

The US dollar shortage in global banking¹

Understanding the global financial crisis and the stresses on bank balance sheets requires a perspective on banks' international investment positions and how these positions were funded across currencies and counterparties. This special feature uses the BIS international banking statistics to identify the cross-currency and counterparty funding patterns for the largest banking systems, and to assess the causes of the US dollar shortage during the critical phases of the crisis.

JEL classification: F34, G01, G21.

The current financial crisis has highlighted just how little is known about the structure of banks' international balance sheets and their interconnectedness. During the crisis, many banks reportedly faced severe US dollar funding shortages, prompting central banks around the world to adopt unprecedented policy measures to supply them with funds. How could a US dollar shortage develop so quickly after dollar liquidity had been viewed as plentiful? Which banking systems were most affected? And how have funding pressures affected lending to non-bank end users of funds?

This special feature draws on the BIS international banking statistics to provide some tentative answers to these questions. It splices together two sets of statistics to reconstruct the global balance sheet positions for each of the major *national banking systems*.² The dynamics of the crisis can then be analysed across banks' consolidated balance sheets rather than along geographical (ie residency-based) lines. With information on both the *currency* and the type of *counterparty* for banks' foreign assets and liabilities, we can investigate how banks *funded* their foreign investments, and thus can better identify the vulnerabilities that threatened the financial system.

Global banking activity had grown remarkably between 2000 and mid-2007. As banks' balance sheets expanded, so did their appetite for foreign

¹ The authors thank Claudio Borio, Linda Goldberg, Már Gudmundsson, Robert McCauley, Perry Mehrling, Frank Packer and Philip Wooldridge for helpful comments, and Emir Emiray, Sebastian Goerlich and Swapan Pradhan for research assistance. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

² In the context of this special feature, a national banking system refers to the set of large internationally active banks *headquartered* in a particular country (eg US banks, German banks, Swiss banks, etc), as opposed to banks *located* in a particular country.

currency assets, notably US dollar-denominated claims on non-bank entities, reflecting in part the rapid pace of financial innovation during this period. European banks, in particular, experienced the most pronounced growth in foreign claims relative to underlying measures of economic activity.

We explore the consequences of this expansion for banks' financing needs. In a first step, we break down banks' assets and liabilities by currency to examine *cross-currency funding*, or the extent to which banks fund in one currency and invest in another (via FX swaps). After 2000, some banking systems took on increasingly large net on-balance sheet positions in foreign currencies, particularly in US dollars. While the associated currency exposures were presumably hedged off-balance sheet, the build-up of large net US dollar positions exposed these banks to *funding risk*, or the risk that their funding positions could not be rolled over.

To gauge the magnitude of this risk, we next analyse banks' *US dollar funding gap*. Breaking down banks' US dollar assets and liabilities further, by counterparty sector, allows us to separate positions vis-à-vis non-bank end users of funds from interbank and other sources of short-term funding. A lower-bound estimate of banks' funding gap, measured as the net amount of US dollars channelled to non-banks, shows that the major European banks' funding needs were substantial (\$1.1–1.3 trillion by mid-2007). Securing this funding became more difficult after the onset of the crisis, when credit risk concerns led to severe disruptions in the interbank and FX swap markets and in money market funds. We conclude with a discussion of how European banks, supported by central banks, reacted to these disruptions up to end-September 2008.

The long and short of banks' global balance sheets

The propagation of the global financial crisis runs along the contours of banks' consolidated global balance sheets, rather than along national borders. That is, banks have become so globalised that residency-based data (eg domestic credit, or a country's external position) are insufficient for identifying vulnerabilities in the global banking system. Understanding the causes of the crisis requires measurement of banking activity at the level of the decision-making economic unit, ie an internationally active bank taking decisions on its worldwide consolidated asset and liability positions.³

While not at the level of individual banks, the BIS international banking statistics can be used to reconstruct the global balance sheet positions for specific national banking systems.⁴ Details on how this is done are provided in the box on page 61. The advantages of this data compilation are that it provides (1) the consolidated foreign assets *and* liabilities for each banking

The BIS banking statistics track banks' funding positions

³ Bank-level information on assets and liabilities broken down by currency and type of counterparty (ie location and sector) may be available to bank examiners but is not included in publicly available sources (eg BankScope, national data).

⁴ See Lane and Shambaugh (2008) for an examination of the international balance sheets and foreign currency exposures of particular countries.

system, (2) estimates of the gross and net positions *by currency*, and (3) information on the sources of financing (ie interbank market, non-bank counterparties and central banks). The data cover the Q2 1999 – Q3 2008 period at a quarterly frequency. While this dataset facilitates an analysis of banks’ funding patterns, it is important to emphasise that the figures presented here are, at best, estimates. They provide an incomplete picture of the structure of any particular banking system, and in places are based on imperfect underlying data (see box).

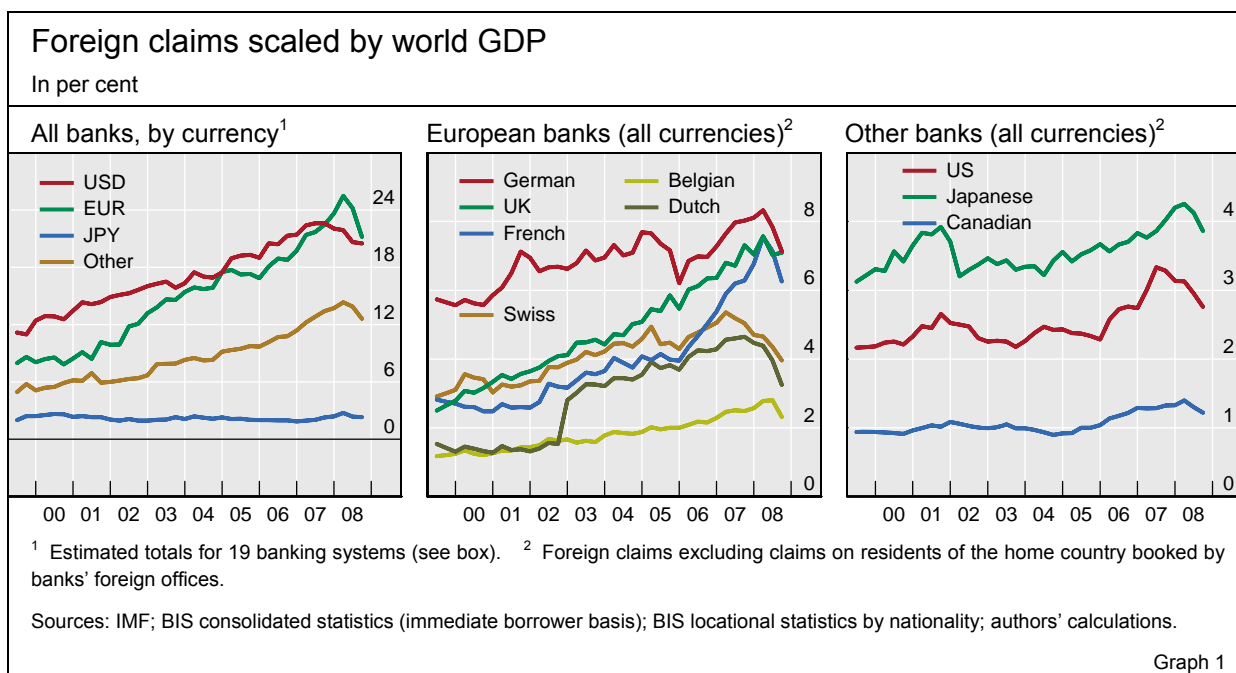
Banks’ global expansion

Banks’ foreign positions have surged since 2000. The outstanding stock of BIS reporting banks’ foreign claims grew from \$11 trillion at end-2000 to \$31 trillion by mid-2007, a major expansion even when scaled by global economic activity (Graph 1, left-hand panel). The year-on-year growth in foreign claims approached 30% by mid-2007, up from around 10% in 2001. This acceleration coincided with significant growth in the hedge fund industry, the emergence of the structured finance industry and the spread of “universal banking”, which combines commercial and investment banking and proprietary trading activities.

