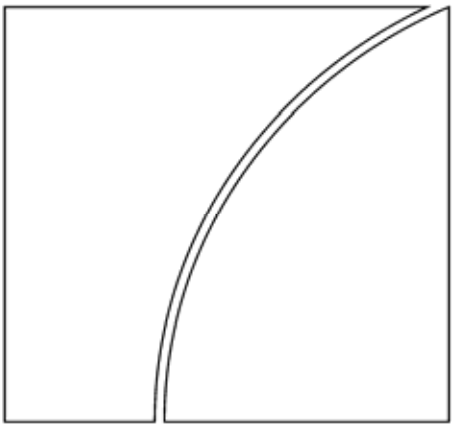
Committee on the Global Financial System



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No 29

Research on global financial stability: the use of BIS international financial statistics

Proceedings of a CGFS workshop held at the BIS in December 2006, chaired by Aviram Levy of the Bank of Italy

December 2007

BANK FOR INTERNATIONAL SETTLEMENTS

This volume contains papers presented at a CGFS workshop on “Research on global financial stability: the use of BIS international financial statistics” held at the BIS in December 2006. These papers are to be considered as working papers and are reproduced here to make them easily available to anyone having an interest in the workshop. The views expressed in this volume are those of the authors and do not necessarily reflect the views of the BIS or the institutions represented at the workshop. Authors retain the copyright for their individual papers.

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Foreword

BIS statistics on international bank lending, collected by central banks under the auspices of the Euro-currency Standing Committee at the BIS since the late 1970s, have long been used to monitor risk exposures in the international financial system. For instance, these statistics provided clear and timely warnings about the scale and nature of external bank debt accumulation before almost all the crises to hit the emerging markets from the early 1980s. As international financial intermediation has evolved over the years, the scope of these statistics has been gradually broadened beyond bank lending to cover debt securities, syndicated credit facilities, and derivatives.

These statistics are being used increasingly in economic research on questions related to global financial stability. However, it had been clear to us for some time that different researchers using these statistics were not always aware of each other's work. The BIS's Committee on the Global Financial System (the successor to the Euro-currency Standing Committee) therefore decided to sponsor a workshop of research based on the BIS international financial statistics. The work reported here represents the views of the authors, and not of course official views of the CGFS. I am very grateful to Aviram Levy of the Bank of Italy for taking the lead in organising this workshop, and I hope this publication encourages the greater use of these data in research.

Donald L Kohn
Chairman
Committee on the Global Financial System

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Introduction

Aviram Levy*

In December 2006 the CGFS held a workshop in Basel on the use of the BIS international financial statistics in research on global financial stability.

These statistics are one of the few sources of detailed information on stocks and flows, and on the currency denomination and maturity structure of cross-border banking assets and liabilities, on both a locational and a nationality basis.

The origins of the BIS international banking statistics go back to the mid-1960s and the emergence of the so-called eurocurrency markets that had sprung up to circumvent domestic regulations. To monitor the rapid growth of these markets, the central banks of the G10 countries and the BIS started to collect data on banks' international positions in major countries. These data provided invaluable information about the expansion of international bank lending aggregates and about the scale of individual country borrowing from international banks. Alexandre Lamfalussy has described just how useful these data were in providing early warnings (often ignored) of crisis from the late 1970s onwards.[1]

Since then, the coverage of the international banking statistics has been broadened to include a wider range of activity. As a result of the increasing role of the international securities markets in global financial intermediation, the BIS was mandated in the mid-1980s to collect and publish international debt securities statistics on the basis of data from commercial databases and information available to individual central banks. Currently, aggregated international debt securities statistics are available by country of residence and nationality of issuer, and broken down by currency and type of issue. The BIS also started to collect domestic debt securities statistics in the early 1990s.

A third group of financial statistics which is collected and published by the BIS is data on derivatives. Data on OTC derivatives have been available, based on an ad hoc semiannual survey, since 1998; in 2004 they were supplemented with data on credit default swaps. Data for exchange-traded derivatives, which are provided by the exchanges, are also published by the BIS, with a longer time series.

In the past, the BIS financial statistics have been used by the financial community and in academic circles for a variety of applications. One major use of the data is the calculation of country risk and related indicators (eg banking sector vulnerability), which is routinely performed by both the official sector (central banks, banking supervisors, government agencies) and the private sector (inter alia rating agencies, investment banks, institutional investors).

Apart from country surveillance, the BIS banking and debt securities statistics have also been increasingly used by researchers in central banks and the academic community to investigate broader developments in the international banking market. Initially, the academic literature that emerged in the 1970s focused on the implications of the expanding eurodollar market for monetary aggregates and the transmission of monetary policy. In the 1980s and 1990s, the scope of analytical work broadened to include the determinants and patterns of cross-border banking flows, with a view to ascertaining the strategies adopted by banks in

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* Chairman of the workshop and Bank of Italy.

1 See especially pp 9–13 of Lamfalussy (2000).

industrialised countries to penetrate emerging markets. After the Asian crisis of the late 1990s a number of studies used the BIS database for assessing global financial stability, for instance by analysing the role played by banking systems in financial contagion.

The main motivation for the workshop was to provide a forum for researchers from the "demand side", so to speak, allowing them to learn about new areas of research which make use of these statistics, in particular on issues related to financial stability.

After a call for papers, eight presentations were ultimately selected. Speakers and participants included representatives from academia, central banks and the BIS.

The workshop concluded with a discussion of how to sustain the momentum provided by the meeting. Most participants indicated that regular meetings, for example every 18 months to two years, would be useful for sharing ideas on market monitoring and the construction of better capital flow measures.

Since the BIS statistics are rather broad and research topics have become quite diverse, some participants suggested that future meetings should concentrate on particular themes, in order to make the discussion more focused and enhance the exchange of ideas.

Reference

Lamfalussy, A (2000). *Financial crises in emerging markets: an essay on financial globalisation and fragility*, Yale University Press, New Haven.

What can BIS statistics tell us about the risks of crises in emerging markets?

Ramon Moreno and Karsten von Kleist*

Abstract

We discuss how creditor- and market-sourced BIS banking and securities statistics improve stability analysis by providing globally standardised financial data not readily available elsewhere. BIS data help to systematically quantify risk exposures that develop from financing positions, including low external liquidity, currency mismatches or common creditor linkages.

1. Introduction

Initiatives to compile (BIS) data originate in the Committee on the Global Financial System (CGFS) or Markets Committee, when senior central bank representatives consider that new data need to be collected. These compilation initiatives have provided data important to analysing financial stability concepts not available elsewhere.

Two main sets of BIS statistics that are particularly relevant to emerging markets are reviewed in this note.[1] The first set, the banking statistics, is obtained from a group of BIS reporting countries. These statistics are aggregated from banks' balance sheets, so, unlike traditional flow data, they enable analysts to measure the impact of valuation changes on outstanding stocks. Other statistical initiatives, such as the compilation of international investment position (IIP) data, which complement traditional balance of payments (BoP) data, seem to validate the BIS approach.[2]

The second set of statistics pertains to international debt securities. In response to the shift from bank finance to bond finance in the aftermath of the international banking crisis of 1982, the CGFS suggested that the BIS compile a database of individual international securities that can be analysed in at least 12 dimensions. Experience with this database has informed more recent securities databases, such as at the European Central Bank (ECB). In particular, the information from this BIS database has helped in building and checking the new Centralised Securities Database (CSDB) at the ECB, which is intended to provide better quality data on issues (and later holdings) of securities in the Euro area.

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* Bank for International Settlements. The views expressed in this paper are those of the authors and do not necessarily reflect the official position of the BIS. We would like to thank Philip Turner for useful comments, Michael Chui for contributing to the analysis of common lender effects, and San Sau Fung and Pablo Garcia-Luna for research assistance.

1 The BIS triennial survey on foreign exchange and derivatives turnover and amounts outstanding also provides data relevant to financial stability in emerging markets.

2 For example, see Lane and Milesi-Ferretti (2006). At the IMF, in line with the increased emphasis on key balance sheet risks and financial vulnerabilities, recent issues of the World Economic Outlook and Global Financial Stability Report, and other studies (eg Rosenberg et al (2005)) have applied balance sheet analysis.

Some ways in which these BIS statistics have been used for financial stability analysis are summarised below.

2. Uses of BIS statistics for financial stability

2.1 Exposures of BIS reporting banks

BIS statistics reveal aspects of the exposures of BIS reporting banks and their debtors that are not available from other sources.

2.1.1 Measurement of external debt

BIS statistics provide an alternative reliable source of estimates of external debt to private creditors based on data provided by market and creditor sources, as opposed to (official) debtor information. As a result, they have helped improve measurement of external debt. To illustrate, Figure 1, left-hand panel shows debtor data (in columns, based on data published in the World Bank's "Global Development Finance" (GDF) reports available up to 1998) and BIS data (stacked so that the line segments sum to the total) available around the time of the Asian crisis. They reveal that in 1997, Thailand's external debt to private creditors was estimated at $75 billion; in fact the BIS statistics suggest that it was at least 40% higher. Indeed, Thailand's external data were subsequently revised upward,[3] changing perceptions of Thailand's external debt vulnerability. Under the original estimates, the ratio of external debt to exports of goods and services in 1996 was 106%; under revised estimates it turned out to be considerably higher. The fact that BIS banking statistics have contributed to a much better understanding of external debt data is particularly noteworthy because not all countries report to the BIS, so BIS data normally will cover a substantial fraction, but not the totality of credit to a given country.[4] Apart from signalling higher debt, BIS data were more timely than publicly available external debt data.

New data collection mechanisms such as the IMF's Special Data Dissemination Standard (SDDS) statistics today provide more comprehensive and more timely data than in the past. Partly as a result, the coverage of GDF statistics has improved, providing a more complete picture of overall debt burdens (Figure 1, right-hand panel). But BIS statistics still offer an additional perspective.

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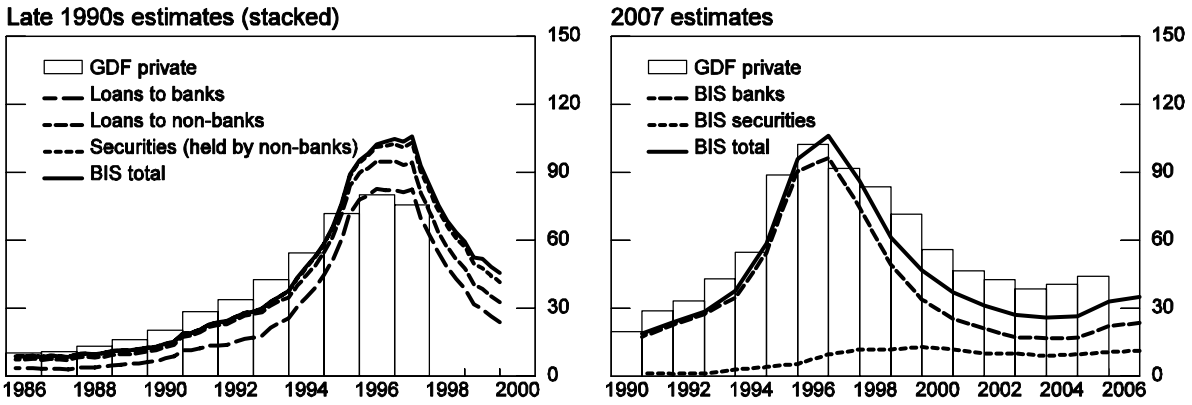
[3] The Bank of Thailand suggested a number of explanations for the substantial upward revision of external debt data based on a comprehensive survey. See Bank of Thailand Press Release no 78, 30 June 2000, http://www.bot.or.th/BOThomepage/General/PressReleasesAndSpeeches/PressReleases/News%202543/Eng/n7843e.htm.

[4] Comparisons between BIS creditor data and national external debt data are discussed in von Kleist (2002). The BIS statistics do not cover the following: (i) trade credit not extended by banks; (ii) loans from banks not included in the reporting for BIS statistics; (iii) any other non-bank private sector loans; (iv) some private placement bonds.

Figure 1
Thailand's external debt to private creditors

In billions of US dollars



Sources: World Bank GDF, BIS locational banking and securities data.

2.1.2 Lending to banks and non-banks

BIS statistics break down cross-border bank credit according to whether the recipient is a bank or non-bank. This can be of use for a number of reasons. First, the data on external borrowing of non-banks are sometimes of poor quality; BIS data offer an independent perspective on this. A case in point is credit extended to the Indonesian corporate sector prior to the Asian crisis. Because a lot of these transactions occurred offshore, the data available from debtor sources were incomplete; indeed market commentary well before the Asian crisis of 1997 expressed concerns about the quality of this kind of data (see Union Bank of Switzerland (1995)). BIS information from creditors shows the importance of cross-border lending to non-banks in Indonesia (Figure 2, left-hand panel). The implications can also be seen by noting that according to BIS data, total cross-border bank lending to Indonesia totalled around $66 billion at its peak in Q3 1997. This was about $28 billion (74%) higher than the nearly $38 billion Indonesian publicly-guaranteed and non-guaranteed commercial bank debt outstanding estimated from debtor-reported data (see World Bank (1999)). Second, cross-border interbank lending can be associated with risks to financial stability as it is short term and directly affects liquidity in the financial system (for example, a sudden interruption could affect the ability of market participants to settle payments). An example is the experience of Thailand on the eve of the Asian crisis (Figure 2, right-hand panel). As can be seen, the rapid growth in total cross-border bank credit in BIS statistics was driven by interbank lending; cross-border loans to the corporate sector were relatively stable. Furthermore, the crisis was associated with a sharp reduction in cross-border interbank lending.

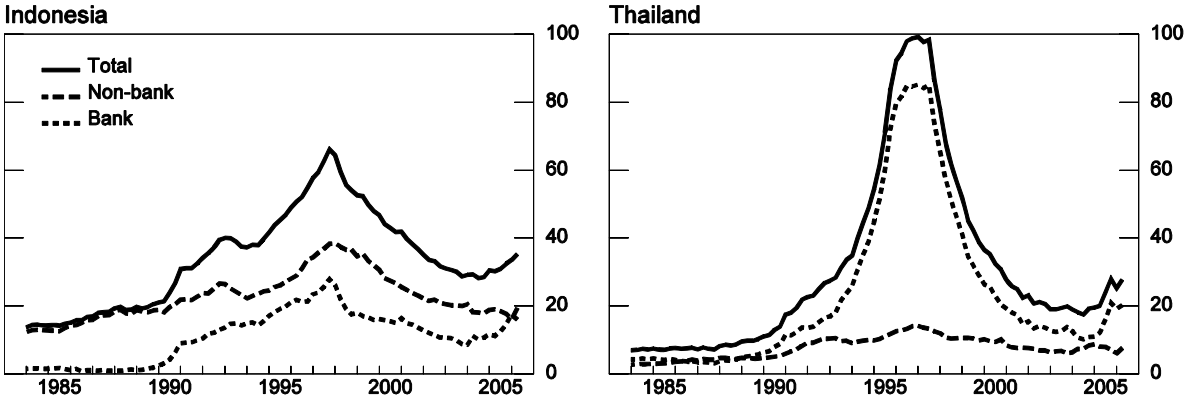
2.1.3 Cross-border to local shift

BIS consolidated statistics give information on cross-border bank lending and on local claims of BIS reporting banks, reflecting activity through branches and subsidiaries. The breakdown is useful in assessing overall exposure of BIS reporting banks and its characteristics. To illustrate, after the Asian crisis, the amount of cross border bank lending (as proxied for by BIS reporting banks' international claims) to emerging market economies fell sharply in Asia.[5] Such lending fell from $740 billion in 1995 to $488 billion in 2000, but has since

[5] The proxy is an approximation to pure cross-border lending in part because the BIS international claims include onshore claims in foreign currency by foreign bank branches or subsidiaries. These onshore claims would be small in countries that are not dollarised. While pure cross-border data are available from the locational statistics, the latter do not provide information on local claims.

exceeded its previous peak, to total $774 billion in 2006 (Table 1). Taken together with BIS statistics on local claims the data reveal two things. First, during the period when cross-border bank lending declined, there was a significant increase in local claims, that is, the reduction in reporting bank activity was not as severe as suggested by cross-border data alone, which are the focus of balance of payments statistics. Second, in spite of the recent rebound in cross-border lending, there has been a shift in favour of local claims since 1995. In 2006, in the Asia Pacific region the ratio of local claims to foreign claims was about 80%, down from a peak of 85% in 2003 but well above 24% in 1995. On balance, experience and some research suggest that foreign bank activity can be beneficial (CGFS (2005) and Moreno and Villar (2005)), so the increase in onshore foreign bank activity indicates that conditions under which emerging markets receive financing from BIS reporting banks may have improved since 1995. Financial stability is enhanced further to the extent that onshore banking involves credit in local rather than foreign currency, which could reduce currency mismatches (see Section 2.3.3 below).

Figure 2
Cross-border bank lending
In billions of US dollars



Source: BIS locational banking statistics.

2.2 Maturity structure of external debts and financing requirements

Apart from having good estimates of total external debt for crisis prevention, it is important to have estimates of its maturity structure. BIS statistics allow us to do this, and have the desirable characteristic of defining debt structure by remaining maturity.

These statistics have at least two applications. First, they can tell us what the proportion of short-term and long-term debt is as an indicator of possible vulnerability. As can be seen in Figure 3, prior to the Asian crisis of 1997, the share of short-term bank debt had become quite large in Thailand. It subsequently declined but has since risen again. There was also an increase in the share of short-term debt in Turkey prior to its November 2000–February 2001 crises.

Second, the statistics can allow us to estimate financing requirements. These are reported for Thailand and Turkey in Figure 4. It is apparent that financing requirements increased in the periods before crises. For example, in Thailand, financing requirements up to a one-year horizon rose sharply in the 1990s, from $9 billion in December 1990 to $48 billion in 1996, on the eve of the Asian crisis. For Turkey, the financing requirement rose from around $20 billion in 1999 to $27 billion in September 2000.

Table 1

Claims of BIS reporting banks

	International claims[1]			Local currency local claims			Local/International claims %		
	1995	**2000**	**2006**	**1995**	**2000**	**2006**	**1995**	**2000**	**2006**
China	48	58	127	0	3	21	1	6	16
India	16	22	66	8	17	42	54	76	64
Indonesia	45	40	38	4	5	14	8	11	37
South Korea	78	59	124	8	18	144	11	31	116
Malaysia	17	21	39	4	29	49	25	139	126
Philippines	8	17	22	1	5	5	17	32	25
Taiwan, China	23	18	39	10	16	41	44	90	105
Thailand	63	27	23	5	17	26	9	62	115
Asia	740	488	774	174	315	618	24	64	80
Argentina	38	69	17	4	23	14	10	34	81
Brazil	57	68	69	21	72	112	36	107	163
Chile	14	22	26	8	28	37	58	124	142
Colombia	11	12	8	1	5	9	8	46	112
Mexico	57	64	71	4	80	202	8	126	286
Peru	6	13	10	1	3	3	10	24	31
Venezuela	12	13	12	0	10	13	3	76	112
Latin America & Caribbean	212	285	249	44	231	397	21	81	160

[1] Cross-border claims in all currencies and local claims in non-local currency.

Source: BIS Consolidated banking statistics.

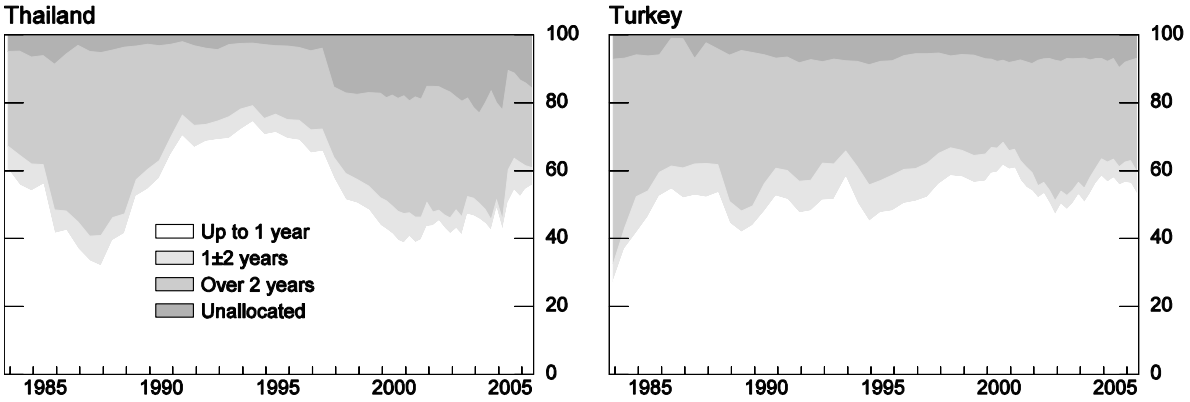
2.3 Quantifying risk exposures

2.3.1 Refinancing (ie liquidity) risk and reserves to short-term external debt

One reason a high share of short-term debt is a concern is because it poses “refinancing” risk; during periods of uncertainty creditors may be unwilling to provide additional financing because they do not know if there will be enough hard currency resources to service the debt (this was the problem faced by Korea in late 1997-early 1998). This can be addressed if enough foreign reserves are available to cover short-term debt obligations. A by now conventional rule of thumb, known as the Guidotti-Greenspan rule, is that foreign reserves should cover at least 100% of short-term external debt; about a year of external debt obligations. The Guidotti-Greenspan ratio was found to be a key vulnerability indicator in a recent early warning system model of financial crises (Bussiere and Fratzscher (2006)).

Figure 3
Share of debt at various maturities in total debt

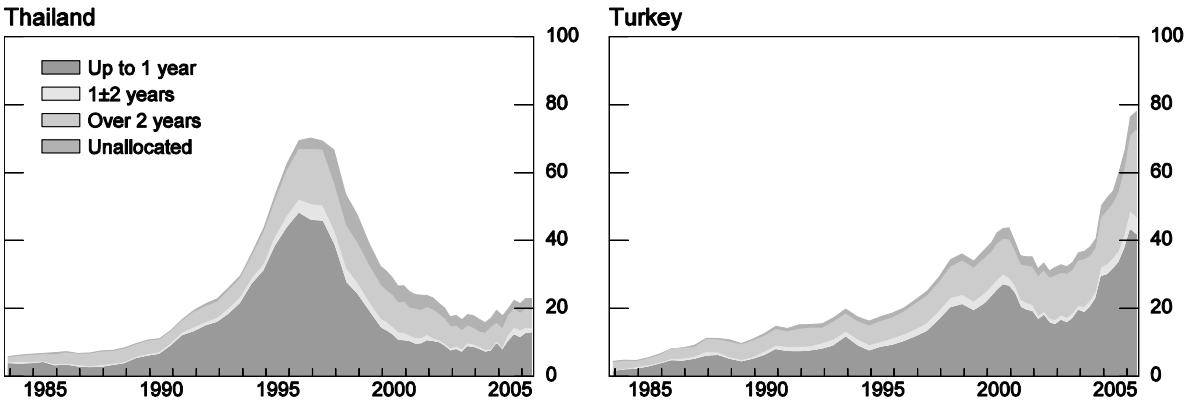
Scaled to total 100%



Source: BIS consolidated statistics, quarterly data as from December 1999.

Figure 4
Financing requirements

In billions of US dollars

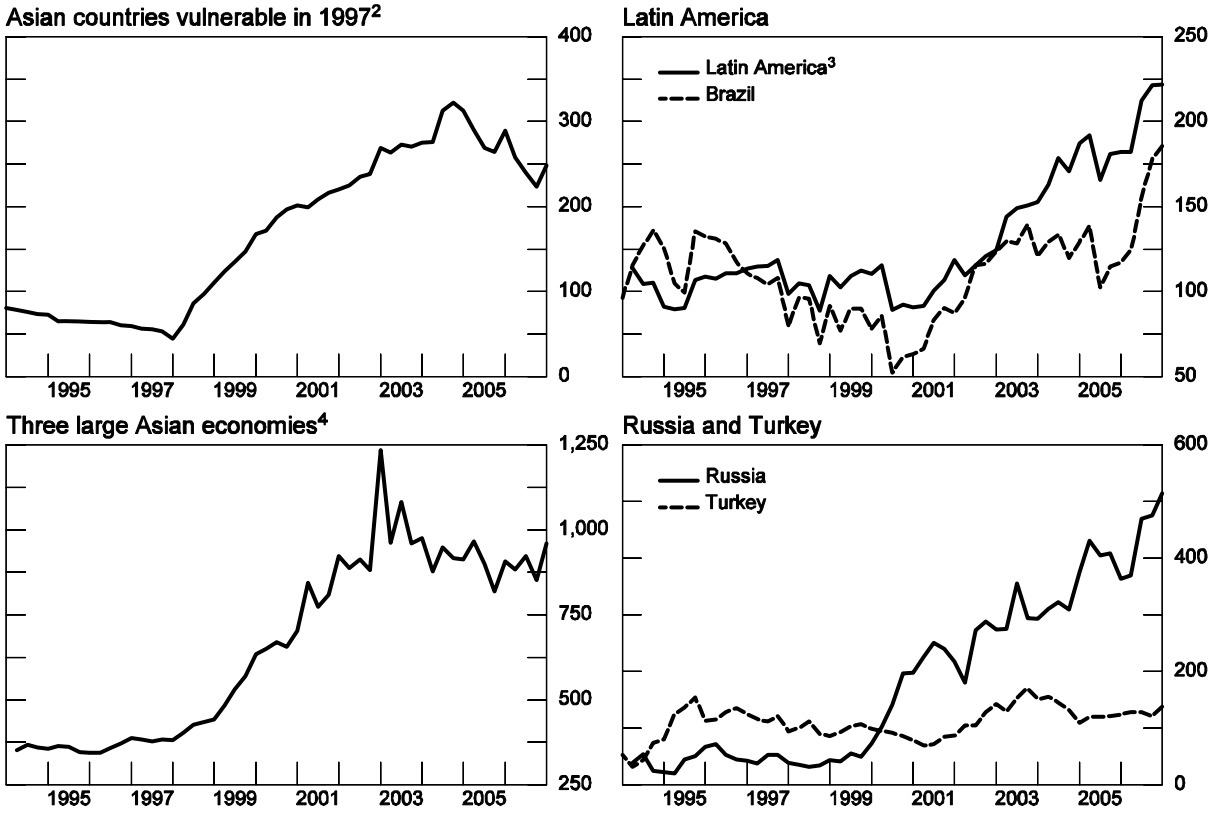


Source: BIS consolidated statistics, quarterly data as from December 1999.

The BIS statistics provide the only source of standard data on the remaining maturity of bank loans and international bond issues. In combination with IMF statistics on foreign reserves, they allow us to see how well countries or regions satisfy the Guidotti-Greenspan criterion. As can be seen in Figure 5, four countries hit by the Asian crisis failed to satisfy this criterion between 1994 and 1997. Latin America also fell below this benchmark around 2000, while Russia was below it until that year. The situation has changed considerably, foreign reserves now substantially exceed external debt in most emerging market economies. Turkey's foreign reserve cover has recently hovered near 100%.

Figure 5

Foreign exchange reserves as a percentage of short-term external debt[1]



[1] Short-term external debt defined as short-term liabilities to BIS reporting banks: consolidated cross-border claims to all BIS reporting banks on countries outside the reporting area with a maturity up to and including one year plus international debt securities outstanding with a maturity of up to one year. [2] Asian countries whose reserves were less than short-term external debt in 1997, ie Indonesia, Korea the Philippines and Thailand. [3] Brazil, Chile, Colombia, Mexico, Peru and Venezuela. [4] China, India and Taiwan (China).

Sources: IMF; national data; BIS.

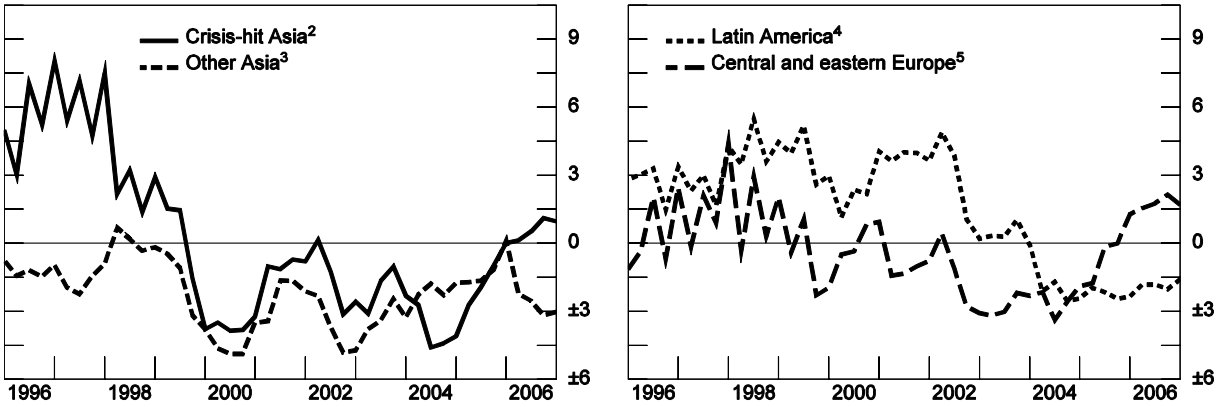
2.3.2 CGFS vulnerability indicators

The CGFS has selected a series of indicators to track potential vulnerabilities in emerging market economies, focusing on exchange market pressure, external sector vulnerability and banking sector vulnerability (see Hawkins and Klau (2000)). The external vulnerability index includes 3 indicators pertaining to external debt (international bond and bank debt as a percentage of GDP, level and percentage change over 2 years) and short-term debt as a percentage of foreign reserves, the ratio discussed under Section 2.3.1 above.[6] BIS data on liabilities to international banks and on international bonds outstanding are available more frequently, are more timely, and are more internationally comparable than data on other forms of external debt, at least for many countries which do not report SDDS data.

Moreover, changes in such positions can be important in year-to-year movements in the financial account of the balance of payments, and especially during episodes of financial stress (eg the Asian crisis). Figure 6 reveals recent trends in indices of external vulnerability, of which BIS data on external debt form a part.

[6] The other indicators are the real effective exchange rate, the current account balance and export growth.

Figure 6
External vulnerability indices[1]



[1] An increase in the index (expressed as a weighted average, based on 2000 GDP and PPP exchange rates of the economies in each group) implies an increase in risk. [2] Indonesia, Korea, Malaysia, the Philippines and Thailand. [3] China, Hong Kong SAR, India, Singapore and Taiwan (China). [4] Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela. [5] The Czech Republic, Hungary, Poland, Russia and Turkey.

Sources: IMF; national data; BIS calculations.

2.3.3 Currency mismatch

An important source of vulnerability in emerging markets is that some borrowers whose earnings are in local currency engage in unhedged foreign currency borrowing. The resulting currency mismatch implies that a sharp depreciation of the currency can raise the debt burden considerably. For example, around the time of the Asian crisis, the Indonesian corporate sector had borrowed heavily in foreign currency. When the rupiah crawling peg collapsed, many of these firms went bankrupt, weakening their creditors (domestic banks). Goldstein and Turner (2004) use BIS statistics to construct a measure for currency mismatches and to quantify a country's exposure to an exchange rate shock. One potential limitation is that a mismatch on the balance sheet can be identified but not the extent to which the position has been hedged. In spite of this, the information can be useful. The presence of large mismatches would highlight the need to see the extent to which hedging does in fact take place. In a number of cases (eg Indonesia in 1997), it was apparent that hedging was too costly and did not occur; many Indonesian firms that borrowed from abroad could not service their debts. Also, when a systemic crisis occurs, the financial position of the providers of hedges may also be impaired.[7] Large mismatches would point to the need to examine these issues with some care.

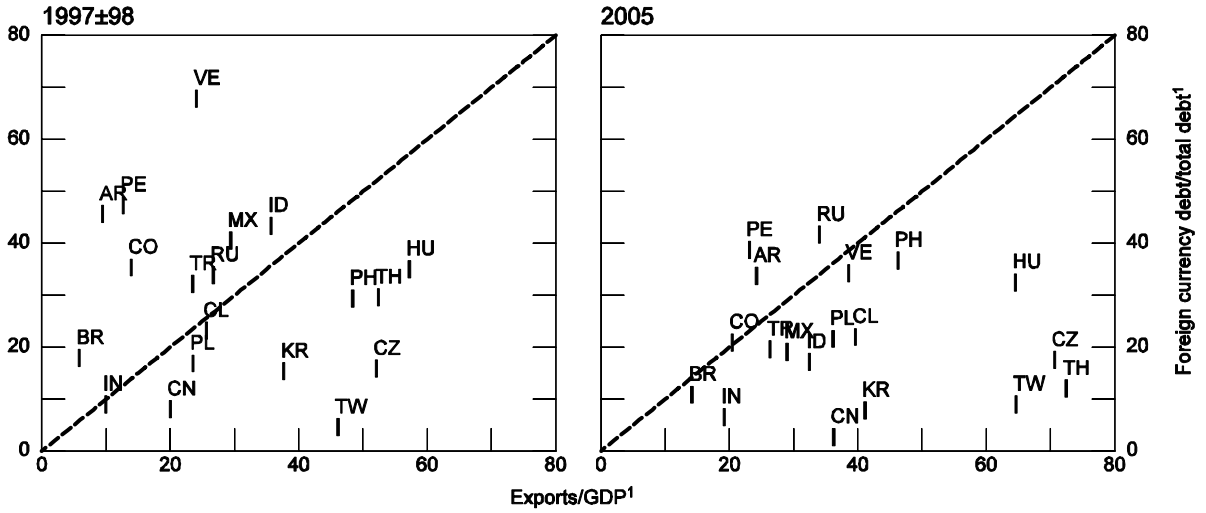
A key ratio is the ratio between the currency denomination of debt and the share of tradables in GDP. More precisely, the currency mismatch (CURMISM) equals the ratio of the foreign currency share of total debt ($FC\%TD$) to the ratio of exports to GDP (X/Y).[8] That is, $\text{CURMISM} = \dfrac{FC\%TD}{X/Y}$.

[7] In line with this, Allayanis, Brown and Klapper (2000) find that firms in East Asia tended to use foreign earnings as a substitute for hedging with derivatives and that during the Asian crisis firms that hedged with derivatives did no better than firms that did not hedge. For further discussion see Moreno (2007).

[8] The formula is $FC\%TD = \dfrac{NBKL\$ + BKL\$ + DCP\$ + IB\$ + DB\$}{NBKL + BKL + DCP + IB + DB}$ where \$ refers to debt denominated in foreign currency and $NBKL$ is liabilities of non-banks (cross-border) to BIS reporting banks, in all currencies, BKL is liabilities of banks (cross-border) to BIS reporting banks in all currencies; DCP is domestic credit to the private sector (line 32 of monetary survey of IMF IFS); IB is international debt securities (bonds) outstanding in all

Figure 7

Indicator of currency mismatch



[1] In per cent. Data for Malaysia (not shown) for exports/GDP and foreign currency debt/total debt are 105% and 16% for 1997-98 and 123% and 15% for 2005, respectively.

Sources: IMF; BIS.

If this ratio is large – that is, there is relatively more foreign currency debt than foreign currency earnings to finance it – then a country could have a problem. In Figure 7, a threshold of unity (the 45º line) is used to separate the more vulnerable countries. As can be seen, there has been a broad improvement in currency mismatch positions as countries have generally moved to the right of the 45º line between 1997-98 and 2005.[9]

2.3.4 Credit linkages

Many emerging market financial crises in the 1990s quickly spread to other countries. By contrast, spillovers from the Argentina crisis in 2001-02 appear to have been much more limited. Trade and financial linkages are often found to be important determinants of spillovers.[10] The BIS consolidated banking statistics, which contain information of bilateral flows between the reporting countries and the rest of the world, are naturally an important data source for gauging financial linkages. One interesting issue is the impact of countries sharing a "common bank lender" on the spread of a financial crisis. Assessment of emerging market economies' financial obligations has often been based on the consolidated cross-border bank lending data compiled by the BIS. A simple measure is to compare the shares of total claims to emerging market economies by major creditors. Table 2 shows that, for example, Spanish banks are important lenders to most Latin American countries, while UK banks have significant claims on a number of Asian economies. In the event of a crisis in one emerging market economy, the spillover depends on how major creditors respond. It may be that losses in emerging markets lead to withdrawals of lending predominantly to their large debtors; to all debtors proportionately; to those who appear similar in risk characteristics; or

currencies; and *DB* is domestic debt securities (bonds) outstanding in all currencies. In all baseline calculations, all domestic bonds and domestic bank loans (domestic credit) are assumed to be denominated in domestic currency ($DB\$/DB = DCP\$/DCP = 0$).

[9] The preceding measure can be multiplied by a measure of the net foreign currency asset position for the economy, to construct a measure of the aggregate effective currency mismatch. This is a different concept from the net foreign asset position as it focuses on debt (equities and FDI are excluded) and where data are available, would take into account the balance sheet position in foreign currency onshore.

[10] See Forbes and Rigobon (1999) for a review of the literature.

to none at all. Those most vulnerable to changes are likely to be the economies with high financial dependence on the same developed economy creditor.

Table 2

Developed countries' claims on selected EMEs[1]

	Sweden	UK	Euro area[2]	Austria	France	Germany	Spain	Japan	US
Asia									
China	0.6	18.2	21.9	0.6	6.4	8.2	0.2	15.8	13.4
Hong Kong SAR	0.1	47.4	15.9	0.1	6.8	3.3	0.2	8.6	8.2
India	0.4	20.6	28.6	0.7	4.7	9.3	0.1	6.6	20.7
Indonesia	0.4	12.1	29.5	1.4	3.4	16.4	0.1	13.7	9.3
Korea	0.1	30.4	17.4	0.5	6.7	4.7	0.1	6.7	25.2
Malaysia	0.1	27.4	12.8	0.5	3.2	5.7	0.0	7.1	14.3
Philippines	1.1	13.9	28.8	1.1	11.2	9.1	0.2	9.0	17.2
Singapore	1.4	24.4	26.8	0.8	6.1	11.2	0.4	12.0	14.1
Taiwan, China	0.1	17.9	23.9	0.0	6.7	4.0	0.1	7.6	21.6
Thailand	0.1	15.8	14.6	0.4	4.4	6.6	0.0	27.2	16.7
Latin America									
Argentina	0.0	6.8	57.5	0.1	8.5	10.9	31.5	1.6	22.0
Brazil	0.2	12.6	56.0	0.2	4.0	4.2	23.0	2.7	16.0
Chile	0.6	3.3	66.9	0.1	3.3	4.8	53.1	1.8	19.2
Colombia	0.3	2.6	57.3	0.0	2.7	5.2	44.2	1.9	22.3
Mexico	0.2	10.0	49.3	0.2	1.4	2.2	42.0	1.2	29.8
Peru	0.2	2.6	63.0	0.0	1.9	5.9	52.0	2.3	17.0
Uruguay	0.6	6.7	49.6	0.7	2.2	6.2	17.1	1.7	22.7
Venezuela	0.3	4.4	78.1	0.1	7.6	11.6	53.2	2.1	7.9

[1] Percentage of total foreign claims of each EME in 2006 Q1. [2] Includes Austria, Belgium, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain.

Source: BIS.

Key: 0 – 40% | 40 – 50% | 50 – 60% | > 60%

Van Rijckeghem and Weder (1999) estimate the similarity in the dependence of emerging market economies on common creditors for financing (see Chui, Hall and Taylor (2004)).[11] One such measure is an index of relative fund competition (B) in third markets (subscript K) by two emerging market economies (subscripts i and j). This index has two terms. The first term captures the overall importance of the common lender (say UK banks) for the two emerging market economies, while the second term measures the extent to which the two emerging markets compete for bank loans from the common creditor. The index is designed to lie between 0 and 1 with a maximum value of 1 indicating countries that share the same set of common creditors. Table 3 shows index values for a number of emerging market

[11] They do this by extending the approach used by Glick and Rose (1999) to measure trade linkages.

economies which share common creditors in 2006 Q1 in the form of a heat map. It is interesting to note that regional patterns can be observed in this fund competition index.[12]

Table 3

Index of international bank credit linkage (2006 Q1)

		Asia			Latin America						Other		
		China	Korea	Thailand	Argentina	Brazil	Chile	Mexico	Uruguay	Venezuela	Russia	South Africa	Turkey
Asia	China												
	Korea	0.78											
	Thailand	0.82	0.73										
Latin	Argentina	0.59	0.62	0.54									
America	Brazil	0.54	0.56	0.48	0.67								
	Chile	0.41	0.47	0.39	0.75	0.61							
	Mexico	0.37	0.50	0.40	0.80	0.66	0.79						
	Uruguay	0.53	0.62	0.51	0.75	0.81	0.62	0.71					
	Venezuela	0.49	0.43	0.38	0.76	0.55	0.84	0.68	0.55				
Other	Russia	0.55	0.50	0.45	0.54	0.46	0.34	0.28	0.49	0.52			
	South Africa	0.53	0.59	0.51	0.35	0.38	0.27	0.27	0.33	0.34	0.36		
	Turkey	0.69	0.63	0.58	0.60	0.55	0.37	0.36	0.51	0.50	0.67	0.45	

K: Creditor countries: Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, United Kingdom and United States. *i* and *j*: Emerging market economies.

Source: BIS consolidated banking statistics.

While the heat map creates a snapshot of potential vulnerability at a point in time, the development of the index for a given country pair over time provides information on the ebb and flow of credit concentrations. This has been plotted for Argentina and Uruguay in Figure 8.[13]

Following very high creditor linkage during the Latin American debt crisis of the early 1980s, when both countries depended on US banks for almost all their credit, there is clear diversification of creditor origin during the early 1990s, followed by a return of US banks.

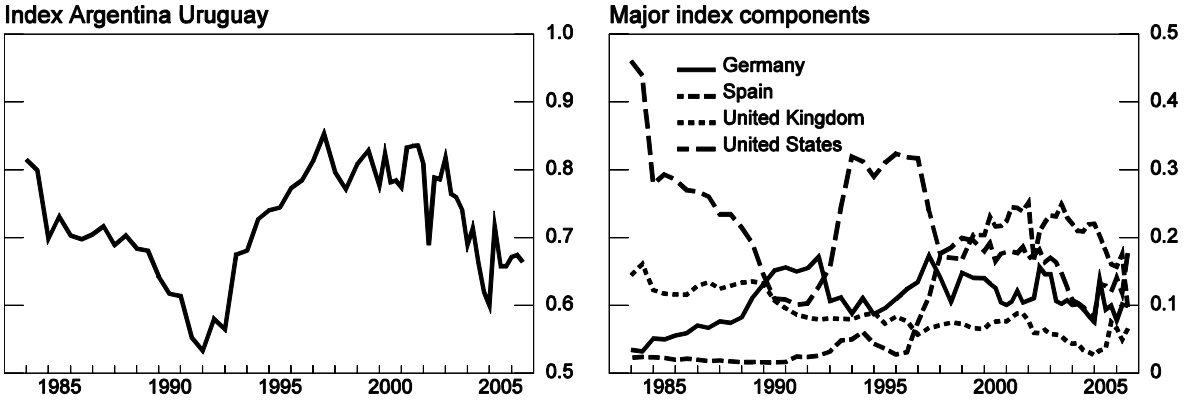
[12] The index formula is:

$$Index = \sum_{K}\left(\frac{B_{iK} + B_{jK}}{B_i + B_j}\right) \times \left\{1 - \left[\frac{\left|\frac{B_{iK}}{B_i} - \frac{B_{jK}}{B_j}\right|}{\frac{B_{iK}}{B_i} + \frac{B_{jK}}{B_j}}\right]\right\}, i \neq j.$$

[13] The index formula for the left-hand panel of Figure 8 is calculated taking *i* for Argentina and *j* for Uruguay, the *K* countries are in the note of Table 1. In the right-hand panel of Figure 8, the four lines are the 4 largest of the *K* components which sum to the index. For example, *K* is fixed at, say, country 5 and then the index is calculated through *i* and *j* for all periods.

These withdrew during the Asian crisis, resulting in a credit concentration from Spanish banks in both countries. Spanish banks retreated partially during the Argentine crisis, when the crisis spillover hit Uruguay, causing a temporary concentration of credit on German banks. In the most recent past, the index indicates that both countries have stabilised their credit source concentration at a fairly low level.

Figure 8
Credit linkages



Source: BIS consolidated statistics, quarterly data as from December 1999.

3. Conclusions

BIS statistics have a wide range of applications. They made up for gaps in other data or indicators at the time that they were introduced. This has resulted in cooperative efforts to improve national debt reporting systems (eg non-bank BoP flows) that now systematically rely on or are cross-checked with BIS statistics. We have provided examples of certain types of analysis that can only be done systematically and in a timely fashion using BIS statistics.

Looking ahead two issues arise. First, whether some of the BIS data will be superseded by data compilations elsewhere. Second, the possibilities for enhancing BIS data. For example, before the introduction of the Euro, the CGFS examined whether the currency breakdown in the banking statistics could be streamlined. The resulting distortions in the data were, however, regarded as unacceptable. Instead, today one might consider expanding the currency breakdown with currencies used in important emerging economies, in cases where these data are available without additional reporting burden. Apart from this, policy makers may identify new information needs (eg on hedge funds) that warrant the compilation of new types of BIS statistics to address new types of risks.

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Developments in a cross-border bank exposure "network"*

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Abstract

In this paper we explore the developments in cross-border bank exposures using the BIS international banking statistics. To this end, we treat the web of cross-border bank exposures as a "network", investigate the characteristics of the network topology and compute various statistical measures for that topology. We find that the network of cross-border bank exposures has become more tightly connected over time. It now has higher connectivity, a shorter average path length, a higher average degree and a higher clustering coefficient than in the past. In particular, we observe that this tendency has never been hampered by any disturbances or crises in international financial markets (such as the East Asian currency crisis in 1997 or the LTCM near-default event in 1998). We see both costs and benefits from these developments in cross-border bank exposures. On the one hand, systemic risk in international financial markets is likely to increase because of the more direct and more widely spreading spillover effects of a crisis in one country once it occurs. On the other hand, the efficiency of international financial markets is expected to further improve in terms of capital and risk allocation.

1. Introduction

In an overview of developments in international financial markets and global financial crises, we generally focus on the time series movements of prices, transaction volumes and outstanding amounts, eg the amounts of international capital or credit flows, foreign exchange rates and sovereign bond credit spreads. This line of research helps us understand the structure and functioning of international financial markets more thoroughly (see, for example, Bisignano *et al* (2000), Glick *et al* (2001)).

* In the preparation of this paper, we received insightful comments from the participants of the CGFS workshop "Research on global financial stability: the use of BIS international financial statistics" held at the BIS, the workshop "Selected Economists' Research Forum: Modelling the financial sector" held at the Bank of England, Bank Indonesia's "5th International Seminar on Financial Stability: Financial sector deepening and financial stability – benefits and challenges", and from some staff members of the Financial Systems and Bank Examination Department, Bank of Japan. The views expressed in this paper are solely those of the authors and do not necessarily reflect those of the Bank of Japan. Any errors or omissions are the responsibility of the authors. The corresponding author is Masazumi Hattori.

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In this paper we employ a new approach, network analysis, to understand the developments in international financial markets. We explore the changes in cross-border bank exposures by treating the web of cross-border bank exposures as a network. We first compute various statistical measures for the network topology using the BIS international banking statistics. We then examine the changes in such statistical measures for the network topology over time, thereby attempting to gain some new insights into the developments in international linkage via bank exposures.[1]

To our knowledge, this paper is the first to apply the concepts of network topology in analyses of the changes in international financial markets. A similar approach for network analysis is applied in studies on other financial architectures such as interbank payment flows, for example Inaoka *et al* (2004), Soramaki *et al* (2006), Bank of Japan (2006) and Soejima (2007).

This paper is organised as follows. Section 2 briefly introduces some key elements in network analysis and presents cases in which international financial markets can be understood using BIS international banking statistics, with due consideration of the limitations in available data. Section 3 introduces several topological statistical measures to characterise a network, then applies these measures to the analysis of the cross-border exposure network of banks. Section 4 first investigates the relationship between the topology characteristics and the total gross cross-border bank exposures. Then, it assesses the influence of crises on the topology characteristics. It also discusses some conjectures as to why the cross-border bank exposure network becomes tightly connected and the implications that those developments hold for international financial stability. Section 5 offers a concluding discussion.

2. BIS international banking statistics for network analysis

In this section we introduce some key concepts in order to sketch out a network. The concepts explained are specific to the analysis in this paper. The latter part of this section describes cross-border bank exposures as a network. This will prepare us to characterise the network by some of the topological coefficients often used in papers on network analysis.

2.1 Networks

A *network* consists of *nodes* and the connections between them, *link*s. The number of nodes *n* defines the size of a network. Links can be either *undirected* or *directed*. If the direction of a link from one node to another is known and meaningful, it is often best to analyse the network in question as a network with directed links.

A sequence of nodes in which each node is linked to the next is defined as a *walk*, and a walk is called a *path* if all links are directed. The *length of a path* between two nodes is measured by the number of links between the two nodes. These terms actually differ slightly in papers and books, but the concepts here are equivalent (de Nooy *et al* (2005), Batagelj (2006), Soramaki *et al* (2006)).

[1] Bank of Japan (2007) includes a brief summary of this paper.

2.2 BIS international banking statistics

The BIS international banking statistics cover individual countries and the amounts outstanding of cross-border bank exposures between one country and another country. The analysis in this paper uses consolidated banking statistics on an immediate borrower basis in the international banking statistics from the international financial statistics published by the BIS. The central bank of a country collects the data on foreign claims of reporting banks in the country and reports it to the BIS. The statistics used in this paper give us data on risk exposures to individual countries by the nationalities of the reporting banks.

Following the definitions in the literature on network analysis, we define a country in the database as a *node* and an exposure from one reporting country to another country as a *link*. A link in these statistics is treated as a *directed* link, and we define a *path* and *length of a path* according to the definitions in the last subsection.

In this regard, we should note the difference between reporting and non-reporting countries. Reporting countries are required to report the credit exposures of their domestic banks to the other countries in the country list. The amounts outstanding of credit exposures from each reporting country to the other countries at the end of each quarter are available.[2] The amounts outstanding of credit exposures from non-reporting countries to the other countries are not available. Thus, reporting countries have both inward and outward links, while non-reporting countries have only inward links. We refer to inward and outward links as directed-in and directed-out links, respectively.

Considering some significant discontinuities in the data, we make some adjustments to the BIS international banking statistics.

First, we treat just 16 out of the current 30 countries as reporting countries: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. We include Finland and Spain as reporting countries; though they did not actually become reporting countries until the second half of 1985, their inclusion does not seem to cause any noticeable discontinuity in the time series of any of the topological statistical measures. We, however, exclude Australia, Brazil, Chile, Greece, Mexico, Panama, Portugal and Taiwan, which became reporting countries after 1998. We also exclude Norway because its data are available only up to the first quarter of 2004. In addition, we need to exclude Hong Kong SAR, India, Luxembourg, Singapore and Turkey from the reporting countries, because the data on their exposures to other countries are not available in the consolidated banking statistics on an immediate borrower basis.[3]

Second, we fix the number of sample countries to be 215 throughout the sample period, to mitigate the impact of changes in the number of sample countries. The largest change in the number of sample countries occurs when the Soviet Union collapsed in 1991 and was divided into 15 countries. This discontinuity seems to mislead us in understanding the developments in the cross-border bank exposure network over time.

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[2] The credit exposure of one reporting country to another reporting country was not recorded before the second half of 1998. Thus, we detect a sudden increase in the total gross amounts outstanding in the first half of 1999, when the reporting countries started reporting their credit exposures to other reporting countries.

[3] This seems to be the case from the authors' investigations of the BIS website. Even if we included those countries as reporting countries, we believe, the findings in this paper on trends and changes in the topological characteristics of the cross-border bank exposure network would not be affected to a considerable degree.

Third, we exclude the period between the second half of 1983 and the first half of 1985 from our analysis. The reason is that data for the period show a high volatility because, presumably, data collection operations did not work well at first in the sample countries.

Finally, we interpolate missing data using data from the subsequent period. The frequency of the data changes from semi-annual to quarterly from the first quarter of 2000. Thus, the data for the first and third quarters up to the end of 1999 are retroactively unavailable.

2.3 Preliminary checking by visualisation

As a first step, the cross-border bank exposure network is visualised in Figures 1 and 2. We see that the network is complex in spite of the extremely low number of nodes in comparison with other networks in preceding papers such as those on interbank payment flows.

Figures 1 and 2 are different visualisations of the same network, based on the data for the fourth quarter of 2006: developed countries are in the top-left area in Figure 1 and the reporting countries are in the top-left area in Figure 2. The nodes in red (or dark shading) are reporting countries with directed-in and directed-out links. The nodes in sky blue (or light shading) are non-reporting countries with only directed-in links. The relative scale of each node represents its weight in the total gross exposures in the network, and the arrows indicate the direction of exposures. The large nodes are, in order of size, the United States, the United Kingdom, France, Germany, Italy and the Cayman Islands.

Figure 1
Cross-border bank exposure network (1)

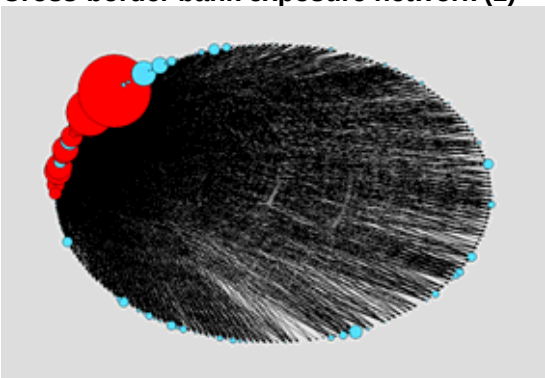
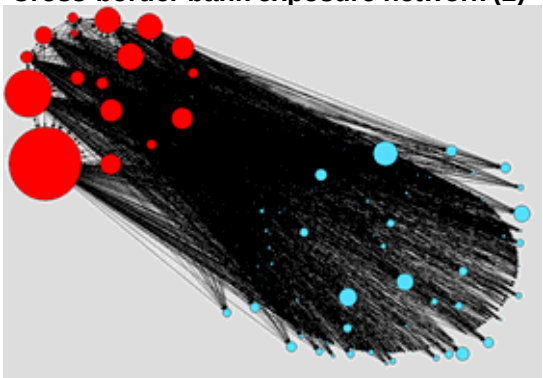


Figure 2
Cross-border bank exposure network (2)



If we are interested in the changes of the network over time, it may be effective to draw the figures for every period, compare them period by period, and extract tendencies and changes. Readers are likely to agree, however, that this visualisation approach is not very fruitful, especially if we want to understand changes over a long time horizon such as that in this paper. Alternatively, we can calculate some commonly used statistical measures in the literature on network analysis and try to understand the trends and changes in the cross-border bank exposure network from the standpoint of the topological characteristics. This is what we attempt in the sections below.

3. Trends and changes in the topological characteristics of the cross-border bank exposure network

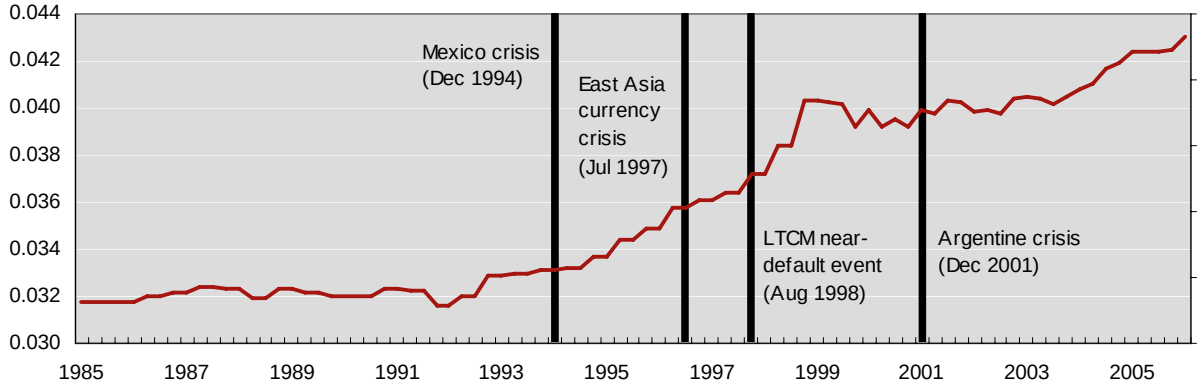
In this section we describe the statistical measures used to elucidate the topological characteristics of the cross-border bank exposure network.[4]

3.1 Connectivity: likelihood of connection between countries

In this paper, the number of sample countries (ie, nodes, n) is 215. The number of links m is determined as follows in our analysis. When gross credit exposure from one country (node) to another is recorded as neither zero nor "not available", we count it as one link. The number of such links is expressed as m.

The number of links relative to the number of "possible" links is defined as the *connectivity* of a network. In other words, the connectivity p is the unconditional probability that two nodes share a link. For a directed network like the one in our analysis with the BIS statistics, the connectivity is calculated as $p = \frac{m}{n(n-1)}$.

Figure 3
Connectivity



The time series of connectivity is shown in Figure 3, which demonstrates two points. First, the connectivity follows an increasing trend, implying that the likelihood of the connection of two countries via bank exposures keeps increasing throughout almost the entire sample period. Second, in retrospect, the increasing trend is not hampered severely by well-known disturbances in the international financial markets such as the Mexican crisis, the East Asian crisis, the LTCM near-default event and the Argentine crisis. Once connectivity rises it is not easily reversed. This is equivalent to the claim that disconnection is a rarity once two countries are connected.

The connectivity in the fourth quarter of 2006 is 0.043. This means that only 4.3% of the potential links (215 times 214 = 46,010) are used. We take care, however, in interpreting the

[4] Papers on network analysis often compare a topological statistical measure of a network in question with a certain benchmark, such as a *random network* (Soramaki *et al* (2006)). Due to the unavailability of directed-out links from non-reporting countries in the BIS statistics, however, it is not useful for us to take this approach in our analysis. Instead we focus on changes in the topological statistical measures over time to discuss the evolution of the characteristics of the cross-border bank exposure network.

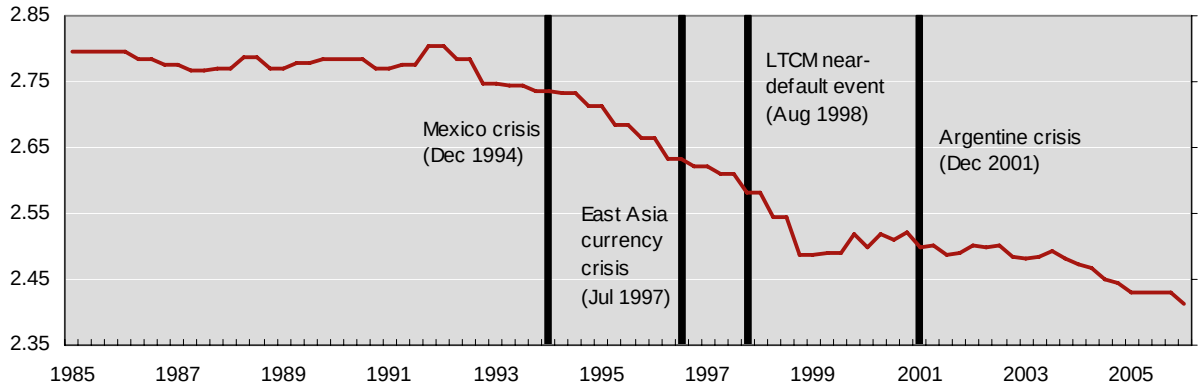
small value of this statistic. It would be higher if the potential links directed from one non-reporting country to another country were reported in the BIS statistics.[5]

3.2 Average path length: distance between nodes

The distance from node i to node j, d_{ij}, can be measured by the length of the shortest path between the two nodes. If node i has a link to node j, then $d_{ij} = 1$. The average distance from node i to other nodes, commonly referred to as the *average path length of node i*, is $\ell_i = \frac{1}{n-1}\sum_{j \neq i} d_{ij}$. The average of the average path length of each node in a network (hereafter, the *average path length*) shows how many steps on average are required to move from one node to another in a network.

Figure 4 shows the time series of the average path length in the cross-border bank exposure network. The average length declines rapidly after the mid-1990s, suggesting that the network becomes increasingly compact in the second half of the 1990s.[6]

Figure 4
Average path length



3.3 Degree: multilateral connections

In a directed network, we can differentiate the number of links originating from a node from the number of links terminating at a node. The first is referred to as the *out-degree* (m_i^{out}) of a node and the second is referred to as the *in-degree* of a node (m_i^{in}). The *average degree* of a

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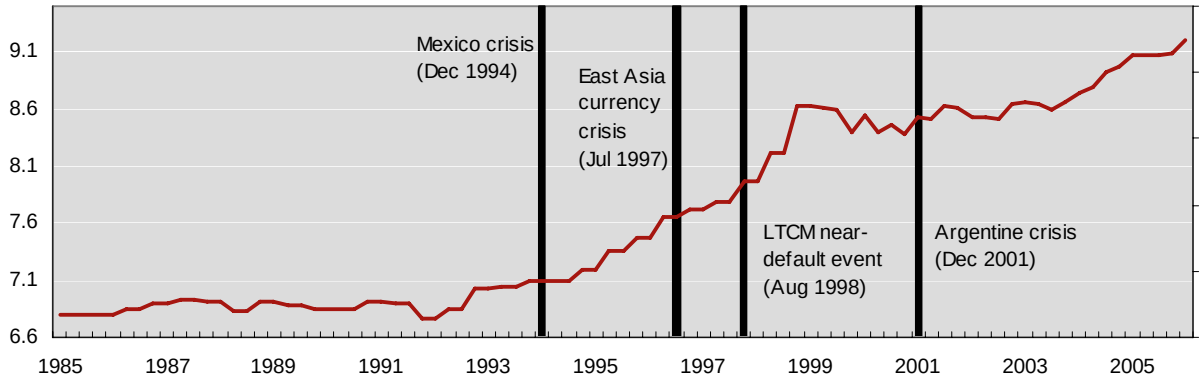
[5] A statistical measure closely related with connectivity is *reciprocity*. Reciprocity is the fraction of links in a network which have links in the opposite direction. A reciprocal link can be observed only between the reporting countries in the BIS statistics. Thus, we do not use this measure to characterise or compare the cross-border bank exposure network across time in this paper.

[6] We use an approximation to get the average path length. We use a formula $\langle \ell \rangle \approx \frac{\ln(n)}{\ln(p \cdot n)}$ for a random network. This approximation is nonsense if we are interested in comparison between a network in question and a random network as its benchmark; however, we believe that the approximation works without any significant problems as a means to gain an overview of trends and changes in the characteristics of the cross-border bank exposure network.

node in a network is defined as the number of links divided by the number of nodes. In a network, the following holds: $\langle m \rangle = \frac{1}{n}\sum m_i^{out} = \frac{1}{n}\sum m_i^{in} = \frac{m}{n}$.

Figure 5 shows the time series of the average degree in the network. The shape of the line is almost identical to the shape for connectivity in Figure 3. This reflects a feature of the BIS statistics and our adjustment to it; we fix the number of nodes, hence connectivity is determined by the number of links directed from reporting countries, that is, the out-degree of those countries.

Figure 5
Average degree



Another way to depict basically the same phenomenon is a comparison between histograms of in-degree per country at two different points in time. Figures 6 and 7 are the histograms of in-degrees in the second quarter of 1999 and the fourth quarter of 2006, respectively. For comparison we show the histogram for the second quarter of 1999, the year when the BIS statistics started to include bank exposures between reporting countries. It is obvious that the histogram for the fourth quarter of 2006 has more countries in a higher range of in-degrees than the fourth quarter of 1999, and the average and the median are both higher in the former than in the latter.

Figure 6
Histogram of in-degrees in 1992 Q2

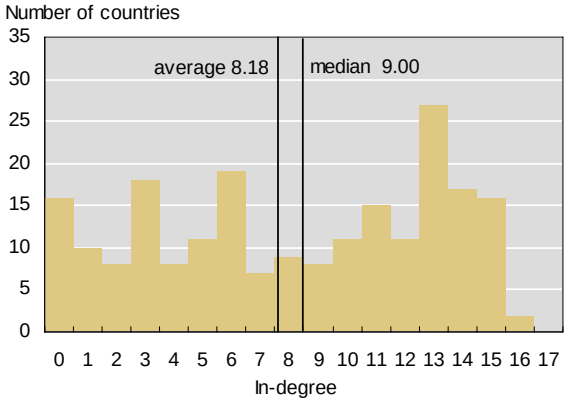
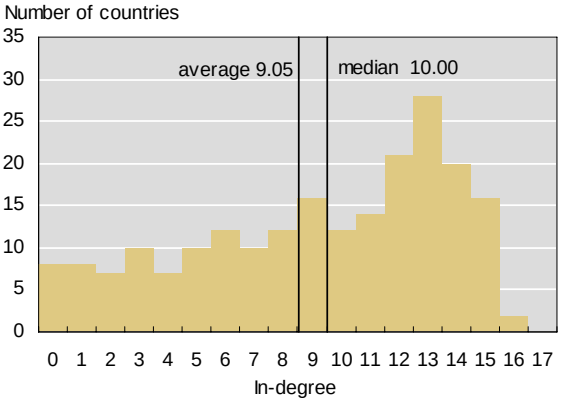


Figure 7
Histogram of in-degrees in 2006 Q4



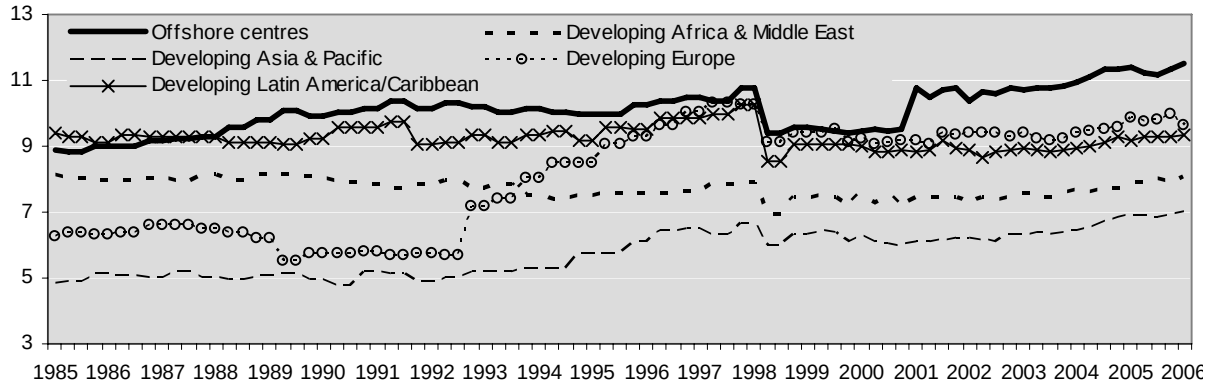
It is illuminating to compare the numbers of directed-out links from reporting countries in two time periods. In the second quarter of 1999, 16 reporting countries had 240 directed-out links to reporting countries. In the fourth quarter of 2006, the number is almost the same, 239. Given that there are 16 reporting countries in our analysis and 16 times 15 = 240, the network among the reporting counties has been almost a *complete network*: all the reporting countries are linked with each other. In contrast, the number of directed-out links from reporting to non-reporting countries increased drastically, from 1,527 to 1,741. Hence, we

know that reporting countries are connected directly with more non-reporting countries in the network than before.

Next, we focus on the changes in the regional average degree over time. In particular, we pay due attention to the contribution of each developing region defined by the BIS to the changes in the average degree of the whole network. Their changes virtually determine the trajectory of the average degree of whole network.[7]

Figure 8 shows the average degree of each region: Offshore Centres, Developing Asia and Pacific, Developing Latin America and Caribbean, Developing Africa and Middle East, and Developing Europe. The relative size of an increase in each regional average degree in a period can be interpreted as the extent of its contribution to an increase in the average degree of the whole network, because by definition the average of the regional average degrees is the average degree of the whole network.[8]

Figure 8
Average degree by region



The figure shows that each region contributes to the increase in the average degree of the whole network in the second half of the 1990s, before the LTCM near-default event, to a different extent. Developing Europe most significantly contributes to the average of the whole network, and the increase in the average degree of Developing Asia and Pacific looks to be the second largest contributor. The other three regions also have an increase in average degree, but it is smaller than that in Developing Europe and Developing Asia and Pacific in the same period. In contrast, in the recent period observing an increase in the average degree of whole network after 2003, roughly speaking, all the regions increase their average degree to almost the same extent. That is, the development of the cross-border bank exposure network in the recent period goes on evenly, in terms of average degree, in all parts of the world.

An increase in the sum of the out-degree of each node in the network causes higher connectivity, a shorter average path length and the higher clustering coefficient described below. Thus, it is worth determining which regions contribute to the increase in number of directed-out links in the network. Focusing on the recent phenomenon, in Table 1 we list countries in order of increase in out-degree from the fourth quarter of 2003 to the fourth

[7] The only exception is the second quarter of 1999, when the banks in the reporting countries started to report their credit exposures to reporting countries. The trajectory of the average degree of the whole network is affected by this and shows a relatively large increase. We have checked the trajectories of average degree of Developed Europe and Developed Others according to the definition in the BIS statistics. They are virtually flat over the whole sample period, except for a large increase in the second quarter of 1999.

[8] The same caveat in footnote 7 applies here.

quarter of 2006. It is obvious that the significant contributors are banks in developed European countries.

Table 1

Changes in out-degree between 2003 Q4 and 2006 Q4

Number	Country	Degree
1	Sweden	27
2	Austria	22
3	United Kingdom	21
4	Switzerland	15
5	Finland	12
6	Netherlands	9
7	Spain	8
8	Canada	6
9	Japan	5
10	United States	3

With regard to the number of links directed out of each reporting country, Table 2 ranks the out-degree of nodes. France is the biggest contributor, and several other European countries are ranked in high positions. Table 3 compares this ranking in terms of total gross outstanding amounts of cross-border bank exposures. The top contributors to the number of directed-out links tend to be the top contributors to the total gross outstanding amounts of cross-border bank exposures. More connected nodes tend to play a bigger role in transferring cross-border risk exposures in terms of amounts outstanding. Japan may appear to be an exception, but it is actually in the 12th position (with an out-degree of 105) in the ranking of out-degree contributors.

Table 2

Top 10 out-degrees in 2006 Q4

No	Country	Degree
1	France	180
2	United Kingdom	178
3	Germany	173
3	Netherlands	173
3	Switzerland	173
6	Belgium	158
7	Spain	151
8	Austria	144
9	United States	144
10	Sweden	134

Table 3

Top 10 exposures in 2006 Q4

No	Country	Exposures[1]
1	Germany	3,527,298
2	United Kingdom	3,087,535
3	France	2,610,978
4	Switzerland	2,456,430
5	Netherlands	2,084,448
6	Japan	1,854,216
7	United States	1,332,218
8	Belgium	1,108,955
9	Spain	986,840
10	Sweden	602,538

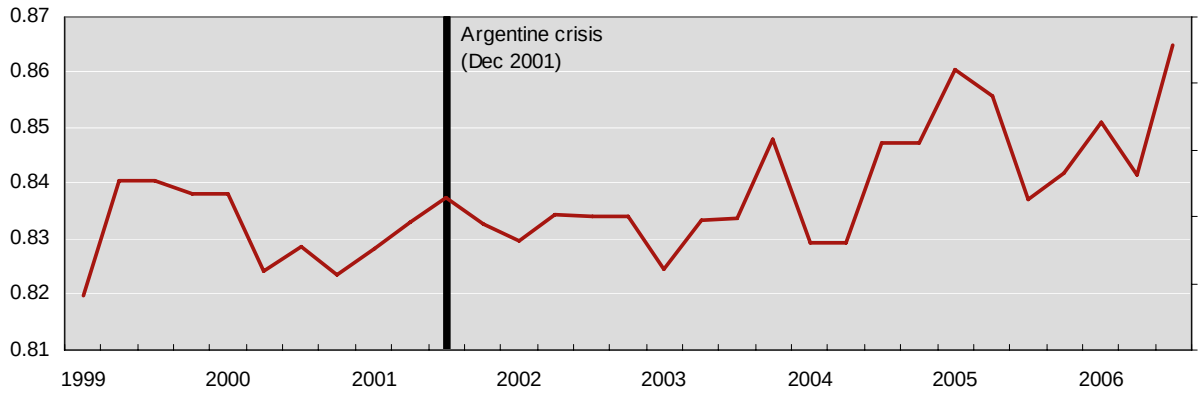
[1] In millions of US dollars.

