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The liquidity consequences of the euro area sovereign debt crisis

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Abstract

We examine the liquidity effects of the euro area sovereign debt crisis, including its effects on euro area banks as a group, on intra-euro area financial flows, on the supply of and demand for collateral, and on international liquidity. The lending capacity of the euro area banking system has been much weakened, despite the remarkable growth of the operations of the Eurosystem, including its greatly increased lending, its intermediation between national central banks in surplus and deficit countries and its collateral policy. The euro crisis has also created international liquidity stresses. We find that central bank swap lines have only had limited effectiveness in alleviating the stresses, probably owing to some stigma being attached to their use.

JEL classification: E58, F31, G01

Keywords: Financial crisis, liquidity, foreign exchange swaps, central bank swap lines

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1. Introduction

The euro sovereign debt crisis erupted in May 2010 when the Greek government needed financial support, though, as we will show (in section 5), there were signs of an emerging crisis in 2007. Other euro area governments received support subsequently, and the Greek government needed further help. The cause of the crisis has been diagnosed alternatively as excessive borrowing on the part of some euro area governments, and as loss of competitiveness in some euro area countries, resulting in large current account imbalances within the euro area which became unfinanceable and thus unsustainable. In Ireland and Spain, the fiscal crisis is fairly clearly a by-product of banking problems.

The euro area crisis persisted after May 2010 as the authorities struggled to assess and agree on how large a fiscal adjustment member countries could be expected to make, and how the losses arising from the inability of some governments and banks to pay their debts should be distributed. These issues are still under debate at the time of writing. It is not yet possible to provide a complete narrative of the crisis. Instead, we describe, and explain as far as we can, such consequences of the crisis for liquidity as had become apparent by the middle of 2012, and the policy measures that have been taken in response to them. The paper does not discuss the further measures announced since that time. Using a range of statistical sources, the aim is to quantify these liquidity consequences.

The paper is organised as follows. Section 2 discusses the various phases of the euro area sovereign debt crisis, and section 3 the macro-financial risks associated with the crisis. Section 4 describes the liquidity consequences for euro area banks as a group, and section 5 intra-euro area financial flows. Section 6 is about the effects of the crisis on collateral availability, and in section 7 we examine the international liquidity problems that arose from the crisis, including a surge in demand for dollars in the euro area, and the effectiveness of the Fed-ECB swap line in satisfying the demand. Finally, we draw conclusions in section 8.

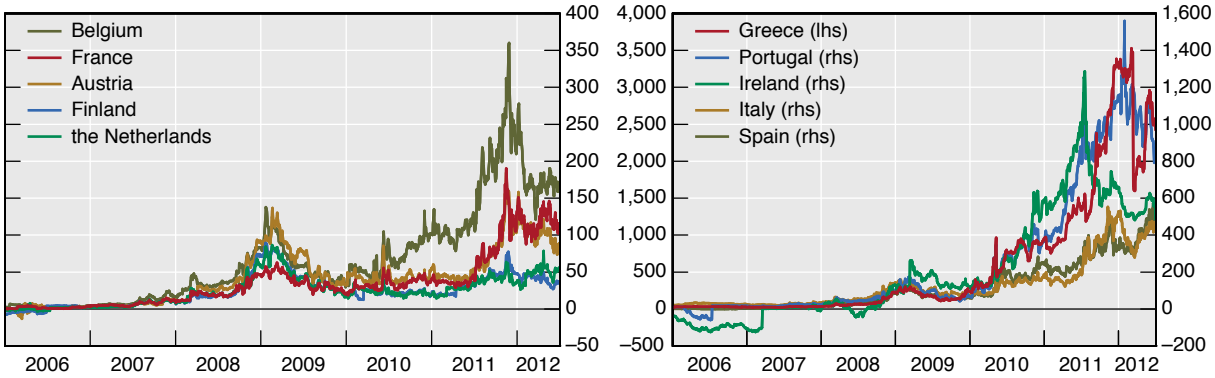
2. Indicators of financial stress and the phases of the crisis

This section discusses indicators of financial stress and uses them to identify different phases of the crisis. Several market indicators can be used to gauge market stress. As regards government securities markets, two useful indicators are yield differentials among euro area government securities, and sovereign credit default swap (CDS) spreads (see graphs 2.1 and 2.2). These spreads widened during 2010 and by much more in 2011, particularly in the second half of the year. They fell back somewhat in early 2012, but remained very wide by historical standards.

Graph 2.1

Euro area sovereign yield spreads[1]

In basis points



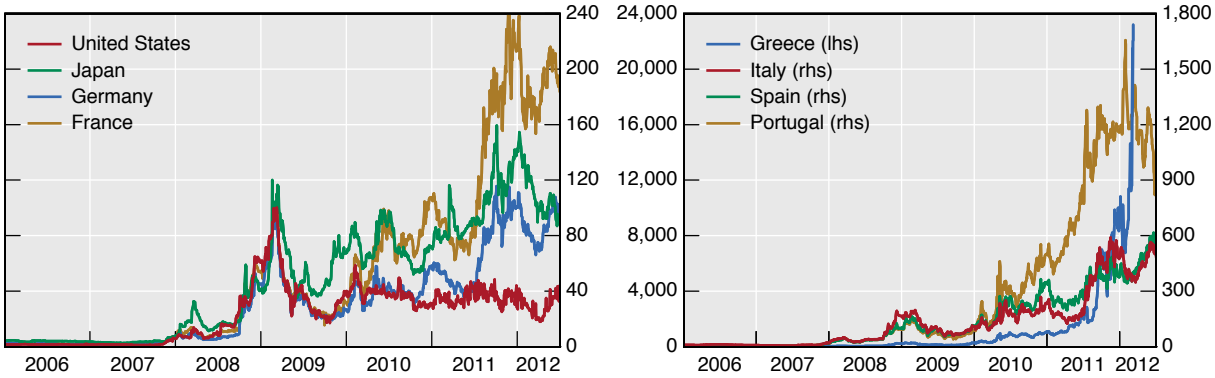
[1] Ten-year general government bond yield vis-à-vis the correspondent German yield. For Ireland, 9-year general government bond yield after October 2011.

Sources: Bloomberg; BIS calculations.

Graph 2.2

Sovereign CDS spreads [1]

In basis points



[1] Five-year on-the-run CDS spreads.

Source: Markit.

As regards bank stress, useful indicators are LIBOR-OIS spreads[4], and banks' CDS spreads. The left hand panel of graph 2.3 shows that the LIBOR-OIS spread widened in mid-2011 in the euro money market, and by much more than in the dollar and sterling markets. The CDS spreads of euro area banks widened sharply in mid-2010 and continued to widen in 2011 (graph 2.3). They fell back somewhat in the first quarter of 2012, but picked up again in the second quarter of 2012. The margin between the CDS spreads of European and U.S. banks, previously negligible, has become very wide.

The indicators of bank stress are closely correlated with the indicators of stress in government securities markets. This demonstrates the close relationship between the perceived solvency of governments and the solvency of their countries' banks.[5]

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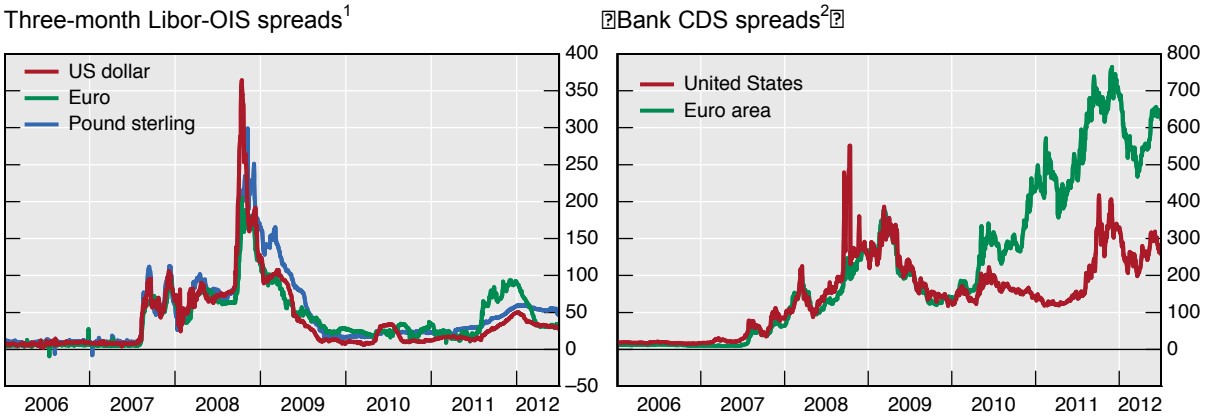
[4] These are the spreads between LIBOR rates, which are an estimate of the rates that banks have to pay to acquire deposits, and overnight indexed swap (OIS) rates.

[5] See CGFS (2011).

Graph 2.3

Bank CDS and money market spreads



[1] In basis points. [2] Five-year on-the-run credit default swap spreads. Simple average across leading banks, in basis points.

Sources: Bloomberg; Markit.

Further indicators of bank stress are the covered interest rate differentials and cross-currency basis swap spreads of the euro against the US dollar. These provide indicators of the ease or difficulty that euro area banks experience in acquiring US dollar liquidity, and thus can help to identify US dollar liquidity shortages.[6] They are shown in graphs 7.1 and 7.2 respectively. Both showed major stress after the failure of Lehman Brothers in September 2008; more recently, they show moderate stress in May 2010 and greater stress in the second half of 2011. This suggests that there has been a surge in demand for dollar liquidity in the euro area. Covered interest differentials and the demand for dollar liquidity are discussed further in section 7.

The indicators discussed in this section suggest that the crisis has had three phases up to the middle of 2012, and the suggestion is supported by the examination of financial flows in sections 4 and 5 below.[7] The first phase was from May 2010 until the middle of 2011, when at least some of the stress indicators seemed to stabilise after the news of Greece's financial problems. During the second phase, in the second half of 2011, all the stress indicators deteriorated. In the third phase, in the first half of 2012, the stress indicators generally improved in the first quarter, but some worsened again somewhat in April.

There is strong circumstantial evidence that the deterioration of the stress indicators after the middle of 2011 was related to concerns about banks' possible losses on sovereign debt holdings, together with the expectation that in any future crisis, banks' bondholders, and perhaps even wholesale depositors, would not be protected by government action. The initial widening of banks' CDS spreads (especially of euro area banks) occurred immediately after the statement issued by the European Council on 21 July, which referred to a 'voluntary contribution' from the private sector to covering the financing gap of Greece. The news in the first half of October that Dexia Bank was in distress and would be bailed out by governments, even though the stress tests conducted under the auspices of the European Banking Authority had indicated that it was financially strong, further undermined market confidence in banks. And, as graph 2.4 shows, bank CDS spreads again widened sharply after the European Council statement of 26 October, which referred to 'deeper' private sector involvement in establishing the sustainability of Greece's debt, and despite its reiteration that

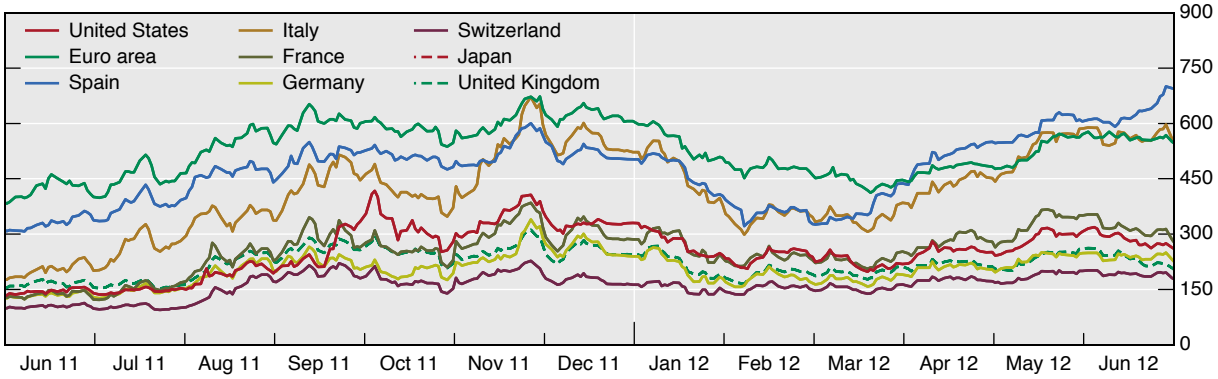
[6] See Allen and Moessner (2010).

