity can be invested in neither M nor B. $\widetilde{e}$ falls: exchange rate expectations indicate an appreciation of the home currency.

Second, the ECB could stop its full-allotment policy. This would prevent capital flight altogether, as investors can no longer borrow from the NCB against collateral. It would be equivalent to becoming a passive central bank, associated with the price changes on safe and risky assets discussed above.

Third, the central banks could also forego their monetary target and tolerate an increase in M. In this case the common yardstick, λ, is no longer fixed as the marginal utility of money falls (see equation 12). From equation (16) can be inferred that the investor will again transfer part of the deposits into the deposit facility of the home country: D rises. However, deposits will not fall back to their original level as the stock of home bonds remains the same. In equation (13), the marginal increase in preferences for home bonds will be offset by an increase in prices. Capital does not flow from deposits into home bonds anymore. A rise in deposits reduces their marginal utility. According to equations (11), (12) and (14), the Lagrangian variable and the marginal utility of cash holdings, U_M, must be lower compared to preshock levels, which is due to an increase in the stock of money, M. Summing up, not only cash increases, but also the aggregate of both countries' deposits, $D + D^*$.

4.3.3 Dynamics and target of the speculative attack

In the above analysis, we analyze an essentially static equilibrium and perform comparative statics with respect to preference changes on specific items of assets. What was modeled as a shock in the second phase could also be a series of small shocks, or a continuous process based on a country's fundamentals, like an ongoing balance of payments deficit. With such a process in mind, our model helps to understand the dynamics of the euro crisis, which are similar to first generation speculative attack models.

[28] This is equivalent to a single country with a fixed exchange rate in which central bank reserves dropped to zero.

[29] These responses are in line with those discussed by Caballero et al. (2017), who argue that in a situation where safe assets are short equilibrium may be restored either through price changes or an adjustment in the exchange rate.

From an investors' point of view, one could raise the question whether capital flight has been "successful" and whether there is any other motivation except the pure change in preferences. Indeed, one can argue that our portfolio model adds a motivation for the attack, based on anticipated price changes. To illustrate this point it is interesting to look at the price of foreign bonds in terms of home bonds:

$$\frac{P^*}{P} = \frac{1}{\tilde{e}} \frac{(1 + \sigma^* U_{B^*}) + r^*}{(1 + r + \sigma U_B)}. \tag{17}$$

Equation (17) describes the effective rate of exchange between both types of bonds. From the perspective of a representative investor holding foreign bonds, this indicates whether capital flight can be "successful" in the sense that he is able to indirectly convert risky foreign bonds into safe home bonds at favorable prices. With a passive central bank and the stock of assets fixed (and thereby also their marginal utilities, U_B and U_{B^*}, fixed), any shock in preferences simply translates into price (and yield) changes. After an increase in σ and a decrease in σ^*, the total return of foreign bonds relative to home bonds is lower than in the preshock equilibrium. Holders of foreign bonds cannot avoid taking losses.

Once we consider an active central bank, however, this result changes. Despite the change in preferences away from foreign bonds into home bonds, their relative rate of return does not change. During Phase I, changes in preferences are completely offset by changes in the supply of risky bonds, B^*, and safe bonds, B, without any further need for price adjustments. Compared to the case with a passive central bank, an investor holding foreign bonds is better off now—thus capital flight via the Eurosystem of central banks can be considered successful. This result, however, hinges critically on the fact that a wire transfer reduces the need for central bank liquidity and frees up collateral in the receiving country.

In Phase II, independent of the central bank's policy decision, (P^*/P) decreases according to equation (17). Compared to the case with an active central bank in Phase I, an investor holding foreign bonds is worse off. Holders of foreign bonds cannot engage in capital flight anymore without taking losses.

Thus, capital flight cannot go on successfully forever. When the amount of refinancing credit in the receiving country reaches a critically low limit, investors might anticipate that not all of them can trade their foreign bonds into home bonds at a favorable rate of exchange. Because everybody knows that not everybody can get his money out without losses, everybody will uncoordinatedly try to be among the first: A speculative attack occurs, forcing the central bank to either let the exchange rate in the currency union float, or to give up its independent monetary policy.

