INTERNATIONAL MONETARY FUND

Mapping Cross-Border Financial Linkages: A Supporting Case for Global Financial Safety Nets

Prepared by the Strategy, Policy, and Review Department

In consultation with other departments

Approved by Reza Moghadam

June 1, 2011

Contents Page

I. EXECUTIVE SUMMARY

Objectives. This paper maps cross-border financial linkages and identifies factors that drive them, contributing to the discussion on the appropriate design of a global financial safety net (GFSN). It builds on previous staff work and complements the findings of the companion paper on the *Analytics of Systemic Crises and the Role of Global Financial Safety Nets.* This paper notes the growing roles of financial linkages and complexity in injecting latent instability into the global financial system, underscoring the value of a GFSN design that is effective in forestalling the risk that a localized liquidity shock propagates through the global financial network turning into a large-scale systemic crisis.

Mapping the linkages. Cross-border financial linkages have increased dramatically over time and have become more complex. Yet, a few "core" advanced economies (AEs), including some financial centers, still dominate the web of linkages across asset classes and regions, both as sources and recipients. As a result, emerging markets' (EMs) strongest linkages remain with AEs, even though cross-EM linkages have increased very rapidly during the last decade (from a low base).

Systemic instability. Increased cross-border financial linkages promote risk diversification at the individual country level, reducing exposure to localized shocks. However, increased interconnectedness, by facilitating transmission of shocks, also generates a network externality that makes the global financial network more prone to systemic risk—the risk that shocks to a "core" node leads to a breakdown of the entire network. Moreover, as the extent and complexity of cross-border financial linkages grow, investor information about specific exposures becomes less certain, amplifying systemic risks from panic responses to shocks.

Shock transmission. The paper points out that (i) countries with shallow domestic financial markets and concentrated exposures to a few lenders are more prone to synchronized shifts in cross-border flows; and (ii) common factors (such as global risk aversion) increasingly drive global financial markets and tend to intensify abruptly during periods of stress, amplifying shock transmission. These features point to potentially large costs of systemic shocks to "crisis bystanders" (countries with relatively strong fundamentals for which the likelihood of an idiosyncratic crisis is normally low), and reinforce the case for a GFSN that is designed to help ring-fence such countries from systemic shock contagion.

Determinants of linkages. Empirical evidence shows that geographical and historical factors remain important determinant of cross-border linkages—in particular, stronger linkages occur among economies closer to each other, and those that are larger, more developed, and financially more advanced. Beyond providing general principles that could underpin the design of a GSFN, these findings suggest that an insurance mechanism against sudden shifts in cross-border exposures driven by aggregate or global shocks is essential to complement local or regional risk-sharing mechanisms.

II. CONTEXT AND MOTIVATION[1]

1. ***Global trends***. Global economic linkages have intensified dramatically over the past two decades, underpinned by an exponential rise in trade and financial flows (Figure 1). Cross-border linkages have been dominated by financial flows among advanced economies (AEs). However, flows to, and among, emerging markets (EMs) have also risen in importance, both in absolute terms and in relation to the size of their economies.[2] As linkages among economies have intensified, their patterns have also grown in complexity. One example of growing complexity in cross-border financial networks is the thickening of the web of financial links among European EMs observed during the last decade (Figure 2).

2. ***Focus of this paper***. Understanding the evolving nature of cross-border financial linkages—the "plumbing" of the global economy—helps map out the channels through which shocks are potentially transmitted, and better tailor global and local policy responses to shocks. The recent crisis has vividly illustrated the costs and benefits of increased interconnectedness—"linkages" and "interconnectedness" will be used interchangeably in this paper—exposing lacunae in the global financial architecture. This experience carries important lessons, which this paper and the companion paper on the *Analytics of Systemic Crises and the Role of Global Financial Safety Nets* (*Systemic Crises* paper from now) aim to internalize. A key goal of this paper is to map and explain the drivers of cross-border financial linkages and their macroeconomic consequences. The resulting empirical evidence lends support to the establishment and appropriate design of a global financial safety net (GFSN) that mitigates the impact of global liquidity shocks.

3. ***Linkages and systemic instability***. This paper's main thesis is that efforts to increase the resilience of the global financial system face a delicate trade-off between (a) the benefits at the country level from increased international risk diversification—a force that pushes toward increasing the system's overall interconnectedness (i.e., the number of linkages in the network)—and (b) the increased systemic risk that this heightened interconnectedness generates at the global level. This trade-off can be understood using insights from network theory, which has been applied to understand the properties of complex financial networks and their implications for financial stability (Box 1 and Annex II). It is the fundamental—and to some extent unavoidable—tension between country-level benefits and the externality they create via increased systemic fragility that provides the key rationale for erecting truly global defenses against liquidity shocks that go beyond the national and regional boundaries.

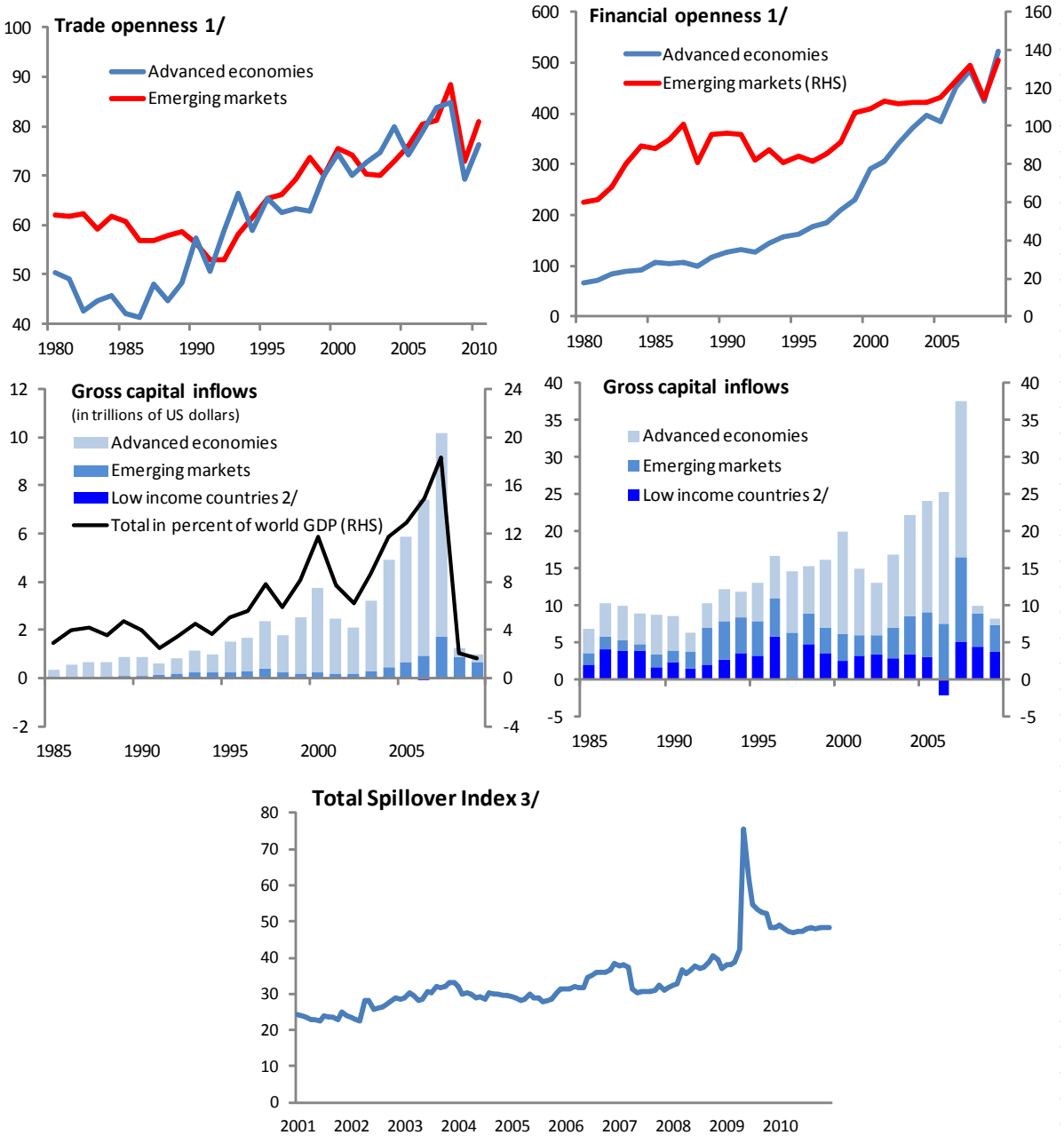
---

[1] Prepared by an SPR team comprising R. Bi, M. Chivakul, M. Goretti, K. Guo, S. Lanau, R. Llaudes, Y. Miao, J. Noah Ndela Ntsama, N. Porter, F. Presciuttini, F. Salman, and C. Serra (now in WHD), and led by R. Benelli under the supervision of L. Giorgianni.

