

Financial Stability Paper No. 8 – September 2010

# Understanding international bank capital flows during the recent financial crisis

Glenn Hoggarth, Lavan Mahadeva and Jeremy Martin



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We are very grateful for helpful suggestions and comments from colleagues at the Bank of England, including Martin Brooke, David Osborn, Gabriel Sterne and Garry Young, and from statisticians at the Bank for International Settlements.

Financial Stability, Bank of England, Threadneedle Street, London, EC2R 8AH

(1) Corresponding author: [lavan.mahadeva@bankofengland.co.uk](mailto:lavan.mahadeva@bankofengland.co.uk).

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# Understanding international bank capital flows during the recent financial crisis<sup>(1)</sup>

Glenn Hoggarth, Lavan Mahadeva and Jeremy Martin

Cross-country bank lending mushroomed over the past decade. This helped to spread risks but also meant that international banks were more vulnerable than previously to shocks from abroad including from each other. Following the outbreak of the US sub-prime crisis, and especially after the collapse of Lehman Brothers, cross-border bank flows reversed dramatically. This paper is aimed at better understanding how the recent crisis propagated through the international banking system. It describes the pattern of deleveraging by international banks in reaction to their funding and capital pressures, the international spillovers and the vulnerability of the UK banking system to shocks from abroad given its global role.

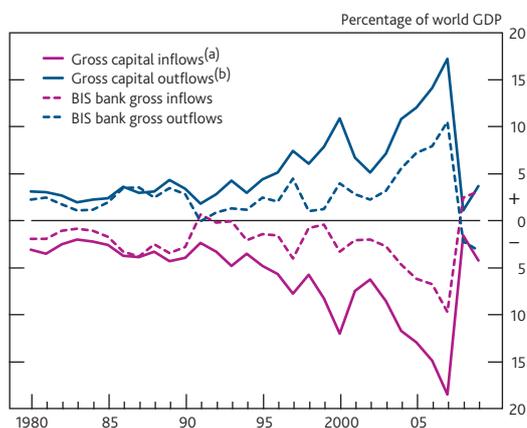
## Introduction

In the run up to the recent financial crisis there was a massive increase in capital flows across country, particularly by and to international banks (Chart 1). This increase in financial globalisation spread risks among countries, but also made it more likely that an adverse shock in any one major financial system would transmit across countries. And indeed that is what transpired after the outbreak of the US sub-prime crisis. The crisis led to a marked increase in the actual or perceived credit risk of banks internationally and resulted in the failure of a number of major financial institutions.<sup>(2)</sup> A rise in suspicion about the creditworthiness of counterparties combined with a

desire to hoard liquidity meant that international banks (and other financial institutions) became less willing to lend to each other.

Consequently, gross capital flows collapsed (Chart 1). Having peaked in 2008 Q1, cross-border bank flows, especially intergroup, fell sharply, particularly after Lehman's failure (inflows into G20 banks are included in the 'other' flows in Chart 2).

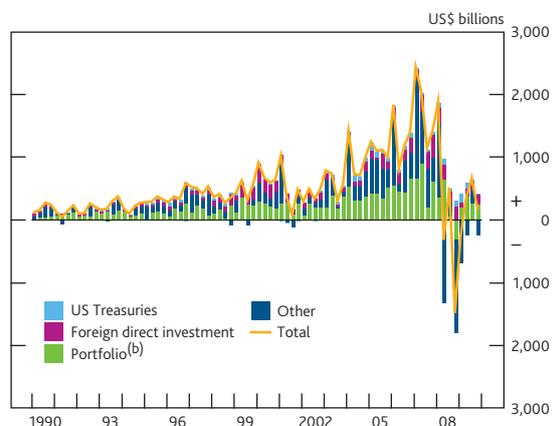
Chart 1 Financial globalisation, 1980–2009



Sources: BIS, IMF *World Economic Outlook* (Spring 2010) and Bank calculations.

- (a) Sum of global net purchases of foreign assets by residents.  
(b) Sum of global net purchases of domestic assets by foreigners.

Chart 2 Foreigners' gross purchases of financial assets in G20 countries,<sup>(a)</sup> 1990 Q1–2009 Q4



Sources: Bank of England, IMF *International Financial Statistics*, ONS, Thomson Reuters Datastream, US Treasury International Capital reporting system and Bank calculations.

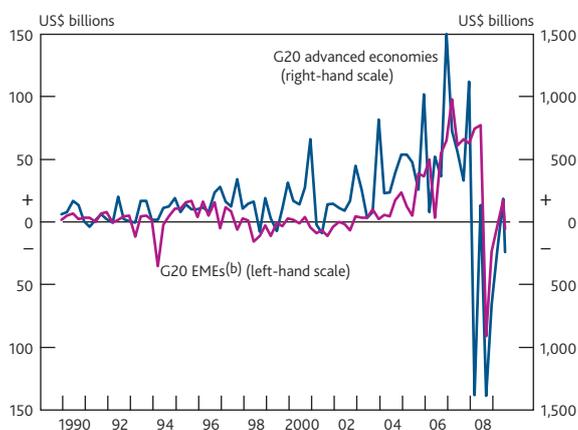
- (a) Includes net purchases from other G20 countries but excludes net purchases of assets in China and Saudi Arabia due to unavailability of consistent quarterly data. Also data exclude financial derivatives.  
(b) Other than US Treasury securities.

(1) Data up to 2009 Q4 unless otherwise stated.

(2) See Claessens, Dell'Ariccia, Igan and Laeven (2010) for a description of the causes, transmission and policy lessons from the recent crisis.

Unlike most previous periods of sharp reversals in capital flows, the recent fall in flows to (and from) banks has affected developed countries at least as much as emerging market economies (EMEs) (Chart 3). Adjusting for changes in exchange rates, from their peak in March 2008, gross cross-border claims of and liabilities on all Bank for International Settlements (BIS) reporting resident banking systems fell by \$4.4 trillion and \$4.5 trillion respectively — 8% of annual 2009 world GDP — through to their trough at end-2009. Over the same period, the gross liabilities of UK resident banks alone fell by \$1.5 trillion (70% of annual UK GDP).<sup>(1)</sup> This is easily the biggest fall in estimated gross cross-border bank flows<sup>(2)</sup> since records began over 30 years ago.<sup>(3)</sup>

**Chart 3** Foreigners' gross purchase of 'other' assets in G20 countries,<sup>(a)</sup> 1990 Q1–2009 Q4



Sources: Bank of England, IMF *International Financial Statistics*, ONS, Thomson Reuters Datastream and Bank calculations.

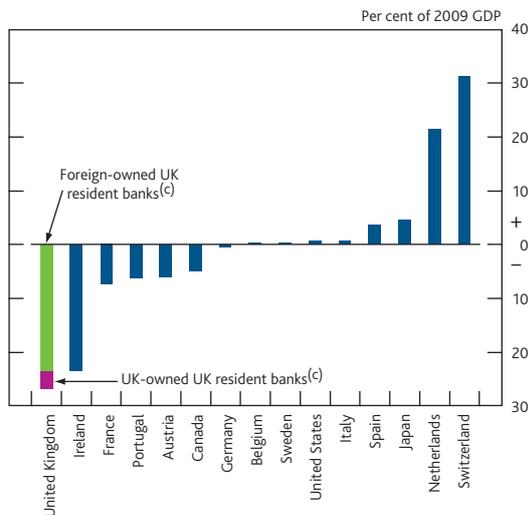
- (a) Includes net purchases from other G20 countries. Data exclude financial derivatives.  
 (b) Excludes net purchases of assets in China and Saudi Arabia due to unavailability of consistent quarterly data.

Why might this matter? A major bank or whole banking system with a mismatch between the composition of its external assets and liabilities — such as in maturity, currency or counterparty — may find its supply of liquid assets exhausted when subjected to a large withdrawal of its gross external liabilities.<sup>(4)</sup> It may, therefore, be forced to reduce lending, fire sale assets or, *in extremis*, default — all of which could have negative spillover effects for the domestic real economy.

UK resident banks appeared to suffer a particularly large *net* withdrawal of funding from banks abroad, equivalent to 28% of GDP (Chart 4). This mainly reflected a withdrawal of funding from foreign banks resident in the United Kingdom, especially by non-affiliated banks. This, in turn, likely contributed to the particularly sharp cutback in domestic lending by foreign-owned banks to UK non-financial companies over the period.

Furthermore, as also witnessed in the recent crisis, a weakening or failure of a major bank or whole banking system

**Chart 4** Net cross-border borrowing by selected resident banking systems from non-resident banks,<sup>(a)</sup> cumulative flows,<sup>(b)</sup> end-2008 Q1–end-2009 Q4



Sources: BIS and IMF *World Economic Outlook* (Spring 2010). BIS locational by residence and Bank of England data.

- (a) The change in the banking system's net liabilities to banks in all other countries.  
 (b) Exchange rate adjusted change in stock.  
 (c) Spilt for United Kingdom based on Bank of England data.

can transmit abroad through the international banking network resulting also in a withdrawal of funding from and an increase in credit losses to banks (and non-banks) in other countries. These banks, in turn, may reduce their own lending to other banks. The 'beggar thy neighbour' spillover effects of international banks withdrawing funding from each other are considered formally below.

The main conclusions of the paper are as follows. During the pre-financial crisis period there was a broad-based boom in international bank lending. But during the crisis the reversal of inflows — based on the available data — has been selective. Lending appears to have been cut back especially to non-core markets. So banks have reduced lending more abroad than domestically, particularly if made cross-border rather than from their local operations in foreign countries. Interbank lending has fallen especially sharply, whereas cross-border intragroup lending has held up better. Relatedly, the limited data suggest that banks' short-term lending has fallen most. So from the borrowers' perspective, they have been most vulnerable to a withdrawal of bank funding if they are a (non-related) bank, borrowed cross-border and at shorter maturities.