3.4. Clustering coefficient: likelihood of connection between neighbours

The *clustering coefficient* is another commonly used topological statistical measure. It shows the probability that two neighbours with a direct link to a node are linked together. The clustering coefficient of node i is calculated as the ratio of the actual number of directed links between the *neighbours* of node i ($m_{nn,i}$) over the number of potential links among them. *Neighbours* of a node i are defined as nodes which are directly linked to node i. Then, when the number of the neighbours of node i is m_i, the number of potential links among the neighbours of node i is $m_i (m_i - 1)$. Therefore, we can calculate the clustering coefficient of node i as $C_i = \frac{m_{nn,i}}{m_i(m_i - 1)}$. We can also define the clustering coefficient of a network as the average of the clustering coefficient of each node in the network. The clustering coefficient of a network $C = \frac{1}{n}\sum C_i$ measures the tendency of a network to cluster.

Figure 9 shows that the clustering coefficient of the network increases after 2003. This is due to an increase in the in-degrees of non-reporting countries after 2003. Remember that the in-degree of a node is the number of terminating links at the node. The logic behind this can be explained with the following example. Suppose a non-reporting country has only one directed-in link from a certain reporting country. One day, this non-reporting country receives bank exposures from another reporting country as well. If the two reporting countries are linked with each other, clustering occurs: two neighbours with a direct link to the non-reporting country are linked together. As we found in the previous subsection, almost all the reporting countries are linked with each other. In other words, the network consisting of reporting countries is a virtually complete network. Therefore, it is almost always the case that an increase in the in-degree of non-reporting countries results in an increase in the clustering coefficient.

Figure 9
Clustering coefficient



Some limitations in the data should be noted in interpreting the clustering coefficients. First, it is impossible to precisely calculate the clustering coefficient, because a non-reporting country in the BIS statistics by definition has no directed-out links. Second, we need to choose the sample period for the clustering coefficient only from the second quarter of 1999 onwards, when the reporting countries start reporting their bank exposures to other reporting countries. By definition, the clustering coefficient is zero before the reporting countries start reporting their bank exposures to other countries, and it is meaningless to include the periods before the second quarter of 1999 in the sample period.

4. Discussion

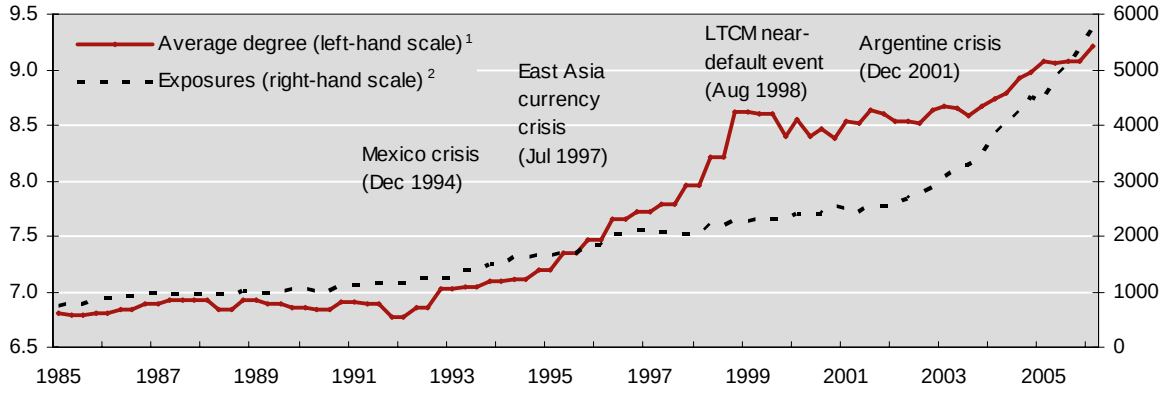
4.1 Topology characteristics and gross cross-border bank exposures

In this section, we investigate the relationship between the topology characteristics of the cross-border bank exposure network and the gross bank exposures in the network. Because we already know that the main cause of the evolution of the topology characteristics of the network is change in the average degree of the network, we investigate the relationship by focusing on the relationship between the average degree and total gross cross-border bank exposures.

Figure 10 shows the time series of the total gross exposures and the average degree.[9] Two observations are worth pointing out in the figure. First, both time series are basically on increasing trends. Second, we can detect that the total gross exposures started increasing before the average degree in recent years. The total gross exposures increased at an accelerated pace beginning in 2002. Following such a significant increase in the total gross exposures, the average degree started increasing in 2003.

From the second observation above, we could conjecture that the expansion of total gross exposures might have propelled the developments in the network. International banks seek entry into new countries with opportunities for profits. Once within a new country, they increase their exposure to the country until the profit opportunity becomes scarce. Next they start seeking entry into a new country, and a new cross-border bank exposure link emerges. The frontier of their business moves from one country to another. We can speculate that the increase in exposures might have preceded the increase in links in this fashion, though clearly more research would be required.

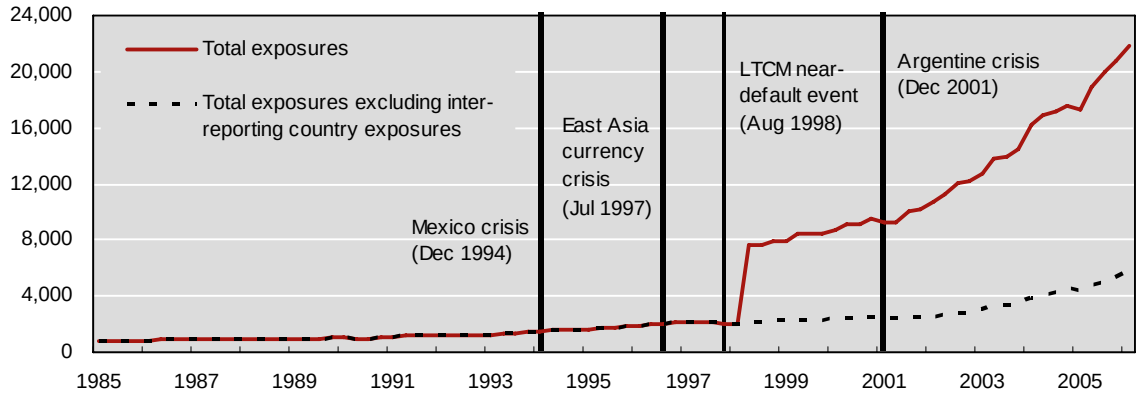
Figure 10
Average degree and exposures



1 level. 2 In billions of US dollars.

9 To obtain a longer consistent time series for investigation, we use the time series of the total gross exposures, excluding exposures between reporting countries. The gross exposures, including exposures between reporting countries, are only available from the second quarter of 1999 onwards. Figure 11 shows both time series, including and excluding exposures between reporting countries, for reference.

Figure 11
Total exposures[1]

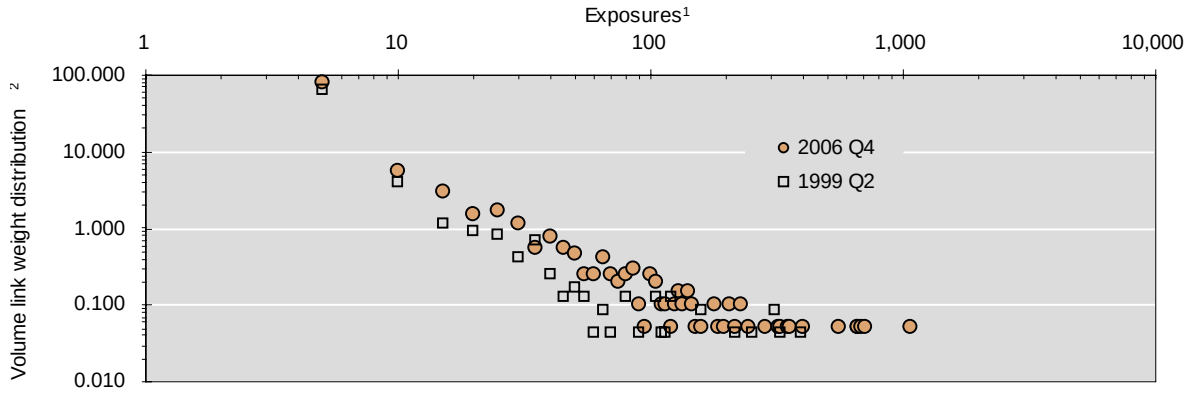


[1] In billions of US dollars.

Figure 12 shows another way to depict the relationship between links and amounts of exposures. The power-law distribution figure in logarithmic scale plots the frequencies of links vis-à-vis the total number of links falling in a certain range of amounts of exposures per link. The range unit for amounts of exposure is 5 billion US dollars. The figure also enables us to compare the state in the fourth quarter of 2006 with the one in the second quarter of 1999.

The power-law distribution reveals the following. First, links bearing less than 5 billion US dollars have a weight of about 80% of the total number of links. Second, the slope of the power-law distribution in the fourth quarter of 2006 is flatter than the one in the second quarter of 1999. This change in slope is attributable to increases in the weight of links bearing amounts of exposures roughly between 35 billion and 100 billion US dollars, and to increases in the amount of exposures of a small number of links bearing the largest amount of exposures in the second quarter of 1999.

Figure 12
Power-law distribution



[1] In billions of US dollars, logarithmic scale. [2] Share in total *m* , in per cent, logarithmic scale.

4.2 Influence of crises

International financial markets are sometimes significantly influenced by turbulent crises, such as currency crises, which tend to be perceived as massive forces when underway. The Mexican crisis in 1994, the East Asian crisis in 1997, the LTCM near-default event in 1998, and the Argentine crisis in 2001 were all such events. Our interest in this subsection is to investigate how these crises influenced the cross-border bank exposure network.

Figure 10 shows the approximate timing of the occurrence of well-known turbulences in the international financial markets (hereafter, crises). We can point to two features of the trajectory of the two time series. First, the trend of increasing average degree has never been severely affected by any crisis. Second, total gross cross-border bank exposures experienced a small dip after the LTCM near-default event, though the average degree was not affected considerably even under those circumstances. These features are closely related to the irreversibility of the connectivity discussed earlier: once a country has a link with another country, the link tends to be very persistent.

4.3 Driving forces: conjectures

As shown in the previous sections, the cross-border bank exposure network recorded by the BIS statistics has become more connected, smaller and more clustered. We have described how these are parallel phenomena propelled by an almost constant increase of the out-degrees (the number of directed-out links of a node) of the reporting countries. Thus, our next task is to identify the driving force behind this increase.

There are several possibilities. One is the globalisation of the business activities of non-financial firms. Banks of a firm's home country will have a lending opportunity to fund the activities of the firm in a foreign country.

The second possibility is acceleration of economic development in developing countries. With help from the above-mentioned globalisation of firms of developed countries, developing countries have tended to achieve historically high economic growth. Firms in those countries may have thus had to seek financing from financial markets. If so, this would have made it easier for international banks to find lending opportunities in those developing countries.

The third possibility is the "search for yield" behaviour of financial institutions when the returns of financial assets in domestic markets stay low. We have already noted the relationship between the time series of average out-degree and total gross cross-border bank exposures. In recent years, the average out-degree has increased almost in parallel with total gross cross-border bank exposures. This would mean that an increase in total exposures is not only attributable to an increase in exposures to already linked countries, but also to an increase in the number of links. An increase in the number of links means that at least one of the reporting countries has new credit exposures to a country to which it never had exposures before. The following may clarify the factors underlying this phenomenon. In domestic financial markets, credit tends to expand when domestic interest rates are low. It is often observed that ongoing credit expansion narrows the credit spreads of domestic financial assets. Financial institutions need to find opportunities for yield, and start looking outside their country. They begin increasing credit exposures to their familiar foreign financial markets, and the spread of assets in these foreign financial markets starts shrinking. Finally, the financial institutions try to enter unexplored territories. Hence, a new directed-out link emerges.

The fourth possibility is a wave of financial liberalisation. This allows the entry of foreign banks into domestic financial markets and will raise the possibility for cross-border credit exposure. In this connection, we may ask what the driving force behind financial liberalisation is. One driving force would be the finance needs of firms in developing countries. This is the phenomenon mentioned above as the second possible cause for the increasing out-degrees of developed countries. Some may point out a possible relationship between this question and the behaviour of financial institutions described in the last paragraph.

4.4 Implications for international financial stability

In this subsection, we discuss the implications of the changing characteristics of the international financial markets for international financial stability.

The changes in the characteristics of the cross-border bank exposure network identified in the preceding sections of this paper imply that the international financial system may be becoming more "robust yet fragile" than in the past, in terms of cross-border bank exposures (Allen and Gale (2000)). A higher average degree implies a greater possibility for agents such as firms and governments to finance from outside a country, and this will lower the probability of a financial crisis in the country triggered by a domestic cause. At the same time, once a financial crisis occurs in one country, the impact could be more significant to the system because a country within it is exposed to a greater number of countries in the second round effects of the initial financial crisis.

With regard to international financial stability, especially systemic risk, in the international financial markets, we introduce additional material for discussion and point to the fact that, on average, countries currently depend on their large financiers more than in the past. The Herfindahl-Hirschman Index (hereafter, HHI) for a country in terms of the amount of exposures directed to the country is a gauge of the extent of concentration: the higher a country's HHI, the fewer countries play an influential role from the perspective of bank exposure provision to the country. Figures 13 and 14 are the histograms of the HHI for countries in the second quarter of 1999 and the fourth quarter of 2006, respectively. Comparison of the histograms for the two periods indicates that, on average, concentration has increased, which means a country is more susceptible to changes in exposures from a small number of countries than before.

Figure 13
HHI in 1999 Q2

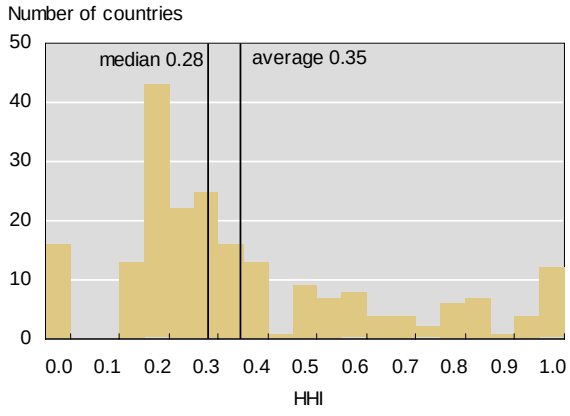
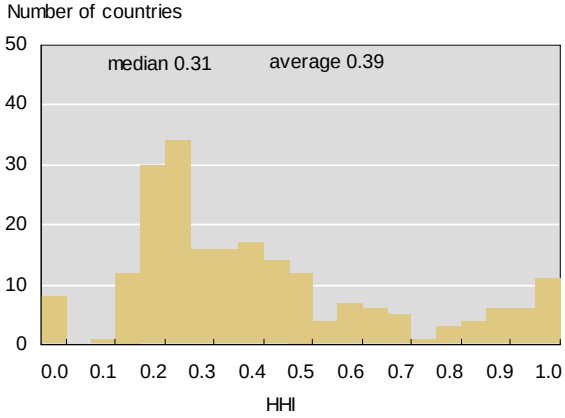


Figure 14
HHI in 2006 Q4



Thus far we have investigated changes in the characteristics of a cross-border bank network and in exposure concentrations in terms of HHI, and have explored their implications for international financial stability. However, it seems prudent not to rush to a conclusion that systemic risk in international financial markets is either higher or lower than before. The size of systemic risk in international financial markets is of course determined by more than just the extent of linkage in the markets and exposure concentrations. The resilience of a country's domestic financial markets to external shocks depends on numerous factors which do not stay unchanged. We need to consider these factors when assessing systemic risk in international financial markets. We have investigated characteristics of the cross-border bank exposure network and have shown they have changed over time, which implies changes in risk-sharing and transmission of a shock. The bottom line is that the past may not be a good guide to the future (Clark (2007)).

Moreover, it should be noted that global financial flows provide important benefits, and we should not pay attention only to possible increases in systemic risk due to the trends and changes in the cross-border bank exposure network (Summers (2000)).[10]

5. Concluding remarks

In this paper we have explored the developments in cross-border bank exposures using the BIS international banking statistics. We have treated the web of cross-border bank exposures as a network and have investigated the characteristics of the network topology by computing various statistical measures.

We find that the network of cross-border bank exposures has become more tightly connected over time. It currently has higher connectivity, a shorter average path length, a higher average degree and a higher clustering coefficient than in the past. Moreover, we observe that this tendency has never been hampered by any disturbances or crises in international financial markets (such as the East Asian currency crisis in 1997 or the LTCM near-default event in 1998).

The above developments in the cross-border bank exposure network have some implications for the stability of international financial markets. In this regard, we should note both costs and benefits from these developments in cross-border bank exposures. On the one hand, systemic risk in international financial markets is likely to increase because of more widespread and direct spillover effects of a crisis in one country once it occurs. On the other hand, the efficiency of international financial markets is expected to further improve in terms of capital and risk allocation.

As a final remark, we should point out a limitation of our analysis due mainly to a feature of the BIS international banking statistics. We have repeatedly explained the difference between a reporting country and a non-reporting country in the statistics. We can obtain information on the bank exposures directed from a reporting country to another country in the sample, but no information on the ones directed from a non-reporting country to any countries in the sample. This limits our knowledge of the international linkage in terms of bank exposures, and the results of our network analysis therefore need to be interpreted with some caution. We note, in particular, that many of the linkages via off-shore markets are out of reach of our analysis using the BIS international banking statistics. Nevertheless, the main findings in this paper are not undermined by this limitation: the cross-border exposure network for banks has become more connected with more direct linkages, and the world has gotten smaller over time.

[10] Summers (2000) argues this view with an illuminating analogy: “The jet airplane made air travel more comfortable, more efficient, and more safe, though the accidents were more spectacular and for a time more numerous after the jet was invented. In the same way, modern global financial markets carry with them enormous potential for benefit, even if some of the accidents are that much more spectacular.” He continues, “As the right public policy response to the jet was longer runways, better air-traffic control, and better training for pilots, and not the discouragement of rapid travel, so the right public policy response to financial innovation is to assure a safe framework so that the benefits can be realised, not to stifle the change.”

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Contagion and the composition of Canadian banks' foreign asset portfolios: do financial crises matter?

Eric Santor*

Abstract

This paper uses a unique Bank of Canada panel data set to assess the impact of information-based contagion on the foreign asset exposures of Canadian banks. Specifically, banks' foreign asset exposures include loans, deposits and holdings of public and private securities from 1984 to 2003 on a quarterly basis vis-à-vis over 150 foreign jurisdictions. Preliminary results find that, conditional on fundamentals, banks do not adjust their overall asset portfolios immediately in the presence of crisis events. However, there is weak evidence that the composition of foreign claims adjusts in the presence of informational contagion.

1. Introduction

The role of banks as intermediaries in global financial markets continues to evolve as regulatory reform, financial product innovation and information technology allow them to further broaden the scope of intermediation activity. A popular perception of this process is that banks have become more globalised, as witnessed by their ever increasing operations in foreign jurisdictions. Canadian banks are no exception. At the same time, this perceived rise in the global nature of banks has occurred during a period of increased financial fragility. The 1990s witnessed a plenitude of banking, currency, financial and sovereign debt crises (Glick and Hutchinson (1999)). In particular, the recent Asian, LTCM and Russian crises focused the attention of policymakers and academics alike on the notion that contagion may have disruptive effects on global financial markets and ultimately, financial stability.

Unfortunately, little progress has been made on empirically identifying the existence of contagion (Karolyi (2003)). Simply, it is difficult to determine if the response of financial market participants to crisis events reflects the effects of interdependency, ie fundamentals, or that of "informational contagion." The objective of this paper is to address whether financial intermediaries respond to informational contagion above and beyond what is warranted by fundamentals. Three questions are considered. First, do Canadian bank's total foreign asset exposures respond to contagious crisis events? Second, do these banks adjust the composition of their portfolios? And third, does local information matter? That is, in response to crisis events, do locally booked claims respond more adversely than claims booked in the banks' head office?

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In order to address these questions, this paper uses a unique Bank of Canada panel data set on Canadian banks' foreign asset exposures. The data extend from 1984 to 2003 on a quarterly basis for a set of Canadian banks with claims in over 150 foreign jurisdictions. Banks' foreign asset exposures include loans and deposits vis-à-vis foreign firms, banks, and public sector entities, and holdings of public and private securities. Additionally, foreign asset exposures can be disaggregated into claims booked in the foreign jurisdiction and those booked in Canada. I find that, conditional on fundamentals, banks do not adjust their portfolios immediately in the presence of crisis events. This suggests that informational contagion is not an important determinant of Canadian bank portfolio behaviour. However, the composition of bank foreign asset portfolios adjusts in response to crisis events.

The paper will proceed as follows. Section 2 reviews the empirical literature on banking crises and contagion. Section 3 offers a theoretical framework for assessing the effects of crisis events on the composition of Canadian banks' portfolios. Section 4 presents the empirical model and Section 5 describes the data. Section 6 presents descriptive statistics and offers regression results of the effect of banking crises on the behaviour of Canadian banks' foreign asset exposures. Section 7 concludes and offers future avenues for research.

2. Literature review

The effect of crisis events and contagion on the behaviour and composition of Canadian foreign bank exposures has not been examined in the economics literature.[1] More generally, there are few empirical studies that examine the existence of contagion and banking crises.[2] The definition of contagion is, naturally, a source of some contention. For the purposes of this study, contagion will be defined in terms of "informational" contagion. In this case, informational contagion is the process by which the occurrence of an event in one market affects other markets, above and beyond the effect consistent with fundamentals. This definition of contagion seeks to distinguish itself from simple "interdependency", or "fundamentals-based" contagion.[3]

The evidence of informational contagion and bank behaviour is limited. At the macro-level, Santor (2003) assesses whether a banking crisis is more likely to occur when a country shares similar characteristics with another country experiencing a crisis. On average, the occurrence of a banking crisis leads to the higher likelihood of a future crisis if the countries appear similar in terms of macro fundamentals. However, the use of macroeconomic data prevents identification of the contagion effect separately from the common shocks that may be driving fundamentals.

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[1] Freedman (1998) and Armstrong (1997) describe Canadian banks' aggregate foreign currency exposures from the 1950s to the early 1990s, but the analysis does not extend to the level and composition of foreign asset exposures.

[2] Substantial empirical literature seeks to determine whether banking crises can be characterised and/or predicted. Demirgüç-Kunt and Detragiache (1997, 1998 and 2002), Eichengreen and Rose (1998), Eichengreen and Arteta (2000), Glick and Hutchinson (1999), Hardy and Pazarbasioglu (1998), Kaminsky and Reinhart (1998), and Hernandez and Valdes (2001), among others, provide mixed evidence for the determinants of banking crises. Banking crises are related to slow economic growth, high inflation, high real interest rates, declining terms of trade, poor legal and accounting standards, and lower per capita income. With respect to institutional features, Demirgüç-Kunt and Detragiache (1998 and 2002) find that deposit insurance is positively related to banking crises, as is financial liberalisation. There is considerable empirical literature on the incidence of contagion in financial markets and with respect to currency crises. See Rigobon (1999) for a standard treatment.

[3] "Fundamentals-based" contagion is the process by which common shocks are propagated by real-side economic activity (Dornbusch, Park and Claessens (2000)).

Similarly, Van Rijckeghem and Weder (2000) provide evidence that capital flows to emerging markets are affected by the occurrence of banking crises, given that the affected countries share common lenders with the crisis country. Similarly, Peria, Powell and Hollar (2002) show that contagion can affect capital flows to emerging markets through the impact of domestic shocks. Specifically, the foreign claims of domestic banks are affected by shocks to the domestic economy. However, this effect has diminished over time, since they find that host country conditions matter more, and thus lending has become less "indiscriminate". This is due to the fact that an increasing proportion of foreign claims are booked in the foreign jurisdiction, and thus banks are more apt to take country effects into account. Lastly, Jeanneau and Micu (2002) explore the determinants of international bank lending, again with aggregate BIS data. They find "significant" evidence of herding, as European banks followed UK and US bank behaviour. They also find evidence of regional contagion, as lenders tended to substitute lending from crisis areas to non-crisis areas in the late 1990s.[4]

A shortcoming of the studies cited above, and more generally for the current literature on banking crises and contagion, is that the empirical methodology often confounds the effects of real-side interdependencies with informational contagion (Karolyi (2003)). The objective of this paper is to mitigate this shortcoming: that is, to try to distinguish between the notion of "fundamentals-driven" contagion, and pure "informational" contagion. Simply, can one find empirical evidence that the arrival of information that is orthogonal to observed fundamentals leads to a change in the level and composition of foreign asset exposures of Canadian banks?

3. Theoretical framework

The motivating assumption of most empirical work on contagion and bank capital flows is that banks follow an optimal portfolio rule that responds to changes in fundamentals and, to some extent, to information. For example, Goldberg's (2001) framework is predicated on the assumption that banks follow a portfolio rule to determine the level and change in foreign asset exposures. Specifically, foreign asset exposures vary according to innovations in changes in foreign and domestic interest rates, and foreign and domestic GDP growth rates. Similarly, the aggregate level studies of foreign bank exposures using BIS data also implicitly invoke a "portfolio" theory of banks' foreign asset exposures. For example, these studies rely on the argument that the arrival of "information" from the crisis events may cause banks to reduce not only their asset position in the event country, but in related countries as well. Thus, the question then arises as to what kind of portfolio rules generate the responses typically cited in the contagion literature.

Schinasi and Smith (1999) offer a useful framework in which to place the expected behaviour of banks during crisis events. In their model, banks choose a portfolio with a position in risky assets.[5] The risky assets can be thought of as the foreign asset claims of banks to various countries. Given information at time t regarding the conditional joint normal returns over the means, variance, covariances and conditional correlations of the risky assets i and j, portfolio managers choose portfolio weights accordingly. Schinasi and Smith then describe three portfolio rules that bank managers could potentially follow: the expected return benchmarking

[4] At the micro-level, Goldberg (2001), Palmer (2000) and Bonfin and Nelson (1999) analyse the behaviour of the foreign asset exposure of US banks, but do not explicitly explore the composition of foreign asset exposures, nor their response to crisis events. A related literature explores the effects of contagion within the interbank market. For example, see Upper and Worms (2004).

[5] This section follows Schinasi and Smith (1999) directly.

rule, the tradeoff rule and the loss constraint rule. The usefulness of defining these three portfolio rules is seen when Schinasi and Smith assess the impact of a change in the variance of one asset, and how each portfolio rule requires the bank to alter its weight in both the event asset and the other asset in the portfolio. For example, what would happen if the bank held claims against Colombia and Mexico, and Mexico suffered a banking crisis? Naturally, the crisis would lead to an increase in the volatility of returns in Mexico. The question Schinasi and Smith wish to evaluate is what kind of portfolio rule would induce the bank to reduce (or increase) its foreign asset exposures to Colombia.

Given a "volatility event" (such as a banking crisis) which is defined as an event at time t which increases the variance of the asset at time $t + 1$, Schinasi and Smith show that different portfolio rules yield different portfolio rebalancing responses (Table 1).

Table 1

Effects of increases in volatility on return on asset *i*

	Correlation of returns of asset *i* and *j*	
Rule	**Positive correlation between assets *i* and *j***	**Negative correlation between assets *i* and *j***
Benchmark	Decrease in asset *i* Increase in asset *j*;	Decrease in asset *i* Increase in asset *j*;
Trade off	Decrease in asset *i* Increase in asset *j*;	Decrease in asset *i* Decrease in asset *j*;
Loss constraint	Decrease in asset *i* Ambiguous effect on asset *j*;	Decrease in asset *i* Ambiguous effect on asset *j*;

For instance, under both the benchmark and tradeoff rules, given that the correlation between the two assets is positive, a volatility event in asset i will lead to a decrease in the position of asset i and increase in asset j. If the correlation is negative, then under the benchmark rule the same result holds, while under the tradeoff rule the portfolio manager will reduce the position in both risky assets. Conversely, they then show that under the loss constraint rule with positive correlation between assets, a volatility event in asset i can lead to a decrease in the position of asset j.

The consequences of their analysis have significant implications for how one views the possible effects of crisis events on the foreign asset exposures of banks. Previous literature that has explored the effect of contagion has posited the notion that investors (banks included) respond to crisis events in one asset class by reducing their positions in other similarly risky asset classes. But how a bank responds to an increase in volatility due to the occurrence of a crisis depends heavily on the portfolio rule utilised. Additionally, the current literature does not account for the fact that banks may adjust the composition of their portfolios. Simply, one cannot make claims with respect to the responses of banks to crisis events. Rather, the question must be addressed from an empirical perspective.

4. Empirical model of foreign bank exposures

4.1 Benchmark model

The empirical model used to assess the effects of crises on the optimal portfolio behaviour of Canadian banks follows Goldberg (2001). Utilising basic portfolio theory, she posits that a bank's exposure to a particular foreign country will be a function of the return of investment of

that country, relative to the bank's domestic country portfolio. Empirically, foreign country fundamentals can be proxied by the country's real interest rates and real GDP growth, while domestic fundamentals are captured by domestic real interest rates and GDP growth. Thus, the foreign asset exposures of Canadian banks can be characterised by the following equation:

$$Exp_{ijt} = \alpha_{1i} + \alpha_{2r} + \sum_{i=1}^{k} \beta_i X_{it} + \sum_{j=1}^{l} \beta_j X_{jt} + \varepsilon_{ijt} \quad (1)$$

where Exp_{ijt} is the log of the real foreign asset exposure of bank i to foreign country j at time t, X_{jt} is a vector of foreign country macroeconomic variables and X_{it} is a vector of Canadian macroeconomic variables. Regional and bank fixed effects α_r and α_i are entered to account for regional and bank specific differences: some foreign regions may, regardless of fundamentals, attract larger claims.

4.2 Econometric issues

This framework can be augmented to better reflect the portfolio decisions made by banks. First, instead of specifying bank and regional effects, the data are broken into country-bank observations across time. Thus, bank i's exposure to country j across time t is one panel where the error term can be correlated within the panel. Similarly, bank i's exposure to country k across time t is a separate panel, with error terms that are correlated within the panel. Second, to account for the possibility of state dependence in foreign asset exposures, (1) can be augmented to account for the fixed costs of commencing foreign claims, and the adjustment costs associated with their disposal. Third, to account for potential omitted variables, institutional characteristics can be included since financial intermediation could benefit from political stability and low levels of corruption. Thus, (1) is augmented as follows:

$$Exp_{ijt} = \alpha_{ij} + \lambda_k \sum_{i=1}^{K} Exp_{ijt-k} + \beta_1 X_{it} + \beta_2 X_{jt} + \delta Z_{jt} + \varepsilon_{ijt} \quad (2)$$

where α_{ij} is a bank-country fixed effect, Exp_{t-k} is a vector of lagged exposures, the X's are vectors of the macroeconomic characteristics of the foreign countries and Canada, and Z_{jt} is a measure of the political and institutional characteristics of the foreign country. This vector could include measures of political risk, bureaucratic quality, corruption, democracy, investor protection, law and order, and stability.[6] Estimation of (2) is complicated by the inclusion of lagged dependent variables, which would necessarily be correlated to the error term. However, utilisation of standard GMM estimation techniques can mitigate this problem. Additionally, in this instance, GMM would first difference the data by the ij dimension, thus accounting for the $I(1)$ nature of the data.[7]

4.3 Measures of contagion

The benchmark model described above can be augmented to include a measure of contagion. But finding appropriate measures of informational contagion is problematic.

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[6] For instance, one would expect that positive changes in the level of investor protection would lead to higher levels of foreign claims, while controlling for fundamentals.

[7] If there is an equilibrium level of foreign asset exposures, then an error correction specification may be warranted. The equilibrium level could be based on the notion that banks hold a certain percentage of their portfolio in foreign assets, for the purposes of optimal portfolio diversification. However, there is no reason to suggest that the exposure to a particular country must be a certain level. Nevertheless, future research will need to consider this question.

Ideally, the researcher would like to utilise a measure that captures a flow of information which would inform (rightly or wrongly) banks about the conditional moments of the return of assets but, at the same time, is not correlated closely to changes in fundamentals in the affected country. This is crucial in order to identify a "contagion" effect, and not simply a common shock or response to changes in fundamentals. Measuring contagion in this context proceeds as follows. Given that a crisis occurs in country i, does the bank change its exposure to country j, conditioning on the fundamentals that the crisis in i has on j? The idea is that the crisis in i reveals information about the volatility and mean of returns on country j's assets, above and beyond what can be detected from changes in fundamentals. Then, the direction of the change in exposures, as noted by Schinasi and Smith, would be determined by the portfolio rule being used by the bank.

I propose a simple measure of informational contagion. The contagion measure takes a positive value of one for country i if country j experiences a banking crisis and country i and j are in the same region. However, simple inspection would suggest that if there were a common shock that caused the crisis in j then the contagion measure may simply be proxying for this effect, even when controlling for fundamentals. A potential solution is to introduce an interaction term. The "interaction" contagion measure takes a value of one if country j experiences a banking crisis and country i and j are in the same region, and the bank has exposures in both countries. If the additional information of joint exposure induces changes in exposures, over and above the simple crisis event, then this would suggest that information is causing a change in behaviour. This test can be implemented by augmenting the benchmark model of foreign asset exposures (2) with the measure of informational contagion:

$$Exp_{ijt} = \alpha_{ij} + \lambda_k \sum_{i=1}^{K} Exp_{ijt-k} + \beta_1 X_{it} + \beta_2 X_{jt} + \delta Z_{jt} + \theta C_{jt} + \varepsilon_{ijt} \quad (3)$$

where C is the contagion measure. The measure C can also be augmented to include the amount of information that is generated by the crisis event. In this case, one could include the number of times the crisis is mentioned (or mentioned at all) in the interaction term. Crises that receive a greater number of "hits" in a newspaper database would take higher values of the index C. Similarly, crises that are not mentioned would receive lower "information" scores, and thus a lower value of C.[8]

Alternative contagion measures can also be considered. As suggested by Ahluwalia (2000), a measure of "informational contagion" can be defined building on the visible similarities argument: if two economies share similar characteristics, then the occurrence of a crisis in one country may predict a change in the portfolio being held by the bank in the other country, even if there are no real linkages between the countries. Two variations of this index can be considered. The first variation (C_{2A}) creates the index such that it takes a value of one for each country in the region that is having a crisis and has a macro characteristic beyond its threshold. The second variation (C_{2B}) of the index takes a value of one for each macro characteristic that the non-crisis country has in common with the country having a crisis.[9] Each measure of contagion will be considered in turn.

Empirical estimation of the effects of contagion is complicated by the problem of identification. In most contagion studies, correlation between the measure of contagion and

[8] Clearly, countries that are more systemically important would receive more news coverage, and thus provide more information. However, identification can be achieved if the effect occurs even when fundamentals are controlled for.

[9] The second contagion index, in this case, uses yearly data to compare threshold values of the macro variables. Ideally, quarterly data would be used, but they are not available for many of the relevant series.

other independent variables (such as macroeconomic variables) is likely. That is, the occurrence of a crisis in the same region as the affected country is typically correlated with macroeconomic outcomes in the same region, thus complicating identification. However, identification of the individual country effects from the contextual effects (a regional crisis or contagion index, for example) is possible if there is a non-linear relationship between the respective effects (Brock and Durlauf (2001) and (2007)). Specifically, Brock and Durlauf show that if non-linearities exist, then this is a sufficient condition for identification. To test for the presence of non-linearities between the contagion index and the individual-level country effects, a RESET test can be conducted.

5. Data

The foreign asset exposures for all Canadian banks come from the consolidated quarterly banking statistics report compiled by the Bank of Canada.[10] Foreign asset exposures include all claims to every foreign jurisdiction where exposures exist. This includes deposits to other financial institutions, loans to financial institutions and firms, and securities, both government and corporate. These data are collected by location of booking: the foreign jurisdiction or at the Canadian head office. The data cover all Canadian banks' exposures to over 150 jurisdictions from 1984 to 2003.[11] Additional bank balance sheet data are collected, including assets, market capitalisation, and other bank specific characteristics.

The macroeconomic data are from the International Financial Statistics and include standard measures of GDP growth rates, interest rates, inflation, government finances, current account, money supply, and private credit. The data on political institutions are from the International Country Risk Guide. This includes measures of bureaucratic quality, corruption, democracy, investor protection, law and order, and stability, which are combined into an overall measure of political risk from 1984 to the present.

Banking crisis dates are initially taken from Glick and Hutchinson (1999) and updated by the author to the current period. However, official crisis dates may not be the relevant measure of when "information" becomes available to banks, and is only reported yearly. To better capture the exact timing of the crisis dates, an alternative dating system is used. Using Dow Jones Factiva, the date of a crisis is determined by the occurrence of the first event that is mentioned in the Dow Jones Factiva database of newspapers. This has the advantage of being able to specify the exact quarter when the crisis began, and is more likely to reflect the timing of the information available to bank managers. Furthermore, the intensity of the information can be assessed by examining the number of "hits" in the database. That is, how many times the crisis event is mentioned, and how long it persists.

6. Descriptive statistics

The descriptive statistics would suggest, at a glance, that Canadian banks are extensively globalised. Table 2 lists a sample of the countries to which Canadian banks had foreign

[10] Consolidation is conducted as per guidelines in the Canadian Institute of Chartered Accountants Guide. Foreign claims of domestic Canadian banks are adjusted to account for exchange rate revaluation.

[11] While there are over 50 banks operating in Canada, six banks account for 92% of the assets and 96% of all foreign exposures. The focus of this analysis is on the six largest banks in Canada. For the United States, Goldberg finds that the largest 10 banks account for 86% of foreign exposures.

asset claims in 2002.[12] However, the extent of exposures has actually declined, relative to its peak in the 1980s. Table 3 lists the average, mean and median number of countries that each Canadian bank had foreign claims on from 1984 to 2002.[13] The size and extent of these foreign claims is considerable: total foreign claims, in constant 1997 dollars, were over $200 billion in 1984, rising to over $477.2 billion in 2002 (see Figure 1). As a percentage of total assets, however, the trend in foreign assets is quite stable. Figure 2 shows that foreign asset exposures in 2002 constituted 33% of total assets for Canadian banks. This is similar to the reported levels in the 1990s, but is considerably lower than the average of the 1980s, and is below its peak in 1984.

Table 2

Countries reporting a foreign asset exposure to Canadian banks (selected countries)

Industrialised countries	Latin America	Asia	Offshore banking centres
United States	Argentina	Sri Lanka	Bahamas
United Kingdom	Brazil	India	Barbados
Austria	Chile	Indonesia	Bermuda
Belgium	Colombia	Korea	Cayman Islands
Denmark	Ecuador	Philippines	
France	El Salvador	Singapore	
Germany	Guatemala	Thailand	
Italy	Honduras		
Netherlands	Mexico		
Norway	Paraguay		
Sweden	Peru		
Switzerland	Uruguay		
Japan	Venezuela		
Finland	Guyana		
Ireland	Jamaica		
Portugal			
Turkey			
Australia			
New Zealand			

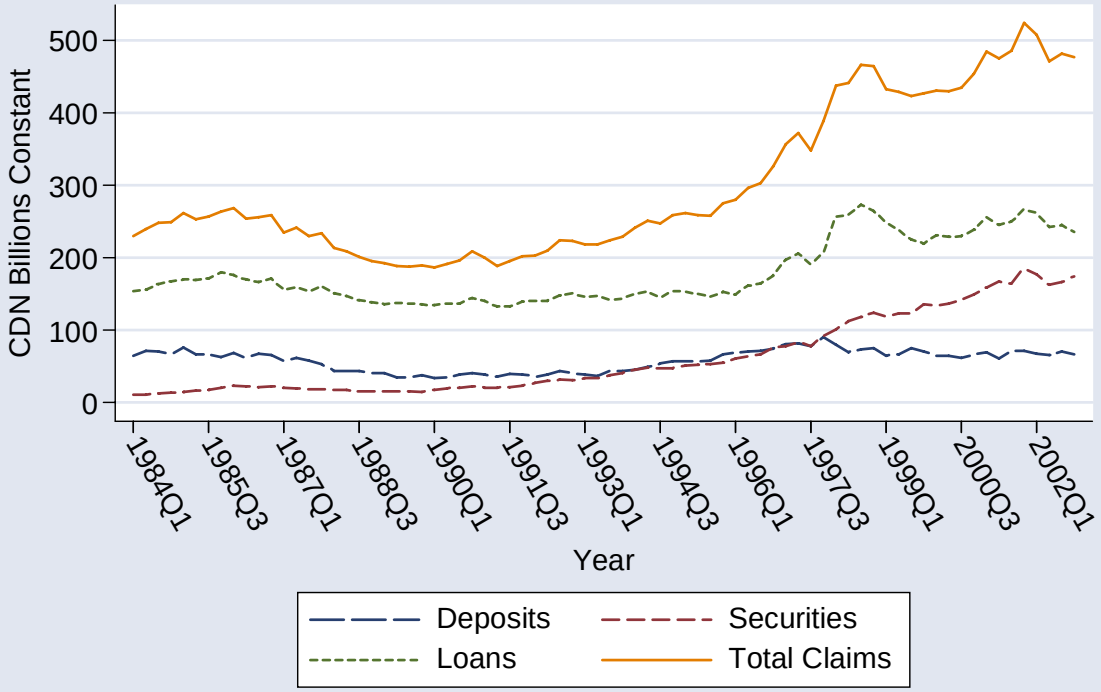
Source: Bank of Canada.

The composition of foreign asset exposures is also important to consider. Focusing only on deposits and loans, the proportion of exposures-to-assets has fallen, from 42% to only 21% from 1984 to 2002 (Figure 2). The rise in the holding of foreign securities accounts for much of the rise in total claims in the 1990s. Since foreign securities are predominated by US Treasuries, one could argue that banks have become less exposed to foreign risk (at least if one considers US T-Bills to be the most risk-free security in existence).

[12] Overall, banks reported claims to over 159 countries.

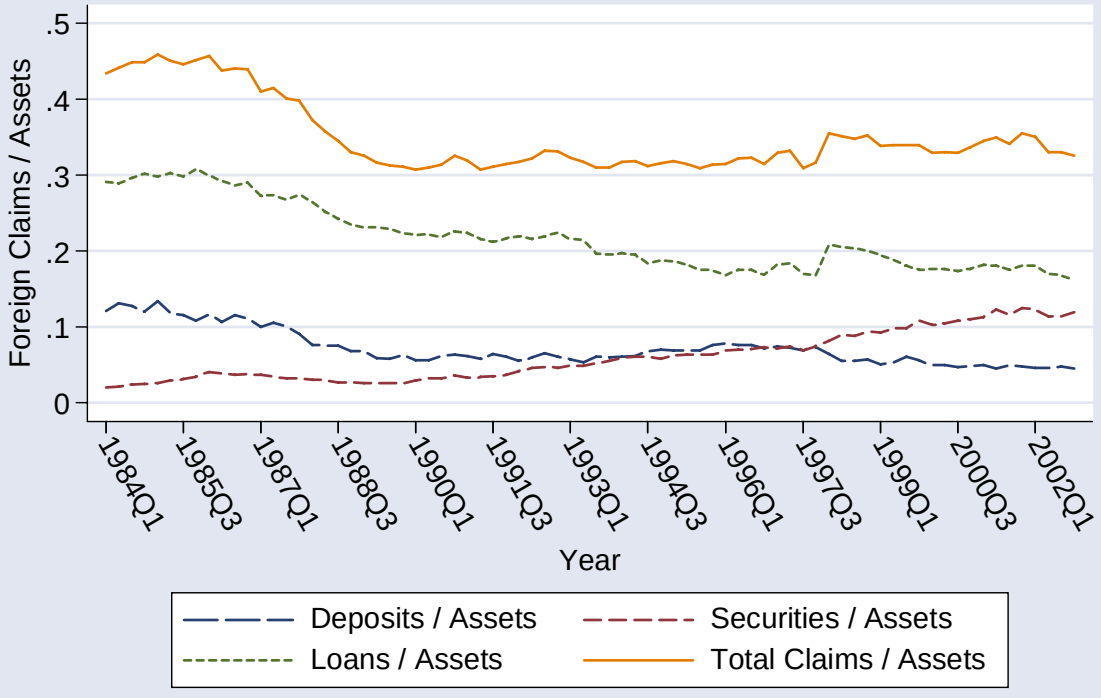
[13] In terms of the panel to be estimated, this means that there will be at least 360 ij panels with a time dimension t of 76.

Figure 1: Foreign Claims, All Banks 1984-2002



Source: Bank of Canada

Figure 2: Foreign Claims / Assets, All Banks 1984-2002



Source: Bank of Canada

Table 3

Foreign asset exposures:
Number of countries per bank reporting exposures > $1 million

Year	All banks	
	Mean	Median
1984	41	33
1985	40	30
1986	38	31
1987	36	28
1988	33	22
1989	31	20
1990	28	15
1991	27	15
1992	28	16
1993	27	17
1994	27	18
1995	30	22
1996	32	23
1997	33	21
1998	33	22
1999	32	18
2000	31	21
2001	30	23
2002	30	20

Source: Bank of Canada.

The value of foreign exposures by region is shown in Figure 3. The United States accounts for the majority of exposures at $295.7 billion in 2002, which is around 60% of total foreign exposures.[14] The increase in total claims is attributable to larger holdings of securities, particularly after 1994. The balance of remaining exposures occurs in the industrialised countries, Latin America and East Asia. The evolution of foreign claims to the industrialised countries follows that of the United States somewhat, with all claim types showing significant growth after 1993. Also, securities constitute a larger part of claims than ever before. Interestingly, exposures to Latin America fell as a share of total foreign exposures in the 1980s and early 1990s, but have risen substantially in the last few years (Figure 3). Loan exposures fell sharply in the 1980s and early 1990s, but then grew quickly, along with deposits and securities. A similar pattern for Asia emerges, with decreases in the 1980s followed by increases in the 1990s, after 1993. However, the impact of the Asian crisis is felt, as loans eased and deposits plummeted after 1997.[15] Lastly, the origin of booking has

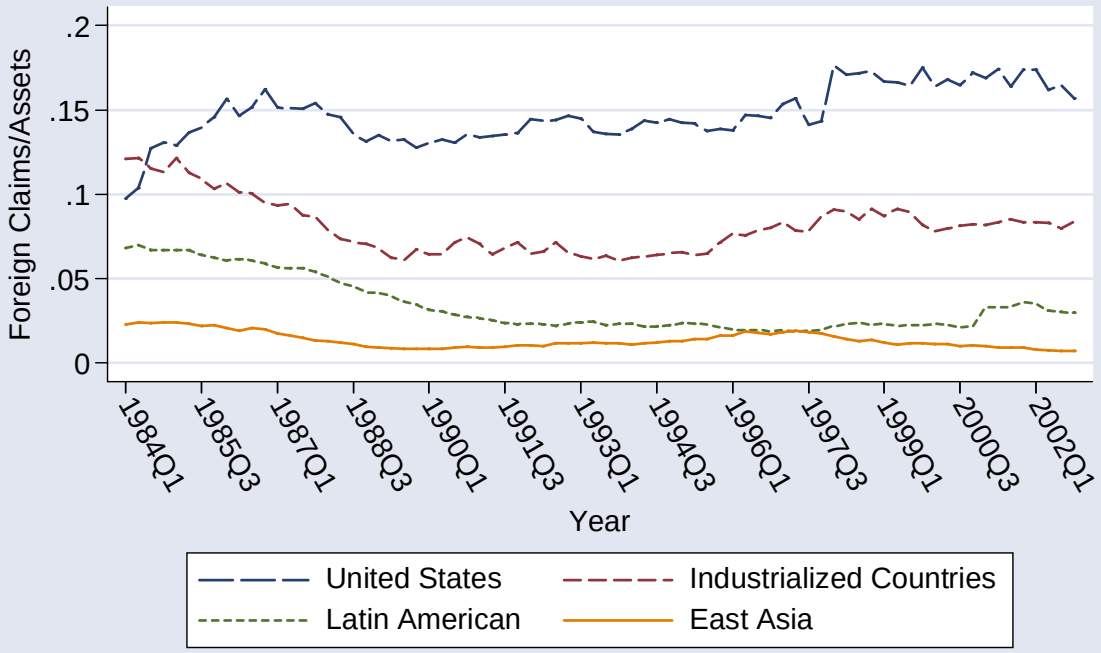
[14] The secular increase, absolutely and proportionally, in US assets suggests that Canadian banks are not holding these assets simply due to their higher returns. Rather, it could be the case that US assets, in particular T-Bills, are held for other reasons, such as collateral or for derivatives trading purposes. Future research on the determinants of these holdings of US assets is warranted.

[15] The level of exposures to Africa and the Middle East is negligible.

changed over the sample period. The ratio of claims booked inside Canada has fallen relative to the ratio of claims booked outside Canada (Figure 4).

Figure 3: Foreign Claims / Assets by Region

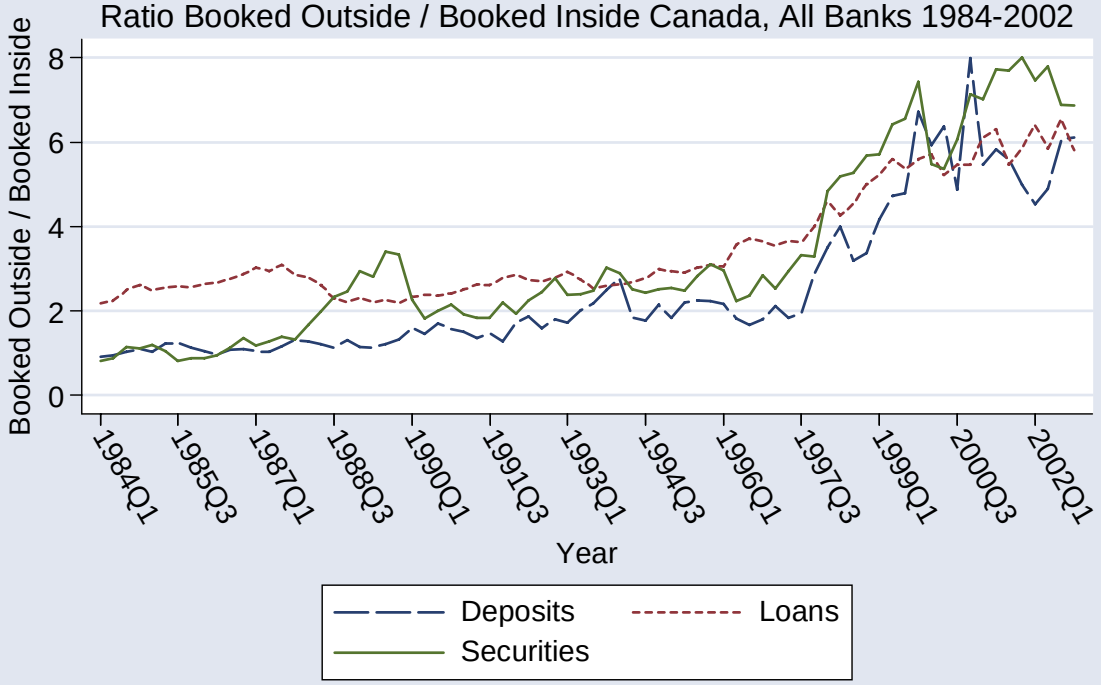
All Banks 1984-2002



Source: Bank of Canada

Figure 4: Foreign Asset Exposures

Ratio Booked Outside / Booked Inside Canada, All Banks 1984-2002



Source: Bank of Canada

The crisis dates, and additional information about the prominence of the crises are indicated by the number of "hits" in Dow Jones Factiva. The number of hits closely follows the occurrence of crises in the respective regions. For example, the number of hits for articles describing banking crises in East Asia rises sharply in 1997, and then slowly abates.[16] This information can be used in conjunction with the crisis dates to assess whether informational contagion exists.

7. Does contagion exist? Regression results

The results of estimating the benchmark model of foreign asset exposures (equation (2)) by GMM in first differences is presented in Table 4. The GMM estimation technique is that developed by Arellano and Bond (1991) and Anderson and Hsiao (1981). All regressions include time dummies, and the right-hand macro variables are treated as exogenous. This latter claim is reasonable given that it is unlikely that the volume of Canadian banks' asset exposures is sufficiently large to affect output and interest rates in the countries considered.[17] Four lags of the dependent variable are included in order to remove autocorrelation in the error term. Lagged levels of the dependent and exogenous macro variables are used as instruments for the endogenous lagged dependent variable, and the maximum number of lagged instruments is set at six.[18]

For the entire sample of countries, the results show that previous levels of exposures are significant determinants of changes in the level of foreign asset exposures, suggesting that there is a large degree of inertia.[19] This could be due to the existence of fixed costs for commencing claims on foreign residents in a country, and the adjustment costs for altering the level of those claims. The degree of inertia is larger for securities than for loans and deposits.[20]

The influence of macro variables is not strong. For total claims, foreign and domestic macro variables do not influence foreign exposures. Interestingly, there are significant but different impacts when claims are disaggregated into their respective types. For deposits, higher Canadian GDP growth leads to lower foreign deposits. This suggests that as the Canadian economy offers higher returns to domestic lending, funds lent to other countries' banks are reduced. Except for the foreign real interest rate, the effect of the macro variables on loans is not significant. Foreign exposures in the form of securities are not correlated to foreign or domestic interest rates, or foreign or Canadian GDP growth.[21] Lastly, changes in political risk have no effect on foreign exposures.

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16 The details of the search mechanism used are available from the author upon request.

17 One step estimates are conducted for all regressions, for inference purposes.

18 Inclusion of four lags of the dependent variable was sufficient to remove second order autocorrelation for most specifications.

19 Only the largest 73 countries, in terms of exposures, are considered.

20 These differences are statistically significant when comparing loans and deposits to securities.

21 Preliminary results indicate that inclusion of lagged values of the macro variables does not alter the results.

Table 4
Benchmark model: GMM estimates
Dependent variable: ΔClaims (by type)

Variable	Deposits (1)	Loans (2)	Securities (3)	Total claims (4)
Claims $_{t-1}$	0.1470*	0.1871*	0.3160*	0.2122*
	(0.0212)	(0.0192)	(0.0224)	(0.0194)
Claims $_{t-2}$	0.0260**	0.0944*	0.0233*	0.0670*
	(0.0148)	(0.0125)	(0.0144)	(0.0120)
Claims $_{t-3}$	–0.0083	–0.0298*	0.0460*	0.0399*
	(0.0126)	(0.0110)	(0.0135)	(0.0103)
Interest Rate$_{FOR}$	0.1206	0.6165*	–0.2708	0.3737
	(0.5628)	(0.2965)	(0.4026)	(0.2353)
GDP$_{FOR}$	–0.3041	–0.0485	–0.0560	–0.4301
	(0.568)	(0.3850)	(0.4259)	(0.2917)
Interest Rate$_{CAN}$	1.4606	0.8230	–1.9037	–0.5436
	(1.9680)	(1.4371)	(1.4095)	(1.0567)
GDP$_{CAN}$	–1.8887**	0.6195	–0.8466	–0.4393
	(1.0998)	(0.7915)	(0.7348)	(0.5794)
Political Risk	0.0042	0.0097	–0.0004	–0.0018
	(0.0090)	(0.0064)	(0.0062)	(0.0048)
AR(2)	0.6390	0.0000	0.0000	0.2238
N	9536	9522	5574	11508

* indicates significance at the 5% level, ** indicates significance at the 10% level. Time dummies included. All independent variables are first differenced. Instrument matrix is limited to 6 lags. Right-hand variables are treated as exogenous. *AR*(2) is the Arellano-Bond test for autocorrelation.

The sample is then broken down into two groups to examine whether banks respond differently to changes in fundamentals depending on whether the assets are booked in the head office of the Canadian bank (booked inside) or if the claim is booked locally in the foreign jurisdiction (booked outside). Recent anecdotal evidence has suggested that locally booked claims should be less sensitive to contagion and more reliant on fundamentals. Table 5 presents the results, by asset type, for claims booked inside and outside Canada. Deposits booked inside Canada have higher persistence than claims booked outside Canada – this may reflect the fact that booking at head office may be over longer maturities. With respect to fundamentals, deposits booked inside Canada do not respond to macro variables. However, deposits booked outside Canada respond negatively to changes in the real interest rate and Canadian GDP growth. The former is counterintuitive, as higher interest rates should draw more deposits. The latter suggests that higher Canadian GDP growth leads to a substitution away from foreign deposits for the higher returns to lending in Canada. Loans booked inside Canada are also more persistent that those booked outside. Interestingly, loans booked inside Canada fall as foreign interest rates rise, while the opposite is true for those booked in the foreign jurisdiction. There are no significant differences in the behaviour of securities by place of booking. Lastly, overall claims are less persistent when booked outside Canada. This stands in contradiction to the anecdotal evidence that claims booked locally will be less sensitive than claims booked inside Canada.

Table 5
Benchmark model: GMM estimates
Dependent variable: ΔClaims (by type)

	Booked inside Canada				Booked outside Canada			
Variable	**Deposits (1)**	**Loans (2)**	**Securities (3)**	**Total claims (4)**	**Deposits (1)**	**Loans (2)**	**Securities (3)**	**Total claims (4)**
Claims $_{t-1}$	0.2423*	0.2114*	0.2040*	0.3550*	0.0285*	0.1103*	0.3219*	0.1237*
	(0.0208)	(0.0241)	(0.0299)	(0.0198)	(0.0211)	(0.0216)	(0.0259)	(0.0180)
Claims $_{t-2}$	0.0231	0.0666*	0.0069	0.0370*	–0.0106	0.0200	–0.0024	–0.0060
	(0.0149)	(0.0165)	(0.0206)	(0.0132)	(0.0157)	(0.0129)	(0.0158)	(0.0119)
Claims $_{t-3}$	–0.0037	0.0306**	0.0432*	0.0445*	–0.0641*	–0.0918	–0.0122	–0.0029
	(0.0137)	(0.0143)	(0.0207)	(0.0121)	(0.0137)	(0.0118)	(0.0149)	(0.0107)
Int Rate$_{FOR}$	–0.2152	–0.0218	0.0559	–0.1278	–2.0188*	0.4729*	–0.5092	0.0560
	(0.6861)	(0.4761)	(0.3073)	(0.4174)	(0.7815)	(0.2381)	(0.4891)	(0.2550)
GDP$_{FOR}$	–0.5146	–1.1012**	0.6883	–0.4615	0.9024	0.4180	0.2042	0.0968
	(0.7247)	(0.6658)	(0.4401)	(0.5269)	(0.7306)	(0.3041)	(0.4616)	(0.3199)
Int Rate$_{CAN}$	2.8204	0.2699	–0.0810	4.8037*	0.3106	0.8680	–0.3046	0.1416
	(2.2556)	(2.3231)	(1.3195)	(1.8131)	(2.1643)	(1.1350)	(1.4437)	(1.1076)
GDP$_{CAN}$	1.4182	0.5547	–1.0698	–0.0846	–2.3541**	0.3378	–1.0573	–0.8502
	(1.3451)	(1.2930)	(0.6869)	(1.0086)	(1.2401)	(0.6230)	(0.7599)	(0.6146)
Pol Risk	0.0074	0.0065	0.0006	0.0059	0.0381*	–0.0009	–0.0002	0.0087**
	(0.0111)	(0.0109)	(0.0050)	(0.0085)	(0.0108)	(0.0052)	(0.0070)	(0.0052)
AR(2)	0.2489	0.8470	0.2849	0.9697	0.1237	0.5028	0.0000	0.0065
N	7720	6964	2029	10606	7320	7800	4688	9823

* indicates significance at the 5% level, ** indicates significance at the 10% level. Time dummies included. All independent variables are first differenced. Instrument matrix is limited to 6 lags. Right-hand variables are treated as exogenous. *AR*(2) is the Arellano-Bond test for autocorrelation. Booked inside Canada refers to claims booked at head office. Booked outside Canada refers to claims booked in the foreign jurisdiction at a branch of the bank.

The lack of significant relationships between macro fundamentals and claims may be related to the fact that banks' portfolio rules behave differently by market. Table 6 presents estimates of equation (2) with the sample divided by region. The most striking feature is the persistence of exposures to the United States and Japan when compared to the other industrialised counties. While Latin America has high initial persistence, this is short-lived. The results suggest varying effects for macro variables on exposures. For the United States, total claims only respond positively to higher Canadian interest rates – this may be because higher interest rates are related to slower economic growth in Canada, particularly during the 1991 recession. In this environment, banks may have substituted with US claims, and in particular, securities. For industrialised countries and Asia, higher foreign GDP is negatively related to total claims, a counterintuitive result. However, the positive coefficient on the foreign interest rate suggests substitution towards higher returns in the case of Asia. Overall, while there is some variation across regions, the effect of macro fundamentals on the level of exposures is not strong.

Table 6
Benchmark model: GMM estimates
Dependent variable: ΔTotal Claims (by type)

Variable	United States (1)	Industrialised countries (2)	Asia (3)	Latin America (4)	Japan (5)
Claims $_{t-1}$	0.5328*	0.1567*	0.0644*	0.4955*	0.3331*
	(0.0310)	(0.0193)	(0.0273)	(0.0312)	(0.0415)
Claims $_{t-2}$	0.2335*	0.0400*	0.0818*	0.0399	0.2254*
	(0.0299)	(0.0136)	(0.0209)	(0.0286)	(0.0422)
Claims $_{t-3}$	0.1608*	0.0140	–0.0088	0.0444	0.0859*
	(0.0290)	(0.0120)	(0.0202)	(0.0283)	(0.0410)
Int Rate$_{FOR}$	1.2965	0.2859	1.4656*	0.0126	–1.3624
	(2.5989)	(0.2915)	(0.5234)	(0.1527)	(3.9010)
GDP$_{FOR}$	–0.7154	–0.8396*	–0.6159**	0.3922	1.6076
	(1.8746)	(0.3940)	(0.3835)	(0.2521)	(2.1255)
Int Rate$_{CAN}$	2.9004**	1.2051	–3.4720	1.9297	–1.7145
	(1.7314)	(1.3536)	(2.5446)	(1.9427)	(2.7667)
GDP$_{CAN}$	–0.0152	–0.2241	0.4598	–0.5880	–3.6101*
	(0.8315)	(0.6602)	(1.1304)	(0.8704)	(1.4877)
Pol Risk	–0.0089	–0.0048	–0.0095	0.0053	–0.0064
	(0.0074)	(0.0059)	(0.0077)	(0.0067)	(0.0098)
AR(2)	0.0300	0.0003	0.1336	0.2523	0.0128
N	687	8652	2461	1642	640

* indicates significance at the 5% level, ** indicates significance at the 10% level. Time dummies included. All independent variables are first differenced. Instrument matrix is limited to 4 lags. Right-hand variables are treated as exogenous. *AR*(2) is the Arellano-Bond test for autocorrelation.

The impact of banking crises and contagion is presented in Table 7. For all countries (specifications (1) through (4)), the occurrence of a contemporaneous banking crisis does not affect foreign asset exposures. In terms of the theoretical model, a banking crisis can be considered to be a "volatility event" that contains information. However, it appears that this information does not affect the level of exposures. When the contemporaneous contagion index (C_1) is entered, there is no evidence of contagion. This could be due to the fact that banks do not adjust their exposures immediately, but only slowly over time.[22] That is, when a country in the same region experiences a crisis and the bank has an exposure to the crisis country, it does not affect the foreign asset exposures in other countries in that region for the bank. The lack of a significant relationship may be due to the lag in the reaction to the crisis event. To account for this effect, the contagion index is entered with a lag. Strikingly, the effect is positive only for deposits: a crisis in another country in the region leads to higher deposits in the non-crisis countries.

[22] Another possible explanation is that asset exposures that are booked in the foreign country react differently than exposures booked in country i of the head office of the bank (Goldberg (2001)). A closer examination of this issue is considered for future research.

Table 7
Benchmark model: GMM estimates, contagion index C_1
Dependent variable: ΔClaims (by type)

	All countries				Developing countries			
Variable	**Deposits (1)**	**Loans (2)**	**Securities (3)**	**Total Claims (4)**	**Deposits (5)**	**Loans (6)**	**Securities (7)**	**Total claims (8)**
Model 1								
Banking crisis	–0.0057	0.1159	0.2094	–0.0716	0.0417	0.0429	–0.2682	0.0180
	(0.1849)	(0.1406)	(0.1683)	(0.1062)	(0.2557)	(0.1629)	(0.2243)	(0.1352)
Regional Crisis x Bank Exposure (C_1)	0.0203	–0.0489	0.0000	–0.0348	–0.2375*	–0.0315	0.0977	–0.0740
	(0.0472)	(0.0381)	(0.0379)	(0.0286)	(0.0958)	(0.0623)	(0.0697)	(0.0515)
Model 2								
Banking crisis	–0.0155	0.0767	0.2112	–0.0950	0.0407	0.0266	–0.2945	0.0246
	(0.1866)	(0.1419)	(0.1699)	(0.1067)	(0.2539)	(0.1600)	(0.2223)	(0.0478)
Regional Crisis x Bank Exposure$_{t-1}$ (C_1)	0.0875*	0.0151	–0.0143	–0.0249	–0.2581*	0.0370	0.1748*	–0.0942*
	(0.0424)	(0.0340)	(0.0330)	(0.0252)	(0.0933)	(0.0585)	(0.0659)	(0.0478)

* indicates significance at the 5% level, ** indicates significance at the 10% level. Lagged claims, macroeconomic variables, political risk and time dummies included. All independent variables are first differenced. Instrument matrix is limited to 6 lags. Right-hand variables are treated as exogenous. C_1 is interaction of a regional crisis with shared exposures and the number of "hits" the crisis event received in the DJ Factiva database.

The lack of significance may be the result of sample choice: perhaps crises only matter for developing countries. The model is re-estimated for developing countries only (specifications (5) through (8)). For the lagged contagion index the effect on deposits is now negative, but securities are positive, leading to an overall negative effect for total claims. This suggests that the occurrence of a crisis in another country in the same region where the bank has claims, when controlling for fundamentals, leads to a reduction in those claims.

To check the robustness of this result, the second contagion index (C_2) is estimated (Table 8). Two variations are considered. The first variation (C_{2A}) creates the index such that it takes a value of one for each country in the region that is having a crisis and has a macro characteristic beyond its threshold. The second variation (C_{2B}) of the index takes a value of one for each macro characteristic that the non-crisis country has in common with the country having a crisis.[23] For all countries, the contemporaneous contagion indices C_{2A} and C_{2B} are only significant for deposits (and are the opposite of the expected sign). Inclusion of the lagged values of the contagion index is also considered. Both variations of the lagged C_2 indices are negatively related to securities, but are insignificant for the other types of claims. This result has two potential implications. First, banks do react to information from crises in

[23] The second contagion index, in this case, uses yearly data to compare threshold values of the macro variables. Ideally, quarterly data would be used, but they are not available for many of the relevant series.

the same region, but only slowly, when conditioning on macro fundamentals, political risk and the state-dependent nature of foreign claims. And second, the reaction leads to lower exposures to securities. This suggests that banks do not "panic" in the presence of crisis events. The estimates are repeated for the developing countries with roughly similar results (Table 10), with the notable exception that there is a small, negative correlation between the lagged contagion index (C_{2A}) and total claims. However, for contagion C_{2B}, the effect is negative but insignificant. Interestingly, the effect on loans is positive in this latter case. Nevertheless, these results bear further investigation regarding the sensitivity of the results to alternate specifications of the "contagion" indices, and tests of the orthogonality of the indices from macro fundamentals.

Table 8
Benchmark model: GMM estimates, contagion index C_2
Dependent variable: ΔClaims (by type)

Variable	Contagion index C_{2A}: Similarity by number of countries in crisis in region				Contagion index C_{2B}: Similarity by number of macro variables in crisis in region			
	Deposits (1)	**Loans (2)**	**Securities (3)**	**Total claims (4)**	**Deposits (5)**	**Loans (6)**	**Securities (7)**	**Total claims (8)**
All countries								
Model 1								
Contagion Index (C_2)	0.0480*	–0.0092	–0.0271	–0.0101	0.0245*	–0.0034	–0.0093	0.0033
	(0.0239)	(0.0188)	(0.0213)	(0.0145)	(0.0120)	(0.0098)	(0.0119)	(0.0075)
Model 2								
Contagion Index$_{t-1}$ (C_2)	0.0098	0.0050	–0.0571*	–0.0027	0.0068	0.0080	–0.0304*	0.0085
	(0.0238)	(0.0187)	(0.0208)	(0.0144)	(0.0119)	(0.0096)	(0.0115)	(0.0073)
Developing countries only								
Model 1								
Contagion Index (C_2)	0.0900*	0.0293	–0.0103	–0.0250	0.0685*	0.0232	–0.0129	–0.0062
	(0.0445)	(0.0258)	(0.0293)	(0.0217)	(0.0299)	(0.0180)	(0.0229)	(0.0151)
Model 2								
Contagion Index$_{t-1}$ (C_2)	0.0195	0.0363	–0.0235	–0.0453*	0.0000	0.0399*	–0.0141	–0.0156
	(0.0453)	(0.0255)	(0.0290)	(0.0215)	(0.0295)	(0.0175)	(0.0216)	(0.0146)

* indicates significance at the 5% level, ** indicates significance at the 10% level. Lagged claims, macroeconomic variables, political risk, banking crisis dummies and time dummies included. All independent variables are first differenced. Instrument matrix is limited to 6 lags. Right-hand variables are treated as exogenous.

Table 9
Benchmark model: GMM estimates, contagion index C_1
Dependent variable: ΔClaims (by type)

	Booked in Canada				Booked in foreign jurisdiction			
Variable	**Deposits (1)**	**Loans (2)**	**Securities (3)**	**Total claims (4)**	**Deposits (5)**	**Loans (6)**	**Securities (7)**	**Total claims (8)**
All countries								
Banking crisis	0.2684*	–0.1907*	–0.1090**	0.1650*	–0.4239*	–0.0366	–0.0138	–0.1495*
	(0.0982)	(0.0892)	(0.0594)	(0.0730)	(0.1043)	(0.0497)	(0.0744)	(0.0489)
Regional Crisis x Bank Exposure $_{t-1}$ (C_1)	0.0214	–0.0071	0.0231**	0.0011	0.0478	0.0237	–0.0516*	0.0399*
	(0.0371)	(0.0317)	(0.0117)	(0.0252)	(0.0339)	(0.0165)	(0.0233)	(0.0155)
Developing countries								
Banking crisis	0.0427	–0.0359*	–0.0266	0.2977*	–0.5245*	0.0504	0.2117	–0.1171
	(0.2228)	(0.1523)	(0.0788)	(0.1225)	(0.2113)	(0.0848)	(0.1687)	(0.0826)
Regional Crisis x Bank Exposure$_{t-1}$ (C_1)	0.0921**	0.0278	0.0033	–0.0413	0.0794*	0.0574*	–0.0621	0.0680*
	(0.0497)	(0.0343)	(0.0096)	(0.0295)	(0.0473)	(0.0196)	(0.0389)	(0.0201)

* indicates significance at the 5% level, ** indicates significance at the 10% level. Lagged claims, macroeconomic variables, political risk and time dummies included. All independent variables are first differenced. Instrument matrix is limited to 6 lags. Right-hand variables are treated as exogenous. C_1 is interaction of a regional crisis with shared exposures and the number of "hits" the crisis event received in the DJ Factiva database.