[7] See also Vause and von Peter (2011) for the effects of the sovereign debt crisis on financial markets.

Greece required an 'exceptional and unique' solution. Spreads widened much further shortly afterwards, following the announcement that Greece would hold a referendum on the terms of the agreement that was thought to have been concluded with the European Council. Although the referendum decision was later reversed, it increased the perceived risk of a disorderly default and of Greece leaving the euro area, and of larger losses for banks. There is no sign that concerns about counterparty risk of euro area banks were relieved by the requirement from the European Banking Authority that banks increase their capital ratios to 9% by June 2012 (see graph 2.4).

Graph 2.4

Bank CDS spreads[1]



[1] Five-year on-the-run credit default swap spreads. Simple average across leading banks, in basis points

Source: Markit.

3. Macro-financial risks

In this section we next review the risks which the evident financial stresses in the euro area discussed in the previous section posed to banks.

One risk was simply that some governments would be unable to service their debts and that they would either simply default, or put bondholders in a position where they had no alternative but to agree to a variation in the terms of the bonds which would involve a loss of value. These two possibilities, though legally distinct, would have had similar effects on banks and are both referred to as 'default' in this section. At the end of 2010, European banks (including non-euro area banks) had gross exposures of EUR 90 billion to Greek sovereign debt, compared with core tier 1 capital of EUR 1,006 billion. The Greek exposures were not evenly spread, however. Greek banks had gross exposures to Greek sovereign debt of EUR 54 billion, compared with core tier 1 capital of EUR 25 billion.[8]

The risk that a government's default would imperil the solvency of commercial banks caused a contagious reaction. It was obvious that some banks were in danger, but nobody knew which other banks were exposed to those endangered banks. Therefore the risk of sovereign default implied a risk of bank failure that could not be precisely quantified. The risk of bank failure was the main reason for the contraction in inter-bank lending after the global financial crisis of 2008–09 and the migration of the inter-bank money market onto the balance sheets of central banks.

[8] Sources of data on bank capital and exposures to Greece: European Banking Authority (2011), authors' calculations.

A financial crisis in a monetary union carries the additional risk that the union might break up, ie that one or more members might leave. There is no provision in the Treaty on European Union for a country to leave the euro area; when the Treaty was drafted, it was assumed that the euro area would progressively expand to embrace the whole of the European Union. The absence of any legal provision for a departure makes the risk more serious, because a departure would require changes in law, and its consequences would depend on how exactly the law was changed. A crucially important issue would be the treatment of outstanding debts. This includes the question of which debts would be repaid in euros, and which in the new currency that the departing country adopted in place of the euro. There can be no certainty about how the law might be changed. But a country which left the euro area because of an unmanageable debt burden would be likely to do whatever it could to reduce the burden. Thus the break-up risk for a holder of euro-denominated assets is the risk that the assets will be redenominated by law into another currency which proves to be worth less than the euro.[9]

The risk of sovereign default has long been familiar in financial markets, and the risk of bank failure became very evident during the global financial crisis.[10] The euro area break-up risk appeared gradually in financial markets in 2010 and 2011 before receding markedly in 2012 following the statement from the ECB on the irreversibility of the euro, and the associated policy actions aiming at eliminating the tail risk of a break-up.

4. Liquidity consequences for euro area banks as a group

This section discusses the balance sheet development of euro area banks as a group, and considers how it was affected by the crisis and the measures taken to mitigate its effects. Banks started to lose confidence in each others' creditworthiness in August 2007, and the margins between inter-bank deposit rates and the interest rates on high-quality sovereign debt widened sharply. In the euro area, in addition to this widening, deposits were withdrawn from banks in countries where the banking system and the public finances were perceived as weak. This development is explored in section 5 below.

This section discusses the changes in the balance sheet of banks in the euro area as a whole.[11] The changes are summarised in table 4.1, which shows the aggregated balance sheet of euro area banks[12] over the period July 2007–June 2012.

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[9] Goodhart and Tsomocos (2010) suggest that a country facing extreme stress in the euro area could have dual currencies: the euro to be used in external transactions and a domestic currency to be used for payment of wages and other domestic costs. In this way a country might be able to achieve a real devaluation, and thereby restore economic growth, without technically leaving the euro area. However, the use of such an expedient would not avoid the issues surrounding the treatment of outstanding debts that a full-blown departure from the euro area would raise.

[10] J. P. Morgan reported in December 2011 that "Client inquiries around euro breakup have risen exponentially over the past month". See Normand and Sandilya (2011).

[11] The data published by the ECB are for 'monetary financial institutions' (MFIs), of which commercial banks are the main constituent. Central banks, too, are MFIs, and their assets and liabilities need to be deducted from the MFI total for various purposes.

[12] Strictly speaking, table 4.1 shows the aggregated balance sheet of Monetary Financial Institutions (MFIs) excluding the Eurosystem. The Eurosystem is the central banking organisation of the euro area. It consists of the European Central Bank and the national central banks of the euro area countries. Being an aggregated balance sheet, table 4.1 does not net out liabilities and claims of members of the reporting population vis-à-vis one another.

Table 4.1

Aggregated balance sheet of euro area MFI excluding the Eurosystem, 2007–12

In billions of euro

Assets

Changes	Total assets	Loans to domestic non-MFIs	Loans to domestic MFIs	Govt securities	External assets	Other assets including cash
Jul 07–Jun 08	2,814	961	735	–62	14	341
Jul 08–Jun 10	1739	339	220	352	–316	692
Jul 10–Jun 11	–842	235	–719	–116	–283	233
Jul–Dec 11	1,803	–62	657	–62	–41	1,215
Jan–Jun 12	643	27	152	193	40	276

Liabilities

Changes	Deposits from non-MFIs	Deposits from MFIs	Debt securities issued	External liabilities	Other liabilities
Jul 07–Jun 08	1,009	717	285	348	270
Jul 08–Jun 10	969	275	196	–334	493
Jul 10–Jun 11	362	–851	–90	–495	48
Jul–Dec 11	92	665	118	–160	1,122
Jan–Jun 12	86	252	–15	77	201

Source: ECB.

The flows recorded in the table reflect both the after-effects of the global financial crisis of 2008 and the effects of the euro area sovereign debt crisis. The discussion below is in five parts. The first is a summary review of events from the onset of the global crisis until mid – 2010. The second, third and fourth parts describe events in the phases of the crisis that were identified in section 2. And the fifth part is about the demand for banknotes.

4.1 2008–mid 2010

Banks in the euro area, like banks elsewhere, made large losses during the global crisis, particularly after the collapse of Lehman Brothers in September 2008. They were suddenly under severe liquidity pressure, and were soon under pressure to rebuild their depleted capital bases as well. Nevertheless deposits from non-MFIs (ie households and non-financial companies) continued to grow. Banks reacted to the pressures on them by building up liquidity and slowing the growth of total assets; thus non-liquid asset growth slowed down. Table 4.1 shows that they generally maintained positive growth in lending to domestic non-MFIs, but that they reduced external assets quite sharply. They continued to accumulate government securities. Their loans to domestic MFIs continued to increase, but the increase was more than fully accounted for by deposits with the Eurosystem. Between mid-2008 and mid-2010, inter-commercial bank loans (ie loans by non-central bank MFIs to other non-central bank MFIs) decreased by EUR 106 billion (table 4.2).

4.2 Mid-2010–mid-2011

Deposits from non-MFIs continued to grow, suggesting that there was no general loss of confidence in banks. As at the middle of 2010, MFIs excluding the Eurosystem held EUR 1,574 billion of government securities. They began to sell government securities after the middle of 2010, and over the following year, their holdings fell by EUR 116 billion.[13] They were helped by the ECB, which bought EUR 19 billion under its Securities Market Programme. Loans to domestic non-MFIs went up by EUR 235 billion, including EUR 168 billion of mortgage lending to households; mortgage lending was possibly supported by the ECB's willingness to accept mortgage assets as collateral for loans (see section 6).

Inter-commercial bank loans fell by EUR 487 billion (table 4.2). This suggests that the mutual loss of confidence among euro area commercial banks was much more serious in this period than it had been between mid-2008 and mid-2010.

External assets contracted by EUR 283 billion (table 4.1). Moreover, within the total of external assets, liquid assets appear to have risen very sharply. Foreign-related commercial banks in the United States increased their holdings of cash assets by $501 billion in the period (see table 4.3). The reasons for the increase are discussed in section 7 below. The fall in total external assets will therefore have included a very large fall in non-cash external assets. It is thus clear the deleveraging of euro area banks during this period fell disproportionately on external rather than domestic assets.

Table 4.2

Deposits of MFIs (excluding the Eurosystem) with other MFIs

In EUR billion

Changes	Deposits of non-ES MFIs with all MFIs	ES deposit liabilities to non-ES MFIs	Deposits of non-ES MFIs with non-ES MFIs
Jul 07–Jun 08	735	22	713
Jul 08–Jun 10	220	327	–106
Jul 10–Jun 11	–719	–232	–487
Jul–Dec 11	657	363	294
Jan–Jun 12	152	428	–276

Source: ECB.

[13] Hedging holdings of weak government securities by means of credit default swaps (CDS) was an unreliable strategy, because of the determination of the euro area authorities to go to great lengths to prevent any formal default on any euro area government securities, by insisting that any variation of the terms of the securities had to be agreed with the creditors. It was thought that an agreed variation in terms might not trigger payouts on CDS contracts, but in the event, investors who had bought CDS protection against a Greek default were compensated.

Table 4.3

Changes in selected assets and liabilities of foreign-related commercial bank institutions in the United States 2010–12

In $ billion

	Total assets	Cash assets	Deposits	Net due to related foreign offices
30/06/2010 to 29/12/2010	118	67	86	–28
29/12/2010 to 29/06/2011	454	434	29	412
29/06/2011 to 28/12/2011	49	–9	–192	185
28/12/2011 to 27/06/2012	–50	–55	–53	–7

Source: Federal Reserve table H8.

Although the external assets of euro area banks fell, their external liabilities fell by more, and the net external assets of euro area banks increased by EUR 134 billion.[14] This figure is derived from the ECB's statistics; however the BIS international banking statistics suggest that the net external assets of euro area banks fell (table 4.4).

Table 4.4

Changes in net external assets of euro area banks

In EUR billion

	ECB data	BIS data	o/w euro	o/w other currencies
Jul 07–Jun 08	–332	–47	–19	–28
Jul 08–Jun 10	–72	–113	–432	319
Jul 10–Jun 11	134	–98	–156	59
Jul–Dec 11	11	–42	–216	174
Jan–Mar 12	–121	–144	–39	–105
Apr–Jun 12	63			

Sources: ECB, BIS, Bank of England (exchange rates), authors' calculations.

4.3 Second half of 2011

The aggregated balance sheets of euro area MFIs excluding the Eurosystem increased by EUR 1,803 billion in the second half of 2011; the increase was dominated on the assets side by loans to MFIs and 'remaining assets including cash', and on the liabilities side by deposits from MFIs and 'remaining liabilities'. We do not know what accounts for this parallel increase

[14] This figure cannot be derived from table 4.1, since it allows for changes in the euro valuation of existing external assets and liabilities.

in 'remaining assets' and 'remaining liabilities', but it seems unlikely that it had much macro-economic significance.[15]

Growth of deposits from non-MFIs slowed down, suggesting that depositors had begun to share the concerns that were afflicting financial markets (table 4.1). The rate of growth of the currency circulation increased slightly, so that the amount of currency outstanding at the end of 2011 was perhaps EUR 20–30 billion higher than might otherwise have been expected (authors' estimate).[16] Loans to non-MFIs, which had continued to increase earlier in the crisis, now fell slightly. Inter-commercial bank lending recovered moderately, however.

The external assets of banks located in the euro area continued to fall (see table 4.1). No direct information about the geographical incidence of the fall is available, but there were large and broadly-based reductions in the external exposures of banks *domiciled* in the euro area in the second half of 2011, amounting to $932 billion (12.6%). The countries which experienced the largest reductions in exposures are shown in table 4.5.