- (1) There was a modest increase in the gross cross-border liabilities of all BIS reporting banks and UK resident ones in 2010 Q1 of \$525 billion and \$90 billion respectively.  
 (2) Throughout this paper 'flows' are estimated using the quarterly change in stock. Note that these are not true flows, due to valuation changes. Locational data are adjusted for changes in the exchange rate. Consolidated data are unadjusted, as data on the currency composition of the stocks are not available.  
 (3) During the previous world recession in the early 1990s global claims of and liabilities on BIS reporting resident banks fell in the first three quarters of 1991 by \$0.16 trillion and \$0.18 trillion respectively (around ¾% of annual world GDP at the time).  
 (4) In a recent speech Paul Tucker (2009) noted that at the outbreak of the crisis 'It is surprising that some big banks, not all, ran such truly massive maturity mismatches'.

## Box 1 Limitations of BIS data on international bank lending

Improvements in international banking statistics would help the official and private sectors better assess the external credit and funding risks faced by national banking systems and economies. The main data on the external balance sheet positions of national banking systems are published by the BIS. Banking systems are defined on either a locational or consolidated basis. The locational data show resident (domestic and foreign-owned) banks' cross-border liabilities and assets (including intragroup). These data are consistent with the balance of payments national accounts. The consolidated data look at the foreign claims of banking groups aggregated according to the nationality of the parent bank. So these data exclude intragroup claims. The data are useful in helping to analyse international banking flows. They emphasise that the reversal of foreign lending by and to international banks was an important aspect of the recent financial crisis. But the available data only give a partial description of this reversal in funding. There are some large data gaps:

**Banks' foreign liabilities on a consolidated (banking group) basis.** No explicit data are collected for BIS-reporting banks (with some minor caveats). Foreign liabilities — especially cross-border — are usually thought of as a fickle funding source and according to the bank data on a residency basis, which are available, the external liabilities of resident banks in most BIS countries fell sharply during the current crisis after Lehman's failure. This suggests that crucial data on the composition of the liabilities of a banking group as a whole are missing.

Using the BIS statistics on location-by-nationality, it is possible to construct an estimate of a banking system's aggregate consolidated external cross-border liabilities. But estimates of cross-border liabilities to individual countries cannot be constructed. These data are likely to be relevant to financial stability when funding risks arise from a particular country or region. Further, such an estimate does not permit disaggregation by maturity (see below).

**Maturity.** There is no maturity breakdown of banks' external liabilities and assets on a locational basis. These data are a key component of the capital account of the balance of payments. According to the consolidated international claims data there was a sharp fall, in particular, in short-term claims during the recent crisis.

**Limited sectoral breakdown of foreign claims on a consolidated basis and external liabilities and assets on a locational basis.** On a consolidated basis, foreign claims are split only into those on banks, the government (including the central bank) and the non-bank private sector. On a locational basis the sectoral split of claims (and liabilities) is more broad brush still — just banks (including the central bank, intragroup as well as intergroup) and non-banks (including the government and non-bank financial institutions as well as the non-financial private sector). And a number of banking systems' bilateral consolidated foreign claims at this broad level of disaggregation are confidential to the BIS. This implies that it is difficult, even on a residency basis, to identify banks' wholesale funding, which was revealed during this financial crisis as a significant stress point, especially between banks and other financial institutions. It also makes it difficult to assess the credit risk on banks' external claims and which sectors of the economy would be hurt most by a withdrawal of lending by foreign banks. It would be desirable to strip out non-bank financial institutions from the data to allow an assessment of the impact of real economy developments in other countries on domestic-owned banks' credit risk and the financing risk faced by the domestic real economy and banks from foreign banks. Greater granularity of cross-border exposures would also help domestic authorities assess the contribution of non-resident banks to credit cycles in different sectors of the domestic economy.

**Currency composition.** There is no breakdown of claims (or liabilities) by currency on a consolidated basis. This means it is difficult to measure the currency mismatches and thus potential foreign currency funding pressures faced by banking groups — one of the factors highlighted in this paper as responsible for the fall in cross-border lending during the recent crisis. This data limitation also means that changes in claims on a consolidated basis cannot be reported on an exchange rate adjusted basis. This makes it difficult to interpret the underlying changes in consolidated claims.

**Derivatives.** There are only limited available data on derivatives. On a consolidated basis positive market values by residency of counterparty are available. But no netting is available for negative market values with the same counterparties. There is also no information on risk category or type of counterparty.

**Risk transfers.** In principle, bilateral consolidated claims data are measured both directly ('immediate borrower') and after taking into account which country is the ultimate bearer of the risk ('ultimate risk'). But these bilateral risk transfers are not collated by all banking systems and some which are collated are confidential to the BIS (see Annex 2).

Given the importance identified to the decline in lending across banking systems during the crisis, simulations were carried out on the interactions of funding shocks in 19 major banking systems. This emphasised the important role that the United Kingdom (and other systemic banking sectors) play not only because of their direct claims on, or liabilities to, other banking systems but in transmitting funding shocks through the global banking network.

The next section assesses the causes and patterns of the reversal in international banking flows focusing, in particular, on the direct impact. Given that an important part of the story is how international banks cut back lending to each other, the final section uses simulations from a model to highlight these spillover effects through the global banking network. (Annex 1 provides a glossary of the data used in this paper.)

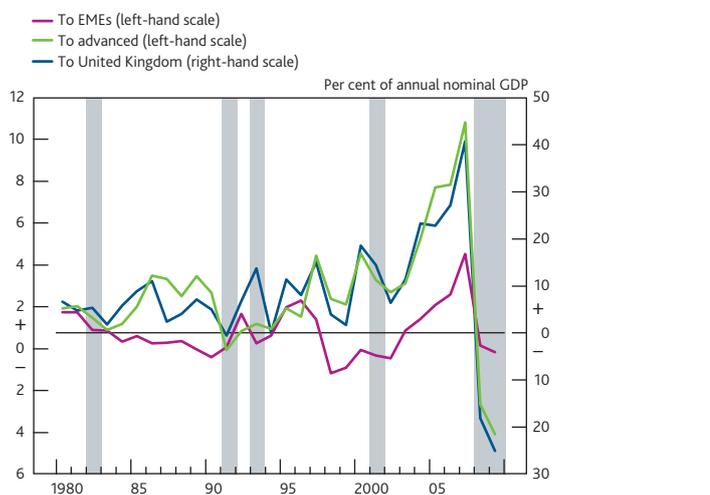
## Causes and patterns of the reversal in bank flows

While the pre-crisis expansion of foreign claims was fairly uniform across banking systems, there was considerable differentiation in the subsequent cutback, both by creditor banking system and on debtor country. This section examines the causes and patterns of the reduction in foreign lending.

### Weak demand for international finance

A reduction in demand for international finance has likely played a role.<sup>(1)</sup> During the financial crisis, GDP growth fell sharply around the world with many countries witnessing a recession. Everything else equal, this would have reduced the demand for international finance, with firms and households wishing to borrow less at any given interest rate. However, the decline in gross cross-border bank lending to G20 countries, in

**Chart 5** BIS banks' gross cross-border lending flows 1980 Q1–2009 Q4



Sources: BIS locational by residence statistics and IMF *World Economic Outlook* (Spring 2010).

Shaded areas represent calendar years in which (purchasing power parity weighted) real GDP growth in advanced economies was below 1.5%.

aggregate, has been much greater than the fall in recipient countries' nominal GDP — especially in developed countries (**Chart 5**). The fall has been unprecedented even compared with previous periods of low world GDP growth over the past 30 years.

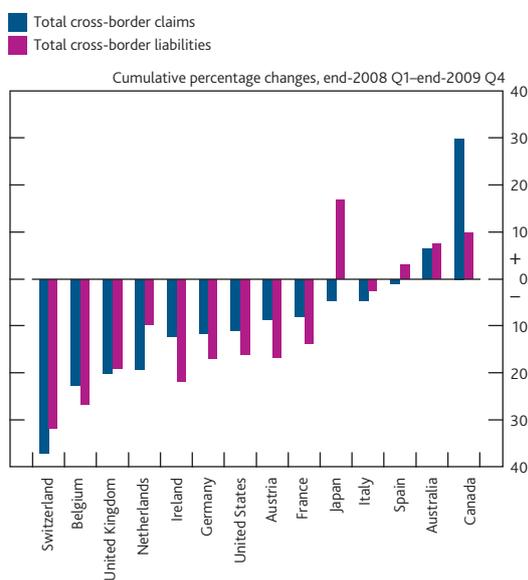
Also, as shown in **Chart 2**, cross-border portfolio (debt and equity) capital flows, at least, rebounded strongly from 2009 Q2 onwards, suggesting that demand was not the only factor restraining bank finance during the crisis.

### Funding and capital shortfalls

Discussions with major international banks have also highlighted the desire, or need, of banks to deleverage as an important factor in explaining the reduction in foreign lending.

Uncertainty about the quality of banks' balance sheets grew during 2008, and particularly in the wake of Bear Stearns' and Lehman Brothers' collapse. Increased perceptions of counterparty risk led to creditors withdrawing funding from banks. The banks, in turn, drew down their own claims in order to repay their creditors. BIS resident banking systems that faced the largest cross-border withdrawals tended also to reduce their own cross-border lending by most (**Chart 6**).