At the level of individual banking systems, the growth in European banks’ global positions is particularly noteworthy (Graph 1, centre panel). For example, Swiss banks’ foreign claims jumped from roughly five times Swiss nominal GDP in 2000 to as much as eight times in mid-2007. Dutch, French, German and UK banks’ foreign claims expanded considerably as well. In contrast, Canadian, Japanese and US banks’ foreign claims grew in absolute terms over the same period, but did not significantly outpace the growth in domestic or world GDP (Graph 1, right-hand panel). While much of the increase for some European banking systems reflected their greater intra-euro area lending following the introduction of the single currency in 1999, their

Financial innovation since 2000 ...

... spurs bank balance sheet growth



estimated US dollar- (and other non-euro-) denominated positions accounted for more than half of the overall increase in their foreign assets between end-2000 and mid-2007.

Banks' foreign currency positions

How did banks finance this expansion, especially their foreign currency positions? In principle, a bank can finance foreign currency assets in several ways. It can borrow foreign currency from the interbank market or from non-bank market participants or central banks.⁵ Alternatively, the bank can use FX swaps to convert liabilities in other currencies into the desired foreign currency for the purchase of the foreign currency assets.⁶

This section examines *cross-currency* funding, or the extent to which banks invest in one currency and fund in another. This requires a breakdown by currency of banks' gross foreign positions, as shown in Graph 2, where positive (negative) positions represent foreign claims (liabilities). For some European banking systems, foreign claims are primarily denominated in the home country (or "domestic") currency, representing intra-euro area cross-border positions (eg Belgian, Dutch, French and German banks). For others (eg Japanese, Swiss and UK banks), foreign claims are predominantly in foreign currencies, mainly US dollars.

These foreign currency claims often exceed the extent of funding in the same currency. This is shown in Graph 3, where, in each panel, the lines indicate the overall *net* position (foreign assets minus liabilities) in each of the major currencies. If we assume that banks' on-balance sheet *open* currency positions are small, these cross-currency net positions are a measure of banks' reliance on FX swaps. Most banking systems maintain long positions in foreign currencies, where "long" ("short") denotes a positive (negative) net position. These long foreign currency positions are mirrored in net borrowing in domestic currency from home country residents.⁷ UK banks, for example, borrowed (net) in pounds sterling (some \$800 billion, both cross-border and from UK residents) in order to finance their corresponding long positions in US dollars, euros and other foreign currencies. By mid-2007, their long US dollar positions surpassed \$300 billion, on an estimated \$2 trillion in gross US dollar claims.

Banks fund foreign
currency
investments ...

... by borrowing
at home and
converting via
FX swaps

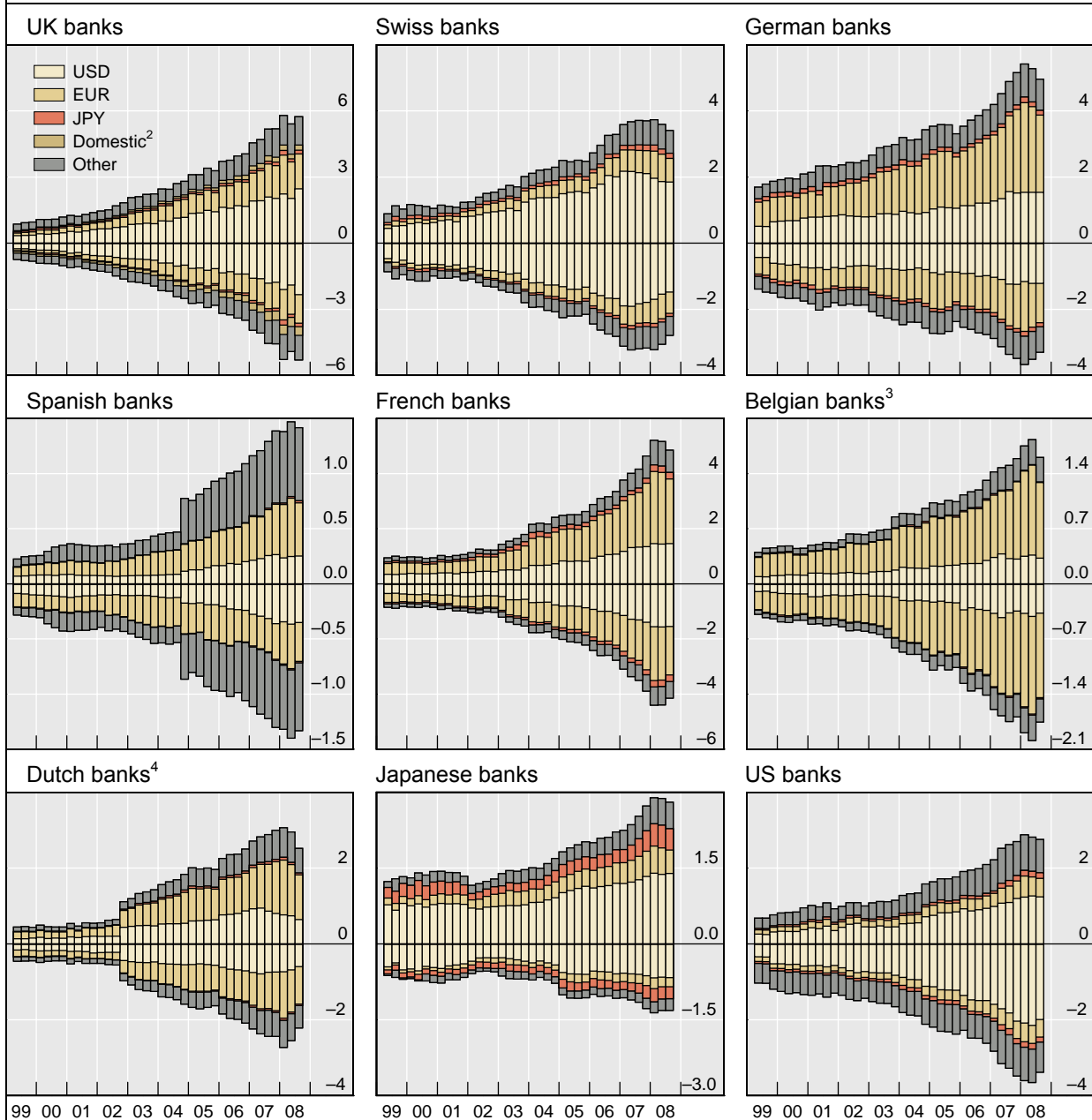
⁵ In the BIS locational banking statistics by nationality, reporting banks' liabilities to official monetary authorities typically reflect international deposits of foreign exchange reserves in commercial banks.