[2] The country groupings used in this paper are described in Annex 1. Data availability permitting, these groupings will be used consistently throughout the paper.

Figure 1. Increasing Global Linkages

(percent of GDP, unless otherwise indicated)



Sources: Direction of Trade Statistics; Lane and Milesi-Ferretti (2006), updated through 2009, Datastream, Bloomberg, WEO and IMF staff calculation. Capital flows charts are from IMF (2010a).

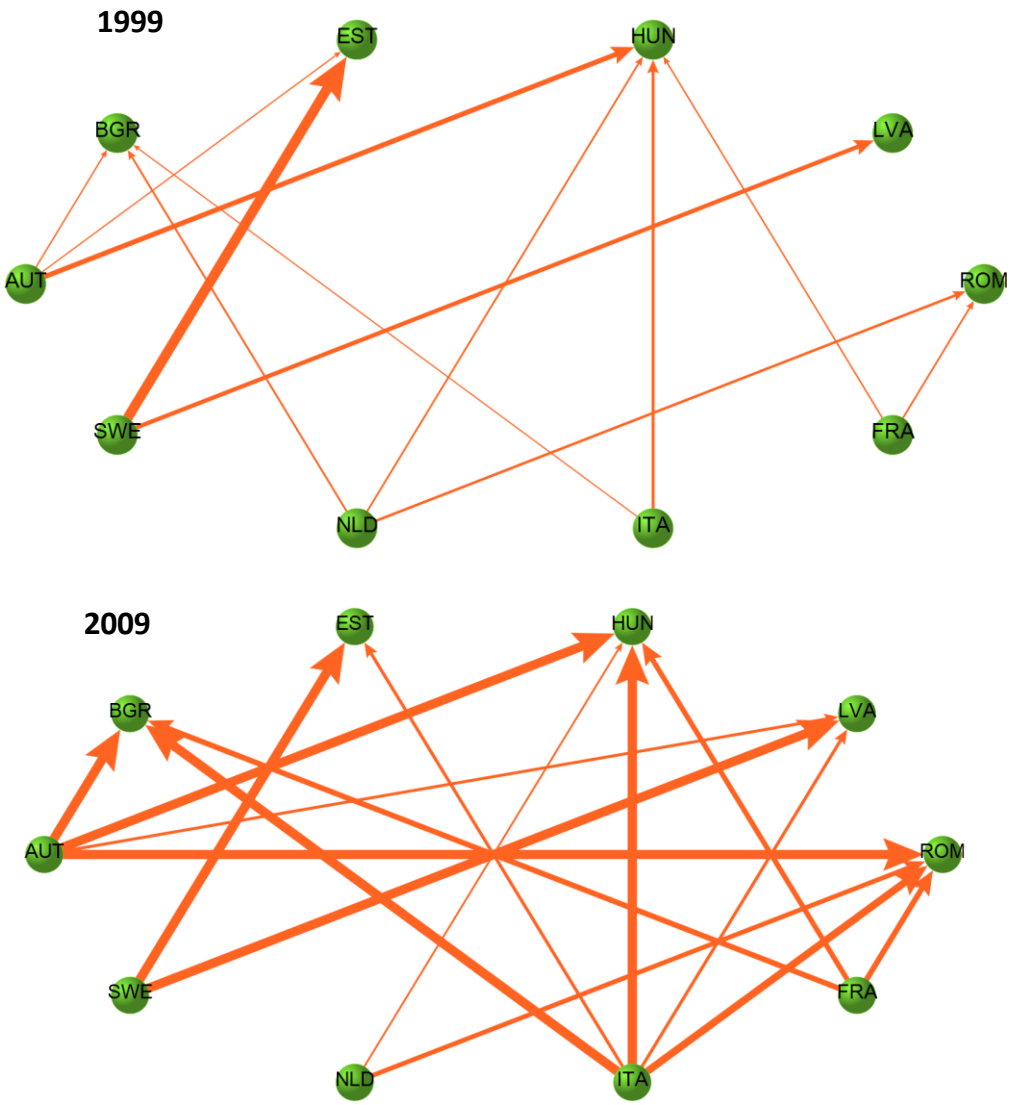
1/ Trade openness is the sum of exports and imports as a share of GDP. Financial Openness is the sum of external assets and liabiliites as a share of GDP.

2/ WEO classification.

3/ Index calculated based on Diebold and Yilmaz (2009,11). Intuititively, this index captures the magnitude of spillovers across markets by computing the total share of forecast variance explained by shocks originating in other markets. The estimated model included the VIX, S&P500, a commodity price index, the Fed fund rate, and the first principal component of EM real stock market returns. The index is calculated over rolling samples of 60 months. See annex V for details.

Figure 2. Cross-Border Bank Claims Between European AEs and EMs 1/

(1999 vs. 2009)



Source: BIS; and IMF staff calculations

1/ The figures show foreign bank claims among a subset of advanced and emerging European countries in 1999 and 2009. The origin of the arrows indicates the country of origin of the banks holding the claims, while the arrows' thickness is proportional to the size of the claims (scaled by the recipient's GDP).

Box 1. Financial Networks and Systemic Risks[3]

Robust yet fragile network. As argued in the financial network literature, interconnectedness is a double-edged sword: it has the potential of making a network more *robust* via improved risk sharing, yet it could also render a network more *fragile* by increasing systemic risk. At a low level of interconnectedness, additional links among countries make the system more "robust" by strengthening individual countries' ability to withstand shocks. Efforts to reduce interconnectedness may reduce welfare from the perspective of an individual country. However, in a complex network, even an initially localized shock to a "core node" could propagate widely and in a non-linear fashion through the network, leading to costly systemic crises. Such latent fragility of complex networks results from the tension between country-level optimal choices (better risk sharing via more linkages) and the externalities to the system (higher systemic risks). These negative externalities are unlikely to be internalized by individual countries.

Complex networks and incomplete information. A complex network is likely to give rise to incomplete information and increase the potential for herding behavior, flight to quality and liquidity crunches, as shown in a growing body of literature. As a result, even countries not considered to be "systemic" *ex ante* (i.e., small and less connected countries) could trigger "systemic" market responses, as their crises serve as a "wake up" call to creditors, triggering a broad-based pull back from other similarly-situated countries.

Concentration risks. Additional risks arise in a network where recipient countries have an unusually large concentration of exposures to a few sources. In these circumstances, a large shock hitting a main source could create more severe deleveraging than in an alternative situation where all links are uniform across sources. Higher concentration increases exposure to local/regional shocks and thus reduces the benefit of regional or local insurance mechanism based on local/regional risk-sharing.