Table 4.5

Large reductions in external exposures of banks domiciled in the euro area

Changes in the second half of 2011, in $ billions

Exposures to	Change	Exposures to	Change	Exposures to	Change
United Kingdom	–224	Mexico	–26	Romania	–14
United States	–183	Australia	–24	Turkey	–14
Poland	–33	South Korea	–23	Norway	–14
Switzerland	–33	Canada	–21	Jersey	–13
Brazil	–33	Cayman Islands	–19	Hong Kong SAR	–13
Hungary	–29	China	–17	Chinese Taipei	–12
Japan	–28	Denmark	–15	Russia	–12
Czech Republic	–28	Singapore	–15	Croatia	–10

Source: BIS consolidated banking statistics, table 9B, authors' calculations.

Some of these reductions were probably in exposures to financial companies, and others will have resulted from sales of subsidiaries. Nevertheless, the reductions very likely caused a significant tightening of credit in some countries outside the euro area. For example, in the second half of 2011, there was an outflow of short-term funds through the banks of $19.9 billion in South Korea.[17]

Banks as a group increased both their deposits with and their borrowing from the Eurosystem, using as collateral for their borrowing assets within the increasingly wide range that the Eurosystem was willing to accept as collateral. It seems possible that the increase in

[15] The increase is likely to be related to changes in the accounting of derivatives positions. 'Remaining assets' and 'remaining liabilities' are described in Regulation (EC) no 25/2009 of the European Central Bank of 19 December 2008. See European Union (2009, pages L 15/47 and L15/51-52), or http://www.ecb.europa.eu/ecb/legal/pdf/l_01520090120en00140062.pdf (accessed on 25 January 2012).

[16] See section 4.5 for further discussion of banknotes.

[17] The deficit on short-term loans, currency and deposits of deposit-taking corporations other than the Bank of Korea in the Korean balance of payments accounts was $19.9 billion in the second half of 2011. Source: Bank of Korea.

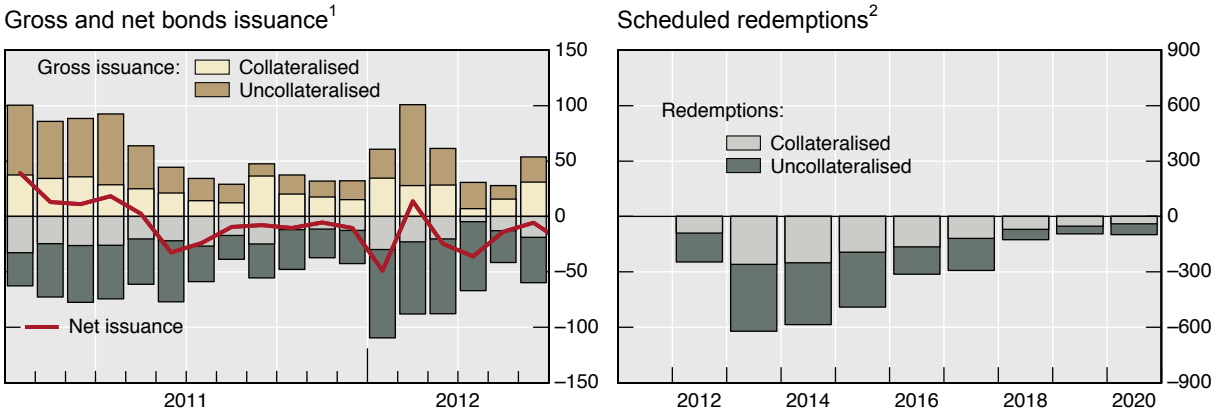
euro-denominated liquidity was made in response to regulatory pressures and in anticipation of the Basel III Liquidity Coverage Ratio.[18]

Banks needed to raise medium-term funding to replace maturing debt (including emergency loans raised during the crisis of 2008–09 and guaranteed by governments), to finance increased holdings of liquid assets and to facilitate compliance with the Basel III Net Stable Funding Ratio. As graph 4.1 shows, there are large bond maturities in 2012; nevertheless gross issuance declined sharply during 2011 and fell short of maturing debt, both in total and in the case of uncollateralised debt. The drying up of the new issue market reflected the concerns described in sections 2 and 3.

As noted above, the Eurosystem provided additional liquidity to the banking system in the second half of 2011. Its liquidity provision included the provision as from 22 December of EUR 489 billion of three-year loans to banks (the Long-Term Refinancing Operation, or LTRO). This operation was comparable in size to the banks' bond maturities for 2012 and replaced the market sources of medium-term funding, which had largely disappeared.[19] It had substantial effects on market prices, as graphs 2.3 and 2.4 show.

Graph 4.1

Euro area banks' medium-term funding



[1] Issuance of domestic and international securities by banks headquartered in euro area countries, in billions of euros. [2] As of end-June 2012.

Source: Dealogic Loan Analytics; BIS calculations.

4.4 First half of 2012

Commercial banks' liquidity problems were further eased by the Eurosystem's provision of an additional EUR 529 billion of three-year LTRO loans, as from 1 March. The provision, in December 2011 and March 2012, of more than EUR 1 trillion of three-year loans at low interest rates was intended to help commercial banks to maintain the flow of credit to the private sector, but loans to non-MFIs barely increased at all in the first half of 2012. Of course, in the absence of the three-year loans, loans to non-MFIs might have contracted.

[18] The Basel III liquidity requirements were published in December 2010. They comprise the Liquidity Coverage Ratio, which is to become a requirement in 2015, and the Net Stable Funding Ratio, which is to become a requirement in 2018, in each case after a review period. Investors demanded increasingly detailed disclosures of banks' liquidity. This issue is discussed further in section 7.

[19] See also Vause and von Peter (2011). The data for bond redemptions shown in graph 4.1 include indistinguishably the redemptions of bonds that are both issued by banks and held by banks. Such redemptions do not create any funding need for the banking system as a whole. Therefore the data shown in the graph overstate the funding need created by bond redemptions.

Banks did, however, resume purchases of government securities (table 4.1), and the International Monetary Fund (2012, figure 2.9) show that the Italian and Spanish governments sold large amounts of debt to domestic banks in the first quarter of 2012. External assets ceased to contract. Deposits from non-MFIs again grew only a little.

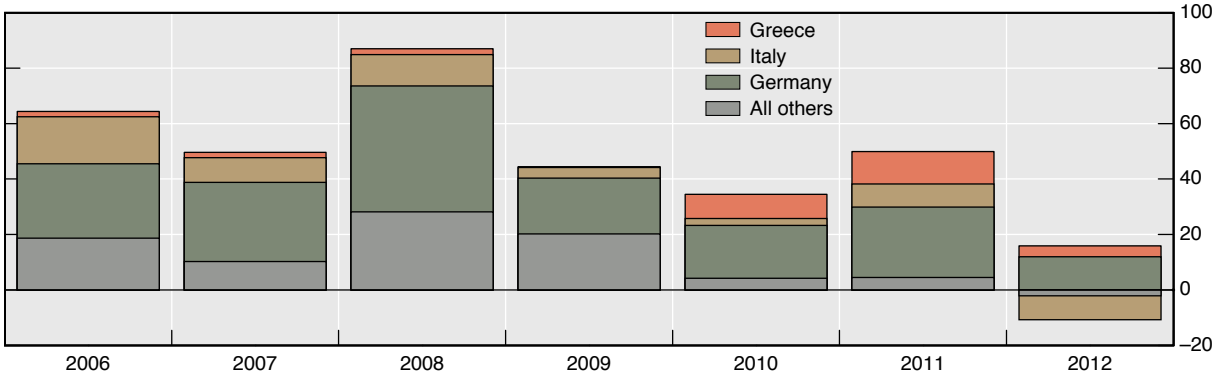
To summarise the development of banks' balance sheets from 2008 to the middle of 2012, the contraction of banks' assets has fallen disproportionately heavily on external assets. The flow of credit to non-bank borrowers has gradually diminished, but banks have continued to acquire government securities. Inter-bank lending has greatly diminished and much of the inter-bank deposit market has migrated onto the balance sheet of the Eurosystem, while increases in bank liquidity have been financed by ECB lending, including 3-year loans.

4.5 Banknotes

A generalised loss of confidence in the security of deposits in commercial banks would have been expected to lead to an increased demand for banknotes. There was an unusually large increase in 2008, as graph 4.2 shows, but there was no exceptional increase in 2010 or 2011, except in Greece.

Graph 4.2

Euro currency put into circulation[1]



[1] Changes in end-of-period stocks, in billions of euros. Latest figures refer to changes in July 2011 - June 2012.

Source: IMF, *International Financial Statistics*.

5. Intra-euro area financial flows

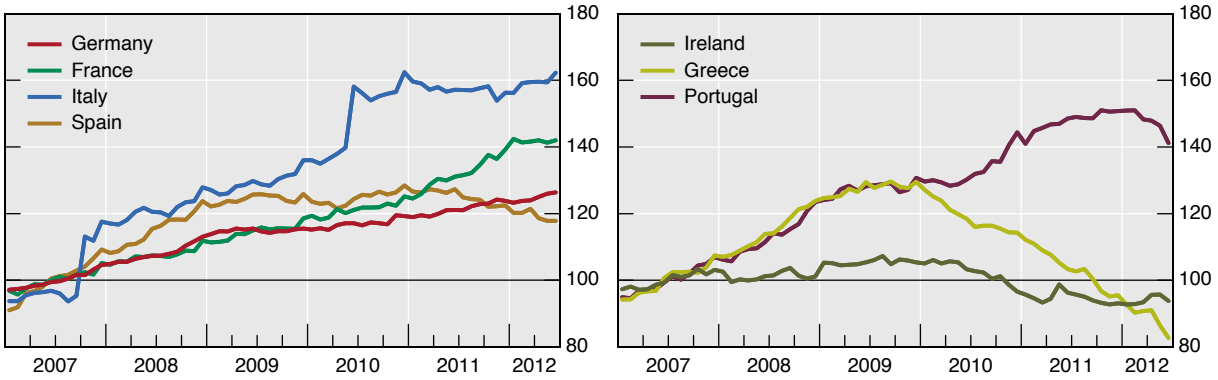
Having discussed the liquidity consequences of the euro area sovereign debt crisis for euro area banks as a group, we now turn to describing the divergent experiences of national banking systems within the euro area and discussing the consequences for intra-euro area financial flows in this section.

5.1 Bank deposits and Eurosystem lending

In most euro area countries, domestically-owned bank deposits were stable in 2010 and 2011, but in Greece and Ireland they fell heavily (graph 5.1). Greek and Irish banks were unable to replace the lost deposits with wholesale or other market borrowing, and filled their funding gaps by borrowing from their central banks (graph 5.2). The migration of the money market onto the balance sheets of central banks created very large inter-central bank debts within the Eurosystem, which are described in section 5.2.

Graph 5.1

Deposits of domestic residents with depository corporations[1]

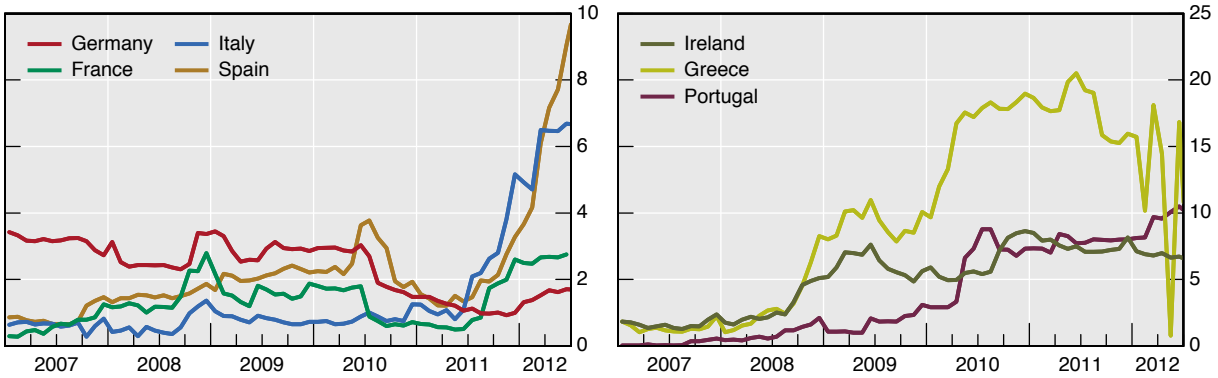


[1] Demand deposits and other deposits; rebased to 2007 average = 100; excluding central banks.