5 Exchange Market Pressure in the Euro Area

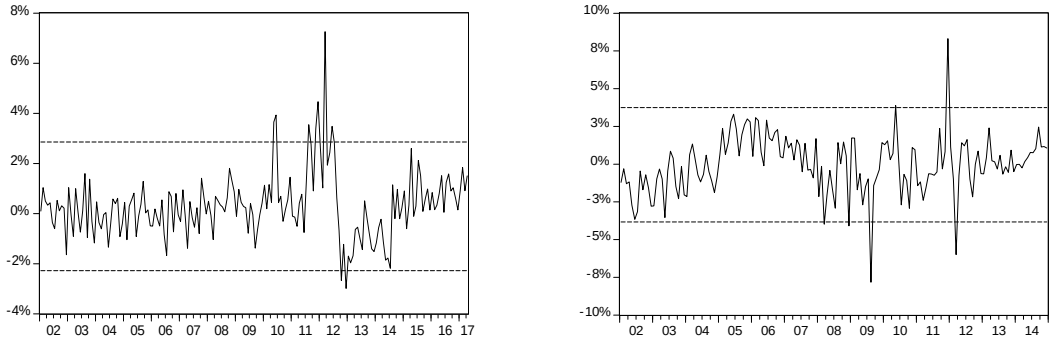
In the previous sections we have used theoretical consideration to show that the ECB faces a trilemma. Both a model based on central bank balance sheets and the portfolio balance model suggest that in the presence of capital flight the ECB either faces break-up expectations of the currency union or needs to give up its monetary target. In the following section, we examine whether this trilemma may be identified empirically. To this end, we develop a new exchange market pressure index for the euro area and analyze its behavior around the events in 2011.

In the literature, exchange market indexes are typically based on three components, namely the change in the exchange rate, the interest differential between two countries and the change in reserve holdings.[30] Our index for the euro area is related to that concept, but differs slightly in all three aspects. First, there is no exchange rate between the GIIPS and the rest of the euro area. Thus, exchange rate changes are zero for the full time period. Secondly, the relevant interest rate—the ECB's main refinancing rate—is also the same in all countries of the euro area. It does not constitute a motivation to move central bank money from one country to the other.

[30] See, among others, Aizenman and Binici (2016), Girton and Roper (1977) and Weymark (1995).

The biggest difference, however, is related to reserve holdings. On the one hand, NCBs are legally not permitted to simply buy and sell reserves without coordination with the ECB. Thus, as shown in the empirical section (see Panel B of Figure 3), changes in international reserves of individual countries are negligible and most likely reflect valuation changes rather than active purchases. On the other hand, NCBs' ability to sustain net capital outflows is not limited by reserves, but—as shown in the theoretical section—by TARGET2 liabilities a country can accumulate. These liabilities are potentially limited by (i) the ECB targeting the monetary base or (ii) political factors in creditor countries.

Figure 10: Exchange Market Pressure of the Euro Area



(A) Internal Pressure (B) External Pressure

Notes: Panel A shows internal exchange market pressure as measured by the change of GIIPS' TARGET2 liabilities over their contribution to M2. Panel B shows the commonly used external exchange market pressure index with the US as a reference country (see, e.g., Aizenman and Binici, 2016). The length of the sample is restricted by data availability. Sources: Euro Crisis Monitor, ECB SDW, IMF IFS (Codes: RAFA, ENDA_XDC_USD_RATE, FIMM_PA), authors' calculations.

In Panel A of Figure 10, we display the changes in the TARGET2 liabilities of the GIIPS countries, standardized by M2 of the same group of countries. While TARGET2 reflects the ability to accommodate capital flight, the monetary aggregate M2 proxies for the potential amount of funds that could be moved abroad via the central bank system. In May 2010, for the first time, the index signals an increased break-up risk. This is when government bond yields in Greece skyrocketed and the first bailout funds were launched. The second increase in exchange market pressure was taking place during the suspected speculative attack at the end of 2011. During the month surrounding the monetary expansion, exchange market pressure was as high as ever during the full sample period. In the aftermath of the "whatever-it-takes" statement, pressures declined and ultimately came back to normal.

With regard to the policy debate in summer 2017, new concerns of exchange market pressure could arise again. In the end of the sample, developments coincide in a way that is reminiscent of the 2011 period. First, banks in Italy are under pressure and borrow substantial amounts from the Bank of Italy that are wire transferred to the rest of Europe. Second, the ECB is discussing the next exit strategy. In combination, it is not surprising to see yet another increase in exchange market pressure towards the end of the sample period.

We externally verify our index using two alternative break-up indices. The ups and downs in our index mirror quite closely the break-up risk that is also visible in the stylized facts reported above. The simple correlation between our index and the Google "euro break-up" searches and the implied break-up risk by the Intrade betting data (see Figure 5) is 0.52 and 0.53, respectively.