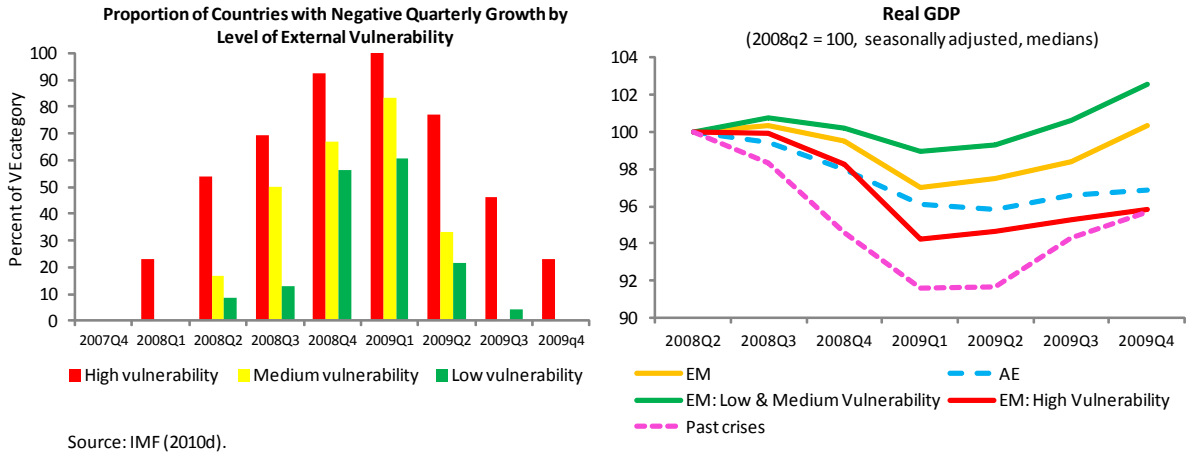
Stylized facts. Based on measures developed in the literature to capture network characteristics (Annex II), interconnectedness is much stronger for AEs than EMs and has generally increased in the last decade across the two groupings as well as across asset classes. In EMs, interconnectedness is higher for cross-border bank claims than portfolio claims. Concentration is still significantly higher in EMs than AEs, but has generally been on a declining trend in the past decade. The most notable exception is cross-border bank claims in European EMs, for which concentration increased rapidly in the years before the crisis.

4. ***National defenses***. The increased systemic instability arising from growing cross-border linkages often manifests itself in capital flow volatility. This volatility can be mitigated in principle at the national level by accumulating international reserves as a form of self insurance and taxing the externality-generating flows (or by throwing sand in the wheels through administrative or prudential measures). Taxing away the negative externality is, however, complicated by the difficulty of measuring the unobservable externality and by the need to properly account for the (equally difficult to quantify) multilateral benefits of increased interconnectedness. Pursuing self insurance is also constrained by the potential fiscal costs of carrying (low-yielding) foreign assets, the diminishing returns to reserve accumulation (IMF, 2010d), and the fear of using reserves in times of crisis. Not surprisingly, the recourse to taxes and self insurance has varied considerably across countries (IMF, 2011c, and Magud and others, 2011).

[3]Prepared by Ran Bi and Sergi Lanau. See Annex II for a review of literature on financial networks, technical details of network measures and charts.

5. ***Regional and global defenses***. To the extent that national defenses are insufficient to reduce the source of volatility and instability embedded in the global financial system, regional and global financing mechanisms have a role to play in cushioning the impact of this residual volatility on individual countries and on the system as a whole (see IMF, 2011d). From this perspective, the recent global crisis underscores the value of an effective global mechanism to coordinate liquidity injections and other policy responses: in 2008-09, a number of "crisis bystanders"—countries with relatively strong fundamentals (IMF, 2010d, and the *Systemic Crises* paper)—were hit later and less severely than countries with weaker fundamentals and were able to recover from the crisis more rapidly; however, they still suffered a deep output contraction (Figure 3).[4] This, combined with the limited opportunities to diversify against the risk of cross-border shocks (see below), points to the significant global welfare gains from an effective global financial safety net.

Figure 3. Impact of Crisis on Output 1/



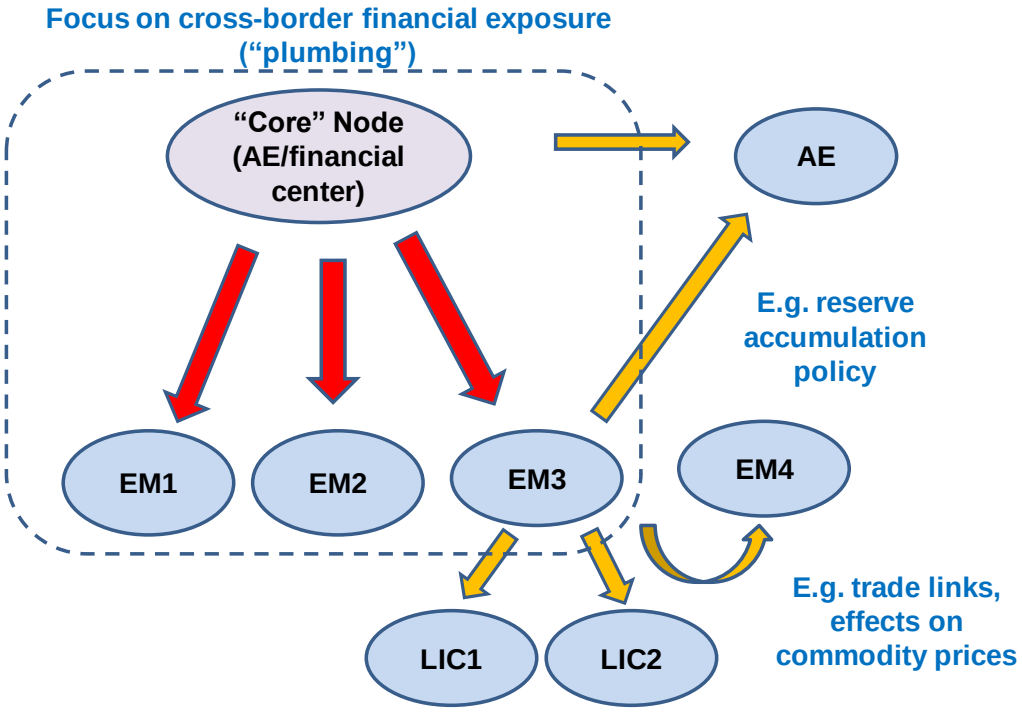
Source: IMF (2010d).
1/ Vulnerability Exercise for Emerging Markets, Spring 2007. Crisis bystanders refer to countries with medium and low vulnerability.

6. ***Country coverage***. To illustrate the benefits of a GFSN, the empirical analysis of this paper focuses mostly, but not exclusively, on how the changing pattern of cross-border linkages impacts financially-developed EMs with (partially) open capital accounts. For these countries, linkages with AEs and financial centers—the "core" nodes of the global network—dominate other channels. In Figure 4, these linkages are highlighted in the dotted-line box, with arrows representing the direction or the linkages from their origin. Of course, the web of cross-border linkages is infinitely thicker and more complex than this stylized representation, as there are many channels through which AEs, EMs and low-income countries (LICs) are interconnected. Some of these linkages are represented outside the dotted-line box in Figure 4. Among others, these could stem from reserve accumulation decisions in large EMs, or trade and commodity price linkages among EMs, AEs and LICs.

[4] The *Systemic Crises* paper looks at the experiences of these countries during past systemic crises, and argues that a GFSN could help contain contagion and ring-fence them.

Indeed, large EMs have been shown to have important macroeconomic spillovers for their regional LIC neighbors (IMF, 2011a). Similarly, rapid growth in large EMs has had a large impact on global commodity prices, shifting the terms of trade of other EMs and LICs. These linkages are undoubtedly important but are not analyzed here, in part because of data limitations (Box 2), but also because they are less likely to play a major role in the propagation of global shocks.

Figure 4: Simplified Pattern of Cross-Border Linkages



7. ***Relation to other staff work***. This paper complements recent staff work on financial linkages presented in IMF 2009a, 2010b and 2010c. It also builds on recent staff work on cross-border capital flows (IMF 2010a and 2011e). One contribution of this paper is to bring together those aspects of the global financial infrastructure that are relevant for the design of a GFSN. Finally, this paper should be read in conjunction with the above-mentioned *Systemic Crises* paper, which focuses more explicitly on the triggers, propagation, and policy responses to past systemic crises, with a view to ascertaining whether the existing global financial safety net is adequate to deal with future systemic shocks.