Source: IMF IFS.

Graph 5.2

Use of Eurosystem lending[1]



[1] Eurosystem lending to Monetary Financial Institutions (excluding central banks) as a percentage of their total liabilities.

Sources: Datastream; national data.

5.2 Inter-commercial bank and inter-central bank lending

Inter-commercial bank lending within a monetary area is a means of transmitting funds from areas which are in surplus to areas which are in deficit. For example, a deposit withdrawn from a Greek bank and placed in a German one would leave the Greek bank short of funds and the German bank with surplus funds. In normal market conditions, the German bank might lend the funds back to the Greek bank. Other banks, including international banks outside the euro area, also intermediated such interbank flows.

Until 2007, market conditions were normal. After 2007, when banks lost confidence in each others' solvency, the money market migrated onto the balance sheets of central banks. Euro area banks with surplus funds began to place them on deposit in the Eurosystem, and banks which were short of funds borrowed from the Eurosystem, as reflected in the balance sheet of the Eurosystem. Thus, in the example, the German bank would place its surplus funds on deposit with the Eurosystem, in the form of the Deutsche Bundesbank, and the Greek bank would borrow from the Eurosystem, in the form of the Bank of Greece.

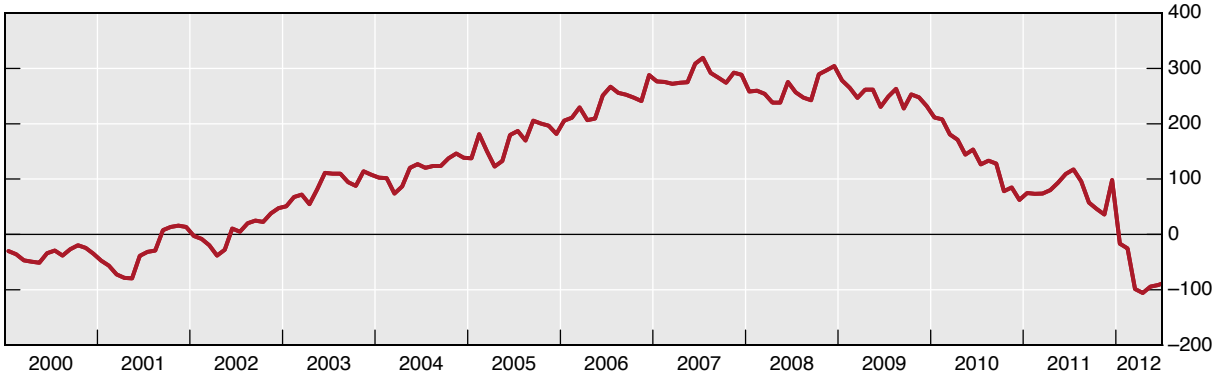
This process was reflected in the developments of cross-border net interbank claims. To illustrate the magnitudes involved, Graph 5.3 shows net interbank claims (loans and advances minus liabilities to foreign banks denominated in euros) by banks located in

Germany. These decreased from EUR 289 billion at end-2007 to EUR –91 billion in June 2012, a decrease of EUR 380 billion, falling sharply in the first quarter of 2012 (Graph 5.3).

Graph 5.3

Net euro-denominated claims by banks in Germany vis-à-vis banks abroad

(Loans and advances minus liabilities to foreign banks)[1]



[1] Amount outstanding, in billions of euros.

Source: Deutsche Bundesbank, BIS calculations.

This process was also reflected in the pattern of claims and liabilities of the national central banks of the euro area vis-à-vis the ECB. Central banks of deficit countries borrow from the ECB to lend to commercial banks in their countries, while the central banks of surplus countries lend surplus funds from their banks to the ECB. Graph 5.4 shows the evolution of some of these claims and liabilities from January 2002–June 2012.[20]

Until 2007, the balances were very small by more recent standards. In those days, the private sector was willing to finance payments imbalances within the euro area. After 2007, the balances grew rapidly. Until mid-2011, the intra-eurosystem debts were concentrated in Greece, Ireland and Portugal. In the second half of 2011, the pattern changed as deficits emerged in Spain, Italy and France, and by the end of the year, Germany had built up an accumulated surplus of nearly EUR 500 billion, or 19% of Germany's GDP, and the Netherlands an accumulated surplus of EUR 155 billion, or 26% of GDP. Greece's accumulated deficit at the end of 2011 was EUR 104 billion, or 48% of GDP. As noted in section 4.5, demand for banknotes in Greece was unusually high in 2010 and 2011, suggesting a loss of public confidence in Greek banks. The surplus of Germany increased further to EUR 739 billion, or 28% of GDP, in the first half of 2012. While the intra-eurosystem debts of all the debtor countries shown in the middle panel of Graph 5.4 levelled off in the first half of 2012, with the net position of France returning close to balance in June 2012, the net debts of Spain and Italy increased significantly further in the first half of 2012, to EUR 404 billion (37% of GDP) in Spain and to EUR 265 billion (16% of GDP) in Italy, respectively, in June 2012.

These imbalances reflected the anxieties described in sections 2 and 3, which have inhibited flows of funds into the liabilities of governments, commercial banks and other companies in countries perceived to be financially insecure, and prevented the normal flows of private funds from surplus to deficit countries from taking place. The imbalances, which the market was not willing to finance, were instead financed by the Eurosystem, which took increasingly

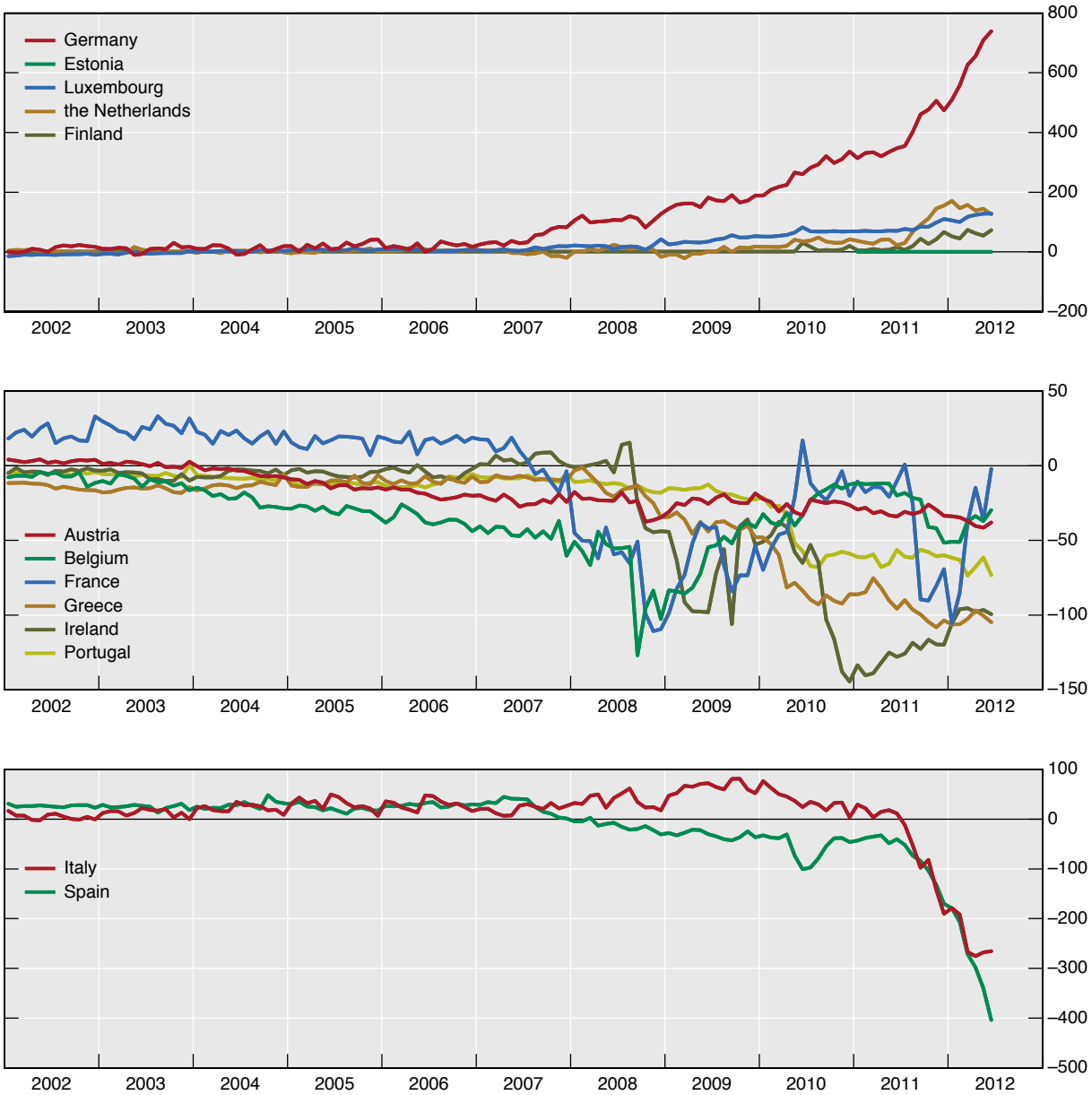
[20] Sinn and Wollmershäuser (2011) have drawn attention to these intra-euro area central bank assets and liabilities (Target2 balances). For an overview of the recent debate on these intra-euro area central bank assets and liabilities see eg Bindseil and Koenig (2012) and Grjebine (2012).

large deposits from commercial banks in surplus countries and extended increasingly large loans to commercial banks in deficit countries (see graph 5.2).

Graph 5.4

Net claims on Eurosystem minus intra-Eurosystem claims related to banknote issuance

In billions of euros



The data are calculated as "net claims on the Eurosystem" minus the difference between "currency issued" (which represents an NCB's share in banknote issuance based on its share in the ECB's capital) and "currency put in circulation" (which is the actual amount of banknotes issued by an NCB). See European Central Bank (2011d, page 36, footnote 5) and Sinn and Wollmershäuser (2011, pages 37-38).

Source: IMF *IFS*.

6. Effects of the crisis on collateral availability

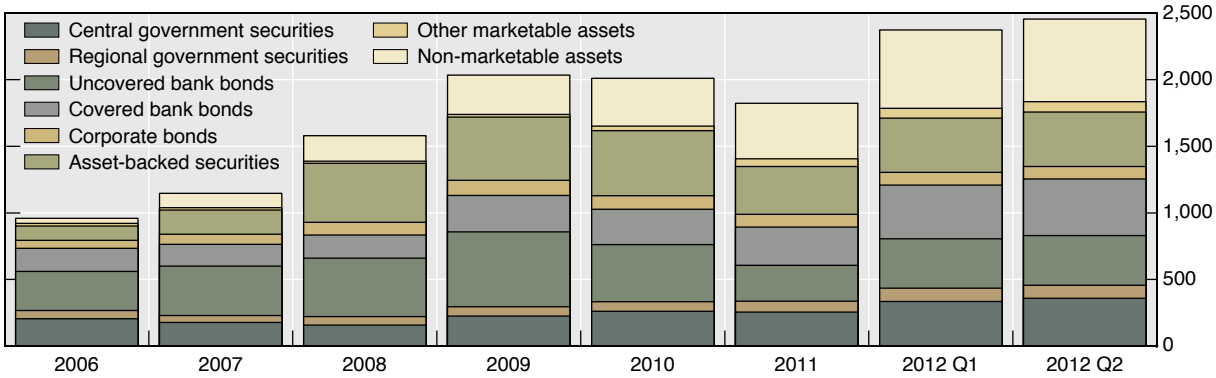
Having discussed consequences of the crisis for intra-euro area financial flows in the previous section, we now review the signs of a resulting collateral squeeze in the euro area.