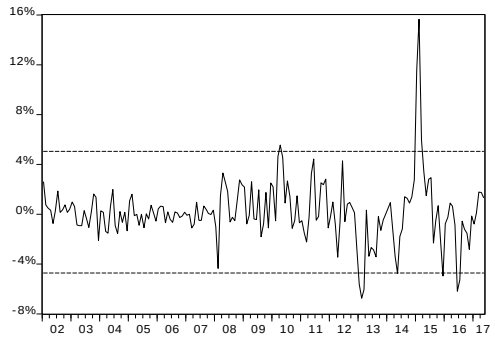
Panel B of Figure 10 further compares our index of internal pressure to an adjusted index of external pressure vis-à-vis the United States as a reference country. The definition of external exchange market pressure follows Aizenman and Binici (2016, eq. 5). However, we slightly adjust this index to account for unconventional policy measures during the crisis. The use of international reserve holdings is not the only way to satisfy international liquidity needs and to fend off speculative capital flight. The USD swap line provided by the Federal Reserve Bank has become another important source of liquidity for many central banks, including the ECB. While the swap line has no publicly known upper limit, it is likely to hit a political one in the case of a speculative attack. We therefore interpret increases in the use of the swap line similar to the loss of international reserve holdings.

Similar to the internal-pressure index, a first visible peak in the external exchange market pressure index can be identified in May 2010 with the onset of the Greek debt crisis. The external pressure then reaches its global maximum in December 2011, the month of the first LTRO, before returning to normal levels after the second LTRO. As the United States serves as a reference country, it comes as no surprise that the exchange market pressure of the euro area was—in comparison to the US—very low at the time of the Lehman Brothers-collapse in the fall of 2009.

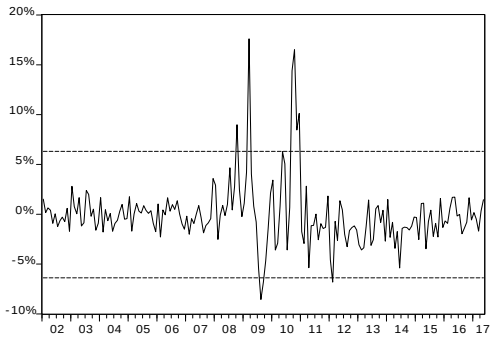
We further calculate internal exchange market pressure on a country-level basis (shown in Figure 11). This helps to gain insights into the heterogeneous nature of the crisis across countries.[31] Panel A of Figure 11 depicts the internal exchange rate pressure of Greece vis-à-vis the rest of the Eurosystem. There are two visible spikes in the exchange rate pressure deviating more than two standard deviations from the mean. The first was at the time of the first Greek bailout. The second, more dramatic increase, happened shortly after the snap election in which the eurosceptic party Syriza won the majority of seats in the parliament. Ireland was one of the first countries to feel the repercussions of the Global Financial Crisis (Panel B). As early as March 2009 first tensions are visible. Another high was reached after what the press called "Ireland's Black Thursday," when the bailout of its banking system was announced to hit €50 bn. Italy's increase in internal exchange market pressure, in contrast, manifested rather late; starting before the announcement of the first LTRO and returning to normal after the launch of the second LTRO (Panel C). Panel D shows that Portugal experienced a strong increase in the volatility of exchange market pressure. At several points in time, starting in mid-2010, pressure exceeded two standard deviations. Lastly, Panel E depicts Spain's internal exchange market pressure. Similar to most of the other countries, the first spike occurred in May 2010. Spain then returned to normal levels, only to find itself on an upward path again by the beginning of 2011. The pressure reached its maximum in March 2012 and only calmed down after Mario Draghi's commitment to do whatever it takes to preserve the euro. The decline in internal pressure after his statement is visible not only in Spain but also—to a larger or lesser extent—in the other countries of the euro area. The promise to conduct a potentially unlimited monetary expansion finally relieved the internal exchange market pressure. This lasted until the ECB started to verbally hint at the possibility of an exit strategy from its expansionary policies.

[31] The determinants of internal exchange rate pressure are not only different across countries but—very likely—also changed as the crisis evolved. In a recent paper, Auer (2014) analyzes to what extent changes in TARGET2 balances have been accommodating different imbalances in Europe's internal balance of payments. Both, current account deficits and private capital flight seem to be important in different stages of the crisis.

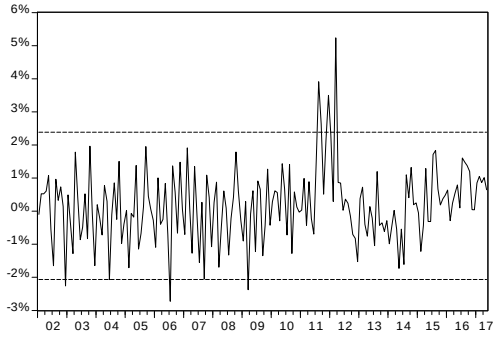
Figure 11: Internal Exchange Market Pressure at Country-level