Box 2. Data Sources and Limitations

A number of data gaps preventing a full-fledged understanding of financial linkages were identified in previous staff work (IMF, 2010b) and efforts are ongoing to address some of these gaps, as discussed in a recent Board paper (IMF, 2011f). Understanding EM financial linkages is also hampered by the fact that bilateral data coverage for EMs is generally less complete than for AEs. Milesi-Ferretti and others, 2010, for instance, found that coverage for AEs is very satisfactory while it varies for EMs, being particularly low for Middle-Eastern oil exporters and ranging between 2/3 and 3/4 for a number of large EMs. Moreover, data is released with substantial lags. With these caveats, two main datasets were used throughout this paper:

- Information on foreign bank claims was obtained from the BIS Consolidated Banking Statistics (immediate borrower basis). These statistics were collected on a group worldwide-consolidated basis, including the claims of subsidiaries and branches. However, only a subset of source countries (24) reported data consistently through the period 1999-2009. Moreover, only a few EM countries participated in recent years as source countries. One important caveat is that BIS consolidated banking statistics have a few breaks in the series. These breaks have not been taken into account in the analysis.

- Information on cross-border portfolio holdings was obtained from the IMF's Coordinated Portfolio Investment Survey (CPIS), the annual survey of bilateral portfolio holdings. This data has some well-known limitations (Lane and Milesi-Ferretti, 2008, and Milesi-Ferretti and others 2010). First, not all the economies participate in the survey, including some that are likely substantial holders of external assets (these include some oil-exporting economies with large sovereign wealth funds, offshore centers, and economies with large holdings of official reserves or portfolio assets, such as China and Taiwan province of China). Second, there may be under-reporting of cross-border assets, including because of the incomplete institutional coverage of the survey. Third, the survey may not capture the portfolio holdings of entities resident in a given reporting country but owned by foreign investors. Similarly, holdings on residents in a financial center typically do not capture their ultimate destination. These limitations imply that a country's implied external liabilities (as computed from the claims on the country held by residents in countries reporting cross-border claims) are typically below those reported in the country's International Investment Position. To overcome some of these shortcomings, efforts to increase the frequency and to shorten the timeliness of the data and to collect data on the institutional sector of foreign debtors on an encouraged basis are ongoing. The implementation of these enhancements, beginning with the 2013 data, and efforts to increase the number of the participating countries, are also part of the G-20 Data Gaps Initiative.

This paper does not consider foreign direct investment (FDI), an investment class generally viewed as relatively stable and driven by longer-term considerations. One caveat is that the increased use of special purpose vehicles and other financial conduits by direct investors may suggest that not all FDI may be as stable as normally held. Finally, the analysis of banking sector linkages does not include off-balance sheets positions owing to data limitations, although these linkages are likely to be important for some countries.

III. SNAPSHOT OF CROSS-BORDER FINANCIAL LINKAGES

8. ***A bird's-eye view***. The key stylized fact is that AEs still dominate cross-border financial linkages (Figure 5). In particular, more than 90 percent of claims issued by residents in EMs are held by residents in AEs or financial centers, while the share held in EMs is in most cases fairly small, generally 5 percent or less.[5] This is true across asset classes and regions with the exception of debt holdings of Asian EMs for which linkages to EMs are relatively more important (Milesi-Ferretti and others, 2010). It is important to note that cross-EM linkages have increased very rapidly over the last decade (Table 1), but because of the low initial base they are still dwarfed by linkages emanating directly from AEs.

Table 1. Cross-Border Portfolio Claims (US$ billion)

	Equity			Debt		
	2001	2009	% change	2001	2009	% change
AE claims on AEs	4,357	9,732	123	4,875	15,813	224
AE claims on EMs	244	1,560	539	255	679	167
EM claims on AMs	43	269	530	35	187	430
EM claims on EM	1	41	3,668	5	29	534

Source: CPIS; and IMF staff calculations

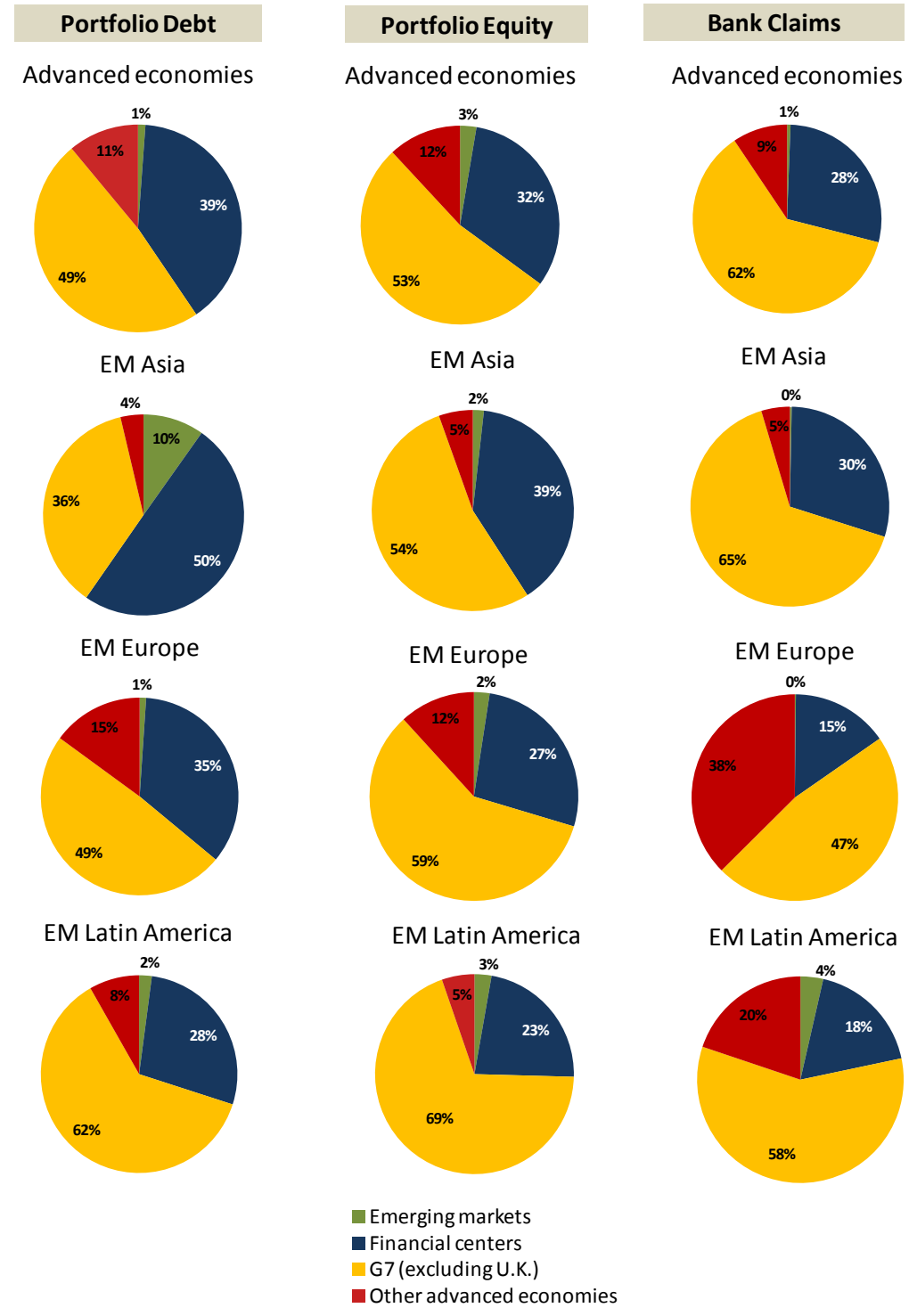
9. ***Core nodes***. An essential feature of the global financial system is that it has relatively few countries at its "core" (Box 3). Moreover, the same countries tend to dominate the system across different asset classes. These "core" nodes, from both the source and recipient perspectives, are mostly AEs or financial centers; only a few EMs appear in this core list.[6] This concentration of global financial activity within a handful of countries has been identified in previous research as a critical feature of the current global financial system (von Peter, 2007, and IMF, 2010c).