⁶ A third funding option, which produces no subsequent foreign currency needs, is to convert domestic currency through a single FX spot transaction. Doing so, however, exposes the bank to currency risk, as the on-balance sheet mismatch between foreign currency assets and domestic currency liabilities remains unhedged. Our working assumption is that banks employ FX swaps to fully hedge any on-balance sheet currency mismatch (see Stigum and Crescenzi (2007), Chapter 7).

⁷ Banks' "strictly domestic" banking activity is not reported in the BIS banking statistics. Their *gross* positions in their domestic currency vis-à-vis home country residents are therefore unknown, but their *net position* (shown as the shaded area in Graph 3) can be inferred as a residual from the balance sheet identity (see box). German banks' foreign claims in Graph 2, for example, comprise *all* of their foreign currency positions, but their euro positions only vis-à-vis counterparties outside Germany.

Gross foreign assets and liabilities, by currency¹

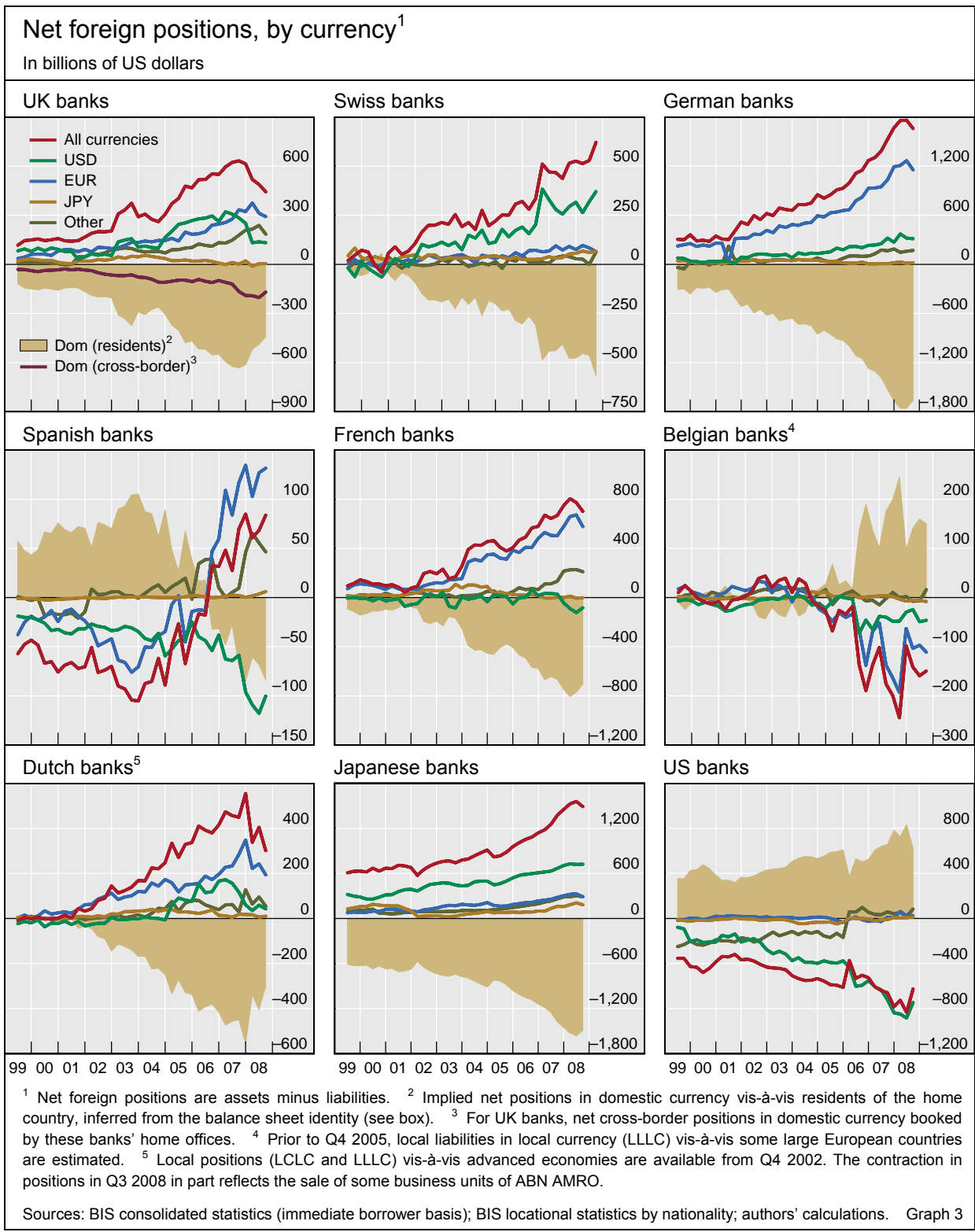
In trillions of US dollars



¹ Positive (negative) values are assets (liabilities). ² For UK banks, gross positions in domestic currency booked by these banks' home offices. ³ Prior to Q4 2005, local liabilities in local currency (LLC) vis-à-vis some large European countries are estimated. ⁴ Local positions (LCLC and LLLC) vis-à-vis advanced economies are available from Q4 2002. The contraction in positions in Q3 2008 in part reflects the sale of some business units of ABN AMRO.

Sources: BIS consolidated statistics (immediate borrower basis); BIS locational statistics by nationality; authors' calculations. Graph 2

Similarly, German and Swiss banks' net US dollar books approached \$300 billion by mid-2007, while that of Dutch banks surpassed \$150 billion. In comparison, Belgian and French banks maintained a relatively neutral overall US dollar position prior to the crisis, while Spanish banks had borrowed US dollars to finance euro lending at home, at least until mid-2006.



Taken together, Graphs 2 and 3 thus show that several European banking systems expanded their long US dollar positions significantly after 2000, and funded them primarily by borrowing in their domestic currency from home country residents. This is consistent with European universal banks using their retail banking arms to fund the expansion of investment banking activities, which have a large dollar component and are concentrated in major financial

centres. In aggregate, European banks' combined long US dollar positions grew to more than \$800 billion by mid-2007 (Graph 5, top left-hand panel), funded by short positions in pounds sterling, euros and Swiss francs. As banks' cross-currency funding grew, so did their hedging requirements and FX swap transactions, which are subject to funding risk when these contracts have to be rolled over.

Maturity transformation across banks' balance sheets

From the perspective of financial stability, a key metric of interest is the extent to which banks engage in *maturity transformation*. A sudden inability to roll over their short-term funding positions will require that banks "deliver" foreign currency, which may force them to sell or liquidate assets earlier than anticipated, typically in distressed market conditions ("distress selling").⁸ Unfortunately, data limitations make it difficult to obtain an aggregate maturity profile of banks' foreign assets and liabilities. However, the counterparty sector breakdown available in the BIS banking statistics may serve as a rough proxy for maturity transformation, and hence funding risk, since the maturity of positions is likely to vary systematically with the type of counterparty. We use this counterparty information to construct a measure of banks' *US dollar funding gap*, or the amount of US dollars invested in longer-term assets which is not supported by longer-term US dollar liabilities, this gap being the amount that banks must roll over before their investments mature. We build up this argument in several steps.