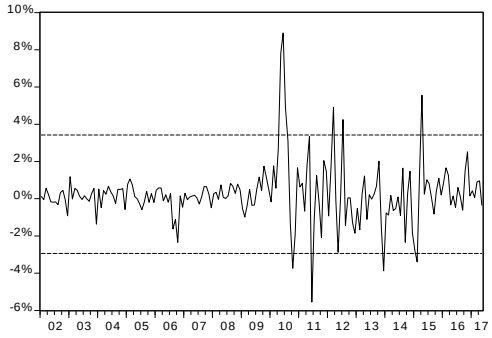
(A) Greece



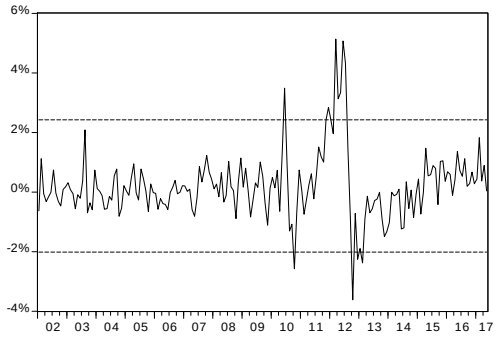
(B) Ireland



(C) Italy



(D) Portugal



(E) Spain

Note: The figure shows internal exchange market pressure by country. Sources: Euro Crisis Monitor, ECB SDW, authors' calculations.

6 Related Literature

Our findings suggest that policy choices in a currency union—especially of the European type—are restricted by a trilemma: In the face of free capital mobility, central banks may not be able to pursue a predefined monetary policy, such as an exit strategy, while simultaneously accommodating capital flight via a full-allotment policy. These policy decisions are incompatible and ultimately generate break-up expectations on the side of investors. This is a special version of the classical macroeconomic policy trilemma (Mundell, 1963; Obstfeld and Taylor, 1998) applied to currency unions.[32] The main difference lies in the interpretation of monetary dependence: When the exchange rate is fixed and capital internationally mobile, the classical trilemma predicts that monetary policy is determined by the world interest rate through spillovers from center countries. In a currency union, however, the trilemma restriction applies also within the union independently of the international policy environment. After a certain threshold, the amount of net cross-border flows within the union determines the degree of monetary expansion. That is, although the euro is floating with respect to the rest of the world, monetary policy cannot be set freely.

As the global financial crisis has highlighted global interdependencies, the trilemma constraint has gained renewed interest, which shows up in a number of recently published papers. The discussion centers around the question whether the trilemma is still relevant in a highly integrated world. Three different views may be distinguished: First, in a series of papers, Rey (2013, 2016) argues that the global financial cycle has transformed the trilemma into a dilemma. A floating exchange rate regime is unable to isolate the economy from foreign shocks because capital flows obey global factors rather than domestic ones. This finding is in line with evidence provided by Frankel et al. (2004) for the post-Bretton Woods period. Second, a different view argues that central banks' international reserves help to relax the trilemma constraint and basically turned it in a quadrilemma (Aizenman, 2013; Steiner, 2017). The third view argues that the trilemma trade-off is still a valid description of the international monetary system (see, among others, Georgiadis and Mehl, 2016; Obstfeld et al., 2017). Recent empirical evidence based on trilemma indexes supports the trilemma constraint (Aizenman et al., 2013; Klein and Shambaugh, 2015).[33] This confirms findings from previous decades (Shambaugh, 2004; Obstfeld et al., 2005). Finally, there is a literature that puts the trilemma in a wider context by changing one of its corners leading to a financial or policy trilemma besides the monetary one.[34]

Policies inconsistent with the trilemma constraint might induce a speculative attack. Speculative attacks are the response to the depletion of resources in fixed-price environments: A shrinking stock of natural resources at fixed prices in the Hotelling-Salant-Henderson model (see Obstfeld, 1994; Salant and Henderson, 1978) or declining reserves in fixed exchange rate systems (see Krugman, 1979) are typical examples. In our case of a currency union, refinancing credit of the countries with net TARGET claims —and the associated safe asset collateral— is the shrinking resource.

The literature on the creation of the European Monetary Union already discussed the possibility of a speculative attack linked to the final bilateral conversion rates, the so-called "endgame problem." Garber (1999), Flood and Garber (2000), and Kenen (2000) argue that the operational rules of the TARGET system enable central banks to defend the currency union against any speculative attack. The reason for this is that NCBs can accumulate unlimited claims and liabilities towards each other. They also point out the risk of an attack, if the political support for unlimited TARGET2 balances is not given. Overall, there was a widespread consensus in the academic literature that corner solutions—purely floating exchange rates and monetary unions—are not vulnerable to speculative attacks (see,

[32] The classical trilemma, based on the works of Mundell, states that only two out of the three potential policy goals of an independent monetary policy, a fixed exchange rate regime and free capital mobility are jointly feasible.

[33] Aizenman et al. (2013) and Popper et al. (2013) examine countries' policy choices within the trilemma constraint over time.