The global financial crisis caused a severe 'collateral squeeze' in the United States in 2008, which was partly relieved by prompt action on the part of the Federal Reserve, but which nevertheless had profound macro-economic consequences in the United States and the rest of the world.[21]

There are signs that the euro area sovereign debt crisis has likewise caused a collateral squeeze in the euro area. There was plainly no such squeeze in 2010, when banks had lodged collateral with the Eurosystem equivalent to about three times their outstanding borrowings; in that year, banks maintained their holdings of collateral with the Eurosystem at much the same average level as in 2009, even though average borrowings were lower.[22] But increasing anxiety about bank solvency (and about the ability of governments to rescue banks in distress, and about the terms of any such rescue), and increasing asset price volatility seem to have caused a tightening of collateral conditions in 2011. Collateralised lending by the ECB increased sharply in the last few months of that year and in the first quarter of 2012, and the amount of collateral lodged with the ECB increased (graph 6.1).

Graph 6.1

Collateral lodged with the Eurosystem, by type



[1] In billions of euros, average of end-of-month figures.

Source: European Central Bank.

The collateral squeeze developed in a number of ways. First, the migration of the short-term money market to the balance sheet of the Eurosystem meant that uncollateralised inter-bank borrowing was replaced with collateralised borrowing from central banks. Banks which were net borrowers could no longer borrow unsecured in the wholesale interbank market but had to borrow from their national central banks, which demanded collateral. Commercial bank borrowing from the Eurosystem increased by EUR 289 billion net during 2011 (reflecting a EUR 56 billion decrease in 2011H1 and a EUR 345 billion increase in 2011H2), and by a further EUR 435 billion in the first half of 2012 (table 6.1), and this will have drained collateral from the banking system.[23] Eurosystem lending to banks had increased from Jul 08–Jul 10 presumably because the euro area was somewhat affected by the global banking crisis and unsecured inter-bank lending contracted, so that more inter-bank intermediation was done by the Eurosystem. Eurosystem lending to banks then decreased in the second half of 2010, perhaps because markets believed that the risks in inter-bank lending had diminished in the light of the financial assistance provided to Greece and Ireland.

[21] See Allen and Moessner (2012).

[22] See European Central Bank (2011a, page 97, especially chart 47).

[23] These figures include borrowing under the LTRO, as well as short-term borrowing.

Table 6.1

Eurosystem lending to commercial banks

Changes in EUR billion

Jul 07–Jun 08	15
Jul 08–Jun 10	280
Jul–Dec 10	–227
Jan–Jun 11	–56
Jul–Dec 11	345
Jan–Jun 12	435

Source: ECB.

Second, as noted in section 4.3, banks have needed to issue large amounts of medium-term debt, and it became much more difficult for banks to issue such debt in the commercial market in the second half of 2011. It became relatively more difficult, and more expensive, to issue medium term debt in unsecured form than in the form of covered bonds, partly because unsecured bondholders are unlikely to be protected from loss in any future episode of bank distress. As already noted, banks filled the gap by borrowing for three years from the ECB, against collateral.

It seems likely that banks' future medium-term debt issuance to private investors will be predominantly in the form of covered bonds.[24] Holders of covered bonds have recourse to a pool of the issuing bank's assets, and the assets in that pool are therefore not available for use as collateral for other debt, nor are they available to unsecured creditors in the event of a liquidation. Therefore replacing unsecured bonded debt with covered bonds drains collateral from the banking system (and weakens further the position of unsecured creditors of the banks).

Third, US depositors withdrew substantial unsecured deposits from foreign banks in the US in the second half of 2011 (see table 4.3); the banks had anticipated the withdrawal by remitting funds from their non-U.S. offices as described in section 7 below, and the financing of those remittances will probably have required the pledging of collateral, or the sale of assets which might otherwise have been used as collateral.

Fourth, the increased volatility of government securities prices caused the required margins of surplus collateral to increase. This represented, in effect, a narrowing in the range of assets regarded as liquid and safe.[25] For example, on 9 November 2011, presumably in response to market volatility in the wake of the European Council statement of 26 October, LCH Clearnet SA increased collateral margins on unsettled trades, including repos, in Italian government securities by between 3 and 5.5 percentage points. The increase caused a sharp fall in Italian government securities prices – an example of positive feedback created by the use of algorithms designed to manage risk.

More generally, anxiety about the solvency of trading counterparties led to an increased demand for collateral in wholesale market transactions. In addition, market participants

[24] There has been significant unsecured issuance so far in 2012 (see graph 4.1), but the International Monetary Fund (2012, page 29) comment that 'the bulk of issuance [secured and unsecured] by periphery banks since mid-2011 has been taken up by the banks themselves (so-called self-funded issues) to be used as collateral', and that 'during 2011–12, just over half of the €340 billion of debt issued by periphery banks was self-funded'.

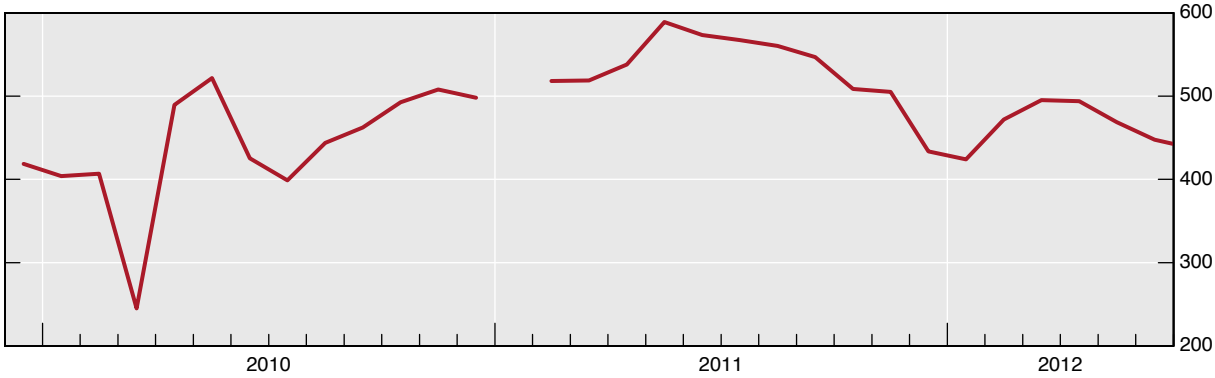
[25] See Allen and Moessner (2012).

appear to have become more concerned about the quality of the collateral they take. The ICMA European repo market survey for December 2011 reported a substantial increase in the share of repo transactions that involved government securities in the second half of 2011.[26]

Several of the above indicators suggest that the squeeze intensified in late 2011. And the broking company ICAP reported a sharp fall in repo turnover (see graph 6.1), which they attributed to a shortage of collateral (see graph 6.2).[27]

Graph 6.2

Repo market turnover reported by ICAP[1]



[1] Daily averages in billions of US dollars.

Source: ICAP.

The ECB was well aware of the collateral squeeze and the related increase in 'asset encumbrance' – that is, the percentage of banks' assets that are pledged as collateral to specified creditors.[28] It reacted to the collateral squeeze by reducing its reserve requirements, and by substantially relaxing its own collateral eligibility rules. For example, in May 2010, it suspended the application of its normal minimum credit rating requirement to Greek government securities, and in March and July 2011 it did likewise in respect of Irish and Portuguese government securities, respectively, thus preventing a shrinkage of the pool of eligible assets that would otherwise have had a severe effect on banks which were already suffering from liquidity problems. And in December 2011 it announced that it would be reducing its rating threshold for certain asset-backed securities and allowing national central banks, at their own financial risk, to accept as collateral certain kinds of bank loans.[29] The total quantity of assets eligible as collateral at the ECB was increased by 62% between 2006, before the crisis began, and the second quarter of 2012 (see table 6.2). It fell between 2010 and 2011 because the amount of government-guaranteed bank bonds outstanding contracted, but increased again after the further extensions of eligibility in December 2011. The figures for non-marketable assets in table 6.2 after 2007 show the amount pledged as collateral; the amount outstanding and available for pledging is unknown.

Quantification of the collateral squeeze is important but beyond the scope of this paper. More generally, eligibility policy is an aspect of central banking which was regarded as being of considerable importance in the 19th century, and in the 20th century until the Second World

[26] International Capital Market Association (2012).

[27] See report in Financial Times Alphaville, 'Collateral squeeze as strong as ever, ICAP says', 20 January 2012.

[28] See European Central Bank (2012, box 7). The ECB draws attention to the absence of comprehensive data on asset encumbrance. The Bank of England has identified asset encumbrance as a problem for UK banks – see Bank of England (2012, box 6).

[29] See European Central Bank (2010 and 2011b, c and f).

War led to a massive increase in the supply of government securities. Now that central banks are supplying very large amounts of credit, their choice of asset is plainly a matter of macro-financial significance. The ECB's net acquisition of EUR 250 billion of covered bonds and EUR 298 billion of asset-backed securities between 2006 and the second quarter of 2012 was the equivalent of 76% of banks' net mortgage lending over that period, and its holdings of such assets in the second quarter of 2012 amounted to 22% of total bank mortgages outstanding.

Table 6.2

Assets eligible as collateral at Eurosystem central banks, by type

In EUR trillion, averages over the time period shown of end-of-month data

	2005	2006	2007	2008	2009	2010	2011	2012 Q1	2012 Q2
Central government securities	4.1	4.3	4.4	4.6	5.2	5.8	6.0	6.0	6.1
Regional government securities	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
Uncovered bank bonds	1.2	1.4	1.6	2.2	2.8	2.7	1.9	2.3	2.3
Covered bank bonds	1.2	1.2	1.2	1.2	1.4	1.4	1.5	1.6	1.6
Corporate bonds	0.7	0.8	0.8	0.9	1.3	1.5	1.2	1.2	1.2
Asset-backed securities	0.4	0.5	0.7	1.1	1.3	1.3	1.0	1.0	1.0
Other marketable assets	0.3	0.3	0.3	0.6	0.5	0.6	0.7	0.8	0.9
Non-marketable assets	0.1	0.1	0.1	0.2	0.3	0.4	0.4	0.6	0.6
Total	**8.3**	**8.8**	**9.5**	**11.1**	**13.1**	**14.0**	**13.2**	**14.0**	**14.3**

Source: ECB.

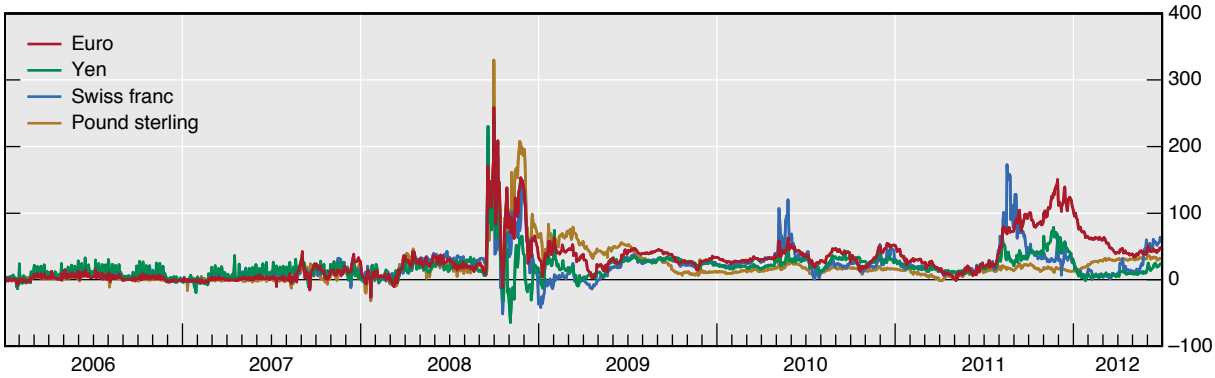
7. Consequences of the crisis for international liquidity

As noted in section 2, market indicators also showed serious stresses in international finance. Large violations of covered interest parity (CIP) in foreign exchange swap markets such as had been observed in the 2008–09 crisis betrayed severe tensions in those markets (graph 7.1). These deviations reflected difficulties in swapping euros into dollars. Violations of CIP in cross-currency basis swap markets were another indicator of the same tensions, and the same problems in swapping euros into dollars (graph 7.2). This section discusses the causes of the market tensions and the limited effectiveness of the measures that central banks took to alleviate them.