Counterparty sector
can proxy for
maturity

The counterparty sector breakdown for European banks' gross US dollar assets and liabilities is shown in Graph 5 (top right-hand panel). Interbank claims, which include interbank loans and debt securities, tend to be shorter-term or can be realised at shorter notice than claims on non-banks. We think of US dollar claims on non-banks as banks' desired US dollar investment portfolio, which includes their retail and corporate lending, and lending to hedge funds, as well as holdings of securities, ranging from US Treasury and agency securities to structured finance products.⁹ Whether these non-bank assets can be readily converted to cash depends upon the maturity of the underlying positions as well as on their market liquidity.

These US dollar investments are funded by liabilities to various counterparties. Banks can borrow US dollars directly from the interbank market. They also raise US dollars via FX swaps (with bank or non-bank

⁸ Banks also face risks inherent in transforming maturities in their domestic currency alone. However, in a purely domestic banking context the central bank can act as lender of last resort. By contrast, *foreign currency* funding needs may have to be met from sources abroad.

⁹ No counterparty sector breakdown is available for banks' US dollar claims on US residents booked by their offices in the United States (LCLC and LLLC or "Local US positions" in Graph 5, top right-hand panel). However, alternative sources of data indicate that the bulk of these positions is likely to be transactions with *non-bank* counterparties. For instance, BankScope data suggest that European bank subsidiaries in the United States book a small share (below 5%) of their total assets as interbank assets. Data on foreign banks' offices in the United States from the Federal Reserve H.8 release point in the same direction. Thus, our estimate of US dollar positions vis-à-vis non-banks (in Graphs 4 and 5) is the sum of banks' *international* US dollar positions in non-banks and their local US positions.

counterparties), which are even shorter-term on average.¹⁰ In contrast, US dollar funding provided directly by non-banks includes corporate and retail deposits, as well as financing from money market funds, and is thus of varying maturities. If banks' liabilities to non-banks were *all* short-term, then an upper-bound estimate of banks' US dollar funding gap is their *gross* US dollar investment position in non-banks. If, on the other hand, the effective maturity of liabilities to non-banks matches that of their investments in non-banks, then a lower-bound estimate of their funding gap is the *net* position vis-à-vis non-banks. Below we focus on this latter measure.

As shown in Graph 4, there is considerable heterogeneity in the way European banks met their US dollar funding requirements. For example, Dutch, German, Swiss and UK banks had the largest funding gaps by mid-2007 (green line). However, their reliance on the interbank market (blue line), central bank deposits (red line) and FX swaps (shaded area) differed markedly.¹¹ UK banks maintained largely balanced net interbank US dollar positions, thus implying cross-currency funding, while German banks relied relatively more on interbank funding.

Funding patterns ...

Taken together, these estimates suggest that European banks' US dollar investments in non-banks were subject to considerable funding risk. The net US dollar book, aggregated across the major European banking systems, is portrayed in Graph 5 (bottom left-hand panel), with the non-bank component tracked by the green line. By this measure, the major European banks' US dollar funding gap reached \$1.1–1.3 trillion by mid-2007.¹² Until the onset of the crisis, European banks had met this need by tapping the interbank market (\$400 billion) and by borrowing from central banks (\$380 billion),¹³ and used FX swaps (\$800 billion) to convert (primarily) domestic currency funding into dollars.

The funding patterns for Japanese and US banks in Graph 4 deserve comment as well. Japanese banks' estimated net US dollar claims on non-banks rose beyond \$600 billion by end-2007 and, compared with other banking

... differ across banking systems

¹⁰ Evidence from the BIS Triennial Central Bank Survey (2007) indicates that 78% of FX swap turnover is accounted for by contracts with a maturity of less than seven days.

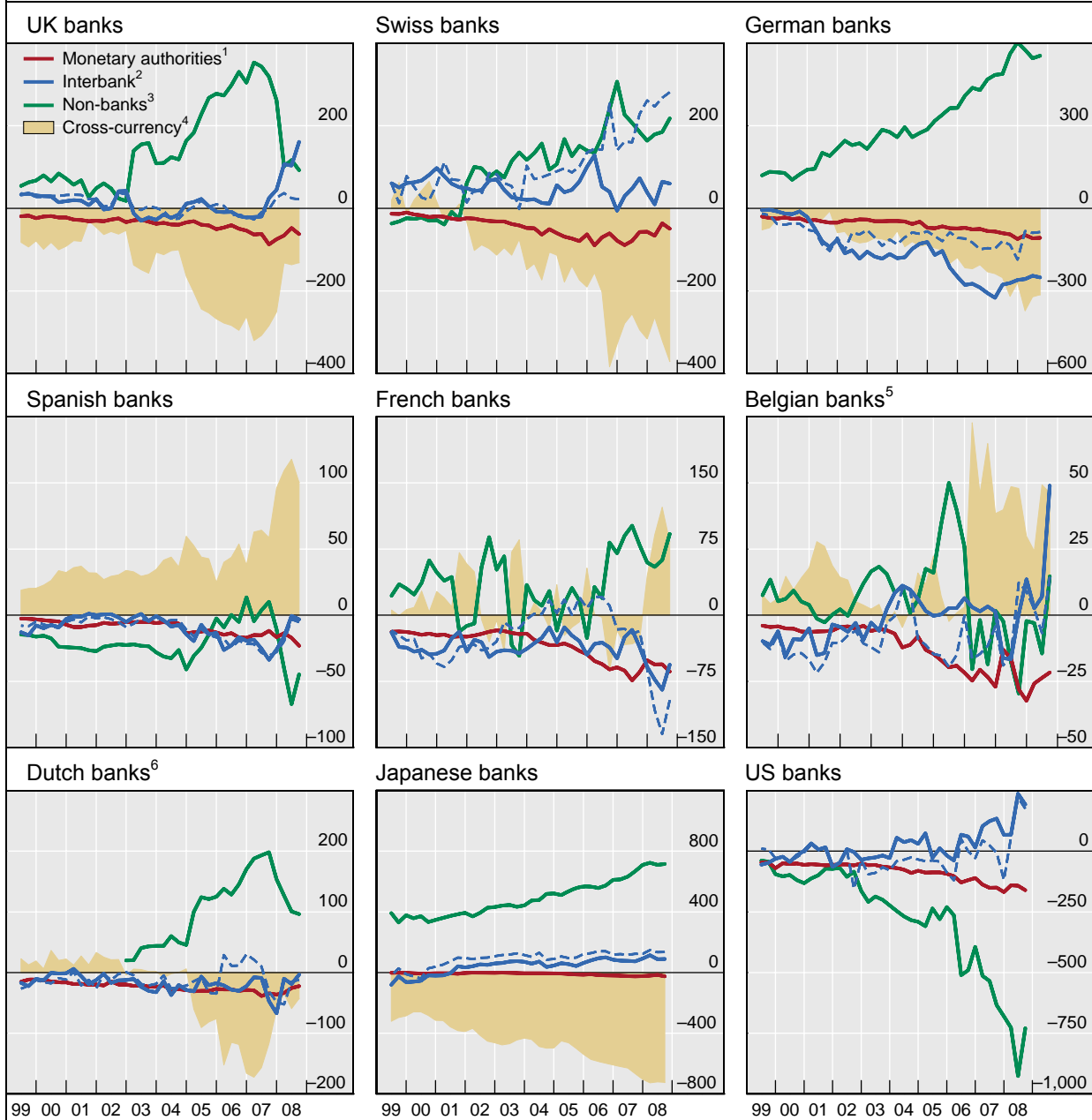
¹¹ The blue lines in Graphs 4 and 5 depicting net interbank lending to other (unaffiliated) banks should be interpreted with caution, due to incomplete reporting of inter-office positions (see box). This problem is particularly acute for Swiss banks.