**Chart 6** Deleveraging by resident banking systems



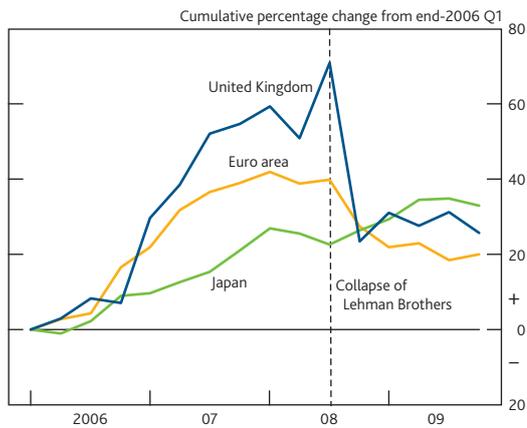
Source: BIS locational by residence statistics.

Bars show exchange rate adjusted changes in stock.

The funding withdrawal was particularly acute for banks headquartered in a number of European countries, which suffered difficulties in replacing dollar funding after the fall of Lehman Brothers. In the run up to the crisis, UK and euro-area banking systems, in particular, expanded their international dollar claims on non-banks substantially (**Chart 7**), both on

(1) See, for example, BIS (2009), Chapter 3.

**Chart 7** National banking systems' international dollar claims on non-banks from end-2006 Q1–2009 Q4



Source: BIS locational by nationality. Cross-border and local claims in US dollars of banks grouped by nationality of the bank's head office.

balance sheet and through off balance sheet structured investment vehicles (SIVs).

The on balance sheet dollar claims were mainly funded by borrowing from US money market mutual funds, other commercial banks, foreign central banks and through swapping local currency liabilities into dollars ('cross-currency funding').<sup>(1)</sup> Following the collapse of Lehman Brothers, all of these funding sources became less stable: interbank funding by banks concerned about counterparty risk was cut; foreign monetary authorities (particularly those from EMEs) withdrew dollar deposits to stabilise their own domestic banking systems and currencies; and US mutual funds repatriated assets. European banks responded by trying to raise more local deposits and swapping them into dollars, which, in turn, exacerbated stress in the euro and sterling-dollar swap markets.

Furthermore, from 2007, banks' SIVs faced a drying up in their funding especially from short-dated commercial paper. Some of these SIVs had to be brought back on to banks' balance sheets, adding particularly to European banks' measured dollar assets (Chart 7).

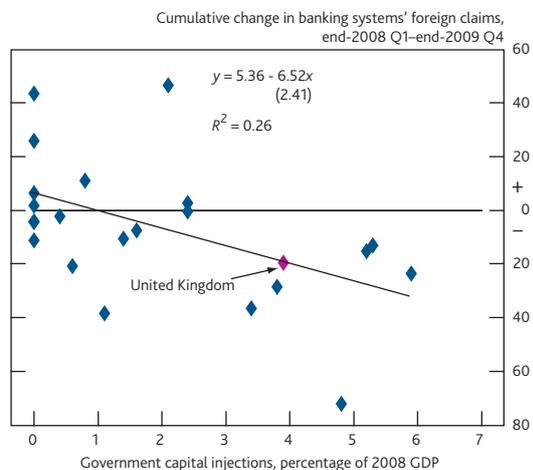
These losses in funding sources put intense pressure on European banks to reduce their dollar claims. Meanwhile, some of their dollar assets — particularly securitised and structured ones — had become much less liquid, leaving the banks with a larger effective maturity mismatch.

In contrast, Japanese banks had funded the build-up of their dollar assets almost entirely by swapping local yen liabilities into dollars. This market was somewhat less disrupted than the euro and sterling-dollar swap markets — possibly because the Japanese banking system was seen as being less risky than the US and European ones. Furthermore, Japanese banks had tended to purchase safer and more liquid assets, such as US Treasuries, and relatively few structured products. So, to

the extent that they needed to liquidate dollar assets, it was much less costly for them to do so. Japanese banks were therefore placed under less stress by the dollar funding shortage than were European banks.

Banks also increasingly came under capital pressure. The IMF estimates that banks' worldwide credit-related write-downs were around \$1.6 trillion between mid-2007 and end-2009.<sup>(2)</sup> The national banking systems that have tended to cut back lending relatively sharply were the ones that have received the largest capital injections from their governments (Chart 8) — a proxy for the pressure on their capital positions.

**Chart 8** Government support to banking systems and cumulative change in their foreign claims, end-2008 Q1–end-2009 Q4



Sources: BIS consolidated ultimate risk data (not exchange rate adjusted) and IMF *Staff Position Note 3/11/09* ('The state of public finances cross-country fiscal monitor: November 2009', Annex Table 3, page 37).

Standard errors are in parentheses. US data have been adjusted for a structural break: US investment banks were reclassified in 2009 Q1, adding \$903 billion to the claims of US banks. For further details, see the BIS *Quarterly Review*, March 2010.

### Withdrawals from non-core markets, particularly cross-border lending

How did banks cut back lending to foreign markets? One key factor that market contacts have identified is that banks tried to cut back most to their peripheral markets while preserving lending to their 'core' business. This is most evident in a comparison of banks' lending in their home and foreign markets. For nearly all major resident banking systems, the fall in their cross-border credit to non-banks was much sharper than the decline in domestic credit. For example, from end-2008 Q1 to end-2009 Q4, UK resident banks' lending in all currencies to non-banks in the domestic market increased by 10% but cross-border fell by 30%. This may have been due to banks' preference to reduce exposures in markets where they have less knowledge of their customers.

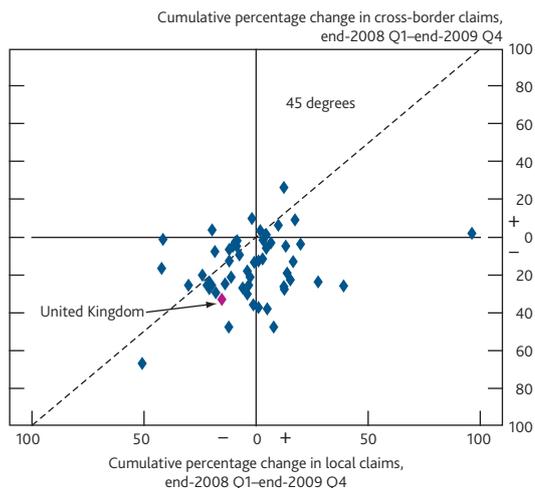
(1) See McGuire and von Peter (2009) and BIS (2010).

(2) IMF (2010).

This 'locational' definition of banks may not be the most relevant though, as multinational banks might make decisions at the overall group rather than individual country level. The BIS also produces data on international banks on a consolidated basis. These show the foreign claims of the banking group as a whole, based on the nationality of the parent bank, whether made cross-border or from foreign subsidiaries and branches.<sup>(1)</sup>

The consolidated data show that BIS-reporting banks increased their foreign claims markedly before the crisis, both cross-border and from their local operations.<sup>(2)</sup> However, during the financial crisis banking groups cut back their cross-border claims significantly more than the local claims of their local operations. This is the case whether viewed from the perspective of the lending banking system and especially the borrowing country (Chart 9), ie most of the diamonds lay to the right of the 45-degree line.<sup>(3)</sup>

**Chart 9** BIS-reporting banks' claims by recipient country, local versus cross-border, 2008 Q1–2009 Q4



Source: BIS consolidated data, ultimate risk basis. Not exchange rate adjusted. Includes the 50 debtor countries with the largest foreign liabilities, excluding Netherlands and Belgium (where the transfer of a bank in 2008 Q4 substantially distorts the data) and offshore centres. The included countries cover 88% of total reported foreign liabilities.

Therefore, lending by banking groups to foreign markets seems to have been cut back more the longer the arms length of the relationship. In addition, local claims, especially in local currency, were more likely to have been funded by local deposits, which proved to be a more stable source of funding during the crisis.

In consequence, overall total claims on debtor countries by foreign-owned banks have tended to fall by less where foreign banks have a large local presence, such as in a number of countries in Central and Eastern Europe. This is despite the relative weakness of economies in the region and the fact that lending by foreign banks grew particularly rapidly there during the pre-crisis period.

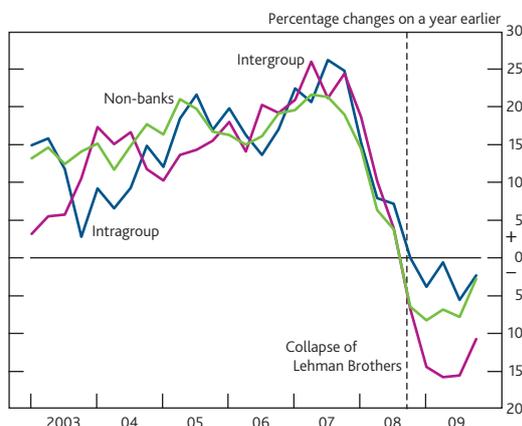
## Withdrawals from unrelated banking groups

There is no clear evidence that banks reduced their foreign lending most in countries which *ex ante* looked riskier, where risk is proxied, for example, by sovereign credit default swap premia or credit ratings. But according to the available broad sectoral data, there is evidence that the *sector* of the borrower mattered.