Graph 7.1

CIP deviations as measured by 3-month FX swap spreads against the US dollar

In basis points

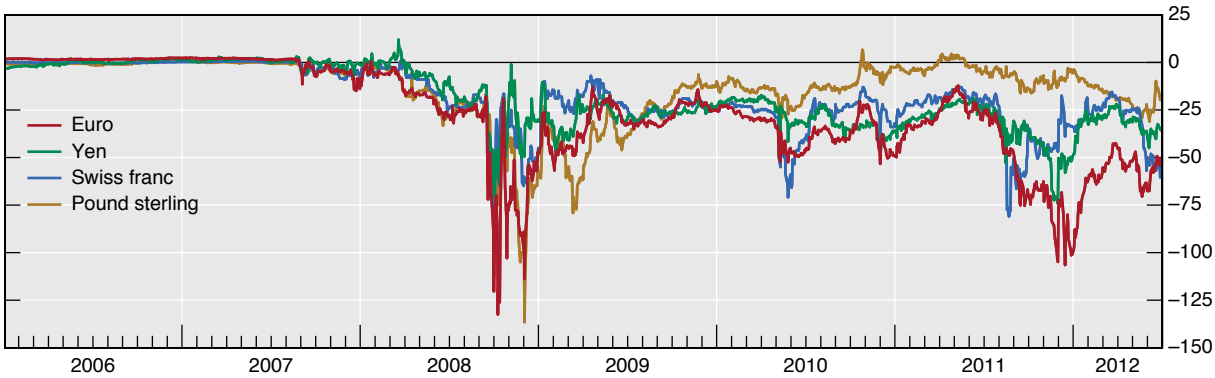


Sources: Bloomberg; BIS calculations.

Graph 7.2

CIP deviations derived from 1-year cross-currency basis swap spreads against the US dollar

In basis points



Source: Bloomberg.

7.1 Cash flows

There were large dollar-specific liquidity shortages in the euro area before the 2008–09 crisis (McGuire and von Peter (2009), Moessner and Allen (2012)), euro-area banks having previously used their branches in the United States as a source of funding. These US dollar liquidity shortages were reduced during and after the crisis, turning from a net shortage of around $513 billion in the middle of 2008 to a net shortage of around $266 billion at end-2010 and $106 billion at the end of June 2011, and a surplus of around $54 billion at the end of September 2011 (Graph 7.3), according to the proxy measure in Moessner and Allen (2012).[30] This is consistent with the large build-up of cash assets by foreign related

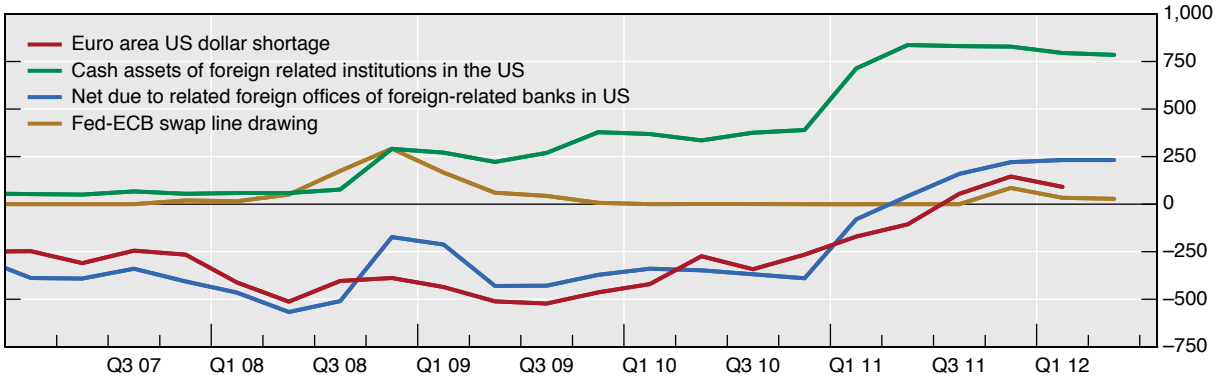
[30] The proxy measure for the US dollar liquidity shortage used is the net outstanding US dollar cross-border claims on BIS reporting banks by the euro area, defined as cross-border total US dollar liabilities minus claims (in both foreign and domestic currency) of all BIS reporting banks vis-à-vis banks and non-banks located in the euro area, calculated from the BIS locational international banking statistics (see Moessner and Allen 2012).

institutions in the United States in the first half of 2011, which was financed almost completely by borrowing (or loan repayments) from those institutions' related foreign offices (Graph 7.3 and Table 4.3). The ratio of cash assets to deposits of foreign-related institutions increased remarkably during the first half of 2011, and was close to 100% towards the end of the year (graph 7.4).

Graph 7.3

Euro area US dollar liquidity shortage, cash assets and net due to related foreign offices of foreign related bank institutions in the US, and Fed-ECB swap line drawings

In billions of USD



Sources: BIS international banking statistics; Federal Reserve Table H8.1, authors' calculations.

Why did foreign-related institutions in the United States build up their cash balances so much? Foreign-related institutions are (mostly) branches of foreign banks in the United States; they are not of course all domiciled in the euro area, but many of them are. Deposits in foreign bank branches established after 19 December 1991 are not covered by US deposit insurance. The branches do not have to pay insurance premia to the Federal Deposit Insurance Corporation, but, being uninsured, are not allowed to take deposits of less than $100,000 from US citizens and residents. Therefore they cannot receive any smaller deposits that might be fleeing from other institutions, such as money market mutual funds. If there is a general loss of confidence in financial institutions, they are therefore at greater risk of deposit loss than US-domiciled banks. In the 2008 crisis, this risk materialised (see Baba, McCauley and Ramaswamy 2009). Concern that foreign bank branches might experience renewed deposit withdrawals is likely to have contributed to the increase in their dollar liquidity.

Kreicher, McCauley and McGuire (2012) demonstrate that the change in the calculation of the FDIC insurance premia mandated by the Dodd-Frank Act, which became effective in early 2011, had the incidental effect of making foreign bank branches more attractive repositories for wholesale deposits in the United States money market.[31] The change in the FDIC premium calculation meant that insured banks could not offer depositors as high an interest rate as foreign bank branches, so that depositors had an incentive to switch deposits from insured banks to branches of foreign banks. Nevertheless, it is unclear why a bank would voluntarily increase its cash/deposit ratio to around 100%, because of the adverse implications for profitability. The deposits of foreign bank branches rose by only $29 billion during the first half of 2011, and the increase in their cash assets was financed almost

[31] Before the change, the premia were calculated as a percentage of insured deposits. After the change, they were calculated as a percentage of total assets less tangible shareholders' equity; therefore an increase in balances with the Fed matched by an increase in large and therefore uninsured deposits meant an increased FDIC premium.

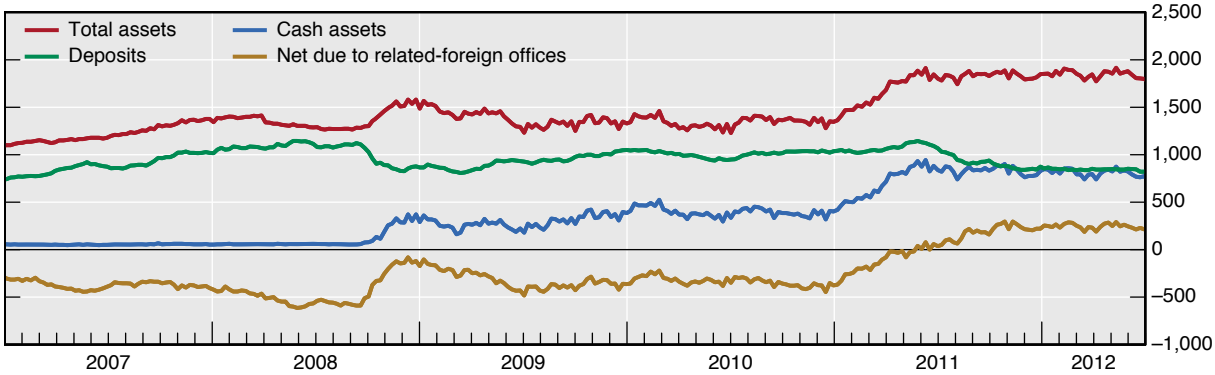
entirely from 'related foreign offices' (graph 7.4). In our judgment, it is unlikely that the change in the calculation of FDIC insurance premia was alone responsible for the build-up in foreign banks' cash assets in the first half of 2011. Large depositors would be greatly reassured by a very liquid balance sheet. Regulatory concerns that foreign banks could experience renewed deposit withdrawals from money market mutual funds, which had previously been important sources of funds to them, may have also played a role. Indeed, there were deposit withdrawals in the second half of 2011 (graph 7.4), partly financed by drawing on cash assets.[32]

The need to build up cash assets in the United States will have added substantially to the liquidity pressures on the affected banks, and created demand for dollar liquidity in the euro area. The Fed's provision of unlimited dollar swap facilities to the ECB and other foreign central banks served to help foreign commercial banks acquire additional liquid assets.

Graph 7.4

Foreign-related institutions in the United States - balance sheet items

In billions of USD; nsa



Source: Federal Reserve, table H.8.

During the 2008–09 financial crisis, central banks established swap lines to alleviate international liquidity problems arising from that crisis (see Allen and Moessner (2010, 2011), Moessner and Allen (2012)). All of the Fed's temporary swap lines were repaid, and they expired on 1 February, 2010. The international liquidity problems arising from the euro area sovereign debt crisis of 2010–12 led to a renewed increase in deviations from CIP, which had previously risen to extreme levels during the global financial crisis in 2008. During the euro crisis, CIP deviations of the euro, the Swiss franc and the yen against the dollar rose to levels close to those of autumn 2008 (see graphs 7.1 and 7.2).

As soon as the euro area sovereign debt crisis erupted, major central banks reintroduced and expanded swap line arrangements. On 10 May 2010, 'in response to the re-emergence of strains in U.S. dollar short-term funding markets in Europe' due to market concerns about sovereign debt, the Federal Reserve reestablished swap lines with the central banks of Canada, the United Kingdom, the euro area, Switzerland and Japan.[33] Later, on 15 September 2011, in cooperation with the Federal Reserve, the ECB, the Swiss National Bank, the Bank of Japan, and the Bank of England announced that they would conduct

[32] Fitch Ratings (2011) report large reductions in the exposures of U.S. money market mutual funds to euro-area banks after May 2011.

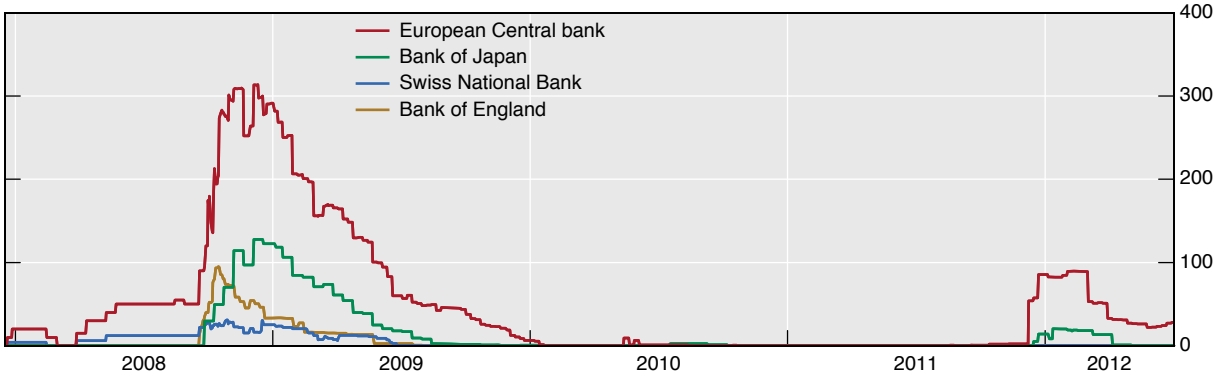
[33] See ECB press release, http://www.ecb.int/press/pr/date/2010/html/pr100510_1.en.html, Bank of England press release http://www.bankofengland.co.uk/publications/news/2010/040.htm, and Federal Reserve press releases http://www.federalreserve.gov/newsevents/press/monetary/20100509a.htm and http://www.federalreserve.gov/newsevents/press/monetary/20100510a.htm.

additional US dollar tenders, at a term of approximately three months covering the end of the year, in addition to the weekly 7-day tenders of dollar funding announced on 10 May 2010.[34] And on 30 November 2011, six major central banks jointly announced measures to enhance the cross-border provision of liquidity via central bank swap lines. The swap lines were extended to 1 February 2013, and remained unlimited in amount. An important element of the announcement on 30 November was that the price would be reduced from 100 basis points above to 50 basis points above the US dollar overnight index swap (OIS) rate (see Board of Governors of the Federal Reserve System (2011)). The ECB also reduced the initial margin for three-month US dollar operations from 20% to 12% on 30 November (see ECB (2011e)).[35] The amounts drawn on the Fed's US dollar swap lines are shown in Graph 7.5.