[5] It is not possible, however, to ascertain the ultimate location of residents holding cross-border portfolio claims. This issue is likely to be most important for claim holdings intermediated by financial centers. Moreover, Figure 5 is based on data reported by countries covered by the CPIS and BIS databases. This does not include holdings by some source countries (such as China) that could potentially affect these shares.

[6] This exercise is based on cross-border linkages that can be identified in the BIS and CPIS databases covering bank claims and portfolio holdings. Because not all countries participate in these surveys, the identification of core sources is limited to participating countries. For instance, only a handful of EMs participate in the BIS bank survey. Similarly, many EMs (e.g. China) do not participate in the CPIS survey.

Figure 5. Composition of Cross-Border Claims by Residence of Claimholders

(percent of total claims, 2009)



Source: CPIS; BIS; and IMF staff calculations

10. ***Overlapping nodes***. Virtually all countries that are singled out as core in one asset class are core nodes for at least two of the three asset classes considered here, and many of them for the three classes. This overlap adds a further element of complexity to the global financial system.[7] In addition, the large overlap between the top sources and top recipients suggests that shocks can be transmitted in both directions, significantly accelerating the spread of shocks. Indeed, the interplay among different asset classes has been singled out as a defining feature of the 2008 global crisis, when a shock originating in one specific corner of the U.S. financial system—subprime mortgages—was amplified through multiple linkages across asset classes and borders (Bordo and Langdon, 2010, and IMF, 2010c).

11. ***Have EMs been overlooked?*** Many large EMs do not participate in the databases considered here, and CPIS data do not provide a geographic breakdown of reserve assets by individual holder. However, using a more comprehensive database including reserve assets, Milesi-Ferretti and others, 2010, confirm that EMs still account for a small part of cross-border financial linkages. In 2007, the share of emerging Asia including China in external assets holdings was only about 5 percent of total global external assets; the same was true for external liabilities. In addition, China, which has supplied large savings to the U.S., still accounts for a limited share of U.S. asset market capitalization (Box 4).

Box 3. What Countries Are "Core" Nodes?[8]

To gauge what countries are core to the global financial system across the three asset classes considered here (portfolio equity, portfolio debt, and bank claims), all source and recipient countries were ranked—for each asset class—according to their importance as sources and recipients on a bilateral basis. The top global source and borrower countries were then identified as those countries that recurred most frequently in these bilateral rankings (Box Figure). This approach to "core" nodes complements the measure of interconnectedness used in IMF (2010b), in two aspects:

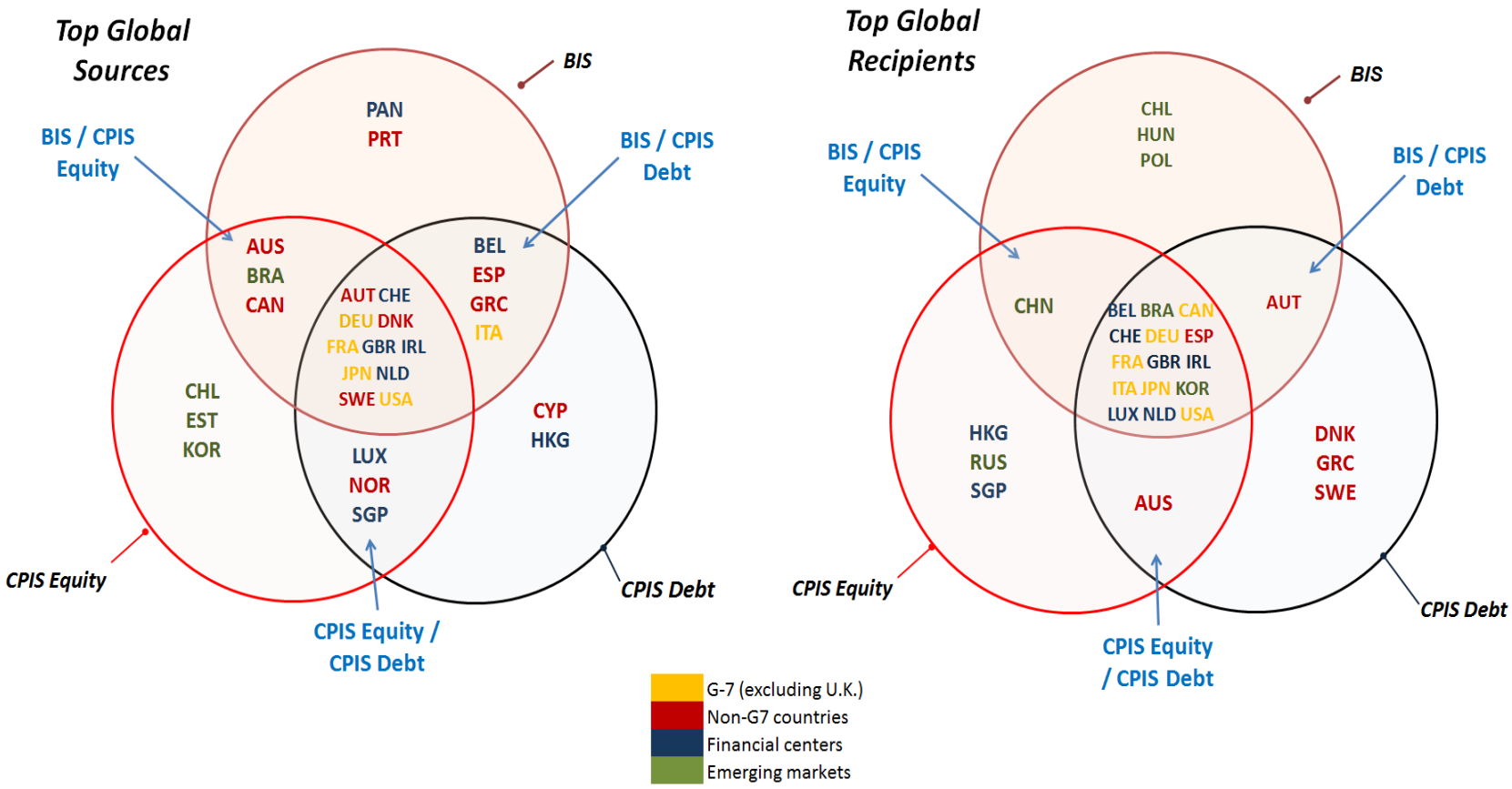
- It took into account both the asset side (i.e., top sources) and the liability side (i.e., top recipients), while IMF (2010b) focused only on the latter.
- It identified core nodes across three asset classes while IMF (2010b) covered bank claims only.

This exercise revealed some interesting, albeit unsurprising, features of the global financial system (Annex III presents the complete rankings). First, most core nodes were AEs or financial centers; the only EMs classified as core nodes were Brazil for top sources, and Brazil and Korea for top recipients. Second, virtually all countries that were singled out were core nodes for at least two asset classes, and many of them for the three classes (Germany, France, Japan, Ireland, Netherlands, U.K., and U.S. appeared as core global sources and recipients for all three classes).

[7] Another feature found in studies of the structure of the global financial system is the presence of a second layer of concentration at the regional level (IMF, 2010c). See Section V.

[8] Prepared by Ran Bi.