8. Conclusions

The objective of this paper was to examine the foreign asset exposures of Canadian banks and to determine whether they react to informational contagion. This study found that, while Canadian banks are very active globally, they are less so than in the 1980s. Canadian banks have a lower proportion of exposures in the form of deposits and loans than in the 1980s, but higher levels of foreign securities. The reaction of Canadian banks' foreign exposures to crisis events is then explored. Banks' foreign exposures display considerable inertia, as banks only slowly adjust their portfolios: they react only weakly to changes in macro-variables and political risk. This also translates into a lack of the effect of crises on their level of exposures, at least in the short run. However, there is preliminary evidence that when countries share similar characteristics to countries in crisis, banks react to the event by changing the composition of their exposures, but only slowly. This result is striking, as it suggests that banks do not panic in the face of crises. Interestingly, foreign claims booked inside Canada were more persistent than claims booked in the foreign country.

This study raises many questions for future research. The most obvious extension is to explore why Canadian banks do not adjust their portfolios of foreign assets rapidly in response to crisis events or changes in macro fundamentals. It could be the case that the adjustment occurs either on their domestic balance sheet or off-balance sheet. Second, the steady level of internationalisation also raises the simple question as to why banks are accumulating higher claims on securities, and lower claims in the form of deposits and loans.

The exploration of these issues has important consequences for the Canadian financial system.

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The pecking order of cross-border investment

Christian Daude and Marcel Fratzscher*

Abstract

Is there a pecking order of cross-border investment in that countries become financially integrated through some types of investment rather than others? Using a novel database of bilateral capital stocks for all types of investment – foreign direct investment (FDI), portfolio equity securities, debt securities as well as loans – for a broad set of 77 countries, we show that such a pecking order indeed exists. The paper focuses on two key determinants of this pecking order: information frictions and the quality of host country institutions. Overall, we find that in particular FDI, and to some extent also loans, are substantially more sensitive to information frictions than investment in portfolio equity and debt securities. We also show that the share as well as the size of FDI that a country receives are largely insensitive to institutional factors in host countries, while portfolio investment is by far the most sensitive to the quality of institutions. This provides new evidence in favour of some hypotheses but contradicts others put forward in the literature on trade in financial assets.

1. Introduction

The debate in the literature on trade in financial assets makes the important point that the type of foreign financing of cross-border investment may not pursue a random pattern, but follows a certain "pecking order" regarding the composition of capital flows. One key focus has been on the role of information frictions, with some important theoretical contributions arguing that portfolio investment should be more sensitive to information frictions than FDI or bank loans due to a lack of ownership control of the former (Razin, Sadka and Yuen 1998). A second important strand of the literature has concentrated on the role of institutions in influencing the composition of cross-border investment (Albuquerque 2003; Wei 2000a), with the empirical work still being inconclusive on which types of capital are most affected by the institutional environment.

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The main contribution of the paper is to test empirically for the existence of such a pecking order and to identify its determinants in a bilateral country-pair setting. We concentrate on two determinants that have been central in the literature on trade in financial assets: the role of information frictions, and the role of institutions as drivers of cross-border investment. The paper builds on several seminal studies. In particular, Portes, Rey and Oh (2001) show that information frictions for a number of countries indeed exert a larger effect on portfolio equity and corporate debt than on government bond flows with the United States. The present paper is complementary to this as well as other studies, but innovates in a number of ways. First, using a novel dataset on bilateral holdings, the present paper is the first that includes all types of capital, ie also FDI and other investment/loans, and thus allows for a systematic comparison of all types of investment in the capital account. This is an important difference because especially FDI and loans are the dominant types of investment received by many if not most emerging markets and developing countries.[1]

Second, the empirical analysis covers 77 countries and thus is much broader in scope through addressing the issue of cross-border investment also from an emerging market economy (EME) perspective. This allows us to investigate and indeed empirically confirm that the effect of information on cross-border investment exhibits a sizeable asymmetry across countries, exerting a larger influence on EMEs. Third, our empirical methodology is distinct from most of the literature through building on the trade literature on the border effect (Anderson and van Wincoop 2003; Cheng and Wall 2005) which stresses the importance of including source and host country fixed effects and shows that the exclusion of such fixed effects may generate a sizeable estimation bias.

Our empirical results show that information frictions have a substantial effect on the pecking order as we find that FDI and loans are the most sensitive and foreign portfolio investment (FPI) equity and FPI debt securities the least sensitive types of investment to information frictions. For instance, the distance among country pairs has a 1.5 to 2 times larger impact on FDI stocks than on equity securities and debt securities. Similarly, we find loans to be as sensitive as FDI to information asymmetries, thus confirming and being in line with the literature on the capital structure of firms which has emphasised the special role of loans and their sensitivity to information (Myers 1984; Bolton and Freixas 2000). We use various proxies for information frictions – distance, the volume of bilateral telephone traffic, bilateral trade in newspapers and periodicals, and the stock of immigrants from the source country in the host – showing the robustness of this result to alternative specifications. While these empirical findings are new, we also confirm some of the existing findings, in particular that equity portfolio investment is not more sensitive to information frictions than debt securities (Portes, Rey and Oh 2001). Using our different econometric approach also reveals that the effects of information frictions tend to be larger than some found in the literature, though a precise comparison is impossible due to different country samples across studies.

Regarding the second determinant – the impact of institutions on the composition of cross-border investment – we make two key points. First, while many papers in the literature have focused on the effects of institutions on one or two particular types of capital flows, our analysis is the first to test for differences across all major components of the capital account. Our results show that portfolio investment is much more sensitive than FDI or loans to a broad set of institutional indicators, such as the degree of information disclosure in local credit market regulations, as well as accounting standards in the host country. Portfolio investment also reacts much more strongly to the risk of expropriation and repudiation costs,

[1] For example, in our sample the average share of FDI in total foreign investment is 46% for developing countries but only 22% for developed countries. Moreover, the share of combined FDI and loans accounts for even 76% of total foreign inward investment for EMEs. We discuss these issues in detail in section 3 of the paper.

confirming the hypothesis put forward by Albuquerque (2003), who argues that portfolio investment is easier to expropriate than other types of investment. Other hypotheses of the literature are, however, not confirmed by our analysis. For instance, portfolio investments in particular, but also loans, decrease substantially with the degree of corruption. By contrast, the stock of FDI is found to be less sensitive to corruption, which is consistent with some findings in the literature (see Daude and Stein, 2004) but contrary to others (eg Wei, 2000a). Overall, portfolio investment, and in particular equity securities, appear to be the most sensitive type of investment to institutional factors. Our results prove robust to various alternative proxies of institutions and country samples.

An additional point of the paper is that we also study the impact of financial market development on the pecking order of cross-border investment positions. We find that portfolio investment is substantially more sensitive to the degree of market openness and development than FDI or loans. For instance, capital account liberalisation and financial development change the *composition* of financial liabilities of a country by raising the share of portfolio investment substantially. Moreover, we find that the *volume* of FDI and loans is relatively insensitive to market developments as, for instance, capital account liberalisation does not have a statistically significant effect on the volume or stock of FDI or loans. This is in line with the evidence for capital flows of previous studies that use a different empirical strategy (see eg Montiel and Reinhart, 1999, Magud and Reinhart, 2005).

The findings of the paper have a number of implications. The paper underlines the role of bilateral information frictions as a barrier to cross-border investment, in particular for FDI and loans. Importantly, the paper emphasises that FDI should not necessarily be seen as an unconditional blessing for host countries. We present evidence that the share of inward FDI and also foreign loans is highest for countries with weak institutions and poorly developed or badly functioning capital markets. Therefore, although FDI may have beneficial effects on the economy, a composition of foreign investment that is heavily tilted towards FDI is likely to be a signal of some fundamental weaknesses of the host country economy, thus providing support for the argument of Hausmann and Fernández-Arias (2000) and Albuquerque (2003).

The remainder of the paper is organised in the following way. The next section provides a brief overview of the literature on the determinants of capital flows and the pecking order of cross-border investment. Section 3 outlines the empirical methodology and presents the data, together with a number of stylised facts on cross-border investment. The empirical results are discussed in Sections 4 and 5, including various robustness and sensitivity tests. Section 6 concludes and offers a short discussion of policy implications.

2. Related literature

Information frictions have been at the core of the debate on international capital flows.[2] Razin, Sadka and Yuen (1998) present a model that extends the pecking order argument from the corporate finance literature by Myers and Majlauf (1984) and Myers (1984) to international capital flows to analyse issues of capital taxation. In particular, they assume that FDI circumvents the informational problems completely, while portfolio debt and equity are subject to informational asymmetries where domestic investors observe the real productivity of the firm, while foreign investors do not. Therefore, FDI is the preferred form of financing in

[2] Portes and Rey (2005) and Portes, Rey and Oh (2001) provide references and a discussion of the finance literature related to information frictions. Also, see Harris and Raviv (1991) for an earlier survey on the empirical corporate finance literature on information frictions and asset markets.

the presence of information frictions, followed by portfolio debt and then equity. Neumann (2003) presents a version of lending with a moral hazard model by Gertler and Rogoff (1990) that focuses on the differences between international debt and equity financing. In contrast to Razin, Sadka and Yuen (1998), she assumes that ownership, even in the form portfolio equity, conveys some control and therefore information on the investment. Assuming that monitoring costs are decreasing in ownership, the implied pecking order is that FDI and equity are less costly ways of financing domestic investment than instruments that do not convey some degree of ownership and therefore information, like loans or debt.

Goldstein and Razin (2006) present a model that explains differences in volatility of FDI versus FPI through information asymmetries. Again the key assumption is that FDI implies ownership control of the firm and therefore more information than FPI. In addition, FDI is subject to a fixed cost in contrast to FPI. They assume that foreign investors are subject to privately observed liquidity shocks which drive down the price of selling the asset before maturity due to a standard "lemons" problem. Thus, there is a trade-off between efficiency and liquidity for foreign investors. Under these conditions, they show that in equilibrium, if production costs are higher in developed countries, developed countries will receive more FPI that developing countries, given that it would be less profitable to pay the fixed cost associated with FDI. Finally, Mody, Razin and Sadka (2003) present a similar model that predicts also that more countries with good corporate governance attract more FPI. While several of these theoretical models assume different sensitivity to information frictions across the different components of the capital account, it has not been tested systematically. Our paper tries to fill this gap in the literature.

Despite limited empirical evidence, the perceived wisdom is that certain types of capital inflows are more beneficial for receiving countries than others. In particular, FDI is generally seen as a "good" type of capital because it may promote growth in host countries by encouraging a transfer of technology and knowledge and by opening market access abroad (eg Aitken, Hanson and Harrison, 1997; Borensztein, De Gregorio and Lee, 1998).[3] On the other hand, portfolio investment flows are considered to be more volatile, may exacerbate the magnitude of business cycles and also induce or at least worsen financial crises (eg Claessens, Dooley and Warner, 1995; Chuhan, Claessens and Mamingi, 1998; Sarno and Taylor, 1999).

Other papers have challenged the view of considering FDI necessarily as "good cholesterol" (eg Hausmann and Fernández-Arias, 2000; Albuquerque, 2003). These papers show that actually the richest and least volatile economies, and countries with good institutions and well functioning markets, receive more FPI and relatively less FDI from abroad as a fraction of total capital inflows.

Finally, the existence and functioning of markets are potentially an important determinant of foreign investment, and are closely linked to the effects of information asymmetries. If markets are absent or are functioning poorly, firms may have no other choice than to use FDI to carry out an investment project (Hausmann and Fernandez-Arias, 2000). In this sense, FDI may function as a substitute for a functioning market mechanism. Thus, portfolio investment or bank loans may be preferred options for firms in an environment in which markets function well. In a broader sense, the quality of economic and political institutions is

[3] For papers that find a positive and differential impact of FDI on domestic investment and economic growth compared to portfolio investments, see Bosworth and Collins (1999), Razin (2004), and Mody and Murshid (2005). However, the literature is not conclusive on the impact of FDI on growth or the channels through which it acts. Alfaro, Kalemli-Ozkan and Volosovych (2004) find that FDI has a positive impact on economic growth provided that the domestic financial sector is sufficiently developed. Alternatively, Borensztein, De Gregorio and Lee (1998) find a positive impact of FDI in interaction with human capital. For some evidence of the effects of capital flow composition on currency crises, see Frankel and Rose (1996).

an analogy to the functioning of markets. In a country where property rights are poorly enforced and the risk of expropriation is high, firms may prefer FDI as it is harder to expropriate due to its information intensity and its inalienability (Albuquerque, 2003). Moreover, different types of investment may react differently to factors such as the degree of corruption, the functioning of the legal system and transparency (eg Wei, 2000b; Faria and Mauro, 2004; Alfaro, Kalemli-Ozkan and Volosovych, 2005; Papaioannou, 2005; Gelos and Wei, 2005). While several of these papers look at the effects on total capital flows, a specific type of flow, or the difference between portfolio and FDI, we contribute to the literature by analysing the effect of institutional variables on all major concepts of the capital account.[4] Moreover, other important differences between the present paper and the existing literature are the focus on bilateral capital stocks as well as the methodological approach, which allows us to control for information asymmetries as well as for both source and host country factors. Finally, we also study the impact of financial market development on the composition of the capital account.

3. Methodology, data and some stylised facts

This section gives an outline of the methodology and the main hypotheses for the empirical analysis (Section 3.1). The subsequent presentation of our data (Section 3.2) is then followed by a discussion of some key stylised facts of the pecking order of cross-border investment positions derived from our data (Section 3.3).

3.1 Methodology and hypotheses

The empirical analysis consists of two parts. In the first part, we attempt to understand the role of information frictions as a determinant of the pecking order of cross-border investment. The effects of information frictions are likely to be different across country pairs, ie one particular source country i may face a different degree of information costs and asymmetries vis-à-vis host country j than other source countries. For this purpose, we use a pseudo-fixed effects model of bilateral capital stocks held by residents of source country i in host country j:

$$\log(1+y_{ij}^{k}) = \alpha_i^k + \alpha_j^k + \beta^k X_{ij} + \varepsilon_{ij}^k \quad (1)$$

with y_{ij}^{k} as the holdings in US dollars of asset type k – where k = FDI, portfolio equity, portfolio debt securities, or loans – of residents of source country i in host country j; X_{ij} as a proxy of bilateral information frictions and additional controls; and α_i^k and α_j^k as source country and host country fixed effects.

Given that in our first step we want to identify consistently the effect of information frictions – a pair-effect variable – we also need to control for all other relevant factors that affect the volume of bilateral investment from a particular source country by including source and host country dummies as well as other bilateral controls that are likely to affect the level of

[4] While Alfaro, Kalemli-Ozkan and Volosovych. (2005) also test the effects of institutions on the capital account, their focus is on aggregate capital flows (defined as the sum of FDI and portfolio investment flows). Therefore, they do not include bank loans nor do they test or comment on differences among the different types of investment. As we will show below, we find this distinction to be important as different types of capital react fundamentally differently to information frictions as well as institutions.

bilateral investment.[5] In the second step, we try to explain the country fixed effects in order to understand which factors make host countries attractive places for investment.[6]

The vector of coefficients of interest to us in this first step is β^k, ie we want to test whether different types of asset holdings have a different degree of sensitivity to various proxies of information frictions X_{ij}. Note that we are interested in two separate hypotheses, one relating to the *volume effect* of information frictions (H_1) and the second one to the composition or *pecking order effect* (H_2), ie that one type of financial asset holdings (k_1) reacts differently to information frictions than other types of assets (k_2):

$$\text{Volume effect hypothesis} \quad H_1 : \beta^k = 0$$

$$\text{Pecking order effect hypothesis } H_2 : \beta^{k1} = \beta^{k2}$$

Our empirical analysis is cross-sectional, hence the explanatory power of the model comes purely from the cross-section, which is sensible given the focus on capital stocks and the fact that the independent variables on information frictions and institutions mostly change little over time.

Note also that we estimate the model using y_{ij}^k as the stocks in US dollars of asset type k. More precisely, we take the log value of the value in millions of US dollars and add one in order to be able to keep observations that are zero.[7] As there are several observations with a value of zero, it may raise the problem of censoring at zero. Although we use a TOBIT estimator and a two-step Heckman procedure to show that the results are largely robust to this specification, our preferred estimation technique is via seemingly unrelated regressions (SUR). This means that we estimate the four equations for each type of capital k simultaneously. The advantage of the SUR estimator is that it improves the efficiency of the estimates by allowing for cross-correlations of the residuals of the four equations. Moreover, it allows us to directly test our pecking order hypothesis H_2 in the model.

Note that we do not "normalise" the dependent variable by dividing by host country GDP for H_1 on the volume effect or by dividing by total asset liabilities of host country j for H_2 on the pecking order effect, as is frequently done in the literature. The reason is that each of these "normalisations" imposes restrictions on the parameters of the model that may not hold. Although such a normalisation is possible, our preferred specification is the one using the log of the levels of cross-border investment, given that it allows for more flexibility and enables us to test the volume and composition hypothesis in the same equation.[8]

More generally, although it may seem appealing to exclude the fixed effects in order to explicitly allow for including vectors of source country-specific variables X_i and of host

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[5] The inclusion of these country fixed effects has also been recommended by Anderson and van Wincoop (2003) in empirical trade models to control for multilateral resistance. In the case of investment positions, the problem of omitted and unobserved variables at the source or host level might also be more serious, given the lack of an overall accepted theory of bilateral investment positions that could be used as a benchmark for the empirical exercise.

[6] See Cheng and Wall (2005) for the relevance of such a two-step approach for trade. Lane and Milesi-Ferretti (2004) use a very similar approach to ours for the case of bilateral portfolio positions.

[7] However, in our final sample the number of zeros is relatively small. Out of the final 1,116 observations, FDI values are all strictly positive, FPI portfolio has 187 zero observations, FPI debt 125, and loans 84, respectively. Our results do not change if we drop these observations. While not reported here, these regressions are available upon request.

[8] It should be pointed out that the country dummies capture the size effects of the source and host in an accurate way.

country-specific variables X_j, this would imply excluding important unobserved components of relevant fixed effects and is likely to bias the estimators of interest β^k. We show below that the estimates of β^k indeed mostly change substantially when excluding the fixed effects.

In the second part of the analysis, our aim is to understand the factors that explain the host country fixed effects. More precisely, we want to understand the *role of markets and institutions in host countries as determinants of the composition of cross-border financial positions*. As these factors are symmetric, ie investors in all source countries face the same conditions in a particular host country, we use the fixed effects obtained from the gravity model (1) to test for the role of host country institutions and market conditions X_j on the pecking order and volume effects:

$$\alpha_j^k = \kappa^k + \lambda^k X_j + \mu_j^k, \tag{2}$$

where μ_j^k is an error term. Analogously to model (1), this specification allows us to formulate and test the two hypotheses with regard to the *volume effect* (H_3) and the *pecking order effect* (H_4) of markets and institutions:

$$\text{Volume effect hypothesis} \quad H_3 : \lambda^k = 0$$

$$\text{Pecking order effect hypothesis} \quad H_4 : \lambda^{k1} = \lambda^{k2}$$

Our preferred estimator is again the SUR, and the same caveats and discussion apply to this second stage as to the estimation of model (1).

3.2 Data

As the focus of the paper is on the pecking order of cross-border investment, our data are on *stocks* of various types of foreign investment, rather than capital flows per se. We use three different data sources to construct a comprehensive database that covers all four categories of the financial account – or what is still often referred to as the capital account; two terms which we use interchangeably throughout the paper – ie for FDI, for portfolio investment – distinguishing also between equity and debt securities – and for loans. For FDI, we use the UNCTAD database on bilateral FDI stocks. A database that is often employed in studies on FDI is the one provided by the OECD. However, the UNCTAD database is more comprehensive as it includes both industrialised countries and developing countries. The UNCTAD data have annual entries in US dollars for around 90 reporting countries vis-à-vis most countries in the world from 1980 to 2003. Unfortunately, there are many missing entries, so that we do not have bilateral stocks for all country pairs. Moreover, country pairs are excluded from the analysis if there are no entries for the past 10 years.

For portfolio investment, we use the Consolidated Portfolio Investment Survey (CPIS) by the IMF. It provides bilateral assets of portfolio equity and portfolio debt securities for 68 reporting countries.[9] We use the average figures for equity securities and for debt securities for 2001, 2002 and 2003. The CPIS also provides a breakdown between short-term and long-term debt securities. We conducted several tests but did not find systematic differences with this distinction, and thus ignore this dimension in the remainder of the paper.

[9] In fact, the effective number of reporting countries ends up being 67, because Pakistan reports only missing data.

For loans, we use the International Locational Banking Statistics (ILB) data provided by the Bank for International Settlements (BIS). The database comprises aggregate assets as well as aggregate liabilities of banks in 32 reporting countries vis-à-vis banking and non-banking institutions in more than 100 partner countries, capturing exclusively private claims. The reported assets and liabilities capture mostly loans and deposits, but may also include other transactions that fall under portfolio or direct investment (see BIS, 2003). To minimise this overlap, we use inter-bank claims, ie the data for assets and liabilities of banks in reporting countries vis-à-vis banks in partner countries. Although the number of reporting countries is smallest for this database, the fact that it includes data not only for assets but also for liabilities allows us to obtain a proxy also for asset holdings of non-reporting countries vis-à-vis reporting countries.

There are several caveats that are present for the various data sources. A first potential caveat is that the data stem from different sources, thus raising the issue of how comparable they are, though the definitions used are the same across sources. Moreover, one potentially important issue is that the data collection is generally based on the residence principle. This may imply that countries may report their asset holdings vis-à-vis their direct counterpart country but not vis-à-vis the country where the financial asset is ultimately invested. This of course would give enormous importance to financial centres as a lot of capital is channelled through these, but does not reflect the true bilateral holdings of financial assets. Hence we exclude financial centres from our analysis.

Moreover, note that our empirical analysis is purely cross-sectional for two reasons: due to the fact that capital stocks obviously change little from one year to the next and also due to data availability. Due to the potential importance of valuation changes and other special factors affecting the size of capital stocks in individual years, our cross-section is the average size of capital stocks over the five-year period of 1999–2003.

It is important to emphasise that we include only those country pairs for which all four types of asset holdings are available. This reduces the sample size to 77 countries. Appendix A shows the countries which are included. It reveals that the sample includes 22 richer, industrialised countries and 55 mainly emerging markets, but also some poorer developing countries. The country sample for the EMEs is roughly balanced across regions, with 12 in Africa/Middle East, 13 in Central and Eastern Europe, 13 in Asia and 17 in Latin America. The exclusion of many of the poorer developing countries is required by the fact that they do not have stock markets and/or bond markets. Thus the results on the pecking order are not driven by the absence of stock and bond markets in less developed countries. Further tests focusing only on industrialised countries and only for EMEs are conducted below and show the robustness of the findings to different country samples.

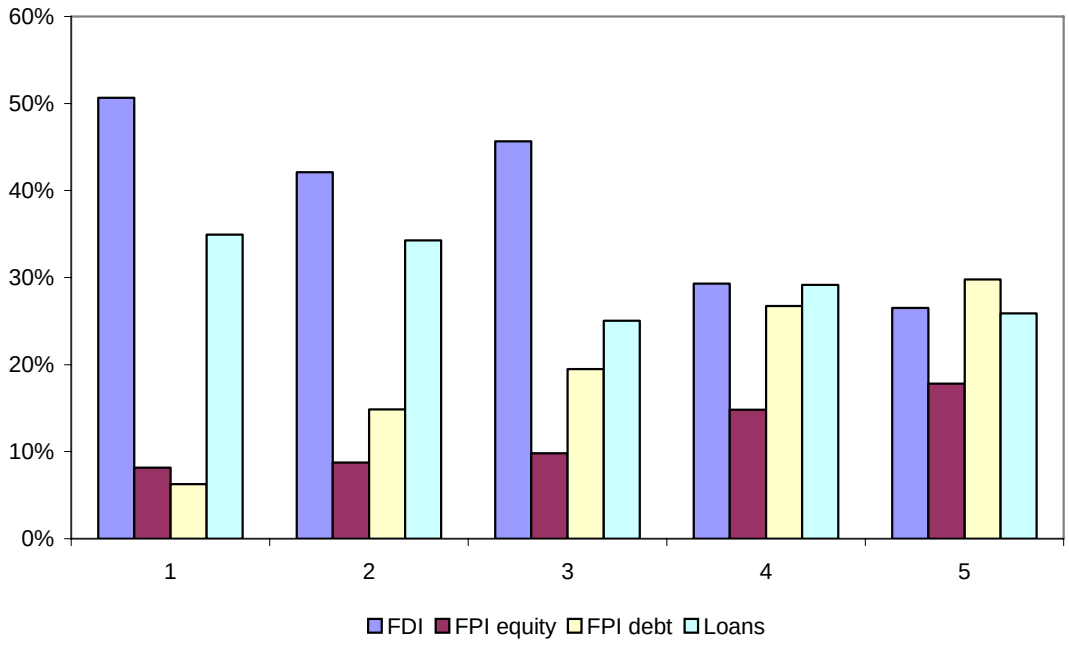
3.3 Some stylised facts on the pecking order

Figure 1 shows for a broad set of developed and emerging market economies that the poorest countries have the highest shares and the richest the lowest shares of FDI in total capital stocks.

This stylised fact – as well as several others discussed in detail in the paper – makes the important point that the type of foreign financing of cross-border investment does not pursue a random pattern, but follows a certain “pecking order”.

Figure 1

Composition of foreign investment by per capita country groups



Note: GDP per capita is measured as the average PPP GDP per capita over the period 1999-2003. The x-axis shows the first to fifth quintile of countries, ranging from those with the lowest to those with the highest GDP per capita.
Sources: IMF CPIS and IFS; UNCTAD; BIS; authors' calculations.

Table 1 presents some summary statistics for the different types of financial liabilities, ie the table shows the total stocks of different types of capital held by foreigners in the host countries implied by the data described in the previous subsection. There are clear, systematic differences in the composition and volume of capital stocks across countries. First, developing countries receive on average a higher *share* of FDI and loans than developed countries. For example, the average share of FDI in total foreign capital for developing countries is 44% while in the case of the developed countries FDI amounts only to 22%. In contrast, the share of portfolio equity and portfolio debt holdings is significantly higher for developed countries. Second, in terms of the *volume* of investments, developed countries receive significantly higher volumes of all types of capital. Developed countries receive on average – as a ratio of their GDP – around 2.5 times more FPI portfolio, 6.6 times more FPI debt, 2 times more loans, and 1.3 times more FDI than developing countries.

Table 2 shows the correlation coefficients and the significance of investment shares with regard to selected indicators of income, market development and institutions. First, there is a large negative correlation of -0.38 between the share of FDI in stocks and per capita income of a country. Loans are also negatively correlated, though the correlation coefficient is not statistically significant. The same finding applies to domestic financial market development – as proxied by the degree of capital account liberalisation and by the ratio of credit to the private sector as percentage of GDP: the more developed financial markets are, the lower the shares of FDI and loans a country receives. Figure 2 illustrates in more detail the relationships between these different types of capital and per capita GDP. Moreover, countries with a higher risk of expropriation (indicated by a lower value in the figure) receive a significantly higher share of FDI and loans.

Table 1

Summary statistics

Variable	Obs	Mean	Std dev	Min	Max
EMEs / developing countries					
FDI share	55	0.46	0.22	0.10	0.90
Loans share	55	0.30	0.18	0.00	0.70
FPI debt share	55	0.14	0.11	0.00	0.40
FPI portfolio share	55	0.10	0.11	0.00	0.50
FDI/GDP	55	0.42	0.48	0.00	2.70
Loans/GDP	55	0.34	0.91	0.00	6.80
FPI debt/GDP	55	0.13	0.14	0.00	0.50
FPI equity/GDP	55	0.11	0.22	0.00	1.40
Developed countries					
FDI share	22	0.22	0.10	0.05	0.38
Loans share	22	0.26	0.09	0.13	0.49
FPI debt share	22	0.35	0.16	0.03	0.66
FPI portfolio share	22	0.17	0.11	0.03	0.44
FDI/GDP	22	0.56	0.59	0.03	2.44
Loans/GDP	22	0.65	0.51	0.11	1.65
FPI debt/GDP	22	0.86	0.86	0.05	3.17
FPI equity/GDP	22	0.40	0.43	0.05	1.45
Total					
FDI share	77	0.394	0.23	0.05	0.92
Loans share	77	0.292	0.16	0.05	0.74
FPI debt share	77	0.198	0.16	0.00	0.66
FPI portfolio share	77	0.117	0.11	0.00	0.51
FDI/GDP	77	0.462	0.51	0.03	2.66
Loans/GDP	77	0.424	0.82	0.01	6.79
FPI debt/GDP	77	0.339	0.57	0.00	3.12
FPI equity/GDP	77	0.190	0.32	0.00	1.43

Sources: IMF CPIS and IFS; UNCTAD; BIS; authors' calculations.

By contrast, both equity security and debt security holdings are strongly positively correlated with GDP per capita. In addition, countries that have a large share of portfolio equity and debt stocks also have more developed domestic financial markets and better institutions. Moreover, when considering the correlation of the shares of different types of assets with the average growth rate of GDP per capita over 1980–2003, the correlations show that there is a positive and significant correlation only for portfolio investment.

Table 2

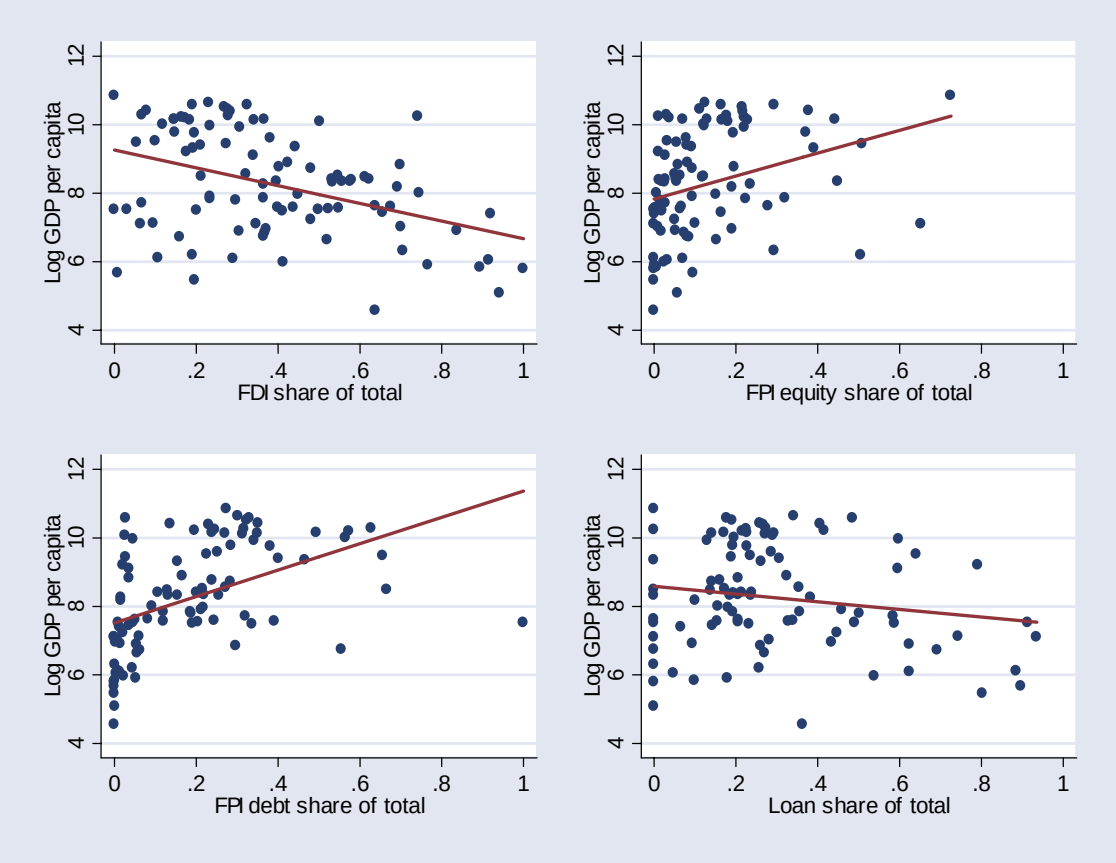
Correlation matrix

	FDI share	Loans share	FPI debt share	FPI equity share
FDI share	1.0000			
Loans share	**–0.5140**	1.0000		
FPI debt share	**–0.4270**	**–0.3380**	1.0000	
FPI equity share	**–0.2810**	**–0.2960**	–0.0570	1.0000
GDP per capita (log)	**–0.4050**	**–0.1700**	**0.4750**	**0.3190**
Private credit/GDP	**–0.3570**	–0.1060	**0.2460**	**0.4710**
KA openness	–0.1370	–0.1520	**0.2080**	**0.2020**
Property rights	**0.3470**	0.1470	**–0.3420**	**–0.4490**
GDP per capita growth	0.0300	–0.1440	–0.0970	**0.2870**

Note: Significant correlations at the 95% level are shown in bold.

Figure 2

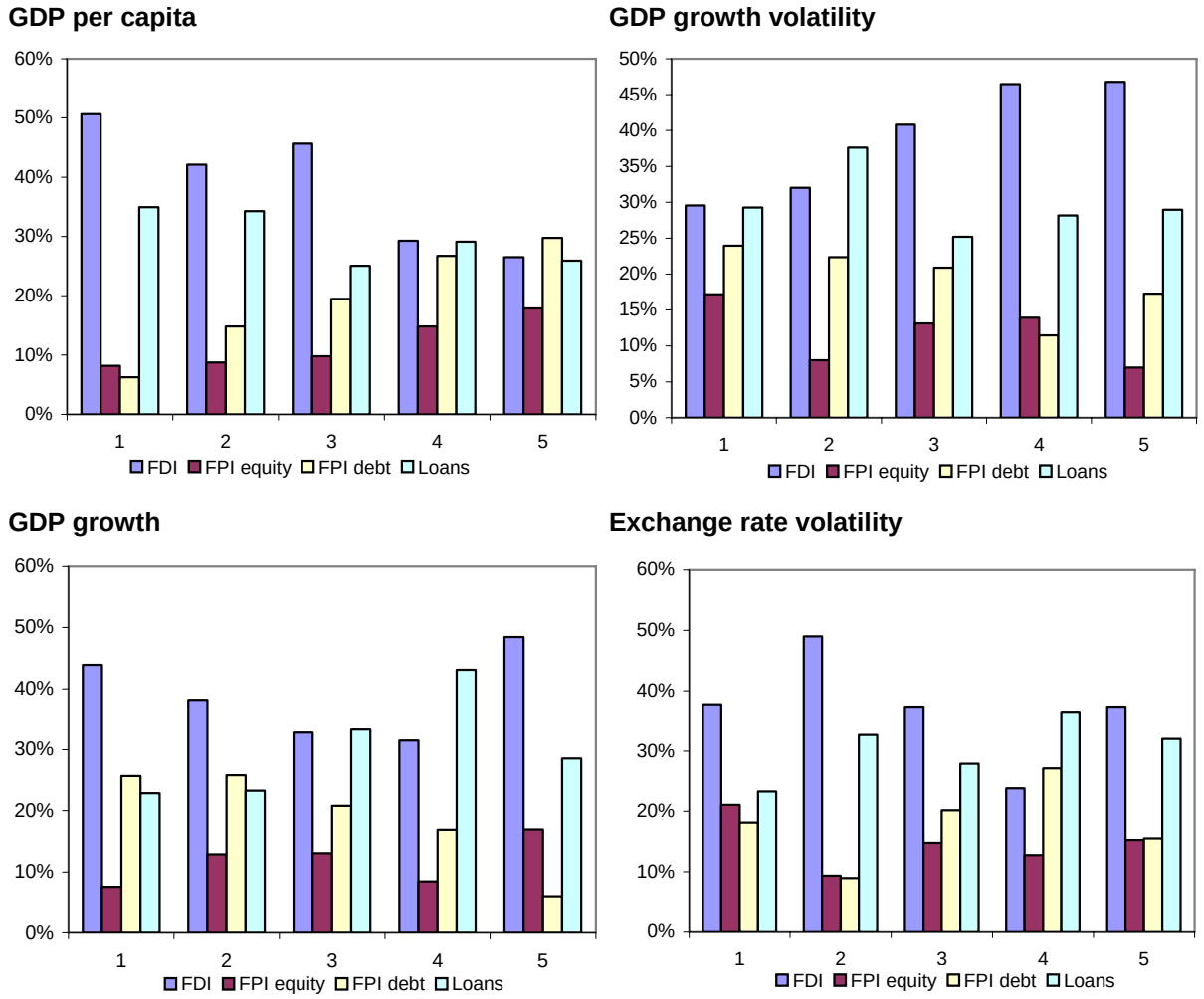
Stylised facts of pecking order: GDP per capita



Sources: IMF CPIS and IFS; UNCTAD; BIS; authors' calculations.

Figure 3

Stylised facts of pecking order: macro and exchange rate variables



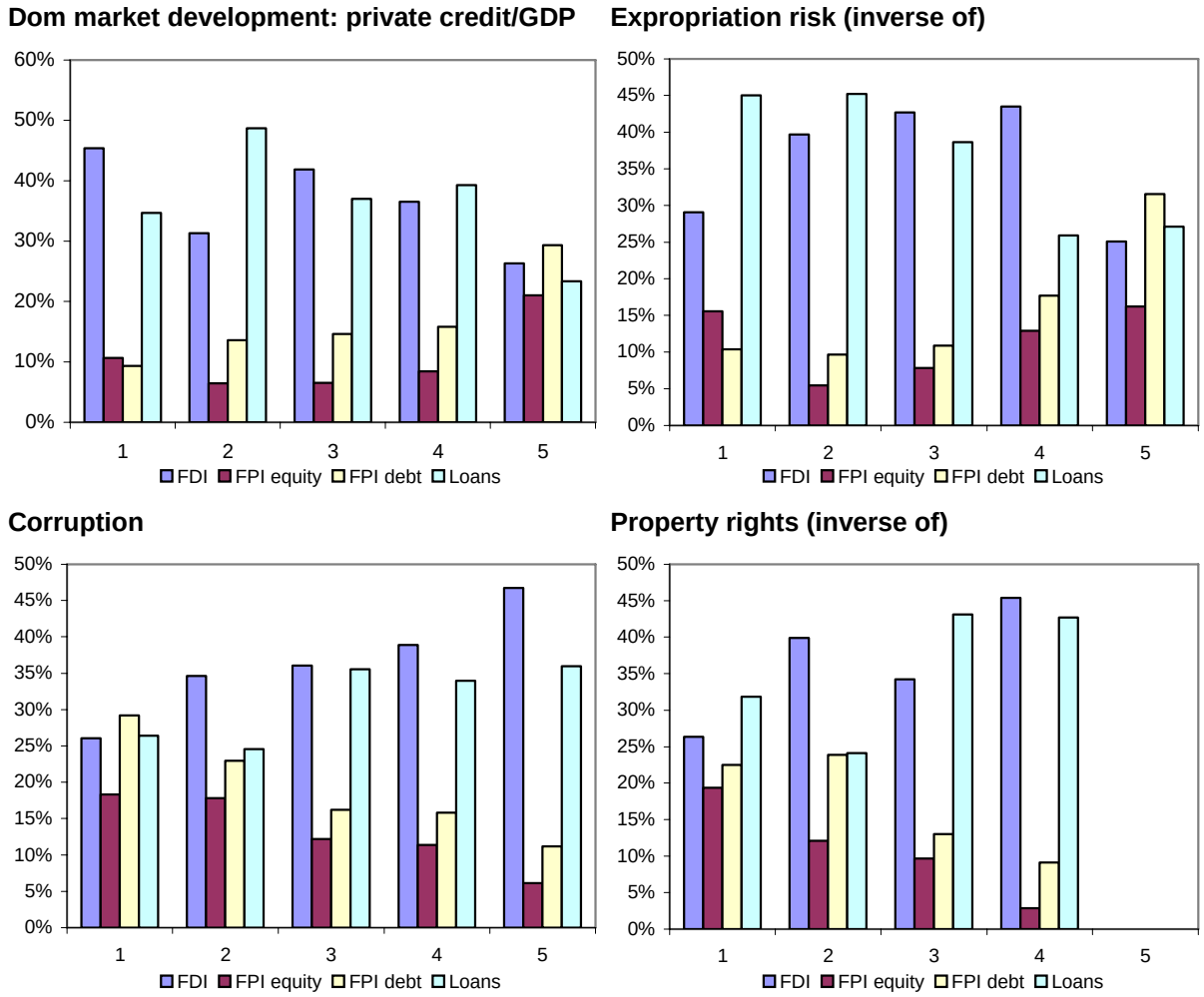
Note: GDP growth volatility is the standard deviation of annual real GDP growth rates over the period 1980-2003. Exchange rate volatility is defined as the standard deviation of the monthly nominal exchange rate changes vis-à-vis the US dollar over the period 1980-2003. The x-axis shows the first to fifth quintiles of countries. Sources: IMF CPIS and IFS; UNCTAD; BIS; authors' calculations.

Figures 3 and 4 illustrate these points in more detail by showing the distributions of the shares of individual types of capital by quintiles of the variable of interest, eg starting with the quintile of countries with the lowest GDP per capita on the left and leading up to those with the highest GDP per capita (top left panel of Figure 3). The top right panel of Figure 3 shows that countries that had the highest volatility in GDP growth rates – as measured as the standard deviation of annual real GDP growth rates over the period 1980-2003 – also experienced the highest degree of output volatility.

Figure 4 shows corresponding charts for market development and various institutional indicators. For instance, countries with the least developed domestic financial markets – as proxied by credit to the private sector to GDP – have the highest share of the inward investment from abroad in the form of FDI and loans, which both fall as domestic financial development improves. Moreover, the bottom left panel of Figure 4 indicates that countries with higher corruption receive relatively more FDI and loans, and substantially less portfolio investment. Finally, also countries with a worse protection of property rights – as indicated by a rise in the indicator shown – have a larger share of FDI and loans and relatively fewer equity and debt securities.

Figure 4

Stylised facts of pecking order: market development and institutions



Note: A higher value of the expropriation risk indicator means a lower degree of risk, and a larger indicator for property rights indicates a worse protection of property rights. The x-axis shows the first to fifth quintiles of countries.

Sources: IMF CPIS and IFS; UNCTAD; BIS; authors' calculations.

Overall, these stylised facts provide some first, descriptive evidence that there is indeed a pecking order in cross-border investment, as the various types of foreign capital stocks are strongly correlated with indicators of market development and institutions. A detailed analysis of the causality underlying these relationships is provided in the subsequent sections.

4. The pecking order and the role of information frictions

We now turn to our econometric results. We start with the analysis of the role of information frictions (Section 4), before presenting the findings with regard to the role of markets and institutions (Section 5).

4.1 Benchmark results

What is the role of information frictions in explaining the pecking order of cross-border investment positions? A first important issue is how to measure information frictions. We start

by following the common practice in the literature both on trade in goods and on trade in financial assets and proxy information frictions through the log geographic distance between country pairs. We then proceed by using various alternative measures for information. Table 3 shows the results of our benchmark model (1), which includes in addition to distance a set of standard gravity variables, such as dummy variables on whether or not the two countries have a common language, a common legal origin and colonial links, and whether they have a trade agreement or a joint investment treaty to facilitate cross-border investment. The results are compelling both with regard to our hypothesis H_2 about the pecking order of cross-border investment positions and with regard to the volume effects hypothesis H_1.

Table 3

Information frictions: distance

	FDI	**FPI equity**	**FPI debt**	**Loans**	**Significance for pecking order**					
					FDI vs			equity vs		debt vs
					equity	debt	loans	debt	loans	loans
Distance	–1.180***	–0.676***	–0.808***	–1.231***	**0.00**	**0.00**	0.52	**0.07**	**0.00**	**0.00**
	(0.068)	(0.057)	(0.063)	(0.068)						
Common language	0.433***	0.324**	0.111	0.247	0.54	0.11	0.32	0.22	0.67	0.46
	(0.160)	(0.135)	(0.149)	(0.161)						
Common legal origin	0.713***	0.568***	0.395***	0.438***	0.24	**0.02**	**0.04**	0.15	0.31	0.74
	(0.112)	(0.094)	(0.104)	(0.113)						
Colonial links	0.924***	0.333*	0.198	0.321	**0.01**	**0.01**	**0.02**	0.56	0.96	0.62
	(0.216)	(0.182)	(0.200)	(0.217)						
Trade agreement	–0.167	–0.336**	0.617***	0.230	0.38	**0.00**	**0.06**	**0.00**	**0.00**	**0.05**
	(0.175)	(0.147)	(0.163)	(0.176)						
Investment treaty	0.260**	0.027	0.094	0.429***	**0.06**	0.24	0.20	0.58	**0.00**	**0.01**
	(0.113)	(0.095)	(0.105)	(0.113)						
# obs	1116	1116	1116	1116						
R-squared	0.828	0.907	0.881	0.847						

Note: The underlying econometric model is that of (1): $\log\left(1+y_{ij}^{k}\right)=\alpha_i^k+\alpha_j^k+\beta^k X_{ij}+\varepsilon_{ij}^k$, with the right-hand columns showing the p-values for the pecking order hypothesis: $H_2:\beta^{k1}=\beta^{k2}$.

***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

FDI and loans are substantially more sensitive to changes in distance than portfolio equity and portfolio debt investment. The differences in the effects are sizeable as the coefficients for FDI and loans are both around -1.2 as compared to point estimates of -0.67 and -0.80 for portfolio equity and debt. Also, these differences are highly statistically significant as shown in the right-hand columns of the table.[10]

[10] Note that while the information variables have a larger effect on FDI than on portfolio investment (our pecking order hypothesis), the goodness-of-fit of the model for FDI is generally somewhat lower than that of portfolio investment equity and debt. This finding comes from the lower explanatory power of the fixed effects in the models for FDI, which can be seen by estimating the models including only the fixed effects.

It is interesting to point out that the size of the estimated coefficients for distance is in line with the empirical literature on trade in assets, eg Portes and Rey (2005) report a coefficient of –0.89. In addition, the effect of distance on asset trade is greater than its effect on trade in goods, which according to Leamer and Levinsohn (1995) is mostly around -0.6. In the case of goods, Grossman (1998) shows that for sensible values of transportation costs, the distance elasticity should be around –0.03.[11] Thus, he concludes that information costs must be behind the empirical result that the effect is around 20 times larger. For trade in assets, it therefore seems that the case for distance reflecting information rather than trade costs is even more compelling. We explore this information hypothesis in more detail below.

The point estimates for the variables on what is often referred to as "familiarity" effects are sensible as they have the correct sign and are mostly statistically significant. Like for the distance variable, FDI reacts much more strongly to these familiarity effects than is the case for portfolio equity and debt investment. For instance, when both countries speak the same language, FDI stocks in host countries are 54 percent higher and portfolio equity investment 38 percent larger, whereas portfolio debt investment and loans are not statistically significantly different.[12]

4.2 Robustness: alternative proxies for information frictions

How robust are these findings to different proxies for information frictions? Clearly, it may seem odd to proxy information frictions for trade in financial assets through geographical distance as one would expect that geography should have little to do with financial transactions. However, the literature on capital flows has repeatedly found distance to be highly significant, see eg Portes and Rey (2005) for equity flows. Nevertheless, it is useful to employ alternative and ideally more direct proxies for information frictions. We use three proxies: the amount of telephone traffic between two countries, the trade in newspapers, and the bilateral stock of immigrants of the source country living in the host country and vice versa.

The intuition for the use of these variables as proxies for the degree of information frictions is straightforward. The volume of telephone call traffic was proposed first by Portes and Rey (2005) and has been used in the most recent empirical literature.[13] Telephone traffic is a proxy of the amount of information that flows between both countries, and it is assumed that a larger volume of information flows – controlling additionally for the size of both economies – implies less informational frictions. A similar rationale has been put forward to use trade in newspapers and periodicals by Nicita and Olarreaga (2000) to study information spillovers in goods markets. They report a high correlation of trade in newspapers with telephone traffic (a simple correlation of 0.77), but prefer their measure due to greater data availability. Finally, Gould (1994) analyses the impact of the stock of immigrants in the United States on trade between the Uunited States and the immigrants' country of origin. The intuition is that immigrants have better information on the markets and institutions in their home country, which would lower transaction costs.

Table 4 shows the results when adding telephone traffic to the benchmark model. One important result is that when adding telephone traffic, it is not only highly significant, but distance becomes insignificant for FDI and portfolio equity and debt investment. Distance

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[11] For a recent survey on the importance of trade costs, see Anderson and van Wincoop (2004).

[12] Note that the coefficients for the dummy variables are not strictly elasticities. The calculation of the elasticity, for instance for the former variable, can be done by using: exp(0.43) – 1 = 0.537.

[13] See Portes, Rey and Oh (2001) for the case of equity flows; Loungani, Mody and Razin (2002), as well as di Giovanni (2005) for FDI; and Mody, Razin and Sadka (2003) for FDI and equity.

retains its significance for loans, albeit with a much smaller coefficient of –0.34 as compared to –1.23 in the benchmark model of Table 3. It is important to point out that this result is not driven by multicollinearity problems between telephone traffic and distance, given that the simple correlation between both variables in our sample is just –0.13. In addition, although the sample is reduced due to the availability restrictions on telephone traffic, if we re-estimate the regression from Table 3 for this subsample, the distance coefficients are negative, significant, and not different from the estimates for the whole sample. Therefore, distance seems to be a proxy for overall information frictions in asset trade. When comparing the pecking order effect of information frictions, telephone traffic is again significantly larger for FDI and also loans than for equity and debt.

Table 4

Information frictions: distance versus telephone traffic

	FDI	**FPI equity**	**FPI debt**	**Loans**	**Significance for pecking order**					
					FDI vs			equity vs		debt vs
					equity	debt	loans	debt	loans	loans
Distance	–0.072	–0.091	–0.071	–0.341**	0.90	1.00	**0.10**	0.90	0.12	**0.09**
	(0.130)	(0.112)	(0.131)	(0.134)						
Telephone traffic	0.721***	0.447**	0.399***	0.595***	**0.00**	**0.00**	0.23	0.63	0.15	**0.06**
	(0.083)	(0.072)	(0.084)	(0.086)						
Common language	–0.016	0.130	0.126	–0.144	0.49	0.56	0.57	0.98	0.22	0.22
	(0.181)	(0.157)	(0.184)	(0.187)						
Common legal origin	0.505***	0.448***	0.327**	0.402***	0.70	0.30	0.52	0.42	0.77	0.63
	(0.126)	(0.109)	(0.128)	(0.130)						
Colonial links	0.353	–0.055	–0.177	–0.357	0.13	**0.10**	**0.01**	0.66	0.30	0.53
	(0.216)	(0.182)	(0.200)	(0.217)						
Trade agreement	–0.106	–0.299*	0.845***	0.304	0.37	**0.00**	**0.07**	**0.00**	**0.01**	**0.02**
	(0.184)	(0.159)	(0.186)	(0.190)						
Investment treaty	0.078	0.314**	0.313*	0.591***	0.21	0.29	0.01	1.00	0.17	0.16
	(0.162)	(0.140)	(0.164)	(0.167)						
# obs	595	595	595	595						
R-squared	0.873	0.928	0.884	0.850						

Note: The underlying econometric model is that of (1): $\log\left(1+y_{ij}^{k}\right)=\alpha_{i}^{k}+\alpha_{j}^{k}+\beta^{k}X_{ij}+\varepsilon_{ij}^{k}$, with the right-hand columns showing the p-values for the pecking order hypothesis: $H_2:\beta^{k1}=\beta^{k2}$.

***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

Table 5

Information frictions: alternative information proxies

	FDI			FPI equity			FPI debt			Loans		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Distance	–1.021*** (0.073)^{E,D}	–0.736*** (0.115)^{E,D}	–0.225 (0.148)^{L}	–0.602*** (0.062)^{F,L}	–0.521*** (0.085)^{F,D,L}	–0.258** (0.111)	–0.722*** (0.069)^{F,L}	–0.345*** (0.095)^{F,E,L}	–0.073 (0.124)	–1.062*** (0.074)^{E,D}	–0.855*** (0.122)^{E,D}	–0.438*** (0.163)^{F}
Trade in newspapers	0.064*** (0.012)^{E,D}			0.030*** (0.010)^{F,L}			0.035*** (0.011)^{F,L}			0.069*** (0.012)^{E,D}		
Stock of foreigners		0.180*** (0.050)			0.105*** (0.037)			0.107** (0.041)			0.127** (0.053)	
Principal component			0.498*** (0.087)^{E,D}			0.298*** (0.065)^{F}			0.209*** (0.073)^{F,L}			0.406*** (0.096)^{D}
Common language	0.364** (0.159)	0.244 (0.207)	0.066 (0.229)	0.292** (0.135)	0.146 (0.153)	0.128 (0.172)	0.073 (0.148)	–0.069 (0.172)	0.097 (0.191)	0.173 (0.159)	–0.089 (0.220)	0.082 (0.252)
Common legal origin	0.665*** (0.111)^{D,L}	0.767*** (0.166)^{E}	0.759*** (0.186)^{E}	0.545*** (0.094)	0.451*** (0.123)^{F,L}	0.418*** (0.139)^{F,D,L}	0.368*** (0.104)^{F}	0.654*** (0.138)^{L}	0.712*** (0.155)^{E}	0.386*** (0.112)^{F}	1.012*** (0.176)^{E,D}	0.967*** (0.204)^{E}
Colonial links	0.778*** (0.215)^{E,D,L}	–0.274 (0.357)	–0.380 (0.370)	0.265 (0.182)^{F}	–0.279 (0.264)	–0.358 (0.278)	0.118 (0.201)^{F}	–0.071 (0.296)	–0.324 (0.309)	0.166 (0.216)^{F}	–0.577 (0.378)	–0.597 (0.407)
Trade agreement	–0.162 (0.173)^{D,L}	0.241 (0.197)^{D}	0.171 (0.205)^{D}	(0.333)** (0.147)^{D,L}	–0.037 (0.146)^{D,L}	0.022 (0.154)^{D,L}	0.620*** (0.162)^{F,E,L}	0.917*** (0.163)^{F,E,L}	0.693*** (0.172)^{F,E}	0.235 (0.174)^{F,E,D}	0.438** (0.209)^{E,D}	0.446** (0.226)^{E}
Investment treaty	0.218* (0.112)^{E}	–0.026 (0.225)^{D,L}	–0.435 (0.279)^{E,D,L}	0.007 (0.095)^{F,L}	0.334** (0.167)	0.318 (0.209)^{F}	0.071 (0.105)^{L}	0.617*** (0.187)^{F}	0.698*** (0.233)^{F}	0.385*** (0.112)^{E,D}	0.483** (0.239)^{F}	0.766** (0.307)^{F}
# observations	1116	474	332	1116	474	332	1116	474	332	1116	474	332
R-squared	0.832	0.864	0.876	0.908	0.928	0.938	0.882	0.904	0.913	0.851	0.842	0.839

Note: The underlying econometric model is that of (1): $\log\left(1+y_{ij}^{k}\right)=\alpha_{i}^{k}+\alpha_{j}^{k}+\beta^{k}X_{ij}+\varepsilon_{ij}^{k}$. The superscripted letters indicate for the pecking order hypothesis, $H_2:\beta^{k1}=\beta^{k2}$, that the respective coefficient is different that of FDI for ^{F}, different that of equity portfolio investment for ^{E}, different that of debt securities for ^{D} and different that of loans for ^{L}. ***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

Table 5 gives the estimates for the other two alternative information proxies as well as for a model that instead includes the first principal component of the three proxies. We include the principal component of all three alternative proxies because it may help alleviate measurement errors related to each individual variable.[14] The results confirm that FDI and loans are more sensitive to information frictions. However, distance remains significant in most of these specifications, and with the same order as before as information generally has the largest effects on FDI and loans and the smallest impact on portfolio equity and debt.

4.3 Robustness: alternative model specifications and controls

Finally, we conduct a battery of sensitivity tests by using alternative econometric specification and by adding various controls to the empirical specification of the model. A first test is to ask whether the results are robust to taking ratios, of GDP or of total capital stocks, as dependent variables, which is commonly done in the literature, despite the controversial assumptions underlying such a specification, as discussed in Section 3.1. Table 6 shows the estimates for the benchmark model where the dependent variable is measured as a percentage of source and host country GDP and as a percentage of total capital flows from source country i to host country j. The results indicate that although the coefficients are very different, our overall results with regard to the pecking order still hold: FDI and loans are in both specifications significantly and substantially larger than portfolio equity and portfolio debt investment.

As the next step, we investigate the robustness of the results to using alternative econometric estimators. Table 7 provides the results for a TOBIT estimator and for an OLS estimator without source and host country fixed effects. The estimates of the TOBIT model are in line with those obtained from our OLS benchmark. Recall that the TOBIT model is a non-linear estimator that uses a mixture of a continuous distribution over the non-censored observations and a discrete distribution for the censored ones. The point estimates shown in the table are the marginal effects evaluated at the mean of the independent variables. Hence the size of the marginal effects is not so meaningful.

There are some interesting differences between the model with and that without fixed effects. The model without fixed effects is estimated by including nominal GDP (in US dollars) and the population of both the source country and the host country instead of the fixed effects. There are two important points to note from the results. First, almost all point estimates for the proxies of information frictions are substantially different from those of the benchmark fixed effects model. This lends support to the point we made above that it is important to estimate the model by including fixed effects as otherwise the point estimates are biased due to omitted variables. Nevertheless, even without the fixed effects our pecking order hypothesis is confirmed. Second, note that the hypothesis that the point estimates of the GDP variables are equal to one is rejected in almost all equations. This is a noteworthy fact because it stresses that a "normalisation" of the model, ie including the dependent variables as ratios of GDP, imposes incorrect restrictions on the parameters of the model.[15]

[14] About 81 percent of the total variation in the three alternative proxies is explained by their first principal component. The factor loadings are high for all three variables, so that they seem to be well represented by the first factor.

[15] We also tested for the importance of censoring, due to a few of the observations in our sample being zero, by using Heckman's (1979) two-step procedure. While the results are not shown for brevity reasons, the point estimates are very similar, underscoring that there is no significant bias stemming from a censoring problem in our data.

Table 6

Information frictions: ratios as % of GDP and total capital stocks

	FDI	FPI equity	FPI debt	Loans	FDI	FPI equity	FPI debt	Loans
	Ratio as % of GDP				Ratio as % of total capital stocks			
Distance	–0.453*** (0.054)^{E,D}	–0.105*** (0.016)^{F,D,L}	–0.243*** (0.030)^{F,E,L}	–0.527*** (0.056)^{E,D}	–0.282*** (0.065)^{E,D}	0.086 (0.062)^{F,L}	0.051 (0.062)^{F,L}	–0.339*** (0.050)^{E,D}
Common language	0.425*** (0.127)^{E,D,L}	0.058 (0.037)^{F,L}	0.010 (0.070)^{F,L}	–0.255* (0.131)^{F,E,D}	0.097 (0.150)^{L}	0.012 (0.142)	–0.238* (0.143)	–0.286** (0.115)^{F}
Common legal origin	–0.027 (0.089)^{D}	0.060** (0.026)^{D}	0.170*** (0.048)^{F,E}	0.151 (0.092)	0.246** (0.104)	0.212** (0.098)	0.021 (0.099)	0.109 (0.080)
Colonial links	0.355** (0.170)	0.200*** (0.050)^{L}	0.271*** (0.093)	0.516*** (0.176)^{E}	0.457** (0.204)^{E,L}	–0.100 (0.193)^{F}	0.009 (0.194)	–0.102 (0.157)^{F}
Trade agreement	0.127 (0.136)^{D}	–0.007 (0.040)^{D}	0.470*** (0.075)^{F,E,L}	–0.107 (0.141)^{D}	–0.219 (0.159)^{D}	–0.335** (0.151)^{D}	0.482*** (0.151)^{F,E,L}	–0.117 (0.122)^{D}
Investment treaty	–0.308*** (0.092)^{E,D}	–0.066** (0.027)^{F,L}	–0.080 (0.050)^{F,L}	–0.271*** (0.095)^{E,D}	–0.058 (0.121)^{L}	–0.002 (0.115)^{L}	–0.081 (0.115)^{L}	0.293*** (0.093)^{F,E,D}
# obs	1027	1027	1027	1027	842	842	842	842
R-squared	0.323	0.499	0.549	0.369	0.985	0.932	0.937	0.756

Note: The underlying econometric model is that of (1): $\log\left(1+y_{ij}^{k}\right)=\alpha_i^k+\alpha_j^k+\beta^k X_{ij}+\varepsilon_{ij}^k$. The superscripted letters indicate for the pecking order hypothesis, $H_2:\beta^{k1}=\beta^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}.

***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

Next, we test for the presence of asymmetries in the effects of information fictions across samples. In particular, it is possible that some types of countries are much more sensitive to information than others, for instance those where information is already very scarce. Table 8 shows the results when estimating the benchmark model (1) separately for when only industrialised countries and when only EMEs are the host countries. Overall, the results confirm that FDI and loans are most sensitive to information frictions. Moreover, some interesting differences across country groups emerge. In particular, capital stocks are much more sensitive to information and familiarity effects when the host country is an emerging market economy. The elasticity for FDI, for instance, is –1.54 for EMEs but only –0.89 for industrialised countries. Investment in EMEs also appears to be more sensitive to the common language and the colonial links. Taken together, these findings confirm our hypothesis on the pecking order, but also underline the presence of important asymmetries in the effect of information frictions.

One set of explanations that we have not analysed so far is *risk sharing or risk diversification* as a driver of cross-border investment. As discussed in Section 2, there is a large literature on the determinants of risk sharing and home bias. Thus the motivation for the type and direction of cross-border capital flows may not only be information frictions and institutions but also the attempt to diversify idiosyncratic, home country risk. Obstfeld and Rogoff (2000), Lane and Milesi-Ferretti (2004) and Aviat and Coeurdacier (2005) argue that a source country that receives a high share of its imports from a particular host country will want to acquire more capital in this specific host country in order to insure itself against terms of trade shocks to this country. Extending this argument to risk diversification, it may be optimal for investors to invest relatively more in those countries with the lowest or even a negative degree of output correlation with its own.

Table 7

Information frictions: alternative estimators

	FDI	FPI equity	FPI debt	Loans	FDI	FPI equity	FPI debt	Loans
	Without fixed effects				TOBIT estimator			
GDP: source cty	1.985*** (0.065)^{E,D,L}	2.167*** (0.062)^{F,D,L}	1.821*** (0.069)^{F,E,L}	1.100*** (0.074)^{F,E,D}				
GDP: host cty	0.854*** (0.045)^{E,D,L}	1.647*** (0.043)^{F,D,L}	1.386*** (0.048)^{F,E,L}	1.137*** (0.051)^{F,E,D}				
Population: source cty	–1.108*** (0.071)^{E,L}	–1.543*** (0.067)^{F,D,L}	–1.100*** (0.075)^{E,L}	–0.106 (0.080)^{F,E,D}				
Population: host cty	–0.093* (0.051)^{E,D,L}	–0.650*** (0.048)^{F,L}	–0.619*** (0.054)^{F,L}	–0.326*** (0.058)^{F,E,D}				
Distance	–0.462*** (0.064)^{E,L}	–0.181*** (0.061)^{F,D,L}	–0.460*** (0.067)^{E,L}	–0.717*** (0.073)^{F,E,D}	–1.072*** (0.051)	–0.988*** (0.056)	–0.954*** (0.057)	–1.445*** (0.054)
Common language	0.949*** (0.179)^{E,D,L}	1.263*** (0.169)^{F,D,L}	0.309 (0.188)^{F,E}	0.307 (0.202)^{F,E}	0.641*** (0.134)	0.556*** (0.125)	0.425*** (0.127)	0.183 (0.114)
Common legal origin	0.940*** (0.146)^{E,D}	0.603*** (0.138)^{F}	0.574*** (0.154)^{F}	0.805*** (0.165)	0.704*** (0.092)	0.547*** (0.090)	0.380*** (0.091)	0.271*** (0.080)
Colonial links	1.181*** (0.282)	0.729*** (0.267)^{D}	0.889*** (0.297)^{E}	1.370*** (0.319)	1.096*** (0.167)	0.917*** (0.168)	0.456** (0.176)	0.898*** (0.146)
Trade agreement	0.486*** (0.181)^{E}	0.723*** (0.172)^{F,D}	1.576*** (0.191)^{E,L}	0.837*** (0.205)^{D}	0.592*** (0.146)	0.453*** (0.146)	0.929*** (0.153)	0.011 (0.152)
Investment treaty	0.310** (0.125)^{E}	–0.153 (0.119)^{F,L}	0.048 (0.132)^{L}	0.504*** (0.142)^{E,D}	–0.129 (0.086)	–0.039 (0.087)	0.002 (0.088)	0.579*** (0.074)
# obs	1030	1030	1030	1030	1116	1116	1116	1116
(Pseudo) R-squared	0.651	0.757	0.679	0.589	0.357	0.486	0.418	0.369

Note: The underlying econometric model is that of (1): $\log\left(1+y_{ij}^{k}\right)=\alpha_i^k+\alpha_j^k+\beta^k X_{ij}+\varepsilon_{ij}^k$. The superscripted letters indicate for the pecking order hypothesis, $H_2:\beta^{k1}=\beta^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}. Note that no such tests are possible for the TOBIT specification because it is not estimated as a system of equations.

***,** and* show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

Table 8

Information frictions: developed countries versus emerging market economies

	FDI	FPI equity	FPI debt	Loans	FDI	FPI equity	FPI debt	Loans
	Developed countries				Emerging market economies			
Distance	–0.893*** (0.097)^{E,D}	–0.693*** (0.076)^{F,D,L}	–0.513*** (0.076)^{F,E,L}	–1.047*** (0.096)^{E,D}	–1.543*** (0.106)^{E,D}	–0.589*** (0.095)^{F,D,L}	–1.019*** (0.097)^{F,E,L}	–1.595*** (0.100)^{E,D}
Common language	0.097 (0.203)	0.153 (0.158)	0.175 (0.159)	–0.091 (0.200)	0.942*** (0.260)^{E,D}	0.444* (0.232)^{F,L}	0.336 (0.238)^{F,L}	0.975*** (0.244)^{E,D}
Common legal origin	0.975*** (0.144)^{E,D}	0.655*** (0.112)^{F,D}	0.393*** (0.113)^{F,D,L}	0.853*** (0.142)^{D}	0.550*** (0.177)^{L}	0.543*** (0.158)^{L}	0.411** (0.162)^{L}	–0.104 (0.167)^{F,E,D}
Colonial links	0.681** (0.294)^{L}	0.326 (0.229)	0.397* (0.231)^{L}	–0.218 (0.291)^{F,D}	0.998*** (0.330)^{E}	0.083 (0.294)^{F,L}	0.387 (0.302)	0.851*** (0.310)^{E}
Trade agreement	0.206 (0.218)^{D}	–0.183 (0.170)^{D,L}	1.099*** (0.171)^{F,E,L}	0.441** (0.216)^{E,D}	0.212 (0.748)	1.226* (0.667)	0.808 (0.684)	0.663 (0.702)
Investment treaty	0.150 (0.224)^{L}	0.079 (0.175)L	0.374** (0.176)^{L}	0.879*** (0.222)^{F,E,D}	0.238* (0.140)^{D}	0.016 (0.125)	–0.065 (0.128)^{F}	–0.006 (0.132)
# obs	573	573	573	573	543	543	543	543
R-squared	0.872	0.928	0.917	0.848	0.780	0.857	0.842	0.854

Note: The underlying econometric model is that of (1): $\log\left(1+y_{ij}^{k}\right)=\alpha_i^k+\alpha_j^k+\beta^k X_{ij}+\varepsilon_{ij}^k$. The superscripted letters indicate for the pecking order hypothesis, $H_2:\beta^{k1}=\beta^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}.

***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

We therefore add to our benchmark model imports of source country *i* from host country *j* (see left panel of Table 9) to investigate whether the findings for information frictions change when controlling for proxies of risk sharing. The table shows that trade is indeed positively correlated with all four types of capital investment. As an alternative control, we include bilateral real exchange rate volatility, measured over the period 1990-2003, as a regressor (middle panel of Table 9) in order to test whether uncertainty and risk affects cross-border investment. It is, however, found to be significant only for investment in debt securities, and to a lesser degree for FDI.[16] We also attempt to control for the effect of global factors on cross-border investment. The intuition is that two countries that exhibit a very different responsiveness to global shocks should also have less bilateral investment. We use daily US short-term interest rate changes as our proxy for global shocks, and take the difference in the reaction of short-term interest rates between the source country and host country as our measure of the different response to global shocks.[17] The right panel of Table 9 shows that the difference in the response to such global shocks indeed reduces bilateral portfolio investment and loans, though not FDI.

[16] We also tested for the interaction effect of exchange rate volatility and information, but did not find any additional effect of this interaction in the empirical model.

[17] Short-term interest rates for most countries are three-month money market rates, if available. The estimation is based on daily interest rate changes over the period 1990–2004.

Table 9

Information frictions: robustness tests with trade, exchange rate volatility and global interest rate shocks as controls

	FDI	FPI equity	FPI debt	Loans	FDI	FPI equity	FPI debt	Loans	FDI	FPI equity	FPI debt	Loans
	With control for trade				With control for exchange rate volatility				With control for global interest rate shock			
Distance	–0.692*** (0.088)^{E}	–0.362*** (0.074)^{F,D,L}	–0.689*** (0.083)^{E}	–0.773*** (0.088)^{E}	–1.232*** (0.073)^{E,D}	–0.655*** (0.062)^{F,L}	–0.694*** (0.068)^{F,L}	–1.246*** (0.074)^{E,D}	–0.995*** (0.079)^{E,D}	–0.605*** (0.063)^{F,L}	–0.563*** (0.075)^{F,L}	–1.063*** (0.083)^{E,D}
Trade: imports	0.384*** (0.047)^{E,D}	0.247*** (0.040)^{F,D,L}	0.119*** (0.044)^{F,E,L}	0.382*** (0.047)^{E,D}								
Exchange rate volatility					10.875* (5.968)^{D}	–4.388 (5.028)^{D}	–23.816*** (5.502)^{F,E,L}	3.136 (6.004)^{D}				
Global interest rate shock									0.191 (0.150)^{E,D,L}	–0.389*** (0.119)^{F}	–0.345** (0.142)^{F}	–0.322** (0.158)^{F}
Common language	0.384** (0.161)^{D}	0.334** (0.136)^{D}	0.037 (0.152)^{F,E}	0.176 (0.162)	0.454*** (0.160)	0.316** (0.135)^{D}	0.066 (0.148)^{E}	0.253 (0.161)	0.368** (0.175)^{D,L}	0.257* (0.139)	0.050 (0.166)^{F}	0.025 (0.184)^{F}
Common legal origin	0.603*** (0.113)^{L}	0.500*** (0.095)	0.390*** (0.106)	0.330*** (0.113)^{F}	0.703*** (0.112)^{D,L}	0.572*** (0.094)	0.417*** (0.103)^{F}	0.435*** (0.113)^{F}	0.628*** (0.124)^{D}	0.538*** (0.098)	0.443*** (0.118)^{F}	0.631*** (0.131)
Colonial links	0.811*** (0.216)^{E,D,L}	0.208 (0.183)^{F}	0.135 (0.203)^{F}	0.209 (0.218)^{F}	0.922*** (0.215)^{E}	0.334* (0.181)^{F}	0.200 (0.199)	0.321 (0.217)	0.905*** (0.252)^{E,D,L}	0.380* (0.199)^{F}	0.221 (0.239)^{F}	0.304 (0.265)^{F}
Trade agreement	–0.075 (0.173)^{D}	–0.283* (0.147)^{D,L}	0.632*** (0.163)^{F,E,L}	0.267 (0.175)^{E,D}	–0.068 (0.183)^{D,L}	–0.376** (0.154)^{D,L}	0.399** (0.169)^{F,E}	0.258 (0.184)^{F,E}	0.080 (0.184)^{D,L}	–0.170 (0.145)^{D,L}	0.877*** (0.174)^{F,E}	0.463** (0.193)^{F,E}
Investment treaty	0.042 (0.118)^{L}	–0.038 (0.100)D	–0.010 (0.111)^{E,L}	0.297** (0.119)^{F,E,D}	0.222* (0.115)^{L}	0.042 (0.096)^{L}	0.177* (0.106)^{L}	0.419*** (0.115)^{F,E,D}	0.458*** (0.144)	0.335*** (0.114)	0.330** (0.137)	0.532*** (0.152)
# observations	1027	1027	1027	1027	782	782	782	782	1027	1027	1027	772
R-squared	0.841	0.911	0.883	0.851	0.845	0.920	0.895	0.849	0.830	0.912	0.876	0.823

Note: The underlying econometric model is that of (1): $\log\left(1+y_{ij}^{k}\right)=\alpha_{i}^{k}+\alpha_{j}^{k}+\beta^{k}X_{ij}+\varepsilon_{ij}^{k}$. The superscripted letters indicate for the pecking order hypothesis, $H_2:\beta^{k1}=\beta^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}.