Graph 7.5

Central bank drawings on Fed swap lines

In billions of USD



Sources: National data; BIS calculations.

7.2 Swap line effectiveness

We now investigate whether strains in international dollar funding markets were alleviated by the swap line announcements of 2010-11, by studying the impact on 3-month euro-US dollar foreign exchange swap spreads of these swap line announcements, as well as of the amounts drawn on the swap lines. To our knowledge this is the first study of the impact of the Fed swap line announcements during the crisis of 2010–12.

The effects of swap lines established during the 2008–09 crisis have been analysed in Baba and Packer (2009) and in Baba and Shim (2010). In the following, we build on their analysis employing an EGARCH(1,1) (exponential generalized autoregressive conditional heteroskedasticity) model to study the effect of the 2010-12 swap lines on 3-month euro-US dollar FX swap spreads. We estimate an EGARCH(1,1) model, with the specification of equations (1) and (2) over various periods between 2006 and 2012, thus embracing both

[34] See ECB press release, http://www.ecb.int/press/pr/date/2011/html/pr110915.en.html, SNB press release, http://www.snb.ch/en/mmr/reference/pre_20110915_2/source/pre_20110915_2.en.pdf , Bank of Japan press release, http://www.boj.or.jp/en/announcements/release_2011/rel110915a.pdf, and Bank of England (2011). The ECB added three additional auctions, while the Bank of Japan, which had already conducted three-month US dollar auctions prior to this announcement, added one additional auction.

[35] The swap line announcement preceded the ECB's announcement on 8 December 2011 of measures to support lending and money market activity, including two longer-term (three-year) euro refinancing operations and widening of its rules for eligible collateral (see ECB (2011f)).

crises. The mean equation for the CIP deviation, as measured by 3-month euro-USD FX swap spreads, EUR CIP dev_t, takes the form

$$\begin{aligned} d(\text{EUR CIP dev}_t) = {} & c + b_1 * d(\text{EUR CIP dev}_{t-1}) + b_2 * \text{EUR CIP dev}_{t-1} + \\ & \textstyle\sum_{j=1}^{n} f_j * \text{FEDEURSWAPdate}^j_t + g_1 * \text{Allotted swap amts at auction}_t + \\ & g_2 * d(\text{ECB swap draw}_t) + g_3 * d(\text{vix}_{t-1}) + g_4 * d(\text{EUR dep-OIS sprd}_{t-1}) + \\ & g_5 * d(\text{USD dep-OIS sprd}_{t-1}) + g_6 * d(\text{EUR bank CDS}_{t-1}) + \\ & g_7 * d(\text{US bank CDS}_{t-1}) + \varepsilon_t \ , \\ & \varepsilon_t \sim N(0, \sigma^2_t) \qquad (1) \end{aligned}$$

where the difference operator is $d(y_t) := y_t - y_{t-1}$.

The explanatory variables include dummy variables for the dates of Fed-ECB USD swap line announcements, $\text{FEDEURSWAPdate}^j_t$, which take the value of 1 on the dates of the swap line announcements, and zero otherwise, and n is the number of dummy variables for the period considered. For the 2008–09 crisis, we include a separate dummy variable for the announcement on 13 October 2008 that the Fed-ECB swap line would become unlimited in amount, $\text{FEDEURSWAP13OCT2008}_t$, and group the other swap line announcement dates together in one dummy variable, FEDEURSWAPOTH_t, which takes the value of 1 one each of the swap line announcement dates of 12 December 2007, 11 March 2008, 2 May 2008, 30 July 2008, 18 September 2008, 26 September 2008, 29 September 2008 and 6 April 2009 (see Moessner and Allen (2012)). We also include the amounts allotted from US dollar auctions by the ECB on bid auction dates, Allotted swap amts at auction_t, usually one or two business days ahead of the settlement dates of the auction; and changes in the amounts drawn on the Fed-ECB USD swap line, ECB swap draw_t, on the settlement dates.

To control for AR(1) effects, we include lagged differences of the CIP deviations; and to control for level effects, we include the lagged level of CIP deviations, based on McAndrews et al. (2008), as in Baba and Shim (2010). We control for the impact of general market uncertainty by including lagged differences of the VIX volatility measure, vix_t, and for the impact of tensions in funding markets by including lagged differences of spreads of 3-month deposit rates over OIS rates in the euro area and the United States (EUR dep-OIS sprd_t and USD dep-OIS sprd_t, respectively). Finally, we control for the effect of counterparty risk by including lagged differences of CDS spreads of euro area and US banks (EUR bank CDS_t and US bank CDS_t, respectively), calculated as a simple average over leading banks in each economy. Like Baba and Shim (2010), we consider first differences of the CIP deviations and of the control variables, to be conservative in case some of the variables are integrated of order 1. We also consider first differences in the amounts drawn on the swap line. The amount allotted at the bid auction dates is already a flow variable, so we include it and the dummy variables for the swap line announcements in non-differenced form.

The variance equation of the EGARCH(1,1) model takes the form

$$\begin{aligned} \log \sigma^2_t = {} & \alpha + \beta * |\varepsilon_{t-1} / \sigma_{t-1}| + \gamma * \varepsilon_{t-1} / \sigma_{t-1} + \delta * \log \sigma^2_{t-1} + \mu * \text{Allotted swap amts at auction}_t + \\ & \textstyle\sum_{j=1}^{n} \kappa_j * \text{FEDEURSWAPdate}^j_t \qquad (2) \end{aligned}$$

The inclusion of the amounts allotted at the US dollar auctions by the ECB, and of the dummy variables for swap line announcement dates, in the variance equation allows to study whether they significantly affected volatility.

The EGARCH approach has been used to study the effects of central bank communication on financial asset prices in the past, for example in Ehrmann and Fratzscher (2007). An advantage of the EGARCH model compared with a GARCH model is that the conditional

variance specification is of logarithmic form, so that no non-negativity constraints need to be imposed, as noted in Baba and Packer (2009).

Results from the EGARCH(1,1) model of equations (1) and (2) are shown in Tables 7.1 to 7.4 (in the appendix) for the whole crisis period from the start of December 2007 to 6 January 2012, the pre-crisis period from the start of January 2006 to end-November 2007, the 2008–09 crisis period from the start of December 2007 to end-December 2009, and the 2010–12 crisis period from the start of January 2010 to 6 January 2012, respectively. Results for the pre-crisis period are shown for comparison. The 2008–09 crisis period is taken to start at the start of December 2007, the month in which the swap lines were introduced. The 2010–12 crisis is taken to start at the beginning of 2010, to include the intensification of the crisis of May 2010 and the second half of 2011, and to end at the end of our available data at the time of the analysis in early January.

Some of the control variables are significant for the CIP deviations in some periods. When they are significant, the effects of these control variables are as would be expected. In particular, the VIX measure of general market uncertainty has a positive effect on CIP deviations in the 2010–12 crisis period, where it is significant at the 1% level. US bank CDS spreads have a significant positive effect on CIP deviations at the 10% level for the whole crisis period, and at the 1% level for the 2010–12 crisis period. Such a positive effect is consistent with higher counterparty risk concerns leading to higher CIP deviations. Euro area bank CDS spreads have a significant positive effect on CIP deviations at the 10% level for the 2008–09 crisis period, and at the 1% level for the 2010-12 crisis period. Such a positive effect is again consistent with higher counterparty risk concerns leading to higher CIP deviations. In the pre-crisis period, spreads of euro area 3-month deposit rates over the OIS rate have a positive impact on CIP deviations at the 10% significance level. This could reflect higher funding tensions in the euro money market leading to greater concern about counterparty risk of banks with funding problems, with the counterparty risk concern leading to higher CIP deviations.

We find that each swap line announcement during the 2010-12 crisis significantly reduced euro-dollar CIP deviations at the 1% significance level, and led to reductions in CIP deviations between around 15 and 30 basis points (Tables 7.1 and 7.4). The joint announcement by six major central banks on 30 November of measures to enhance the cross-border provision of liquidity via central bank swap lines had the largest impact, being associated with a fall of around 30 basis points in 3-month euro-dollar FX swap spreads on the day of the announcement. This result is present when estimating the model both over the whole crisis period (Table 7.1) and over the 2010–12 crisis period (Table 7.4).

Amounts allotted in US dollar auctions by the ECB at the bid auction dates significantly reduced CIP deviations at the 10% significance level for the whole crisis period, and at the 1% significance level during the 2008–09 crisis. During the 2010-12 crisis, amounts allotted at US dollar auctions by the ECB at the bid auction dates did not have a significant effect on CIP deviations. This finding is consistent with the interpretation that sufficient swap amounts were drawn during the 2008–09 crisis to alleviate the market stresses revealed by CIP deviations, but not in 2010–12, perhaps because in 2010–12 euro area banks were afraid to use central bank dollar liquidity facilities for fear of being stigmatised as weak. However, the econometric finding may reflect mainly the period from the start of January 2010 until the price of the swap facility was reduced by 50 basis points on 30 November 2011, when the stigma was probably greater than it was afterwards (see below for explanation).

Changes in the actual amounts drawn on swap lines had no additional significant impact on CIP deviations for the crisis period as a whole, or for any of the subperiods, over and above the impact of the amounts allotted at auction on the auction bid dates, ie prior to the settlement date of the auction at which actual swap drawings are measured (see Tables 7.1 to 7.4). This is probably because earlier information available on the amounts on the days of the auction bids would have already been incorporated into CIP deviations (see Baba and Packer (2009)). It also indicates that there were no strong concerns in the market about

banks failing during the one or two business days between the bid and the settlement dates of the auction, but that instead markets expected that banks would survive or receive official support, with the availability of swap lines possibly providing an indication that official support would be available.

The three swap line announcements during the 2010-12 crisis also significantly reduced the volatility of CIP deviations implied by the EGARCH(1,1) model at the 1% level (Table 7.4), and thereby also aided in stabilisation of the foreign exchange swap market.

By contrast, amounts allotted in US dollar auctions by the ECB at the bid auction dates significantly increased volatility during the 2010-12 crisis at the 1% significance level. This could indicate that larger allotments were perceived as an indication of stress in the financial system, with swap allotments not being large enough to calm the market, due to reluctance in their use on account of some remaining stigma effect associated with their use.

The announcement that the Fed-ECB swap line was becoming unlimited in amount on 13 October 2008 led to a large significant reduction in CIP deviations during the 2008–09 crisis (Table 7.1 and Table 7.3). This result is consistent with the results of Baba and Packer (2009), and with the analysis in Allen and Moessner (2010), which highlights the importance of the unlimited nature of the swap lines in reducing market tensions. While the three swap line announcements during the 2010–12 crisis significantly reduced the volatility of CIP deviations (Table 7.4), the announcement of the unlimited nature of the swap line on 13 October 2008 had no significant effect on volatility (Table 7.3). In that respect, the announcements of the 2010–12 crisis were more effective in stabilising foreign exchange swap markets.

The swap lines were little used from the time of their reintroduction in May 2010 until November 2011. According to market anecdote, this had been owing to stigma associated with their use. Investors were said to have asked banks about their use of emergency liquidity facilities, and at the then prevailing price for the US dollar swap line, such use would have been interpreted negatively, as a sign of distress. The reduction in the swap price by 50 basis points on 30 November might have been expected to reduce the stigma of using the US dollar swap lines for banks by making such dollar borrowing more commercially attractive, and therefore not only a last resort.