Top Global Sources and Recipients across Asset Classes, 2009 1/

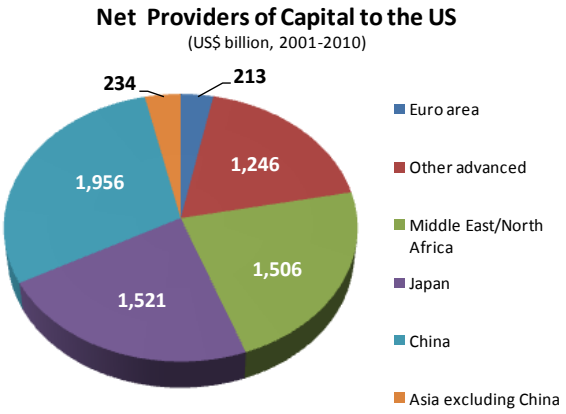


Source: BIS; CPIS; and IMF staff calculations

1/ Top sources (recipients) were identified as follows. First, for each recipient (source) country, cross-border sources (recipients) were ranked according to the size of their bilateral claims to construct a list of the country's top ten sources (recipients). Then, the twenty top global sources (recipients) were identified as those countries that recur most frequently across these lists of country top-sources (-recipients). This exercise was repeated for each of the three asset classes considered (bank claims, portfolio debt and equity).

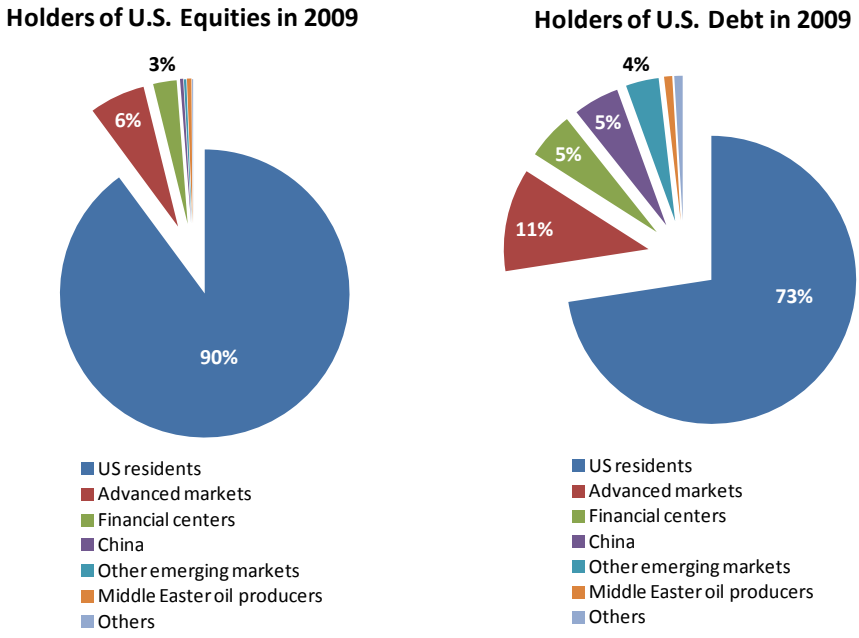
Box 4. China's Supply of Savings and Holdings of U.S. Financial Assets[9]

While AEs still hold the bulk of the *stock* of cross-border claims, on a *flow* basis, some EMs have been increasingly large providers of net savings to advanced countries (Box Figure). China, in particular, has been a large supplier of net savings to AEs, especially the U.S. For example, during 2001-2010, the U.S. imported US$5.8 trillion from the rest of the world (measured as the cumulative current account balance over the period). This flow of savings was largely supplied by a limited number of economies, most notably Japan, China and oil producers and took largely the form of accumulation of official reserves.



Source: TIC and IMF staff calculations.

The role of China as a source in the network of cross-border linkages is difficult to establish, though, given that China does not report data to the BIS and CPIS databases. The U.S. Treasury's Treasury International Capital System (TIC) data, however, allows taking stock of China's holdings of a core AE (Box Figure). This data confirms the stylized fact that, when looking at stocks, the penetration of China—and EMs more generally—in this core node remains limited and concentrated in sovereign debt markets.



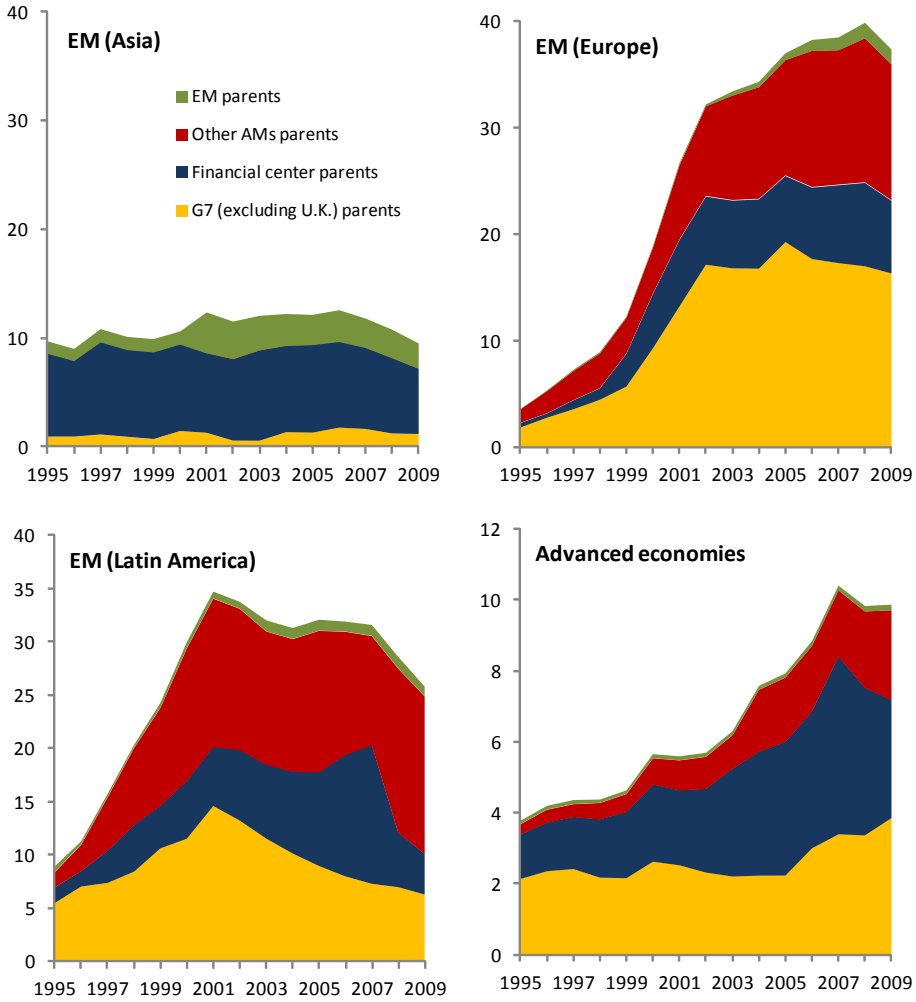
Source: TIC and IMF staff calculations.

[9] Prepared by Roberto Benelli.

12. ***Bank ownership linkages***. Cross-border bank ownership has provided an important impetus to cross-border financial linkages between AEs and EMs. This is clear in a novel dataset of cross-border bank ownership put together by staff. This shows that the importance of cross-border banking groups has grown over time, most notably in European and Latin American EMs, where on average assets belonging to foreign-owned groups represent between 30 and 40 percent of total domestic assets—with the group parents mostly residing in AEs and financial centers (Figure 6). By contrast, the importance of cross-border asset ownership is much lower in AEs. Moreover, cross-border groups are still largely owned by a parent bank residing in AEs and financial centers.

13. ***Takeaways***. (i) Cross-border financial linkages are still overwhelmingly to AEs; and (ii) there are relatively few countries, mostly AEs and financial centers, that act as "core" nodes in the global financial system.