***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

Table 10

Information frictions: robustness tests with institutional controls

	FDI			FPI equity			FPI debt			Loans		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Information:												
Distance	–1.180*** (0.068)^{E,D}	–0.939*** (0.079)^{E,D}	–1.162*** (0.073)^{E}	–0.676*** (0.057)^{F,L}	–0.557*** (0.066)^{F,D,L}	–0.652*** (0.061)^{F,L}	–0.808*** (0.063)^{F,L}	–0.628*** (0.078)^{F,E,L}	–0.802*** (0.068)	–1.231*** (0.068)^{E,D}	–0.933*** (0.083)^{E,D}	–1.228*** (0.074)^{E}
Common language	0.433*** (0.160)	0.302* (0.160)	0.358** (0.173)	0.324** (0.135)	0.265* (0.134)	0.287** (0.144)	0.111 (0.149)	0.096 (0.158)	–0.024 (0.161)	0.247 (0.161)	–0.131 (0.168)	0.093 (0.175)
Common legal origin	0.713*** (0.112)^{D,L}	0.683*** (0.112)^{E}	0.808*** (0.130)^{E}	0.568*** (0.094)	0.565*** (0.094)^{F,L}	0.598*** (0.108)^{F,D,L}	0.395*** (0.104)^{F}	0.314*** (0.111)^{L}	0.347*** (0.120)^{E}	0.438*** (0.113)^{F}	0.695*** (0.118)^{E,D}	0.587*** (0.131)^{E}
Colonial links	0.924*** (0.216)^{E,D,L}	0.838*** (0.226)	1.289*** (0.255)	0.333* (0.182)^{F}	0.428** (0.190)	0.440** (0.212)	0.198 (0.200)^{F}	0.686*** (0.224)	0.309 (0.237)	0.321 (0.217)F	0.475** (0.238)	0.472* (0.257)
Trade agreement	–0.167 (0.175)^{D,L}	0.209 (0.186)^{D}	–0.032 D (0.187)	–0.336** (0.147)^{D,L}	0.038 (0.157)^{D,L}	–0.233 (0.156)^{D,L}	0.617*** (0.163)^{F,E,L}	1.130*** (0.185)^{F,E,L}	0.736*** (0.174)^{F,E}	0.230 (0.176)^{F,E,D}	1.036*** (0.197)^{E,D}	0.504*** (0.189)^{E}
Investment treaty	0.260** (0.113)^{E}	0.237 (0.144)^{D,L}	0.224* (0.123)^{E,D,L}	0.027 (0.095)^{F,L}	0.051 (0.121)	0.003 (0.102)^{F}	0.094 (0.105)^{L}	0.300** (0.143)^{F}	0.065 (0.114)^{F}	0.429*** (0.113)^{E,D}	0.471*** (0.152)^{F}	0.467*** (0.124)^{F}
***Institutions*:**												
Cap account openness	6.821*** (0.466)^{E,D}			2.525*** (0.392)^{F,L}			4.039*** (0.433)^{F}			4.786*** (1.246)^{E}		
Expropriation risk		0.938*** (0.305)^{E,D,L}			1.796*** (0.286)^{F,L}			2.384*** (0.302)^{F,L}			–0.657* (0.359)^{F,E,D}	
Property rights			0.834*** (0.271)^{D}			1.052*** (0.228)^{L}			2.121*** (0.269)^{F,L}			0.778*** (0.196)^{E,D}
# observations	1116	1027	704	1116	1027	704	1116	1027	704	1116	1027	704
R-squared	0.828	0.841	0.841	0.907	0.911	0.917	0.881	0.883	0.881	0.847	0.851	0.837

Note: The underlying econometric model is that of (1): $\log\left(1+y_{ij}^{k}\right)=\alpha_{i}^{k}+\alpha_{j}^{k}+\beta^{k}X_{ij}+\varepsilon_{ij}^{k}$. The superscripted letters indicate for the pecking order hypothesis, $H_2:\beta^{k1}=\beta^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}.

***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

It is important to stress that trade, exchange rate volatility and possibly are likely to be to some extent endogenous to cross-border investment and one would need to find suitable instruments if one wanted to investigate the link between risk sharing and capital flows. However, the important point to note for the objective of this paper is that information frictions as proxied by distance (or other information proxies when substituted for distance) retain their significance and the pecking order of FDI and loans being the most sensitive to information frictions and portfolio investment the least sensitive is confirmed.[18]

Finally, in order to ensure that the coefficients of the information variables are not capturing, for instance, the differential between host and source country institutional characteristics, we estimate the benchmark model (1) by including interaction variables between host and source country institutional characteristics X_{ij}, measured as the sum of the institutional variables of both. Table 10 shows the results of this extension, using three different institutional variables (KA openness, expropriation risk, and property rights). Most importantly, the table shows that the pecking order hypothesis regarding our information proxies is confirmed, ie FDI continues to be significantly more sensitive to information than portfolio investment. Moreover, the explanatory power stemming from institutional factors – gauged from estimating the model separately with only information proxies and only institutional variables – is similar in magnitude. However, the main difficulty relates to institutions, as their coefficients cannot be interpreted in a meaningful way in this context. In particular: better institutions in the host country should *raise* cross-border investment from country i in country j. The opposite holds true for the source country: better institutions in country i should *lower* cross-border investment outflows from country i. Hence an insignificant coefficient for institutional interactions X_{ij} in the framework of Table 10 cannot be interpreted in a meaningful way as institutions may still be highly important, only that the positive effect of institutions in host country j may be offset by the negative effect of institutions in source country i. Thus, as explained in Section 3.1, we attempt to analyse the role of institutions in the second step of model (2), to which we turn in the next section.

Overall, the first key result that we take from this section is that there is a clear pecking order with regard to information frictions. FDI and loans are substantially more sensitive to information frictions than portfolio investment. The differences are large and statistically significant. These findings are also robust to several alternative proxies for information frictions, in particular when using telephone traffic. Moreover, various robustness tests confirm the specification of the model and underline the robustness of the results on the pecking order hypothesis to alternative specifications and different econometric estimators.[19]

Thus, the results indicate that FDI and loans are more sensitive to information frictions – or more information-intensive – than portfolio investment, equity and debt. A possible explanation for this fact is that FDI and loans in general require frequent interaction and a deeper knowledge of the markets where they operate. Also, especially for the case of FDI, once an asset has been acquired, direct ownership makes the asset less liquid given the potential lemon problem in case of a re-sale, as Goldstein and Razin (2006) point out. Thus,

[18] As a final check, we find that the results are robust to using alternative country samples, i.e. our pecking order hypothesis that FDI and loans are most sensitive to information frictions is confirmed for both emerging market countries as well as industrialised countries. Results are available upon request.

[19] We have also conducted further robustness checks, especially splitting the sample between industrialised and emerging economies, and the results hold for both groupings of countries. While we do not present the results here due to space considerations, they can be found in an earlier working paper version (Daude and Fratzscher, 2006).

FDI becomes partially irreversible or costlier to liquidate, and therefore more sensitive to information in the first place.[20]

5. The pecking order and the role of institutions and financial market development

We now turn to the role of financial markets and institutions. The central focus is on the question of whether we can identify a pecking order of cross-border capital positions with regard to the degree of development and openness of markets and the quality of institutions in the host country. For this purpose, we extract the host country fixed effects from model (1) and then estimate model (2), ie we attempt to explain the host country fixed effects through market conditions and institutions. Note that given the specification of model (1) where the dependent variable is measured in value terms, we need to control for size effects in model (2). We do so by including host country GDP in each of the specifications below, though we omit to show the point estimates for this variable for brevity reasons.[21] All variables used are described in more detail in Appendix B.

We start with the role of *market development and openness*. We use three different proxies. First, we employ a capital account openness dummy. This dummy takes the value of one if the country had fully liberalised its capital account by the mid-1990s, and is zero otherwise. Data for this variable come from the IMF's Annual Report of Exchange Arrangements and Exchange Restrictions (AREAER). The finding is remarkably strong as portfolio equity and portfolio debt investment react strongly to capital account openness, whereas the coefficients for FDI and loans are positive but only marginally statistically significant (see Table 11). The magnitude of the effects is large: a country that is open receives about 80% more equity capital and 80% more debt investment compared to an economy with a closed capital account.[22]

Second, we investigate the effect of the development of the domestic financial sector on the pecking order. We include credit to the private sector as a proxy for financial development. Table 11 shows that the elasticities are by the far the largest for equity investment, which is about twice as large as that for debt securities and FDI. These differences are statistically significant, while in the case of FDI investment appears to not react to changes in the degree of financial market development in the host country.

Third, we analyse the role of the development of the local stock market, and proxy this through stock market capitalisation. The bottom panel of Table 11 indicates again that equity investment is most strongly related to changes in market capitalisation but nevertheless also cross-border investment in debt securities, loans and FDI react, though to a lesser extent.

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[20] Although we cannot distinguish between greenfield investments and mergers and acquisitions in our data, this informational friction is linked to ownership control and thus applies to both types of FDI.

[21] Observe that all regressions exhibit a very high R-squared. This reflects the fact that the country effects are highly correlated with country size measured by GDP of 0.87, 0.90, 0.81 and 0.83 between the estimated host country fixed effects and the host's GDP for FDI, portfolio equity, portfolio debt and loans, respectively.

[22] Recall that only countries with existing stock and bond markets are included in the analysis, so that the results are not driven by an absence of such markets in closed economies.

Table 11

Role of market development and transparency

	FDI	FDI equity	FPI debt	Loans		FDI	FDI equity	FPI debt	Loans
	Market openness and development					**Transparency**			
Cap account openness	0.262 (0.232)	0.825** (0.354)	0.803** (0.372)	0.387 (0.288)	**Quality disclosure**	0.137* (0.074)^{E}	0.389*** (0.111)^{F,D,L}	0.191 (0.121)^{E}	0.134 (0.093)^{E}
# observations	69	69	69	69	# observations	65	65	65	65
R-squared	0.7556	0.8184	0.6801	0.7019	R-squared	0.7449	0.8355	0.6968	0.7079
Financial development	0.462 (0.321)^{E,D,L}	2.270*** (0.424)^{F,D,L}	1.396*** (0.469)^{F,E}	1.344*** (0.366)	**Accounting standards**	0.019 (0.011)^{E}	0.067*** (0.014)^{F,D,L}	0.033** (0.015)^{E}	0.024** (0.012)^{E}
# observations	64	64	64	64	# observations	37	37	37	37
R-squared	0.7311	0.8693	0.7537	0.7575	R-squared	0.5543	0.8117	0.6446	0.6261
Stock market capitalisation	0.435*** (0.126)^{E,L}	1.104*** (0.131)^{F,D,L}	0.560** (0.219)^{E}	0.743*** (0.133)^{F,E}	**Property rights**	–0.139 (0.118)^{E,D,L}	–0.847*** (0.158)^{F,L}	–0.904*** (0.156)^{F,L}	–0.570*** (0.133)^{F,E,D}
# observations	46	46	46	46	# observations	63	63	63	63
R-squared	0.6589	0.8880	0.6045	0.7349	R-squared	0.7410	0.8680	0.7992	0.7684

Note: The underlying econometric model is that of (2): $\alpha_j^k = \kappa^k + \lambda^k X_j + \mu_j^k$. The superscripted letters indicate for the pecking order hypothesis, $H_4 : \lambda^{k1} = \lambda^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}. ***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

Table 12

Role of investor protection and corruption

	FDI	FDI equity	FPI debt	Loans		FDI	FDI equity	FPI debt	Loans
	Investor protection					Corruption			
Expropriation risk	0.054 (0.125)^{E,D,L}	0.913*** (0.166)^{F,L}	0.952*** (0.175)^{F,L}	0.492*** (0.143)^{F,E,D}	**TI**	–0.048 (0.049)^{E,D,L}	–0.407*** (0.059)^{F,L}	–0.372*** (0.061)^{F,L}	–0.198*** (0.052)^{F,E,D}
# observations	66	66	66	66	# observations	61	61	61	61
R-squared	0.7497	0.8644	0.7562	0.7326	R-squared	0.7508	0.8835	0.7896	0.7618
Repudiation costs	0.078 (0.093)^{E,D,L}	0.781*** (0.115)^{F,,L}	0.701*** (0.132)^{F,L}	0.445*** (0.103)^{F,E,D}	**WDR**	–0.146 (0.099)^{E,D,L}	–0.583*** (0.137)^{F,L}	–0.434*** (0.143)^{F}	–0.335*** (0.107)^{F,E}
# observations	66	66	66	66	# observations	56	56	56	56
R-squared	0.7516	0.8832	0.7528	0.7542	R-squared	0.7330	0.8372	0.7109	0.7382
Days of enforcements	–0.103 (0.147)^{E,D}	–0.626*** (0.222)^{F,L}	–0.573** (0.229)^{F}	–0.277 (0.182)^{E}	**German survey**	–0.025 (0.036)^{E,D,L}	–0.254*** (0.048)^{F,L}	–0.242*** (0.048)^{F,L}	–0.113** (0.044)^{F,E,D}
# observations	65	65	65	65	# observations	57	57	57	57
R-squared	0.7335	0.8258	0.7127	0.7091	R-squared	0.7210	0.8477	0.7630	0.7051

Note: The underlying econometric model is that of (2): $\alpha_j^k = \kappa^k + \lambda^k X_j + \mu_j^k$. The superscripted letters indicate for the pecking order hypothesis, $H_4 : \lambda^{k1} = \lambda^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}. ***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

As a next step, we analyse the role of institutions for the pecking order of cross-border capital positions. As discussed in detail in Section 2, there have been a number of studies arguing that different types of capital should react differently to various institutional features. For instance, Albuquerque's (2003) model implies that FDI is harder to expropriate as the information required for and obtained by FDI is inalienable. Various other studies have focused on individual types of capital flows and how they are linked to other institutional elements such as corruption, transparency and political risk (eg Wei, 2000a; Papaioannou, 2005; Gelos and Wei, 2005).

We test the effect of various institutional features. While it is hard to determine which institutional factors to focus on, we are guided in our choice of institutional variables by the mostly theoretical literature discussed in Section 2. The sources for these variables are manifold, stemming partly from La Porta, Lopez-de-Silanes and Shleifer (1998) and Djankov et al (2002) and partly from the databases of the World Bank Doing Business and of the International Country Risk Guide (ICRG).

Tables 11 and 12 show the findings for three sets of institutional variables. First, we look at the role of *transparency*. For this, we employ both a measure of the quality of information disclosure and of the quality of the accounting standards required by law in the host country – with higher values indicating a better quality. For both measures, portfolio equity investment reacts the strongest to changes in these transparency measures, while in the case of accounting standards the coefficient for debt securities and loans is also significant at a 10% level. FDI and loans are the least responsive. In fact, the elasticity of equity investment is about three times larger than that for FDI and for loans.

Second, we analyse the role of *investor protection* (last regression in Table 11 and Table 12). In particular, a lower risk of *expropriation* – indicated by a higher value of the variable in the table – has a highly significant impact mainly on portfolio investment. By contrast, the elasticity of loans is only about one half of that of portfolio investment, while FDI does not react at all to differences in expropriation risk. This finding thus provides strong support for the hypothesis formulated by Albuquerque (2003) and is line with the stylised facts presented above in Section 3.

Moreover, Table 11 shows that an improvement in the quality of property rights – indicated by a decline in the variable in the table – has a significant and the largest impact on portfolio equity and debt investment, a lower effect on loans, but no effect on FDI. An almost identical picture emerges for repudiation costs and for the quality of enforcement of laws and regulations – which is measured in terms of the number of the days it takes to enforce a particular ruling: the higher the number, the worse the system of enforcement. Overall, all three measures therefore indicate that investor protection has the largest effect on portfolio investment but does not appear to have any significant effect on FDI stocks.

Third, we analyse the importance of *corruption* for the pecking order. We use three alternative proxies for corruption: the first from Transparency International, the second from the World Development Report of the World Bank, and the third from a survey of German manufacturing firms. All three indicators have been used previously by Wei (2000b). In all cases, a higher value indicates a higher degree of corruption. Overall, the same finding emerges for all three of the proxies: corruption has the strongest negative effect on portfolio investment and some, though smaller, effect on loans. Corruption does not appear to have any significant effect on FDI. This finding is in line with Daude and Stein (2004), who do not find a robust relation between different corruption indicators and FDI in contrast to other institutional indicators.

Table 13

Role of market development and transparency – 3SLS estimator

	FDI	FDI equity	FPI debt	Loans		FDI	FDI equity	FPI debt	Loans
	Market openness and development					Transparency			
Cap account openness	0.828* (0.460)^{E,D}	1.796** (0.717)^{F,D}	2.953*** (0.850)^{F,E,L}	1.112* (0.572)^{D}	**Quality disclosure**	–0.035 (0.136)^{E}	0.548*** (0.199)^{F,D,L}	0.117 (0.215)^{E}	0.147 (0.165)^{E}
# observations	65	65	65	65	# observations	65	65	65	65
R-squared	0.7162	0.8015	0.5682	0.6843	R–squared	0.7238	0.8303	0.6950	0.7079
Financial development	0.898* (0.538)^{E,L}	2.376*** (0.700)^{F}	1.491* (0.775)	2.207*** (0.266)^{F}	**Accounting standards**	0.019 (0.015)^{E}	0.069*** (0.018)^{F,D,L}	0.039* (0.019)^{E}	0.022 (0.015)^{E}
# observations	64	64	64	64	# observations	37	37	37	37
R-squared	0.7233	0.8692	0.7535	0.7364	R–squared	0.5543	0.8117	0.6434	0.6256
Stock market capitalisation	0.520*** (0.199)^{E,L}	1.036*** (0.205)^{F}	0.595* (0.341)	1.027*** (0.218)^{F}	**Property rights**	–0.468 (0.288)^{E,D,L}	–1.922*** (0.533)^{F,L}	–1.291*** (0.422)^{F}	–0.970*** (0.330)^{F,E}
# observations	45	45	45	45	# observations	33	33	33	33
R-squared	0.6374	0.8793	0.6017	0.6970	R–squared	0.7345	0.6593	0.6848	0.6645

Note: The underlying econometric model is that of (2): $\alpha_j^k = \kappa^k + \lambda^k X_j + \mu_j^k$. The superscripted letters indicate for the pecking order hypothesis, $H_4 : \lambda^{k1} = \lambda^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}. The estimator is a three-stage least-squares (3SLS) one, where the instruments are legal origin dummies and religion dummies for market development and settler mortality (in logs) for institutions.

***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

Table 14

Role of investor protection and corruption – 3SLS estimator

	FDI	FDI equity	FPI debt	Loans		FDI	FDI equity	FPI debt	Loans
	Investor protection					**Corruption**			
Expropriation risk	0.532* (0.306)^{E,D,L}	2.188*** (0.511)^{F,L}	1.473*** (0.462)^{F}	1.108*** (0.325)^{F,E}	**TI**	–0.163 (0.101)^{E,D,L}	–0.689*** (0.162)^{F,L}	–0.462*** (0.141)^{F}	–0.338*** (0.116)^{F,E}
# observations	34	34	34	34	# observations	31	31	31	31
R-squared	0.7683	0.7560	0.7003	0.7406	R–squared	0.7564	0.7691	0.7098	0.6773
Repudiation costs	0.416* (0.239) ^{E,D,L}	1.711*** (0.389) ^{F,L}	1.152*** (0.371) ^{F}	0.867*** (0.266)^{F,E}	**WDR**	–0.441 (0.270)^{E,D,L}	–1.860*** (0.618)^{F,L}	–1.274*** (0.485)^{F}	–0.890*** (0.351)^{F,E}
# observations	34	34	34	34	# observations	28	28	28	28
R-squared	0.7695	0.7691	0.6828	0.7165	R–squared	0.7460	0.5087	0.5050	0.5714
days for enforcement	–0.649 (0.444)^{E,D,L}	–2.666*** (0.444)^{F,L}	–1.791** (0.725)^{F}	–1.346** (0.646)^{F,E}	**German survey**	–0.125* (0.076)^{E,D,L}	–0.470*** (0.114)^{F,L}	–0.317*** (0.101)^{F}	–0.232** (0.096)^{F,E}
# observations	33	33	33	33	# observations	27	27	27	27
R-squared	0.6712	0.5034	0.5159	0.3297	R–squared	0.6809	0.7435	0.7024	0.5492

Note: The underlying econometric model is that of (2): $\alpha_j^k = \kappa^k + \lambda^k X_j + \mu_j^k$. The superscripted letters indicate for the pecking order hypothesis, $H_4 : \lambda^{k1} = \lambda^{k2}$, that the respective coefficient is different from that of FDI for ^{F}, different from that of equity portfolio investment for ^{E}, different from that of debt securities for ^{D} and different from that of loans for ^{L}. The estimator is a three-stage least-square (3SLS) one, where the instrument is settler mortality (in logs).

***,** and * show statistical significance of the coefficients at the 99%, 95% and 90% levels, respectively.

We conduct various sensitivity tests to check for the robustness of these findings. For instance, we find very similar results when controlling also for GDP per capita in model (2). The stylised facts of Section 3 underline that there is a high correlation between per capita GDP and the pecking order of cross-border capital positions. However, the fact that the results hold also when controlling for GDP per capita stresses that market development and institutions have a large and significant effect on the pecking order independent of the level of development of a country.

As a further important sensitivity test, we use an IV estimator to take into account the possibility that institutional arrangements and market development may be. We estimate the system using a three-stage least-squares estimator (3SLS), which in essence implies instrumenting the institutional variables. An additional advantage of this approach is that we also address potential measurement errors in the institutional variables with our estimation technique. We draw our instruments from the literature on law and finance and the literature on institutions and economic development. Specifically, we use legal origin dummies and dummies for religion which have been found to be important determinants of financial markets development and regulations (see La Porta, Lopez-de-Silanes and Shleifer, 1997, 1998). In the case of institutions, we use the mortality of settlers from Acemoglu, Johnson and Robinson (2001). Our approach therefore also draws on Alfaro, Kalemli-Ozkan and Volosovych (2005).[23]

The results for the 3SLS estimates are given in Tables 13 and 14. Overall, the key point is that the results are highly robust to those without instrumenting of the institutions. All the results described above are qualitatively identical when using 3SLS, underlining that portfolio investment is substantially more sensitive to institutions and market development than FDI, and to some extent also than loans. It is also reassuring to observe that with the IV estimates the effects on FDI turn significant, but remain significantly smaller than for portfolio investment. Moreover, the fact that the size of the coefficients and their significance increase somewhat also helps to stress the robustness of the results.[24]

In summary, we find that market development and institutions are strongly related to the pecking order of cross-border investment. The key finding of this section is that portfolio investment, in particular in equity securities, is the type of capital that is the most sensitive to differences in market development/openness and the quality of host country institutions. A second key result is that FDI appears to be the type of capital that is most immune to the quality of domestic institutions. We find that FDI is least sensitive in all institutional categories, including with regard to transparency, investor protection, the degree of corruption and expropriation risk.

6. Conclusions

Is there a pecking order of cross-border investment in that countries become financially integrated primarily through one type of investment rather than others? The perceived wisdom in much of the debate on financial integration and trade in financial assets is that FDI constitutes a type of investment that is desirable from a host country perspective because it

[23] We recognise that the instruments, especially the legal code dummies, might be poor. However, it is reassuring that in general our instrument for institutions – settler mortality – passes over-identification tests. Moreover, it is by itself not significant and therefore excludable from the empirical model.

[24] Finally, we also find that the results are largely robust across country subsamples, ie when only analysing emerging markets/developing countries, with few qualitatively meaningful differences across these groups. Results are available upon request.

brings about a transfer of know-how, creates access to foreign markets and reduces the risks of financial distress. However, the facts of cross-border capital positions also show that countries that are richer have higher growth and that better institutions receive a higher share of their foreign investment in the form of portfolio investment and a much lower share through FDI and loans.

The objective of this paper has been to analyse whether there is a natural pecking order in cross-border investment. We focus on the role of two key determinants for the trade in financial assets that have been central in this literature in recent years: the importance of information frictions, and the role of institutions. Recent theoretical contributions to this literature emphasise the importance of differences in the ownership structure of different forms of investment. In particular, FDI has stronger ownership implications and thus tends to be more information-sensitive than portfolio equity or debt investment. A second strand of the literature has focused on the implications of this theory for the role of institutions. One line of reasoning is that, due to the larger information sensitivity of FDI, it is also harder to expropriate and thus it may be more immune to differences in the quality of institutions and market development.

The intended contribution of the paper is to test these hypotheses empirically for a broad set of countries. To our knowledge, this is the first paper that provides a comprehensive comparison of all four types of cross-border investment – distinguishing between FDI, portfolio equity securities, debt securities and loans. We develop and use a unique, combined data source of the capital stocks, rather than capital flows, for 77 countries.

The empirical results are compelling and confirm our hypotheses on the pecking order of cross-border investment. First, information frictions across countries are an important determinant of the pecking order of cross-border capital positions. In line with the theory on the capital structure of the firm, we find that FDI, and to some extent loans, are the types of capital most sensitive to information frictions, whereas portfolio investment is much less responsive. The magnitude of these pecking order effects is large: FDI and loans are about 1.5 to 2 times more sensitive to information frictions than equity and portfolio investment. This finding is robust to several sensitivity tests, including: the use of alternative proxies for information frictions; various specifications of the econometric model; controlling for other determinants, such as risk diversification; and across-country samples, both for industrialised and for emerging market economies.

The second key result of the paper is that the degree of market development and the quality of host country institutions are important determinants of the pecking order of cross-border investment. We find that portfolio investment is substantially more sensitive than FDI and loans to both market development – such as the openness of the capital account and the development of the domestic financial sector – and to domestic institutional features. We use three proxies for the quality of institutions – the degree of transparency, investor protection and corruption – and show that this result is robust across all these different elements of host country institutions. These results confirm some hypotheses formulated in the literature but contradict others. For instance, in line with the argument by Albuquerque (2003), we find that FDI does not react to differences from the risk of expropriation, whereas portfolio equity and debt investment are highly sensitive to this risk. Similarly, we do not find that corruption has a more detrimental effect on FDI, as hypothesised in the literature, but that the magnitude of FDI is not sensitive to corruption, whereas portfolio investment is. This implies that, in fact, corruption tilts the composition of foreign investment significantly towards FDI, and to a lesser extent towards loans.

The findings of the paper have a number of important policy implications. In particular, the empirical results indicate that a large share of foreign investment that takes the form of FDI – despite the various benefits FDI may ultimately entail – may not necessarily be a blessing, but may in fact also be a signal of some underlying weaknesses – either in terms of weak institutions or in terms of the poor functioning or underdevelopment of domestic financial

markets – of the host country. By contrast, a large share of foreign investment that comes through portfolio equity or debt securities is likely, at least in part, to signal well functioning domestic financial markets and the trust of foreign investors in domestic institutions.

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Appendix

A: Country sample

EMEs and developing countries				Developed countries	
Latin America	**Asia**	**Eastern Europe**	**Africa/Middle East**	**Europe**	**Other**
Argentina	Bangladesh	Bulgaria	Cote d'Ivoire	Austria	Australia
Bolivia	China	Croatia	Egypt	Belgium	Canada
Brazil	Hong Kong	Cyprus	Ghana	Denmark	Japan
Chile	India	Czech Republic	Israel	Finland	New Zealand
Colombia	Indonesia	Estonia	Kenya	France	United States
Costa Rica	Kazakhstan	Hungary	Morocco	Germany	
Ecuador	Korea	Latvia	Namibia	Greece	
El Salvador	Malaysia	Lithuania	Nigeria	Iceland	
Guatemala	Pakistan	Poland	South Africa	Ireland	
Honduras	Philippines	Romania	Tanzania	Italy	
Jamaica	Singapore	Russia	Tunisia	Netherlands	
Mexico	Sri Lanka	Slovenia	Zambia	Norway	
Paraguay	Vietnam	Turkey		Portugal	
Peru				Spain	
Trinidad & Tob.				Sweden	
Uruguay				Switzerland	
Venezuela				United Kingdom	

B: Variable definitions and sources

Variable definition	Source
Bilateral FDI stocks – FDI asset holdings of source country *i* in host country *j* in millions of US dollars	UNCTAD
Bilateral portfolio equity and portfolio debt stocks – average 2001-2003 holdings of source country *i* in host country *j* in millions of US dollars	Coordinated Portfolio Investment Survey (CPIS), IMF
Bilateral loans – aggregate assets and aggregate liabilities of banks in reporting countries vis-à-vis banking and non-banking institutions in host countries	International Locational Banking Statistics (ILB), BIS
Distance – log bilateral great circle distance in miles between economic centres of source country and host country	Andy Rose's website
Telephone traffic – volume of telephone call traffic between source and host country	ITU Directions of Trade

Trade in newspapers and periodicals – exports from country *i* to country *j* plus exports from *j* to *i* in millions of US dollars	UN Comtrade database Exports of item 8922 SITC Rev.2
Bilateral stock of foreigners – sum of foreigners born in country *i* currently living in country *j* and vice versa	OECD Database on Foreign-born and Expatriates
Common language – dummy equal to one if both countries speak the same language and zero otherwise	Andy Rose's website; CIA World Factbook
Common legal origin – dummy equal to one if both countries have legal system with same origin and zero otherwise	La Porta et al (1998)
Colonial links – dummy equal to one if both countries have been linked through colonisation	Andy Rose's website; CIA World Factbook
Trade agreement – dummy equal to one if both countries have a bilateral trade agreement or are part of a common agreement and zero otherwise	Andy Rose's website
Investment treaty – dummy equal to one if both countries have a bilateral investment treaty and zero otherwise	UNCTAD
Bilateral trade – the imports of goods and services of host country from source country in millions of US dollars	IFS, IMF
GDP correlation – bilateral correlation of annual real GDP growth rates between host and source countries over the period 1960-2003	IFS, IMF and OECD
Capital account openness – dummy equal to one if the host country had fully liberalised its capital account by 1996 and zero otherwise	Annual Report of Exchange Arrangements and Exchange Restrictions (AREAER), IMF
Financial development – credit to the private sector in USD millions	IFS, IMF
Stock market capitalization – average stock market capitalisation in USD millions over the period 1999-2003	Datastream and national sources
Quality of information disclosure – index that goes from 0 to 7 with higher values indicating that regulation requires more disclosure of information (see source for more details)	World Bank – Doing Business Database
Accounting standards – rating of companies in seven different categories in 1990. The index goes from 0 to 100, with higher values representing better standards	La Porta et al (1998)
Property rights – index that goes from 0 to 5, with higher values representing bad protection of property rights	Heritage Foundation
Expropriation risk – index goes from 0 to 10, with high values representing low risk	ICRG – PRS
Repudiation risk – index goes from 0 to 10, with high values representing low risk	ICRG – PRS
Days of enforcement – the time taken to resolve a dispute – in calendar days – counted from the moment the plaintiff files the lawsuit until settlement or payment	World Bank – Doing Business Database
TI corruption – index goes from 0 to 10, with higher values indicating higher levels of corruption	Transparency International (Wei, 2000b)
WDR corruption – index goes from 1 to 8, with higher values indicating higher levels of corruption	World Bank (Wei, 2000b)
German exporters' corruption index – survey-based index that goes from 0 to 10. Higher values represent higher levels of corruption	Wei (2000b)

Financial exchange rates and international currency exposures*

Philip R Lane and Jay C Shambaugh†

Abstract

Our goal in this project is to gain a better empirical understanding of the international financial implications of currency movements. To this end, we construct a database of international currency exposures for a large panel of countries over 1990–2004. We show that trade-weighted exchange rate indices are insufficient to understand the financial impact of currency movements. Further, we demonstrate that many developing countries hold short foreign currency positions, leaving them open to negative valuation effects when the domestic currency depreciates. However, we also show that many of these countries have substantially reduced their foreign currency exposure over the last decade. Last, we show that our currency measure has high explanatory power for the valuation term in net foreign asset dynamics: exchange rate valuation shocks are sizeable, not quickly reversed and may entail substantial wealth shocks.

1. Introduction

In recent years, there has been a wave of research that has emphasised that exchange rate movements operate through a valuation channel, in addition to their traditional impact on real-side variables such as the trade balance. The valuation channel refers to the impact of capital gains and losses on the international balance sheet. While such valuation effects have always been present, their quantitative significance has grown in recent years in line with the rapid growth in the scale of cross-border financial holdings (Lane and Milesi-Ferretti (2007a)). Since currency movements are an important contributor to capital gains and losses on foreign assets and liabilities, the goal of our project is to gain a better empirical understanding of the international financial impact of shifts in exchange rates.[1]

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1 Gourinchas and Rey (2007a, 2007b) and Tille (2003, 2005) have made studies of the valuation channel for the United States, while Lane and Milesi-Ferretti (2001, 2003, 2005, 2007a, 2007b, 2007c) have examined valuation effects for a large panel of countries in a variety of settings. See also the review by Obstfeld (2004).

This effect varies across countries based on the scale of the international balance sheet, the net value of the position and the currency composition of foreign assets and liabilities. For instance, authors such as Tille (2003), Gourinchas and Rey (2007a) and Lane and Milesi-Ferretti (2003, 2005, 2007b) have highlighted that the foreign liabilities of the United States are mostly denominated in dollars while there is a substantial non-dollar component in its foreign assets. Accordingly, unanticipated dollar depreciation improves the net international investment position of the United States by increasing the dollar value of its foreign assets relative to its foreign liabilities. In contrast, many emerging markets have historically issued significant amounts of foreign currency debt – for these countries, currency depreciation has had an adverse impact on the net foreign asset position.

Although there has been a significant expansion in the availability of data on many dimensions of international balance sheets in recent years, remarkably little is known about the currency composition of the foreign assets and liabilities of most countries. Accordingly, a major contribution of our project is to address this data deficit by building an empirical profile of the international currency exposures of a large number of countries. We exploit the estimated currency positions to create financially weighted exchange rate indices that better capture the valuation impact of currency movements relative to standard trade-weighted indices. In turn, the interaction of the financial exchange rate indices and the gross scale of the international balance sheet allow us to capture the valuation impact of currency movements on net foreign asset positions. In addition, the currency exposure data may be useful in evaluating the new wave of global macroeconomic models that endogenise the composition of international portfolios and analysing the "wealth" channel of monetary policy in open economies. Accordingly, the analysis of currency exposure data may provide new insights into the interaction between financial globalisation and macroeconomic behaviour.

Our analysis yields three important findings. First, financially weighted exchange rates move quite differently from trade-weighted exchange rates. In particular, we find that the mean and median within-country correlation of trade and financial exchange rates is negative. Many countries have effectively stabilised their financial exchange rates by matching currency exposures on the liability side with corresponding asset positions, leading to stable financial exchange rates even when trade-weighted exchange rates move considerably. For others, negative net currency positions generate negative correlations with trade-weighted exchange rates or positive positions generate positive (albeit not complete) correlations with trade-weighted exchange rates. In short, trade-weighted exchange rates are not particularly informative regarding the financial impact of shifts in exchange rates, without knowing the structure of cross-border currency exposures.

Second, in relation to the aggregate net position in foreign currencies, we find that the majority of countries have a net negative exposure, implying that unexpected depreciation generates wealth losses. These net negative positions are quite large in many cases and leave countries exposed to substantial valuation losses in the event of a depreciation. At the same time, over the last decade, many countries have shifted their hedging positions in a positive direction: shifts to equity and direct investment financing of liabilities and large increases in reserves have been more important in alleviating currency mismatches than increases in the share of international debt that is denominated in domestic currency.

Finally, we examine the size and properties of exchange rate valuation shocks. We find that the shocks are substantial and are not reversed by quick exchange rate turnarounds (the autocorrelation of exchange rate valuation shocks is in fact positive). Furthermore, the exchange rate valuation shocks calculated based on our indices are good predictors of the overall valuation shocks an economy faces, especially for developing countries. Their scale and long-lasting nature mean that these wealth shocks may have non-trivial impacts on the wider economy. In addition, since currency movements lead to cross-border wealth redistributions, these are especially important for the international transmission mechanism relative to other asset price shocks.

Our analysis is partial equilibrium in nature, since we effectively treat exchange rate movements as exogenous. That said, the empirical insights in the paper have implications for the design of dynamic stochastic general equilibrium models that feature endogenously determined international portfolios and seek to incorporate the wealth effects of exchange rate changes that feed back into the economy. Understanding why the exchange rate changes does not change the positive aspects of our work – the examination of the wealth effects – but it does have implications in terms of the optimal composition of international portfolios.

Our work is related to several previous contributions on international currency exposures. Along one strand, Eichengreen, Hausmann and Panizza (2003) compiled data on the currency composition of the external debts of developing countries, while Goldstein and Turner (2004) extend the analysis by constructing estimates of net foreign currency debt assets. However, these contributions do not take into account the portfolio equity and FDI components of the international balance sheet. Tille (2003) calculates the foreign currency composition of the international balance sheet of the United States, while Lane and Milesi-Ferretti (2007c) calculate dollar exposures for a large number of European countries, plus Japan and China. Relative to these contributions, we provide greatly expanded coverage for a large number of countries and estimate the full currency composition of the international balance sheet.

While our work represents a dramatic improvement relative to the status quo, it is important to be clear about its limitations. In particular, we have made many assumptions in constructing our estimated international currency exposures. Moreover, in some cases, we infer values for missing data by modelling the relation between known country characteristics and international financial holdings. Obviously, estimated data will not be perfectly accurate, nor will every assumption made fit every country perfectly. We make every effort to cross-check our data where possible, and we detail and defend the choices made in the appendix describing our data methods.

After the description of the conceptual basis of the valuation channel in the next section, Section 3 provides a brief outline of the methods employed to construct the currency position data; the appendix provides a detailed description of the methods by which we construct our dataset on currency exposures and a discussion of our key assumptions, the empirical model that generates values where data are missing and the robustness of these estimates. We turn in Section 4 to the construction of financial exchange rate indices. Section 5 reports the main results of our empirical analysis. Some conclusions are offered in Section 6.

2. Conceptual framework

Traditionally, the main focus of attention in analysing the role of the exchange rate in the international adjustment process has been its impact on real variables such as the trade balance and domestic and foreign levels of output and other macroeconomic variables. However, in recent years, there has been a resurgence in interest in the balance sheet impact of currency movements. While this valuation channel was recognised in the portfolio balance literature that was developed during the late 1970s and early 1980s, the increase in the scale of gross holding of foreign assets and liabilities means that its quantitative importance is larger now than in previous decades.[2]

[2] We focus on the valuation impact of currency movements; shifts in domestic and foreign asset prices also influence the overall value of the international investment position.

The recent literature has two main strands. One focuses on emerging market economies, which are characterised by large stocks of foreign currency debt. For these countries, currency depreciation has a negative valuation impact on the balance sheets of domestic entities, since the foreign currency debt increases in value in terms of domestic currency. This feature has led to a large policy and academic literature that investigates whether this channel is sufficiently strong to alter optimal policy decisions, such as the choice of exchange rate regime and the appropriate role for domestic interest rates during periods of financial turmoil.[3]

The other concentrates on the nature of the valuation channel for the major advanced economies.[4] In particular, this line of work highlights that these economies are typically short in domestic currency and long in foreign currencies. That is, a substantial proportion of foreign liabilities are denominated in domestic currency, while foreign currencies play a large role in the composition of foreign assets. With this profile, unanticipated depreciation of the domestic currency boosts the net value of the international investment position, since it raises the value of foreign assets relative to foreign liabilities.

At a general level, the role of the valuation channel in the dynamics of the external position can be expressed using the following accounting framework. Following Lane and Milesi-Ferretti (2005), the change in the net foreign asset position between periods $t-1$ and t can be written as

$$NFA_t - NFA_{t-1} = CA_t + VAL_t \tag{1}$$

where CA_t is the current account surplus and VAL_t is net capital gain on the existing holdings of foreign assets and liabilities

$$VAL_t = KG_t^A - KG_t^L \tag{2}$$

$$= kg_t^A A_{t-1} - kg_t^L L_{t-1} \tag{3}$$

where kg_t^A, kg_t^L are the "rates" of capital gain on foreign assets and liabilities. This expression highlights that the importance of capital gains is increasing in the gross scale of the international balance sheet – given values of kg_t^A and kg_t^L have a bigger impact on VAL_t, the larger A_{t-1} and L_{t-1} are.

In turn, this implies that the valuation impact of a shift in a currency depends on its impact on the capital gains earned on foreign assets and liabilities

$$\frac{\partial VAL_t}{\partial E_t} = \frac{\partial kg_t^A}{\partial E_t} A_{t-1} - \frac{\partial kg_t^L}{\partial E_t} L_{t-1} \tag{4}$$

where E_t is the exchange rate. Accordingly, in order to make such calculations, it is necessary to establish the currency composition of both sides of the international balance sheet. While the literature cited above has emphasised the split between domestic and foreign currency in the international balance sheet, very little is known in terms of the composition of the foreign currency element across the different currencies. In particular, Tille (2003) and Lane and Milesi-Ferretti (2007c) have emphasised that the "finance" currency weights for the United States are quite different from the "trade" currency weights,

[3] See, amongst others, the contributions of Eichengreen and Hausmann (2005), Devereux and Lane (2003) and Devereux, Lane and Xu (2006).

[4] See, amongst others, Tille (2003, 2005), Gourinchas and Rey (2007a) and Lane and Milesi-Ferretti (2001, 2003, 2005, 2006a, 2006b).

with European currencies much more heavily represented in the former. Accordingly, we seek to gain a more comprehensive understanding of the distribution of currency exposures for a large set of countries.

To create these currency composition weights, we combine a number of datasets, augmented by a fair amount of model-generated imputed data. The details of these procedures are reported below. Before we address the details, we consider two broad concerns regarding whether currency weights based on the currency denomination of foreign assets and liabilities accurately represent the currency risk exposure a country faces.

First, local currency asset prices could be negatively correlated with the exchange rate, such that investor currency returns might be insulated from currency movements. However, there is a wealth of evidence suggesting that currency movements do matter for investor currency returns (Lane and Milesi-Ferretti (2005)). For instance, the failure of uncovered interest parity and the success of financial trades such as the carry trade show that returns do not counter exchange rate movements in bond markets, but instead often reinforce them (Burnside et al (2006)). In relation to portfolio equity and FDI positions, a depreciation could be accompanied by an improvement in export performance, boosting the local currency returns on holdings in export-oriented firms and export platform FDI. However, in the other direction, a depreciation is also frequently accompanied by a slowing of the economy, such that local-currency returns on domestically oriented stocks and FDI positions are negatively affected. These conflicting forces may result in a weak average correlation between currency movements and local currency returns on portfolio equity and FDI returns. In related fashion, Pavlova and Rigobon (2006) show that the co-movement between asset prices and exchange rates depends on the relative importance of productivity shocks versus demand shocks: in their model, a positive productivity shock boosts the domestic stock market and induces exchange rate depreciation, while a positive demand shock also boosts equity returns but leads to exchange rate appreciation.

Furthermore, bank loans and deposits, reserves, and other assets or liabilities that are not marked to market do not have price valuation effects, only exchange rate based valuation effects, so there is no offset for these asset classes. Thus, in total, while one would expect exchange rate returns and local currency asset returns to cancel one another out in some ways, in practice there is considerable "pass-through" from exchange rate movements to investor currency returns.[5] While there is some evidence that exchange rate and equity returns negatively covary at high frequencies for industrial countries (Hau and Rey (2006)), there is no evidence of this correlation in annual data such that a depreciation of the foreign currency reduces the home currency value of an equity investment in the foreign country (Lane and Milesi-Ferretti (2005)).

Second, if domestic agents hedge all currency exposure by buying insurance from foreign agents, they will receive offsetting gains on their derivative positions against any spot exchange rate losses. Lack of data means that the extent of cross-border currency hedging is difficult to assess; while the volume of currency-related derivatives trading is very large, much of this is between domestic residents, which does not alter the aggregate net exposure of the economy.[6,7] Hau and Rey (2006) estimate that only 10 percent of foreign equity

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[5] In our empirical analysis, we investigate the co-movement between the valuation effects generated by currency movements (VAL^{XR}) and the valuation effects generated by shifts in asset prices (VAL^{MV}). Since we residually calculate VAL^{MV} as the difference between the overall valuation effect VAL and VAL^{XR}, it is not surprising that the two are negatively correlated, but we do find that VAL^{XR} is positively correlated with VAL and has a significant impact on the direction of VAL, such that there is significant "pass-through" from exchange rate movements to the net foreign asset position.

[6] However, see Becker and Fabbro (2006) for an extensive study of hedging in Australia that shows that Australia is a net purchaser of currency insurance from foreign investors.

positions are hedged, often due to institutional restrictions on the use of derivatives contracts. Furthermore, as noted above, if the counterparty in a derivatives contract is another domestic resident, the currency risk still resides within the same country. In addition, any hedging that comes through balancing of asset and liability exposure (e.g. simultaneously holding dollar assets and liabilities) is captured in our weights: it is only the more complex derivatives contracts that will be missed. Finally, it is not clear that an optimising agent would hedge out all currency risk, depending on the correlation of particular currencies with the entire portfolio of assets and liabilities and consumption growth in the investor's country (see Campbell et al (2006) for a discussion).[8]

3. Data

We follow a two-step procedure in estimating currency positions. First, we determine the currency composition of assets and liabilities within individual asset classes. Second, we weight the asset classes by their shares in the international balance sheet in order to construct the aggregate index.

The currency composition of assets and liabilities is calculated by combining information from several international data sources. These include: the BIS international banking statistics; the BIS international securities statistics; the IMF's Coordinated Portfolio Investment Survey (CPIS); UNCTAD's database on bilateral FDI positions; the World Bank's Global Development Finance database; data series from the Bureau of Economic Analysis, the US Treasury, the Federal Reserve, the European Central Bank and national central banks; and the "External Wealth of Nations" dataset on foreign asset and liability positions that has been developed by Lane and Milesi-Ferretti (2001, 2007a). The method for determining the currency composition of asset classes varies across asset classes, due to differences in sources and data availability.

Since there are considerable data gaps for some countries, the construction of currency composition weights is not entirely mechanical – inference procedures are required to interpolate some of the missing data. We then rely on recent advances in the modelling of the geographical distribution of international financial portfolios to generate predictions for asset holdings that allow us to fill in missing observations (Lane and Milesi-Ferretti (2007d)). The appendix provides a detailed description of the methods employed to construct estimates of the currency composition of international balance sheets.

Our full sample of countries includes 117 countries where we have full data. We eliminate hyperinflation episodes due to their status as outliers, and start a country's data after the conclusion of a hyperinflation (countries with hyperinflations late in the sample are dropped). Many results examine the change from 1994 to 2004. These results use a smaller 102-country sample that has full data from 1994 to 2004.

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[7] In some cases, cross-border hedging can exacerbate overall exposures. In particular, suppose that hedging is mostly carried out by holders of foreign currency liabilities. For countries such as the United States that are net long in foreign currencies, this form of hedging raises the aggregate net currency position.

[8] Even more generally, the optimal degree of currency hedging will also depend on the covariances between currency movements and risk factors in production and trade.

4. Index creation

The dataset allows us to build a number of "financially weighted" effective exchange rate indices for a large number of countries. For instance, the "bond-asset-weighted" effective exchange rate index for a country would attach a 50 percent weight to the dollar, a 30 percent weight to the euro and a 20 percent weight to the yen if our procedure indicated that the country's foreign bond asset position had a 50-30-20 split between these currencies. Similarly, the "bank-asset-weighted" index would reflect the relative importance of different currencies in foreign deposits. While the same foreign currencies tend to be involved in most weights, the crucial result from our work is to identify for each country the relative shares of domestic and foreign currencies in foreign assets and liabilities and the relative importance of different international currencies in the foreign currency component of the international balance sheet.

Once we have the currency composition data for each asset class within assets and liabilities, we can combine these asset classes to create aggregate weights, using data from the "External Wealth of Nations" database constructed by Lane and Milesi-Ferretti (2007a). This dataset reports the levels of foreign assets and liabilities for 145 countries over 1970–2004, together with the composition of each side of the international balance sheet between portfolio equity, direct investment, reserves and debt. This is important since two countries could have similar currency exposures within individual asset classes but different aggregate exposures, due to differences in the relative importance of different investment categories across the two countries. Moreover, the structure of international balance sheets has been shifting over time – even if currency exposures were stable for individual asset classes, aggregate exposures could change due to this composition effect.[9] This gives us the currency composition weights for individual asset classes as well as a set of aggregate weights that would take into account differences in the relative importance of the different investment categories across countries and over time. We calculate an aggregate finance-weighted index as well as asset- and liability-weighted indices.

Accordingly, the weights are given by the formulae

$$\omega_{ijt}^{A} = \sum_{k=1}^{k=N} \lambda_{it}^{Ak} \times \omega_{ijt}^{Ak} \tag{5}$$

$$\omega_{ijt}^{L} = \sum_{k=1}^{k=N} \lambda_{it}^{Lk} \times \omega_{ijt}^{Lk} \tag{6}$$

where $\omega_{ijt}^{A}, \omega_{ijt}^{L}$ are the weights for currency j in period t in country i's asset- and liability-weighted exchange rate indices, $\lambda_{it}^{Ak}, \lambda_{it}^{Lk}$ are the relative importance of category k (portfolio equity, FDI, debt, reserves) in country i's assets and liabilities in period t and $\omega_{ijt}^{Ak}, \omega_{ijt}^{Lk}$ are the weights for currency j in period t in category k for country i's assets and liabilities respectively. Accordingly, the aggregate weights are a function of the weights for currency j in period t for a particular k asset class of country i's assets or liabilities, and the weights across the k asset classes (represented by λ_{it}^{k}). This allows us to derive the valuation impact on country i of a change in the value of currency j in a straightforward manner

[9] See Faria et al (2007) and Lane and Milesi-Ferretti (2007a) on the sources of changes in the external capital structure of countries.

$$\frac{\partial VAL_{it}}{\partial E_{ijt}} = \omega_{ijt}^{A} A_{it-1} - \omega_{ijt}^{L} L_{it-1} \tag{7}$$

where A and L are defined as the size of foreign assets and liabilities relative to GDP and VAL is defined as the change in net foreign wealth (relative to GDP) caused by valuation changes. More generally, we are interested in asset- and liability-weighted exchange rate indices and the overall impact on net foreign wealth of these exchange rate changes.

Finally, it is also useful to define aggregate net financial weights

$$\omega_{ijt}^{F} = \omega_{ijt}^{A} s_{it-1}^{A} - \omega_{ijt}^{L} s_{it-1}^{L} \tag{8}$$

where $s_{it-1}^{A} = A_{it-1}/(A_{it-1} + L_{it-1})$ and $s_{it-1}^{L} = L_{it-1}/(A_{it-1} + L_{it-1})$ are the shares of foreign assets and foreign liabilities in total cross-border holdings. The weights generated by equation (8) indicate the direction of the valuation impact of a movement in currency j. If the net foreign asset position is zero such that foreign assets and liabilities are perfectly balanced, this reduces to simply subtracting the liability weights from the asset weights. Conceptually, an index crafted with these weights will capture the directional effect of a set of bilateral exchange rate changes on the net external position.

An exchange rate index based on weights from equation (8) is conceptually different from a trade-weighted index because it has currencies entering both positively and negatively. Moreover, if net positions and currency compositions are balanced, there is no movement in the index regardless of bilateral exchange rate movements. For this reason, to enable comparisons to other indices, we also separately examine asset- and liability-weighted indices.

The particular details of index creation also warrant some attention. Our index uses the weights (trade or asset or liability) to average the percentage changes of the exchange rate versus other currencies, and this is multiplied by the index from the previous period. The index formula is given by

$$I_{it}^{A} = I_{it-1}^{A} \times \left(1 + \sum \omega_{ijt}^{A} \times \%\Delta E_{ijt}\right) \tag{9}$$

$$I_{it}^{L} = I_{it-1}^{L} \times \left(1 + \sum \omega_{ijt}^{L} \times \%\Delta E_{ijt}\right) \tag{10}$$

where I_{it} is the index for country i, ω_{ijt} is the weight given to currency j in period t and E_{ijt} is the nominal exchange between i and j.

As with a trade-weighted index, however, we cannot assess the scale of the impact without knowing the size of the gross foreign asset and liability positions. Accordingly, another way to summarise the valuation impact is

$$\frac{\partial VAL_{it}}{\partial E_{ijt}} = \omega_{ijt}^{F} \times IFI_{it-1} \tag{11}$$

where the valuation impact is increasing in the gross scale of the international balance sheet $\left(IFI_{it-1} = A_{it-1} + L_{it-1}\right)$.

In turn, this means that the aggregate sensitivity of the net foreign asset position to currency movements (as opposed to total valuation effects) is given by

$$VAL_{it}^{XR} = \%\Delta I_{it}^{A} \times A_{t-1} - \%\Delta I_{it}^{L} \times L_{t-1} \tag{12}$$

where the superscript XR indicates valuation changes from the exchange rate movement.[10] As the absolute value of VAL_{it}^{XR} goes up, the extent to which net foreign wealth is affected by the exchange rate increases.

Equation (12) is the equivalent of multiplying the percentage change in an index based on weights from equation (8) times the sum of assets and liabilities. To see this, define the aggregate index by

$$I_{it}^{F} = I_{it-1}^{F} \times \left(1 + \%\Delta I_{it}^{A} \times s_{it-1}^{A} - \%\Delta I_{it}^{L} \times s_{it-1}^{L}\right) \quad (13)$$

In turn, this allows us to write

$$VAL_{it}^{XR} = \%\Delta I_{it}^{F} \times IFI_{it-1} \quad (14)$$

where $IFI_{it-1} = (A_{it-1} + L_{it-1})$. Equation (15) highlights the fact that the magnitude of currency-related valuation effects depends on two factors: (i) the movement in the financially weighted exchange rate index; and (ii) the gross scale of the international balance sheet. I_{it}^{F} can also be written in the same form as equations (11) and (12) using the aggregate net financial weights defined in equation (9).

Our index is a rough approximation of a geometric average that focuses on the percentage change versus each currency in a given time period as the relevant information, not the level.[11] It will also move similarly to a portfolio that uses these weights to define shares of the portfolio.[12]

Often, when the impact of outliers is an issue, one might prefer a geometric weighted average. However, that is not the appropriate specification in this case. We define the exchange rate in the standard manner, the home price of foreign currency, such that a negative movement represents an appreciation of the home currency. This assumption means that, if a trading partner experiences a major depreciation due to a hyperinflation or some other crisis, that partner's exchange rate in the index will decrease rapidly towards zero – not explode towards infinity. In this way, if the only change in the various bilateral exchange rates were a collapse of a rate towards zero, our index would simply drop by the amount of the weight. This is the equivalent of some portion of a portfolio becoming worthless and thus fits our needs well.

In contrast, a geometric index is strongly affected by such an outlier heading close to zero, even if the weight on it is relatively small. Due to the property of raising the value to the power of the weight, any number that is very close to zero winds up having an unusually large presence in reducing the index towards zero. That is, the index would drop down by far more than the weight on the currency, suggesting that if we simply assumed that all assets in

[10] By definition, then, the total valuation effect is the sum of the exchange rate valuation effect and the asset price valuation effect.

[11] Note that the log of a geometric average is the weight times $\log(E)$ for each currency, and thus the approximation of the percentage change of the geometric average would simply be the sum of the change in $\log(E)$, or roughly the percentage change. The approximation breaks down when there is a very large outlier (with a very large percentage change), in which case that outlier will take on a larger weight in our index than in a pure geometric index.

[12] A pure geometric index will not move like a portfolio and thus could not be tracked by a portfolio assembled using its weights.

a particular currency were now worthless, the index would drop by more than the amount those assets were worth.[13]

Accordingly, we find that to reduce the impact of outliers and have the index move in a way that matches what the values of a portfolio of assets would do, defining an exchange rate such that an appreciation of the home currency is a negative movement and using the summation index is the appropriate method.

In many settings, when calculating an index and changing the weights over time, one must worry that a change in the weight with no change in the value of the item in question will lead to a change in the index. One, in fact, would like this to happen as, for example, if the weight on more expensive items goes up, this will lead to a cost of living increase: one must chain-weight the weights to appropriately smooth over time. In our case, we are simply concerned with the change in the exchange rate index over time: if the exchange rate for all countries were constant, and the weights changed, we would want zero change in the index. Our index method ensures that this would be the case, since the index combines percentage changes in the exchange rate. Accordingly, more complex chain-weighting is not necessary; we can simply employ new weights whenever they are available.

Thus, in the end, our index tells us about the change in the exchange rate against a set of partners weighted by information for that year. When a gap in years is present, we average across to fill in the missing weights. 1997 weights are extended back to 1990 for asset classes that have their earliest data on currency composition in 1997 (equity and debt asset).

5. Analysis

The weights and indices described open a variety of avenues for analysis that were previously unavailable due to a lack of data. Our analysis proceeds along three lines. First, we examine the various indices described in Section 4. Next, we explore the variation in aggregate foreign currency exposures across countries and over time. Finally, we look at the role played by financially weighted exchange rate indices in driving the valuation component of the dynamics of net foreign asset positions.

5.1 Comparison of exchange rate indices

Our first task is to compare exchange rate indices across trade, asset, liability and net financial weights. A comparison of trade- and finance-weighted exchange rates demonstrates the extent to which we need to know currency exposures in the international balance sheet in order to understand the financial impact of exchange rate changes. If a trade-weighted exchange rate could easily summarise what is happening in our net index, the new index would be far less important. Furthermore, by comparing asset- and liability-weighted indices, we can better understand the extent to which countries have currency mismatches in their assets and liabilities.

[13] For example, if an exchange rate fell from 100 to 0.1 and it made up 10 percent of an index and there were no other changes, the summation index would fall from 100 to 90, but the geometric index would fall from 100 to 50. Again, note that if we had defined the exchange rate such that the outliers were going from 100 to 10,000, the geometric index would go from 100 to 158, but the summation would jump to over 1,000.

5.1.1 Correlations

Table 1 provides the mean and median within-country correlation of the monthly percentage changes in different indices. The asset and liability indices show a high pairwise correlation. In addition, both are individually correlated with the trade index, although the correlation is a bit weaker for the liability index (largely reflecting the importance of domestic currency liabilities). A country tends to have similar financial partners on both the asset and liability side of the international balance sheet, or at least its currency moves in similar directions against the two sets of partners.

Table 1

Correlations between financial and trade-weighted exchange rate indices

Group	Statistic	Assets Liabilities	Assets Trade	Liabilities Trade	Net finance Trade	Exports Imports
All	Mean	0.96	0.90	0.86	–0.30	0.95
	Median	0.98	0.95	0.92	–0.72	0.98
Advanced	Mean	0.97	0.92	0.88	0.41	0.97
	Median	0.98	0.93	0.89	0.70	0.98
Dev. & Emerging	Mean	0.96	0.90	0.86	–0.47	0.95
	Median	0.99	0.96	0.95	–0.82	0.98
Developing	Mean	0.96	0.88	0.84	–0.61	0.94
	Median	0.99	0.95	0.94	–0.89	0.97
Emerging	Mean	0.94	0.93	0.88	–0.13	0.98
	Median	0.97	0.97	0.95	–0.37	0.99

Correlations between the percentage change in monthly Financial and Trade-weighted Exchange Rate Indices. Monthly data, 1990.1–2004.12. Full sample of countries.

However, Table 1 also shows a strongly negative average correlation between the net financial index and the trade-weighted index for the full sample and the developing sample. This can be reconciled with the high pairwise correlation between the asset and liabilityindices by understanding that it is the net positions and also the size of the movements of asset and liability indices that generate the diverging pattern for the net financial index from the trade index, rather than directly opposing moves of the asset and liability indices. This largely reflects the typical profile of a country with a negative net foreign currency position: if it depreciates, its trade index and net financial index move in opposite directions. Although the typical correlation between these indices is positive for the advanced economies, the magnitude is much lower than for other pairs of indices.[14]

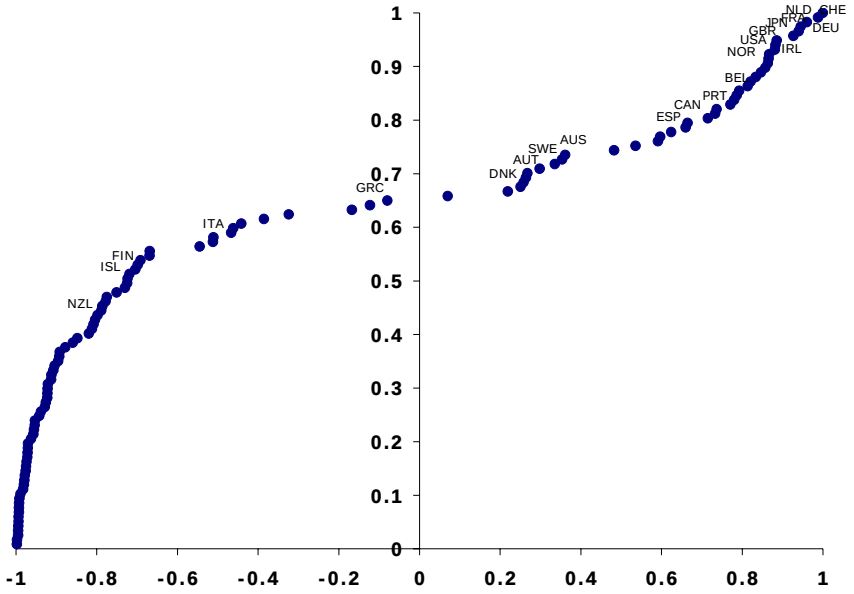
Figure 1 shows the cross-sectional distribution of this correlation. A cluster of countries are correlated near minus 1: these countries typically had very large depreciations at some point

[14] This table, as do many others, breaks countries down into advanced, emerging and developing groups. The advanced countries are the group typically known as industrialised countries (ifs code less than 199 except Turkey). The emerging sample is the group of countries in the Morgan Stanley emerging market index with some additional eastern European countries. The developing sample is all other countries.

during the sample period, while maintaining negative foreign currency positions. Even beyond this group, the correlation between the two indices is quite weak for a large range of countries, since the differences between trade partners and financial partners mean the two indices simply move differently. For example, industrial countries (marked by their country abbreviation), which on average have net positive foreign currency positions, have a mean of 0.41 and a median of 0.70. For comparison, we see that the pairwise correlation between any other type of index (assets and trade, imports and exports, etc.) is above 0.85. Thus, it appears that the trade index does a poor job of summarising the net financial impact on a country when the exchange rate changes.

Figure 1

Distribution of correlation between financial and trade-weighted exchange rate indices: all countries



5.1.2 Exchange rate volatility

Along another dimension, Table 2 shows the volatilities across indices. The liability index is much more stable than the asset index, especially for industrial countries: the average standard deviation of the percentage change of the liabilities index is only 3.5 percent for industrial countries as opposed to 5.9 percent for the assets. This again reflects the greater share of the domestic currency in liability indices. The leader in this regard is the United States, where over 90 percent of liabilities are in dollars and as a result the liability index has a volatility of less than 1 percent a year.

Since the liability index is so much more stable than the asset index, even if the two move directionally together and are highly correlated, the amplitude of the asset index is greater. In turn, this implies that currency movements may generate valuation effects, even for countries with zero net foreign asset positions. Table 2 also shows that net financial indices are far more stable than any other index for all types of countries. This again represents the fact that the net valuation impact of currency movements is limited by the offsetting effects on the value of foreign currency assets and foreign currency liabilities. However, especially for developing countries, there is a fair degree of volatility in this index.[15]

[15] The pattern is the same if one examines the average absolute value of the percentage change of the index instead of the standard deviation of the changes.

Table 2

Exchange rate volatility: financial and trade-weighted exchange rates

Group	Statistic	Trade	Net	Assets	Liabilities
All	Mean	0.123	0.050	0.140	0.105
	Median	0.066	0.023	0.067	0.055
Advanced	Mean	0.050	0.013	0.058	0.035
	Median	0.046	0.010	0.053	0.034
Dev. & Emerging	Mean	0.140	0.058	0.159	0.122
	Median	0.081	0.028	0.071	0.068
Developing	Mean	0.133	0.069	0.153	0.121
	Median	0.071	0.035	0.064	0.068
Emerging	Mean	0.158	0.036	0.173	0.123
	Median	0.090	0.021	0.101	0.071
Sudden Stops	mean % Δ	44%	–8%	54%	41%
Big Change	mean % Δ	88%	–30%	107%	88%

Standard deviation of monthly changes in exchange rate indices over 1994–2004, full sample of countries. The bottom panel shows percentage change in these indices during financial crises, where Sudden Stops represent sudden stop observations and Big Change represents large depreciations (over 50 percent) against the relevant base currency.

The bottom panel of Table 2 shows that, in either sudden stops or in cases where a country depreciates 50 percent or more against its base, the net index both is strikingly more stable and moves in an opposite direction to the trade index. Despite the relative stability, a negative 8 percent move of the net index (for sudden stops) can generate large valuation losses and the negative 30 percent move for the large depreciation countries suggests large losses. In fact, the sudden stop countries lost 6 percent of GDP on average and the large depreciation countries 29 percent of GDP.[16]

5.1.3 Co-movement of asset- and liability-weighted indices

An alternative way of considering the movements of asset- and liability-weighted indices is to regress the change in the liability index on the change in the asset index

$$\%\Delta I_{it}^{L} = \alpha + \beta \times \%\Delta I_{it}^{A} + \varepsilon_{it} \qquad (15)$$

This allows us to consider both the direction of the changes and the magnitudes. If $\beta = 1$, it suggests that its currency exposure is well matched in assets and liabilities: a country still may be exposed to valuation changes if it has a positive or negative net foreign asset position, but the problem will not be currency mismatches.

[16] These calculations are based on 17 sudden stops that are not classified as hyperinflations and 52 large depreciations (where the year average exchange rate depreciates against the base by at least 50 percent) that are not hyperinflations. The sudden stop episodes are those listed by Durdu et al (2007).

Table 3 shows that the estimated $\widehat{\beta} =$ 0:80 for the full sample and the developing group, with a very high R^2 in each case. For the advanced country group, $\widehat{\beta} =$ 0:66 and the R^2 is marginally lower. Again, this difference is intuitive in view of the greater reliance of developing countries on foreign currency liabilities. Since $\widehat{\beta} =$ < 1 in all cases, a generalised movement in the value of the home currency against other currencies will induce a shift in the value of the net foreign asset position, even for a country with an initially balanced international investment position.

Table 3

Co-movement of asset- and liability-weighted exchange rates

	(1) All	(2) Advanced	(3) Dev. & Emg.	(4) Developing	(5) Emerging
ΔIND_{it}^{A}	0.77 (0.01)***	0.66 (0.01)***	0.77 (0.01)***	0.77 (0.01)***	0.77 (0.01)***
R^2	0.95	0.89	0.95	0.96	0.94
N	1499	308	1191	802	389
Countries	117	22	95	65	30

Fixed-effects panel estimation over 1994–2004 regressing the annual percentage change in the liability index on the annual percentage change in the asset index.

5.1.4 Case studies

We conclude our examination of exchange rate indices by looking at a selection of six countries in Figures 2a–f. In the US case, the indices for assets and liabilities are quite different due to the stability of the liability index. While the net financial index is correlated with the trade-weighted index, the relative magnitude of changes varies from year to year. In the last few years, the asset index has moved more dramatically than the trade index. The net remains more stable due to the offsetting effects from liabilities.

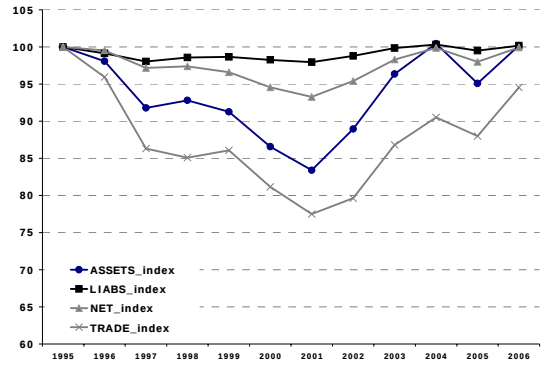
In contrast, for France, we see the liabilities index move more similarly to the asset index, so the net index is flat regardless of fluctuations in the trade index. Also, all the indices are relatively stable, reflecting the role first of the EMS and then EMU in limiting multilateral volatility for France.

The patterns for Brazil are representative of the typical emerging market economy. The exchange rate depreciates for trade, asset and liability weighting, but the net index moves in the opposite direction (a depreciation worsens the net index for indebted countries). Since 2002, we see that Brazil has appreciated against both trade and finance partners and this has led to valuation gains. China's asset, liability and net indices are virtually flat due to the peg against the dollar and the outsized weight of the dollar in all finance indices for China. Alternatively, the trade index for China moves with the dollar versus other non-dollar trade partners (although, in the last year, the Chinese depreciation has been smaller than the US due to the small RMB appreciation against the dollar).

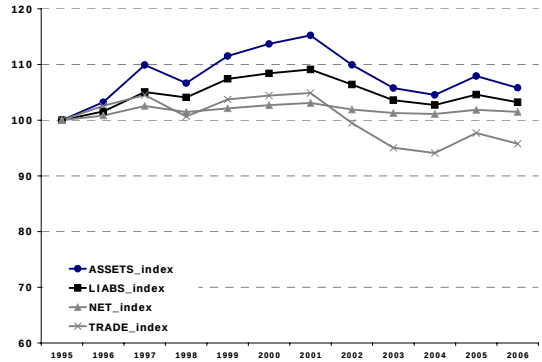
Benin is an example of a country where trade weights and asset and liability weights are quite different with a slowly appreciating trade index moving in an unlinked fashion from the indices for assets and liabilities. The net and trade indices are nearly mirrors. Finally, in Bangladesh, like Brazil, the net index falls as the currency depreciates on a trade, asset and liability basis, although, in final years, the liability index is flattening relative to the asset index as more liabilities are denominated in domestic currency.