¹² If we assume that European banks' estimated liabilities to money market funds (roughly \$1 trillion; see Baba et al in this issue) are also short-term liabilities, then the estimate would be \$2.1–2.3 trillion. Were *all* liabilities to non-banks treated as short-term funding, the upper-bound estimate of their US dollar funding gap would be roughly \$6.5 trillion (Graph 5, top right-hand panel).

¹³ In the BIS locational banking statistics, several countries (eg Germany, Japan and the United States) do not report liabilities (in foreign currency) vis-à-vis *domestic* official monetary authorities, which makes it difficult to identify precisely total liabilities to these counterparties. For example, data on foreign exchange reserve holdings reported to the IMF indicate that Japanese monetary authorities held roughly \$118 billion in banks *located in* Japan in mid-2007 (\$26 billion in Japanese banks and \$92 billion in foreign banks in Japan). To the extent that these reserves are US dollar-denominated, the red lines in Graph 4 understate liabilities to official monetary authorities for all those banking systems which have offices in Japan, and which receive deposits from Japanese monetary authorities.

Net US dollar-denominated foreign positions, by counterparty sector

In billions of US dollars

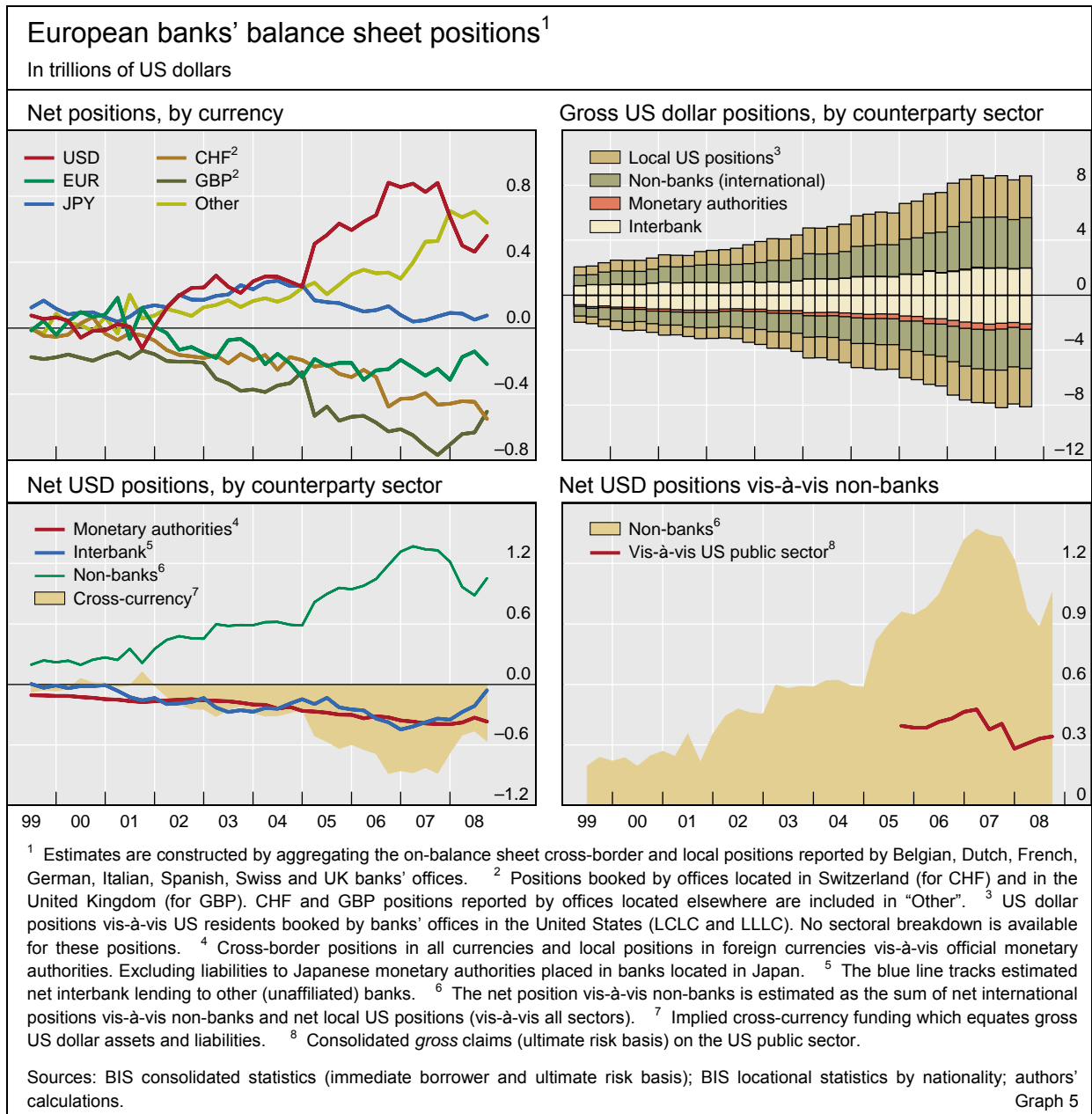


¹ Cross-border positions in all currencies and local positions in foreign currencies vis-à-vis official monetary authorities. Excluding liabilities to Japanese monetary authorities placed in banks located in Japan. ² The solid blue line tracks net interbank lending to other (unaffiliated) banks. The dashed blue line is an alternative measure of interbank positions which makes use of the available information on inter-office positions (see box). ³ The estimated net position vis-à-vis non-banks is the sum of net international claims on non-banks and net local claims on US residents (vis-à-vis all sectors) booked by the US offices of the reporting bank. See footnote 9 in main text. ⁴ Implied cross-currency funding (ie FX swaps) which equates gross US dollar assets and liabilities. ⁵ Prior to Q4 2005, local liabilities in local currency (LLC) vis-à-vis some large European countries are estimated. ⁶ Local positions (LCLC and LLC) vis-à-vis advanced economies are available from Q4 2002. The contraction in positions in Q3 2008 in part reflects the sale of some business units of ABN AMRO.

Sources: BIS consolidated statistics (immediate borrower basis); BIS locational statistics by nationality; authors' calculations. Graph 4

systems, were skewed towards holdings of US government securities.¹⁴ Japanese banks financed these holdings primarily by borrowing in yen from Japanese residents, although incomplete reporting of liabilities to official monetary authorities makes it difficult to pin these figures down precisely (see footnote 13).