The locational data separate cross-border claims into those made on banks (both inter and intragroup) and on non-banks resident in other countries. The consolidated data separate banking groups' foreign claims into those on other banks, the non-bank private sector and the public sector.<sup>(4)</sup>

During the boom preceding the crisis, lending growth was rapid to all these broad (non-government) sectors. But during the recent financial crisis banks' cross-border interbank lending fell more than their lending to non-banks as well as intragroup (Chart 10). That was also the case in the United Kingdom, where foreign-owned banks cut back their interbank exposures much more than their intragroup ones, while UK-owned banks actually increased slightly their cross-border lending to their subsidiaries and branches in other countries (Chart 11). Similarly, the consolidated data show that BIS-banks' interbank foreign claims fell particularly sharply (Chart 12).<sup>(5)</sup>

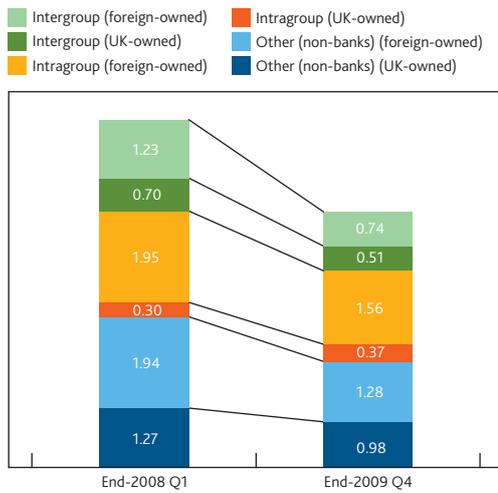
**Chart 10** BIS resident banks' external claims by sector, 2003 Q1–2009 Q4



Source: BIS locational by nationality data. Exchange rate adjusted.

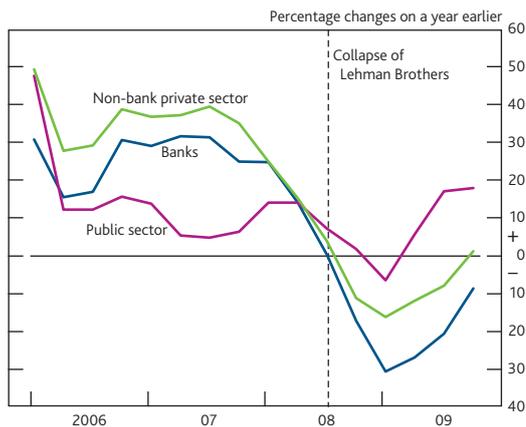
- (1) These data exclude intragroup lending.
- (2) The consolidated data are not exchange rate adjusted so changes in claims will include the impact on non-dollar denominated claims of changes in exchange rates against the dollar once these claims are converted into dollars.
- (3) There are no data available that split foreign bank claims into banks and non-banks separately for cross-border and local claims. Note also since a large part of local claims are made in local currency and these currencies generally fell against a rising dollar during the crisis period these data, which are measured in dollar terms, will understate the growth in local claims over the period.
- (4) Public sector includes general government, central banks and multilateral development banks.
- (5) 'Non-banks' include non-bank financial institutions as well as household and non-financial companies. Although further sectoral disaggregation is unavailable, it is likely that within the 'non-banks' category lending fell more during the recent financial crisis to other financial institutions than to the non-financial private sector.

**Chart 11** Counterparties to UK-resident banks' external claims (trillions of US dollars)



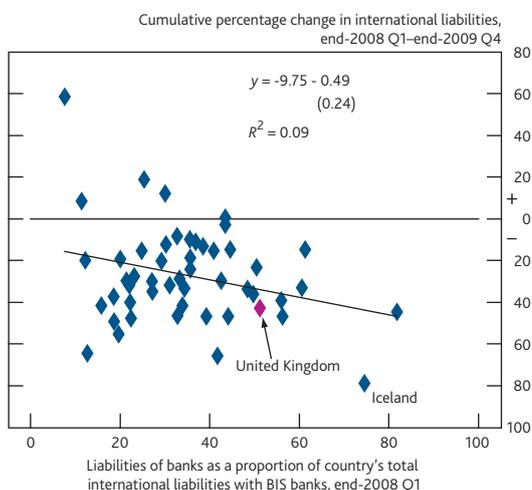
Source: BIS locational by nationality data.

**Chart 12** BIS consolidated banks' foreign claims by sector, 2006 Q1–2009 Q4



Source: BIS consolidated data, ultimate risk basis. Not exchange rate adjusted.

**Chart 13** Cumulative change in international liabilities and share of borrowing by banks — by debtor country, end-2009 Q4



Source: BIS consolidated international claims, immediate borrower basis. Not exchange rate adjusted. Standard errors are in parentheses.

In addition, foreign banks' total international claims<sup>(1)</sup> fell by more, on average, in debtor countries where a higher share of that country's borrowing was by banks (excluding intragroup) rather than non-banks. This was most noticeable in Iceland but was also the case in the United Kingdom where the share of foreign-owned banks' international claims on banks was large — around 50% (**Chart 13**). One explanation of this is that concerns about counterparty credit risk were particularly heightened in relation to (unrelated) banks.

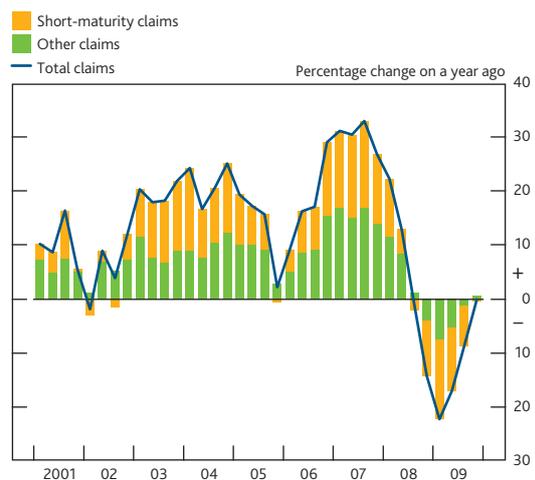
**Withdrawals from short-maturity claims**

During the crisis two opposing forces are likely to have affected the maturity mix of lending. On the one hand, the outstanding stock of short-maturity lending can, by its nature, be redeemed more quickly than long-maturity lending. This would act to reduce the share of short-term lending. Working in the other direction, the increasing desire to hoard liquidity and concern over the credit risk of counterparties meant that banks shortened the maturity of their new lending.

International banking data on the maturity profile of claims and liabilities are limited. Data are only available for claims and then only on a consolidated international claims basis. This means that they exclude the largest part of foreign banks' local claims — those made in local currency.

Bearing this caveat in mind, short-term claims fell by much more during the crisis than long maturity claims.<sup>(2)</sup> They also contributed more to the fall in aggregate claims on all sectors during this crisis (**Chart 14**). This suggests that the deleveraging effect was dominant.

**Chart 14** Contribution by maturity to annual growth in international claims, 2001 Q1–2009 Q4

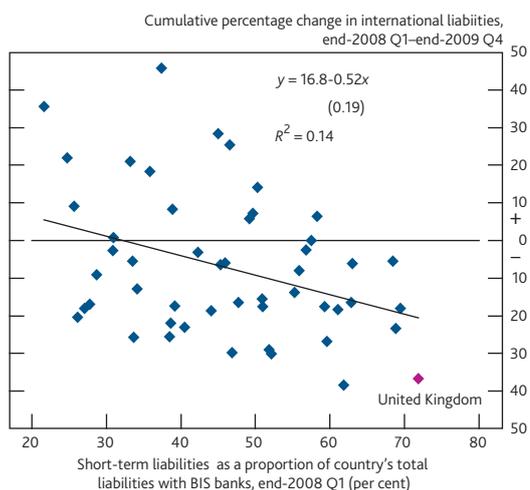


Source: BIS consolidated international claims by immediate borrower. Not exchange rate adjusted.

- (1) International claims are the consolidated claims, on an immediate borrower basis, made cross-border and by locally based subsidiaries and branches in foreign currency (but not in local currency).
- (2) Short maturity refers to debt claims of up to one year on a residual basis to all sectors. More disaggregated data showing separately the maturity structure of claims on banks and non-banks are unavailable. Such data would be helpful in identifying whether there has been a larger decline in foreign interbank claims once taking account of the maturity of the loan.

The United Kingdom was particularly notable for the large share of its borrowing that was at short maturities (**Chart 15**). That is likely an important reason why the United Kingdom suffered a particularly large withdrawal of funding during the crisis.

**Chart 15** Cumulative change in international liabilities and short-maturity share<sup>(a)</sup> — by debtor country, end-2009 Q4



Source: BIS consolidated international claims by immediate borrower. Not exchange rate adjusted. Standard errors in parentheses. Sample of 50 largest debtors in terms of international claims, amounting to 96% of BIS reporting banks' claims on all countries. Iceland is not included on this basis.

(a) Defined as claims with remaining maturity less than one year.

### What have we learned?

Whereas the boom in international lending prior to the financial crisis was broadly based, the reversal in lending during the crisis has not been. Faced with both funding and capital shortfalls international banks have tended to reduce lending by more if it has been cross-border (rather than from local affiliates), made to banks outside of their banking group, and if extended at short-maturities.

In principle, an empirical way to check the relative importance of these explanations is in a regression where each factor is an explanatory variable for the decline in foreign lending across debtor countries during the crisis. In practice, data on the three factors are not available on the same definition of claims.<sup>(1)</sup>

Where comparable data are available the regressions suggest that the share of lending to banks is the dominant factor.<sup>(2)</sup> It would be unwise though to place too much weight on this result given that these factors are likely to be closely intertwined. Bank borrowing tends to be at shorter maturities than for non-banks and would probably more likely be made cross-border than in the case of household lending. A simple cross-country correlation of the 70 biggest borrowers (excluding offshore financial centres) suggests that there is a strong positive association between, on the one hand, the share of foreign/international claims that are on banks and, on

the other hand, the share of claims that are cross-border (0.45) and short term (0.50). Cross-border lending may also more likely be made short term (and *vice versa*) although there are no available data to verify this.