Figure 2a–f
Examples of indices

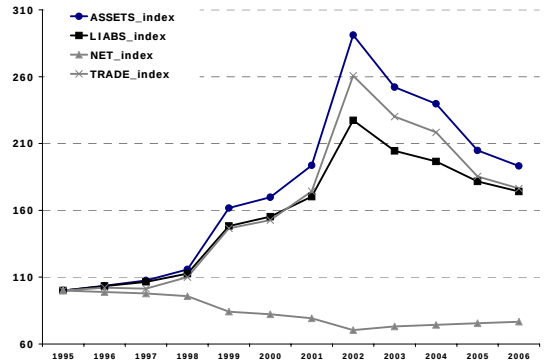
United States



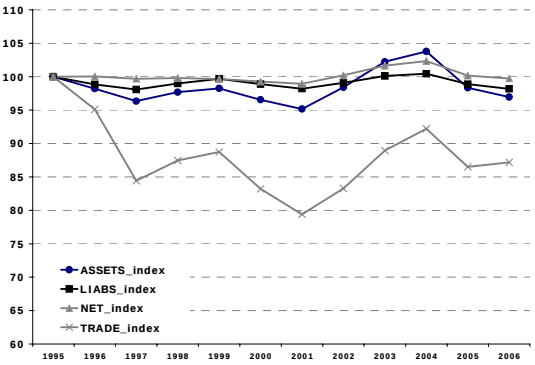
France



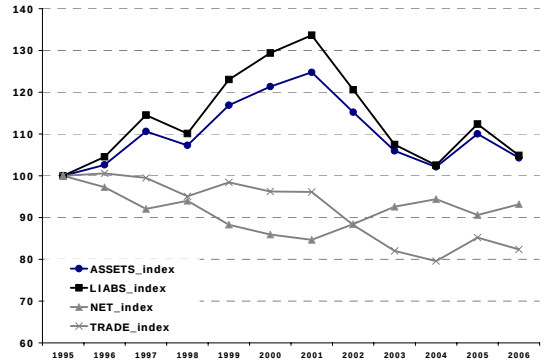
Brazil



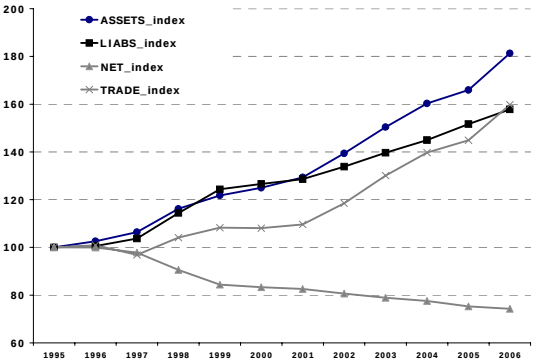
China



Benin



Bangladesh



Comparing the emerging and developing countries can highlight the role of the exchange rate regime. China has pegged to its main financial partner and thus effectively stabilised its asset, liability and net indices, but not its trade index. Alternatively, Benin (a member of the CFA) has a relatively stable trade index due to a stable exchange rate against both local countries and the euro. Its financial indices, though, move considerably as the US dollar plays a large role in these (despite almost no role in trade). The large net negative position against the world (and in particular the dollar) means that as the euro and dollar move back and forth, Benin's net index does as well. Finally, as it has not maintained a tight peg in this era, Brazil sees much more volatility in all these indices.

In summary, we see a diverse range of patterns, with the trade index relatively uninformative about the financial impact of currency movements. We now turn to one of the key drivers of the net financial index: the net foreign currency exposure.

5.2 Net foreign currency exposures

There has been a recent flurry of work that seeks to calculate optimal international portfolios within the framework of dynamic stochastic general equilibrium macroeconomic models (Engel and Matsumoto (2006), Devereux and Saito (2006), Devereux and Sutherland (2006a, 2006b, 2006c), Kollmann (2006), Benigno (2006) Tille and van Wincoop (2007)). One question addressed by this literature is the optimal pattern in nominal exchange rate exposures, with the answer depending on the configuration of shocks hitting the economy and the range of assets that are internationally traded. Although results are typically dependent on the precise specification of the model, the general pattern is that a positive domestic productivity shock raises domestic welfare and induces exchange rate depreciation. Accordingly, a good hedge is to hold a negative position in foreign currency assets. In contrast, a positive domestic demand shock raises domestic welfare but induces exchange rate appreciation. In this case, the hedging portfolio involves a positive position in foreign currency assets.

Another strand in this literature has highlighted the fact that structural differences across economies can help explain the configuration of international portfolios. For instance, Mendoza et al (2007) show a model in which differences in the degree of financial development mean that the advanced economy becomes a net debtor but holds a long equity position in the developing economy. (See Caballero et al (2006) for a related model and Devereux and Sutherland (2007) for a related result.)

In order to inform this literature at an empirical level, we can look at the net weight on the rest of the world to see if countries have taken positive or negative aggregate foreign currency positions.[17]

5.2.1 The cross-sectional distribution of foreign currency exposures

For this purpose, it is useful to work with the concept of aggregate foreign currency exposure. Define foreign currency exposure by

$$FX_{it}^{AGG} = \omega_{it}^{A} s_{it}^{A} - \omega_{it}^{L} s_{it}^{L} \tag{16}$$

where ω_{it}^{A} is the share of foreign assets denominated in foreign currencies, s_{it}^{A} is the share of foreign assets in the sum of foreign assets and foreign liabilities and $\omega_{it}^{L}, s_{it}^{L}$ are defined analogously. Aggregate foreign currency exposure captures the sensitivity of a country to a uniform currency movement by which the home currency moves proportionally against all foreign currencies. In turn, the net impact on the external balance sheet is given by

$$NETFX_{it} = FX_{it}^{AGG} \times IFI_{it-1} \tag{17}$$

Figure 3 and Table 4 show the cross-sectional distribution of FX^{AGG} in 1994. We see that a majority (70 percent) have a net negative position in foreign currencies with an average weight of –27 percent. Over 20 percent have below –50 percent weight, leaving them with a considerable short position in foreign currencies. On the other hand, industrial countries are

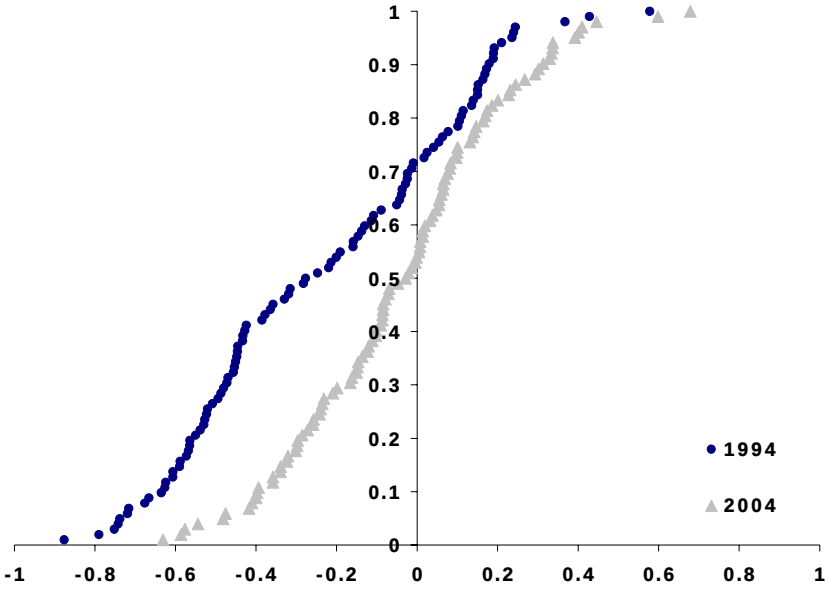
[17] In principle, multi-country versions of these models could deliver predictions about net holdings of different currencies. To our knowledge, these models have not yet been developed in the literature.

on average close to balance (mean and median weight are between zero and 10 percent) and 60 percent of industrial countries have a positive net weight in foreign currencies. Emerging countries are on balance negative, but much closer to zero than the poorer developing countries.

Figure 3 also shows the same distribution but for the year 2004. By 2004, 17 percent more of the sample had taken a positive position against the rest of the world. The mean position and median position have both moved close to zero (–7 percent) and only roughly 10 percent, have positions of –50 percent or worse. The industrial countries still have means and medians close to positive 10 percent with 86 percent of them having net positive exposure. Emerging countries are also on average positive by 2004. It should be noted that shifting to a positive net position does not eliminate exchange rate based valuation effects: it simply means that the sign will be positive when the country depreciates against the rest of the world.

Figure 3

Distribution of aggregate foreign currency exposures: 1994 and 2004



To put these figures in context, a negative foreign currency exposure of 50 percent against the rest of the world means that a 10 percent depreciation would generate a valuation loss of 10 percent times 50 percent times total assets and liabilities divided by GDP (recall that equation (15) shows that the valuation gain is the percentage change in the index times the gross scale of international financial integration). Thus, a country at the average gross position of 200 percent of GDP would experience a 10 percent of GDP loss from such a depreciation. These wealth effects are considerable and demonstrate why the aggregate foreign currency position against the rest of the world is an important indicator.[18]

[18] We also note that there can still be considerable exchange rate shocks due to bilateral movements even if FX_{it}^{AGG} is zero. All but 10 countries are short some other currency in 2004, and 50 percent have a negative weight of 11 percent or more against some other currency. The largest net negative position varies, with half short the dollar and the others roughly evenly split between the euro and yen. All but one country are long another currency, though the average position is smaller (7 percent weight). The long positions are spread across the dollar (33 percent), the pound (20) and the euro (28) along with 16 other currencies which are the largest long position for somewhere between one and three other countries. The more minor currencies become important due to a large FDI holding in the country and no offsetting liabilities in that currency. Thus, even countries with roughly balanced net positions tend to have considerable exposure to movements across bilateral rates.

Table 4

Aggregate foreign currency exposure

	1994		2004	
	mean	**median**	**mean**	**median**
FX^{AGG}				
All	–0.24	–0.26	–0.04	–0.03
Advanced	0.04	0.08	0.11	0.09
Dev. & Emerging	–0.31	–0.43	–0.08	–0.10
Developing	–0.42	–0.47	–0.15	–0.18
Emerging	–0.11	–0.07	0.04	0.06
$NETFX$				
All	–0.31	–0.22	0.11	–0.04
Advanced	0.17	0.08	0.51	0.36
Dev. & Emerging	–0.45	–0.36	0.00	–0.13
Developing	–0.73	–0.52	–0.21	–0.22
Emerging	0.06	–0.08	0.38	0.06

Note: $FX_{it}^{AGG} = \omega_{it}^{A} s_{it}^{A} - \omega_{it}^{L} s_{it}^{L}$ $NETFX_{it} = FX_{it}^{AGG} \times IFI_{it-1.}$ Sample includes the 102 countries with data from 1994 to 2004.

The bottom half of Table 4 shows the values of $NETFX_{it}$ in 1994 and 2004. This helps to demonstrate the scale at which a change in the exchange rate would affect the economy. The changes from 1994 to 2004 show a similar pattern to the raw FX_{it}^{AGG} statistics in the top half of the table, with the exception that the industrial countries position has improved even more by this measure. While many industrial countries have not shifted FX_{it}^{AGG} dramatically, their scale of financial globalisation (IFI) has increased considerably, so their overall net long exposure to foreign currencies has increased as a share of the economy. Again, they do not risk negative wealth effects following depreciation, but they are exposed to exchange rate movements.

5.2.2 The dynamics of currency exposures

Next, we provide a decomposition of the shifts in currency exposures over the 1994–2004 period. The shift in foreign currency exposure between periods $t–N$ and t can come either from increasing the share of assets relative to liabilities in IFI (s_{it}^{A}) or from reducing the foreign currency weight of liabilities (ω_{jit}^{L}). Table 5 shows the driving factors underlying the changes in FX_{it}^{AGG}. There is a considerable range of behaviour of $FXAGG_{it}$ over the decade. First, to understand why countries' positions have changed, we can divide the sample into quartiles by the extent that FX_{it}^{AGG} has changed (top panel of Table 5). While the lowest quartile sees a small decline in FX_{it}^{AGG}, the top quartile has a 34–92 percentage point increase in the index.

Table 5

Decomposition of shift in aggregate foreign currency exposure, 1994–2004

Quartile	Obs	Mean	Min	Max	Δs_{it}^{A}	$\Delta \omega_{it}^{A}$	$\Delta \omega_{it}^{L}$	EMU	Non-EMU
1	25	–0.09	–0.34	0.04	–0.07	–0.15	–0.17	0.28	0.12
2	25	0.12	0.06	0.19	0.05	–0.06	–0.08	0.12	0.12
3	26	0.26	0.19	0.34	0.07	0.01	–0.21	0.00	0.15
4	26	0.48	0.34	0.92	0.16	–0.02	–0.29	0.04	0.04
All	102	0.20	–0.34	0.92	0.06	–0.05	–0.19		
Advanced	22	0.08	–0.14	0.50	0.03	–0.25	–0.24		
EMU	11	0.00	–0.14	0.41	0.01	–0.52	–0.42		
Non-EMU	11	0.15	–0.04	0.50	0.06	0.02	–0.07		
Dev. & Emg.	80	0.23	–0.34	0.92	0.06	0.00	–0.17		
Developing	52	0.27	–0.26	0.92	0.08	0.00	–0.17		
Emerging	28	0.15	–0.34	0.63	0.03	0.00	–0.18		

Top panel shows the change in FX_{it}^{AGG} in 1994–2004 split across quartiles of the size of the change. Δs_{it}^{A} represents the change in the share of assets in total IFI, $\Delta \omega_{it}^{A}$ shows the change in the foreign currency share of foreign assets, and $\Delta \omega_{it}^{L}$ represents the change in foreign currency share of liabilities. The final two columns show the percentage of each quartile which is EMU and non-EMU industrial countries.

We see that all parts of the decomposition are important in explaining the shift in positions. The top quartile saw a large positive shift in net foreign asset positions (the asset share of gross assets and liabilities has increased strongly, 16 percentage points), as opposed to a decrease for the low quartile. In addition, the top quartile drastically reduced the foreign currency share of their liabilities (29 percentage points) without a shift in the share of assets. The bottom quartile showed a considerable drop in the share of both assets and liabilities.

The drop in assets simultaneously with liabilities is largely an EMU phenomenon (28 percent of the countries in the bottom quartile where this behaviour is strongest are in the euro area). We can see this better by examining the decomposition across country types in the bottom part of Table 5. EMU countries drastically increased the importance of domestic currency on both sides of the international balance sheet, with the foreign currency shares of assets and liabilities decreasing by 52 and 42 percentage points respectively. Combined with an essentially average NFA position, we see why EMU countries did not see much improvement in their aggregate foreign currency exposure.[19]

Non-EMU industrial and developing countries saw much bigger improvements in aggregate exposures. In both groups, the average net foreign asset positions improved (on average s_{it}^{A}

[19] The crucial difference within the EMU countries seems to be the share of foreign currency liabilities at the start. They all reduce their foreign currency liabilities weight to 10—20 percent. Countries such as Finland that were near 90 percent to start with therefore see much bigger changes in the foreign currency liabilities. Also, countries that started with more liabilities tend to see better improvement because even if they reduce the foreign currency share of assets and liabilities simultaneously, the impact of the liabilities is bigger.

went up), and, in particular for the developing countries, the foreign currency share of liabilities has fallen sharply. Only the EMU countries have experienced a substantial shift in the foreign currency components of assets.

Table 6 shows more details of the sources of the change in the foreign currency exposure. We focus on why the share of assets in the international financial integration index rose and why the foreign currency share of liabilities fell. FDI and equity are denominated in local currency, so increasing their share of liabilities will lower the foreign currency component of liabilities. Panel A of Table 6 shows that the top two quartiles (the ones that improved FX_{it}^{AGG} the most) saw substantial shifts towards equity-oriented financing, while Panel B demonstrates that this shift is found most strongly in the emerging and developing countries. On the other hand, there is effectively no change in the foreign currency share of debt liabilities beyond the EMU countries, and these changes are trivial for the top two quartiles.

Table 6

Factors underlying the shift, FX_{it}^{AGG} 1994–2004: quartiles

		$\Delta RES / \Delta A$		ΔNFA^{priv}		$\Delta(\lambda_{Lit}^{PEQ} + \lambda_{Lit}^{FDI})$		$\Delta DebtL^{FC}$	
Quartile	Obs	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1	25	0.21	0.05	–0.18	–0.18	0.09	0.08	–0.13	–0.01
2	25	0.30	0.36	0.08	0.02	0.02	0.03	–0.08	0.00
3	26	0.42	0.46	0.14	0.03	0.21	0.20	–0.01	0.00
4	26	0.50	0.58	0.43	0.37	0.27	0.26	–0.03	0.00
All	102	0.37	0.41	0.12	0.04	0.15	0.15	–0.06	0.00
Advanced	22	0.02	0.00	0.03	0.05	0.07	0.05	–0.27	–0.20
EMU	11	–0.02	–0.01	–0.01	0.01	0.07	0.04	–0.53	–0.51
Non-EMU	11	0.07	0.03	0.08	0.09	0.08	0.05	–0.01	–0.02
Dev. & Emg.	80	0.47	0.52	0.15	0.04	0.17	0.16	0.00	0.00
Developing	52	0.51	0.54	0.28	0.15	0.17	0.16	0.00	0.00
Emerging	28	0.40	0.46	–0.07	–0.06	0.18	0.18	–0.01	0.00

$\Delta RES / \Delta A$ represents the share of asset growth which comes from reserves. ΔNFA^{priv} represents change in private (non-reserve) *NFA*. $\Delta(\lambda_{Lit}^{PEQ} + \lambda_{Lit}^{FDI})$ represents the change in the portfolio equity and FDI shares of liabilities. $\Delta DebtL^{FC}$ represents the change in the foreign currency share of Debt Liabilities. 1994–2004.

As for the improved net foreign asset position of many countries, we examine whether this is purely a result of increases in the accumulation of reserves. We see that all quartiles increased the reserve share of total assets. For the top quartile, over 50 percent of the increase in total assets came from an increase in reserves, while only the top quartile saw a substantial increase in the non-reserve net foreign asset position. Across country groups, we see that only the non-advanced countries were truly stockpiling reserves and that, for emerging countries, it was this behaviour that drove the shift in s_{it}^{A} as the non-reserve net external position was actually negative on average. Thus, the shift away from negative foreign currency positions is not coming from borrowing in domestic currency but from the shift towards equity finance and improvements in the net foreign asset position.

As was shown in equation (17), the net balance sheet impact of a uniform movement of the home currencies against all foreign currencies is given by the product of FX^{AGG} and IFI (the

scale of gross holdings of foreign assets and liabilities). Accordingly, the change in the net balance sheet impact over time can be written as

$$\Delta_{t-N,t} NETFX_{it} = \Delta_{t-N,t} FX_{it}^{AGG} \times IFI_{it-N} + FX_{it-N}^{AGG} \times \Delta_{t-N,t} IFI_{it} + \Delta_{t-N,t} FX_{it}^{AGG} \times \Delta_{t-N,t} IFI_{it} \quad (18)$$

Table 7 shows the driving forces behind this decomposition. Table 7 shows that the gross scale of international financial integration has been increasing across all quartiles, which is reinforced by an increase in foreign currency exposure for the top three quartiles. However, the bottom quartile experiences an average decline in $NETFX_{it}$, since the latter effect dominates the former for this group.

Table 7

Decomposition of shift in $NETFX$, 1994–2004

Quartile	Obs	Mean	Min	Max	ΔFX_{it}^{AGG}	ΔIFI	EMU	Non-EMU
1	23	–0.07	–0.52	0.04	–0.04	0.78	0.22	0.00
2	24	0.15	0.08	0.24	0.16	0.56	0.17	0.17
3	24	0.36	0.25	0.50	0.28	0.28	0.00	0.13
4	25	1.17	0.51	3.11	0.33	0.65	0.08	0.16
All	96	0.41	–0.52	3.11	0.20	0.57		
Advanced	22	0.30	–0.52	1.40	0.07	2.18		
EMU	11	0.14	–0.52	0.91	0.00	2.89		
Non-EMU	11	0.46	0.11	1.40	0.15	1.47		
Dev. & Emerging	74	0.45	–0.25	3.11	0.23	0.09		
Developing	48	0.52	–0.14	3.11	0.27	–0.21		
Emerging	26	0.32	–0.25	2.53	0.15	0.64		

1994–2004.

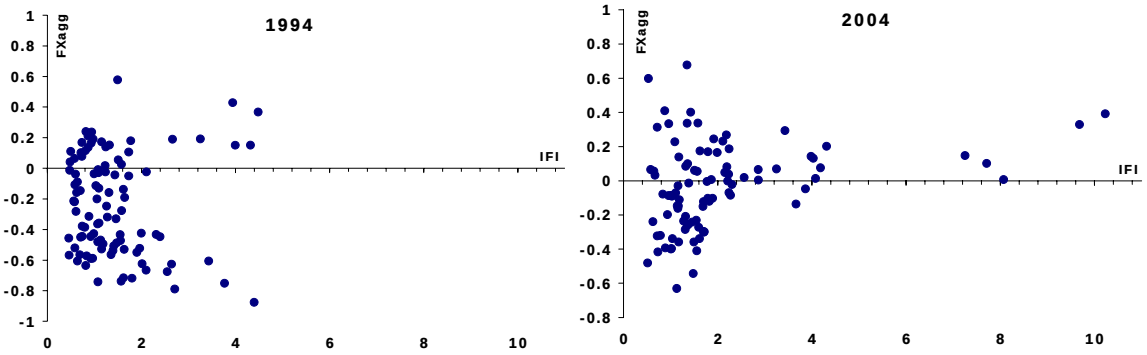
The bottom panel of Table 7 shows the decomposition by country group. All groups saw an average increase in the importance of foreign currency exposure over this period. However, the difference in composition across groups is striking. First, we see that $NETFX_{it}$ increased for the EMU group, despite the mean fall in FX_{it}^{AGG}: the growth in gross cross-border holdings was sufficiently large to dominate the declining share of foreign currencies in these positions. While the non-EMU group of advanced economies and the developing country group had broadly similar increases in $NETFX_{it}$, this was driven by the growth in gross international financial integration for the former group whereas the compositional shift towards a most positive foreign currency balance was relatively more important for the latter group. Non-emerging developing countries actually pulled back from the global financial

economy with a shrinking IFI on average, but, again, their rapidly improving FX_{it}^{AGG} meant that they still saw $NETFX_{it}$ go up.[20]

Finally, Figure 4 shows the FX_{it}^{AGG} and IFI_{it} indices in 1994 and 2004 for all countries. We see that large negative exposures (large negative FX_{it}^{AGG} and large IFI_{it}) were much more prevalent in 1994 than in 2004: countries have pulled back by reducing net external liabilities and net foreign currency exposures. Another noteworthy shift is that there are now a number of countries that combine a high degree of international financial integration with positive aggregate foreign currency exposures. If these countries appreciate against the currencies in which they are long, they will suffer large losses.

Figure 4

Foreign currency exposure and international financial integration in 1994 and 2004



5.2.3 Determinants of net foreign currency exposures

The variation in net foreign currency exposures begs the question of whether the cross-sectional dispersion in foreign currency exposures can be related to country characteristics. We consider an exploratory specification

$$FX_{it}^{AGG} = \alpha + \beta \times Z_{it} + \varepsilon_{it} \tag{19}$$

where the set of covariates Z_{it} includes GDP per capita, trade openness, an institutional quality indicator, country size and an EMU dummy.[21]

Table 8 shows the results for all-country, advanced and developing country samples for 2004. Across all samples, there is clear positive relation between GDP per capita and FX_{it}^{AGG}: richer countries have more positive net foreign currency positions. For the all-country sample, we also note that larger countries and countries with higher trade volumes also have more positive positions: the positive covariation between country size and foreign

[20] We also studied the covariation between FX_{it}^{AGG} and IFI_{it} by running cross-country regressions of FX_{it}^{AGG} and IFI_{it} in levels and differences. For the all-country and developing-country samples, the bilateral covariation between the variables was not significant in 1994 but was significantly positive in 2004. In contrast, the bilateral covariation within the advanced-country group was significantly positive in 1994 but was not significant in 2004 (but marginally negative, if an EMU dummy is included). For each sample, the change in FX_{it}^{AGG} and the change in IFI_{it} between 1994 and 2004 were significantly negatively correlated.

[21] Although we lack strong theoretical guidance in formulating this specification, this list of regressors has been employed to consider other dimensions of external capital structure (see, for example, Faria et al (2007)).

currency positions also holds in explaining variation within the developing country group. These results can be explained through the ability of larger and more open developing countries to issue domestic currency liabilities via portfolio equity and FDI channels (see also Faria et al (2007)).

Table 8
Covariates of foreign currency exposure

	(1) All	(2) All	(3) Adv.	(4) Adv.	(5) Dev.	(6) Dev.
Constant	–89.3 (8.5)***	–128.7 (17.8)***	–207.6 (74.2)***	–171.3 (80.5)**	–112.2 (10.7)***	–126.9 (20.1)***
GDP-PC	10.8 (1.0)***	13.9 (2.3)***	21.6 (7.5)***	18.0 (8.9)*	14.3 (1.5)***	14.4 (2.5)***
Trade		0.1 (0.047)**		0.03 (0.1)		0.07 (0.06)
Inst. Qual.		–4.4 (4.3)		–5.2 (10.6)		–0.63 (5.4)
Population		3.8 (1.7)**		3.8 (3.0)		3.5 (2.0)
EMU		–16.4 (3.9)***		–8.2 (7.1)		
Adj R^2	0.41	0.45	0.28	0.44	0.41	0.39
N	119	113	22	22	97	91

Cross-Section in 2004. Heteroskedasticity-corrected standard errors in parentheses. *, ** and *** denote significance at the 1, 5 and 10 percent levels respectively.

5.3 The valuation channel

We investigate the quantitative importance of our "currency valuation" term by running the regression

$$VAL_{it} = \alpha_{it} + \beta \times VAL_{it}^{XR} + \varepsilon_{it} \quad (20)$$

where VAL_{it} is the aggregate valuation term defined in equation (2) and VAL_{it}^{XR} is the currency valuation term defined in equation (14), with both scaled by GDP.

If movements in the net financial exchange rate index (interacted with the gross scale of international financial integration) were fully offset by shifts in local currency returns, then we would expect $\beta = 0$. In contrast, a non-zero value of β indicates that exchange rate movements exert a valuation impact, whether directly or indirectly (through simultaneous movements in local currency returns).[22]

[22] A complication relates to valuation shocks that cannot be directly tied either to exchange rates or to market price movements. These may include data revisions, debt reduction schemes and capital transfers. In addition to introducing a degree of noise, there may also be some correlation between currency depreciations and debt reduction schemes.

Table 9

The valuation channel and dynamics of net foreign asset positions

	(1) All	(2) Advanced	(3) Developing	(4) Emerging
VAL^{XR}	1.071 (0.05)**	0.574 (0.14)**	1.095 (0.05)**	0.982 (0.12)**
Constant	0.724 (0.15)**	–0.969 (0.07)**	2.529 (0.25)**	–1.745 (0.18)**
N	1,496	304	802	390
R^2	0.65	0.09	0.72	0.51
R^2 (no FE)	0.54	0.06	0.61	0.42

Panel estimation over 1994—2004. Columns (1)–(4) estimated by least squares with country fixed effects. Standard errors clustered by country. Bottom row shows R-squared when regressions are run without country fixed effects. Coefficients are nearly unchanged with or without fixed effects.

The results displayed in Table 9 show an important role for the currency valuation term in explaining that the overall valuation effect. For developing or emerging countries, the "pass through" is approximately one to one: a currency gain of 1 percentage point of GDP (according to our measure) is associated with a 1 percentage point aggregate net capital gain. Moreover, the regression has considerable explanatory power for these groups of countries (between 0.4 and 0.6).

The pattern is quite different for the advanced countries. While the currency valuation term is significant, the explanatory power of the regression is much lower at 0.06–0.09. The estimated $\hat{\beta}$ is also much lower at roughly 0.6, which suggests that there is some degree of offset by which capital gains via currency movements are partially cancelled out by lower foreign currency returns. The differences between the advanced and other country groups are quite intuitive: the larger equity positions of the former group mean that price valuation shocks play a more important role.[23]

These currency-induced wealth effects are not trivial in size. Table 10 shows that the 75th percentile of absolute movements in VAL_{it}^{XR} is 2.8 percent of GDP for advanced countries, 3.8 percent for emerging countries, and 5.3 percent for developing countries, meaning that one in four observations has a shock of these magnitudes. These effects are sizeable enough to dominate current account flows in some years and, depending on the market capitalisation of a country, may rival the wealth effects of stock market booms and busts.[24] In addition, since these are transfers across borders, these may matter more for the international transmission mechanism than price shifts that cause large transfers across agents within an economy.

[23] The regressions are similar with or without fixed effects. Standard errors are clustered by country.

[24] World stock market capitalisation was roughly 100 percent of world GDP in 2005 (Reuters (2007)). Across major countries, capitalisations range from 50 to 200 percent of GDP, meaning that a change of 10 percent in the stock market would generate wealth shocks in the range of 5 to 20 percent of GDP.

Table 10

***VALX* as a percentage of GDP**

	Mean	Median	75%	90%		
All	5.0	1.7	4.3	11.2		
Advanced	2.4	1.2	2.8	5.0		
Developing & Emerging	5.7	1.8	4.7	12.6		
Developing	6.8	2.3	5.3	15.8		
Emerging	3.4	1.2	3.8	10.0		
	$\rho(VAL)$		$\rho(VAL^{XR})$		$\rho(VAL^{MP})$	
	Mean	**Median**	**Mean**	**Median**	**Mean**	**Median**
All	0.02	–0.01	0.12	0.09	0.01	0.01
Advanced	–0.01	–0.06	0.15	0.15	–0.05	–0.04
EMU	–0.02	–0.04	0.20	0.16	–0.01	–0.04
Non-EMU	0.01	–0.08	0.10	0.14	–0.09	–0.03
Developing	0.02	0.00	0.11	0.06	0.02	0.03

Panel A: Distribution of absolute values of VAL^{XR} as a ratio to GDP. Panel B: Mean and median within-country autocorrelation coefficients of different valuation effects.

Quite importantly, these wealth shocks are not just paper gains and losses that reverse with quick exchange rate reversals. In regressions of VAL on lagged VAL, we find that all three types of valuation effects are essentially stationary. They all have autocorrelation coefficients of nearly zero. Individual country coefficients are quite noisy, but only a handful have point estimates lower than –0.2 (suggesting some reversals) for the exchange rate valuation shocks. Thus, the wealth gains or losses from VAL^{XR} appear to be sizeable and persistent, opening the possibility that they have a real impact on the economy.

5.4 An example: a dollar crash

We conclude our analysis with an example that demonstrates the differences across trade indices, finance indices and valuation effects by examining what would happen if the US dollar depreciated by 20 percent across all currencies.[25] Table 11 shows interesting divisions across country groups. While all countries face trade-weighted appreciations, emerging markets see the largest shift due to their tight relationship with the US on a trade basis. In contrast, it is non-EMU advanced countries that face the largest net financial index change, a greater than 1 percent change in the index and almost 5 percent of GDP loss from valuation. Non-emerging developing countries in fact benefit from a dollar depreciation on average.

[25] Warnock (2006) examines the losses other countries would face on US-held assets under a set of shocks to US equity and bond prices as well as the US dollar. Our experiment only focuses on the currency, but importantly includes both the assets and liabilities of countries such that some countries can in fact come out ahead if there is a dollar depreciation (if they have sufficient dollar liabilities). See also Lane and Milesi-Ferretti (2007c) for a study of the impact of a dollar shift on individual European countries.

Table 11

Effects of a 20 percent depreciation of the US dollar

Group	Trade		Net financial		VAL^{XR}	
	Mean	Median	Mean	Median	Mean	Median
All	–2.6	–1.5	1.2	0.2	0.5	0.5
Advanced	–1.3	–1.3	–0.7	–0.7	–3.3	–1.7
EMU	–1.3	–1.2	–0.3	–0.2	–1.9	–0.5
Non-EMU	–1.2	–2.0	–1.1	–1.6	–4.8	–5.1
Developing	–2.8	–1.2	2.7	3.0	3.5	3.1
Emerging	–3.2	–2.5	–0.5	–0.7	–2.9	–0.8

Percentage change in Trade and Net Financial indices in the case of a 20 percent across-the-board depreciation of the US dollar, plus the implied valuation changes.

They have sufficiently large negative positions in the dollar that a dollar depreciation lifts their net index and in fact provides net financial gains in the order of 3 percent of GDP. Whether this sufficiently offsets the effects of an appreciating trade-weighted exchange rate is unclear, but it certainly dampens the effect when compared to emerging market countries that lose on both trade and financial dimensions.

5.5 Discussion

The analysis has several implications for the design of ”new portfolio balance” models. First, our findings highlight the importance of modelling the dual role of exchange rates in the international adjustment process: with the financially weighted exchange rate index operating through the valuation channel, and the trade-weighted index influencing net exports. As we have highlighted, the potential importance of the valuation channel is secularly increasing, in line with the rapid growth in the gross levels of foreign assets and liabilities.

Second, the interaction between external wealth effects and domestic sectoral balance sheets may be important for domestic macroeconomic performance, since the net worth of banks, firms, households and the government may be affected by currency-induced valuation shifts. In this regard, it may be useful to establish the conditions under which such valuation movements may have a stabilising influence versus scenarios under which the impact is procyclical.

Third, an understanding of the financial implications of currency movements is important for the optimal design of monetary and fiscal policies for open economies; moreover, the optimal policy regime plausibly depends on structural characteristics, such as the degree of financial development and the contracting environment in a given economy. Finally, all of these dimensions feed into optimal international portfolio decisions. In view of the potential complexity of such models, it is important to be guided by the empirical regularities in model design and selection.

6. Concluding remarks

Our goal in this paper has been to understand the international financial implications of currency movements. To this end, we have drawn from a wide range of sources to build a large-scale dataset of international currency positions, constructed financially weighted exchange rate indices and calculated net foreign currency exposures.

Our analysis shows that trade-weighted exchange rate indices are an inadequate guide in understanding the wealth effects of currency movements. In addition, we find that many developing countries have historically had a negative net position in foreign currencies, such that depreciations of the domestic currency have generated negative wealth effects. However, we have found that many of these countries have shifted towards a less exposed currency position over the last decade, largely through improvements in their net foreign asset position and an increase in the share of foreign liabilities that are in asset classes denominated in local currency (such as equity and FDI). In addition, many countries, but in particular advanced countries, have increased their international positions so much that, even with relatively balanced net positions, they still may see substantial wealth shocks from currency movements.

Finally, we find that the wealth effects associated with exchange rate changes are substantial, unlikely to reverse quickly, and can explain a sizeable share of the overall valuation shocks that hit the net foreign asset position, especially for developing countries. We view these results as providing an important guide for the appropriate design of the next generation of "new portfolio balance" models of the open economy.

Appendix

A Estimating currency positions: methods

As noted in Section 3, we follow a two-step procedure in estimating currency positions. First, we determine the currency composition of assets and liabilities within individual asset classes. Second, we weight the asset classes by their shares in the country's portfolio in order to construct the aggregate index. This appendix provides a detailed description of how we construct the estimated currency positions.

A.1 Foreign assets

The asset side of a country's international balance sheet is divided into five classes: portfolio equity, direct investment, portfolio debt, other debt (generally bank-related), and reserves. Each requires its own sources and unique methodology, and these methods are described below.

A.1.1 Portfolio equity

The CPIS dataset provides the geographical location of equity asset holdings by country for 68 reporter countries across 220 host countries. In order to provide estimates for country

pairs that are missing from the dataset, we employ a gravity-based model of bilateral equity holdings to construct estimated positions in these cases.[26]

Our approach relies on two key assumptions. First, we assume that equity issued by country is denominated in the currency of country. That is, US stocks are denominated in dollars, Japanese stocks in yen and so on. While there is no automatic relation between equity returns and currency movements, it is reasonable to assume that currency-related equity exposures are correlated with the geographical pattern in portfolio and direct investment equity holdings. In particular, especially for smaller source countries, the domestic currency spot value of a foreign equity should move one for one with the relevant bilateral exchange rate if the foreign currency equity value moves orthogonally to the bilateral exchange rate.[27] (See also the discussion in Section 2 regarding the lack of correlation between returns and exchange rate changes.)

Second, following Lane and Milesi-Ferretti (2007d), we eliminate holdings listed in offshore financial centres. Countries report very large holdings in these offshore centres (such as Luxembourg), but these holdings really represent claims on assets in other final destinations. By excluding these holdings, we implicitly assume that the holdings in offshore centres eventually wind up in the same pattern as those that go directly to other countries. After eliminating offshore centres, we are left with 50 reporting countries and 180 hosts.[28]

In order to generate estimated positions for those country pairs that are missing from the CPIS dataset, we employ a modified form of the specification developed by Lane and Milesi-Ferretti (2007d) by running a bilateral equity holding regression of the form

$$\log(1+EQ_{ijt}) = \phi_j + \theta_t + \beta Z_{ijt} + \gamma X_{it} + \varepsilon_{ijt} \qquad \text{(A.1)}$$

where ϕ_j represents host country fixed effects, θ_t year fixed effects and Z_{ijt} is a vector of bilateral variables – distance, longitude gap (to proxy for time zone differences), common language dummies, colonial relationship dummies, and measures of relative GDP such as a dummy for both countries being industrial, the gap in GDP per capita and the gap in GDP.

We do not include source country fixed effects, since our goal is to estimate missing source country data, but we can include a number of source country characteristics in X_{it} such as latitude, landlocked status, population, capital controls, and GDP per capita.[29] Such time-invariant (or nearly time-invariant) data cannot be included for the host country as the host country fixed effect already controls for all host characteristics.[30] This regression has

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[26] See Lane and Milesi-Ferretti (2007d), Portes and Rey (2005) and Martin and Rey (2004) for theoretical and empirical support for such a procedure. We do not rely on trade flows, but instead are essentially creating an asset allocation model where host GDP proxies for investment opportunities, and distance and other gravity variables proxy for information costs.

[27] This also applies if foreign equity is held in the form of an American or global depository receipt. (In measuring the international investment position, the domestic versus foreign status of an asset depends on the residence of the issuer, not on the location of the transaction.) Consider a US investor holding stock in a Chilean firm through an ADR listed in New York. Since these stocks are listed primarily in Chile, the dollar price in New York automatically moves with the peso/dollar exchange rate and the peso value of the stock in Chile.

[28] We follow Lane and Milesi-Ferretti (2007d) and primarily use the IMF Background Paper, "Offshore Financial Centres" (2000), as our guide to labelling countries as offshore centres.

[29] Geography and other gravity model controls come from the CEPII geography database. GDP data are from the World Bank WDI database.

[30] While Lane and Milesi-Ferretti (2007d) show that the level of trade is a predictor for equity positions, once a sufficient number of gravity controls are included, we find that, despite trade receiving a significant coefficient, the R^2 on the overall regression does not move much when trade is included. Since there are many missing observations for the trade data, we do not include it.

considerable explanatory power (R^2 values in the region of 0.79), high enough to generate sensible predicted values, and the coefficients on the independent variables take expected signs and magnitudes.[31]

We then use these predicted values for the missing observations, along with the actual data, to generate currency composition of equity holdings. For non-reporter countries, we are using synthetic data for their weights. As it turns out, these do not play as dramatic a role as one might fear in our overall index creation, since countries that are not CPIS reporters typically hold fairly small equity portfolios. In fact, the External Wealth of Nations data compiled by Lane and Milesi-Ferretti (2007a) show that half of the non-reporters have no equity assets and non-reporters only have an average of 2 to 3 percent of their foreign assets in equity. For this reason, in an overall index, our derived currency composition of their equity assets plays a small role.

A.1.2 Direct investment

We use the UNCTAD database on stocks of bilateral direct investment assets and liabilities. These data give us both outward and inward stocks of direct investment for 73 reporting countries vis-à-vis up to 196 partner countries. Since we have both inward and outward data, we can infer the bilateral direct investment assets of many non-reporting countries from the bilateral direct investment liabilities of the reporters. Since most major destinations are reporters, this process gives us a reasonable gauge of the currency distribution of the non-reporter countries.

The data are available over 1970–2004, although there are many missing observations. The direct investment stocks are valued at book value or historical cost. While it may be preferable to measure direct investment stocks at market value, this limitation has only limited relevance in establishing the weights for an FDI exchange rate index, since the geographical composition of the stock is the key factor. Since we have both inward and outward data, we can use this to establish bilateral patterns for a large number of countries.[32]

We follow our process for portfolio equity and assume that all direct investment is effectively denominated in the currency of the host country. This is plausible to the extent that direct investment assets have a location-specific component (e.g. structures or installed equipment) and/or profits are largely generated in the host country. However, it is more problematic in the case of export platform FDI: while domestic costs still matter for profitability and the value of the FDI position, it also depends on revenues generated in final customer markets. In addition, the FDI data include both equity and intra-company loans, with the latter plausibly more likely to be denominated in the currency of the source country. While we bear these caveats in mind, we proceed with the assumption that the value of direct investment positions are denominated in the currency of the host country.

A.1.3 Portfolio debt

In some cases, as is detailed by Lane and Milesi-Ferretti (2007c), countries report the currency composition of their foreign portfolio debt asset portfolios. This information is reported for the United States in the Report on the US Portfolio Holdings of Foreign Securities published by the US Treasury, while the Bank of Japan released the currency

[31] Details of these results are available from the authors upon request.

[32] For a small number of countries we rely on flow data to create a general pattern because the stock data are too incomplete. Also, for a handful of countries where FDI is not significant (less than 1 percent of total assets and less than $40 million) and the data appear incomplete, we drop FDI from total assets and rescale remaining assets.

composition of Japanese portfolio debt assets at the end of 2005 in its Portfolio Investment Position Report.

However, for most countries, we do not have direct information on the currency composition of foreign portfolio debt assets. Accordingly, we adopt a multi-step inference procedure. As in the case of portfolio equity, the CPIS dataset provides information on the geographical patterns in bilateral portfolio bond holdings. We again employ a gravity model to fill out the geographical information for missing country pairs (where we have the same number of countries and use the same data as in the equity regressions). For these regressions, the R^2 is approximately 0.77 and again the signs on the coefficients on the independent variables are sensible.

However, since many countries issue foreign currency debt, estimating the currency composition of foreign debt assets requires additional steps. We begin with the international securities dataset maintained by the BIS.[33] This dataset contains information on the currency denomination of international bonds for 113 issuing countries.[34] For some countries (such as the United States), international bonds are issued mainly in domestic currency.

For other countries, international bonds are typically denominated in foreign currency, with the relative importance of the major international financial currencies (dollar, euro, yen, Swiss franc, sterling) varying across countries and over time.

In order to estimate the currency composition of portfolio debt assets, a naïve approach would be to simply assume that if a country holds an amount issued by country A, then the currency composition of those holdings reflects the aggregate currency composition of the international debt issued by country A. However, this would be misleading, since investors from countries whose currencies are popular choices for foreign currency bond issues are apt to disproportionately hold their own currencies when purchasing international debt securities issued by other countries (a tendency seen in the data used below from the US Treasury, Bank of Japan and ECB).

In order to allow for this currency bias, we follow Lane and Milesi-Ferretti (2007c) in exploiting the data provided by the United States Treasury, the European Central Bank and the Bank of Japan regarding the currency composition of the foreign assets of these regions. The United States reports the currency denomination of its portfolio debt assets in each destination country (US Treasury (2004)). From the Bank of Japan data, it is clear that Japanese investors purchase (virtually) all of the yen-denominated debt issued by other countries, while the ECB data suggest that investors from the euro area hold 66 percent of the euro-denominated debt issued by other countries (ECB (2005)).[35] Accordingly, we adjust the currency weights derived from the BIS data to take into account the portfolio choices by

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[33] The construction of this dataset is described in BIS (2003).

[34] Where the BIS dataset lacks data on the currency of issue for a country, we rely on the World Bank's GFD database of the currency composition of external debt. This is an imperfect measure because it includes non portfolio long-term debt (such as bank loans), but the countries which are missing from the BIS data account for a small fraction of internationally held debt assets. Our dataset focuses on international bond issues – while foreign investors have become active in the domestic bond markets of developing countries in very recent years, international bond issues are more important for the vast bulk of our sample period.

[35] Bank of Japan data show the currency composition and amount of Japanese foreign long-term debt assets. When comparing those data with the BIS currency denomination issuance dataset, we see that effectively all yen-denominated debt issued outside Japan is held by Japanese investors.

the investors from the major currency blocs and employ these adjusted weights in working out the currency composition of the foreign holdings of investors from other countries.[36]

In particular, our re-weighting procedure is as follows. For each issuing country, the US Treasury reports the currency composition of portfolio debt holdings in each country, so we are able to directly subtract the exact US holdings from BIS issuance data to generate new "rest of the world" totals for the currency composition of the international bonds issued by each country that are not held by US investors. Since the information from the Bank of Japan shows that Japanese investors hold nearly all the yen debt that is issued outside Japan, yen shares for issuing countries other than Japan are set to zero for investors from outside Japan.[37] Finally, the ECB reports that euro area investors hold 66 percent of euro-denominated debt that is issued by non-EMU countries. In this way, the level of euro-denominated debt issued by a non-EMU country that is held by investors outside the euro area is set equal to 34 percent of the total euro-denominated debt issued by the country. Accordingly, these adjusted levels are the basis for calculating the currency composition of the foreign portfolio debt held by investors from the rest of the world. Then, we can combine the geographical holdings for a country with the "residual" currency composition of all of the countries where a country holds debt to generate the currency composition of its foreign portfolio debt.[38]

For individual members of the euro area, our procedure is as follows. First, we sum across the euro area members to obtain the total holdings of the euro area in each host country. Consistent with the approach described earlier, we assume that the total holdings of the euro area in country A are distributed between euro-denominated debt (equal to 66 percent of the total euro-denominated debt issued by country A) and debt denominated in other currencies. With respect to the latter, the currency denomination is allocated along the lines of the rest of world data described above (using the non-euro proportions, after removing US holdings and yen-issued debt outside Japan). At that point, we have the currency denomination of debt assets held by individual euro area countries across each host destination. This does not generate the same currency weights for each euro area member, since each country has a different geographical pattern in its portfolio.

A.1.4 Other debt

From the BIS, we obtained the breakdown between "domestic currency" and "foreign currency" components for the bilateral foreign assets and liabilities of the bank residents in 20 reporter countries vis-à-vis a large number of counterpart countries over 1977–2005 (on a locational basis).[39,40,41,42] The reporters are the dominant banking centres and, despite the

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[36] That is, if US, European and Japanese investors all hold debt in Brazil and Brazil issues debt in local currency, dollars, euros and yen, then the US investor most probably holds dollar debt, the Japanese investor most probably holds more yen debt and the European investor most probably holds more euro debt.

[37] This is not to say that no country holds yen debt except Japan. Simply, most countries hold yen-denominated securities issued by Japanese entities. When another country issues yen debt, it is typically bought by Japanese investors.

[38] That is, for all other investors, we assume a uniform currency distribution in relation to the international bonds issued by a given host country. In this way, differences in currency exposures among investor countries are driven by dispersion in the geographical distribution of their foreign portfolio debt assets: country A that mostly invests in countries that predominantly issue dollar-denominated bonds faces different country risks compared to country B that mostly targets countries that issue euro-denominated debt.

[39] Although the foreign assets and liabilities of the banking sector include portfolio items, the currency composition of the aggregate should be a good proxy for the predominant non-portfolio debt component. See also BIS (2003, 2006).

[40] Clearly, our study would be enhanced if we could obtain these data for a larger number of reporting countries.

small number, capture the bulk of world bank holdings. Looking at the reporters' assets, 72 to 90 percent of them are in other reporter countries. Furthermore, Turkey, the one reporter most representative of the other non-reporters, has 90 percent of its assets and 91 percent of its liabilities in other reporter countries. Thus, when we use the liabilities of the reporters to infer the assets of the non-reporters, we expect to have good coverage.

We begin with the reporter country asset positions. In calculating the currency composition of non-portfolio debt assets, the "domestic currency" data are useful, since these tell us the levels of dollar-denominated foreign assets owned by the US banking system, yen-denominated foreign assets for Japanese banks and so on.

Regarding the "foreign currency" component, a candidate strategy is to allocate this across the major currencies, in line with the aggregate currency shares in foreign currency assets and liabilities that are reported by the BIS. (Of course, our estimates would be more accurate if it were possible to directly obtain the detailed currency breakdown of the 'foreign currency' component for individual countries.) Furthermore, for those host countries that are also reporting countries (where most of the assets lie), we also know the "domestic currency" versus "foreign currency" split in terms of the foreign liabilities of the banking system. If we assume that this proportion is representative of the claims of foreign banks in the given country, then we only need to use the "world" averages for the non-host currency component of the foreign currency element of the foreign bank claims held by other reporting countries in that destination. Again, because reporters are the dominant banking locations, we are only using world averages for a relatively small portion of assets.

We can make inferences about the currency composition of the foreign assets of the banking systems of non-reporting countries by using the data on currency composition of the foreign liabilities of the banking systems of the reporting countries. These data reveal the geographical pattern of the foreign claims of non-reporting countries vis-à-vis the reporters and the split between the "domestic currency" and the "foreign currency" components for each reporter. Because the currencies of the reporters are dominant currencies, much of their banking liabilities (and hence non-reporters' assets) are in their own currency and directly known (for example, 89 percent of US liabilities are in US dollars). In turn, we can allocate the "foreign currency" component according to the global distribution reported by the BIS. Again, although we only have data for 20 reporters, these include all the major banking centres, so that this approach should yield plausible estimates of the currency composition of the foreign non-portfolio debt assets of the non-reporting countries.

A.1.5 Reserves

The IMF tracks the currency composition of reserves for its member countries, in its COFER (Currency Composition of Official Foreign Exchange Reserves) database.[43] However, for confidentiality reasons, the only reported COFER data are for major aggregates (world, industrial country group, developing country group). Nevertheless, the country-level data have been used on a few occasions in research by IMF-affiliated economists to analyse the determinants of cross-country and time series variation in the currency composition of reserves. We exploit the results from these papers to model currency composition.

The major starting point is Eichengreen and Mathieson (2000). In that paper, the authors run separate regressions by currency to predict the share of reserves held in that currency. The

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[41] The use of the locational data follows balance of payments accounting principles.

[42] Following Lane and Milesi-Ferretti (2007c), some national central banks report the currency composition of the foreign assets and liabilities of the "monetary and financial institutions" sector.

[43] The dataset is described at www.imf.org/external/np/sta/cofer/eng/index.htm.

independent variables are trade shares with major currency countries, the share of debt denominated in these currencies, and exchange rate regime relations with these countries.[44] An important aspect of this work is that it is not simply the trade share with the currency in question included in each regression, but trade and debt shares with the other major currencies are included as well. That way, we can see that having a very large share of trade with Germany can reduce the share of dollars in reserve holdings, even controlling for the share of trade with the United States. The R^2 for these regressions ranges from 0.59 for the US dollar share down to 0.35 for the yen share.

We take the coefficients from these regressions and use them to predict the share for each of the major currencies (the dollar, the Deutsche Mark (euro after 1999), the Swiss franc, the yen and sterling). Once we have predicted values for each currency, we impose an adding-up constraint and re-normalise the results, so that each country has totals that add up to 100 percent.

To ensure that the results match information about world totals and can adjust over time with world trends, we make one more adjustment. The constants reported in the Eichengreen-Mathieson regressions are time-invariant. We assume that these constants could have been allowed to vary over time and alter them such that world totals for our predicted reserves holdings match the world averages reported in the COFER database.

That is, we multiply the predicted currency shares by each country's total reserve holdings and sum across the world. This gives us the world shares. We subsequently adjust the constants such that the predicted shares change until the predicted world averages match the actual world averages. This lets us take into account world trends in reserve holdings over time.[45]

We merge these generated data with actual data on reserves for 2000—2004 for 20 countries from Truman and Wong (2006) and Wong (2007). For any country for which we have actual data, we use actual data for those years. Before 2000, we use data from central banks where available (United States, Canada, United Kingdom) and blend our model-generated data with 2000 actual data where, in 1999 we weigh the actual data .9 and the model data .1, the respective values for 1998 being .8, .2, etc. In practice, our estimates were close to the 2000–04 actual data, so a variety of blending techniques yielded nearly identical results and our model-generated estimates for 2000–04 were quite similar to the actual numbers for most of the 20 countries in question.

We can further confirm that our predictions are sensible by drawing on two additional sources of information. First, some countries occasionally report their reserve shares in announcements or media interviews. Relying on news reports of these currency shares, we compare predicted with actual (or at least reported, since there is no verification) reserve shares. Our results seem to perform quite well on this measure. Countries like Sweden that report roughly equal dollar and euro reserves show 40 percent dollar and 50 percent euro

[44] We use trade data from the IMF DOTS database and exchange rate regime data from Shambaugh (2004). We use debt denomination data from the World Bank GFD database, augmenting with BIS issuance data where necessary. We use the World Bank data as a starting point to be consistent with Eichengreen and Mathieson.

[45] To make the adjustment, we increase (decrease) the constants used to make the predicted values for each currency by the amount that currency is underpredicted (overpredicted) when compared to world averages. Then the new predicted values are calculated and the predicted world averages recalculated and again compared to the actual world averages. The iterations are continued until there is a near perfect match between predicted and actual world holdings by currency. The constants that would generate predictions that match the world average are not in fact uniquely determined, but this process brings us to a set of constants as close as possible to the time invariant ones reported in the empirical work, and small differences in the constants make virtually no difference to the final results.

reserves in our calculations. China, which is reported to hold roughly 70 percent dollar, 20 percent euro and 10 percent other currencies, is found to hold 70–75 percent dollar, approximately 15 percent euro, and 10–15 percent other in our calculations (over various recent years). In general, non-EMU European countries tend to hold 40–50 percent each in dollars and euros in our work; Latin American countries tend to hold mostly dollars, Asian countries hold largely dollars with some yen and euros as well, and all these figures seem to mesh reasonably well with the scattered media reports on the subject.

Second, Lim (2006) studies the changing international role of the euro and the dollar and provides some regional information on the currency composition of reserves. Again, due to confidentiality, the results are deliberately reported in a way to make it difficult to back out actual currency composition, but we can use these results as a broad check. Lim breaks countries into two groups that we can try to replicate: a dollar-oriented group of Asia, the western hemisphere, and other dollar pegs; as well as a euro-oriented bloc of countries neighbouring the euro area plus much of Africa. We aggregate our synthetic country-level reserve shares into the same groups. Because the exact members of each group are not reported, we cannot precisely compare our results, and thus we cannot expect to exactly match his output, but these results provide a useful benchmark. Looking at the most recent data for 2004, world average shares were 67 percent US dollar and 25 percent euro. Lim shows the dollar bloc holding 76 percent dollar and 19 percent euro, while we find 71 percent dollar and 21 percent euro. The euro bloc holds 33 percent dollar and 57 percent euro in his grouping, while we find 46 percent dollar and 50 percent euro. We see that our work moves countries towards their actual data from the starting point of the world averages in both cases. As with the media reports, we do not have perfect matches, but we have a reasonable agreement between our data and our available cross-checks.

A.2 Foreign liabilities

The liability side of the international balance sheet is divided into four groups: portfolio equity, direct investment, portfolio debt, and other debt. In many cases, the source information for portfolio and other debt are combined, so we do not try to disaggregate them.

A.2.1 Portfolio equity

Consistent with our treatment on the asset side, portfolio equity liabilities are assumed to be denominated in the currency of the host country. Thus, there is no foreign currency exposure from equity liabilities. The size of these liabilities is important in creating total liability weights, since the larger the relative share of portfolio equity or FDI liabilities, the greater the local currency share in liabilities. Thus we only need the size of the liabilities, not geography or currency denomination. We return to the way different asset class categories are combined below.

A.2.2 Direct investment

Direct investment liabilities are assumed to be denominated in the currency of the host country.[46]

[46] As noted earlier, we plan to refine this choice in a future iteration. The stock of direct investment liabilities includes both equity and debt components. The debt component may at least in part be denominated in the currency of the parent entity or in other major international currencies.

A.2.3 Portfolio and other debt

All debt liabilities are processed in tandem due to data restrictions. We have data from the BIS banking statistics database on banking liabilities for 20 countries (and the implied liabilities to the 20 reporters based on reporters' assets for the remaining countries). In addition, we know the currency composition of portfolio debt liabilities, based on issuance data from the BIS international securities database for 113 reporting countries.

However, neither database includes information on the currency composition of debt owed to official creditors (bilateral or multilateral official debt), which is a prominent source of debt for many developing countries. The World Bank's Global Development Finance database shows that debt to official creditors ranges from 35 to 53 percent of total developing country debt over the time period 1990—2004. The World Bank does report the currency composition of aggregate external debt which merges bank, bond and official debt data. Due to the importance of the official debt composition, we use this World Bank source for all countries where it is available (it is not available for any industrial country and is missing for a small number of developing countries).[47]

For the remaining countries, we create bond-based weights using the currency composition from BIS issuance data and weights for other debt from the BIS banking data. These two weights are merged together to create total debt currency composition weights. The bond-based weights are simply a reflection of the currency shares of debt issued by the country. The banking shares follow a similar procedure as other debt assets. For the 20 reporting countries, we know the location of all bank liabilities and can use the breakdown of domestic versus foreign currency to determine the extent to which liabilities are in the home currency. Then, for locations that are also reporters, we can derive from that country's assets how much is in that country's currency (it is reported as domestic currency in the reporter's assets). For the remainder, we allocate based on world totals. For the few countries that are neither reporters nor have data in the World Bank database, we rely on the assets of the reporters to determine the location and currency of their liabilities. Again, the reporters are involved in one side or the other of the bulk of banking transactions, and we thus have fairly good coverage. See the discussion of other debt assets for details.

A.3 Measurement error

Our approach calculates the currency composition of the international balance sheet on the basis of: (a) the categorical composition of foreign assets and liabilities between equity and debt components; and (b) the currency composition of debt assets and liabilities. We view the categorical composition of the international balance sheet as reasonably well measured, subject to the limitations discussed by Lane and Milesi-Ferretti (2001, 2007a). The main qualification relates to direct investment positions: these are recorded at market value for some major countries but at book value for most countries. While there is a lack of agreement on which is the most robust measurement technique, the differences in method may qualify some comparisons across countries.

In relation to the currency composition of privately held debt assets, we have made use of data on the geographical distribution of portfolio debt and bank debt assets, together with data on the currency composition of portfolio debt issuance and cross-border bilateral bank positions. For officially held debt assets (foreign exchange reserves), we have relied on regression-based estimates. On the debt liability side, we have relied on official World Bank estimates of the currency composition of external debt for developing countries, and

[47] For the handful of developing countries that show domestic currency international issuance in the BIS database, we adjust the World Bank currency shares to include the domestic currency issuances.

combined the data on portfolio debt issuance and the currency composition of bank liabilities for the advanced economies.

Clearly, these calculations are subject to measurement error, but it is important to be clear about what the scope for error is. For most advanced countries, we have actual data on the geographical distribution of assets and do not need our model-imputed data. In addition, many of these countries were the ones with highest-quality data in the EWN and actual data on reserves. Thus, error on these countries is low. In addition, countries without equity data, for example, tended to have very low shares of equity, so the use of model-imputed data was relatively unimportant. Also, for many of the developing countries that needed large amounts of model-imputed data, their exchange rate moves dramatically against the entire rest of the world, so precise distribution across different major currencies becomes less important for them. Finally, some of our results, notably the results on foreign currency exposure, aggregates the foreign currencies, meaning that these results do not rely on the currency of reserves or the precise distribution of various other foreign currency assets and liabilities as much as simply knowing which are foreign and which are domestic.

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International bank portfolios: short- and long-run responses to the business cycle*

Sven Blank and Claudia M Buch

Abstract

International bank portfolios constitute a large component of international country portfolios. Yet, their response to macroeconomic conditions and their impact on the international transmission of business cycle developments remain largely unexplored. We use a novel dataset on banks' international portfolios to answer three questions. First, what are the long-run determinants of banks' international portfolios? Second, how do banks' international portfolios adjust to short-run macroeconomic developments? Third, does the speed of adjustment change with the degree of financial integration? We provide evidence of significant long-run cointegration relationships between cross-border assets and liabilities of banks and key macroeconomic variables. Both the long-run determinants of banks' international portfolios and the short-run dynamics show a significant degree of heterogeneity across countries and, to some extent, over time. Gravity-type variables help to explain differences in the speed of adjustment to new equilibria.

1. Motivation

International portfolios of commercial banks constitute a large component of international country portfolios.[1] International debt instruments amount to the equivalent of 200% of the GDP of industrialised and about 100% of the GDP of emerging markets and developing countries.[2] They are about four times the size of international equity holdings (Lane and Milesi-Ferretti (2006) and Sørensen et al (2006)). In recent years, the share of bank assets

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1 In the following, we use the term (international) 'bank portfolios' to denote the cross-border assets and liabilities of commercial banks. The term 'country portfolios' denotes the international investment position of countries. In addition to bank portfolios, it comprises international portfolio investments (debt and equity) and stocks of foreign direct investment.

2 'Debt instruments' denotes the sum of assets and liabilities.

and money market flows in gross international capital movements has even increased (Becker and Clifton (2006)).

International debt flows are not only important quantitatively, they also have a higher standard deviation than other capital flows (Kose et al (2006)). This may explain the conventional wisdom that high debt flows expose countries to risks from financial openness. The risk of international debt flows is less evident, however, when considering that international debt holdings contribute to income smoothing across countries (Sørensen et al (2006)). Also, when scaling the standard deviation of capital flows by the respective means, debt flows are not really distinguishable from other types of capital flows (Kose et al (2006)).

In this paper, we look at the role of banks' international portfolios for the exposure of countries to macroeconomic developments from a different angle. We ask whether and how quickly international portfolios of commercial banks react to macroeconomic developments at home and abroad. We depart from earlier work in two main regards. First, we analyse the short-run *and* the long-run determinants of banks' international asset portfolios in an integrated empirical model. Second, we use information on bilateral bank portfolios of OECD countries. Using bilateral quarterly data, we can provide more precise measures of domestic and foreign macroeconomic developments than previous studies. We focus on banking data because comparable evidence at the bilateral level is not available for other asset holdings.[3] In studying the determinants of bilateral cross-border bank portfolios, we provide answers to the following questions:

First, what are the long-run determinants of banks' international portfolios? In finding the determinants of the stocks of banks' cross-border assets and liabilities, earlier literature has been fairly successful. Buch (2003), for instance, studies bilateral cross-border asset holdings of banks that report to the Bank for International Settlements (BIS). She finds that, apart from market size, regulations and information costs affect the patterns of cross-border asset holdings. Buch, Driscoll, and Ostergaard (2005) explain the deviation of banks' portfolios from an optimal mean-variance portfolio. Similarly, gravity-type models perform quite well in explaining cross-border portfolio holdings (see, e.g., IMF (2006)). However, these papers do not study the dynamic adjustments of banks to changes in macroeconomic conditions.

Second, what shapes the short-term dynamics of banks' international portfolios? The response of bilateral bank lending to cyclical factors has been studied less frequently and only for selected countries and time periods. Goldberg (2005) uses bank-level data for US banks. Buch, Carstensen, and Schertler (2005) use a dataset similar to ours but focus on a shorter time period. These studies show that explaining cross-border capital flows is much more difficult than explaining stocks of cross-border assets and liabilities.[4] Although standard proxies for business cycle developments such as interest rates and GDP growth rates do have a significant impact on banks' international activities, the impact of these variables is not very stable over time and across countries. Moreover, the explanatory power of these regressions is low.

Third, what is the impact of financial integration on the speed of adjustment of banks' international portfolios? Instead of estimating the short- and long-run determinants of banks' portfolios separately, we use a panel cointegration model that allows us to estimate different

[3] An exception is the IMF's International Portfolio Investment Survey. However, these data are available only for selected years and not on a quarterly basis. See, for instance, DeSantis and Gérard (2006) for a recent study using these data.

[4] A related strand of the literature studies the transmission of shocks during financial crises through the international activities of banks. See, e.g., Weder and Van Rijckeghem (2003) or Peek and Rosengren (1997). Jeanneau and Micu (2001) use BIS data to study the determinants of bank assets in emerging markets.

short-run dynamics across countries while restricting the long-run cointegration vector to be identical across host countries. The loading matrix, which provides information on the speed of adjustment to a new steady state,[5] is allowed to vary across reporting countries (Breitung (2005)). We expect that the speed of adjustment to short-run macroeconomic fluctuations is higher in more integrated financial markets. Since our estimates yield information on the speed of adjustment to a new equilibrium for different country pairs, we can analyse whether the dynamic responses of banks to macroeconomic developments differ across countries in a systematic way. Hence, in a last step, we use gravity-type regressors as well as information on the openness and structure of countries' financial system to explore systematic patterns in the speed of adjustment to new equilibria.

One special feature of our dataset is that we can analyse adjustment patterns inside and outside the Euro Area. We have data from reporting countries inside the Euro Area (Belgium, Germany, France, Italy, the Netherlands) and outside the Euro Area (Hong Kong SAR, Japan, Switzerland, United Kingdom, United States). As recipient countries, we use information on all OECD countries. Hence, we can study whether the degree of financial integration among the EU countries has an impact on the determinants of bank portfolios, and to what extent adjustment patterns are affected by exchange rate valuation effects. Using OECD countries only has the additional advantage that we exclude emerging markets which were directly affected by the financial crises of the late 1990s.

The data that we use for this paper are richer than data used in earlier studies for four reasons. First, we use data for banks from ten BIS reporting countries. In contrast to Goldberg (2005), we can study the impact of business cycle developments on cross-border portfolios of banks from more than one source country. Second, we use quarterly data for a 10-year period (1995-2005) to study the determinants of banks' portfolios for the pre- and the post-Euro period. Third, we study cross-border lending and borrowing instead of focusing on cross-border asset holdings only. And, fourth, in contrast to research based on the comprehensive datasets on country portfolios compiled by Lane and Milesi-Ferretti (2006), we have information on bilateral financial linkages.

In Section 2, we provide a brief theoretical background for our empirical analysis. In Section 3, we describe the data. In Section 4, we look at banks' international portfolios and other cross-border asset holdings to obtain an idea of how representative banks' portfolios are for total country portfolios. In Section 5, we analyse the long-run and short-run determinants of banks' cross-border activities using a panel cointegration framework. Section 6 concludes and summarises the main results. We provide evidence on significant long-run cointegration relationships between cross-border assets and liabilities of banks and key macroeconomic variables. Both the long-run determinants of banks' international portfolios and the short-run dynamics show heterogeneity across countries and, to some extent, over time. Gravity-type variables help to explain differences in the speed of adjustment to new equilibria across countries.

2. Theoretical background

Our aim in this paper is to analyse the response of banks' international portfolios to macroeconomic developments. In the theoretical literature, the patterns of international bank portfolios and the transmission of macroeconomic shocks across countries have largely been covered separately. Traditionally, open economy macroeconomic models do not assign an

[5] Throughout the paper, we distinguish the speed of adjustment as captured by the loading coefficient from the short-run dynamics as captured by the impact of lagged variables on the change in bank portfolios.

explicit role to financial intermediation and to the composition of international country portfolios.

Recently, dynamic general equilibrium models of open economies have been set up to incorporate international portfolio choices. Evans and Hnatkovska (2005) and Tille (2005), for instance, model international equity and bond holdings within the framework of an open economy macroeconomic model, but both contributions abstract from banks. Ghironi, Lee, and Rebucci (2007) derive a portfolio structure assuming that perfectly competitive financial intermediaries charge (exogenously given) fees on financial market transactions.

Most of these models focus on the linkages between two countries rather than modelling bilateral linkages between a larger set of countries in the context of portfolio models. Portfolio models, in turn, often do not consider different types of macroeconomic shocks. Hence current theoretical models are not very well suited to explain the increasing share of bilateral 'diversification trade' in financial assets: "*At the moment, we have no integrative general-equilibrium monetary model of international portfolio choice, although we need one* (Obstfeld (2004), p 19).

In the remainder of this section, we review the basic adjustment mechanisms of international debt holdings in a simple partial equilibrium framework. We also sketch how banks could be integrated into such a model.

The standard two-country textbook model views changes in cross-border debt holdings of countries as the result of the intertemporal optimisation of households (Obstfeld and Rogoff 1996). Assume that consumers are endowed with output Y_1 in period one and Y_2 in period two. They allocate these endowments to achieve optimal consumption plans C_1 and C_2. Utility of households depends on each period's consumption level and is additively separable with regard to time $u = u(C_1, C_2) = u(C_1) + \beta u(C_2)$, with β as subjective time-preference factor.

Domestic households can raise their first-period consumption over and above first-period income if they borrow internationally: $C_1 = Y_1 - B_2$, where B_2 represents net foreign assets at the end of period one. In the second period, households have to repay their borrowings: $C_2 = Y_2 + (1+r)(Y_1 - C_1)$ where *r* denotes the world market interest rate. Even in this simple textbook model, the impact of changes in the world market interest rate on consumption and bond holdings is ambiguous. It depends on the relative strength of income, substitution, and wealth effects, reflecting the impact of an interest rate change on bond returns and lifetime income. This can be shown using an isoelastic utility function and solving the household's optimisation problem to obtain first and second period consumption:

$C_1 = \frac{1}{1 + (1+r)^{\sigma-1}\beta^{\sigma}}\left(Y_1 + \frac{Y_2}{1+r}\right)$ and $C_2 = (1+r)^{\sigma}\beta^{\sigma}C_1$, where σ denotes the coefficient of risk aversion. Hence, the impact of interest rates on consumption and the demand for bonds is ambiguous: $\frac{\partial C_1}{\partial r}, \frac{\partial B_2}{\partial r} \gtrless 0$.

In this two country setting, the equilibrium with non-zero net foreign assets, the implied international capital flows are one-directional: domestic households would borrow in the foreign economy, but there is no two-way asset trade between the home and the foreign economy.

In reality, households do not buy and sell foreign bonds directly. Instead, most of the international transactions of households are intermediated by commercial banks. Introducing banks into the above framework would necessitate adding a couple of features that characterise (international) banking markets. A full-fledged model of the international bank would, for instance, require modelling the maturity transformation function of banks, the

principle-agent relationships between banks and their customers, or the principle-agent relationships between bank managers and owners. Yet, addressing these aspects is beyond the scope of this paper.

One simple way of linking the choice problem of households with the international portfolio choices of banks would be to assume that households do not invest directly in the foreign economy. Instead, they hold deposits with their local banks. Banks can additionally raise deposits abroad, and they lend to domestic and foreign customers. In deciding on their optimal asset choices, banks have to consider the intertemporal optimisation choices of households. As explained above, however, these would not give rise to two-way 'diversification trades' (Obstfeld (2004)).

Non-zero bilateral asset holdings could be introduced by assuming that banks themselves optimise their portfolios in a mean-variance framework. The objective function of the representative bank would be increasing in expected profits and decreasing in portfolio variance (see Freixas and Rochet (1998) for a closed-economy application). If domestic and foreign banks have – in principle – access to the same types of financial assets, it is reasonable to assume that the banks have different comparative advantages in serving domestic and foreign customers. More specifically, the costs of supplying financial services internationally are likely to be higher than in the national context. Under appropriate assumptions concerning the costs of cross-border financial transactions, domestic and foreign banks will then hold different portfolios of cross-border assets *and* liabilities.

These considerations have three main implications for our empirical work. First, the link between cross-border asset holdings and interest rates is ambiguous from a theoretical point of view. In the intertemporal optimisation decision of households, income and substitution effects work in two different directions. It is, ultimately an empirical question whether cross-border assets and liabilities increase or decrease in the rates of return. Second, adding portfolio considerations (of banks) gives a rationale for two-way 'diversification trade' in cross-border financial assets and liabilities. Third, market size has a positive impact on international portfolio holdings. In contrast, costs of cross-border financial transactions have a negative impact.