In contrast to Japanese banks, the data show that US banks borrowed roughly \$800 billion internationally by end-2007, and channelled these funds to US residents (as implied by the shaded area in Graph 3). A closer look at the



¹⁴ The BIS consolidated banking statistics (ultimate risk basis) show that Japanese banks' foreign claims on the public sector reached \$627 billion at end-2007, or 29% of their foreign claims. Their claims on the US public sector totalled \$218 billion, or 26% of their foreign claims on the United States. These public sector shares are higher than for any other banking system.

underlying data suggests that a large portion of their international liabilities to non-banks were booked by their offices in Caribbean offshore centres as liabilities to non-bank counterparties *located in* the United States (eg firms or money market mutual funds). This could be regarded as an extension of US banks' domestic activity since it does not reflect (direct) funding from non-banks outside the United States. Netting these positions would imply that their US dollar net borrowing from non-banks in the rest of the world is smaller than the green line in Graph 4 suggests (roughly \$500 billion at end-2007).

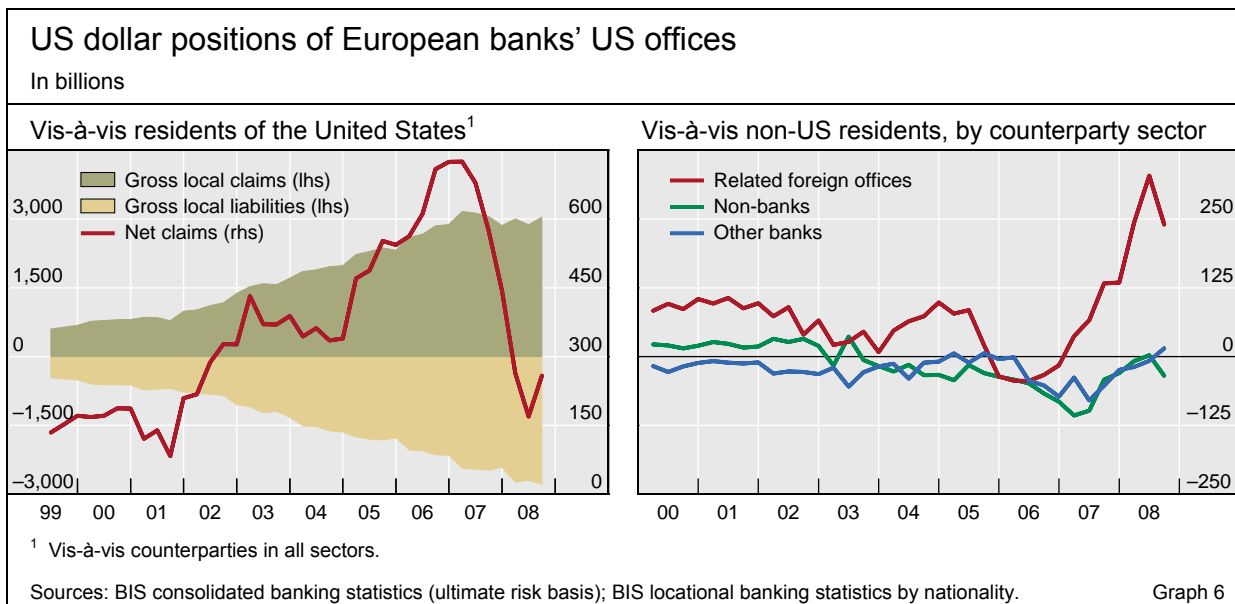
The shortage of US dollars

Sources of short-term funding ...

The implied maturity transformation in Graph 5 (bottom left-hand panel) became unsustainable as the major sources of short-term funding turned out to be less stable than expected. The disruptions in the interbank market since August 2007 compromised one source of short-term funding, visible in the rise of the blue line in the panel. The related dislocations in FX swap markets made it even more expensive to obtain US dollars via currency swaps (Baba and Packer (2008)), as US dollar funding requirements exceeded similar funding needs in other currencies.

... became unstable during the crisis ...

European banks' funding pressures were compounded by instability in the *non-bank* sources of funds on which they had come to rely. Dollar money market funds, facing large redemptions following the failure of Lehman Brothers, withdrew from bank-issued paper, threatening a wholesale run on banks (see Baba et al in this issue). Less abruptly, a portion of the US dollar foreign exchange reserves that central banks had placed with commercial banks was withdrawn during the course of the crisis.¹⁵ In particular, some



¹⁵ Data compiled from the 63 monetary authorities which report details on their foreign exchange holdings to the IMF indicate that central bank deposits with commercial banks dropped by \$257 billion between mid-2007 and end-2008. This is reflected in the BIS banking statistics, as liabilities to monetary authorities worldwide declined up to the second quarter of 2008. See the Highlights section in the December 2008 *BIS Quarterly Review* for discussion.

monetary authorities in emerging markets reportedly withdrew placements in support of their own banking systems in need of US dollars.

Market conditions made it difficult for banks to respond to these funding pressures by reducing their US dollar assets. While European banks held a sizeable share of their net US dollar investments as (liquid) US government securities (Graph 5, bottom right-hand panel), other claims on non-bank entities – such as structured finance products – were harder to sell into illiquid markets without realising large losses.¹⁶ Other factors also hampered deleveraging of US dollar assets: prearranged credit commitments were drawn, and banks brought off-balance sheet vehicles back onto their balance sheets.¹⁷ Indeed, as shown in Graph 5 (top right-hand panel), the estimated outstanding stock of European banks' US dollar claims actually rose slightly (by \$235 billion or 3%) between Q2 2007 and Q3 2008.¹⁸

The frequency of rollovers required to support European banks' US dollar investments in non-banks thus became difficult to maintain as suppliers of funds withdrew from the market. The effective holding period of assets lengthened just as the maturity of funding shortened. This endogenous rise in maturity mismatch, difficult to hedge *ex ante*, generated the US dollar shortage.

... leading to a dollar shortage

Banks reacted to this shortage in various ways, supported by actions taken by central banks to alleviate the funding pressures. Since the onset of the crisis, European banks' net US dollar claims on non-banks have declined by more than 30% (Graph 5, bottom left-hand panel). This was primarily driven by greater US dollar *liabilities* booked by European banks' US offices, which include their borrowing from the Federal Reserve lending facilities.^{19, 20} Their local liabilities grew by \$329 billion (13%) between Q2 2007 and Q3 2008, while their local assets remained largely unchanged (Graph 6, left-hand panel). This allowed European banks to channel funds out of the United States via inter-office transfers (right-hand panel), presumably to allow their head offices to replace US dollar funding previously obtained from other sources.²¹

In a coordinated policy response, central banks also put in place measures to provide US dollars to banks outside the United States. The

Central banks' swap lines provided support

¹⁶ Banks may also have held on to their US Treasury securities, a safe haven and a source of (repo) funding during the crisis (Hördahl and King (2008)).

¹⁷ Off-balance sheet (unused) credit commitments reported by European banks declined by \$233 billion (6%) between mid-2007 and Q3 2008, primarily vis-à-vis US entities (down 21%).

¹⁸ This is despite European banks' disclosed credit losses, which totalled \$257 billion at end-September 2008, and reached \$283 billion by end-2008 (data from Bloomberg).