Each of these factors probably played a role in determining where lending was cut during the crisis: banks tended to treat cross-border lending as part of their peripheral business; perceptions of the counterparty risk of lending to unrelated banks increased sharply during the crisis; and short-term lending was easier to cut back quickly.

### Role of UK banks in the global financial network: simulations of a funding shock

What is clear from the previous section is that the decline in interbank lending, including from and to UK banks, has been marked during the recent crisis. But in the previous section only the *direct* impact was analysed. Yet systemic risk often builds up because of the size and pattern of claims across the whole network. When faced with a funding shock, international banks reduce their own lending to other banking systems, which, in turn, cut their lending to others. To assess the impact of this channel, simulations were carried out on the impact of a funding shock to and from the United Kingdom and other banking systems allowing for feedback effects within the international banking network.<sup>(3)</sup>

In this exercise, banks are defined on a consolidated, rather than a locational, basis since this is the appropriate metric to capture the behaviour of banking groups as a whole.<sup>(4)</sup> The starting point in the analysis was to assume that when a banking system reduces its lending it does so to all the other (18) banking systems in the network.<sup>(5)</sup> Lending is assumed to be cut back initially by 10% and is distributed according to each debtor's share in total loans.<sup>(6)</sup> Each other banking system is then assumed to reduce its own interbank lending to

- (1) On a consolidated (ultimate risk) basis there are data for the share of claims that are cross-border and made on banks but not the share by maturity. On an (immediate borrower) international claims basis there are data on the share of claims on banks and those which are short-term maturity but not — by definition — the share of cross-border versus local claims.
- (2) Two regressions were carried out. The first explained the change in foreign claims during the crisis with a constant, the share of borrowing by banks and cross-border in 2008 Q1 all on an ultimate risk basis. The second explained the change in international claims during the crisis with a constant and the shares of borrowing by banks and short term all on an immediate borrower basis. The sample was of the 70 biggest debtor countries (excluding offshore centres). In both regressions only the share of borrowing by banks was statistically significant as well as having the correct sign.
- (3) For a more sophisticated approach, see IMF (2009a).
- (4) But the data on consolidated banking groups' lending to each other is incomplete. In order to construct a data set for a system of 19 banking systems, including the United Kingdom, assumptions needed to be made to fill in some of the data gaps (see Annex 2).
- (5) Implicitly it is assumed that these funds are not reinvested somewhere else in the network. For example, the withdrawal of interbank lending could be invested instead in safer assets (eg Treasury securities). This could, in turn, have indirect implications for banks but this is beyond the scope of the analysis in this paper.
- (6) Since the data are measured only at the aggregate banking system level it is also implicitly assumed that funding is withdrawn uniformly from all individual banks within the national banking system.

**Table A** Direct impact of a 10% cut in funding (percentage of borrowing country's GDP) = A<sup>(a)</sup>

Funding cut by:	Effect on:								Total funding from all other reporting countries' banks (\$ billions) 2008 Q3	Total funding to all other countries' banks (\$ billions) 2008 Q3
	Germany	France	Japan	United Kingdom	United States	Switzerland	Italy	Canada		
Germany	0.00	-0.46	-0.03	-1.05	-0.02	-0.64	-0.46	-0.15	636	1,353
France	-0.26	0.00	-0.03	-0.93	-0.25	-0.65	-0.25	-0.05	647	1,295
Japan	-0.08	-0.15	0.00	-0.21	-0.06	-0.19	-0.03	-0.07	143	360
United Kingdom	-0.28	-0.46	-0.10	0.00	-0.14	-0.54	-0.11	-0.20	1,165	1,054
United States	-0.11	-0.16	-0.10	-0.43	0.00	-0.26	-0.06	-0.10	1,206	604 <sup>(b)</sup>
Switzerland	-0.16	-0.12	-0.04	-0.52	-0.17		-0.04	-0.09	160	703
Italy	-0.30	-0.09	0.00	-0.15	-0.01	-0.11	0.00	-0.01	269	370
Canada	-0.02	-0.02	-0.01	-0.13	-0.03	-0.06	-0.01	0.00	113	142

(a) These data, and especially German claims, could be severely affected by gaps in the data (see Annex 2).

(b) US consolidated claims here and in the model include an estimate for investment banks' holdings.

all other banking systems by a given fraction of the loss in funding it initially suffered.

This, in turn, causes a further round of cutbacks in lending throughout the network and so on (see Box 2 for a formal description). The initial, or *direct*, impact of a reduction in funding supply on each of a number of major banking systems is shown in **Table A**. The rows show the impact of a reduction in funding by each of these eight major banking systems on the other seven. The columns show the direct impact on each of the eight banking systems. So, for example, the biggest direct impact of a 10% cut in funding on UK-owned banks would be if it was done by either German or French banks (each around equivalent to 1% of annual UK GDP). The impact of a funding withdrawal from Japanese banks would be significantly smaller (equivalent to 0.2% of annual UK GDP). This simply reflects the relative weights of these banking systems as creditors to British banks.

The data on US-owned banks' foreign claims though may significantly understate the reliance of the United Kingdom, and other banking systems, on funding from US financial institutions as a whole. The data exclude the claims of US non-bank financial institutions, in particular money market funds, on European-owned banks including on their branches and subsidiaries in the United States and their SIVs. The latter borrowed hundreds of billions of dollars on US financial markets at the outset of the crisis.<sup>(1)</sup>

Nonetheless, it is worth noting that US-owned banks seem to play an even bigger role as debtors in the global interbank system (as seen in the penultimate column of **Table A**).<sup>(2)</sup>

Consequently, the largest direct impact on other major economies from a withdrawal of UK bank funding in dollar billion terms would be felt in the United States. However, in relation to the size of the economy, the funding withdrawal would be biggest in France and Germany — equivalent to almost 0.5% and 0.3% of their GDP respectively. The impact

on the United States would be more limited (0.14% of US GDP) reflecting the relatively larger size of the US economy.

But this is only the initial impact. If banks face funding pressures from other banks they are likely to reduce their own interbank lending to close their funding gap. Through the network of linkages between the 19 banking systems this is likely to produce a second round of funding pressure for them and, in turn, they will reduce their own interbank lending further and so on. During a crisis period the time intervals between rounds could be very short.

There is no hard evidence on the fraction of a bank's loss of funding that is regained by withdrawing lending from its own borrowers in the heat of a crisis. But for illustrative purposes it is assumed that when each banking sector faces a funding gap it, in turn, reduces its funding to other banking systems by 90% of the reduction in their own funding and distributes this to its borrowers in proportion to their share in its total claims.

Allowing for these indirect effects the impact after six rounds of a funding shock on each of the major banking systems that originates from each of the other major systems is shown in **Table B**.

A key point to take from **Table B** is that feedback effects through the international network amplify the initial impacts materially — often doubling them. These indirect feedback effects seem to be particularly large (as a per cent of own GDP) when the reduction in funding originates from the most systemic banking systems, such as Germany, France, the United Kingdom and the United States. For example, UK-owned banks are estimated to be most sensitive to a chain of funding tightening originating in German or French-owned banks. If German banks cut back funding to all other consolidated banking systems by 10%, the impact on UK banks

(1) See Bertaut and Pounder (2009) and Baba, McCauley and Ramaswamy (2009).

(2) This seems to suggest that US-owned banks pose a bigger credit than a funding risk to the global network.

after six rounds, allowing for feedback effects across the network, rises by an estimated 0.75% of UK GDP (**Chart 16**). The systemic effect is much less when the funding shocks originate in smaller less connected creditor banking systems, such as Japan (a proxy for the importance of size is their exposures to the system as a whole).

**Table B** Total (direct and indirect) impact of a 10% cut in funding (percentage of borrowing country's GDP)

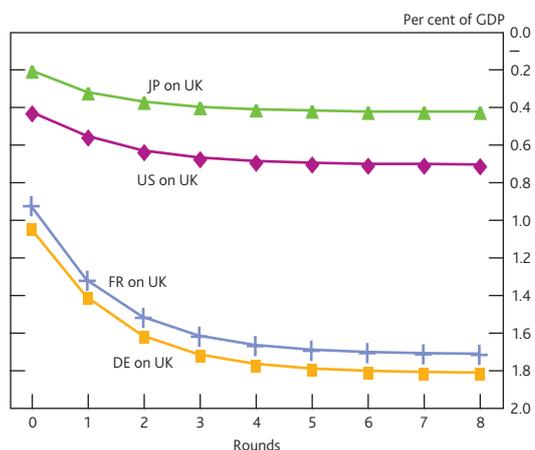
Final effect <sup>(a)</sup> = B		Effect on:								
Funding cut by:	Germany	France	Japan	United Kingdom	United States	Switzerland	Italy	Canada		
Germany	-0.37	-0.90	-0.09	-1.80	-0.14	-1.23	-0.67	-0.29		
France	-0.58	-0.48	-0.12	-1.70	-0.34	-1.24	-0.45	-0.22		
Japan	-0.17	-0.27	-0.02	-0.42	-0.09	-0.35	-0.08	-0.11		
United Kingdom	-0.51	-0.80	-0.16	-0.66	-0.22	-0.99	-0.26	-0.31		
United States	-0.23	-0.33	-0.12	-0.71	-0.05	-0.48	-0.14	-0.16		
Switzerland	-0.32	-0.37	-0.10	-0.94	-0.22	-0.33	-0.15	-0.19		
Italy	-0.38	-0.21	-0.02	-0.36	-0.04	-0.28	-0.07	-0.05		
Canada	-0.05	-0.07	-0.02	-0.21	-0.04	-0.13	-0.03	-0.02		

Systemic effect = B – A

Systemic effect = B – A		Effect on:								
Funding cut by:	Germany	France	Japan	United Kingdom	United States	Switzerland	Italy	Canada		
Germany	-0.37	-0.45	-0.06	-0.75	-0.12	-0.59	-0.21	-0.14		
France	-0.32	-0.48	-0.09	-0.77	-0.10	-0.58	-0.20	-0.17		
Japan	-0.08	-0.11	-0.02	-0.21	-0.03	-0.16	-0.05	-0.04		
United Kingdom	-0.23	-0.33	-0.06	-0.66	-0.08	-0.45	-0.16	-0.11		
United States	-0.12	-0.17	-0.02	-0.27	-0.05	-0.22	-0.07	-0.06		
Switzerland	-0.17	-0.25	-0.06	-0.42	-0.05	-0.33	-0.11	-0.09		
Italy	-0.08	-0.12	-0.02	-0.21	-0.03	-0.16	-0.07	-0.04		
Canada	-0.03	-0.05	-0.01	-0.08	-0.01	-0.06	-0.02	-0.02		

(a) Cumulative impact after six rounds.