3. The data

Rather than testing a particular structural model, the aim of this paper is to provide evidence on the links between banks' international portfolios and macroeconomic variables. In this section, we describe the data on banks' international portfolios as well as the macroeconomic data that we use for our empirical analysis. Details are given in the Appendix.

3.1 Banks' international portfolios

Our data on banks' international portfolios come from the BIS. We have quarterly data for the years 1995-2005 on bilateral cross-border assets and liabilities for ten BIS reporting countries (Belgium, Germany, France, Hong Kong SAR, Italy, Japan, the Netherlands, Switzerland, United Kingdom, United States).[6] As recipient countries, we use all OECD countries. The data are aggregated across individual banks in each reporting country, but they are disaggregated by the country of destination.

[6] For reasons of data confidentiality, we do not report descriptive statistics for Hong Kong SAR and Italy but we use data for these countries in pooled regressions.

The BIS collects information from national central banks on the cross-border assets and liabilities of commercial banks. Whereas the reporting area was formerly restricted mainly to OECD countries, the set of countries has been enlarged over the years to include large emerging markets and financial centres. Until recently, however, data on bilateral activities *among* the BIS reporting countries have not been published by the BIS. Hence, we resort to unpublished data, which have kindly been made available by the BIS' International Financial Statistics group. These data allow for an analysis also of the assets and liabilities *among* the reporting countries for an extended time range.

The BIS publishes two sets of banking statistics. The locational statistics are based on the balance of payments principle, i.e. they include gross on-balance sheet asset and liability positions of resident banks vis-à-vis non-residents (BIS 2006). Information is thus given on a direct, counterparty basis. In the following, we will denote these positions as banks' cross-border assets and liabilities. These data are in principle available from the early 1970s on a bilateral basis. In addition to aggregated positions by country, the BIS asks reporting banks for a breakdown into different types of borrowers (banks/non-banks) and for the currency composition of cross-border portfolios. We have information on the amounts denominated in Euros, Yen, Pounds Sterling, Swiss Francs, US Dollars and other currencies. Each position is given in US Dollars.

In contrast to the locational statistics, the second set of statistics, the BIS consolidated statistics, consolidate inter-office positions among banks and their foreign affiliates. The consolidated statistics provide a more detailed picture of the exposure of banks from specific reporting countries to foreign countries and thus of the ultimate risk positions. The consolidated statistics are also more detailed with regard to the sector coverage than the locational statistics. However, a breakdown into different currencies is not available.

We use the locational instead of the consolidated banking statistics for two main reasons. First, a currency breakdown, which helps in assessing the impact of exchange rate changes on cross-border positions, is available for the locational, but not for the consolidated statistics. Second, the geographical dimension is more explicit in the locational than in the consolidated statistics since the former are based on the balance of payments principle. Essentially, the locational statistics allow the assets and liabilities of residents in countries A and B to be related to macroeconomic developments in countries A and B. In the consolidated statistics, some assets and liabilities between residents in countries A and B are netted out if the residents belong to the same banking group. Nevertheless, it would be interesting to test the stability and robustness of our results using the consolidated instead of the locational statistics. Also, accounting for indirect effects, as funds may be channelled through other countries C, should be addressed in future work.

As regards the impact of valuation changes, we check the robustness of our results by using data corrected and data uncorrected for exchange rate changes. To correct the data for exchange rate changes with respect to the US Dollar, we convert the original data on assets and liabilities into constant US Dollars using the procedure of the BIS in its Quarterly Review (2006). Since the currency breakdown is given in US Dollars, we first transform each series into its original currency for every period t, x_t^{NC}, and then adjust for valuation changes due to changes in the US Dollar by applying the following formula:

$$x_t^c = \sum_{i=1}^{k} \frac{x_{t,i}^{NC}}{e_0^{NC/USD}}$$

where $e_0^{NC/USD}$ is the exchange rate of the national currency to the US Dollar ($\frac{NC}{USD}$) in Q4 1995, the beginning of the sample period, and k is the number of currencies.

Over time, several changes to the reporting requirements and the coverage of the data have been made. Based on a manual summarising these changes provided by the BIS, we have

checked whether these changes affect our data in a significant way. Yet, most of these changes were of relatively small magnitude and indistinguishable from other fluctuations in the time series under study. Hence, we use the original but seasonally adjusted data in the following.

3.2 Explanatory variables

As our main explanatory variables, we include domestic and foreign real GDP – as proxies for real activity – and domestic and foreign real interest rates – as proxies for the rates of return on financial assets. Our dependent variable is specified in real terms as well, i.e. we deflate nominal variables with the domestic consumer price index. We capture rates of return at home and abroad using short-term interest rates with a maturity of three months.

In addition to GDP and interest rates, we include the bilateral exchange rate as an additional explanatory variable. Although we can correct the data for changes in the US Dollar exchange rate, as described above, their adjustment for all remaining exchange rate fluctuations has been difficult. The reason for this is that we do not know the breakdown of assets and liabilities in all currencies, and that information on the currency composition of assets and liabilities is not available for some countries. Hence, the bilateral exchange rate is included to pick up remaining exchange rate valuation effects. The exchange rate series are obtained from Datastream. To avoid structural breaks, the exchange rate series for member countries of the Euro Area are denominated in local currency versus the US Dollar even after the adoption of the Euro, i.e. the exchange rate given in Euros in terms of the US Dollar has been multiplied by the official conversion rate of the respective member country.

All of our explanatory variables are provided by Datastream. When available, we use seasonally adjusted real GDP data, and we seasonally adjust all remaining GDP series using the US Census Bureau's X12 seasonal adjustment procedure as implemented in *EViews*. The data stem from the OECD and national sources and have been retrieved through Datastream. To all other time series which initially have not been seasonally adjusted we apply the same methodology.

4. Descriptive statistics

In the theoretical discussion above, we have assumed that banks' international portfolios can be viewed as being representative for larger classes of country portfolios. Whether this analogy holds is, of course, an empirical question. Evidence provided in Sørensen et al (2006) shows that the ratios of portfolio equity, debt, and FDI to GDP are highly correlated. It is therefore difficult to separate their impact on the degree of risk sharing and consumption smoothing across borders. However, Sørensen et al (2006) do not analyse banks' portfolios and other components of country portfolios separately, as we do here. We begin with a comparison of banks' and other international portfolios, focusing in particular on shifts in the importance of the Euro Area. In addition, we first provide descriptive evidence on the correlation between banks' international portfolios and key macroeconomic variables such as GDP and interest rates.

The focus of this paper is on the long- and short-run determinants of international asset portfolios and the impact of financial integration on adjustment patterns. Ideally, we would like to address these issues using an encompassing dataset including information on bilateral holdings of all types of financial assets for a large range of countries and over a long

time range. Unfortunately, such data are unavailable.[7] Still, our data are relatively representative also for a larger class of international financial assets since bank portfolios account for a considerable part of country portfolios. In the following, we compare total claims of banks as given in Table 9A of the BIS consolidated statistics published in its Quarterly Review with data on country portfolios from the Coordinated Portfolio Investment Survey (CPIS), which is conducted by the IMF. These data are available on a bilateral basis for a large cross-section of countries for the years 2001 to 2004. In contrast to the data used for the regression-based analysis below, these data consolidate claims of domestic banks on their foreign affiliates, which improves comparability with the portfolio data. Using these data, the ratio of total claims of banks to total portfolio investments for Germany amounts to 90% in 2001 and 85% in 2004. In the United Kingdom, banks' assets add up to more than 90% of total portfolio investment. The ratio is lower in the United States and Japan, where claims of banks in 2004 amount to 46% and 24%, respectively. Hence, we use information on a significant part of country portfolios.

Not only do international bank portfolios account for a significant fraction of country portfolios, but both are also highly correlated. Figure 1 compares international bank portfolios and country portfolios with regard to different countries by plotting correlation coefficients between bank and country assets against those for liabilities. Since the data on country portfolios are only available for the years 2001 to 2004, we convert banks' assets and liabilities into yearly averages. In the top panel of Figure 1, correlations are shown year-by-year. Correlations between bank and country assets and between bank and country liabilities are positive and lie in a range from 0.4 to 0.9. Overall, the countries with the highest correlations are Japan, the United Kingdom, the United States, Germany, and France. There is little variation in the coefficients over the four years.

To further investigate the relationship between bank and country portfolios, the bottom panel of Figure 1 presents the correlation coefficients of bilateral portfolio positions for the years 2001 to 2004. Even though there are some negative correlations, the scatter-plots are more concentrated in regions exhibiting positive correlation coefficients. The only exception is Japan, which shows an evenly spread scatter-plot. All in all, we conclude that bank assets and liabilities are positively related to country portfolios.

While Figure 1 reveals that bank portfolios are highly correlated with country portfolios, it does not show the importance of two-way asset trade or, in other words, the importance of 'diversification trade' in financial assets. Figure 2 therefore gives a measure of the importance of bilateral financial linkages as proposed by Obstfeld (2004). Applying a frequently-used indicator of the importance of intra- versus inter-industry trade in goods, Obstfeld computes the Grubel-Lloyd index $GL_{it} = 1 - \frac{|FA_{it} - FL_{it}|}{FA_{it} + FL_{it}}$ where FA = cross-border assets, FL = cross-border liabilities, i = reporting country, and t = time, as a measure of the importance of countries' two-way trade in financial assets. A high value of this index indicates that diversification finance is important. Using data on countries' aggregated international portfolios, Obstfeld reports average values for GL of 0.83 for developing countries and 0.67 for emerging markets. Our own measures using aggregate bank portfolios show similar values for most reporting countries except Japan, where the mean GL index was 0.5. Moreover, the GL indices have been relatively stable over time.

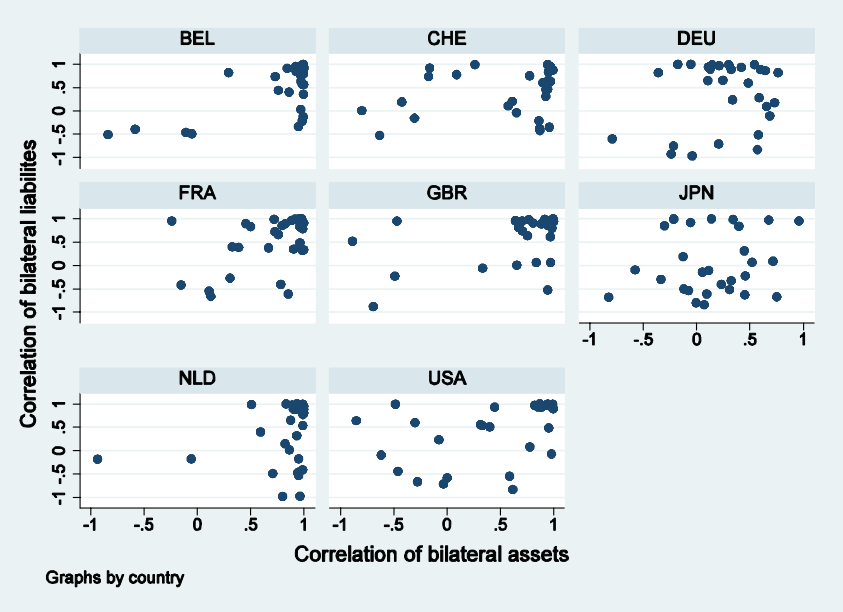
[7] To the best of our knowledge, data similar to the encompassing datasets compiled by Lane and Milesi-Ferretti (2006) are unavailable on a bilateral and/or on a quarterly basis.

Figure 1

Correlation of banks' international portfolios and country portfolios

(a) On a yearly basis

(b) On a bilateral basis



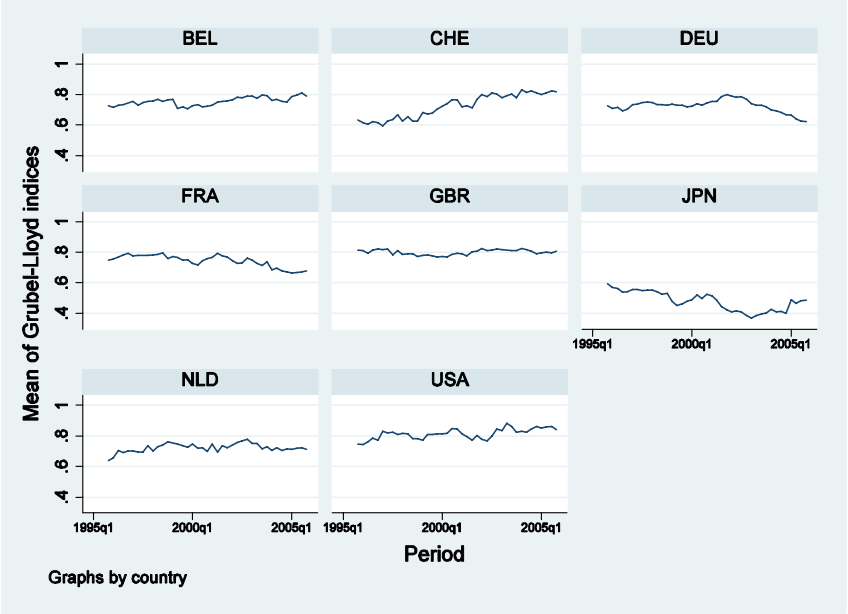
Note: Correlation coefficients between banks' cross-border assets and liabilities and those held by countries as reported in the Coordinated Portfolio Investment Survey of the IMF for 2001 to 2004. BEL = Belgium, CHE = Switzerland, DEU = Germany, FRA = France, GBR = United Kingdom, JPN = Japan, NLD = Netherlands, USA = United States.

Finally, we have run simple gravity-type regressions in order to check whether stocks of foreign bank assets and liabilities are correlated with macroeconomic variables. These regressions show that foreign GDP has a positive, and distance has a negative impact on cross-border assets and liabilities. The results for interest rates are mixed, with a mostly insignificant foreign interest rate and a positive impact of the domestic interest rate on cross-border liabilities. Finding a weak or even unexpected impact of interest rates on cross-border asset holdings is not necessarily at odds with the earlier empirical literature. Niehans (1994) has even argued that empirical studies using interest rates to explain international capital flows are inherently flawed for two reasons. First, the link between capital flows and interest rates depends on the type of underlying shock. Second, interest rate arbitrage may take

place even without changes in the underlying quantities. This argument may in fact hold in a world with complete asset markets and a full set of contingent claims. In the more general case, however, international adjustment following exogenous shocks should take place also through a restructuring of international asset portfolios (Obstfeld (2004)).

Figure 2

Grubel-Lloyd indices for banks' international portfolios



Mean of Grubel-Lloyd Indices for international bank portfolios. BEL= Belgium, CHE = Switzerland, DEU = Germany, FRA = France, GBR = United Kingdom, JPN = Japan, NLD = Netherlands, USA = United States.

5. Short- and long-run adjustment of banks' international portfolios

Earlier empirical literature on international (bank) portfolios has been quite successful in explaining levels of activity (the 'long run'), but it has been less successful in explaining the flow data (the 'short run'). In this section, we test whether analysing the short- and long-run determinants of banks' portfolios simultaneously helps to bridge the gap between these two strands of the literature.

5.1 The empirical model

Our empirical model proceeds in four steps.

First, we test for the presence of unit roots in our data.

Second, since we cannot confidentially reject the presence of unit roots, we test for the presence of a cointegration relationship among our variables of interest, using different panel cointegration tests. We also estimate the long-run cointegration coefficients. The long-run cointegration relationships are assumed to differ across reporting countries but to be homogeneous across recipient countries. As we use a fixed effects estimator, time-invariant variables such as the distance between two countries drop out.

Third, with the estimates for the long-run cointegration coefficients at hand, we estimate the short-run dynamics of banks' cross-border assets and liabilities in an error-correction model. We estimate this model separately for each of the cross-sections, restricting the long-run parameters to those found in the cointegration model. These estimates provide us with a

measure of the speed of adjustment to the long-run equilibrium, which is allowed to be heterogeneous also over the recipient countries.

Fourth, we use gravity-type variables to explain the speed of adjustment to a new equilibrium, i.e. the loading coefficients obtained from the error-correction model.

We use a panel data set of assets and liabilities that banks in country i hold in country j at time t. Our panel comprises ten reporting countries (i = 10), 30 recipient countries (j = 30)[8] (N = 300), and 41 time periods (1995:Q4 – 2005:Q2). We eliminate incomplete cross-sections, which reduces the total number of cross-sectional observations to N = 221. The number of included recipient countries varies according to the respective reporting country. We have the largest number of observations for Belgium (25 recipient countries), followed by France, the Netherlands and Switzerland (24), the United Kingdom (23), Germany (22) and the United States (21). The fewest observations are available for Japan (15). Hence, the total number of panel observations ranges from 1,025 to 615 observations across reporting countries.

Table 1

Descriptive statistics

Variable	Obs	Mean	Std dev	Minimum	Maximum
Cross-border assets	9,061	22,818	51,621	7.07	603,053
Cross-border liabilities	9,061	16,704	36,501	1.24	366,845
GDP *i*	9,061	1,015,981	1,844,988	36,015	6,443,341
GDP *j*	9,061	561,112	1,358,656	1,125	6,443,341
Bilateral exchange rate	9.061	59.75	282.39	0.0003	3,245
Real short-term interest rate *i*	9,061	1.70	1.81	–1.60	10.84
Real short-term interest rate *j*	9,061	2.19	2.66	–7.40	24.78
Bilateral exports	9,061	2,311	4,039	18.71	36,704
Bilateral imports	9,061	2,132	3,778	6.46	40,409
Log cross-border assets	9,061	8.42	2.00	1.96	13.31
Log cross-border liabilities	9,061	7.87	2.25	0.21	12.81
Log GDP *i*	9,061	12.51	1.52	10.49	15.68
Log GDP *j*	9,061	11.57	1.75	7.03	15.68
Log bilateral exchange rate	9,061	–0.67	3.31	–8.08	8.08
Log bilateral exports	9,061	6.70	1.47	2.93	10.51
Log bilateral imports	9,061	6.50	1.63	1.87	10.61

This table reports summary statistics for a balanced panel (T = 41 and N = 221). Assets, liabilities, and GDP are in millions of US Dollars. Interest rates are denoted in percent. The bilateral exchange rate is in price quotation. Data are averages across all reporting and recipient countries for the full time period.

[8] We exclude Turkey because of its high inflation and interest rate environment.

Our baseline specification includes domestic and foreign GDP, domestic and foreign real (short-term) interest rates, and the bilateral exchange rate as explanatory variables. Table 1 provides descriptive statistics for the variables used in the regressions. We specify our models separately for banks' cross-border assets and liabilities. Granger tests for non-causality run on first differences of assets and liabilities show no significant causal relationships between the two (results not reported).

5.2 Panel unit root tests

Since we are using quarterly data over a time period of 10 years, we test for non-stationarity of the time series (Table 2). Tests proposed by Levin, Lin, and Chu (2002) (LLC), and Im, Pesaran, and Shin (2003) (IPS) indicate that only foreign GDP is non-stationary. For domestic GDP, a common unit root is rejected by the LLC test, while according to the IPS test, an individual unit root cannot be rejected. For the bilateral exchange rates, the LLC test cannot reject the null of a common unit root while the IPS test rejects the null of individual unit root processes in the data. For the interest rate differential, bilateral export and imports, both tests reject the existence of a unit root. In addition, we find, perhaps surprisingly, that our main dependent variables, bilateral assets and liabilities, appear to be stationary. Only the LLC cannot reject the null of a common unit root for cross border assets. However, in contrast to LLC and IPS, the test by Hadri (2000) has the null of no common unit root, which is rejected in all cases, implying the existence of a unit root in each series.

These panel unit root tests require the time dimension to be large relative to the number of cross-sections. If we test for unit roots for every reporting country separately, neither the LLC nor the IPS test can reject the null hypothesis of a unit root for foreign assets except for the Netherlands, where an individual unit root process is rejected by the IPS test. For cross-border liabilities, a common unit root is not rejected for any of the reporting countries by the LLC test, contrary to the IPS test, which cannot reject the null of a unit root.

One reason for this mixed picture could be the violation of the usual assumption of cross-sectional independence made by these tests. As Banerjee, Marcellino, and Osbat (2005) argue, if the cross sections are cointegrated, the null hypothesis of a unit root is rejected too often even if the series actually are non-stationary. This may point to the importance of influences on international capital markets such as changes in US interest rates. However, we leave the test for cross-sectional cointegration for future research. We instead proceed under the assumption that cross-border assets and liabilities are integrated of degree one and that we have to take the spurious correlation problem into account, as in time series applications. Hence, in the next step, we establish whether there are long-run cointegration relationships among our variables of interest.

5.3 Long-run determinants of banks' cross-border assets and panel cointegration tests

Since we cannot confidently reject the presence of a unit root in our data, we next estimate whether there is a long-run cointegration relationship among bilateral bank portfolios and macroeconomic variables. We provide estimates for the full sample but we also estimate the long-run determinants of banks' assets and liabilities for each reporting country separately, to allow for cross-country heterogeneity in the long-run cointegration relationships. The panels for each of the reporting countries have a dimension comparable to those of other macro-panels, and panel estimators assuming a similar dimension of N and T can be applied.

Table 2

Panel unit root tests

(a) Levels

Variable	Observations	Cross-sections	LLC	IPS	Hadri
Log cross-border assets	8,693	221	1.25	–2.17**	31.15***
Belgium	998	25	–0.11	–0.42	12.17***
France	942	24	1.79	1.80	10.05***
Germany	858	22	1.47	–0.04	6.23***
Japan	597	15	1.38	1.47	8.06***
Netherlands	948	24	–1.82**	–4.42***	8.24***
Switzerland	941	24	–0.92	–0.33	12.27***
United Kingdom	898	26	0.80	–1.59*	9.23***
United States	821	21	0.03	0.17	9.70***
Log cross-border liabilities	8,703	221	–3.90***	–10.14***	27.10***
Belgium	977	25	–2.15**	–3.51***	8.67***
France	945	24	–1.66**	–3.08***	5.43***
Germany	866	22	–1.50*	–5.88***	9.32***
Japan	592	15	–1.06	–2.37***	9.77***
Netherlands	944	24	–1.41*	–3.13***	7.92***
Switzerland	950	24	–1.02	–4.43***	8.93***
United Kingdom	889	23	–0.82	–1.82**	11.77***
United States	825	21	0.53	–2.47***	8.14***
Interest rate differential	8,576	221	–10.37***	–13.19***	19.34***
Log bilateral exchange rate	8,433	221	19.00	–24.72***	10.90***
Log bilateral exports	8,722	221	–4.42***	–7.84***	29.34***
Log bilateral imports	8,669	221	–3.49***	–9.70***	26.25***
Log domestic GDP	8,414	221	–4.23***	–1.16	39.00***
Log foreign GDP	8,567	221	3.59	7.86	40.85***

This table reports the test statistics of panel unit root tests based on: Levin, Lin, and Chu (LLC) (2002) (H0: common unit root), Im, Pesaran, and Shin (IPS) (2003) (H0: individual unit root), and Hadri (2000) (H0: no common unit root). The maximum lag length was automatically chosen based on the SIC lag selection criterion. Reported observations are those used by the LLC test. Newey-West bandwidth selection uses a Bartlett kernel. *** = significant at the 1% level.

Table 2

Panel unit root tests

(b) First differences

Variable	Observations	Cross-sections	LLC	IPS	Hadri
Log cross-border assets	8,473	221	–68.22***	–79.36***	8.60***
Belgium	950	25	–20.56***	–25.25***	3.57***
France	927	24	–22.89***	–25.69***	1.56*
Germany	834	22	–15.02***	–21.43***	2.28**
Japan	584	15	–16.46***	–18.10***	1.33*
Netherlands	920	24	–25.62***	–31.64***	3.97***
Switzerland	929	24	–29.68***	–31.62***	2.91***
United Kingdom	889	23	–23.10***	–25.81***	4.26***
United States	792	21	–22.14***	–22.56***	4.60***
Log cross-border liabilities	8,437	221	–78.14***	–88.14***	5.08***
Belgium	938	25	–23.05***	–26.38***	2.59***
France	899	24	–24.62***	–26.32***	0.93
Germany	846	22	–24.92***	–29.55***	1.00
Japan	571	15	–22.67***	–21.58***	1.71**
Netherlands	921	24	–28.23***	–33.77***	2.91***
Switzerland	917	24	–27.12***	–29.70***	1.70**
United Kingdom	883	23	–23.54***	–26.99***	2.42***
United States	817	21	–26.00***	–30.41***	–0.59
Interest rate differential	8,331	221	–51.87***	–66.99***	–2.63
Log bilateral exchange rate	8,349	221	–4.26***	–65.33***	3.76***
Log bilateral exports	8,511	221	–77.22***	–89.51***	1.69**
Log bilateral imports	8,479	221	–71.68***	–85.64***	2.81***
Log domestic GDP	8,541	221	–36.96***	–49.46***	9.02***
Log foreign GDP	8,500	221	–42.19***	–52.81***	6.68***

This table reports the test statistics of panel unit root tests based on: Levin, Lin, and Chu (LLC) (2002) (H0: common unit root), Im, Pesaran, and Shin (IPS) (2003) (H0: individual unit root), and Hadri (2000) (H0: no common unit root). The maximum lag length was automatically chosen based on the SIC lag selection criterion. Reported observations are those used by the LLC test. Newey-West bandwidth selection uses a Bartlett kernel. *** = significant at the 1% level.

Our main empirical model is a cointegrated panel VAR model. The presence of a cointegration relationship is tested using a two-step estimator. For a VAR(1) model, the cointegrated model has the following VECM representation (Breitung (2005)):

$$\Delta y_{it} = \alpha_i \beta' y_{i,t-1} + \varepsilon_{it} \quad (1)$$

with $t = 0,1,\ldots,T$ and $i = 1,\ldots,N$, $E(\varepsilon_{it}) = 0$, $\Sigma_i = E(\varepsilon_{it}\varepsilon'_{it})$. This specification assumes the long-run cointegration relationship (β) to be identical across cross-sections while the loading coefficients and thus the speed of adjustment (α_i) varies for each cross-sectional observation. This assumption is key for our purposes as we can interpret the speed of adjustment as a measure of the degree of financial integration. Our expectation is that the speed of adjustment increases in the degree of integration of financial markets.

Estimating equation (1) proceeds in two steps. In a first step, the matrix β is estimated based on a consistent estimator of the short-run parameters α_i and of Σ_i. As $T \to \infty$, a consistent estimator of α_i can be obtained by estimating separate models for each cross-section unit N. At this stage, the restriction that the cointegration vectors are the same over the cross-sections is ignored. In a second step, the cointegration matrix β can be estimated by running an OLS regression on the pooled regression.

Table 3 gives the results of the panel cointegration tests and the estimates for the cointegration vectors for the full sample. Panel (a) gives the results using cross-border assets as the dependent variable. As regressors, we include domestic and foreign GDP, domestic and foreign interest rates, and the bilateral exchange rate. All variables except interest rates are in logs, and the coefficients can be interpreted as elasticities. In Panel (b), we present the same specifications but using cross-border liabilities as the dependent variables. Each regression is estimated for the full sample, for the Euro Area sub-sample, and for each of the reporting countries separately. To save space, we present the results of the two-step estimator introduced above. Results using a fully modified or a dynamic OLS model are qualitatively the same (see also Section 5.4).

Generally, the cointegration tests suggest that there is a long-run cointegration relationship among the variables at the 1% level of significance. The explanatory power of our model differs for assets and liabilities (see also Table 4). For cross-border assets, the R^2 is around 0.2 for the full sample and 0.7 for the Euro Area sub-sample. For cross-border liabilities, the explanatory power is much lower (0.06 and 0.23, respectively). For the individual reporting countries, the (unreported) R^2 ranges from 0.17-0.18 (Switzerland and the United States) to 0.72 for the Euro Area and 0.51 for Germany. For cross-border liabilities, we generally obtain lower R^2s. In the case of bonds issued by banks, the geographical location of the ultimate owners and of the owners reported in the data may not coincide. This could explain the relatively low explanatory power for foreign liabilities.

The most consistent result that we obtain is a positive impact of foreign GDP on cross-border assets and liabilities.[9] It is robust across all reporting countries, the full sample, and the Euroland sub-sample. This confirms the results of the scatter plots above. Also, the magnitude of the coefficient estimates is similar across different specifications. For the full sample, the long-run elasticity is higher for cross-border assets (about 2 for the full sample) than for cross-border liabilities (about 0.5). One reason for some of the relatively high elasticities could be that, over the sample period, the share of cross-border assets and liabilities relative to GDP has been increasing.

[9] The only exception are cross-border liabilities of Japanese banks.

Table 3

Panel cointegration tests

	Log dom GDP	Log for GDP	Log bil exch rate	Int rate differential	Cointeg-ration	*N*	*T*
(a) Cross-Border Assets							
Full sample	–0.68*** (–6.18)	2.32*** (24.74)	–1.79*** (–17.90)	0.01*** (2.61)	Yes	221	41
Euro Area	–1.09*** (–4.35)	2.84*** (12.34)		0.03*** (5.09)	Yes	41	28
Belgium	–2.22*** (–4.14)	4.45*** (9.54)	–3.01*** –(5.75)	0.05*** (5.29)	Yes	25	41
France	–0.44 (–1.22)	2.55*** (8.22)	–1.78*** (–5.19)	0.02*** (3.61)	Yes	24	41
Germany	–4.11*** (–16.92)	4.60*** (23.70)	–3.97*** (–15.43)	0.03*** (6.22)	Yes	22	41
Netherlands	–0.40 (–1.11)	2.02*** (6.21)	–1.92*** (–5.44)	–0.01 (–1.02)	Yes	24	41
Japan	–0.45 (–1.47)	1.92*** (8.69)	–0.87*** (–3.80)	0.02** (2.00)	Yes	15	41
Switzerland	0.56** (2.25)	0.65*** (3.07)	–0.07 (–0.29)	–0.02*** (–3.18)	Yes	24	41
United Kingdom	0.59** (2.55)	0.71*** (3.24)	–0.85*** (–3.79)	0.001 (0.13)	Yes	23	41
United States	2.30*** (4.79)	0.29 (0.77)	–0.41 (–1.09)	–0.04*** (–4.04)	Yes	21	41
(b) Cross-Border Liabilities							
Full sample	0.46*** (3.54)	0.57*** (5.19)	0.21* (1.77)	–0.02*** (–6.86)	Yes	221	41
Euro Area	2.09** (4.98)	–0.57 (–1.49)		0.06*** (5.26)	Yes	41	28
Belgium	–1.36*** (–2.79)	3.25*** (7.65)	–2.56*** (–5.38)	0.004 (0.48)	Yes	25	41
France	–0.45 (–0.93)	1.27*** (3.06)	–0.80* (–1.75)	–0.04*** (–4.54)	Yes	24	41
Germany	–3.84*** (–14.28)	3.72*** (17.30)	–2.47*** (–8.67)	0.02*** (3.53)	Yes	22	41
Netherlands	0.82* (1.72)	–0.38 (–0.88)	–2.05*** (–4.39)	–0.01 (–1.08)	Yes	24	41
Japan	3.27*** (6.30)	–1.72*** (–4.69)	3.66*** (9.58)	–0.06*** (–4.31)	Yes	15	41
Switzerland	–0.43* (–1.83)	0.78*** (3.91)	–0.29 (–1.31)	0.003 (0.51)	Yes	24	41
United Kingdom	1.44*** (5.72)	0.32 (1.33)	0.48** (1.98)	–0.02*** (–3.14)	Yes	23	41
United States	–0.41 (–0.98)	1.35*** (4.11)	–0.37 (–1.15)	–0.02*** (–2.76)	Yes	21	41

This table reports results of panel cointegration tests using a full balanced sample. The interest rate differential is the difference between domestic and foreign interest rates. The bilateral exchange rate is not available for the Euro Area countries as these estimates capture only the post-1999 period. Panel cointegration tests are based on the methods proposed by Kao (1999) and Pedroni (1999). The two-step estimator is based on Breitung (2005). The bilateral exchange rate is not available for the Euro Area countries.

Table 4

Panel cointegration tests – different estimation methods

Sample	Method	Log Domestic GDP	Log Foreign GDP	Log bilateral exchange rate	Interest rate differential	R^2	N	T
Cross-Border Assets								
Full	OLS	–0.93*** (–5.68)	2.54*** (17.00)	–1.97*** (–12.38)	0.01*** (3.20)	0.22	221	41
Full	FMOLS	–1.05*** (–6.27)	2.63*** (17.17)	–1.93*** (–11.87)	0.01** (2.39)	0.22	221	41
Full	DOLS	–0.91*** (–5.16)	2.40*** (14.91)	–1.78*** (–10.36)	0.001 (0.41)	0.24	221	41
Euro Area	OLS	–1.49*** (–3.39)	3.27*** (7.72)		0.03*** (3.65)	0.68	41	28
Euro Area	FMOLS	–1.24*** (–2.72)	3.02*** (8.67)		0.02** (2.36)	0.67	41	28
Euro Area	DOLS	–1.05** (–2.13)	2.69*** (5.80)		0.02*** (2.81)	0.72	41	28
Cross-Border Liabilities								
Full	OLS	0.27 (1.39)	0.72*** (4.05)	0.07 (0.37)	–0.02*** –(6.02)	0.06	221	41
Full	FMOLS	0.15 (0.76)	0.76*** (4.19)	–0.09 (–0.48)	–0.02*** (–6.65)	0.06	221	41
Full	DOLS	0.34 (1.63)	0.63*** (3.32)	0.13 (0.63)	–0.02*** (–4.24)	0.06	221	41
Euro Area	OLS	2.24** (2.49)	–0.74 (–0.86)		0.07*** (3.64)	0.22	41	28
Euro Area	FMOLS	2.36** (2.53)	–0.83 (–0.93)		0.08*** (3.90)	0.21	41	28
Euro Area	DOLS	2.67*** (2.65)	–1.15 (–1.19)		0.10*** (4.54)	0.24	41	28

Notes: See Table 3. FMOLS = fully modified OLS estimator. DOLS = dynamics OLS estimator. The bilateral exchange rate is not available for the Euro Area countries.

in contrast, the impact of domestic GDP differs for cross-border assets and liabilities. We find a negative impact on cross-border assets for the full sample and for the Euro Area sub-sample, whereas the effect on cross-border liabilities is positive. One interpretation would be that a higher domestic GDP is associated with a higher demand for credit. Hence, cross-border lending contracts and cross-border liabilities increase. For the individual reporting countries, however, there is no consistent effect of domestic GDP. One explanation is that, for the country-by-country regressions, domestic GDP captures general trends in the data and thus the time series dimension only. For each recipient country, domestic GDP is identical, and it might thus capture general trend developments in the reporting countries.

Turning next to the impact of real interest rates on cross-border assets and liabilities, we find a couple of significant results. An increase in the interest rate differential between the home and the foreign economy raises cross-border assets and lowers cross-border liabilities in the full sample. If the interest rate differential and simple arbitrage considerations alone were the determinants of cross-border asset holdings, we would rather expect the opposite: cross-border assets should decrease as the interest rate differential between the home and the foreign economy widens, and cross-border liabilities should increase. The counterintuitive results for the full sample are confirmed by most of the results for the individual reporting

countries. For four countries, we reconfirm the positive impact of the interest rate differential on cross-border assets. We find the expected negative impact only for Switzerland and the United States. For cross-border liabilities, we find the same negative impact as for the full sample for four countries, and a positive effect only for Germany.

There are several possible explanations for this result. First, our current specification takes only insufficient account of exchange rate expectations. Second, from a theoretical point of view, the link between cross-border assets and the interest rate differential is not clear-cut. It may depend on the nature of the underlying shocks driving interest rates, and its sign depends on the relative strength of income and substitution effects.

We can check whether the results for interest rates are due to the fact that we take only insufficient account of exchange rate expectations. We have sufficient observations to re-estimate the model for the Euro Area countries and for the post-1999 period only. In this sub-sample, changes in bilateral nominal exchange rates are irrelevant. For cross-border liabilities, the effect of the interest rate differential is indeed positive for the Euro Area sub-sample. However, the positive effect on cross-border assets is confirmed. Explanations of the sometimes unexpected interest rate effects can thus not be based on exchange rate expectations alone.

The log of the bilateral exchange rate has a negative impact on cross-border assets and a mixed impact on cross-border liabilities. Results for the exchange rate are difficult to interpret. We include the bilateral exchange rate, but the assets and liabilities are denominated in US Dollars. Hence, valuation changes are driven by movements of the bilateral exchange rates to the US Dollar *and* by the currency of denomination of assets and liabilities. To isolate the effect of the US Dollar exchange rate, we re-run the model using assets and liabilities in constant US Dollars, as described above. Results for the data in constant US Dollars are given in Table 5. They are practically unchanged in terms of the qualitative results and the significance of the coefficients. If anything, there are some changes in the results for Switzerland.

5.4 Robustness tests

We run several sets of robustness tests. First, we test whether our main results change as we include bilateral trade in our cointegration regression. Second, we use different methods for estimating the long-run coefficients. Third, we drop individual regressors successively to test for the effect of multicollinearity among the regressors. Fourth, we study the cross-border assets and liabilities of banks and non-banks separately. Finally, we estimate the model for different time periods.

Bilateral trade: Turning to the effects of bilateral trade first, we check whether the transmission of macroeconomic developments through international bank portfolios depends on the degree of trade integration between two countries. Earlier work by, for instance, Forbes and Chinn (2004) shows that bilateral trade affects financial linkages and the transmission of shocks between financial markets to a significant degree.

To measure the importance of bilateral trade, we retrieve data from the IMF's Direction of Trade Statistics (DOTS). Bilateral data are available at a quarterly frequency. Results are reported in Table 6. The reason for including trade is that – presumably – a large share of cross-border bank lending is trade-related. If foreign importers receive trade credits from foreign banks, we would expect a positive correlation between bilateral foreign assets and

exports and between cross-border liabilities and imports.[10] In addition, we also include the sum of exports and imports in all equations. All trade variables are in logs.

Table 5

Panel cointegration tests – constant US Dollars

	Log domestic GDP	Log foreign GDP	Log bilateral exchange rate	Interest rate differential	Cointeg-ration	*N*	*T*
(a) Cross-Border Assets							
France	–1.09*** (–2.86)	2.66*** (8.21)	–2.00*** (–5.57)	0.03*** (4.32)	Yes	24	41
Germany	–5.21*** (–20.50)	4.85*** (23.88)	–4.29*** (–15.95)	0.04*** (6.28)	Yes	22	41
Netherlands	–0.56 (–1.45)	1.79*** (5.13)	–1.64*** (–4.33)	–0.0002 (–0.03)	Yes	24	41
Japan	–0.88*** (–2.80)	1.87*** (8.37)	–0.84*** (–3.63)	0.02*** (2.25)	Yes	15	41
Switzerland	–0.16 (–0.64)	0.84*** (3.91)	–0.40* (–1.64)	–0.01*** (–2.58)	Yes	24	41
United States	2.30*** (4.79)	0.29 (0.77)	–0.41 (–1.09)	–0.04*** (–4.04)	Yes	21	41
(a) Cross-Border Assets							
France	–0.87* (–1.83)	1.25*** (3.09)	–0.83* (–1.86)	–0.03*** (–3.46)	Yes	24	41
Germany	–4.92*** (–17.84)	3.98*** (18.07)	–2.80*** (–9.59)	0.02*** (3.59)	Yes	22	41
Netherlands	0.67 (1.42)	0.10 (0.23)	–1.75*** (–3.71)	–0.004 (–0.43)	Yes	24	41
Japan	2.70*** (5.29)	–1.69*** (–4.68)	3.63*** (9.67)	–0.06*** (–4.18)	Yes	15	41
Switzerland	–1.09*** (–4.82)	0.99*** (4.81)	–0.66*** (–2.87)	0.005 (1.05)	Yes	24	41
United States	–0.41 (–0.98)	1.35*** (4.12)	–0.37 (–1.15)	–0.02*** (–2.76)	Yes	21	41

Notes: See Table 3. The dependent variable is measured in constant US Dollars using the method described in Section 3.1.

The first result that can be observed from Table 6 is that all previous qualitative results carry over if we include foreign trade. There are only very few coefficients which switch from being significant in the baseline specification to being insignificant in the specification including trade, or vice versa. Also, the coefficient estimates are similar in magnitude, and there is generally no consistent pattern of coefficient increase or decrease. Hence, we do not find evidence that omitting trade from our baseline specification affects the main results.

[10] Results using the sum of exports and imports are qualitatively the same as results using imports and exports separately.

Table 6

Panel cointegration tests – including foreign trade

(a) Cross-Border Assets

	Log domestic GDP	Log foreign GDP	Log bil exchange rate	Interest rate differential	Log bilateral exports	Cointeg-ration	*N*	*T*
Full sample	–0.69*** (–6.85)	1.97*** (21.70)	–1.61*** (–17.27)	0.001 (0.61)	0.34*** (11.73)	Yes	221	41
Euro Area	–1.20*** (–5.08)	2.77*** (11.91)		0.03*** (5.53)	0.15* (1.77)	Yes	41	28
Belgium	–2.57*** (–6.09)	4.02*** (10.50)	–3.08*** (–7.42)	0.02*** (2.72)	0.52*** (6.12)	Yes	25	41
France	–0.42 (–1.22)	2.07*** (6.76)	–1.52*** (–4.60)	0.02*** (2.68)	0.49*** (6.02)	Yes	24	41
Germany	–3.03*** (–12.30)	2.75*** (10.81)	–2.52*** (–9.23)	0.02*** (3.83)	0.93*** (9.87)	Yes	22	41
Netherlands	–1.18*** (–4.10)	1.45*** (5.55)	–2.07*** (–7.37)	–0.02*** (–3.28)	1.00*** (15.66)	Yes	24	41
Japan	–0.43 (–1.45)	2.14*** (8.50)	–0.91*** (–3.93)	0.02* (1.91)	–0.26** (–2.21)	Yes	15	41
Switzerland	0.57** (2.34)	0.66*** (2.87)	–0.05 (–0.19)	–0.02*** (–3.09)	–0.02 (–0.25)	Yes	24	41
United Kingdom	0.54** (2.45)	0.87*** (4.07)	–0.96*** (–4.47)	0.001 (0.39)	–0.29*** (–4.14)	Yes	23	41
United States	2.04*** (4.29)	0.52 (1.38)	–0.59 (–1.60)	–0.04*** (–3.79)	–0.36*** (–2.83)	Yes	21	41

(a) Cross-Border Assets

	Log domestic GDP	Log foreign GDP	Log bil exchange rate	Interest rate differential	Log bilateral imports	Cointeg-ration	*N*	*T*
Full sample	0.26** (2.06)	0.41*** (3.90)	0.25** (2.19)	–0.02*** (–8.07)	0.35*** (11.68)	Yes	221	41
Euro Area	1.84*** (4.41)	–0.43 (–1.14)		0.06*** (5.28)	0.08 (0.79)	Yes	41	28
Belgium	–1.34*** (–2.96)	2.72*** (6.85)	–2.29*** (–5.18)	–0.004 (–0.45)	0.53*** (6.86)	Yes	25	41
France	–0.37 (–0.81)	1.09*** (2.75)	–0.66 (–1.51)	–0.05*** (–5.48)	0.01 (0.09)	Yes	24	41
Germany	–3.72*** (–14.05)	3.42*** (14.93)	–2.23*** (–7.70)	0.02*** (2.70)	0.28*** (3.49)	Yes	22	41
Netherlands	0.79* (1.77)	0.23 (0.58)	–1.88*** (–4.36)	–0.01 (–1.61)	0.15* (1.94)	Yes	24	41
Japan	1.41*** (2.58)	–1.95*** (–5.64)	3.48*** (9.75)	–0.07*** (–5.27)	1.59*** (6.85)	Yes	15	41
Switzerland	–0.72*** (–3.56)	0.83*** (4.69)	–0.36* (–1.79)	0.002 (0.45)	0.26*** (5.49)	Yes	24	41
United Kingdom	1.42*** (5.83)	0.23 (0.98)	0.52** (2.22)	–0.02*** (–3.63)	0.10* (1.67)	Yes	23	41
United States	–1.12 ** (–2.52)	1.09*** (3.35)	–0.21 (–0.65)	–0.03*** (–2.97)	0.60*** (4.04)	Yes	21	41

Notes: See Table 3. The bilateral exchange rate is not available for the Euro Area countries.

Generally, we find a positive link between banks' cross-border activities and trade. The link between imports and liabilities is positive except for the Euro Area and France, where we find an insignificant effect. The link between exports and assets is positive as well except for Japan, the United Kingdom, and the United States where we find a negative and significant effect. For Switzerland, the link between exports and assets is insignificant. Overall, these results confirm that banks' international activities are trade-related, but these links do not affect the impact of return differentials.

Alternative cointegration estimators: In addition, we check the robustness of our results for the full sample and for the Euro Area sub-sample using different estimators for the long-run cointegration coefficients. Results using an OLS estimator, a fully modified OLS (FMOLS) model (Pedroni (1999)), and a dynamic OLS (DOLS) model (Kao and Chiang (2000)) are presented in Table 4. Both the FMOLS and the DOLS estimator address serial correlation and the potential endogeneity of the regressors. The FMOLS estimator corrects the OLS estimator non-parametrically, while the DOLS estimator uses information from past and future leads and lags of all variables.

For gross cross-border assets, the results are basically unchanged. For cross-border liabilities, in contrast, the log bilateral exchange rate becomes insignificant for the full sample, and foreign GDP becomes insignificant for the Euro Area. Unreported regressions for the individual reporting countries provide fairly consistent results for the different models, and none of the coefficients switches in sign.

Multicollinearity: To check whether including several macroeconomic variables, which are potentially correlated to each other, affects our results, we re-run each model, dropping individual explanatory variables successively. This also addresses the concern that interest rates may be a poor proxy for the long-run macroeconomic environment as they could reflect endogenous policy responses of the central banks. In unreported regressions, we find the most stable results for foreign GDP and the interest rate differential. Results for domestic GDP and for the bilateral exchange rate switch in some of these regressions from being positive to negative, or vice versa. One possible explanation for these somewhat unstable results is that domestic GDP picks up a time trend in the data. For the exchange rate, we have no strong priors about the expected coefficient sign. Both domestic GDP and the bilateral exchange rate thus pick up the effects of the other, omitted explanatory variables. These robustness tests show that the results for foreign GDP and in particular for the interest rate differential are quite robust. In future work, it seems worthwhile to explore the effects of alternative return measures to account for the fact that rates of return tend to vary substantially over time and across asset classes (Lane and Milesi-Ferretti (2003)).

Banks versus non-banks: Finally, we run the regressions separately for cross-border assets and liabilities vis-à-vis banks and non-banks. Table 7 presents the results for the full sample and for the Euro Area sample, using different cointegration estimators. The first thing to notice is that the explanatory power of our model for assets and liabilities vis-à-vis non-banks is much higher than for assets and liabilities vis-à-vis banks. One reason for this could be that banks are active mostly on the wholesale market, for which macroeconomic fundamentals are less relevant than for the retail market.

Also, we obtain more significant coefficient estimates for non-banks. For total assets in the full country sample, the most important difference between banks and non-banks is the sign of the interest rate differential. For banks, we obtain the same positive sign as before, whereas for non-banks we now obtain the (expected) negative sign. For the Euro Area though, this pattern reverses. Here, we have a positive sign for the non-banks and a negative sign for the banks. Turning to cross-border liabilities, we find quite significant differences between banks and non-banks with regard to the impact of the remaining explanatory variables as well. As regards the sign of the interest rate differential, the results for the Euro Area are again in line with expectations for banks. For the full sample, in contrast, results show that the unexpected negative sign is driven by liabilities vis-à-vis banks.

Table 7

Panel cointegration tests – banks versus non-banks

(a) Full sample

	Log domestic GDP	Log foreign GDP	Log bil exchange rate	Interest rate diff	R^2	Log domestic GDP	Log foreign GDP	Log bil exchange rate	Interest rate diff	R^2
	Assets vis-à-vis non-banks					**Assets vis-à-vis banks**				
FMOLS	–1.13*** (–5.33)	2.60*** (13.41)	–2.05*** (–9.89)	–0.01*** (2.62)	0.13	0.08 (0.46)	0.02 (0.14)	0.11 (0.65)	0.02*** (6.62)	0.005
DOLS	–0.62*** (–2.77)	2.08*** (10.19)	–1.57*** (–7.21)	–0.01** (–2.28)	0.15	–0.29 (–1.56)	0.32* (1.87)	–0.21 (–1.14)	0.01*** (3.13)	0.01
Two-step	–0.26* (–1.79)	1.86*** (14.86)	–1.41*** (–10.57)	–0.01*** (–3.86)		–0.40*** (–3.22)	0.44 (4.19)***	–0.37*** (–3.31)	0.02*** (7.69)	
	Liabilities vis-à-vis non-banks					**Liabilities vis-à-vis banks**				
FMOLS	0.0005 (0.003)	1.58*** (9.28)	–0.70*** (–3.84)	0.001 (0.23)	0.13	0.15 (0.67)	–0.82*** (–4.01)	0.60*** (2.78)	–0.24*** (–6.11)	0.02
DOLS	0.34* (1.76)	1.21*** (6.74)	–0.40** (–2.08)	0.003 (0.73)	0.15	–0.003 (–0.01)	–0.57*** (–2.67)	0.53** (2.30)	–0.02*** (–4.38)	0.03
Two-step	0.34*** (2.61)	1.34*** (12.18)	–0.43*** (–3.67)	0.01** (2.25)		0.07 (0.48)	–0.70*** (–5.56)	0.60*** (4.45)	–0.02*** (–7.64)	

(b) Euro area

	Log domestic GDP	Log foreign GDP	Log bil exchange rate	Interest rate diff	R^2	Log domestic GDP	Log foreign GDP	Log bil exchange rate	Interest rate diff	R^2
	Assets vis-à-vis non-banks					**Liabilities vis-à-vis banks**				
FMOLS	0.55 (0.75)	1.73** (2.44)		0.05*** (3.27)	0.52	–1.80*** (–3.22)	1.29** (2.41)		–0.03** (–2.38)	0.07
DOLS	0.74 (0.93)	1.43* (1.88)		0.06*** (3.34)	0.61	–1.79*** (–2.97)	1.32** (2.28)		–0.03*** (–2.67)	0.10
Two-step	0.53 (1.29)	1.67*** (4.39)		0.07*** (6.07)		–1.77*** (–5.80)	1.30*** (4.64)		–0.03*** (–4.02)	
	Liabilities vis-à-vis non-banks					**Liabilities vis-à-vis banks**				
FMOLS	2.69*** (3.27)	–1.12 (–1.42)		–0.04** (–2.16)	0.22	–0.33 (–0.29)	0.29 (0.27)		0.11*** (4.78)	0.02
DOLS	3.07*** (3.45)	–1.51* (–1.77)		–0.02 (–1.22)	0.26	–0.41 (–0.33)	0.37 (0.31)		0.12*** (4.62)	0.06
Two-step	3.04*** (6.89)	–1.43*** (–3.54)		–0.01 (–0.55)		–1.13** (–2.12)	0.99** (2.03)		0.06*** (4.78)	

Notes: See Table 3. FMOLS = fully modified OLS estimator. DOLS = dynamic OLS estimator. The bilateral exchange rate is not available for the Euro Area countries. The number of observations is T = 41 and N = 222 for the full sample and T = 28 and N = 44 for the Euro Area sub-sample.

Sample splits: Our data cover a time period characterised by severe financial crises in some emerging markets in the late 1990s. Although the use of data for OECD countries limits the direct impact of these crises on our model, indirect effects might well affect our estimates, and banks may, in particular, have changed their portfolio strategies in response to the crises. To test whether our results are stable, we thus re-run the empirical model for different time periods, i.e. the first half of the sample (1995:Q4-2000:Q4), the post-crises period (1998:Q1-2005:Q4), and the last half of the sample (2001:Q1-2005:Q4). In unreported regressions, we do indeed find that the sign of the interest rate variables has not been stable

over time. In most cases, the signs switch over time, and we find somewhat greater evidence for the expected signs in the second half of the sample. Also, the explanatory power of our model improves over time.

In contrast, the positive impact of foreign GDP on cross-border assets generally remains positive across the different sample periods. Results for the different sample periods confirm that domestic GDP picks up cyclical variations in the data. Hence, the impact is not very stable over time. The same is true for the impact of the bilateral exchange rate on cross-border liabilities. However, for cross-border assets, exchange rates continue to have a negative (or insignificant positive) impact.

5.5 Short-run determinants of banks' cross-border assets

Results presented so far inform us about the long-run determinants of banks' international portfolios but not about the response of banks' portfolios to short-run macroeconomic developments. Also, we have not yet estimated the speed of adjustment to a new long-run equilibrium.

One way to obtain these two pieces of information is to estimate an error-correction model which allows us to decompose the short- and long-run determinants of banks' international portfolios:

$$\Delta y_t = \alpha_o - \alpha_1 [y_{t-1} - \boldsymbol{\beta}' \mathbf{x}_t] + \sum_{k=1}^{4} \gamma_k \Delta y_{t-k} + \sum_{k=0}^{4} \boldsymbol{\delta}'_k \Delta \mathbf{x}_{t-k} + \varepsilon_t \qquad (2)$$

where $\mathbf{x}_t$ is a vector of explanatory (exogenous) variables, and $\boldsymbol{\beta}$ is the vector of long-run coefficients obtained from the estimation of equation (1) above. The lagged terms on the RHS of this equation capture short-run macroeconomic dynamics. We estimate this model separately for each reporting-recipient country pair on the 41 quarterly time series observations. We set the lag length at $t = 4$.

The loading coefficient $0 < |\alpha_1| < 1$ measures the persistence of deviations of cross-border assets and liabilities from their long-run equilibrium, i.e. from the error-correction term in brackets. The dependent variable is the first difference of the logarithm of cross-border bank assets and liabilities (Δy_t), i.e., we look at percentage changes in banks' cross-border activities. Below, we use the loading coefficients obtained from the estimation of equation (2) to check whether the speed of adjustment to a new equilibrium differs systematically across the country pairs.

One difficulty in estimating equation (2) directly is that it includes lagged dependent variables, which, in a panel framework, leads to biased coefficients. Moreover, standard remedies used in panel applications where N is large relative to T cannot be used here. Our solution is similar in spirit to the two-step cointegration tests used in time series applications. With the estimates of the long-run cointegration parameters obtained above at hand, we have an estimate for the error-correction term for each reporting country. We assume this long-run cointegration relationship to be homogeneous for all recipient countries but we allow the short-run dynamics and the loading coefficients to differ for each country pair. We then estimate the error-correction model for each of the cross-sections separately. Since we have established the presence of cointegration relationships among the variables of interest, we can proceed under the assumption that our parameter estimates follow a normal distribution and that standard critical values apply.

In a final step, we thus regress the loading coefficients (α_1) obtained from equation (2) on standard gravity-type variables (log distance, log size of the reporting and the recipient country). Additionally, we include variables which measure the degree of financial integration,

such as a dummy variable indicating whether the two countries are members of the European Union, whether the two countries are members of the Euro Area, and dummy variables for the presence of capital controls on cross-border financial credits. We also include a proxy for the total country risk, taken from *Euromoney*. Data for country risk and for the presence of capital controls are averages over the post-1995 period. Results are reported in Table 8.

Table 8

Gravity Regressions Explaining Loading Coefficients

	Assets				**Liabilities**			
	No weights	No weights	Weighted	Weighted	No weights	No weights	Weighted	Weighted
Log GDP *i*	–0.022*	–0.02	–0.012*	–0.017*	–0.01	0.00	0.00	–0.01
	(2.09)	(1.47)	(1.86)	(1.65)	(0.82)	(0.15)	(0.27)	(0.45)
Log GDP *j*	0.00	–0.01	0.00	0.00	0.00	–0.02	0.00	–0.01
	(0.58)	(0.82)	(0.18)	(0.33)	(0.19)	(1.24)	(0.78)	(0.65)
Log distance *ij*	–0.02	–0.01	–0.012*	–0.01	–0.02	–0.01	–0.015*	–0.02
	(1.50)	(0.68)	(1.69)	(0.78)	(1.08)	(0.55)	(1.68)	(1.12)
Both Euro Area members (0/1)	–0.03	–0.04	–0.01	–0.03	–0.03	0.02	–0.03	–0.03
	(1.07)	(0.84)	(0.68)	(0.80)	(0.60)	(0.40)	(1.44)	(0.71)
Both EU members (0/1)	0.00	0.04	0.00	0.02	0.01	0.03	0.01	0.01
	(0.00)	(0.71)	(0.18)	(0.36)	(0.14)	(0.33)	(0.47)	(0.20)
Euromoney total risk index *i*	0.001*	0.00	0.001**	0.00	0.00	–0.003***	0.00	–0.001***
	(2.59)	(0.75)	(2.22)	(0.10)	(0.85)	(3.03)	(0.49)	(3.18)
Euromoney total risk index *j*	0.00	0.00	0.00	–0.002**	0.00	0.00	0.00	0.00
	(0.61)	(0.31)	(0.40)	(2.48)	(1.33)	(0.05)	(0.40)	(1.33)
Capital controls *i*	0.07	◊	0.04	◊	0.52	◊	0.05	◊
	(0.26)		(0.22)		(1.51)		(0.24)	
Capital controls *j*	–0.04	0.02	–0.01	0.00	0.03	0.02	0.02	0.02
	(1.29)	(0.18)	(0.29)	(0.01)	(0.77)	(0.18)	(1.05)	(0.31)
Constant	0.37*	0.33	0.20**	0.29	0.23	0.24	0.13	0.30
	(2.33)	(1.12)	(1.97)	(1.32)	(1.20)	(0.71)	(1.13)	(1.25)
Fixed effects *i*	no	yes	no	yes	no	yes	No	Yes
Fixed effects *i*	no	yes	no	yes	no	yes	No	Yes
Observations	227	227	227	227	227	227	227	227
R-squared	0.10	0.24	0.05	0.18	0.03	0.26	0.03	0.20

The dependent variable is the loading coefficient obtained from an estimate of equation (2). Weights are the inverse of the variances of equation (2). See main text and Slaughter (2001) for details on the construction of these weights. *i* = reporting country, *j* = recipient country. ◊ Variable drops out because of collinearity when country fixed effects are included. Robust *t*-statistics in brackets.

In these regressions, we have to take into consideration that the dependent variable is estimated with some degree of imprecision. We follow Slaughter (2001) in first running our equation of interest using OLS. We then use the squared residuals from this equation as the dependent variable in an equation using estimated variances of α_{ij}, squared variances, and

cubed variances as regressors. From this regression, we construct the predicted values, and we use the inverse of the predicted values as weights in our original regression equation.

We report different specifications, including and excluding country fixed effects and using weighted and unweighted regressions. Not all of the results are robust across specifications, but there is some evidence that the impact of domestic market size is negative for foreign assets. This would indicate that cross-border assets and liabilities of large countries are less persistent (i.e. an increase in domestic GDP lowers α_1 in absolute terms, bringing it closer to zero). There is weak evidence for a negative impact of distance. Hence, larger distances – which can be taken as an indication for a lower degree of integration of markets and a greater degree of unfamiliarity – make adjustment to a new equilibrium faster.

The impact of recipient country risk differs for foreign assets and liabilities. Note that a higher index indicates that countries are less risky. Hence, finding a positive coefficient would imply that lower country risk makes the adjustment to a new equilibrium slower. As country risk declines, the speed of adjustment of foreign liabilities increases, and the speed of adjustment of foreign assets decreases. In other words, banks from less risky home countries hold more persistent foreign asset positions but less persistent foreign liability positions abroad.

6. Summary

Using new data on bilateral assets and liabilities of banks of ten BIS reporting countries vis-à-vis the OECD area, this paper has focused on three questions. First, what are the long-run determinants of international portfolio choices? Second, how do banks' international portfolios adjust to short-run macroeconomic developments? Third, does convergence to the long-run equilibrium change with the degree of financial integration?

Our empirical model proceeds in three steps, using panel cointegration techniques. First, we test for the presence of unit roots, which we cannot reject. Second, we test for the presence of cointegration relationships between banks' cross-border assets and liabilities and macroeconomic variables, and we estimate the long-run cointegration parameters. In a third step, we estimate heterogeneous short-run dynamics and adjustment coefficients, conditioned on the homogeneous long-run parameter restrictions.

Our research has five main findings.

First, banks' cross-border assets and liabilities and macroeconomic variables are cointegrated. The most robust results are that banks hold larger assets and liabilities in larger foreign markets. An increase in the interest rate differential between the home and the foreign economy increases cross-border assets and lowers cross-border liabilities. This result is inconsistent with a simple arbitrage model.

Second, within the Euro Area, we find a positive effect of the interest rate differential on both cross-border assets and cross-border liabilities. Unobserved exchange rate expectations can thus not explain the difference between our findings and the predictions of baseline arbitrage models.

Third, our findings are robust against including measures of bilateral trade. We confirm that banks' cross-border activities are significantly and in most cases positively related to foreign trade. The main exceptions are international financial centres, for which we find some evidence for negative links between trade and banks' cross-border assets and liabilities.

Fourth, determinants of assets and liabilities vis-à-vis banks and non-banks differ. Our model performs much better in terms of explaining the linkages between banks and non-banks than those between banks. For the full sample, results for the return proxies are also more in line with expectations for assets and liabilities vis-à-vis non-banks. For the Euro Area sub-sample, in contrast, return proxies have the expected signs for the interbank linkages.

Fifth, there is a large degree of heterogeneity across countries, both with regard to the long-run determinants of banks' international portfolios and the short-run dynamics. Geographic distance, country risk, and market size explain some of the cross-country differences in the speed of adjustment to a new equilibrium.

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Data Appendix

Cross-border assets and liabilities: Data on banks' international portfolios are taken from the Locational Statistics of the BIS. They cover worldwide international on-balance sheet assets and liabilities of BIS reporting banks, including international positions of banks' head offices in the source countries and all offices at home and abroad, in millions of US Dollars. The data are defined as in Tables 2A, 2B, 3A, and 3B of the BIS Quarterly Review. Unpublished bilateral data have kindly been provided by the Statistics Department of the BIS. Over time, several changes to the reporting limits and the country coverage have been made. However, the effects of these changes on the data we use and for the country pairs that are included are minor. The regression results are based on a balanced panel of observations for the quarters 1995:4 through 2005:4 and a total of 221 country pairs.

Exchange rates: Bilateral exchange rates are in price quotation and are calculated using exchange rate series given in national currency against the US Dollar, provided by Datastream. Exchange rates of members of the European Monetary Union are expressed in the former national currency versus the US Dollar by multiplying the exchange rate of the Euro versus the US Dollar with the official conversion rate of the respective EMU member country.

Gross domestic product (GDP): Seasonally adjusted data as provided by the OECD, in millions of US Dollars. Due to the lack of availability or short length of the time-series, seasonally unadjusted data have been used for Iceland, Luxembourg, Mexico, Poland, Sweden, Turkey, and Hong Kong SAR, with this last GDP taken from national sources as reported by Datastream. Data for the Netherlands were taken from the International Financial Statistics (IMF (2006)).

Interest rates: For most countries, we use a monthly average of the three-month interbank offered rate as reported by Datastream. We take 90-day certificates of deposit for Japan, Korea, and the United States and treasury bills with the same maturity for Australia, Canada, Hungary, Iceland, New Zealand, and Sweden. The interest rate series for Luxembourg was taken from Belgium.

Prices: Represented by each country's consumer price index taken from Datastream.

Trade: Bilateral trade data are taken from "Direction of Trade Statistics" (DOTS) of the International Monetary Fund. Data are denominated in US Dollars. Because data for Belgium are only available since 1997 and only the total value of exports and imports for Belgium and Luxembourg together is available before that date, we assign 90 percent of these values to Belgium's exports and imports for the missing observations.

All data have been seasonally adjusted using the US Census Bureau's X12 seasonal adjustment procedure as implemented in *EViews*.

Hedge fund activity and carry trades

Chris Becker and Kristina Clifton*

Abstract

In recent years, hedge funds have been increasingly active in carry trades, which typically involve considerable exposure to exchange rate movements. The lack of available data leads us to use less direct sources such as international bank lending data from the Bank for International Settlements (BIS) to infer some broad conclusions about recent developments related to hedge fund activities and carry trades. We find that the interest earnings of such trades have narrowed noticeably and have become inherently more risky. The unwinding of existing positions could prove to be disruptive for financial markets and appears to have contributed to volatility in currencies which are the destination for borrowed funds as well as the funding currencies themselves.

1. Introduction

Following a period of relative stability from 1980 to 1995, gross international capital mobility began to increase considerably relative to world output. While a number of distinct cycles around this general upward trend are evident, the most recent upswing in international capital movements is characterised by acceleration in bank lending and debt-related flows (Figure 1).[1]

The acceleration in debt-related flows is probably associated with the much discussed accumulation of reserve assets by countries in Asia and oil exporting countries, but the sharp rise in cross-border bank lending has received somewhat less attention. In part, these developments reflect opportunities brought about by unusually low nominal and real interest rates, as well as robust world economic growth in recent years. This has encouraged a greater degree of leverage and risk taking, reflected in the sharp rise in bank and money market capital flows. One example of these flows is the proliferation of carry trades, where funds are borrowed in low interest rate countries, such as Japan and Switzerland, and invested in markets where returns are higher, such as Australia, New Zealand, and a number of less developed countries.

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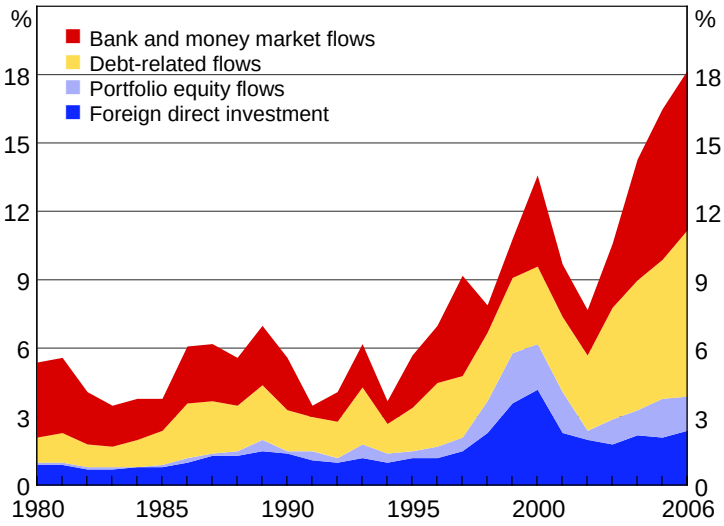
* International Department, Reserve Bank of Australia. This paper combines the work presented in several internal analytical pieces prepared by Chris Becker, Daniel Fabbro, Michael Howes, Kristina Clifton, Arlene Wong, and Michael Plumb of the Reserve Bank of Australia's International Department. We are grateful to Guy Debelle for his insightful comments. Any remaining errors are our own. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Reserve Bank of Australia. Corresponding author: Chris Becker, email: beckerc@rba.gov.au.

1 Recent developments in global capital flows are discussed in Battellino (2006).

Figure 1

Gross International Capital Movements

Per cent of world GDP



Sources: IMF; RBA estimates.

Hedge funds have been very active in carry trades and more generally foreign exchange as an asset class in recent years, as the opportunities in more traditional markets were curtailed by compressed volatility and generally low returns. While there is little direct data available on the activities of hedge funds, we use bank lending data published by the BIS to supplement information from Hedge Fund Research for the purpose of this paper.

Several aspects of hedge fund activities may be of interest to policy makers. If it is correct that carry trades have been an important driver of cross-border bank lending, then a considerable portion of open positions currently in place are likely to have a greater than usual exposure to exchange rate fluctuations. As highly leveraged speculative positions can be more prone to sudden reversals than more fundamentally based investments, these might have a range of undesirable financial market and systemic consequences. The risks surrounding such outcomes are partly related to the prospects for theoretically appealing relationships such as uncovered interest parity to re-exert themselves.

In this paper we bring together several data sources to gauge the current state of the hedge fund industry and focus particularly on some of the issues surrounding carry trade activities. The remainder of the paper is organised in the following way. Section 2 provides some background on the hedge fund industry. We briefly highlight recent growth in investor capital and leverage. Section 3 uses data from the BIS to estimate the carry a hedge fund borrowing in low interest rate countries is able to earn when investing in Australian and New Zealand fixed income. Section 4 raises some considerations with respect to exchange rate implications that may arise. Finally, Section 5 offers some brief concluding remarks. An appendix discusses how carry trades may be financed through derivatives.

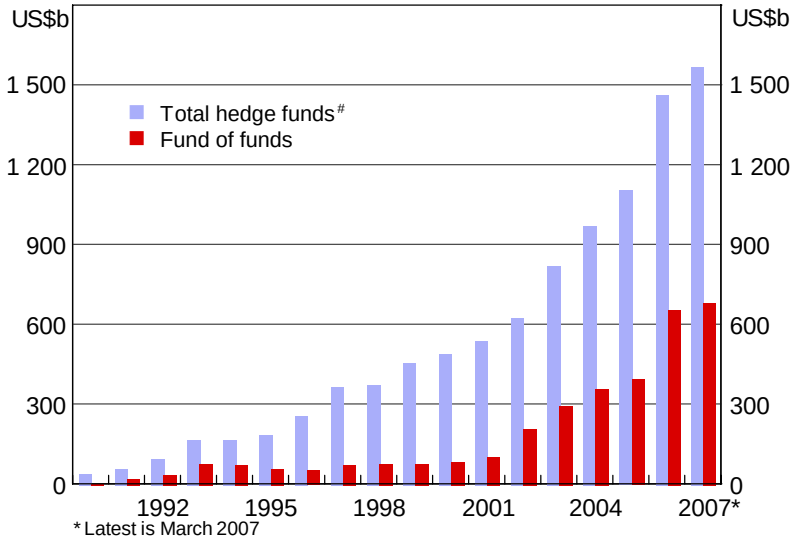
2. Recent developments in the hedge fund industry

Special purpose vehicles and hedge funds often locate themselves in offshore banking centres.[2] This is partly why reliable information about their activities is difficult to obtain, complicating the monitoring and regulation of the industry. As a result, indirect information is generally used for the most up-to-date indications of hedge fund activity. In the sections below, we use international bank lending data from the BIS to supplement data from Hedge Fund Research to make a number of broad analytical points about the industry.

2.1 Growth in the hedge fund industry

While hedge funds' capital under management (ie investor capital) remains modest in comparison with the more traditional investment vehicles, such as pension and mutual funds, the comparatively active trading style of some funds and their extensive use of leverage has meant that their market impact can be important.[3] As systemically important institutions are the counterparties to hedge fund transactions, the industry's activities also pose questions related to financial stability. Particularly strong growth in hedge fund capital under management has occurred in recent years. Investor capital has increased almost threefold between 2002 and March 2007, to well over US$1½ trillion. This has been accompanied by strong growth in 'fund of funds', which now account for around one-third of total hedge fund capital (Figure 2).

Figure 2
Hedge Fund Investor Capital



* Latest is March 2007
# Adjusted for Fund of funds double counting
Source: HFR Industry Reports

Solid net investor inflows from 2002 to 2004 may partly be a reflection of the global 'search for yield' over this period.[4] The view that investments in hedge funds can provide diversification benefits to more traditional portfolios also appears to have become more

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[2] Hedge Fund Research data indicate that in mid-2006 around one-third of hedge funds were registered in the United States, with most of the remaining two-thirds domiciled in offshore banking centres.

[3] The Securities and Exchange Commission (SEC) in the United States recognised as far back as the late 1960s that hedge funds 'may raise special concerns with respect to their impact on securities markets' (see SEC (2003)).