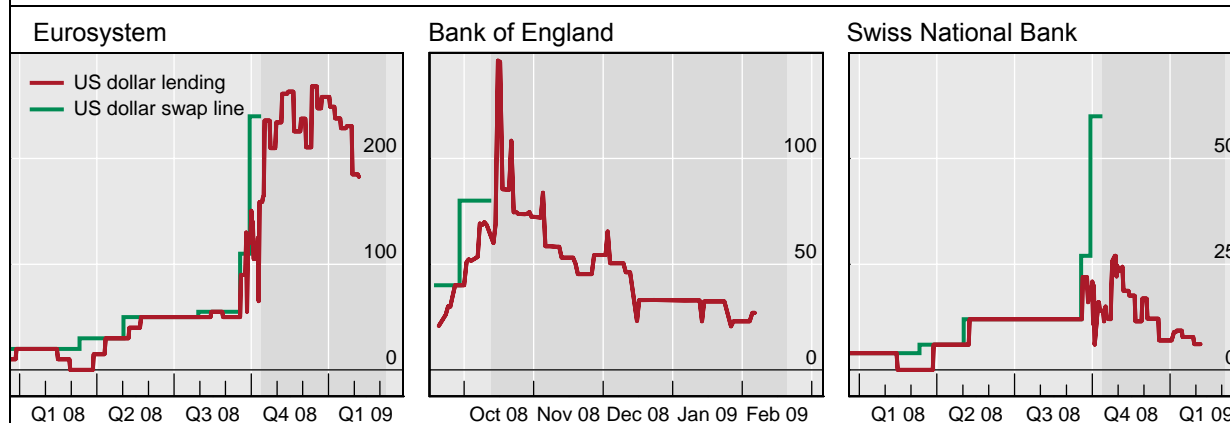
¹⁹ European banks, through their US offices, can borrow against collateral from the Federal Reserve facilities available to depository institutions. A number of European banks have access to additional facilities in their capacity as primary dealers.

²⁰ The borrowing of US dollars by European banks' US offices from the Federal Reserve is captured in these banks' local liabilities in local currency (LLLC) vis-à-vis the United States. It is not captured in their international liabilities to official monetary authorities (as in Graphs 4 and 5) since there is no cross-border transaction.

²¹ Cetorelli and Goldberg (2008) find evidence that US banks often rely on internal markets, ie borrow from foreign affiliates, to smooth liquidity shortages.

Central banks' US dollar swap lines¹

In billions



¹ Amounts outstanding are constructed by cumulating auction allotments, taking into account the term to maturity. The shaded area indicates the period of unlimited swap lines (as of 13 October 2008).

Source: Central banks.

Graph 7

Federal Reserve's reciprocal currency arrangements (swap lines) with other, notably European, central banks enabled the latter to channel US dollars to banks in their respective jurisdictions.²² The quantities of US dollars actually allotted (Graph 7) may provide an indication of European banks' US dollar funding shortfall at any point in time. Following the scramble for US dollars, the Federal Reserve's swap lines with the ECB, the Bank of England and the Swiss National Bank became unlimited in October to accommodate any quantity of US dollar borrowing (against collateral).

Concluding remarks

The crisis has shown how unstable banks' sources of funding can become. Yet the globalisation of banks over the past decade and the increasing complexity of their balance sheets have made it harder to construct measures of funding vulnerabilities that take into account currency and maturity mismatches. This special feature has shown how the BIS banking statistics can be combined to provide measures of banks' funding positions on a consolidated balance sheet basis. The analysis suggests that many European banking systems built up long US dollar positions vis-à-vis non-banks and funded them by interbank borrowing and via FX swaps, exposing them to funding risk. When heightened credit risk concerns crippled these sources of short-term funding, the chronic US dollar funding needs became acute. The resulting stresses on banks' balance sheets have persisted, resulting in tighter credit standards and reduced lending as banks struggle to repair their balance sheets.

²² The provision of US dollars via these swap lines will be captured in international liabilities to official monetary authorities in the BIS locational banking statistics by nationality. These liabilities increased noticeably in the third quarter of 2008, after significant declines in the first half of 2008 (see the Highlights section in this review).

References

Baba, N and F Packer (2008): “Interpreting deviations from covered interest parity during the financial market turmoil of 2007–08”, *BIS Working Papers*, no 267.

Baba, N, R McCauley and S Ramaswamy (2009): “Dollar money market funds and non-US banks”, *BIS Quarterly Review*, March.

Cetorelli, N and L Goldberg (2008): “Banking globalisation, monetary transmission, and the bank lending channel”, *NBER Working Paper* no 14101.

Hördahl, P and M King (2008): “Developments in repo markets during the financial turmoil”, *BIS Quarterly Review*, December.

Lane, P and J Shambaugh (2008): “The long or short of it: determinants of foreign currency exposure in external balance sheets”, *CEPR Discussion Paper*, no 6887.

Stigum, M and A Crescenzi (2007): *Stigum’s Money Market*, fourth edition, New York: McGraw Hill.

Reconstructing banks' global balance sheets

The analysis in this special feature requires estimates of banks' consolidated asset and liability positions broken down by currency and counterparty sector. This box describes how we construct these estimates, and highlights known data limitations.

The BIS banking statistics

Table A shows the relevant balance sheet components (first column) and how the required breakdowns are captured in the BIS international banking statistics. The underlying data are taken from the *BIS locational banking statistics by nationality* (LBSN) and the *BIS consolidated banking statistics on an immediate borrower basis* (CBS). The CBS are organised on the principle of bank *nationality*. They provide reporting banks' worldwide consolidated foreign claims (FC), which comprise cross-border claims (XBC) and local claims (LC), ie positions booked by banks' foreign offices vis-à-vis residents of the host country. Local claims are denominated in either "local currencies" (LCLC), ie the domestic currency of the host country, or in foreign currencies (LCFC). The statistics record cross-border claims and local claims in foreign currencies as a joint item called international claims ($INTC = XBC + LCFC$). These claims can be broken down by the country of residence of the counterparty. Therefore, banking system b 's foreign claims on borrowers in country c are

$$FC_{bc} = LCLC_{bc} + INTC_{bc} \Rightarrow FC_b = \sum_c FC_{bc}.$$

While the counterparty sector (bank, non-bank private sector and public sector) is known for international claims, there is no currency breakdown for these positions nor information about the location of the booking office. Moreover, the CBS data contain no information on *international liabilities* (INTL). In contrast to international positions, both the currency and the location of the booking office are known for LCLC by definition. In addition, banks report their locally booked liabilities in local currencies (LLLC).

In contrast to the CBS data, the LBSN are collected on the principle of bank *residence*. The "reporting unit" in the LBSN is any bank office (head office, branch or subsidiary) in a particular country or jurisdiction – including major offshore financial centres. Each bank office reports its cross-border (XB) claims *and* liabilities, as well as foreign currency claims and liabilities vis-à-vis residents of that country. Importantly, these positions are broken down by *bank nationality* (ie the parent country of the booking office), as well as by *currency* and counterparty sector.⁹ For instance, $XBC_{rb}^{\$}$ represents US dollar cross-border claims booked in reporting country r by banks headquartered in parent country b . The LBSN, unlike the CBS, do not record the residency of the counterparty, nor the local claims and liabilities (ie vis-à-vis residents) in the domestic currency of the reporting country (LCLC and LLLC).