Figure 6. Share of Domestic Banking Assets Owned by Foreign Parents
(by type of parent, in percent of domestic banking assets)



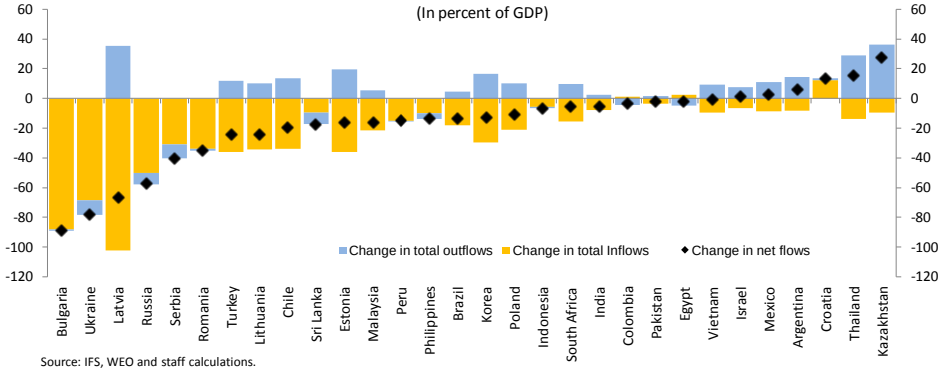
Sources: Bankscope and IMF staff calculations. See annex VI for details.

IV. Cross-Border Financial Linkages and Shock Transmission

14. ***Capital flows and shock transmission***. Shifts in cross-border exposures, especially in the form of rapid synchronized deleveraging, are a key source of systemic risks.[10] EMs are most exposed to such systemic shifts given that the bulk of their exposures are toward core nodes (AEs or financial centers), which tend to be propagators of global shocks. Recent staff work on capital flows to EMs has highlighted a few important stylized facts about capital flows to EMs. While the lessons from this analysis can be generalized to all countries, many features are particularly true for EMs:

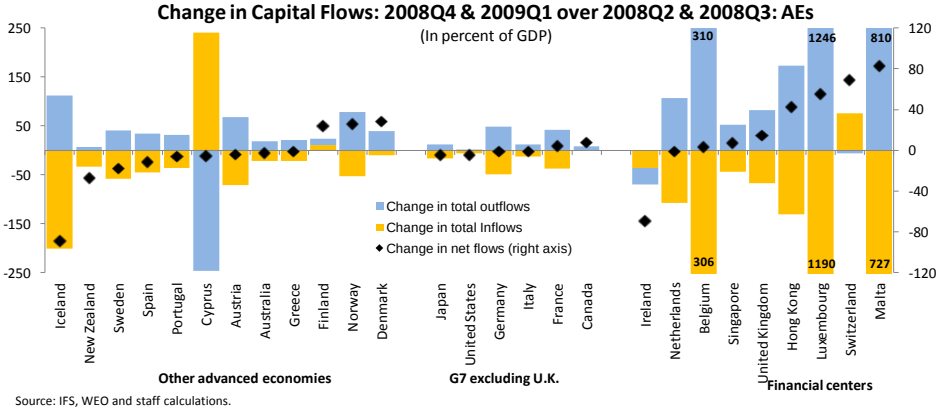
- ***Deleveraging***. As evidenced during the crisis, many EMs experienced a sharp reversal in net capital inflows (Figure 7), which was in many cases driven by a change in external liabilities (that is, a sudden stop in capital inflows), with relatively little action on external assets (limited capital outflows). This is consistent with a more general pattern, whereby changes in EMs' *gross* external liabilities have often been associated with changes in *net* external liabilities, far more than it is the case in AEs.

Figure 7. Change in Capital Flows: 2008Q4 & 2009Q1 over 2008Q2 & 2008Q3: EMs



Source: IFS, WEO and staff calculations.

Change in Capital Flows: 2008Q4 & 2009Q1 over 2008Q2 & 2008Q3: AEs

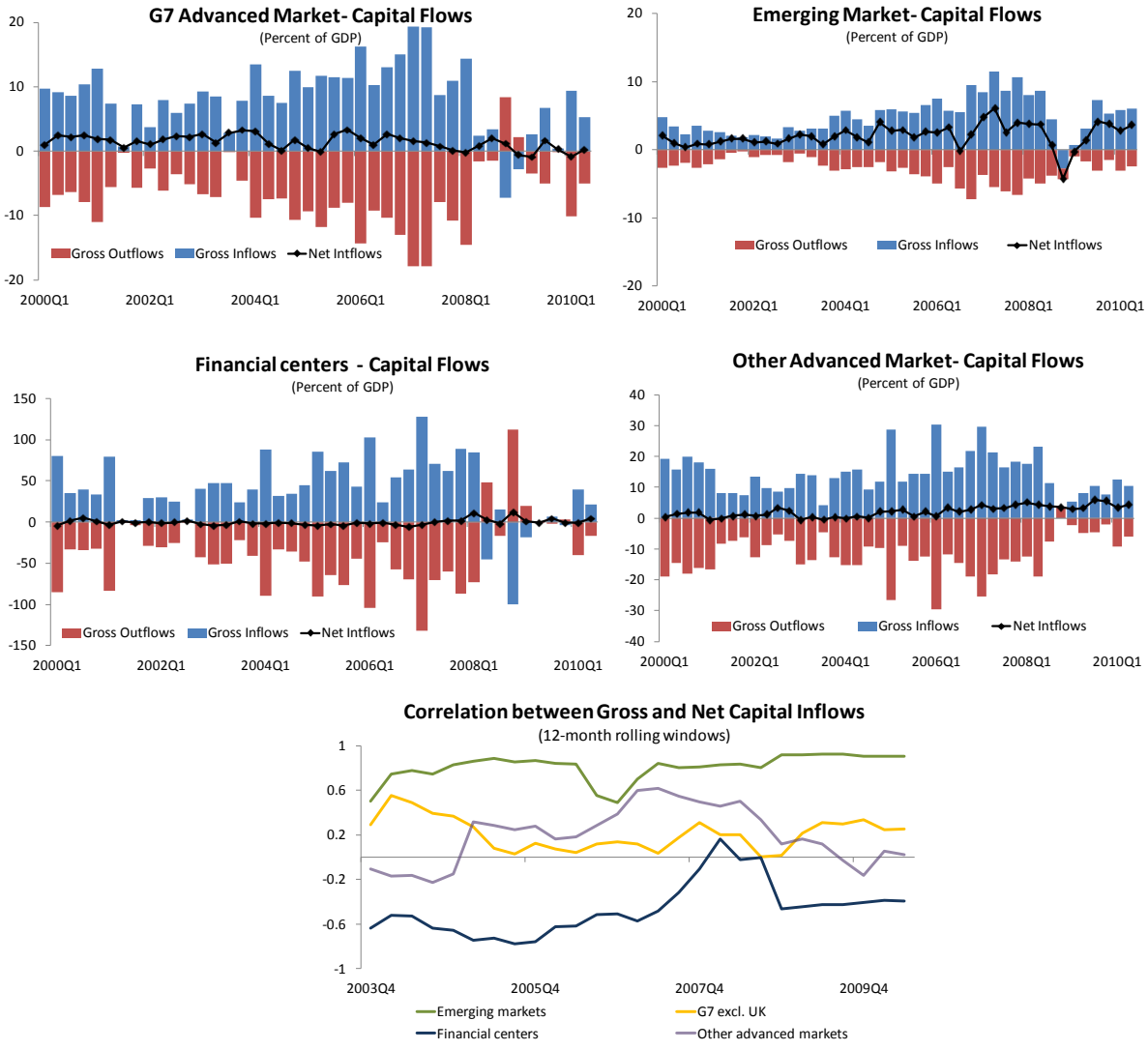


Source: IFS, WEO and staff calculations.

[10] The following analysis is largely based on IMF, 2011e.