[34] For the euro area, Bordo and James (2014) identify a financial trilemma, which highlights the trade-off between financial stability, fixed exchange rates and capital flows. In a policy context the same authors argue that fixed exchange rates and capital flows may be incompatible with independent national policies and democratization. According to Schoenmaker (2011), there exists a financial trilemma besides the monetary one, where financial stability, financial integration and national financial policies are jointly incompatible.

e.g., Frankel, 1999).[35]

Our paper is also closely related to Sinn and Wollmershäuser (2012). This paper was the first to interpret the euro crisis as a balance of payments crisis and the TARGET2 liabilities as an internal balance of payments deficit. It also raised the issue that refinancing credit in Germany has a lower bound and capital flight as well as current account financing via the Eurosystem cannot go on indefinitely. There are, however, several differences with respect to our paper: First, the lower bound of refinancing credit by itself does not constitute a limit on capital flows, as the NCBs with net TARGET claims are able to take deposits and in principle run a negative net balance with private banks in the Eurosystem. Thus, only the combination of the lower bound of refinancing credit in the recipient countries of capital flight and the exit strategy of the ECB (or any fixed monetary target)—Europe's trilemma—create the setting for a speculative attack. Second, Sinn and Wollmershäuser are lacking an important facet of the investors' motivation. The central banks' actions in countries with both TARGET2 claims and liabilities affected the supply of safe and risky assets available for trading. The anticipated price effects of these relative supply changes have fueled the dynamics of capital flows shortly before the ECB gave up its exit strategy. Clearly both views do not exclude each other, but focus on a different dimension of the events in 2011/12.

7 Conclusions

While TARGET balances are *de jure* unlimited according to the statutes of the European System of Central Banks, our analysis shows that there exists a *de facto* limit when the system of central banks sticks to its monetary policy goals. Unlimited credit can only be provided by national central banks if monetary policy does not constrain the length of the balance sheet in the aggregate. Furthermore, political limits may exist that prevent the TARGET2 claims from moving to arbitrarily large amounts.

The analysis in this paper elaborates on this de facto limit and provides the theoretical framework and empirical background needed to discuss policy questions, such as the current debate on exit strategies from unconventional policies. A better understanding of the earlier episode is useful to improve the design of the next exit strategy and reduce the risks of future attacks under the current institutional arrangements.

Moving forward, the euro area needs to take into account what is best described as the European version of the trilemma: It cannot at the same time have a common currency, independent control over the monetary base and accommodate unlimited internal capital flight via central banks. The proposed index of exchange market pressure may help policy makers and investors to monitor the implications arising from this insight.

[35] For instance Jeffrey Frankel states that "*Monetary union and pure floating are the two regimes that cannot be subjected to speculative attack.*" (1999, p.8). Also Dooley (1998, p.24) expressed this view, although more cautiously, when he pointed out that "*a speculative attack is possible in a full currency union but not very likely.*"

References

[1] Aizenman, J. (2013). The impossible trinity – from the policy trilemma to the policy quadrilemma. Global Journal of Economics, 2(01), 1350001.

[2] Aizenman, J., & Binici, M. (2016). Exchange market pressure in OECD and emerging economies: domestic vs. external factors and capital flows in the old and new normal. Journal of International Money and Finance, 66, 65–87.

[3] Aizenman, J., Chinn, M. D., & Ito, H. (2013). The "impossible trinity" hypothesis in an era of global imbalances: measurement and testing. Review of International Economics, 21(3), 447–458.

[4] Aizenman, J., Chinn, M. D., & Ito, H. (2016). Monetary policy spillovers and the trilemma in the new normal: periphery country sensitivity to core country conditions. Journal of International Money and Finance, 68, 298–330.

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

[6] Bordo, M., & James, H. (2014). The European crisis in the context of the history of previous financial crises. Journal of Macroeconomics, 39, 275–284.

[7] Caballero, R. J., Farhi, E., & Gourinchas, P. O. (2017). The safe assets shortage conundrum. The Journal of Economic Perspectives, 31(3), 29–46.

[8] Cecchetti, S. G., McCauley, R. N., & McGuire, P. M. (2012). Interpreting TARGET2 balances. BIS Working Papers No 393.

[9] Dooley, M. (1998). Speculative attacks on a monetary union? International Journal of Finance & Economics, 3, 21–26.

[10] Drechsler, I., Drechsel, T., Marquez-Ibanez, D., & Schnabl, P. (2016). Who borrows from the lender of last resort? The Journal of Finance, 71(5), 1933–1974.

[11] Flood, R. P., & Garber, P. M. (1984). Collapsing exchange rate regimes: some linear examples. Journal of International Economics, 17(1-2), 1–13.

[12] Flood, R. P., & Garber, P. M. (2000). Is launching the euro unstable in the endgame? In: Paul Krugman (ed.), Currency Crises, University of Chicago Press, 163–177.