And indeed, following the 30 November announcement, somewhat greater use was made of the US dollar swap lines. But even though euro-dollar CIP deviations were still more than 100 basis points at end-2011, ECB drawings on the Fed swap line were much lower at EUR 85 billion than at the peak of the 2008–09 crisis, when they reached EUR 314 billion (Graph 7.5). Moreover, euro-dollar CIP deviations remained much wider after the price reduction than they had been after the Fed had relieved the 2008 dollar shortages by means of swap facilities (see graph 7.1). While 3-month CIP deviations had fallen to around 35 basis points on average in January 2009, they were still around 85 basis points in early January 2012. This suggests that there was some stigma effect associated with the use of swap lines during the 2010–12 crisis, which had not been present in 2008. It is therefore likely that unsatisfied demand for US dollars remained in the markets.[36]

We conclude that the swap lines in the 2010–12 crisis did not help protect against banks' deleveraging as much as they had done during the 2008–09 crisis, when swap drawings were much higher at comparable levels of CIP deviations. It seems that increased scrutiny by investors of the affairs of commercial banks frustrated the efforts of central banks to smooth and decelerate the deleveraging process. There were large international flows of US dollars to the United States in the first half of 2011, as there had been in the second half of 2008

[36] 3-month euro-dollar CIP deviations fell further to around 45 basis points on average in June 2012. Some of the decrease is likely to have been due to the effect of the ECB's long-term euro refinancing operations in calming the crisis.

(table 7.5). In 2008, the flows were greatly facilitated by Fed swap lines (see graph 7.3 and Allen and Moessner 2010). In 2011, the swap lines were much less effective and commercial banks financed their acquisition of dollar liquid assets mainly by reducing other assets, or, in other words, deleveraging. The fact that euro area banks' net external foreign currency claims on banks increased by much less than the cash holdings of foreign banks in the United States suggests that much of their deleveraging took the form of reductions in other foreign currency claims on banks outside the euro area, rather than in domestic assets.

Table 7.5

Exchange rate-adjusted changes in banks' net external assets, second half of 2008 and first half of 2011

In $ billion

		Second half of 2008			First half of 2011		
		Total	**Domestic currency**	**Foreign currency**	**Total**	**Domestic currency**	**Foreign currency**
US	Total net external assets	–311	–298	–12	–318	–241	–77
	o/w claims on banks	–438	–436	–3	–340	–289	–51
Euro area	Total net external assets	+236	–76	+312	+185	+105	+80
	o/w claims on banks	209	–55	+264	+126	+72	+54

Source: BIS locational international banking statistics (table 2), authors' calculations.

8. Conclusions

Our analysis has identified and discussed those liquidity consequences of the euro area sovereign debt crisis which had manifested themselves up to the middle of 2012. It is clear that the crisis has damaged the euro area banking system and the flow of bank credit to the domestic private sector remains impaired.

Market expectations of an orderly resolution of the crisis waned during the second half of 2011. The market stress indicators all deteriorated, and intra-eurosystem central bank imbalances grew even faster than previously. Moreover, the limited data that were available suggested that a collateral squeeze was developing. The balance sheet of the Eurosystem, which had been fairly stable in size since just after the 2008–09 crisis, grew by 59% between end-June 2011 and end-July 2012, to the equivalent of 33% of a year's euro area GDP. The Eurosystem has expanded the range of eligible collateral, so as not to aggravate the developing collateral squeeze. Eligibility policy – the decision as to which assets should be eligible as collateral at central banks – has been for many years a neglected aspect of the theory of monetary policy. It seems inevitable that the eligibility policies of central banks will affect the relative prices of assets, and some serious analysis of the issue would be timely.

The Eurosystem's relaxation of its collateral eligibility policy has exposed it to more credit risk, even relative to its expanding balance sheet, as have its outright purchases of

government securities in its Securities Market Programme.[37] Its leverage ratio (total assets to capital and reserves) increased from 14 at the end of 1999 to 25 at the end of 2010, and it is not surprising that the ECB decided in December 2010 to increase its own capital resources.[38]

The crisis has had international repercussions. For one thing, euro area banks' deleveraging has borne more heavily on foreign than domestic assets. Nevertheless, the cash assets of foreign banks in the United States increased by a very large amount in the first half of 2011. As a result, foreign bank branches in the United States hold liquid assets equivalent to virtually 100% of their deposit liabilities. The reduction in the charges for the use of Fed swap lines might have facilitated the build-up of European banks' cash assets in the United States, but the swap lines were not as extensively used as they had been in 2008–09, perhaps because of the stigma attached to their use.

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[37] The relaxation of collateral eligibility policy has been accompanied by a fairly conservative policy on excess collateral margins, however.

[38] See ECB press release of 16 December 2010 http://www.ecb.int/press/pr/date/2010/html/pr101216_2.en.html.

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APPENDIX
Regression estimates (tables 7.1 – 7.4)

Table 7.1: Euro-dollar CIP deviation at 3 month maturity for whole crisis period

Dependent Variable: D(EUR CIP deviation)
Sample (adjusted): 12/03/2007 1/04/2012

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.415770*	0.244888	1.697794	0.0895
D(EUR CIP deviation (-1))	-0.013075	0.043753	-0.298826	0.7651
EUR CIP deviation (-1)	-0.009611	0.006896	-1.393711	0.1634
Allotted swap amts at auction	-0.012631*	0.006509	-1.940424	0.0523
D(ECB swap drawings)	0.008201	0.051833	0.158210	0.8743
FEDEURSWAPOTH	-1.743130	2.539729	-0.686345	0.4925
FEDEURSWAP13OCT2008	-38.97679***	6.587982	-5.916347	0.0000
FEDEURSWAP10MAY2010	-17.41539***	2.092681	-8.322048	0.0000
FEDEURSWAP15SEP2011	-14.33095***	1.137665	-12.59681	0.0000
FEDEURSWAP30NOV2011	-29.20411***	1.161571	-25.14190	0.0000
D(VIX(-1))	0.124343	0.096918	1.282979	0.1995
D(EUR deposit-OIS sprd(-1))	-0.005417	0.013090	-0.413823	0.6790
D(USD deposit-OIS sprd (-1))	-9.81E-05	0.005570	-0.017616	0.9859
D(EUR bank CDS(-1))	0.012049	0.008727	1.380777	0.1673
D(US bank CDS (-1))	0.032316*	0.017003	1.900526	0.0574
Variance Equation				
α	-0.211243***	0.052844	-3.997469	0.0001
β	0.523816***	0.097706	5.361132	0.0000
γ	0.030383	0.078133	0.388868	0.6974
δ	0.945704***	0.017204	54.97009	0.0000
Allotted swap amts at auction	0.000824	0.001977	0.416819	0.6768
FEDEURSWAPOTH	0.740228**	0.358440	2.065135	0.0389
FEDEURSWAP13OCT2008	-0.253860	0.889897	-0.285269	0.7754
FEDEURSWAP10MAY2010	-1.529983	1.118688	-1.367658	0.1714
FEDEURSWAP15SEP2011	-1.277071*	0.727009	-1.756609	0.0790
FEDEURSWAP30NOV2011	-0.810560	0.586297	-1.382507	0.1668
Adjusted R-squared	0.065592			
Log likelihood	-3009.284			

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Bollerslev-Wooldridge robust standard errors & covariance

Table 7.2: Euro-dollar CIP deviation at 3 month maturity pre-crisis

Dependent Variable: D(EUR CIP deviation)
Sample (adjusted): 1/05/2006 11/30/2007

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.254357**	0.120551	2.109948	0.0349
D(EUR CIP deviation (-1))	-0.317867***	0.047354	-6.712500	0.0000
EUR CIP deviation (-1)	-0.138938***	0.033504	-4.146858	0.0000
D(VIX(-1))	0.096782	0.119100	0.812609	0.4164
D(EUR deposit-OIS sprd(-1))	0.059045*	0.030990	1.905300	0.0567
D(USD deposit-OIS sprd (-1))	-0.030795	0.041519	-0.741718	0.4583
D(EUR bank CDS(-1))	-0.224915	0.236946	-0.949223	0.3425
D(US bank CDS (-1))	-0.064214	0.138244	-0.464494	0.6423
Variance Equation				
α	-0.069164	0.052834	-1.309081	0.1905
β	0.168701***	0.059451	2.837656	0.0045
γ	0.058875	0.063681	0.924524	0.3552
δ	0.974533***	0.014451	67.43491	0.0000
Adjusted R-squared	0.106702			
Log likelihood	-1224.904			

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Bollerslev-Wooldridge robust standard errors & covariance.

Table 7.3: Euro-dollar CIP deviation at 3 month maturity during 2008–09 crisis

Dependent Variable: D(EUR CIP DEVIATION)
Sample: 12/03/2007 12/31/2009

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.512412	0.456175	1.123281	0.2613
D(EUR CIP DEVIATION(-1))	-0.029788	0.054577	-0.545795	0.5852
EUR CIP DEVIATION(-1)	-0.009455	0.012361	-0.764934	0.4443
Allotted swap amts at auction	-0.017639***	0.006196	-2.846697	0.0044
D(ECB swap drawings)	-0.022760	0.052134	-0.436568	0.6624
FEDEURSWAPOTH	-1.285731	2.635572	-0.487838	0.6257
FEDEURSWAP13OCT2008	-56.62305***	8.490195	-6.669228	0.0000
D(VIX(-1))	0.127078	0.092218	1.378016	0.1682
D(EUR deposit-OIS sprd(-1))	-0.028557	0.019213	-1.486332	0.1372
D(USD deposit-OIS sprd (-1))	-0.003233	0.005633	-0.573891	0.5660
D(EUR bank CDS(-1))	0.093254*	0.049035	1.901776	0.0572
D(US bank CDS (-1))	0.006641	0.017194	0.386243	0.6993
Variance Equation				
α	-0.288306***	0.096474	-2.988434	0.0028
β	0.540375***	0.184709	2.925552	0.0034
γ	-0.012427	0.116492	-0.106674	0.9150
δ	0.971402***	0.013060	74.37802	0.0000
Allotted swap amts at auction	-0.000894	0.002415	-0.370243	0.7112
FEDEURSWAPOTH	0.695001*	0.359746	1.931924	0.0534
FEDEURSWAP13OCT2008	0.022598	0.949708	0.023795	0.9810
Adjusted R-squared	0.037134			
Log likelihood	-1630.418			

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Bollerslev-Wooldridge robust standard errors & covariance.

Table 7.4: Euro-dollar CIP deviation at 3 month maturity during 2010-2011 crisis

Dependent Variable: D(EUR CIP DEVIATION)
Sample (adjusted): 1/01/2010 1/04/2012

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.427843**	0.178396	2.398274	0.0165
D(EUR CIP DEVIATION(-1))	-0.050781***	0.012716	-3.993389	0.0001
EUR CIP DEVIATION(-1)	-0.002262***	2.76E-07	-8202.506	0.0000
Allotted swap amts at auction	0.127072	0.160625	0.791108	0.4289
D(ECB swap drawings)	0.074598	0.072087	1.034828	0.3007
FEDEURSWAP10MAY2010	-15.95331***	0.170099	-93.78845	0.0000
FEDEURSWAP15SEP2011	-13.71839***	0.174398	-78.66149	0.0000
FEDEURSWAP30NOV2011	-31.69889***	0.213572	-148.4222	0.0000
D(VIX(-1))	0.098449***	0.018646	5.279884	0.0000
D(EUR deposit-OIS sprd(-1))	0.006882	0.019437	0.354069	0.7233
D(USD deposit-OIS sprd (-1))	0.028226	0.030807	0.916210	0.3596
D(EUR bank CDS(-1))	0.016692***	0.000153	109.2065	0.0000
D(US bank CDS (-1))	0.039862***	0.001834	21.73450	0.0000
Variance Equation				
α	2.415552	1.713240	1.409932	0.1586
β	0.373424***	0.093318	4.001635	0.0001
γ	-0.049483	0.097816	-0.505879	0.6129
δ	-0.016422	0.679297	-0.024175	0.9807
Allotted swap amts at auction	0.037752***	0.013239	2.851617	0.0043
FEDEURSWAP10MAY2010	-20.90786***	1.550114	-13.48795	0.0000
FEDEURSWAP15SEP2011	-19.12009***	1.547334	-12.35679	0.0000
FEDEURSWAP30NOV2011	-17.99799***	0.891239	-20.19435	0.0000
Adjusted R-squared	0.133791			
Log likelihood	-1403.949			

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Bollerslev-Wooldridge robust standard errors & covariance.