**Chart 16** Simulated effect of a 10% cut in funding from major banking groups on UK banks (percentage of UK GDP)



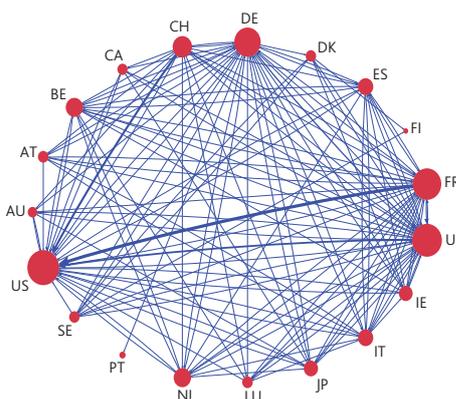
Source: Own calculations.

The role played by the interconnectedness to the whole system can be shown also by comparing the impact on UK banks of a funding shock that originates from each of the Italian and Canadian banking systems. The same size cuts in funding by Italian-owned and Canadian-owned banks have a broadly similar initial impact on UK-owned banks (see the shaded column in **Table A**). But over later rounds, the Italian shock reverberates to inflict withdrawals on UK banks that are two and half times as large compared with only one and half times as large for a shock starting from Canadian banks (**Table B**).

The extra systemic effect comes about because while Italian and Canadian banks hold similar outstanding claims on UK-owned banking groups, Italian banks lend much more than Canadian ones to other banking systems, especially to German banks. As German banks are themselves important for UK banks' funding, this creates a large indirect effect.

More generally, a banking group may be important for the system as a whole because of the pattern as well as the size of its bilateral exposures and liabilities. It may be systemic in a chain of funding contagion because it is itself a large creditor to one or more key creditors in the system. The network interconnectedness of the 19 systems is shown in **Chart 17**. The key bilateral creditors are shown by the width of the arrows.

**Chart 17** The international banking network (consolidated ultimate risk basis, foreign claims) at the time of Lehman Brothers' default, 2008 Q3



Notes: The size of the blobs (the nodes) reflect the size of a national banking system's sum of foreign claims on and liabilities to all other banking systems. The width of each arrow reflects authors' estimates of the value of the bilateral foreign claims. Links smaller than \$10 billion are cut off. Austria (AT), Australia (AU), Belgium (BE), Canada (CA), Switzerland (CH), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FI), United Kingdom (excluding Guernsey, Isle of Man and Jersey) (UK), Ireland (IE), Italy (IT), Japan (JP), Luxembourg (LU), Netherlands (NL), Portugal (PT), Sweden (SE) and the United States (US). US consolidated claims and liabilities include an estimate for investment banks. Arrows point from creditor to borrower.

Sources: BIS consolidated data on an ultimate risk and immediate borrower basis and own assumptions.

The network chart is only as informative as the data that underlie it. For example, Annex 2 notes that there are deficiencies in the German interbank claims data, so it is possible that the German claims on UK-owned banks are overestimated.

## Box 2

### Simulations of a funding shock

In this box the funding shock simulations are formally described.

The starting point of the simulations is to assume that a national banking sector reduces its funding to all other banking groups in the system by 10% of its total lending. That reduction in funding is also assumed to be divided among its borrowers in proportion to the share of their loans from the initiating banking group ( $i$ ). This is termed **the impact effect**.

But a banking group that has had its funding curtailed is then assumed to reduce its own interbank lending to all other banking systems by 90% of the dollar billion value of the loss in its funding in order to keep its net equity close to its previous value. Faced with this further loss in funding, banks cut back their own interbank lending further. At each successive round, the cut in funding passed on gets smaller. The cut in funding following these successive rounds is what we call **the final effect**. In fact, the system settles to a new equilibrium relatively quickly, after six rounds. The exercise is repeated for a cut initiated by each of the banking groups and the impact on each other banking group in the system is traced out.

We define the linear **systemic effect** of the shock as the difference between the final and initial effects.

Formally, let  $L_{ij}$  be the dollar billion value of outstanding funding that banking group  $i$  receives from banking group  $j$  in 2008 Q3 (for illustrative purposes data at the time of the shock of Lehman Brothers' failure has been used), as measured by the BIS consolidated claims and our own approximations. There are  $N = 19$  banking groups in the network. Then the matrix  $\mathbf{A}$  is defined as

$$\mathbf{A} = \begin{bmatrix} L_{11} \\ \sum_j L_{2j} \\ \vdots \\ \sum_j L_{Nj} \end{bmatrix}.$$

Note that the main diagonal entries of this matrix are zero.

The effects on each banking group at  $t$  rounds after the initial shock to banking group  $i$ , in an  $N \times 1$  vector  $\mathbf{x}_{it}$ , is measured as  $\mathbf{x}_{it} = d\mathbf{A}\mathbf{x}_{it-1} + \mathbf{Ae}_i$ .

The  $i^{\text{th}}$  element of the  $N \times 1$  vector  $\mathbf{e}_i$  is equal to 10% of the total value of the  $i^{\text{th}}$  banking group's investments in all other banking groups in our set and all other elements are zero.  $d$  is a scalar damping factor (taken to be 0.9) and  $\mathbf{x}_{it}$  at round  $t = -1$  is zero.

The impact effect of the shock initiated by the  $i^{\text{th}}$  banking group is then

$$\mathbf{x}_{i0}^{\text{impact}} = \mathbf{Ae}_i.$$

The cumulative final effect is

$$\mathbf{x}_i^{\text{final}} = (\mathbf{I} - d\mathbf{A})^{-1} \mathbf{Ae}_i.$$

The linear systemic effect of the shock to the  $i^{\text{th}}$  banking group on all banking groups is the difference between the vector of final and initial effects.

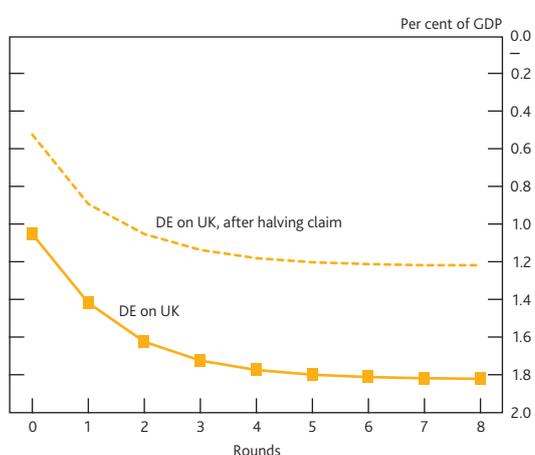
$$\begin{aligned} \mathbf{x}_i^{\text{system}(t)} &\equiv (\mathbf{I} - d\mathbf{A})^{-1} \mathbf{Ae}_i - \mathbf{Ae}_i \\ &= \left( (\mathbf{I} - d\mathbf{A})^{-1} - \mathbf{I} \right) \mathbf{Ae}_i. \end{aligned}$$

The values of the impact, final effect and linear system effect are in dollar billion terms although in the main text they have been scaled by GDP to give some guidance of the size of reduction in capital flow to the domestic economy.

Although we cannot improve on the German data, we can explore the robustness of the simulations to alternative estimates of German claims. We now halve our estimate of German banks claims on UK banks, and re-run the simulations, while leaving all our other calibrations unchanged.

**Chart 18** shows the impact of a funding shock from the German banking system on UK banks and compares them with those from the original simulations. The relative risks to the UK banks of a shock that begins in Germany are reduced, but by less than a half. So the vulnerability of UK banks to a shock that begins in Germany remains significant.

**Chart 18** Simulated effect of a 10% cut in funding from German banking group on UK banks (percentage of UK GDP)



Source: Own calculations.

Taken together, these simulations illustrate the vulnerability of major banking groups to funding shocks from other banking systems, including indirect impacts via a withdrawal of funding between third countries. It suggests there was a significant systemic risk to UK banks arising from a shock hitting any of the other large hubs of the international banking network — France, Germany and the United States.

Moreover, this systemic risk built up in the years preceding the crisis. We estimate that the foreign claims of French, German, UK and US banks on each other increased by 72% from the start of the sample in 2005 Q2 through to 2008 Q1. This is about twice the increase in all other banking groups' foreign claims on each other over the same period, implying that the exposures of the major global banking systems to one another increased substantially (Haldane (2009) and Gai and Kapadia (2010)).

## Conclusion

This paper has sought to better understand the cross-border propagation of shocks from and to international banks during the recent crisis.