[13] Frankel, J. (1999). No single currency regime is right for all countries or at all times. NBER WP 7338. National Bureau of Economic Research.

[14] Frankel, J., Schmukler, S. L., & Serven, L. (2004). Global transmission of interest rates: monetary independence and currency regime. Journal of International Money and Finance, 23(5), 701–733.

[15] Garber, P. M. (1999). The Target mechanism: will it propagate or stifle a Stage III crisis? Carnegie-Rochester Conference Series on Public Policy, 51(1), 195–220.

[16] Georgiadis, G., & Mehl, A. (2016). Financial globalisation and monetary policy effectiveness. Journal of International Economics, 103, 200–212.

[17] Girton, L., & Roper, D. (1977). A monetary model of exchange market pressure applied to the postwar Canadian experience. American Economic Review, 67(4), 537–548.

[18] Kenen, P. B. (2000). Comment on: Is launching the Euro unstable in the endgame? In: Paul Krugman (ed.), Currency Crises, University of Chicago Press, 177–181.

[19] Klein, M. W., & Shambaugh, J. C. (2015). Rounding the corners of the policy trilemma: sources of monetary policy autonomy. American Economic Journal: Macroeconomics, 7(4), 33–66.

[20] Krugman, P. (1979). A model of balance-of-payments crises. Journal of Money, Credit and Banking, 11(3), 311–325.

[21] Marsh, D. (2009). The euro: the politics of the new global currency. Yale University Press.

[22] Mundell, R. A. (1963). Capital mobility and stabilization policy under fixed and flexible exchange rates. Canadian Journal of Economics and Political Science, 29(4), 475–485.

[23] Obstfeld, M. (1994). The logic of currency crises. Cahiers Économiques et Monétaires, 43, 189–213.

[24] Obstfeld, M., Ostry, J. D., & Qureshi, M. S. (2017). A tie that binds: revisiting the trilemma in emerging market economies. IMF Working Papers 17/130.

[25] Obstfeld, M., Shambaugh, J. C., & Taylor, A. M. (2005). The trilemma in history: tradeoffs among exchange rates, monetary policies, and capital mobility. The Review of Economics and Statistics, 87(3), 423–438.

[26] Obstfeld, M., & Taylor, A. (1998). The Great Depression as a watershed: international capital mobility over the long run. In: M. Bordo, C. Goldin, and E. White (eds.), The Defining Moment: The Great Depression and the American Economy in the Twentieth Century, University of Chicago Press, 353–402.

[27] Popper, H., Mandilaras, A., & Bird, G. (2013). Trilemma stability and international macroeconomic archetypes. European Economic Review, 64, 181–193.

[28] Rey, H. (2013). Dilemma not trilemma: the global cycle and monetary policy independence. Proceedings - Economic Policy Symposium - Jackson Hole, Federal Reserve Bank of Kansas City.

[29] Rey, H. (2016). International channels of transmission of monetary policy and the Mundellian trilemma. IMF Economic Review, 64(1), 6–35.

[30] Sachs, J., Tornell, A., & Velasco, A. (1996). The collapse of the Mexican peso: what have we learned? Economic Policy, 11(22), 13–63.

[31] Salant, S. W., & Henderson, D. W. (1978). Market anticipations of government policies and the price of gold. Journal of Political Economy, 86, 627–648.

[32] Schnabl, G. & Freitag, S. (2012). Reverse causality in global and intra-European imbalances. Review of International Economics, 20(4), 674–690.

[33] Schoenmaker, D. (2011). The financial trilemma. Economics Letters, 111(1), 57–59.

[34] Shambaugh, J. C. (2004). The effect of fixed exchange rates on monetary policy. The Quarterly Journal of Economics, 119(1), 301–352.

[35] Sinn, H. W. (2014). The Euro trap: on bursting bubbles, budgets, and beliefs. Oxford University Press.

[36] Sinn, H. W., & Westermann, F. (2005). The Euro, Eastern Europe, and black markets: the currency hypothesis. In P. De Grauwe, Exchange Rate Modelling: Where Do We Stand? MIT Press, 207–238.

[37] Sinn, H. W., & Wollmershäuser, T. (2012). Target loans, current account balances and capital flows: the ECB's rescue facility. International Tax and Public Finance, 19(4), 468–508.

[38] Steiner, A. (2017). Central banks and macroeconomic policy choices: relaxing the trilemma. Journal of Banking & Finance, 77, 283–299.

[39] Steinkamp, S., & Westermann, F. (2014). The role of creditor seniority in Europe's sovereign debt crisis. Economic Policy, 29(79), 495–552.

[40] Steinkamp, S., Tornell, A., & Westermann, F. (2017). The euro area's common pool problem revisited: has the single supervisory mechanism ameliorated forbearance and evergreening? CESifo Working Paper No. 6670.