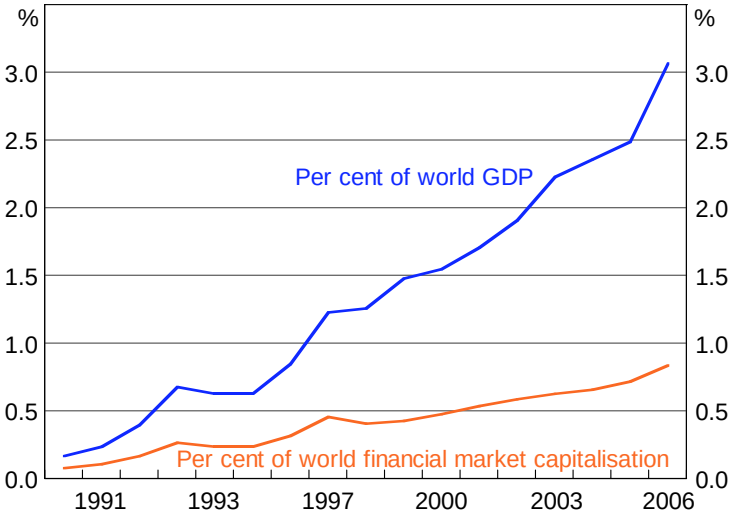
[4] See also RBA (2005).

widespread, supporting the acceptance of hedge funds as a more mainstream investment. This is demonstrated by the substantial increase in the proportion of major global investors adding hedge fund investments to their portfolios.[5] However, re-invested returns have contributed the largest proportion to the increase in investor capital since 2002.

There has also been strong growth in the number of hedge funds, with little noticeable change in the average fund size since the late 1990s despite strong growth in investor capital. In part, this is likely to be the result of 'closed end funds' that place limits on the investor capital that is accepted. The fragmentation of the industry has meant that there are probably fewer very large funds in operation than was the case 10 years ago. Insofar as it may be undesirable to have individual funds exert considerable influence over market prices, the average size of funds would appear to be less of an issue. Also, while the industry has become more important over the past 15 years, its investor capital remains less than one per cent of the total value of the world's financial markets (Figure 3).[6] While this may suggest that the actions of individual funds are somewhat less of a concern, it may still be a problem that groups of smaller funds follow similar investment models and thus act collectively – even if not collusively.

Figure 3

Hedge Fund Investor Capital



Sources: BIS, HFR Industry Reports, IMF, World Federation of Exchanges

In fact, however, over time the investment strategies of hedge funds appear to have become more diverse (Table 1). The outright importance of macro and equity non-hedge investment strategies has declined over time as mandates centring on equity hedge, event driven, and relative value arbitrage have become more prominent.[7] Nonetheless, the size of leverage, the dominance of hedge funds in the market for certain financial instruments (eg credit default swaps), and the link across strategies provided by the emergence of fund of funds complicate the analysis. If, for example, fund of funds were to only invest in managers pursuing macro strategies, then the importance of those strategies would not have changed as noticeably over the past decade.

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[5] See for example the Russell Survey on Alternative Investing, comprising data from 327 pension funds, endowments, and other tax-exempt institutions (Russell (2006)).

[6] The size of world financial markets is defined here by the total market value of government, corporate, and international bonds on issue, market capitalisation of world equities, and the value of total credit outstanding.

[7] Appendix A briefly describes what each of these strategies purports to achieve.

Table 1

Hedge Fund Investor Capital by Strategy

Percentage of total investor capital

	1996	2006
Equity hedge	7.3	27.9
Event driven	4.6	13.2
Relative value arbitrage	1.5	12.9
Macro	53.3	11.6
Fixed income	5.7	8.1
Sector	1.1	5.2
Distressed securities	1.3	4.8
Equity non-hedge	12.0	4.0
Emerging markets	8.0	4.3
Convertible arbitrage	0.5	3.1
Equity market neutral	1.6	2.5
Merger arbitrage	0.6	1.5
Market timing	0.6	0.3
Short selling	0.2	0.3
Regulation D	0.1	0.2
Fund of funds	20.5	44.8

Memorandum items:

Total investor capital was US$257 billion in 1996 and US$1,465 billion in 2006.

Source: Hedge Fund Research.

2.2 Hedge fund leverage

Hedge funds generally use leverage to increase the return on the investor capital that they manage. While this strategy can multiply returns, it also multiplies risk by the same factor in the event that market prices move against the investment strategy. A hedge fund can achieve leverage in two main ways. The first is by borrowing outright, which is often known as 'on-balance sheet' leverage. The second is by using derivatives and other financial instruments to obtain exposure to an asset for a smaller outlay than the value of that asset, often referred to as 'off-balance sheet' leverage (eg margin and futures trading).

Leverage is an important consideration when monitoring hedge fund activities for two main reasons. The first is that leverage increases the funds available for investment. Given the rapid growth in investor capital available to hedge funds, additional borrowing raises the potential market impact that positions could have. This is not to say that leveraged hedge fund investment would always and everywhere constitute a reason for concern. Secondly, since hedge funds may at times pursue very aggressive strategies to maximise profits (ie alpha) this may involve very high gearing ratios that expose funds to market movements that impose substantial losses. The concern here lies less with preventing a given fund from becoming insolvent, but rather with the deleterious impact that may be suffered by counterparties. Since systemically important organisations that fall within the net of prudential oversight are often the prime brokers or lenders to hedge funds, this issue is important from a financial stability perspective.

The use of leverage by hedge funds has attracted particular attention since the collapse of Long Term Capital Management (LTCM). In early 1998 LTCM had investor capital of US$4.7 billion, direct borrowings of US$129 billion, and off-balance sheet derivatives positions mainly in fixed income instruments with a notional value of US$1,250 billion. By late 1998, LTCM had lost US$4.6 billion in capital in the wake of the Russian debt default as this sudden unforeseen event drove market prices sharply against their outstanding positions. The high leverage of the fund was a key factor in its demise. Highlighting the broader systemic implications of the distressed fund, the Federal Reserve stepped in to mediate an organised dissolution of the fund between LTCM's counterparties and prime brokers.

2.2.1 Evidence of stricter lending practices

Research by the BIS provides comprehensive estimates of total leverage of a subset of hedge funds.[8] The authors suggest their estimates of leverage to be most useful as a guide to trends in leverage over time rather than as a measure of actual levels, and conclude that leverage tended to be highest around 1997—98 but is now noticeably lower. These findings are consistent with reports that prime brokers required hedge funds to provide more collateral and imposed more stringent disclosure requirements starting in the late 1990s.[9] The lengthening in the maturity profile of lending to offshore banking centres where hedge funds are prominent lends further support to the view that lending practices have become more discerning.

2.2.2 Maturity profile of leverage

Further useful information is to be gained by examining the maturity profile of the claims reported by the BIS. Since the mid—1990s, the maturity of borrowings has lengthened somewhat.[10] While around 60 per cent of claims were of a maturity of only up to and including one year in 1996, this share declined to less than 50 per cent at the beginning of 2006 (Figure 4). Notably, the shift did not occur gradually over time, but relatively quickly in 1998–99.

It seems feasible that the end of financial turbulence following the Asian financial crisis and Russian debt default, which also coincides with the prominent failure of LTCM, contributed to this change. This may be because the more aggressive funds exited the industry, thereby changing the composition of finance, or that the investment behaviour of the industry changed for one reason or another. An important factor may also have been the tightening of lending criteria at around that time.

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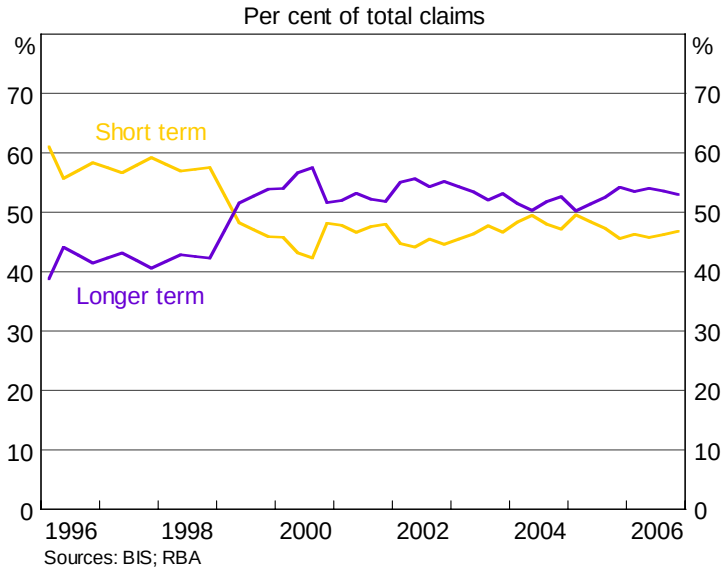
[8] See McGuire et al (2005).

[9] Lenders would usually assess their potential exposure to hedge funds by calculating value at risk (VaR) for a typical period of 10 days, and set loss limits with a confidence interval of between 95 per cent and 99 per cent. Margin limits may also apply depending on factors such as liquidity, concentrations and how positions relate to the prime broker's overall book. As funds engaged in fixed interest tend to have more counterparties to deal with, collateral arrangements may only cover losses at the 95 per cent interval. On the other hand, it would not be uncommon for prime brokers, who are typically more involved with equity markets, to maintain less than a one per cent uncollateralised exposure. For a more detailed description, refer to IMF (2004).

[10] The BIS report maturity as (i) less than or equal to one year, (ii) greater than one year but less than or equal to two years, and (iii) greater than two years. We apportion the sizable 'unallocated' component equally among the three categories and define 'short-term' as being loans with maturity of less than or equal to one year. All remaining claims are deemed to be 'longer-term'.

Figure 4
Banks' Foreign Claims on Offshore Centres



2.2.3 Indirect measures of on-balance sheet leverage

Given the scarcity of data relating to the notional value of derivatives outstanding, it is very difficult to make sensible estimates of the likely extent of off-balance sheet leverage at the disposal of hedge funds (Appendix B discusses the relationship between Japanese banks' derivatives and financing of carry trades). However, the foreign claims of BIS reporting banks on offshore banking centres can be used as a broad indication of the on-balance sheet leverage of hedge funds.[11] The main countries' lending to areas where hedge funds are domiciled accelerated sharply at the beginning of 2004 (Figure 5).[12]

To put this into context, bank lending to Caribbean and European offshore banking centres increased by around US$370 billion, from US$880 billion to US$1,247 billion between 2004 and 2006 (Table 2). Alternatively, this can be thought of as lending to hedge funds at an average annualised rate exceeding 25 per cent. At this rapid rate, the claims of BIS reporting banks on offshore centres increased in importance to the total foreign claims of these banks. In 2004 claims on offshore centres were around 4½ per cent of total claims, but this share had risen to 5½ per cent by the beginning of 2006.

[11] While it is true that direct lending to hedge funds is best captured by the non-bank segment, it is also likely that some lending to banks in offshore centres is then channelled into hedge funds. As a result, we do not make a distinction between lending to banks and non-banks for the purpose of this paper. A detailed discussion of institutions domiciled in offshore centres and their activities is given in Dixon (2001).

[12] Note that we convert the BIS data from US dollars into Special Drawing Rights (SDR) to avoid possible distortions emanating from trends in the US dollar. Given the pronounced weakness in the US dollar over 2003, the point of inflection shown would be shifted forward in time to early 2003.

Figure 5

Banks' Foreign Claims on Offshore Centres

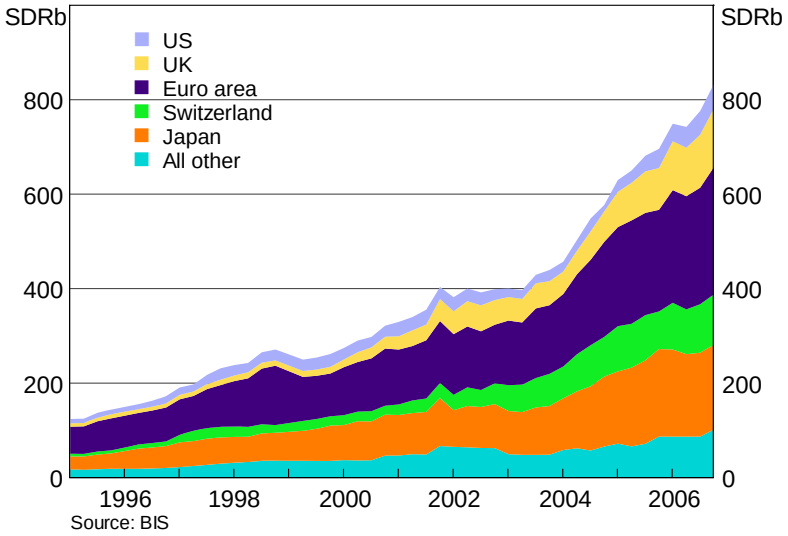


Table 2

BIS Banks' Foreign Claims on Offshore Banking Centres

US$ billion

	March 2004	**December 2006**
Euro area	306.8	402.9
Japan	225.0	267.7
Switzerland	127.5	159.6
United Kingdom	97.6	184.9
United States	20.6	77.4
Other banks' claims	102.4	154.2
Total	**880.0**	**1,246.8**

Memorandum items:

Offshore banking centres are defined here to encompass Aruba, Bahamas, Bermuda, Cayman Islands, Netherland Antilles, Panama, West Indies UK, Gibraltar, Guernsey, Isle of Man, and Jersey. These figures therefore exclude foreign claims on Hong Kong SAR and Singapore, which together amounted to US$546 billion in December 2006. Also excluded are the much smaller centres of Lebanon, Macau SAR, Mauritius, Samoa, Singapore, and Vanuatu.

Source: Hedge Fund Research.

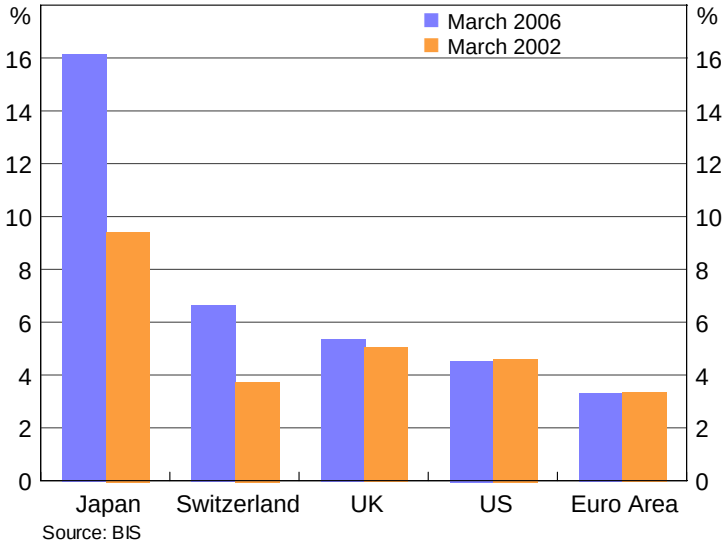
Notwithstanding that there have been large increases in lending to offshore centres from banks located in the euro area, the United Kingdom and the United States, this lending does not represent an increase in the relative importance of hedge fund financing for these countries (Figure 6). That is, overall cross-border lending by banks has grown at the same rate as lending to offshore banking centres. Only for Japan and Switzerland has lending to offshore banking centres gained a significantly more prominent share of total cross-border lending undertaken by banks in those countries.

We infer from the unusually low policy and lending rates that have persisted in Japan and Switzerland for some time that these findings are to be expected. Furthermore, these data are consistent with sizable carry trades financed by borrowing in Japanese yen and Swiss francs.[13]

Figure 6

Share of Foreign Claims Accounted for by Offshore Banking Centres

Percentage of total foreign claims



Source: BIS

2.2.4 Investor capital and leverage

The data available from Hedge Fund Research on the investor capital of offshore hedge funds provides a close approximation of the subset of funds not domiciled in the United States, for which BIS lending data is available.[14] The contribution made by using this data is to provide an approximation of the actual level of on-balance sheet leverage. Thereby we also derive a better calibration of the size of positions held by hedge funds.

Figure 7 shows lending to offshore banking centres and offshore hedge funds' investor capital. There is some evidence to suggest that leverage expands broadly in line with investor capital, with the ratio of total borrowings to total investor capital little changed since the mid—1990s. However, it is instructive to note that this ratio tended to be around the highest in 1997 and 1998, which is similar to the findings of the BIS in McGuire et al (2005).

Together, the bank lending figures and investor capital of offshore hedge funds provide a conservative estimate of the total funds invested by offshore hedge funds. As at the end of 2006 this figure was over US$2 trillion, showing that offshore hedge funds were investing in assets far in excess of their investor capital of US$1,150 billion at that time. Taking into account that additional funds are domiciled in the United States, and the industry's aggressive use of off-balance sheet leverage, the total positions managed by hedge funds is likely to exceed these estimates substantially.

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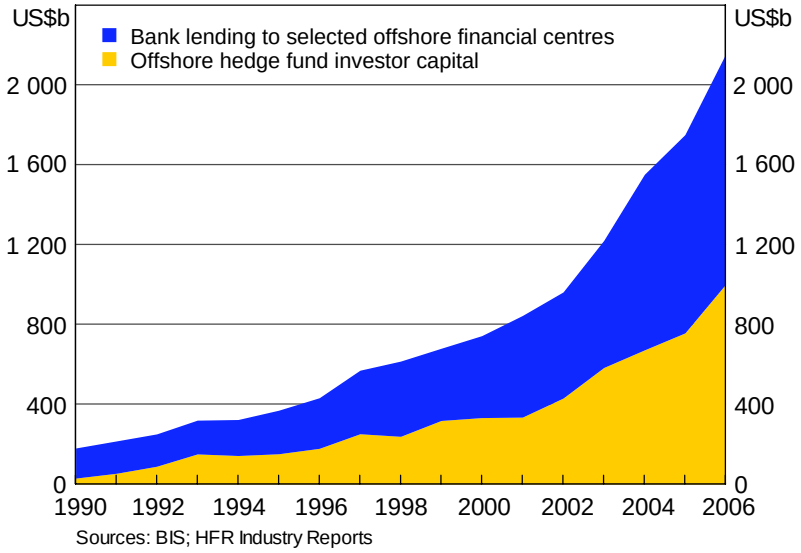
[13] Lending by banks not domiciled in Japan or Switzerland, but denominated in yen and francs, strengthens this result.

[14] A little under 90 per cent of these funds are domiciled in the same set of countries as the offshore banking centres from the BIS dataset.

Figure 7
Offshore Hedge Fund Capital and Leverage



Sources: BIS; HFR Industry Reports

3. The cost of finance and carry trade activity

Given that little information is available on carry trade-related capital movements, we attempt to calculate some of the key decision variables to gain an understanding of hedge fund behaviour. This is of particular interest as the profitability of carry trades directly violates the theoretical underpinnings of uncovered interest parity (UIP).

3.1 Calculating the cost of finance

Using the BIS data on the value and maturity of Japanese and Swiss bank claims on the Cayman Islands, we construct a weighted average cost at which hedge funds may finance carry trades.[15] We restrict the exercise to Japan and Switzerland since the increase in their lending to offshore banking centres has increased noticeably as a share of their total international claims. Furthermore, we are more confident that their lending to offshore centres is largely denominated in their local currency (ie yen and francs) given their low

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[15] The simple arithmetic for this calculation is given by: $i_t = \sum_j \beta_t^j \left[\alpha_t S_t^j + (1-\alpha) L_t^j\right]$

where:

i_t = the weighted average rate at which banks in Japan and Switzerland lend to hedge funds in the Cayman Islands at time t.

j = the two financing countries, Japan and Switzerland.

β_t^j = country j's share in total lending to the Cayman Islands by Japan and Switzerland at time t.

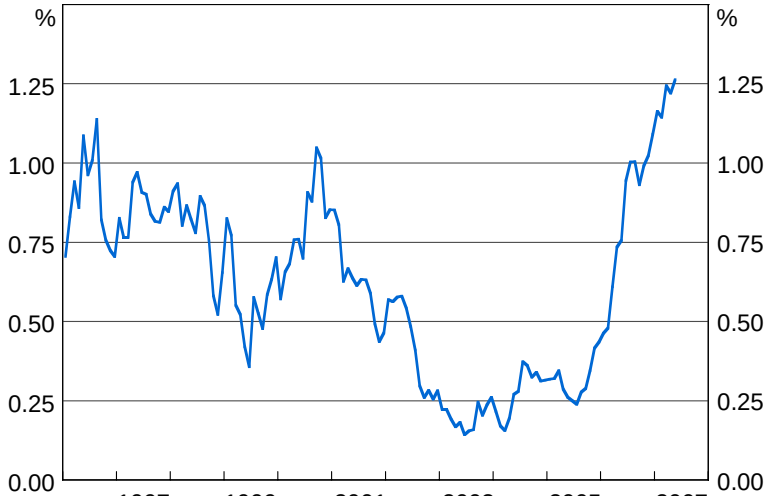
α_t = the share of total claims on the Cayman Islands that is short-term (ie less than one year).

S_t^j = a representative short-term interest rate (three-month) for country j at time t.

L_t^j = a representative long-term interest rate (two-year) for country j at time t.

interest rates compared with other countries in recent years. While banks in Europe and the United States have also substantially increased their lending to hedge funds, we are less certain of the currency denomination of that lending. The weighted average rate at which banks in Japan and Switzerland lend to borrowers in the Cayman Islands is shown in Figure 8.

Figure 8
Hedge Fund Financing Cost



Sources: BIS; Thomson Financial; RBA

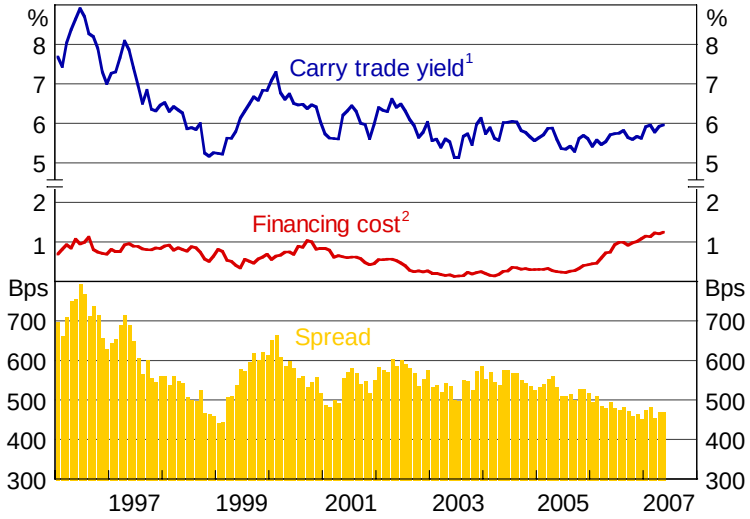
After fluctuating between ¾ to 1 per cent in the mid-1990s, interest rates began to decline in 1998—99, before rising back to 1 per cent in late 2000. From then, a gradual fall in interest rates began that saw a trough below 0.2 per cent in mid-2003. In 2004 and into 2005, average interest rates in Japan and Switzerland remained unusually low at around ¼ of one percentage point. Following the general pick up in economic activity and to a lesser extent inflation over the last two years, central banks in Japan and Switzerland began to normalise policy rates, leading to the gradual increase in rates observed to date. Accordingly, the financing cost faced by hedge funds has now risen above 1¼ per cent for the first time in more than a decade.

3.2 Carry against Australia and New Zealand

Given the resilience of the Australian and New Zealand economies to the global downturn in this cycle, interest rates in these countries were not cut to the unusually low levels that prevailed in other industrialised countries. As a result, Australia, New Zealand, and a number of less developed countries were natural destinations for carry trade investments over recent years. To calculate a yield that hedge funds may have earned on carry trades, we take the unweighted average of 10-year government bond yields in Australia and New Zealand.[16] This carry trade yield and the associated financing cost, along with the corresponding spread (ie the 'carry') are presented in Figure 9.

[16] The resulting spread includes the duration risk implicit from borrowing at the short end of the yield curve to finance investment at the long end. While this may have important implications for the investment, we leave these aside for the purposes of this paper.

Figure 9
Carry Trade



1. Average of Australian and NZ long-term yields
2. Average of Japanese and Swiss funding rates
Sources: BIS; RBA; Thomson Financial

In the second half of the 1990s, the carry was primarily driven by developments in the yield that could be earned rather than the cost of finance. However, the persistent decline in the financing cost began to boost returns from around 2001. Most notable is that since mid-2005 the carry has fallen significantly, not because of a decline in the yields earned, but mainly because the financing cost has risen considerably.

4. Exchange rate considerations

An important aspect of the nature of carry trades is that the foreign currency exposure resulting from raising a liability in one currency to fund an investment in another is either not hedged at all against exchange rate changes, or hedged less than the usual cross-border debt exposure.[17] As a result, the risk to carry trade positions implied by exchange rate changes is substantial and can vary significantly over time. This risk is amplified further by the high degree of leverage employed by hedge funds, which can mean that even a small narrowing in spreads or exchange rate movements will trigger margin calls. Conversely, the capital flows associated with substantial carry trade positions can have important implications for exchange rates themselves.

4.1 Carry trade exposure to exchange rate changes

Persistent interest rate differentials are not competed away by the free movement of capital between the countries in question – not even in the long term. However, this observation is insufficient to explain the ex ante expectation that carry trades would be profitable. That is, if we subscribe to the theoretical idea of UIP, where interest rate differentials can only persist if

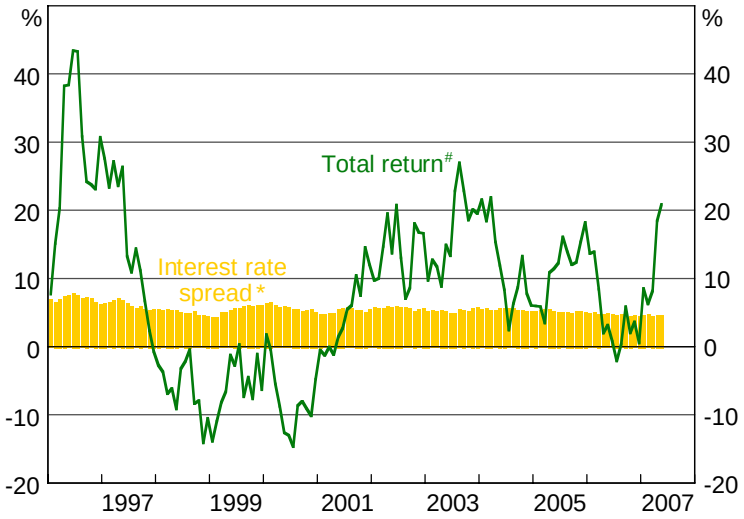
[17] Fully hedging the foreign exchange exposure would involve giving up the carry earned on the debt investment. For a detailed explanation of foreign exchange hedging practices and exposures, see Becker and Fabbro (2006).

expected exchange rate changes offset them fully, then carry trades should not be profitable.[18]

Part of the explanation of why investors continue to pursue carry trades may be that there is a very wide dispersion of expectations about the direction, timing and magnitude of exchange rate changes. Short- to medium-term deviations from UIP may therefore give rise to the capital flows that seek to profit from the combination of interest rate and exchange rate movements. Interestingly, unhedged capital flows from low to high interest rate countries place upward pressure on the exchange rate of the high interest rate country. Once again, this is in direct conflict with UIP, where interest rate differentials are often interpreted as an indication of expected depreciation in the high interest rate country's exchange rate.[19] The 2003 experience in the Australian and New Zealand dollars provides a convenient example of the violation of UIP (Figure 10). While there was a large interest rate differential favouring Australia and New Zealand over Japan and Switzerland, and UIP would predict either for that differential to be competed away or for the high interest rate currencies to depreciate against the low interest rate currencies, neither happened. The interest rate differential of around 5 percentage points in 2003 was further supplemented by the appreciation of the Australian and New Zealand dollars of around 15 per cent. In that year carry trades were very profitable and UIP failed.

More recently, notwithstanding the ongoing narrowing in interest rate differentials, carry trades have again become very profitable due to weakness in the Japanese yen and strength in the Australian and New Zealand dollars. As the speculative positions of traders get longer in these currencies, their value continues to move against UIP.

Figure 10
Carry Trade Returns



* Spread between rates in Japan and Switzerland to rates in Australia and New Zealand
# Interest rate spread plus annualised return on A$ and NZ$ vis-à-vis JPY and CHF
Sources: RBA; Thomson Financial

[18] As a reminder, UIP postulates that the domestic interest rate is equal to the foreign interest rate adjusted for expected exchange rate changes ($i^d = i^* + \Delta s^e$).

[19] Refer to Plantin and Shin (2006) for a detailed examination of how asset prices whose value is sensitive to the flow of funds into the market may be driven further away from fundamentals.

However, because hedge funds characteristically employ a very active management style for their leveraged investments, a number of other considerations affect their carry trade decisions. Thus, while it is likely that there will be persistent interest rate differentials between countries like Australia and Japan, the attractiveness of a carry trade opportunity will diminish as the total return declines. Therefore, carry trade activity will be sensitive to 'changes' in the rate of return, as well as the return itself. As a result, those hedge funds whose investments are most sensitive to returns will commence the unwinding of their carry trade positions as total returns begin to narrow.

Narrowing returns and increased exchange rate volatility in the past 12 months have seen risks begin to move against carry trades. In order to gauge the risk exposure of hedge funds to exchange rate movements, the average absolute percentage change of a number of currencies against the Japanese yen, one of the main funding currencies, is shown in Table 3.

Table 3

Volatility of the Japanese Yen

Average absolute percentage change, 1995 to 2005

	Daily	Monthly	Quarterly	Yearly
A$ per Yen	0.6	2.9	5.4	9.9
NZ$ per Yen	0.6	2.8	5.3	12.0
US$ per Yen	0.5	2.5	4.8	9.6

Sources: RBA and Reuters.

The current 'annualised' carry calculated earlier is around 4¾ percentage points. Since the Japanese yen moves half of one percentage point over an average day, this annualised return could be offset by the exchange rate in just 10 days if the yen were to gather upward momentum. Even if there is no strong uptrend in the yen, within the scope of the average month exchange rate movements can substantially reduce the profitability of an existing position. However, the importance of volatility has some notable asymmetric characteristics. While funds are probably willing to tolerate rising volatility around a trend in the exchange rate that moves in their favour, they are more likely to be constrained by volatility at times when UIP is widely expected to reassert itself.

4.2 Carry trades as a source of exchange rate changes

While hedge funds have an exposure to exchange rate variations, their positions in themselves are at times sufficiently large to cause volatility in foreign exchange markets. This is usually most evident when substantial positions that have built up over a period of time are reversed quickly. This may come about when aforementioned unfavourable exchange rate or interest rate changes trigger some repatriation of investments. Since these flows tend to further push the exchange rate against the profitability of carry trades, they often trigger additional liquidations, and so on. Another reason for such reversals may be an event that triggers a bout of general risk aversion. In such situations, the unruly unwinding of positions by speculative accounts may result in or exacerbate undesirable financial market volatility.

In March 2006, this type of scenario appeared to play out as hedge funds reversed substantial carry trade positions. The New Zealand dollar, Icelandic krona, and the

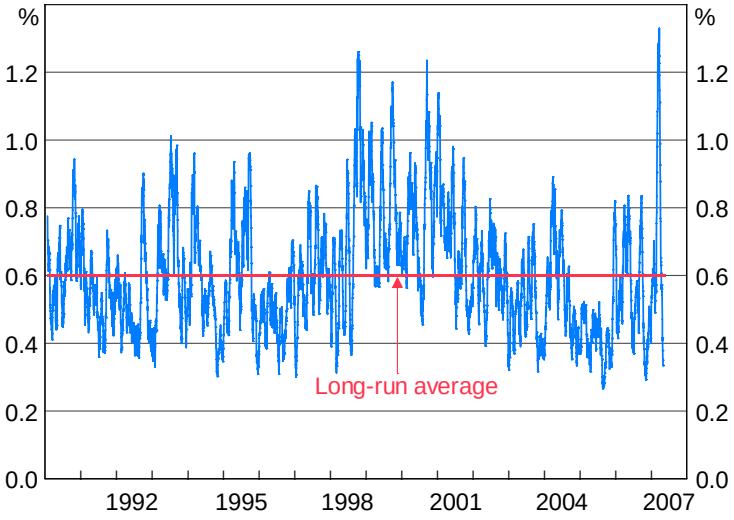
currencies of a number of less developed countries were most affected.[20] Since these currencies are significantly less liquid than the major six currencies in the world, the movements were further exacerbated.[21] Exchange rate volatility therefore represents an important risk for the profitability of carry trades, and in turn the large international capital movements involved also have implications for exchange rate volatility itself.

The evolution of volatility in the New Zealand dollar over recent years is therefore likely to be at least in part due to capital flows that seek the higher rate of return of local debt instruments. Following a period of below average volatility in 2004 and 2005, the New Zealand dollar began to fluctuate more widely against the Japanese yen (Figure 11). Around this time, it was evident that speculative activity was playing an important part in dictating the direction of the exchange rate.[22] The gross turnover in capital flows at around this time was large relative to the size of the New Zealand market, and caused some significant exchange rate movements.

Figure 11

NZ$ per Yen Volatility

Daily absolute percentage change, 22-day rolling average



Source: RBA

At around the same time, volatility in the Australian dollar against the Japanese yen began to rise from its lows to more normal levels. However, there is less evidence of significant or persistent volatility (Figure 12). Perhaps the Australian dollar's high liquidity in global foreign exchange markets was among a number of mitigating factors.[23]

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[20] For a description, see RBA (2006).

[21] In order of importance, the major six currency pairs against the US dollar in 2004 were European euro, Japanese yen, United Kingdom pound sterling, Australian dollar, Swiss franc, and Canadian dollar. See also BIS (2005).

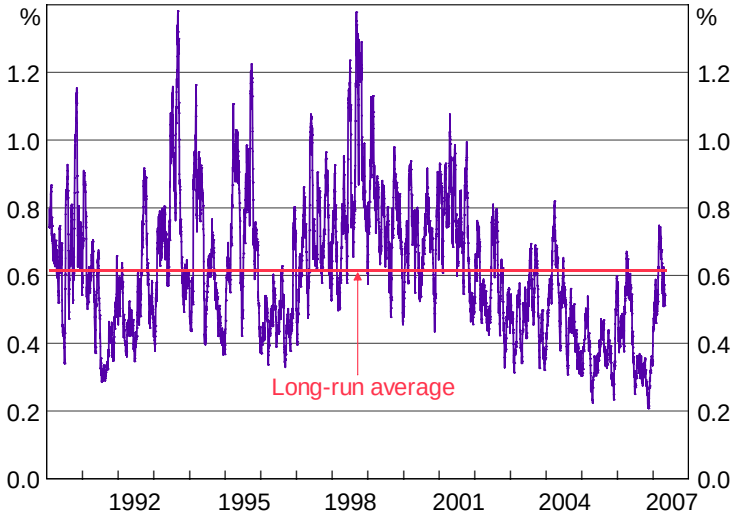
[22] In the case of New Zealand and Australia, the flow of unhedged retail investments from Japan into local currency denominated debt instruments ('uridashi') are also an important type of capital flow. However, since these funds are rarely borrowed, they are somewhat different to the carry trades discussed here.

[23] Importantly, the episode of volatility that followed in March 2007 was mainly driven by factors influencing the Japanese yen rather than the destination currencies. General risk retrenchment at around that time saw unwinding of carry trades that gave rise to volatility in the USD/JPY rate and the NZD/USD rate. The AUD/USD rate, on the other hand, remained relatively unaffected.

Figure 12

A$ per Yen Volatility

Daily absolute percentage change, 22-day rolling average



Source: RBA

Another important aspect of how the risk profile of carry trades has evolved concerns the implicit guarantees that were in place as a result of expansionary policies in some countries. This was especially the case in Japan. For domestic policy reasons, the Bank of Japan had long enunciated its commitment to maintaining the policy rate at zero to ensure an end to domestic deflation. This also ensured that the financing cost for carry trades was reliably tied to evidence that the Japanese economy was recovering. Furthermore, as the Japanese authorities undertook substantial exchange rate intervention to prevent the appreciation of the yen against the US dollar in 2003 and 2004, another guarantee had been put in place to mitigate the risk of entering into carry trades. For a while, carry trades financed in Japanese yen were almost a one-way bet as the authorities appeared to limit both the interest rate and currency risk. Both of these implicit guarantees have since been removed.

5. Conclusion

Narrowing returns on carry trades may make it increasingly difficult for highly leveraged hedge funds to sustain their current positions. As a result, the risk of an unruly unwinding of positions has risen. If this process is rapid or extensive enough, then it could cause some disruption to global financial markets.

Anecdotal evidence indicates that the unwinding of carry trade positions may have already had a significant impact on foreign exchange markets. Much of the depreciation seen in the Australian, New Zealand, and Icelandic currencies in March 2006 was directly related to this type of activity.

Appendix A: 'Hedge Fund Research' strategy groups

Convertible arbitrage – involves purchasing a portfolio of convertible securities, generally convertible bonds, and hedging a portion of the equity risk by selling short the underlying common stock.

Distressed securities – strategies invest in, and may sell short, the securities of companies where the security's price has been, or is expected to be, affected by a distressed situation. This may involve reorganisations, bankruptcies, distressed sales, and other corporate restructurings.

Emerging markets – funds invest in securities of companies or the sovereign debt of developing or emerging countries. Investments are primarily long. Emerging markets include countries in Latin America, Eastern Europe, the former Soviet Union, Africa, and parts of Asia.

Equity hedge – investing consists of a core holding of long equities hedged at all times with short sales of stocks and/or stock index options. Some managers maintain a substantial portion of assets within a hedged structure and commonly employ leverage. Conservative funds mitigate market risk by maintaining market exposure from zero to 100 per cent. Aggressive funds may magnify market risk by exceeding 100 per cent exposure and, in some instances, maintain a short exposure. In addition to equities, some funds may have limited assets invested in other types of securities.

Equity market neutral – investing seeks to profit by exploiting pricing inefficiencies between related equity securities, neutralising exposure to market risk by combining long and short positions.

Equity non-hedge – funds are predominately long equities although they have the ability to hedge with short sales of stocks and/or stock index options. These funds are commonly known as 'stock-pickers'. The important distinction between equity non-hedge funds and equity hedge funds is that equity non-hedge funds do not always have a hedge in place. In addition to equities, some funds may have limited assets invested in other types of securities.

Event-driven – is also known as 'corporate life cycle' investing. This involves investing in opportunities created by significant transactional events, such as spin-offs, mergers and acquisitions, bankruptcy reorganisations, recapitalisations, and share buybacks. Instruments include long and short common and preferred stocks, as well as debt securities and options.

Fixed income: arbitrage – a market neutral hedging strategy that seeks to profit by exploiting pricing inefficiencies between related fixed income securities while neutralising exposure to interest rate risk.

Fixed income: convertible bonds – these funds are primarily long only convertible bonds. Convertible bonds have both fixed income and equity characteristics.

Fixed income: diversified – these funds may invest in a variety of fixed income strategies. While many invest in multiple strategies, others may focus on a single strategy less followed by most fixed income hedge funds. Areas of focus include municipal bonds, corporate bonds, and global fixed income securities.

Fixed income: high-yield – these managers invest in non-investment grade debt. Objectives may range from high current income to acquisition of undervalued instruments. Emphasis is placed on assessing credit risk of the issuer.

Fixed income: mortgage-backed – these funds invest in mortgage-backed securities. Many funds focus solely on AAA-rated bonds.

Macro – involves investing by making leveraged bets on anticipated price movements of stock markets, interest rates, foreign exchange, and physical commodities. Macro managers employ a 'top-down' global approach, and may invest in any markets using any instruments

to participate in expected market movements. These movements may result from forecasted shifts in world economies, political fortunes, or global supply and demand for resources, both physical and financial.

Market timing – involves allocating assets among investments by switching into investments that appear to be beginning an uptrend, and switching out of investments that appear to be starting a downtrend. This primarily consists of switching between mutual funds and money markets. Typically, technical trend-following indicators are used to determine the direction of a fund and identify buy and sell signals.

Merger arbitrage – sometimes called risk arbitrage, involves investment in event-driven situations such as leveraged buy-outs, mergers, and hostile takeovers.

Regulation D – invest in Regulation D securities, sometimes referred to as structured discount convertibles. The securities are privately offered to the investment manager by companies in need of timely financing and the terms are negotiated. Once a deal is closed, there is a waiting period for the private share offering to be registered with the SEC. The manager can only convert into private shares and cannot trade them publicly during this period; therefore their investment is illiquid until it becomes registered. Managers will hedge with common stock until the registration becomes effective and then liquidate the position gradually.

Relative value arbitrage – attempts to take advantage of relative pricing discrepancies between instruments including equities, debt, options, and futures. Managers may use mathematical, fundamental, or technical analysis to determine misvaluations. Securities may be mispriced relative to the underlying security, related securities, groups of securities, or the overall market.

Source: **Hedge Fund Research**, 'HFR Industry Reports', *various issues*, www.hedgefundresearch.com.

Appendix B: A possible link between Japanese banks' balance sheets and derivatives-based financing of carry trades

As is the case in most other developed countries, banks in Japan fully hedge their on-balance sheet foreign currency exposure.[24] While there are no direct data available on off-balance sheet derivatives, trends in on-balance sheet items can be used to infer some important aspects of how Japanese banks choose to lend.[25]

In recent years, an important trend that has developed is that Japanese banks have substantially added to their external net long-term asset position denominated in foreign currency (Figure B1). This has more than offset their external net liability position in short-term foreign currency instruments. Consequently, Japanese banks have accumulated a widening overall external net asset position.

[24] Compliance with Basel accords ensures that capital is set against open foreign currency positions to cover risk. However, this tends to be relatively expensive and banks generally opt to hedge their foreign exchange exposures through natural hedges or derivatives. See also Becker and Fabbro (2006).

[25] The source of yen for the rest of the world must be the Japanese banking system or the Bank of Japan. Even if the yen are not directly sourced from Japanese residents, they have to originate from a transaction in Japan.

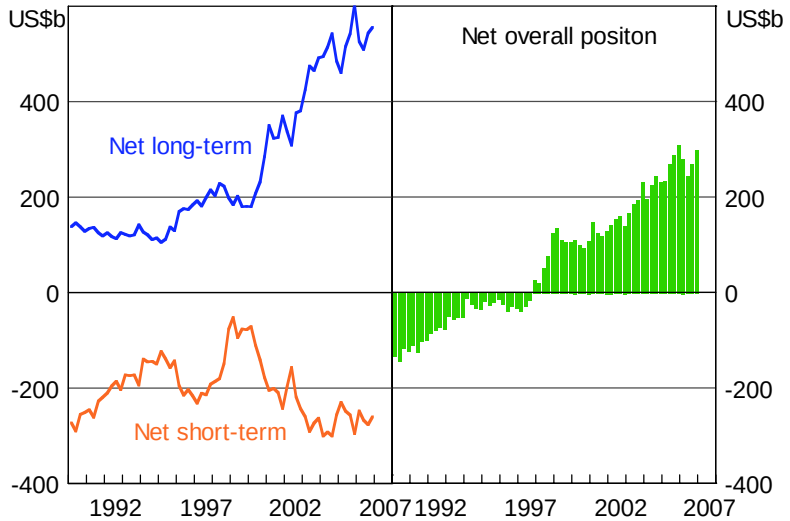
This open foreign currency position implies exposure to movements in the Japanese yen, which is unlikely to exist because banks hedge these exposures.[26] An investigation of how Japanese banks are accumulating foreign currency assets, while hedging the implied exposure to movements in the yen, yields important indirect evidence of the use of derivatives in funding yen denominated lending to non-residents.

Japanese banks could be issuing foreign currency debt to fund their acquisition of foreign currency assets. This would imply equal amounts of foreign currency assets and liabilities which provide a hedge against foreign exchange risk. However, this cannot be the case because the net asset position indicates that assets exceed liabilities.

Alternatively, Japanese banks awash with domestic liquidity could be converting yen in the foreign exchange spot market to acquire foreign assets and then hedge these through derivative transactions in forwards or options. Again, this seems unlikely as these types of hedges provide only an imperfect and high cost offset to foreign exchange risk.

Figure B1

External Foreign Currency Position of Banks in Japan



Source: CEIC

We therefore suggest that Japanese banks are swapping their ample yen liquidity into foreign currencies, thereby selling yen in the near leg of the swap and repurchasing it in the far leg. This amounts to a yen denominated loan for the duration of the foreign exchange swap taken out by the counterparty to the transaction (eg a prime broker to hedge funds). Simultaneously, Japanese banks therefore borrow foreign currency for the duration of the swap and invest the proceeds in long-term foreign assets (eg US bonds). Importantly, since the terms of the second leg of the swap and the exchange rate are agreed at the time the contract is entered into, Japanese banks are not taking on the foreign exchange risk associated with fluctuations in the yen for the duration of the swap.

This explanation is appealing because it accounts for how yen liquidity is converted into foreign currency, how foreign assets are accumulated, and how this apparently open foreign currency position is in fact hedged against fluctuations in the yen. It also happens to be consistent with carry trade financing for which there is little evidence to be found in traditional measures that rely on on-balance sheet measures such as bank lending and capital flows.

[26] There is no indication that Japanese banks are setting aside more capital against open foreign currency positions (despite the rising proportion of assets held in foreign currencies), which implies that these positions are hedged to comply with regulatory standards (see Bank of Japan (2007)).

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Global monitoring with the BIS international banking statistics

Patrick McGuire and Nikola Tarashev*

Abstract

This paper illustrates various applications of the BIS international banking statistics. We first compare international bank flows to measures of real activity and liquidity and show that the international banking system is becoming a more important conduit for the transfer of capital across countries. We then use network analysis tools to construct a bird's eye view of the structure of the international banking market and to identify key financial hubs. Linking this information with balance of payments statistics helps to better understand the role of banks in the financing of current account flows, for example the recycling of petrodollars and Asian surpluses. Finally, the paper illustrates how the BIS statistics can be used to analyse internationally active banks' foreign exposures to credit risk and, thus, spot vulnerabilities in the international banking market.

1. Introduction

The international banking market is a primary conduit through which funds are transferred among countries. Since 2002, cross-border lending and deposits have risen, both in absolute terms and relative to aggregate measures of real economic activity and liquidity. The structure of the international banking market has evolved over the past 30 years. While London has remained a primary financial centre, Asian and Caribbean offshore centres have expanded their global presence, and are important in the global channelling of funds. The growth in both the size and the complexity of international banking has financial stability implications at both the domestic and the international level.

This paper uses the BIS international banking statistics to address these issues. The first section, which relies primarily on the BIS locational banking statistics, places into perspective the growth in international banking activity in recent years by showing how it has increased in size relative to measures of economic activity and liquidity. It discusses the importance of offshore banking in the United Kingdom and Asian and Caribbean offshore centres, and provides a convenient graphical representation of the structure of the international banking market. The first section also analyses the net flow of bank credit between ultimate lenders and borrowers. Internationally active banks are important in the transfer of credit between developed countries, but play a somewhat smaller role in the recycling of petrodollars and Asian surpluses.

After describing the global flow of funds through the international banking system, the paper examines internationally active banks' foreign positions from a credit risk perspective. To this end, it is necessary to refocus the discussion away from the geographical distribution of flows

* Bank for International Settlements. The views expressed in this paper are those of the authors and do not necessarily reflect the official position of the BIS.

and towards an analysis of banks' foreign exposures, grouping banks not according to their location but according to their nationality (ie the country in which they are headquartered).

Banks' foreign exposures can be usefully analysed in the context of banks' capital adequacy ratios. Such an analysis can help to quantify the degree to which a major low-probability event – such as the Asian financial crisis or the Argentine or Russian default – would stress the financial system, and can help to identify pockets of systemic risk in the interbank market. Systemic implications arise when the shock is common to banks headquartered in several countries, or if "second-round" effects occur, whereby the failure of a group of banks generates a cascade of bank failures across countries.

These issues are examined, at a broad level, in the second half of the paper, and make use of the BIS consolidated banking statistics, the most comprehensive source of information about banks' foreign exposures.[1] Foreign exposures are large for some national banking systems, accounting for more than 50% of their reporting banks' total balance sheet assets. As a result, large, low-probability shocks to banks' foreign exposures could have a discernible effect on their capital adequacy. In this section, we propose a simple capital adequacy ratio for national banking systems and then ask how this ratio would change given various hypothetical shocks to these banks' foreign exposures. Evaluating the impact of such shocks on a regular basis promises to provide important information about the evolution of the risk profile of internationally active banks.

The preliminary estimates – based on data for a limited number of reporting countries – suggest that shocks to banks' exposures to emerging markets have only a modest impact on reporting banks' capital adequacy. In contrast, a large loss on interbank exposures could conceivably push capital adequacy below the required 8% for banks headquartered in some reporting countries.

That said, the analysis in this section of the paper is incomplete in that it relies on data for only a subset of the total international banking market. Constructing the simple capital ratios requires, in addition to banks' foreign exposures, information on their total capital and risk-weighted assets. Such information is confidential for many reporting countries. Thus, the analysis below is a mechanical use of the data that *are* available, and sheds light on how such measures *could be* useful in tracking vulnerabilities in the interbank market. Only by incorporating data for a broader set of countries can concrete conclusions be drawn.

1.1 Growth in international banking

International banks play an increasingly important and complex role in the global financial system. In part, this growing complexity is the result of consolidation within the banking industry, globalisation and capital market integration. Cross-border claims today are over 30 times larger in absolute terms than 30 years ago. Relative to monetary aggregates or measures of global macroeconomic activity, international activity grew robustly in the 1980s, slowed somewhat in the 1990s and has trended upwards again since 2000.

The international banking market took off in the 1960s, when banks in London were permitted to accept foreign currency (ie non-sterling) deposits. These banks were able to attract US dollar deposits, or eurodollars, because they faced lower regulatory costs than their counterparts in the United States, which were subject to reserve requirements. The political climate at the time also helped this process along, as the former Soviet Union and

[1] As discussed in more detail below, such an analysis has been possible only since the 2005 enhancements to the *BIS consolidated banking statistics*. These enhancements provide information on banks' ultimate risk exposures that is crucial for evaluating capital adequacy ratios.

oil-exporting states, in search of a store of hard currency outside the United States, deposited a significant amount of US dollars in banks in London.[2]

Since then, international banking activity has grown significantly, in all major currencies. The BIS international banking statistics – the most comprehensive source of information on banks' international assets and liabilities – indicate that the outstanding stock of international claims,[3] primarily loans, increased from $684 billion at end-1977 to $23 trillion in the second quarter of 2006.[4, 5] The growth in this market is evident even when scaled by measures of overall economic activity. Figure 1 portrays cross-border claims of banks in all reporting countries as a ratio of world GDP, as well as a decomposition of this ratio by currency. Total international claims of BIS reporting banks rose from roughly 10% of world GDP in 1980 to 28% at end-1990. This ratio stagnated over the 1990s, in part reflecting the retrenchment of Japanese banks, but has been on the rise since end-1999, reaching 48% by early 2006.[6]

Banks' liabilities, primarily deposits, have grown along with their claims. Cross-border liabilities can be combined with domestic liabilities (eg domestic currency deposits in resident banks) to yield a measure of "liquidity" in a particular currency.[7] Figure 2 plots banks' international liabilities – to (i) non-banks, (ii) non-banks and other banks or (iii) all counterparties (ie including inter-office deposits) – as a fraction of the sum of total international liabilities in that currency and the corresponding monetary aggregate M2.[8] In each of the major currencies, international liabilities have risen as a share of liquid funds in recent years, in line with the GDP-based ratios reported in Figure 1. US dollars held in banks outside the United States are 30–50 percentage points larger than the corresponding ratios for the euro or the Japanese yen, underscoring the importance of the US dollar as an international currency.

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[2] For a thorough treatment of the development of the international banking market, see Mayer (1979), McKinnon (1979), Johnston (1983), Niehans (1984) and Krugman and Obstfeld (1991).

[3] International claims (liabilities) are defined as cross-border claims (liabilities) in all currencies plus foreign currency claims (liabilities) vis-à-vis domestic residents. The BIS locational banking statistics follow balance of payments concepts, and are hence based on the residency of the reporting bank. For a complete description of these statistics, see BIS (2003a,b) and Wooldridge (2002).

[4] Part of this increase is due to a widening of the reporting area. In particular, data for the Cayman Islands, Hong Kong SAR, Singapore and other offshore financial centres became available only at end-1983. Australia, Bermuda, Greece, Guernsey, the Isle of Man and Portugal joined the reporting population in or after 1998. Banks located in these countries accounted for less than 5% of total claims of BIS reporting banks in 2006.

[5] Throughout this feature, the term "euro area" refers to the group of 12 countries that adopted the euro in 1999. In addition, all calculations exclude euro-denominated cross-border positions within the euro area.

[6] The currency distribution of international claims has also evolved. The US dollar share of international bank claims dropped from 73% in mid-1984 to 52% in mid-2006 (evaluated at constant 2006 Q2 exchange rates). Over the same period, the share of euro-denominated claims (including the euro legacy currencies prior to 1999) rose from 11% to 27%.

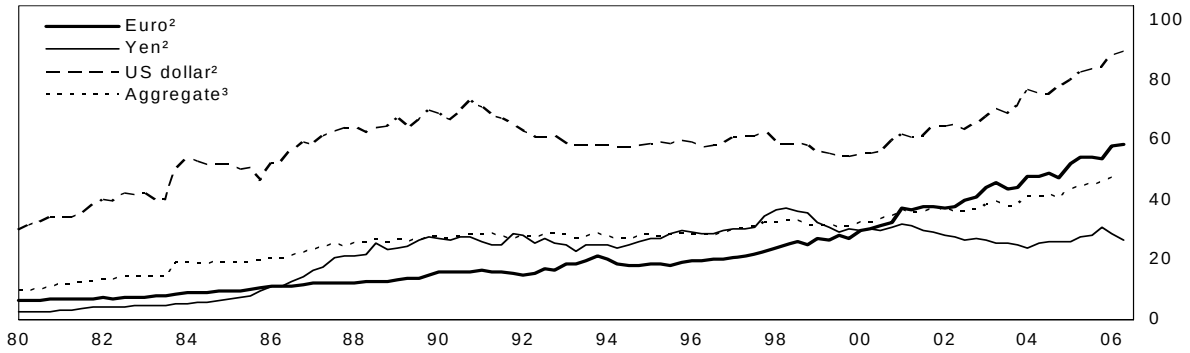
[7] During the 1970s and 1980s, a relatively large literature on the growth of the eurocurrency market emerged. In part, this was driven by concerns that US dollars placed in banks outside the United States would contribute to inflationary pressures in the United States and dull the effect of domestic monetary policy. See McKinnon (1979), Niehans and Hewson (1976) and Mayer (1979).

[8] The definition of M2 varies slightly by country but generally includes domestic currency in circulation, demand deposits, savings deposits, small-denomination time deposits and balances in retail money market mutual funds. Importantly, M2 is in domestic currency and excludes domestic interbank deposits and all eurocurrency deposits.

Figure 1

BIS reporting banks' international claims relative to GDP[1]

In per cent



[1] International claims comprise cross-border claims in all currencies and claims on residents in foreign currencies. Euro-denominated claims among countries that form the euro area are excluded. [2] Stocks outstanding of claims, as a percentage of the annualised GDP of the issuing country or country group. [3] Total stocks outstanding of claims, in all currencies, as a percentage of annualised world GDP.

Sources: IMF; national data; BIS.

Figure 2 also indicates that there has been a sustained shift towards greater liabilities to non-banks since the mid-1990s.[9] In the US dollar market, for example, positions vis-à-vis these entities in the United Kingdom and Caribbean offshore centres, which host many non-bank financial entities, accounted for much of this. Across all currencies, liabilities to non-banks currently account for 29% of total international liabilities, up from 22% in 1996 and 18% in 1988.

1.2 The structure of the market

Banks located in a few countries constitute the core of the international banking market. The United Kingdom has been the largest international banking centre (IBC), a focal point for the lending and depositing of foreign currencies. Asian and Caribbean offshore centres later emerged as regional banking hubs, and currently rival the United Kingdom in terms of overall activity.

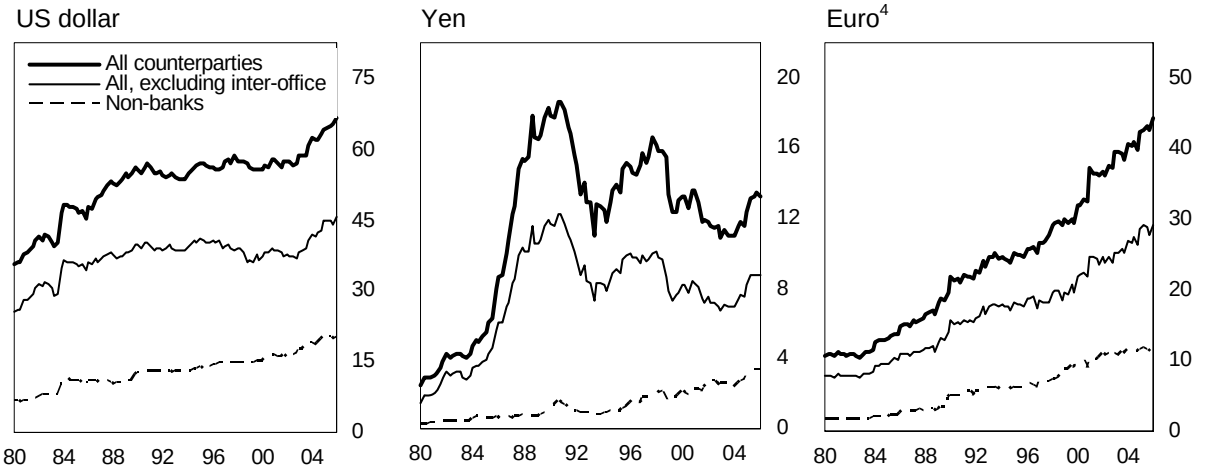
On the whole, however, interbank activity dominates both the claims and the liabilities side of banks' balance sheets. Short-term misalignments in the demand for and supply of funds to end-use borrowers can mean that deposits in banks may be temporarily passed on to other banks. If so, each leg of this chain is reflected in the aggregate claims figure, and can generate what appear to be swellings in interbank loan flows. In mid-2006, inter-office claims accounted for an estimated 32% of total cross-border deposits, while lending to other banks accounted for an additional 39%.

[9] See McGuire (2004) for a discussion of the shift towards lending to non-bank borrowers in the United States by banks in the United Kingdom.

Figure 2

BIS reporting banks' international liabilities[1] relative to M2[2, 3]

By currency and counterparty, in per cent



[1] International liabilities comprise cross-border liabilities in all currencies and liabilities to residents in foreign currencies. [2] In general, M2 includes domestic currency in circulation plus bank liabilities to non-banks denominated in the domestic currency, eg demand deposits, savings deposits, small-denomination time deposits and balances in retail money market mutual funds. For the United States and Japan, M2 includes liabilities to both residents and non-residents. Liabilities to non-residents are subtracted from US and Japanese M2. Euro area M2 includes liabilities to euro area residents only. [3] International liabilities to all counterparties, to all counterparties excluding inter-office (ie to non-banks and other banks) or to non-banks only as a fraction of the sum of international liabilities to all counterparties and M2. [4] The pre-1999 portion of the euro area M2 series is estimated by the ECB. Cross-border liabilities vis-à-vis euro area residents denominated in euros or in the legacy currencies are excluded.

Sources: IMF; national data; BIS.

The size and scope of the operations of banks located in these IBCs are large relative to aggregate economic activity in the host countries. Table 1 illustrates this point by reporting international liabilities of banks located in a particular country or country group, as a proportion of GDP. The United Kingdom and Asian and Caribbean offshore centres (as well as Luxembourg and Switzerland) clearly stand out, with liabilities/GDP ratios of 285% or more in 2006. Elsewhere, these ratios were 62% or less.

Activity in some IBCs is dominated by internationally active foreign banks. In the United Kingdom and Caribbean and Asian offshore centres, for example, banks headquartered in the United States, the euro area (primarily Germany) and Switzerland account for the bulk of international claims (Figure 3, top row). Japanese banks were once dominant in London and Hong Kong, although their cross-border claims declined in the 1990s with the downturn in the Japanese economy and the deterioration in the health of the domestic banking sector. In contrast to the experience in these IBCs, domestic banks (ie banks headquartered in the reporting country) tend to be dominant in other countries (Figure 3, bottom row).

Table 1

Identifying international banking centres

In per cent

	Liabilities to total[1]			Liabilities to GDP		
	1990	**1998**	**2006**	**1990**	**1998**	**2006**
Euro area[2]	16	23	26	21	36	62
United States[3]	10	10	11	11	11	20
Japan	20	9	4	45	22	23
Other developed countries[4]	4	4	5	22	27	44
United Kingdom	21	21	27	143	154	285
Luxembourg	3	4	2	1,834	2,127	1,324
Switzerland	5	5	5	165	207	317
Caribbean offshore centres[5]	9	9	7	–	4,787	5,608
Asian offshore centres[6]	10	12	5	628	491	386
Developing countries[7]	0	0	3	–	–	16

[1] International liabilities of banks located in each country or country group at the beginning of the year, as a share of all BIS reporting banks' total international liabilities. International liabilities comprise cross-border liabilities in all currencies and liabilities to residents in foreign currencies. [2] Excludes Greece and Luxembourg. Euro-denominated cross-border liabilities contracted within the euro area are excluded. [3] Excluding liabilities to residents in all currencies. [4] Australia, Canada, Denmark, Norway and Sweden. [5] The Bahamas, the Cayman Islands and the Netherlands Antilles. [6] Hong Kong SAR and Singapore. [7] Brazil, Chile, India, Korea, Mexico, Taiwan (China) and Turkey.

Sources: IMF; national data; BIS.

The structure of the global banking system can be viewed as a network of interconnected nodes, each representing a hub or particular geographical region.[10] Figure 4 provides one representation of the network of bilateral linkages between regions. The size of each node corresponds to the share of resident banks' cross-border claims in total cross-border claims of BIS reporting banks, and is thus an indicator of the relative importance of particular countries.[11] The thickness of the lines (or links) between regions corresponds to the *sum* of cross-border claims between the regions, and is a gauge of the size of aggregate cross-border positions.

Bilateral linkages vary significantly between country pairs. For much of the last 20 years, the links between banks in the United Kingdom and the euro area (at roughly $4 trillion), and between banks in the United States and the Caribbean (roughly $2 trillion), were the largest. Aggregate positions between the United States and the United Kingdom, and between Switzerland and the euro area, were relatively significant as well. At the onset of the Asian financial crisis in 1997, Japanese banks still had significant positions vis-à-vis their offices in

[10] The country groups OIL, LAT, EM EUROPE and ASIA PAC in Figures 4 and 5 include both reporting and non-reporting countries. Bahrain (OIL), Brazil, Chile and Mexico (LAT), Turkey (EM EUROPE) and Taiwan (China) (ASIA PAC) all started to report data after 2000. Similarly, UK includes positions of banks in the United Kingdom as well as Guernsey, the Isle of Man and Jersey for 2006.

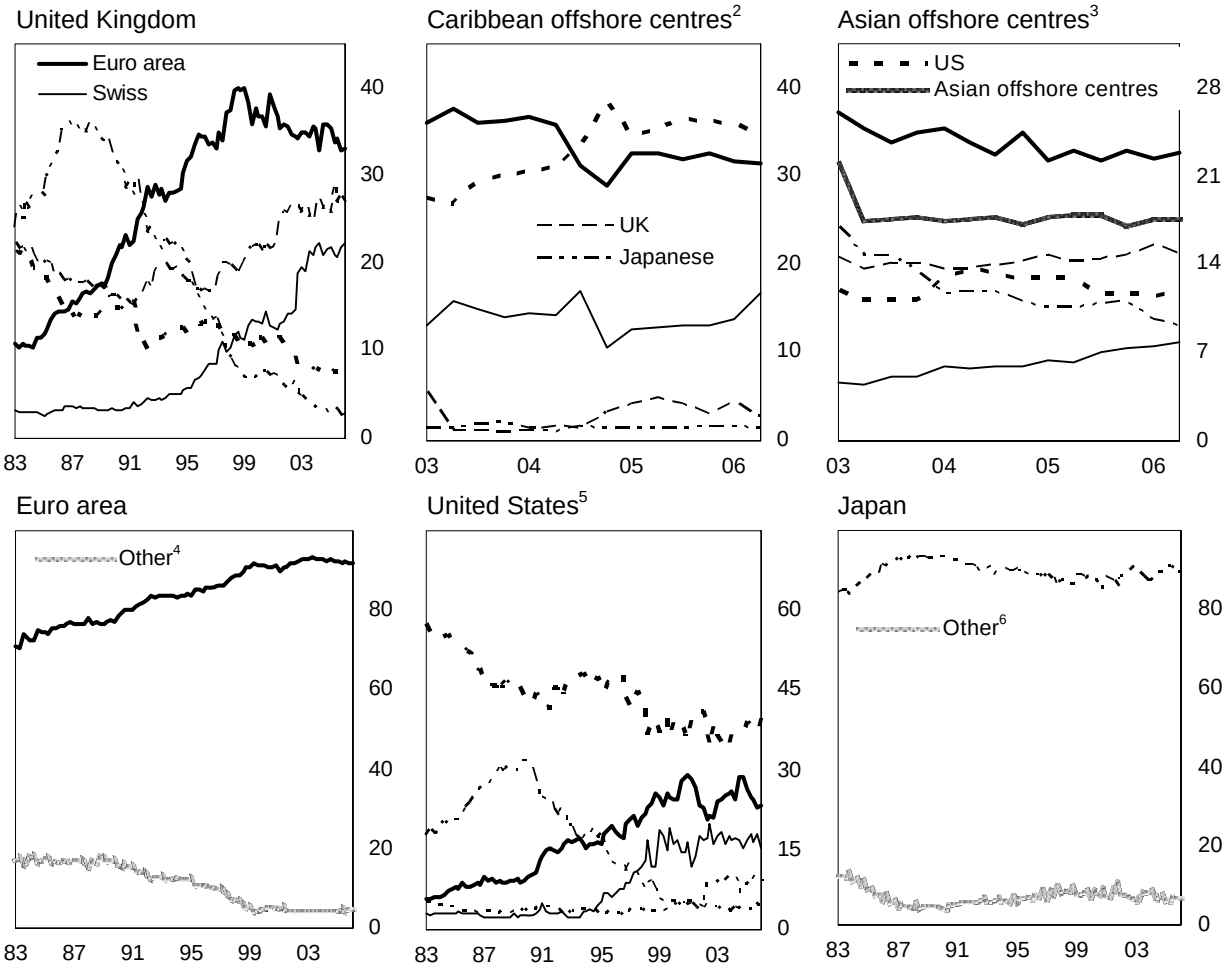
[11] Foreign currency claims on residents are not included in Figure 4.

Hong Kong and the United Kingdom. By mid-2006, their cross-border positions vis-à-vis banks in Asian offshore centres had declined in relative terms.

Figure 3

International claims of foreign and domestically headquartered banks[1]

By reporting country, in per cent



[1] Lines indicate international claims of banks headquartered in various parent countries (identified by legend labels) as a share of total international claims of banks located in the reporting country or country group (identified by panel title). International claims comprise cross-border claims in all currencies and claims on residents in foreign currencies. [2] The Bahamas, Bermuda, the Cayman Islands and Panama. [3] Hong Kong SAR and Singapore. [4] Japan, Switzerland, the United Kingdom and the United States. [5] Excludes foreign currency claims on residents of the United States. [6] The euro area, Switzerland, the United Kingdom and the United States.

Source: BIS.

1.3 Tracking the flow of capital through banks

Through lending, accepting deposits, or purchases of foreign securities, banks play a role in the transfer of capital between countries. The above analysis touches only indirectly on the United Kingdom's and Asian and Caribbean offshore centres' role as redistributors of financial capital. This section attempts to fill this gap by analysing net flows of funds among banks in different geographical regions, with a focus on the flows through banks in these IBCs.

The BIS locational banking statistics track the net flow of financial capital between any two regions which is channelled through the banking system. For concreteness, consider measuring the cumulative net flow of funds over a given period between the residents of country A and the residents of country B. A portion of funds transferred between these residents will be external to the banking system – the purchase of a US Treasury by a non-bank outside the United States, for example – and thus is not covered by the BIS international banking statistics. The portion which is routed through the banking system equals the sum of three components. The first is the cumulative net claim flows (claims minus liabilities) to non-banks in country A reported by banks located in country B. The second is the counterpart to this, the cumulative net flows reported by banks in country A to non-banks in country B. Finally, there is the net interbank component.[12]

Figure 5 presents the net flow of capital channelled through banks, cumulated over two periods (1990–97 and 1998–2006). This allows for a comparison of the net flow of funds through banks before and after the Asian financial crisis. Each arrow in Figure 5 provides two pieces of information: the direction of net capital flows between two given regions and the relative size of these flows (indicated by its thickness).

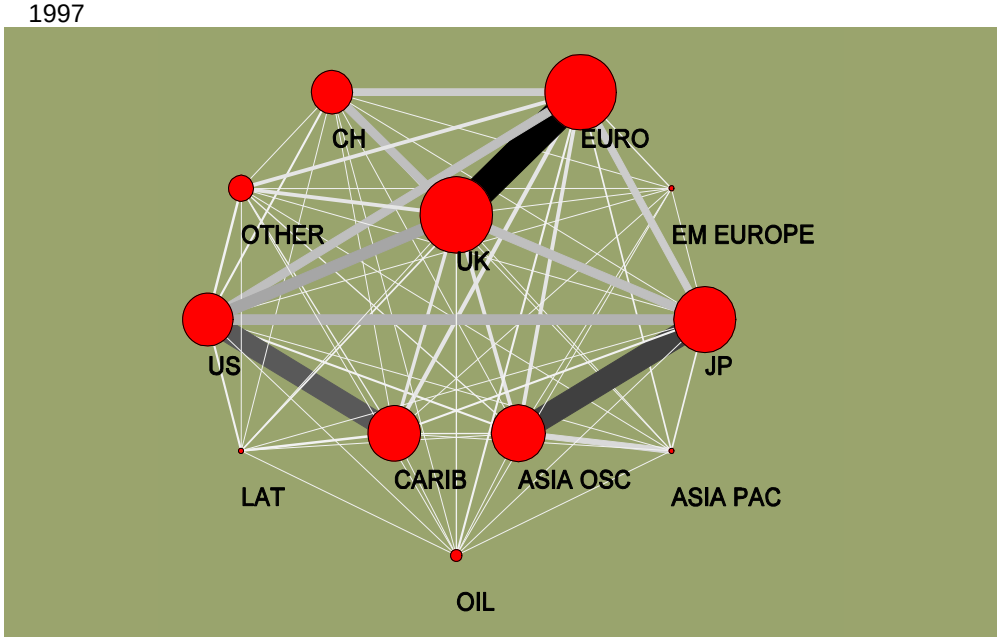
Between 1990 and 1997, the United States and emerging Asia-Pacific stood out as the main net borrowers on the international banking market, whereas Japan was the main provider of funds (Figure 5, top panel). In line with the renewed growth of its current account deficits over this period, the United States experienced a net inflow of $433 billion via the banking market. Roughly 85% of this was provided by Japanese and UK residents. At the same time, residents of Japan and the countries that now comprise the euro area jointly exported $195 billion to Asian offshore centres and emerging Asia-Pacific, accounting for 74% of the overall net banking flows into these economies.