Construction of the dataset

The two sets of statistics contain *complementary* information on banks' global balance sheets. We merge these statistics to construct the required balance sheet components as shown in Table A. The key step is to aggregate the LBSN data across the 40 reporting countries to obtain total international claims *and international liabilities* for each bank nationality (ie banking system), along with the currency and sector breakdowns that are unavailable in the CBS.

Consider, for example, UK-headquartered banks. Summing across all reporting countries (indexed by r) in the LBSN where UK banks have offices gives UK banks' international claims and liabilities on a global consolidated basis, or

$$INTC_b = \sum_r (XBC_{rb} + LCFC_{rb}).$$

This aggregate compares to INTC in the CBS, but now comes with detailed breakdowns by currency and counterparty sector. To match worldwide consolidated foreign claims (FC from the CBS), the only missing balance sheet components are UK banks' local claims and liabilities in the domestic currencies of various host countries (LCLC and LLLC). This information is available in the CBS reported by the United Kingdom. After merging, the only *remaining* missing component in UK banks' global balance sheets is their "strictly domestic" business, ie their claims and liabilities

vis-à-vis UK residents in pounds sterling (DCLC and DLLC in Table A). While their gross domestic positions in pounds are unknown, their *net* position (DCLC – DLLC) can be inferred as a residual from the balance sheet identity (Table A).

A breakdown of banks' consolidated worldwide positions

Balance sheet positions		Data availability				
		Totals	Breakdowns by			
			Booking office location	Residence of counterparty	Sector of counterparty	Currency of positions
ASSETS	Domestic claims (DC) ¹ in foreign currency (DCFC) in local currency (DCLC)	LBSN	LBSN	LBSN	LBSN	LBSN
	Foreign claims (FC)	CBS		CBS		
	Cross-border claims (XBC)	LBSN	LBSN		LBSN	LBSN
	<i>International claims (INTC)</i> ²	CBS LBSN	LBSN	CBS	CBS LBSN	LBSN
	Local claims (LC) ³ in foreign currency (LCFC)	LBSN	LBSN	LBSN	LBSN	LBSN
	in local currency (LCLC)	CBS	CBS	CBS		CBS
LIABILITIES	Domestic liabilities (DL) ¹ in foreign currency (DLFC) in local currency (DLLC)	LBSN	LBSN	LBSN	LBSN	LBSN
	Foreign liabilities (FL)					
	Cross-border liabilities (XBL)	LBSN	LBSN		LBSN	LBSN
	<i>International liabilities (INTL)</i> ²	LBSN	LBSN		LBSN	LBSN
	Local liabilities (LL) ³ in foreign currency (LLFC)	LBSN	LBSN	LBSN	LBSN	LBSN
	in local currency (LLLC)	CBS	CBS	CBS		CBS

CBS = consolidated banking statistics on an immediate borrower basis; LBSN = locational banking statistics by nationality.

¹ Domestic claims (liabilities) in the home country. ² International claims INTC ≡ XBC + LCFC, and international liabilities INTL ≡ XBL + LLFC. ³ Local positions booked by banks' foreign offices *outside* the home country. Table A

The combined dataset thus yields foreign claims and liabilities for 19 banking systems on a worldwide consolidated basis, as well as their cross-border and local components, all broken down by both currency and sector. (Only local positions in local currencies are not broken down by sector.) From these, we calculate *net balance sheet positions* (assets minus liabilities) by currency and sector for each banking system, as described in the text.

Consistency check and data limitations

In principle, the summation of $INTC_b$ across reporting countries (in LBSN) plus the LCLC positions anywhere (in CBS), should correspond to total foreign claims reported in the CBS. That is,

$$\sum_r (XBC_{rb} + LCFC_{rb}) + \sum_c LCLC_{bc} = FC_b.$$

This serves as a consistency check across the two datasets for the asset side of the balance sheet. There is no corresponding check on the liability side since banks do not report foreign liabilities in the CBS.

In practice, some statistical discrepancies arise because the two sets of statistics are collected in fundamentally different ways. For many banking systems (Belgian, Canadian, Dutch, French, German, Italian, Spanish and UK banks) the match is fairly close. The match is not as satisfactory for Swiss and US banks. Discrepancies arise for three main reasons. First, the set of reporting banks in the CBS differs from that reporting LBSN in various reporting countries.²⁰ Second, some banking

in the CBS differs from that reporting LBSN in various reporting countries.^① Second, some banking systems have offices in countries that do not report in the LBSN, yet those offices are included in the worldwide consolidated positions reported in the CBS. In addition, some countries report incomplete positions in the LBSN; the United States, for example, does not report foreign currency positions vis-à-vis US residents.

Third, and most problematic for the analysis, the breakdowns by sector and currency in the LBSN are incomplete. For each banking system b , total interbank claims (IBC) in a particular currency are the sum of claims on other (unaffiliated) banks ($OTHBC$) and inter-office claims (IOC). That is,

$$IBC_b = \sum_r IBC_{rb} = \sum_r (OTHBC_{rb} + IOC_{rb}),$$

with a corresponding equation for interbank liabilities. The inter-office asset and liability positions must be stripped out of total foreign claims in order to make the LBSN and CBS data comparable on a gross basis, as in Graphs 2 and 5. Some LBSN-reporting countries, however, do not provide a complete currency breakdown (eg Singapore, Hong Kong SAR and the Channel Islands), while others provide only limited currency information for inter-office positions (eg France, Germany, Italy and Japan split inter-office activity into domestic and foreign currencies). To the extent possible, we estimate the missing inter-office components, although there is still considerable uncertainty in the overall interbank positions for some banking systems. This makes it difficult to pin down the extent of reliance on interbank financing, as shown by the two alternative estimates presented in Graph 4. On a *net* basis (claims minus liabilities), inter-office positions should, in principle, sum to zero across all reporting office locations. This implies that net “interbank” claims ($IBC - IBL$) should equal net claims on “other banks”, both of which are observable in the data.

$$\sum_r (IOC_{rb} - IOL_{rb}) = 0 \Rightarrow \sum_r (IBC_{rb} - IBL_{rb}) = \sum_r (OTHBC_{rb} - OTHBL_{rb})$$

The solid blue line in Graph 4 tracks $\sum_r (IBC_{rb} - IBL_{rb})$, or net interbank positions calculated without stripping out inter-office positions, while the dashed blue line tracks $\sum_r (OTHBC_{rb} - OTHBL_{rb})$, or the reported positions vis-à-vis unaffiliated banks only. Which estimate is more accurate depends on the relative sizes of observed versus missing inter-office positions, and whether banks have offices with (unobserved) offsetting positions in non-reporting countries.

① The sectoral breakdown distinguishes positions vis-à-vis non-banks, vis-à-vis official monetary authorities and vis-à-vis banks. The interbank positions are further divided into inter-office positions (within the same bank group) and positions vis-à-vis other (unaffiliated) banks. ② This is problematic in the case of US banks, since the major US investment banks are generally included in the LBSN (reported by all countries), but not in the CBS reported by the United States.