[41] Tornell, A., (2013). The dynamic tragedy-of-the-commons in the Eurozone and Target2. Mimeograph, UCLA.

[42] Westermann, F. (2012). Two types of capital flight: will a common deposit insurance help to stabilise the TARGET2 imbalances? In: T. Beck, Banking Union for Europe - Risks and Challenges, Centre for Economic Policy Research, 57.

[43] Westermann, F. (2014). TARGET2 and central bank balance sheets: discussion. Economic Policy, 29(77), 117–125.

[44] Weymark, D. N. (1995). Estimating exchange market pressure and the degree of exchange market intervention for Canada. Journal of International Economics, 39(3), 273–295.

Appendix A: Institutional Background and Bank-Level Perspective

In this appendix, we provide the institutional background of the analysis from the perspective of a single investor and a single bank engaging in capital flight. In our view, this is a necessary preliminary step to understanding the portfolio balance model in Section 4 and the motivation of our exchange market pressure index derived in Section 5.

A.1 The nature of capital flight, full allotment and the TARGET2 system

The capital outflows of 2011, depicted in Figure 2, can certainly be interpreted as a wave of capital flight reminiscent of episodes in emerging market economies such as Latin America or Asia in the mid to late 1990s. To understand the similarities and differences, it is important to analyze the institutional framework that set the stage for the capital outflows. We first give an intuitive example for why the system of central banks and the TARGET2 clearing system played a major role in the capital account reversal and argue that, without the involvement of central banks, capital flight would not have been successful.

Suppose, for instance, the central bank were entirely passive—its policies were neither expansionary nor contractionary. It would not lend to banks or conduct any open market operations. In this setting, a simple thought experiment helps to illustrate why the central banks were important: If an investor took some Spanish government bonds, for instance, put them in his backpack and took the plane from Madrid to Frankfurt, he would not have gained very much from this type of "capital flight." Upon arrival in Frankfurt, he would have realized that Spanish government bonds were traded at unfavorable prices just as in Madrid. After he deposited them in a safe at the Commerzbank in Frankfurt, they would not be any more protected from default of the Spanish government or from Euro break-up risk. This layman's type of capital flight would be entirely unsuccessful.

In Europe, however, the Eurosystem of central banks was not passive. In summer 2011, it had a full-allotment system in place where banks were able to borrow unlimited amounts against eligible collateral. This policy has been used by investors to engage in a more successful type of capital flight via the central banking system: Instead of putting the bonds in their backpack, they gave them to the Central Bank of Spain as collateral and received Euros in exchange, in the form of deposits on a private bank's reserve account at the central bank. These deposits were then wire transferred to Germany via the TARGET2 system. The TARGET system is a clearing platform introduced at the same time as the single currency. In the euro area, all international transactions are settled in central bank money via this TARGET2 system. This is why the Bundesbank became involved in capital flight. The Euros created in Spain and other countries were wire transferred to Germany and credited by the Bundesbank to a reserve account of a private bank in Germany. The investor was then able to use these deposits to buy German government bonds, real estate or equity.

The key difference between the two examples is the following. In the first example, the investor was simply moving his risky assets from one country to another. In the second example, he was able to convert risky assets into a safe investment.

A.2 The balance sheet mechanics

In the following subsections, we examine how a transfer of deposits between two countries affects the balance sheets of their commercial banks and their NCBs.

A.2.1 A transfer of deposits with passive central banks

Let us assume that there are only two private banks and two central banks. We call the private banks Santander and Commerzbank and the central banks are the Bank of Spain and the Bundesbank.[36] The private banks have three types of assets: Governments bonds (B), loans to firms (L) and a reserve account at the central bank (D_r). Moreover, there are two types of liabilities: deposits from private households (D_p) and loans from the central bank (C). The central banks have government bonds and credit to banks as their assets and money (M) and deposits of private banks (D_r) as liabilities. The analysis is conducted from the perspective of Germany as a "home" country and Spain as "foreign" denoted by asterisks.

Figure 12: Deposit Transfers Are Offset by Transfers of Other Private Assets

Bank of Spain

Assets	Liabilities
B^*	M^*
C^*	D_r^*

Bundesbank

Assets	Liabilities
B	M
C	D_r

Santander

Assets	Liabilities
$B^* \downarrow$	$D_p^* \downarrow$
L^*	C^*
D_r^*	

Commerzbank

Assets	Liabilities
$B \uparrow$	$D_p \uparrow$
L	C
D_r	

Suppose the owner of private deposits, D_p^*, would like to move his deposits from Spain to Germany. In normal times, this operation could be achieved without involvement of the central banks (other than for a brief interval when they execute the transfer). In good times, Santander would have three options to raise the liquidity needed to execute the transfer: (i) use excess reserves or borrow in the interbank market, (ii) sell some of its bonds or (iii) let some loans expire to generate the liquidity to execute the transfer. Commerzbank, on the other hand, will receive the deposits and can use them to finance any of the same alternative investments. For instance, as illustrated in the balance sheet presentation in Figure 12, in equilibrium it could buy those bonds sold by Santander.