[12] Unlike net flows to non-banks, the net interbank flows reported by any country pair should be roughly equal. A net inflow reported by banks in country A vis-à-vis banks in country B should be reported as a corresponding outflow by banks in country B. In practice, different populations of banks on the reporting and vis-à-vis side of the data can create some, albeit small, discrepancies. In calculating net interbank flows, we chose the larger asset and liability positions reported across the two sets of reporting banks. Some regions include countries which do not report data. If, for example, country B is not a reporter, then flows from banks in country B to non-banks in country A will be missed. This is potentially a large component of total flows through the banking system for some regions. Finally, a small portion of banks' total liabilities is debt securities liabilities, which are often not allocated to a particular vis-à-vis country.

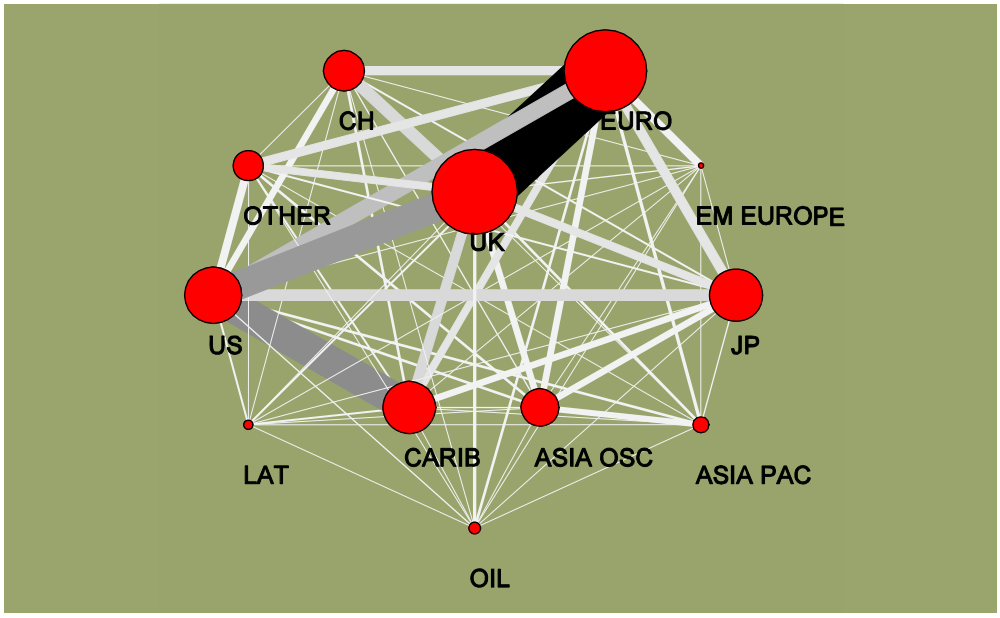
Figure 4

Linkages in the international banking system[1]

1997



2006



ASIA OSC = Hong Kong SAR, Macao SAR and Singapore; ASIA PAC = China, India, Indonesia, Korea, Malaysia, Pakistan, the Philippines, Taiwan (China) and Thailand; CARIB = Aruba, the Bahamas, Bermuda, the Cayman Islands, the Netherlands Antilles and Panama; CH = Switzerland; EM EUROPE = Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, Turkey and Ukraine; EURO = euro area countries; JP = Japan; LAT = Argentina, Brazil, Chile, Colombia, Mexico and Peru; OIL = OPEC member states (excluding Indonesia) plus Russia; OTHER = Australia, Canada, Denmark, New Zealand, Norway and Sweden; UK = the United Kingdom plus the offshore centres Guernsey, the Isle of Man and Jersey; US = the United States.

[1] The size of each red circle is proportional to the outstanding stock of cross-border claims of reporting banks located in the particular geographical region. Some regions include countries which do not report data. The thickness of a line between regions A and B is proportional to the sum of claims of banks in A on residents in B and claims of banks in B on residents of A. The size of the circles and thickness of the lines are scaled by the overall stock outstanding, and thus are not directly comparable across panels.

Source: BIS.

1.4 Global imbalances: tracking OPEC and Asian surpluses

Just how important is the international banking system in the global flow of capital? This question can be answered by tracking the flow of funds through banks *relative to* the total flow of capital to and from various regions. A country's total net financing requirement in a given period can be expressed as the sum of net financial outflows generated by the public and private sectors which, by the balance of payments identity, is equal to the current account balance. A comparison with the BIS international banking statistics will shed light on the portion of a country's net financing requirement which is routed via the banking system, as opposed to via financial markets.

Figure 6 presents this comparison for the United States, the euro area and Japan. By mid-2006, one quarter of the cumulative current account flows into the United States were routed through the international banking system. Similarly, only a small portion of Japan's current account surplus has been channelled through the banking system, although this share has increased substantially over the last decade, from 5% in 1997 to 32% at mid-2006. In the euro area, net bank flows closely tracked the movement of cumulative current account balances up to 1995 and between 1999 and mid-2006.[13]

On a gross basis as well, there is some evidence that the international banking system is less important as a conduit for international capital flows than it once was. Indeed, as shown below, very little of the gross capital flows from two of the largest capital exporting groups of countries – OPEC member states and emerging Asian countries – is transferred through the international banking system. At the same time, these regions are important sources of funds for internationally active banks.

One measure of a country's total foreign financial investment – or "invested funds" – is the change in its total reserves plus gross financial outflows (ie foreign direct investment (FDI) abroad and gross portfolio and other investment).[14] Invested funds, by definition, show up as claims on the rest of the world, through purchases of foreign securities (debt and equity), FDI abroad or deposits in foreign banks. As shown below, what appear to be large changes in BIS reporting banks' deposit liabilities actually account for a rather small share of the total investment abroad by the major emerging Asian economies and OPEC member states.

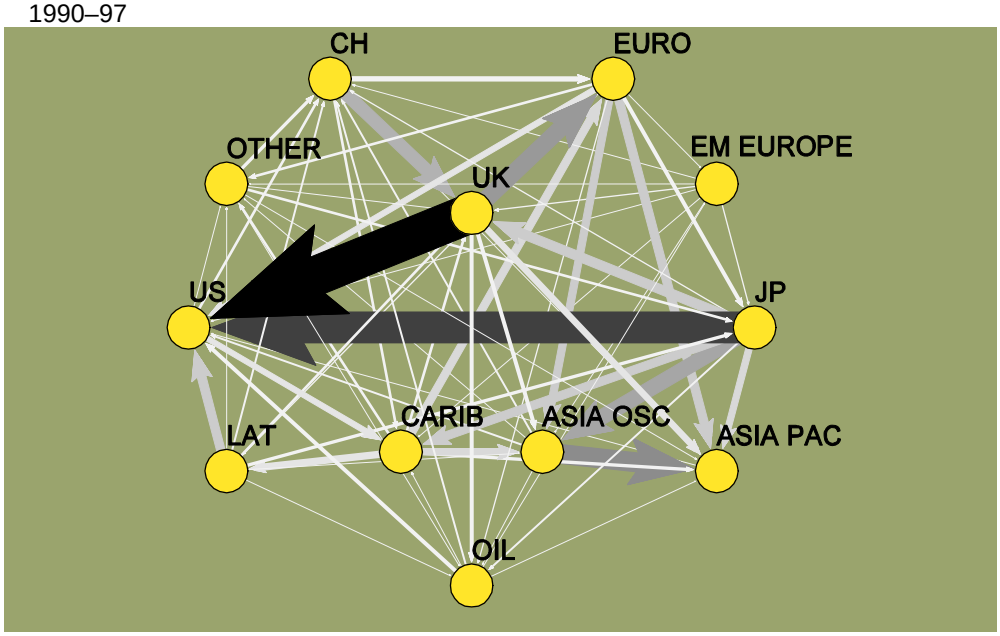
[13] By contrast, from end-1995 to mid-1998, net inflows via banks to the euro area, mainly from the residents of the United Kingdom, Japan and Asian offshore centres, coincided with current account surpluses and the accumulation of reserves in this region.

[14] Alternatively, the balance of payments identity implies that invested funds are the sum of current account surpluses and gross financial inflows. Some items in the balance of payments data for some countries are not available, and are estimated by extrapolating from earlier periods. This analysis does not include derivative assets and liabilities.

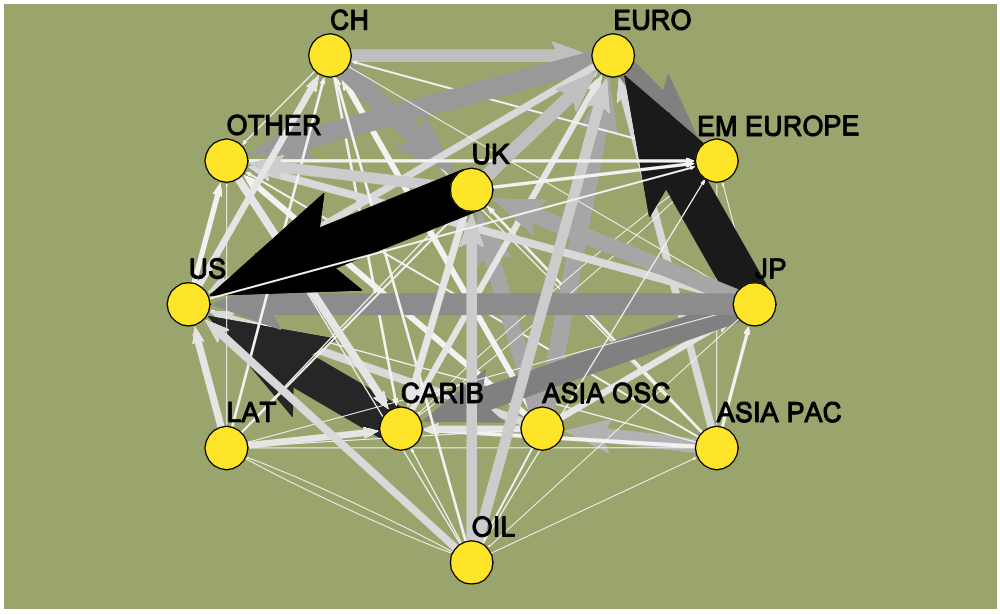
Figure 5

Net flow of funds through the international banking system[1]

1990–97



1998–2006



ASIA OSC = Hong Kong SAR, Macao SAR and Singapore; ASIA PAC = China, India, Indonesia, Korea, Malaysia, Pakistan, the Philippines, Taiwan (China) and Thailand; CARIB = Aruba, the Bahamas, Bermuda, the Cayman Islands, the Netherlands Antilles and Panama; CH = Switzerland; EM EUROPE = Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, Turkey and Ukraine; EURO = euro area countries; JP = Japan; LAT = Argentina, Brazil, Chile, Colombia, Mexico and Peru; OIL = OPEC member states (excluding Indonesia) plus Russia; OTHER = Australia, Canada, Denmark, New Zealand, Norway and Sweden; UK = the United Kingdom plus the offshore centres Guernsey, the Isle of Man and Jersey; US = the United States.

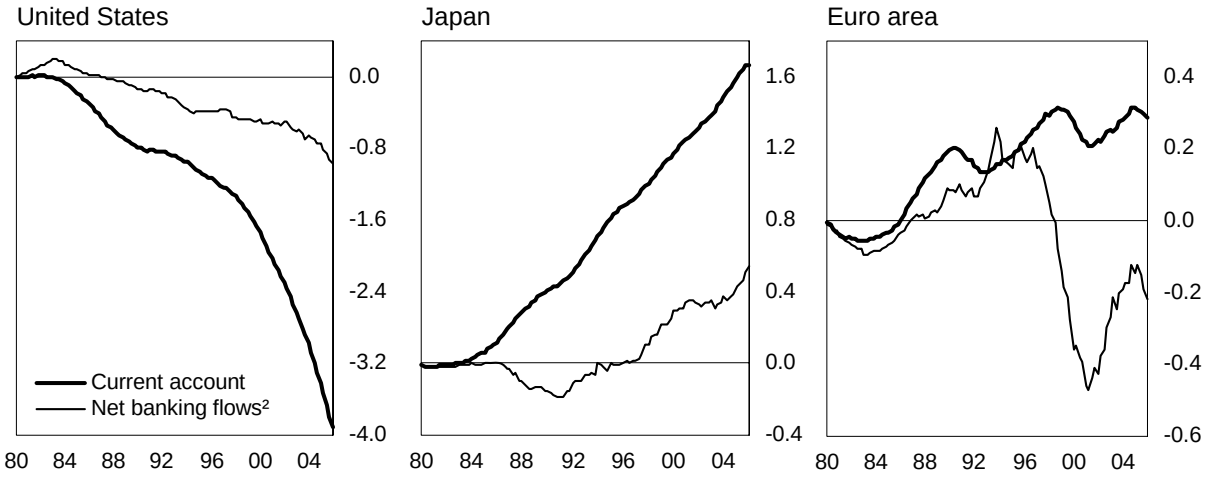
[1] The thickness of an arrow is proportional to the amount of cumulative net bank flows between regions. Net flows between regions A and B equal the sum of: (1) net claims (assets minus liabilities) of banks in A on non-banks in B; (2) net claims of banks in B on non-banks in A; and (3) net interbank flows between A and B. Some regions include countries which do not report data. The thickness of the arrows is scaled by the overall flows cumulated over the respective period, and thus is not directly comparable across panels. In contrast to Figure 4, the size of the circles has no significance.

Source: BIS.

Figure 6

External positions and the international banking market

In trillions of US dollars[1]



[1] Flows are scaled by the US GDP deflator (set to 100 in 1985 Q1) and are cumulated from 1980 Q1 onwards.
[2] A positive flow signifies an outflow from the country or region to the rest of the world. See Figure 5 for a definition of net bank flows.

Sources: ECB; IMF; BIS.

The most recent oil price cycle started in 1999, and has generated substantial inflows into oil-exporting countries.[15] Relative to previous oil cycles, the propensity for OPEC countries to invest these oil revenues abroad seems to have risen. OPEC's total invested funds,[16] as a share of net oil revenues, were higher in the 1999–2005 cycle than in the 1978–82 cycle, implying a higher rate of foreign placements.

The left-hand panel of Figure 7 decomposes OPEC countries' investable funds into the change in foreign exchange reserves and the various components of the financial account. These data indicate a marked change in the types of foreign investment across the two cycles. Between 1999 and end-2005, 28% of *cumulative* investable funds had been channelled into portfolio investment – or net purchases of foreign financial assets by non-monetary authorities – compared with 38% in the 1978–82 cycle. "Other investment", which primarily constitutes deposits in foreign banks but also investment not classified elsewhere, has fallen as a share of investable funds, from 58% in the previous cycle to 47% in the current one.[17]

[15] By end-2005, OPEC members had earned an estimated $1.3 trillion in petrodollars since end-1998, while the world's other large exporters, Russia and Norway, had received $403 billion and $223 billion respectively.

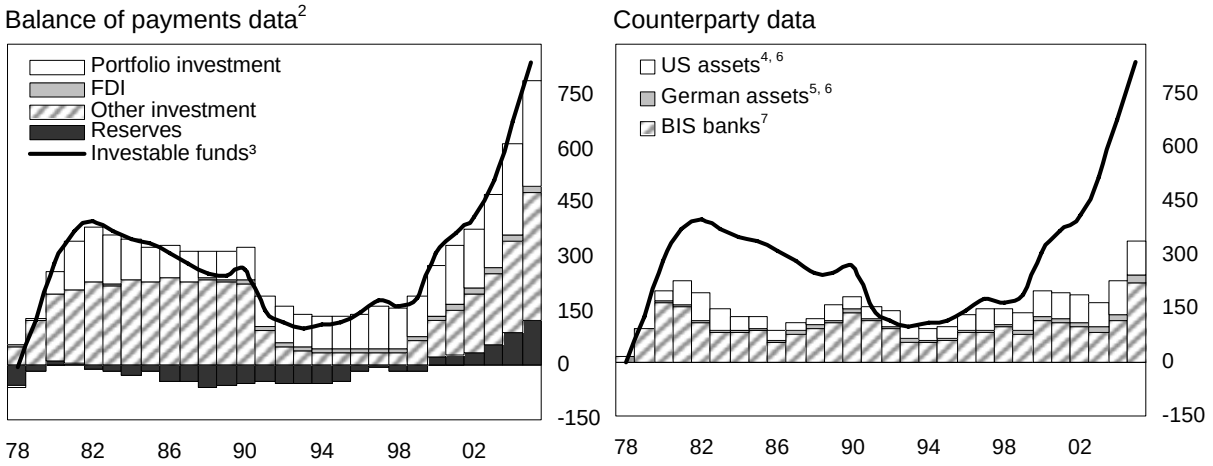
[16] Gross financial inflows are partially based on estimated data. Some items in the balance of payments data for several countries are not available for recent quarters, and are estimated by extrapolating from earlier periods. In addition, no data on gross financial inflows are available for the United Arab Emirates, Qatar and Iraq. Estimates for these countries are based on their current account and foreign exchange reserve data. These estimates imply that cumulative financial inflows accounted for 18% of cumulative investable funds over the 1999–2005 cycle, but were negligible in the previous cycle.

[17] Foreign exchange reserves rose by an estimated $136 billion between end-1998 and end-2005, accounting for 19% of cumulative investable funds. In contrast, reserves accounted for a negligible fraction of cumulative investable funds in the earlier cycle. Most OPEC member countries' oil industries are at least partially state-owned. See the 2004 OPEC Annual Statistical Bulletin for details.

Figure 7

Cross-border investment by OPEC countries[1]

Cumulative flows since 1977 Q4



Note: Data are in billions of real 2005 Q2 US dollars, deflated by the US consumer price index.

[1] Excluding Indonesia. [2] Outflows from OPEC member countries, as implied by the financial accounts in their balance of payments data. Balance of payments data for 2005 are estimated on the basis of EIA data on OPEC net oil revenues. [3] Defined as the sum of the current account balances of and financial inflows into OPEC countries. [4] Purchases of US long-term securities and FDI in the United States by "Other Asia", and Venezuela. [5] Purchases of German securities and FDI in Germany by OPEC countries. [6] The available data may underestimate OPEC's true net purchases of foreign securities to the extent that these purchases are effected through financial intermediaries in third countries. [7] Total claims of OPEC countries on BIS reporting banks, primarily bank deposits.

Sources: IMF; Deutsche Bundesbank; US Treasury; BIS.

A more detailed tracking of where these investable funds are placed is difficult because OPEC member countries generally do not provide a finer breakdown of their capital outflows. The right-hand panel of Figure 7, however, splices various sources of *counterparty* data in order to obtain a better understanding of what is known about aggregate outflows from OPEC countries. Cumulative net purchases of US and German securities are combined with OPEC FDI in these countries. This, coupled with the gross deposits placed in BIS reporting banks worldwide, provides an estimate of OPEC's investable funds based on publicly available counterparty data.[18]

While this combination of counterparty data roughly matches the outflow of investable funds from OPEC member countries in the late 1980s and early 1990s, it tracks the surges in these funds during periods of high oil prices far less accurately.[19] Several possible explanations for

[18] In addition to the United States, France, Japan and the United Kingdom also provide some information on the geographical breakdown of their international investment position. By end-2005, the stock of OPEC's portfolio investment in France had increased by $25 billion since 2000, the earliest date for which such data are available. Data on OPEC's investment in Japan are available since 2005 only. OPEC investment in the United Kingdom is negligible relative to the other identified investment according to the available data, which cover 1997–2003 (for FDI) and 2001–03 (for portfolio investment). These data, however, underestimate the true OPEC net purchases of securities to the extent that these purchases are conducted through financial intermediaries in third countries.

[19] Almost 70%, or $486 billion, of cumulative investable funds cannot be identified in the counterparty data in the most recent cycle, compared with 51%, or $103 billion, in the previous one.

the current large gap come to mind. First, the available counterparty data do not capture offshore purchases of securities. For example, the estimate of OPEC's cumulative net purchases of US securities based on the TIC data would tend to understate the total to the extent that these securities are purchased in London or other financial centres outside the United States. Second, cross-border investment in regional stock and bond markets is likely to have become a more important outlet for petrodollars than before.[20] Finally, there is some evidence that petrodollars are being invested more broadly – more diversified geographically and across the asset spectrum – than they once were. For instance, hedge funds and private equity funds, which have experienced large inflows worldwide in recent years but are not required to release information on the positions of their investor base, are one possible home for these investments. This expansion across the asset spectrum has led to a smaller share of invested funds being channelled into BIS reporting banks.[21]

Even as a smaller share of this investment is channelled through banks, petrodollars remain an important source of funding for the international banking system, although not as important as they once were. In the earlier cycle (1978–82), BIS reporting banks' net liabilities to OPEC member countries roughly doubled, making OPEC countries one of the largest net suppliers of funds to the international banking system (Figure 8, left-hand panel). Funds from these oil-producing countries fuelled the growth in BIS reporting banks' net long positions elsewhere, in particular vis-à-vis emerging economies, which eventually culminated in the 1980s debt crisis. Since this earlier cycle, significant changes in global financial flows have reduced the relative influence of petrodollars on the supply of funds flowing through banks. The most striking change is that BIS reporting banks currently have much larger net short (liability) positions vis-à-vis *offshore centres* and *non-OPEC emerging economies*, and net long (asset) positions vis-à-vis the United States and the euro area, than they did previously (Figure 8, right-hand panel).[22]

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[20] Up to end-2005, many countries in the Middle East had experienced, by some measures, an economic boom; the stock market indices in Saudi Arabia, Kuwait and the United Arab Emirates more than quadrupled between end-2001 and end-June 2005.

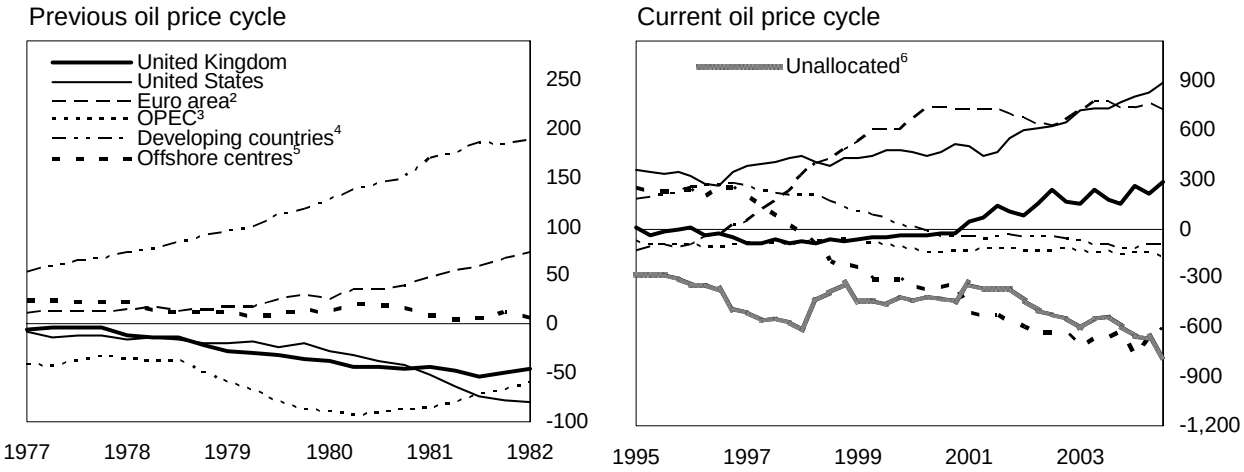
[21] Deposits placed in these banks between 1978 and 1982 accounted for 28% of investable funds accumulated over the same period, but only 20% of the cumulated funds between 1999 and 2005.

[22] The figures used in the right-hand panel of this figure are estimated. A large portion of reporting banks' liabilities is not allocated to a particular country because, unlike *deposit* liabilities, reporting banks often do not know who holds their *debt security* liabilities. BIS reporting banks' liabilities for which the *residence of the counterparty* is unknown have grown to $1.96 trillion, or 10% of reporting banks' total liabilities (from 2% in 1983). However, data on BIS reporting banks' debt security *claims on banks* are used to reallocate much of these unallocated claims by vis-à-vis country.

Figure 8

Net claims of BIS reporting banks, by vis-à-vis region[1]

In billions of US dollars

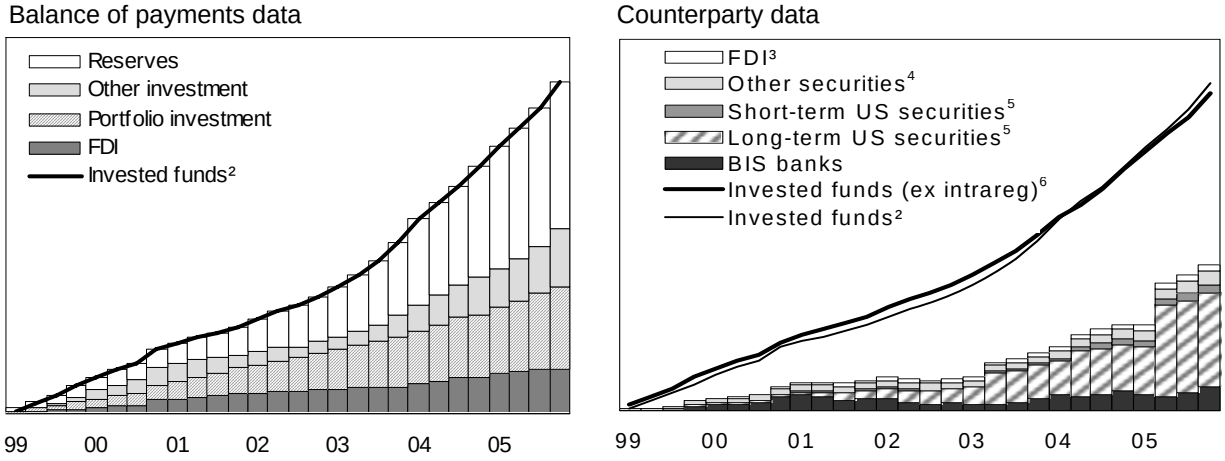


[1] Net claims equal the stock of total claims minus the stock of total liabilities. [2] Excluding intra-euro area net claims. [3] Excluding Indonesia. [4] Excluding OPEC countries. [5] Excluding intra-offshore centre net claims. [6] Unallocated liabilities of BIS reporting banks have been allocated to individual vis-à-vis regions to the extent that these liabilities correspond to debt security assets of other BIS reporting banks. The remaining unallocated liabilities drive the plotted series of unallocated net claims.

Figure 9

Tracking Asia's invested funds[1]

Cumulative flows since 1998 Q1



[1] From China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan (China) and Thailand. [2] Defined as the sum of the changes in reserves, FDI abroad and gross portfolio and other investment. [3] Cumulative FDI flows into Australia, France, Germany, Japan, the Netherlands, New Zealand, Switzerland, the United Kingdom and the United States. Data for 2004 and 2005 are partly estimated. [4] Cumulative portfolio investment in Germany and Japan. [5] Estimated from US TIC data. [6] Invested funds excluding intraregional flows through banks in Hong Kong SAR, India, Korea, Singapore and Taiwan (China).

Sources: IMF; UNCTAD; Bank of Japan; US Treasury; BIS.

The 1997 Asian financial crisis seems to have been a turning point. Prior to the crisis, Asia-Pacific was a large net debtor region. However, since 1999, a portion of the combined funds generated from current account surpluses and capital inflows into the (major) emerging Asian economies[23] has been placed as deposits in BIS reporting banks. This rise in deposits, coupled with a drop in cross-border credit from BIS banks since 1997, has led to a reversal in the net claim position of BIS reporting banks vis-à-vis emerging economies.[24]

As with petrodollars, the available counterparty data provide an incomplete picture of where the gross flow of capital from Asia is invested. Asia's total invested funds, cumulated over 1999–2005, are estimated to have been roughly $2.8 trillion. The left-hand panel of Figure 9 decomposes these invested funds into the change in foreign exchange reserves and the various components of the financial account. By far, official investment has been the major component of these countries' invested funds.[25,26] The right-hand panel of Figure 9, which splices various sources of counterparty data, provides some indication of where Asia's invested funds have gone.[27] Combined, these data can account for almost 46%, or $1.25 trillion, of Asia's invested funds (net of intraregional banking flows) cumulated since end-1998. The bulk of Asia's *identified* invested funds have been channelled into US securities.[28] In contrast, a relatively small share of their invested funds has been channelled into BIS reporting banks. Deposits placed in these banks had accounted for as much as 20% of invested funds cumulated between end-1998 and the first quarter of 2001, but this ratio had fallen to less than 10% by end-2005.

2. Stress testing with the BIS banking statistics

The above analysis relied on the BIS locational statistics to explore the structure and size of the international banking market from a *geographical* perspective. However, as highlighted in Figures 3 and 5, the nationality of a bank (identified by the location of its headquarters) and

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[23] For the purposes of this exercise, the major Asian countries are taken to be China, Hong Kong, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand.

[24] The stock of BIS reporting banks' net claims on borrowers in emerging Asia fell from $220 billion in the second quarter of 1997 to –$97 billion four years later.

[25] Reserve accumulation has accounted for 44% of Asia's total cumulative invested funds since end-1998. This is primarily accounted for by China, although reserve accumulation has been the major factor behind the rise in Korea's and Taiwan's invested funds as well.

[26] Intraregional investment should be removed from the estimate of invested funds for the region as a whole, so as to better approximate gross financial investment elsewhere in the world. The thick blue line in the right-hand panel of Figure 8 gives the estimate of invested funds from the region after stripping out intraregional flows reported by banks in Hong Kong, India, Korea, Singapore and Taiwan. Invested funds *net of intraregional banking flows* cumulated up to early 2004 were actually somewhat larger – by about $90 billion in 2002 – than the estimate implied by the balance of payments statistics alone.

[27] These counterparty data comprise estimated portfolio investment in Japan and the United States, FDI in the United States and other developed countries, and deposits placed in BIS reporting banks worldwide. The estimate of investment in US securities is constructed by using the TIC transactions data and the total holdings of long-term and short-term securities reported in the benchmark surveys. For long-term securities, the total stock of holdings by the major Asian countries is first estimated by taking the holdings as of the benchmark surveys, and tracking changes through time using the cumulative net purchases from the transactions data. Cumulative investment is then generated by subtracting the stock of holdings of long-term securities at end-1998. The stock of holdings of short-term securities is estimated assuming a value of 0 for 1985 and then interpolating between the benchmark survey dates. Cumulative investment in short-term securities since 1998 is then generated by subtracting the estimated holdings at end-1998.

[28] Accumulation of US short-term and long-term securities by residents of these countries since end-1998 totalled an estimated $871 billion, or 32% of their invested funds.

its location are very different things. For example, UK-headquartered banks account for roughly 25% of the total international claims of all banks located in the United Kingdom. Only by understanding the foreign exposures of national banking systems – eg UK-headquartered banks' *global* cross-border and local positions – can we begin to understand how shocks to the banking system are transmitted between banks.

Consider, for example, Japanese banks, which are funded to a large extent by Japanese residents. Much of the funds provided by these residents are routed through Japanese banks' offices in the United Kingdom (or other IBCs) before being distributed to borrowers around the world. An adverse shock to this source of funds might thus be expected to have a larger impact on Japanese banks than a shock affecting only the residents of the United Kingdom. Put differently, flows into and out of banks located in an IBC tend to depend only weakly on the economic conditions in that centre.[29] Shocks to the banks' global balance sheets, when considered on a consolidated basis, often have a bigger impact on the flow of funds through banks.

For this reason, it is important to consider the overall credit risk profile of internationally active banks when trying to understand what drives flows through the banking system. The BIS *consolidated* banking statistics, which group banks according to their nationality and net out inter-office positions, are useful in this regard, and make it possible to evaluate the credit and counterparty risk in internationally active banks' foreign exposures.[30]

The purpose here is to examine whether shocks to banks' foreign exposures have systemic risk implications. Broadly speaking, such shocks come in various flavours. Examples are government debt defaults (Russia and Argentina), moratoriums on the repayment of debt (Mexico), capital flight following changes in market perceptions (the Asian currency crisis) or possibly through disruptions in the interbank market caused, for instance, by the collapse of individual banks and a drying-up of liquidity. Credit events can be of systemic importance if they affect several national banking systems simultaneously (because of similar foreign exposures), or because they generate a contagion effect across national banking systems. The full impact of such credit events can be evaluated only by taking into account the potential "second-round" effects, whereby the failure of a particular national banking system results in a cascade of bank failures across reporting countries. The study of these two types of channels of systemic risk is similar in spirit to existing stress tests that have been limited to domestic banking systems.

The following three subsections outline how the BIS banking statistics can be used in assessing stability in the interbank market. The first section describes the relevant features of the BIS consolidated banking statistics, and presents estimates of national banking systems' foreign exposures. The following sections describe our proposed measure of capital adequacy, and one possible way of estimating banks' foreign exposures expressed on a *risk-weighted basis* (a necessary component of our capital adequacy measure). The final section presents these estimated capital adequacy ratios (for banks headquartered in seven reporting countries), and examines their sensitivity to various hypothetical shocks to foreign exposures and to various assumptions about loss-given-default.

The preliminary estimates – based on data for a limited number of reporting countries – suggest that shocks to banks' exposures to *emerging markets* have only a modest impact on reporting banks' capital adequacy. In contrast, a serious loss on these banks' exposures in

[29] This fact makes the interpretation of gravity models which rely on the BIS locational banking statistics difficult. Such models attempt to relate claim flows between banks in "host" countries to borrowers in "home" countries to home and host country GDP and "distance" measures.

[30] See McGuire and Wooldridge (2005) for a complete description of the BIS consolidated banking statistics.

the interbank market could conceivably push capital adequacy below the required 8% for banks headquartered in some reporting countries.

2.1 A snapshot of banks' foreign exposures

The BIS consolidated banking statistics match closely banks' risk management practices by throwing light upon a wide range of exposures. Whereas the BIS locational statistics in previous sections are strictly tied to geography, the consolidated statistics include the *worldwide* claims (ie claims of home offices and foreign branches) of banks' headquartered in a particular country.[31]

Until recently, the consolidated statistics included only sectoral claims on an *immediate borrower basis* (IB basis), or claims allocated to the country and sector of the contractual counterparty. Since March 2005, the data have included a sectoral breakdown of foreign claims on an *ultimate risk basis* (UR basis), or claims reallocated to the country where the ultimate obligor resides (Table 2).[32] These claims are broken down by sector, ie bank, public and non-bank private sectors, which allows for a finer evaluation of the credit risk in foreign claims. This change now makes it possible to measure interbank exposures, since the data better capture the *nationality* of the borrower rather than the borrower's country of residence. That is, the data now provide information on UK-headquartered banks' global exposure to US-headquartered banks.[33]

In addition, the new statistics now include information on banks' contingent facilities and derivative positions, which are potential foreign exposures. *Foreign claims*, which refers to items on the *assets side* of banks' balance sheets (traditionally loan and securities claims in the context of the BIS statistics), are a subset of banks' total *foreign exposure*, which also includes *contingent* positions booked on both the assets *and* the liabilities side of the balance sheet, specifically derivatives and credit commitments (contingent assets) and guarantees (contingent liabilities).[34, 35]

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[31] In other words, the consolidated statistics contain claims of "UK banks" as opposed to claims of "banks in the United Kingdom".

[32] Previously, a sectoral breakdown (IB basis) was available for only *international* claims but not for *local claims in local currency*. For example, interbank lending from a German bank to the branch of a US-headquartered bank in London would, on an immediate borrower basis, be reported as a claim on the banking sector in the United Kingdom. On an ultimate risk basis, however, this would be reported as a claim on *US banks*.

[33] Note the difference from the BIS locational banking statistics used in previous sections, which contain data on claims of banks *located in the United Kingdom* on borrowers *located in the United States*.

[34] The contingent positions are reported on an ultimate risk basis. Guarantees are contingent *liabilities* arising from an obligation to pay to a third-party when a client fails to perform some contractual obligation. Credit commitments are irrevocable obligations to extend credit at the request of a borrower. Derivative claims (ie positive market values) include, forwards, swaps, options and those credit derivatives held for trading by the reporting bank (independent of whether these are booked as off- or on-balance sheet items). Credit derivatives not held for trading are reported as risk transfers by protection-buying banks, and as guarantees by protection-selling banks.

[35] These contingent exposures totalled $7.5 trillion in the third quarter of 2005, compared to $17.7 trillion in loan and securities claims (UR basis). Derivatives are reported at market value, while guarantees and credit commitments are reported at book value. Thus, only if the market value is not significantly different from book value would an aggregation of these positions yield a measure of total contingent exposures.

Table 2

Consolidated foreign claims and other contingent exposures on an ultimate risk basis

In billions of US dollars

Provisional data

	Vis-à-vis developed countries		Vis-à-vis offshore centres		Vis-à-vis emerging markets		Total[1]	
	2005 Q2	2005 Q3	2005 Q2	2005 Q3	2005 Q2	2005 Q3	2005 Q2	2005 Q3
Memo: Foreign claims (after net risk transfers, Table 2)	*(16,978)*	*(17,681)*	*(1,141)*	*(1,123)*	*(1,983)*	*(2,151)*	*(20,174)*	*(21,030)*
Foreign claims after net risk transfers[2]	14,033	14,667	1,048	1,019	1,816	1,985	16,943	17,719
o/w: local claims	5,824	6,174	352	364	1,029	1,130	7,211	7,679
As % of foreign claims	(41.5)	(42.1)	(33.6)	(35.7)	(56.7)	(56.9)	(42.6)	(43.3)
By sector								
Banks	4,474	4,622	118	118	358	386	4,955	5,133
As % of foreign claims	(31.9)	(31.5)	(11.3)	(11.6)	(19.7)	(19.4)	(29.2)	(29.0)
Public sector	2,641	2,719	48	50	406	429	3,130	3,234
As %	(18.8)	(18.5)	(4.5)	(4.9)	(22.4)	(21.6)	(18.5)	(18.3)
Non-bank private sector	6,560	6,891	844	810	835	937	8,249	8,651
As %	(46.7)	(47.0)	(80.5)	(79.5)	(46.0)	(47.2)	(48.7)	(48.8)
Unallocated	359	435	39	40	217	233	608	701
As %	(2.6)	(3.0)	(3.7)	(3.9)	(11.9)	(11.8)	(3.6)	(4.0)
Other exposures								
Derivatives contracts[3]	2,150	2,069	70	70	94	112	2,322	2,258
Guarantees extended[4]	1,070	1,205	107	126	118	133	1,301	1,470
Credit commitments[5]	2,783	3,055	324	344	292	337	3,406	3,747

[1] Includes positions vis-à-vis international organisations and unallocated. [2] Based on data reported by 24 countries which submitted both sets of data in 2005 Q2 and Q3 and also provide risk transfers and detailed breakdown and contingent exposures. Greece and Ireland are semiannual reporters (Q2 and Q4); data for these two countries relate to 2005 Q2. The data for Spain are carried forward from 2005 Q2 for the preliminary release. [3] Excluding Austria and Chile. Positive market values only. [4] Excluding the United States. [5] Excluding Chile.

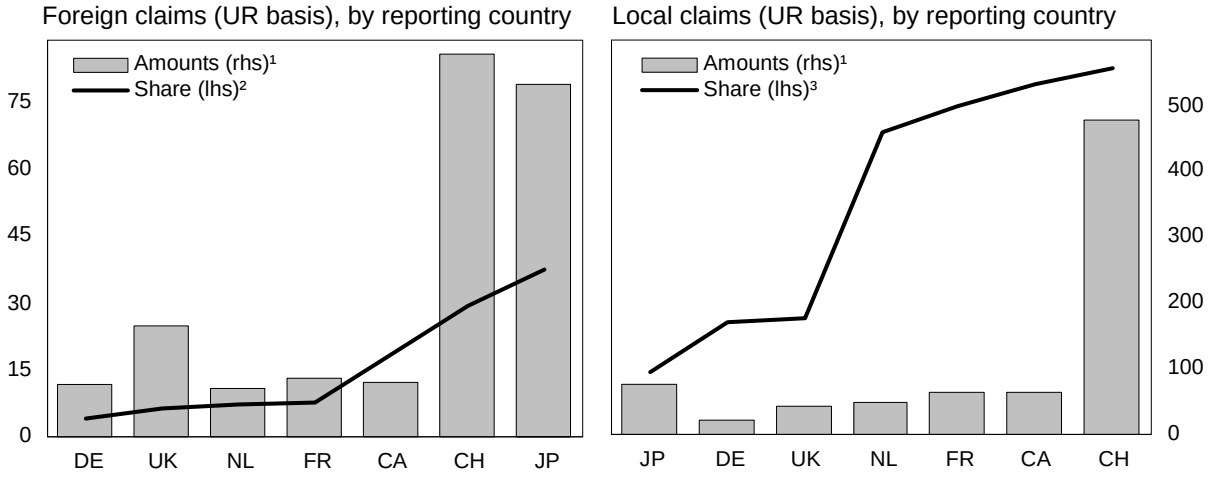
Overall, foreign exposures are sizeable relative to reporting banks' total assets. Foreign claims (consisting of loan and securities claims) accounted for almost 40% of the total assets reported on the balance sheets of internationally active banks headquartered in 10 of the BIS reporting countries.[36, 37] As of the third quarter of 2005, outstanding foreign claims amounted to less than 20% of US, Australian and Italian banks' total balance sheet assets. By contrast, they amounted to more than 50% for UK and Belgian banks, and to more than 60% for Swiss banks.

Assets carrying low credit risk play an important role in banks' portfolio management, and are often used as collateral in financial transactions. Thus, banks are naturally expected to absorb a significant share of the supply of low-risk government debt (ie debt issued by governments in industrialised countries). Yet BIS reporting countries exhibit disparate propensities to hold low-risk claims on foreign public sectors (Figure 10, left-hand panel). For example, one third of Swiss banks' and almost 45% of Japanese banks' total foreign exposures are claims on the public sector in industrialised countries. Combined, these reporting banks account for roughly 60% of the $1.9 trillion in all reporting banks' foreign claims on the public sector in industrialised countries.

Figure 10

Bank claims on the public sector of industrialised countries

As of 2005 Q3, in per cent



CA = Canada; CH = Switzerland; DE = Germany; FR = France; JP = Japan; NL = Netherlands; UK = United Kingdom.

[1] Claims of BIS reporting banks, in billions of US dollars. [2] Claims on the public sector in industrialised countries in total foreign claims, in per cent. [3] Estimated local claims in all public sector claims on industrialised countries.

Sources: ECB; Board of Governors of the Federal Reserve System; Bank of Japan; BIS.

[36] This share drops by only about 6 percentage points if intra-euro area exposures are netted out from total foreign exposures. These 10 reporting countries are Australia, Belgium, Canada, Finland, France, Italy, the Netherlands, Switzerland, the United Kingdom and the United States.

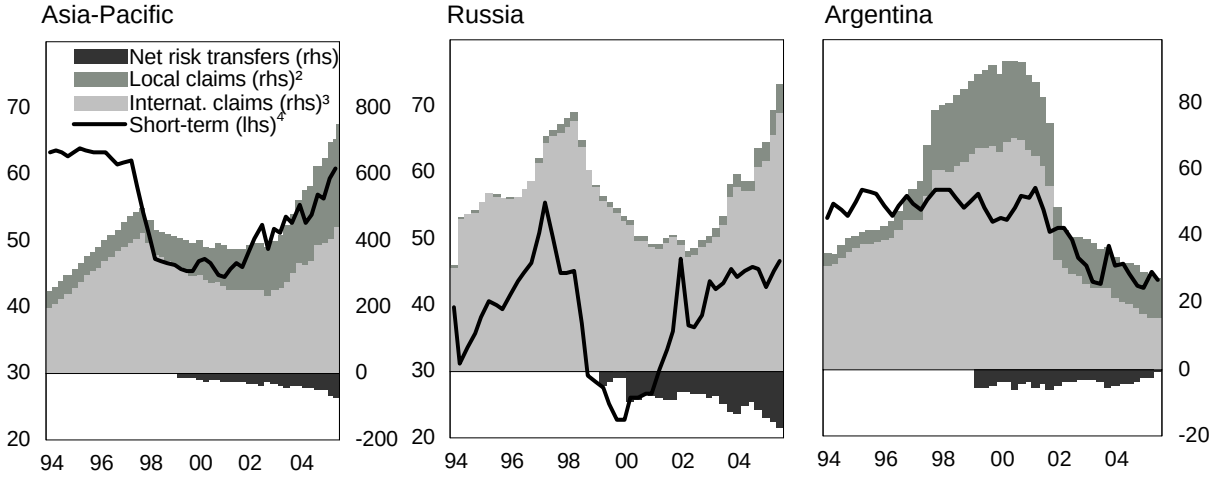
[37] Across all of the 10 reporting countries, the share rises to almost 60% if banks' estimated foreign exposures are considered, ie their derivative and contingent exposures are included in the numerator.

Banks also have large exposures to emerging markets, which have fluctuated significantly during periods of market stress. In the fourth quarter of 2005, foreign claims on emerging economies stood at $2.3 trillion, or 12% of reporting banks' total foreign claims (IB basis). As shown in Figure 11, periods of financial turbulence, such as the Asian crisis (1997) or the sovereign debt crises in Russia (1998) and Argentina (2001), were seen to induce dramatic swings in claims when measured on an immediate borrower basis.

Figure 11

Foreign claims on selected emerging economies, by sector and type[1]

In billions of US dollars



[1] BIS reporting banks' consolidated foreign claims (IB basis). [2] Foreign offices' local currency claims on local residents. [3] Cross-border and foreign offices' local claims in foreign currencies. [4] As a share of total international claims.

Claims on borrowers in emerging markets sometimes have third-party guarantors, leading to net risk transfers out of the borrowing country. A portion of foreign claims (mainly loan and securities claims (IB basis)) on emerging markets is transferred to the major developed countries, as are claims on borrowers in international hubs of financial intermediation (eg London and offshore centres) (Figure 12). Expressing banks' foreign claim positions on emerging markets on an *ultimate risk* basis*,* ie taking these net risk transfers into account, provides a more accurate picture of banks' true exposure. Measured in this way, foreign claims (ie excluding contingent exposures) stood at $2 trillion, or 11% of total foreign claims (UR basis), although differences across reporting countries are apparent (Figure 13).[38]

2.3 Foreign exposures and capital adequacy ratios

What effect would a major shock to emerging markets or a drying-up of liquidity in the interbank market have on the capital adequacy position of a particular banking system? To begin to answer this question, we need an appropriate measure of the *aggregate* capital adequacy ratio of the banks headquartered in a particular reporting country. One simple

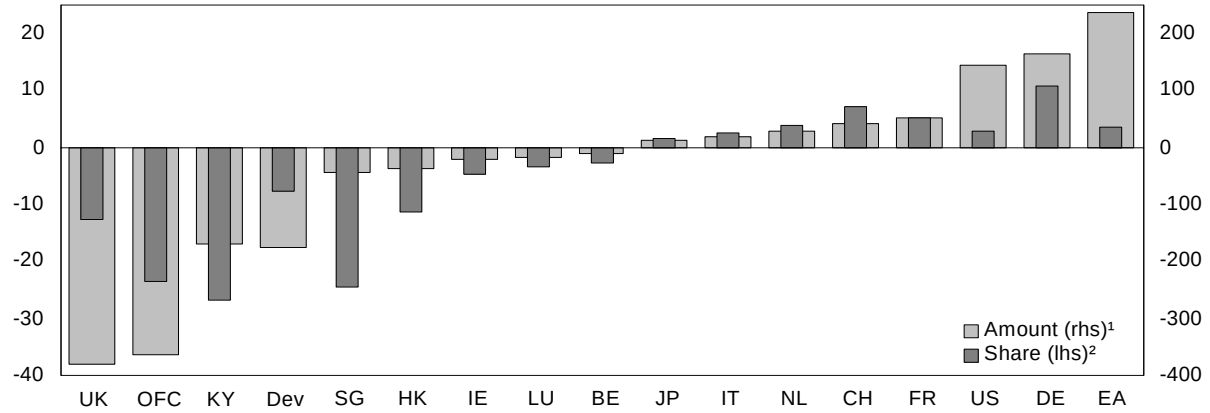
[38] For example, Austrian, US and Spanish banks' foreign claims (UR basis) on emerging markets accounted for 43%, 29% and 27% respectively of their total foreign claims. By contrast, this share is below 10% for other major reporting countries. Virtually all of Austrian and Spanish banks' foreign claims (loans and securities) on emerging markets are on borrowers in emerging Europe and Latin America, whereas US banks' foreign claims are split roughly equally between borrowers in Latin America and Asia-Pacific.

measure is the ratio of these banks' total Tier 1 and Tier 2 capital to their total risk-weighted assets.

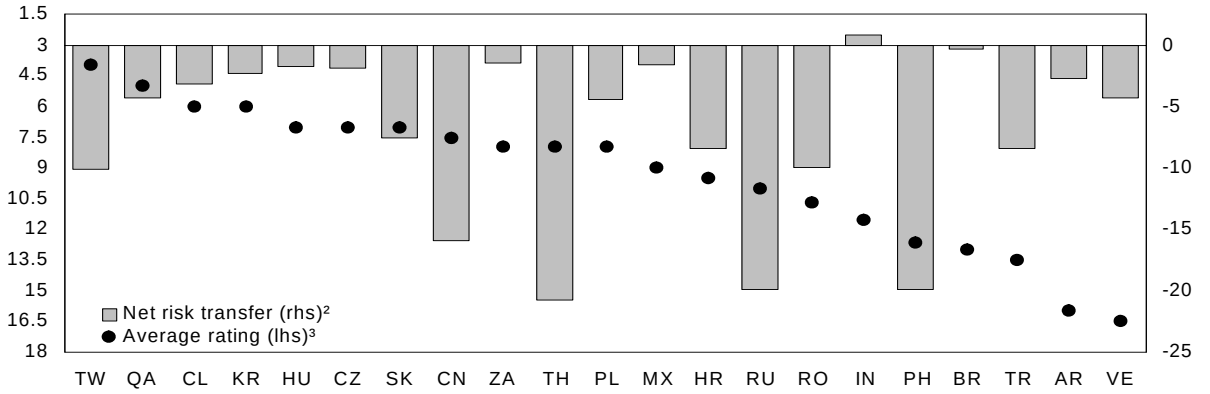
Figure 12

Net risk transfers by vis-à-vis country

From selected countries and regions



From emerging markets, by debtor country



AR = Argentina; BE = Belgium; BR = Brazil; CH = Switzerland; CL = Chile; CN = China; CZ = Czech Republic; DE = Germany; Dev = developing countries; EA = euro area; FR = France; HK = Hong Kong SAR; HR = Croatia; HU = Hungary; IE = Ireland; IN = India; IT = Italy; JP = Japan; KR = Korea; KY = Cayman Islands; LU = Luxembourg; MX = Mexico; NL = Netherlands; OFC = offshore centres; PH = Philippines; PL = Poland; QA = Qatar; RO = Romania; RU = Russia; SG = Singapore; SK = Slovakia; TH = Thailand; TR = Turkey; TW = Taiwan (China); UK = United Kingdom; US = United States; VE = Venezuela; ZA = South Africa.

[1] In billions of US dollars. [2] As a share of foreign claims of all reporting countries on that country, on an IB basis. A negative number implies a transfer away from the residents of a vis-à-vis country. [3] Standard & Poor's foreign currency sovereign ratings as of January 2006.

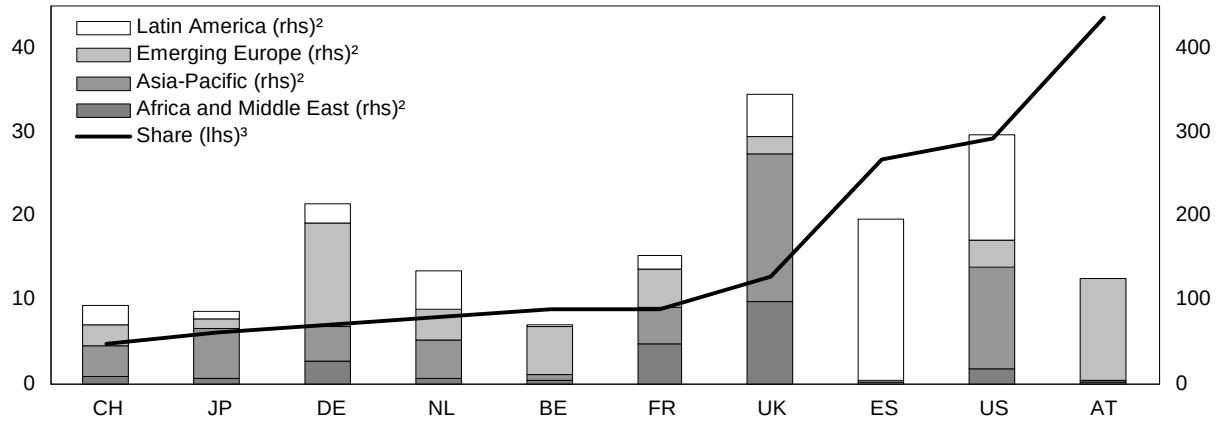
Formally, the aggregate ratio for banks headquartered in reporting country i is

$$CAR_i = \frac{Tier_{1,i} + Tier_{2,i}}{RWA_i^{for} + RWA_i^{dom}}$$

where RWA_i^{for} is risk-weighted foreign assets and RWA_i^{dom} is risk-weighted domestic assets.

Figure 13

Foreign claims (UR basis) on emerging economies, by region[1]



AT = Austria; BE = Belgium; CH = Switzerland; DE = Germany; ES = Spain; FR = France; JP = Japan; NL = Netherlands; UK = United Kingdom; US = United States.

[1] Reporting countries listed on horizontal axis. [2] Includes loan and securities claims, in billions of US dollars. [3] Foreign claims on emerging markets in total foreign claims, in per cent.

A negative shock to banks' foreign exposures would lead to a fall in this ratio through at least two channels. The first effect – the "direct effect" – is the change in the ratio which results from losses on the direct exposures to the borrower. Consider a negative shock to banks' foreign assets of size ΔA, and suppose that the loss-given-default (LGD) is $\lambda \in (0,1)$. The new level of reporting banks' capital adequacy ratio can be estimated by subtracting off the *ultimate risk* value of these foreign exposures ($\lambda * \Delta URA_i^{for}$) from the numerator, and the *risk-weighted* value of these foreign exposures ($\lambda * \Delta RWA_i^{for}$) from the denominator. The second effect – the "ratings effect" – is the decline in the ratio due to a reduction in the credit quality of the borrower. As credit quality declines, the risk weights applied in calculating risk-weighted assets would increase, leading to a rise in the denominator.[39]

2.4 Estimating risk-weighted foreign assets

Actually computing this aggregate measure of capital adequacy poses some challenges. First, it requires data on the risk-weighted assets and equity capital of internationally active banks (ie banks which report in the consolidated data). This is confidential information in many countries. We have received data on total (domestic and foreign) risk-weighted assets and equity capital (for the third quarter of 2005), aggregated across individual banks

[39] As a concrete example, consider a case where a borrowing country's sovereign rating is downgraded in anticipation of a default. Under the standardised approach of Basel II, a lowering of the borrowing country's sovereign rating may require that banks' apply higher risk weights to their exposures to the *banking* and the *non-bank private sectors*, as well as to their exposure to the public sector. This change in the value of risk-weighted foreign exposures can be approximated by taking the difference in the risk-weighted exposure (calculated as described above) to the borrower under the original and default status sovereign ratings.

reporting in the consolidated statistics, for the following reporting countries.[40] The remainder of this analysis relies on these data alone, and thus constitutes only a partial investigation of contagion in the international banking market. Absent data on other large national banking systems, it is impossible to gauge the full effect of shocks.

A second challenge is the estimation of risk-weighted *foreign* assets for these banking systems. The Basel II guidelines provide banks with several different choices on how they can calculate risk-weighted assets. The most sophisticated of these methodologies, the internal ratings-based approach (IRB approach), allows individual banks to assign ratings to individual borrowers based on internal estimates of probability of default (PD) and LGD. This approach is likely to be used by the large internationally active banks which report in the BIS consolidated banking statistics. However, these statistics are aggregated, across both borrowers and lenders, at the country level and do not allow the researcher to estimate exposure-specific PDs and LGDs. As a result, our estimates of risk-weighted foreign assets are based on the simpler standardised approach of Basel II. Under this approach, risk weights rely solely on borrower ratings provided by external rating agencies.

For banks' foreign exposures to the banking and public sectors, the application of the standardised approach is fairly straightforward. The Basel II guidelines provide a simple mapping from the sovereign rating of the country of residence of the ultimate obligor to risk weights for each of these sectors.[41]

In contrast, the risk weights applied to BIS reporting banks' exposure to corporate borrowers (ie the non-bank private sector) must be estimated. Under the Basel II standardised approach, banks should use external corporate ratings – on a borrower by borrower basis – in calculating risk-weighted assets. However, such fine detail is not available at the aggregated level of the BIS consolidated banking statistics. Simply using the sovereign rating of the country where the corporate borrower resides would lead to a downward bias in risk-weighted exposures since, in most countries, the sovereign rating represents an unofficial ceiling on that country's corporate ratings. Moreover, claims on the non-bank private sector include everything from corporate loans to mortgage and other secured lending.

We draw on information contained in data on international syndicated loans to help in creating more accurate risk weights for the non-bank private sector in individual borrowing countries. The syndicated loan database contains borrower-specific information from the tombstones for all international loan syndicates. Thus, the average credit rating across all individual corporate borrowers in a particular country can be constructed. That rating is then translated into an average risk weight for the non-bank private sector in each borrowing country using the mapping in the Basel II guidelines.[42] This approach will tend to understate the risk weight in countries where only highly rated borrowers participate in the syndicated

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[40] Combined, these seven countries account for 43% of all BIS reporting countries' foreign exposures (excluding derivative and contingent claims). Total capital for these banks stood at $945 billion in the third quarter of 2005, or 3% of their $34.8 trillion in total balance sheet assets. Total foreign exposures (UR basis), at $7.363 trillion, accounted for 21% of their total assets.

[41] This analysis relies on Standard & Poor's sovereign rating for end-Sept 2005 for over 125 countries. Exposure to these sectors in unrated countries is given a risk weight of 100%. Unrated countries account for only 4% of total foreign claims (UR basis) on all borrowers, and only 6% of total foreign claims (UR basis) on emerging markets.

[42] Specifically, for each borrowing country, the syndicated loan data are first used to estimate the share of borrowers without a corporate credit rating. This share is then applied to each reporting country's exposures to the non-bank sector in the borrowing country, and assigned a risk weight of 100%. The remaining share is given a risk weight which corresponds to the average rating of those corporates in the borrowing country which do have an external rating. In many cases, the information on the borrower's rating is often missing in the syndicated loan database. As a result, the risk weight applied to the non-bank private sector in most emerging markets is very close to 100%.

loan market. Conversely, it will tend to overstate the risk weight in countries where mortgage and other collateralised lending is a significant portion of foreign exposures. For these reasons, the analysis below focuses primarily on the public and banking sectors.

Our estimates of risk-weighted exposures allow us to gauge the riskiness of the portfolios of national banking systems. Expressed on a risk-weighted basis, exposures to less risky obligors contract more (or expand less) than exposures to riskier obligors. Reporting banks' largest claims are on highly rated borrowers and thus carry small risk weights. In particular, roughly 80% of BIS reporting banks' total exposures to the public sector ($3.2 trillion) and to the banking sector ($5.1 trillion) is concentrated in the United States, the United Kingdom, the euro area and Japan. Most of these claims receive a zero or 20% risk weight under the standardised approach of Basel II and, consequently, require small capital charges. By contrast, exposures to lower-rated borrowers, which can carry a risk weight equal to or greater than 100%, are fairly limited.

Reporting banks' emerging market portfolios carry higher credit risk. Converted on a risk-weighted basis, banks' aggregate foreign claims on emerging economies contract by 18%, while the corresponding contraction in banks' overall portfolios is 54%. That said, individual banking systems differ with respect to the risk profile of their emerging market exposures (Figure 14). For example, Belgian, Irish and Australian banks' emerging market portfolios contract by roughly 30% on a risk-weighted basis. In contrast, German, French and UK banks see a somewhat smaller contraction.[43]

The least risky portion of banks' exposures to emerging markets consists of claims on the public sector. Foreign claims on this sector in Korea, Poland, Malaysia, the Czech Republic, Taiwan (China), Hungary, Mexico and China – all investment grade countries – totalled $275 billion, or two thirds of total foreign claims on emerging market public sectors. These claims receive a risk weight of 50% or less, leading to a 46% contraction in the overall exposure to emerging market public sectors on a risk-weighted basis. By contrast, exposures to banking sectors in emerging markets are deemed considerably riskier and contract by roughly 25%.

2.5 Shocks to banks' capital adequacy

Using our estimates of risk-weighted foreign assets described in the previous section, we now turn to an investigation of the sensitivity of banks' capital adequacy ratios to various shocks. In this analysis, we present the results from only two hypothetical shocks – a loss on exposures to emerging market borrowers, and a loss on exposures in the interbank market – in order to illustrate how the BIS banking statistics can be used to identify vulnerabilities in the international banking system. A host of alternative scenarios could also be investigated using this framework.

Overall, our preliminary analysis indicates that only very large shocks to emerging markets can lead to the collapse of national banking systems. Banks' exposures to individual emerging markets are small relative to their total capital. Thus, exposures to any single emerging market are not large enough to have a substantial effect on the estimated capital adequacy ratios. In contrast, larger shocks *can* have an effect. To illustrate, consider a shock to banks' foreign exposures to *all* emerging markets simultaneously, an admittedly extreme scenario. The lines in Figure 15 trace out the aggregate capital adequacy ratio for banks headquartered in particular reporting countries as a sliding scale of LGD on their exposures to these borrowers. As shown in the left-hand panel, which considers a shock to public sector

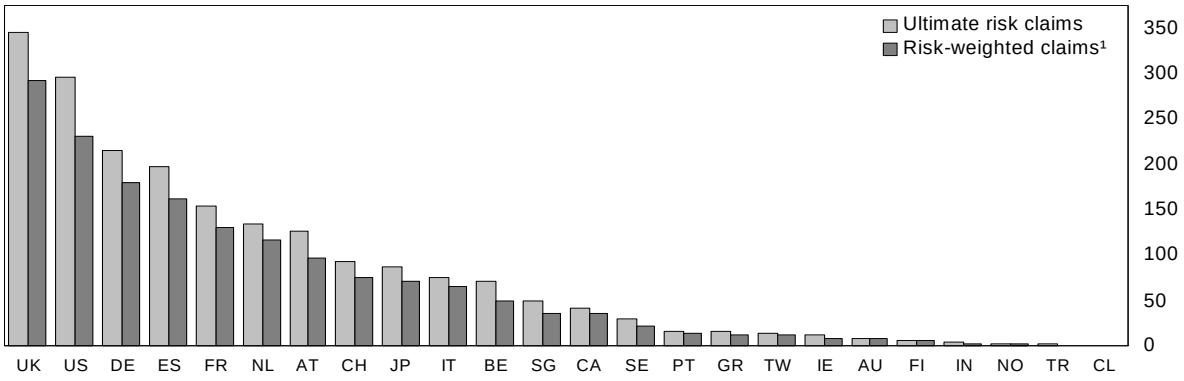
[43] The estimate for banks headquartered in the United States is particularly poor because as much as 45% of these banks' foreign claims are not allocated to a particular sector. These unallocated claims were risk-weighted the same as claims on the banking sector in the borrowing country.

and banking sector exposures only, LGD would have to exceed 60% before any of the estimated capital adequacy ratio for any national banking system dipped below 8%. Moreover, even a 100% LGD on these exposures would still leave these banking systems with a *positive* ratio, implying that total capital has not been driven to zero. The more extreme case, in the right-hand panel, does lead to the collapse of several banking systems, but only at LGDs beyond 70%.

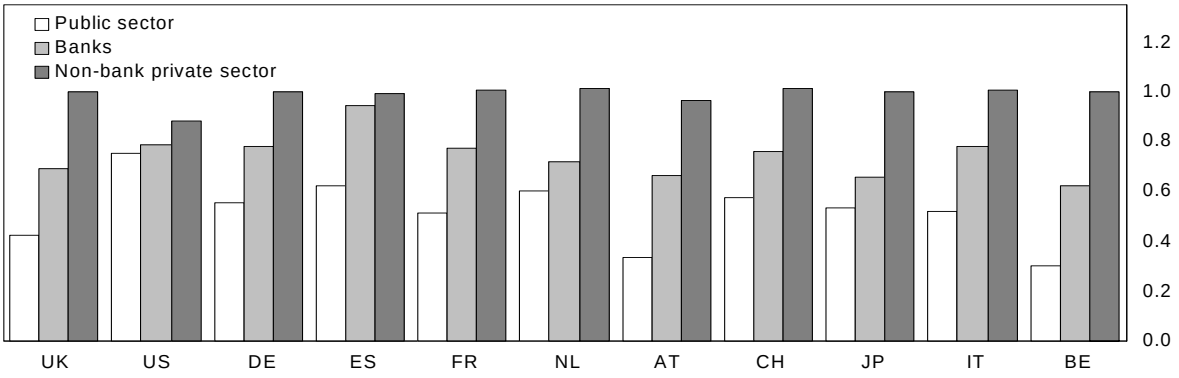
Figure 14

Foreign claims (risk-weighted and UR basis) on emerging economies

Total claims



By sector



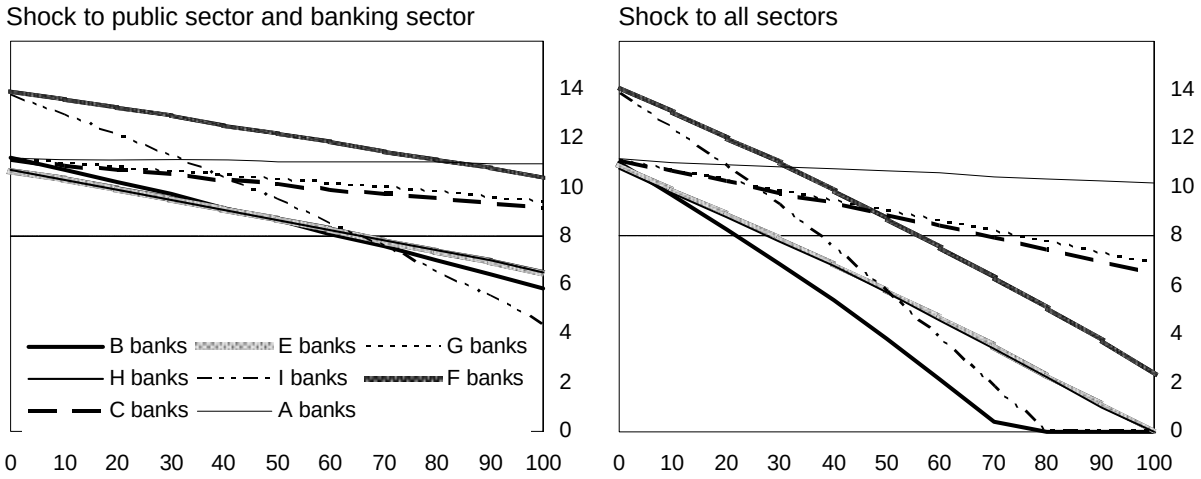
AT = Austria; AU = Australia; BE = Belgium; CA = Canada; CH = Switzerland; CL = Chile; DE = Germany; ES = Spain; FI = Finland; FR = France; GR = Greece; IE = Ireland; IN = India; IT = Italy; JP = Japan; NL = Netherlands; NO = Norway; PT = Portugal; SE = Sweden; SG = Singapore; TR = Turkey; TW= Taiwan (China); UK = United Kingdom; US = United States.

[1] Calculated by applying risk weights to the foreign claims of banks headquartered in a particular reporting country. The risk weights vary by vis-à-vis country and by sector, and are based on the standardised approach under the Basel II guidelines.

Figure 15

Response of banks' capital ratios to shock to emerging markets

In per cent

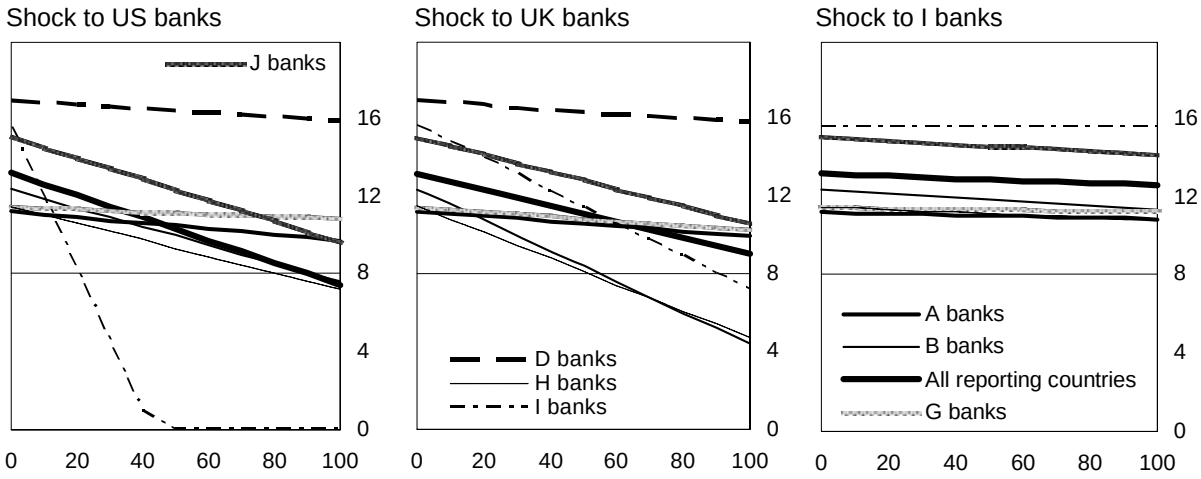


Note: The vertical axis measures the change in reporting countries' banks' estimated capital adequacy ratio for a range of LGD on their exposures to residents in emerging markets. LGD is measured on the horizontal axis.

Figure 16

Response of banks' capital ratios to interbank shocks

In per cent



Note: The vertical axis measures the change in reporting countries' banks' estimated capital adequacy ratio for a range of LGD on their exposures to US, UK and I banks. LGD is measured on the horizontal axis.

A similar analysis is presented in Figure 16, which shows the response of banks' capital adequacy ratios to hypothetical shocks in the interbank market. Interbank exposures are the vehicle through which shocks to individual countries or banking systems are transmitted to other banking systems

Thus, whether or not interbank exposures themselves are large enough to drive capital to zero for any particular banking system will determine, in this framework, whether "second-round" effects are even possible.

The three panels in Figure 16 show, respectively, the effect that a collapse in the market value of exposures to US banks, UK banks and I banks would have on capital adequacy ratios for banks headquartered in particular reporting countries. As shown in the left-hand panel, I banks' capital ratio would fall below 8% at just over a 30% loss on their exposures to US banks. In contrast, a total loss of 80% or more would be required to drive the capital ratio of H banks and B banks to 8%. A shock to UK banks has an equally large effect on some banking systems: capital ratios for B banks, I banks and H banks fall below 8% at total losses on exposures to UK banks of 50% or more. In contrast, exposures to I banks appear to be limited. Even a total loss on exposure to these banks would have only a modest effect on reporting banks' capital ratios.

As mentioned above, restricting the exercise to seven countries makes it impossible to accurately quantify the scope of a shock to the interbank market. Thus, the above exercise should be viewed as an illustration of what can be done with the BIS banking statistics, rather than an accurate description of the vulnerabilities in the international banking market. Data for a broader sample of reporting countries would, for example, shed light on the fraction of the *overall* capital of internationally active banks that would be wiped out by the collapse of a particular banking system.

Likewise, richer data would facilitate a more comprehensive analysis of possible contagion in the international banking system due to "second-round" effects. As shown in Figure 16, I banks' capital would be wiped out by a 50% loss on their exposure to US banks. This does not generate second-round failures across the remaining banking systems for which we have data because of the limited exposure of these banking systems to I banks. Whether this remains true for other banking systems is not known.

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