During most of this century there was a marked and broad-based increase in international banks' lending to other countries both cross-border and from their local operations. However, in the recent financial crisis, faced with pressure on their funding and capital, a number of major international banking systems deleveraged their external positions dramatically.

According to the available data, this deleveraging has been discriminatory. Lending appears to have been cut back especially to non-core markets. So banks have reduced lending more abroad than they have domestically, particularly if made cross-border rather than from their local operations in foreign countries. Interbank lending has fallen especially sharply. Relatedly, banks' short-term lending has fallen most. The large proportion of borrowing made cross-border and by banks seems to have played a role in explaining Iceland's capital account stop. Also, the marked reduction in BIS bank lending to the United Kingdom may also be linked to the large proportion of borrowing done at short maturities, and by banks.

Given the importance of UK banks within the international bank network, simulations were carried out on the impact on (and from) UK banks of a withdrawal of interbank liquidity. This emphasised the important role that the largest international banking systems play not only because of their direct claims on, or liabilities to, UK banks but also in transmitting funding shocks indirectly through the global banking network back onto UK banks.

The paper also highlights that the boom and subsequent bust in bank lending made cross-border, rather than domestically, was particularly marked in recent years. This suggests that it is important for the domestic authorities to take account of lending by non-resident banks when assessing the degree of credit exuberance in the domestic economy.

In light of the recent financial crisis, the FSB/IMF recently highlighted a wide range of data gaps including data for tracking funding patterns in the international financial system.<sup>(1)</sup> This paper has reinforced this gap and pointed to a number of other deficiencies in the international banking data which hinder the assessment of funding and credit risks faced by global-oriented banks. Looking forward, it is important to seek international agreement to ensure, as far as possible, that data are collected by national authorities on a consistent basis across the global banking system. It would also be desirable when using these data if national authorities adopted a consistent approach to analysing risks to and from the global banking system.

(1) FSB/IMF (2009).

## Annex 1 Glossary

**BIS reporting banks.** Banks that report their external positions to the BIS (via local central banks). Banks are defined as institutions located in each reporting country whose business it is to receive deposits and/or close substitutes for deposits, and to grant credits or invest in securities on their own account.

**Consolidated banking statistics.** Data are collected on a banking-group consolidated basis. These include the claims of foreign offices (ie subsidiaries and branches). Interoffice positions are netted out. In contrast to the locational statistics, no data are available on banks' liabilities. Thirty countries currently report consolidated data to the BIS.

**Cross-border claims.** Claims by a resident banking office on non-residents.

**Exchange rate adjusted flow.** Change in stock, adjusted to remove the impact of valuation effects from currency movements.

**Foreign claims.** In the context of the consolidated statistics, foreign claims are defined as cross-border claims plus foreign affiliates' local claims in all currencies. Claims consist of certificates of deposit, promissory notes and other negotiable paper issued by non-residents, banks' holdings of international notes and coin, foreign trade-related credits, claims under sale and repurchase agreements with non-residents, deposits and balances placed with banks, loans and advances to banks and non-banks, holdings of securities and participations including equity holdings in unconsolidated banks or non-bank subsidiaries. Borrowing and lending of securities, gold and other precious metals without cash collateral should not be reported as international banking business. Holdings of securities also include credit-linked notes and other collateralised debt obligations as well as asset-backed securities.

**Immediate borrower basis.** Claims are recorded as on the country of the borrowing entity's location. This is in contrast to 'ultimate risk basis'.

**Intergroup lending.** In the context of locational by nationality statistics, intergroup lending is defined as cross-border lending to offices of an unrelated banking group.

**International claims.** In the context of the consolidated statistics, defined as banks' cross-border claims plus local claims of foreign affiliates in foreign currencies.

**Intragroup lending.** In the context of the locational by nationality statistics, defined as cross-border lending to offices of the same banking group.

**Local claims.** In the context of the consolidated banking statistics, local claims refer to claims of domestic banks' foreign affiliates (branches and subsidiaries) on the residents of the host country.

**Locational by residence.** These data provide information on the external position of resident banking offices, including balance sheet positions that represent financial claims or liabilities vis-à-vis non-residents as well as financial claims or liabilities vis-à-vis residents in foreign currency. Instruments included are the same as for the consolidated foreign claims, but intragroup positions are not netted out. In contrast to the consolidated data, liabilities are also reported. These include loans and deposits from banks and non-banks, funds received and invested on a trust basis in banks' own names, and banks' own issues of securities in international markets. Forty two countries currently report locational data to the BIS.

**Locational by nationality.** These statistics use the same underlying data as the locational by residence statistics, but the data are aggregated by the location of the lending bank's head office, rather than by the location of the lending bank itself.

**Sectoral split.** Within the locational by residence data, claims are split into non-banks and banks (including monetary authorities). Within the locational by nationality data, claims and liabilities are split into non-banks, related banking offices ('intrabank') and unrelated banking offices ('interbank', including the monetary authority). Consolidated claims are split into claims on the public sector (including the government, the monetary authorities, and multilateral development banks), banks (excluding the monetary authorities), and the non-bank private sector. The latter includes non-bank financial institutions as well as other companies and households.

**Ultimate risk basis.** Used in the context of the consolidated banking statistics. In contrast to the country where the actual borrower resides (the country of 'immediate borrower'), the country of ultimate risk is defined as the country in which the guarantor of a financial claim resides and/or the country in which the head office of a legally dependent branch is located.

**Vis-à-vis country.** Country of location of the counterparty to a reporting bank's claim or liability.

For further information see the BIS guides to locational and consolidated statistics ([www.bis.org/statistics/bankstats.htm](http://www.bis.org/statistics/bankstats.htm)).

## Annex 2

### Filling in data gaps in the simulations

The simulations require collection of data on consolidated banking systems' claims on each other. As discussed in Box 1, there are, in fact, no explicit consolidated data on the liabilities of banking systems to each other. But a reasonable proxy for simulation purposes is to use the consolidated bank claims of one banking system on banks in another country on an ultimate risk basis. The latter allows for risk transfer. So the claims on local operations of a foreign-owned bank should be excluded from the claims (outward risk transfer) while claims on domestically owned subsidiaries and branches abroad should be included (inward risk transfer).

Bilateral consolidated foreign claims to banks on an ultimate risk basis have been used to generate the interbank claims for the system of 19 banks used in the simulations. On this basis, the total interbank liabilities of UK banking groups from the other 18 banking groups is estimated at just over \$1.2 trillion in 2008 Q3. The UK banks' interbank claims on the rest of the system are estimated at about \$0.9 trillion.

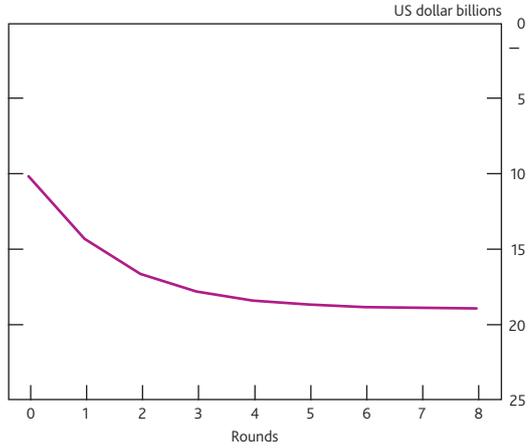
However, there are a number of gaps in these bilateral data. Denmark does not report their bilateral interbank claims while Germany, Belgium and Greece only do so on a confidential basis to the BIS. Also for some bilateral claims, Ireland and Finland only report on a confidential basis. For Germany, Belgium and Greece, we applied the share of claims on individual foreign banking systems relative to claims on all other 18 foreign banking systems from the consolidated international claims on an immediate borrower basis. For Ireland and Finland, we used the international claims data itself as a proxy for foreign claims.

But the immediate borrower data do not allow for risk transfer and so claims on banks are on a purely residency basis. Since there are many foreign-owned banks resident in the United Kingdom, our estimate for claims on UK-owned banks from these countries are likely to be inflated and conversely their claims on other banking sectors in the system will be understated by the same amount. In addition, international claims are defined as claims made cross-border and made locally by foreign affiliates on other banks and non-banks in foreign currency. So, unlike the ultimate risk foreign claims data, they exclude local claims of reporting banks' foreign affiliates on other banks and non-banks in local currency.

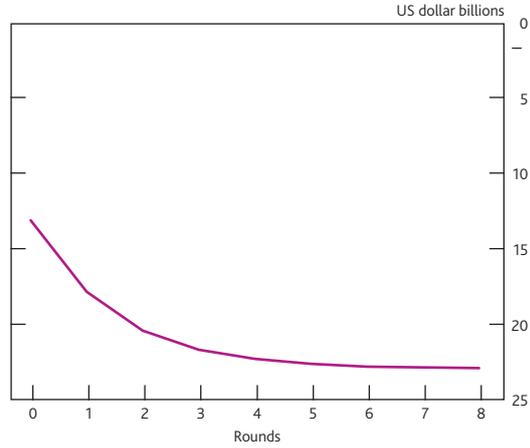
## Appendix of charts

The charts below show the effect over time, in US dollar billion terms, of the illustrative simulations of a 10% funding shock by and onto UK-owned banks with respect to other major banking systems.