A.2.2 A transfer of deposits with an active central bank

Step 1: In crisis times, we assume that (i) there is no functioning interbank market, (ii) Santander cannot sell its assets (without accepting fire-sale prices), (iii) Santander cannot easily let loans expire as a large share is nonperforming and (iv) it does not hold any excess reserves. Furthermore, we assume the central bank is active and pursues a full-allotment policy.

[36] The names of the banks are chosen arbitrarily. Banco Santander is the largest Spanish Bank, with the strongest Tier 1 capital base. For Germany, "Deutsche Bank" is the largest, but the name can easily be confused with a central bank by an international reader. Commerzbank is a close follow-up.

Figure 13: Deposit Transfers Are Offset by TARGET Positions

Bank of Spain	
Assets	Liabilities
B^*	M^*
$C^* \uparrow$	D_r^*
	$T \uparrow$

Bundesbank	
Assets	Liabilities
B	M
C	$D_r \uparrow$
$T \uparrow$	

Santander	
Assets	Liabilities
B^*	$D_p^* \downarrow$
L^*	$C^* \uparrow$
D_r^*	

Commerzbank	
Assets	Liabilities
B	$D_p \uparrow$
L	C
$D_r \uparrow$	

In this case (see Figure 13), the withdrawal of deposits is offset by Santander's borrowing from the Bank of Spain. Via the TARGET2 clearing system, it is the Bundesbank's obligation to credit the deposits to the Commerzbank's reserve account. The Bank of Spain gets a claim on Santander and the Bundesbank gets a liability to Commerzbank. To offset this imbalance, a TARGET2 liability is recorded for the Bank of Spain and a corresponding TARGET2 claim for the Bundesbank.[37]

Step 2: Of course, it is unattractive for Commerzbank to hold simultaneously deposits and loans vis-à-vis the Bundesbank. The loans have a higher interest rate than the deposits and the private bank is losing money this way. Therefore, to the extent possible, Commerzbank uses the liquidity it receives in the first instance to repay the loans from the Bundesbank (see Figure 14).

Figure 14: Sterilization: Monetary Base Remains Constant

Bank of Spain	
Assets	Liabilities
B^*	M^*
C_b^*	D_r^*
	T

Bundesbank	
Assets	Liabilities
B	M
$C \downarrow$	$D_r \downarrow$
T	

Santander	
Assets	Liabilities
B^*	D_P^*
L^*	C^*
D_r^*	

Commerzbank	
Assets	Liabilities
G	D_P
L	$C \downarrow$
$D_r \downarrow$	

An important aspect of this second step is the following: As long as Commerzbank is repaying its loans at the central bank, the total monetary base ($M0 = M^* + M + D_r^* + D_r$) does not increase as a result of capital flight. In a way, the Bank of Spain is pursuing an expansionary monetary policy by lending to Santander and the Commerzbank is sterilizing the effect on the monetary base by repaying its loans to the Bundesbank. However, this sterilization cannot last forever; it only works as long as $C \geq 0$ at the Bundesbank. As the loans of Commerzbank from the Bundesbank, C, approach zero, a limit is reached, where each additional Euro transferred via the TARGET2 system will increase the monetary base. This creates a conflict between two central bank objectives: price stability and financial stability, ensured by the free mobility of capital and the full-allotment policy. In Section 4, we attribute the strength of the capital flight to investors' uncertainty on how the ECB would react to this predicament.

[37] Neither is a direct claim or liability between the two central banks. Rather, they are indirect claims and liabilities against the Eurosystem.

A.2.3 Flight to quality

Although a transfer of deposits is useful to illustrate the balance sheet mechanics, it is not the origin of capital flight in the euro area. Instead, the desire of investors to convert government bonds in crisis countries into assets in safe countries is a more adequate starting point. Santander could place the government bond B^*, as collateral at the Bank of Spain in return for deposits that are wire transferred to Germany to buy German Bunds, B. Regardless of the motivation of capital flight, the balance sheet mechanics would remain unchanged. In fact, Santander could even buy additional Spanish bonds in the rest of the world to pledge them to the central bank. The strength of a potential speculative attack could, thus, be larger than the current total amount of deposits on Santander's balance sheet. Westermann (2014), for instance, pointed out that the aggregate balance sheet of the banking sector in Spain and Italy increased in 2011, which would be consistent with a flight-to-quality phenomenon of a global dimension.