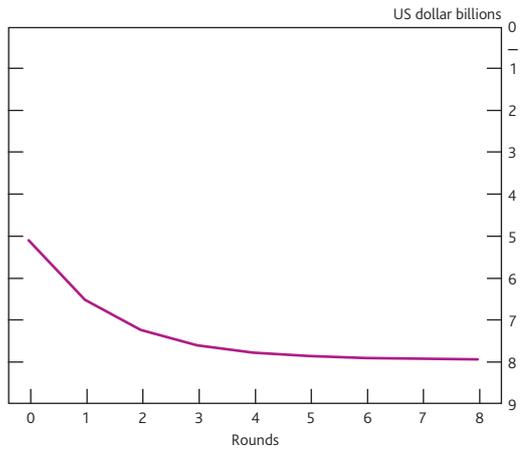
UK on DE



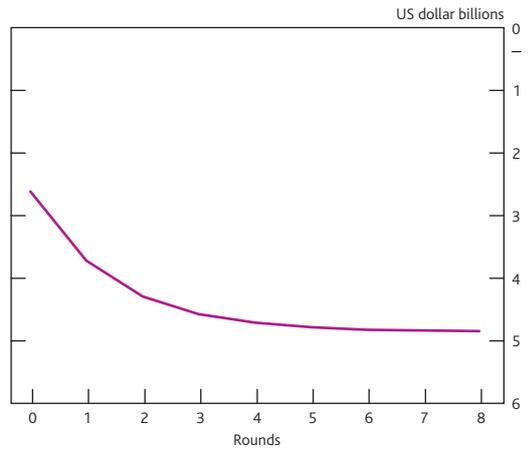
UK on FR



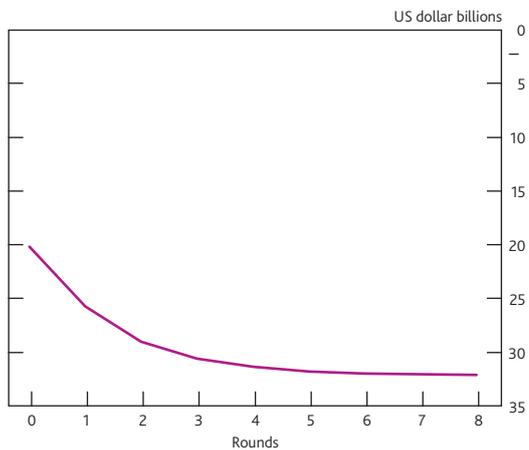
UK on DE



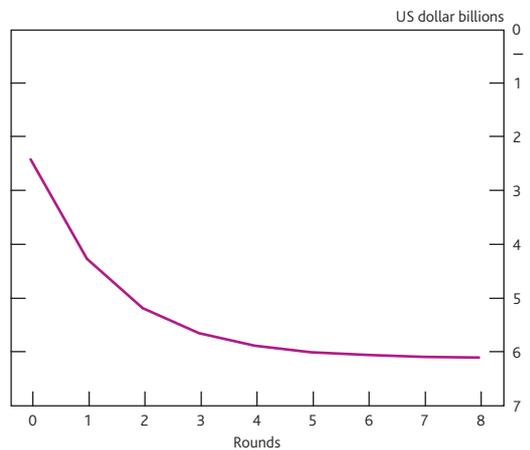
UK on CH



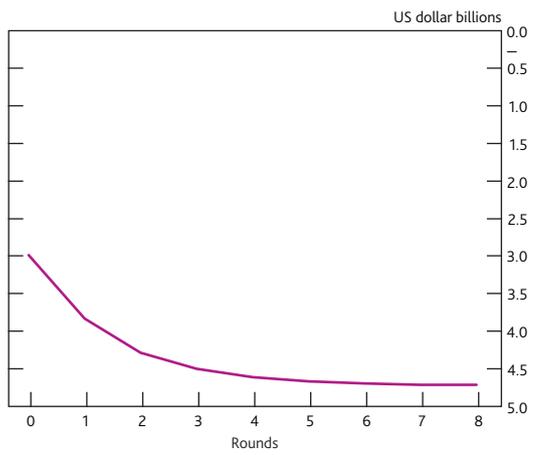
UK on US



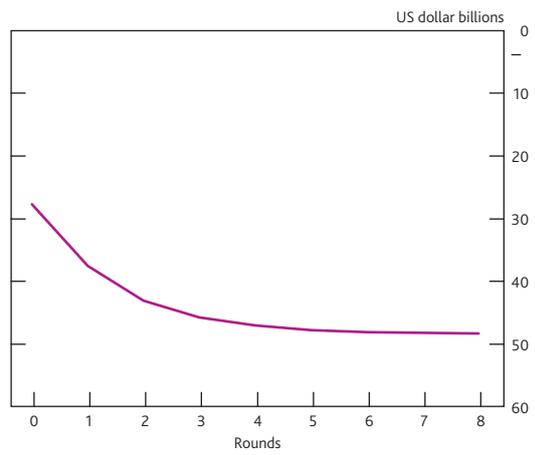
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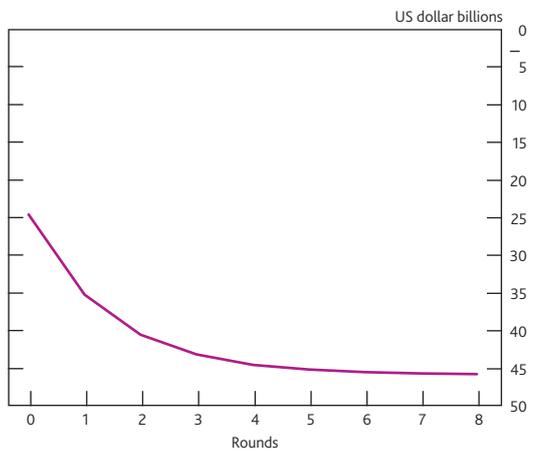
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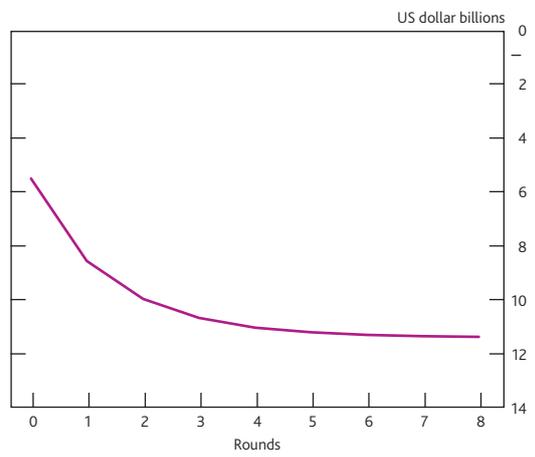
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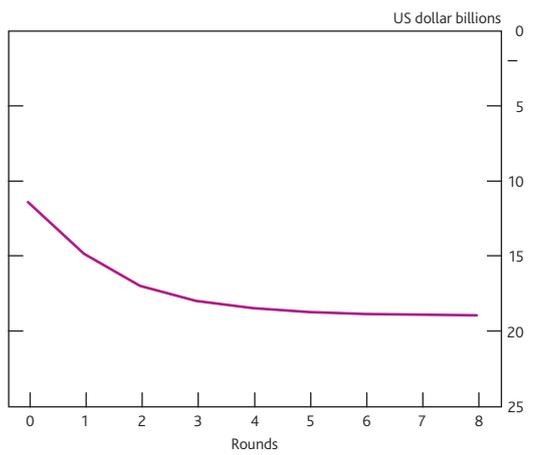
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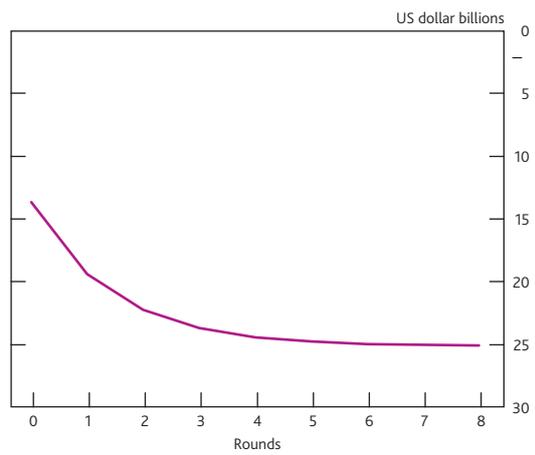
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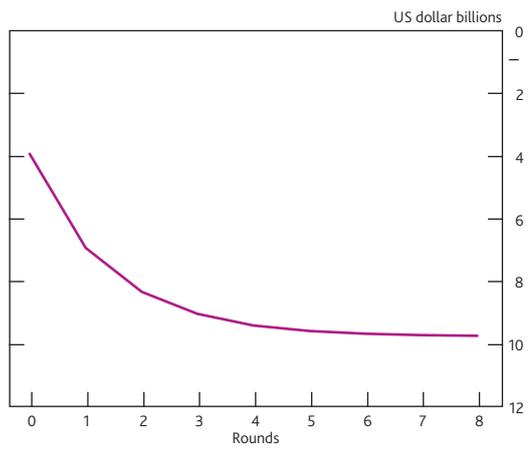
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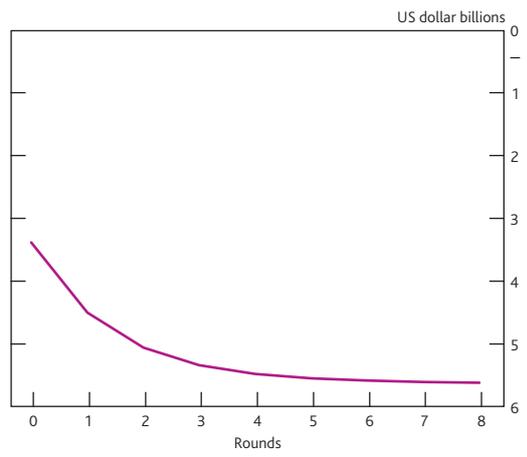
CH on UK



IT on UK



CA on UK



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