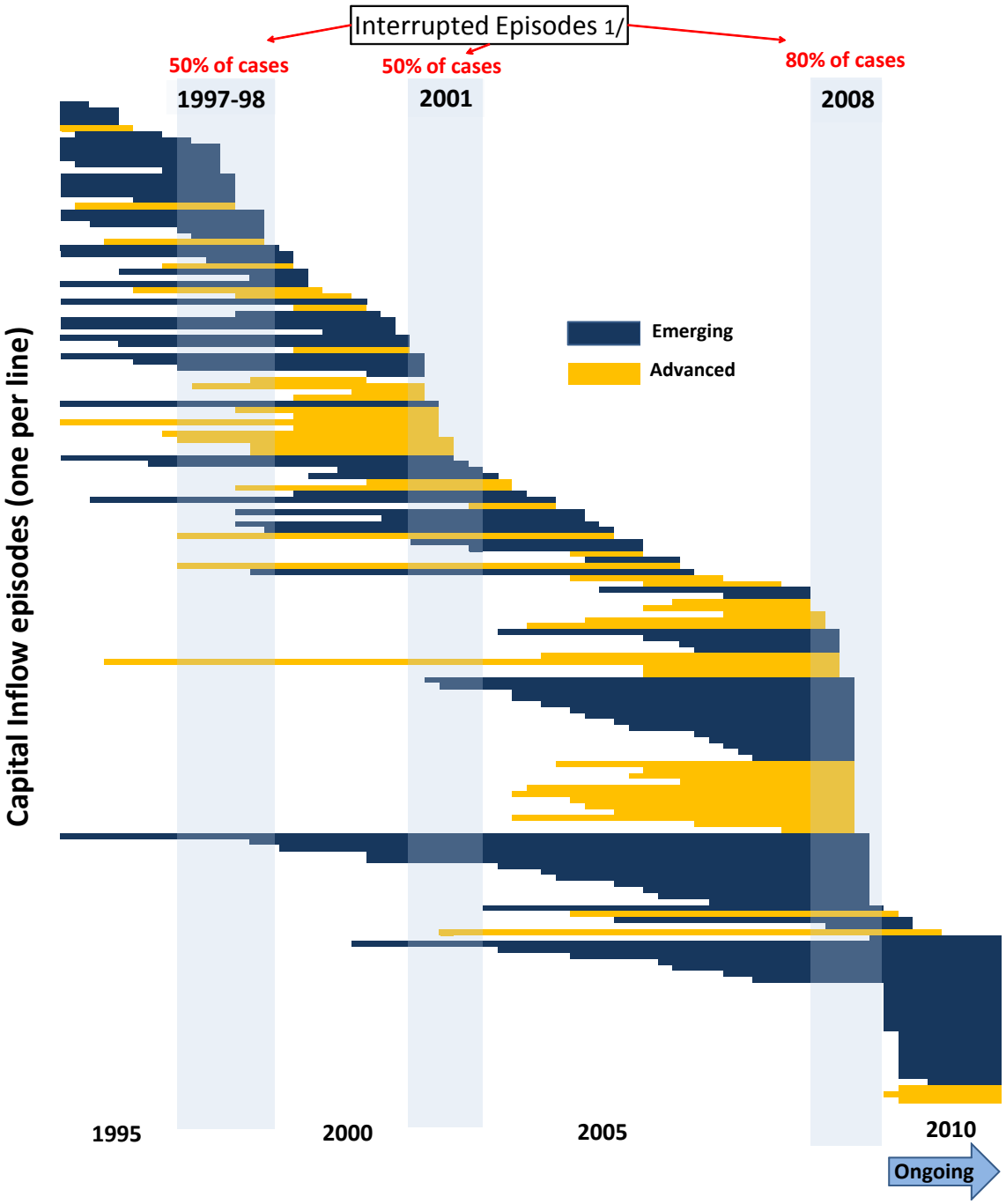
This pattern can be seen in the time series correlation between gross and net capital inflows (Figure 8). This correlation is often close to zero in non-EMs, while it tends to be closer to one in EMs, implying that shifts in gross inflows are normally offset by changes in outflows in AEs but not in EMs. One possible explanation of this pattern is that because AEs are more interconnected both in terms of inward and outward linkages, they have more "degrees of freedom" in offsetting one change in one linkage with another adjustment elsewhere in the network—this is an illustration of the general principle that more links can improve risk diversification. On the other hand, EMs—generally less interconnected—lack this flexibility and are as a result subject to the higher one-way risk of deleveraging. It follows that EMs stand to benefit the most from a global insurance mechanism against this risk.

Figure 8. Correlation between Gross Capital inflows and Net Capital Flows



Source: IFS, WEO and IMF staff calculations.

Figure 9. Capital Inflows to AEs and EMs - Gradual Buildups but Synchronized Stops

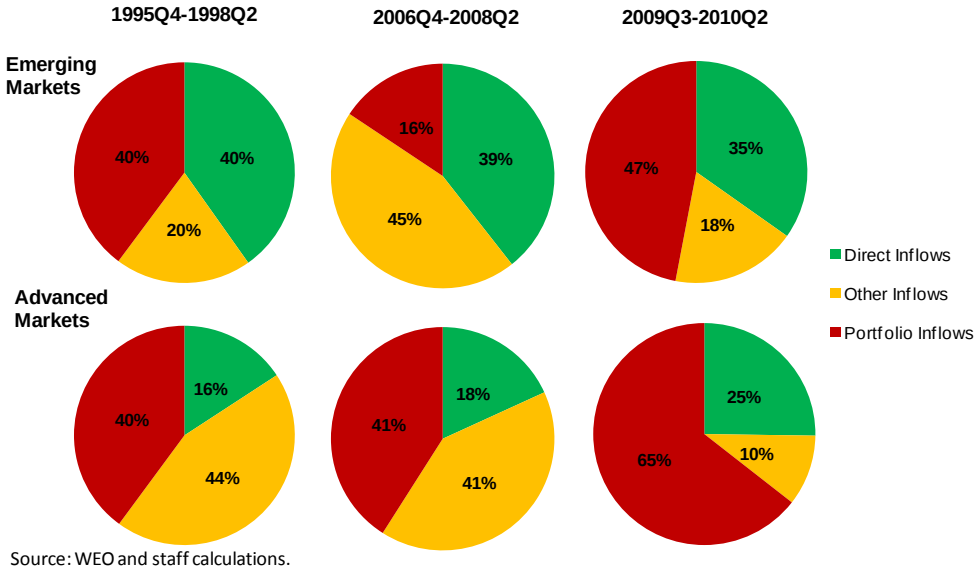


Source: IMF, 2011e, extended to include inflows to advanced economies; and IMF staff calculations.
1/ The percentages indicate the share of countries that experienced an end in their capital inflow surge during the indicated period. Each horizontal line corresponds to an individual episode of capital inflow surge. Repeated episodes for the same country appear as multiple lines.

- ***Synchronization***. Shifts in cross-border exposures can be highly synchronized, especially at times of stress. Episodes of capital inflow surges normally start at different times, likely a reflection of country-specific circumstances and pull factors,[11] but often end together within a narrow time period (Figure 9), as seen for example during the sudden stop episodes of 1997−98 and 2008−09. This suggests that behind these reversals are exogenous factors, such as sudden shocks to global risk appetite. This feature also explains why an insurance mechanism against sudden shifts in cross-border exposures driven by aggregate or global shocks cannot be based exclusively on local or regional risk-sharing mechanisms (Holmström and Tirole, 1998, and Levy-Yeyati, 2010). The evidence discussed in Section V that there remain strong geographical patterns in cross-border networks further reinforces the case for a global insurance mechanism.

- ***Volatility***. In the post-crisis recovery there has been a shift toward flows that are historically relatively more volatile than others, portfolio flows (Figure 10 and IMF, 2011e). Moreover, compared to past episodes of capital flow surges, the average pace of portfolio inflows during this ongoing wave has more than quadrupled. This may increase the risk of sudden reversals. As noted below, portfolio flows are also the flows that appear to be more closely related to global factors—and as a result potentially more exposed to global shocks.

Figure 10. Share of Gross Capital Inflows during Large Inflows Episodes
(In percent of total inflows)



Source: WEO and staff calculations.
1/ Episodes of inflows were identified in IMF (2011e).

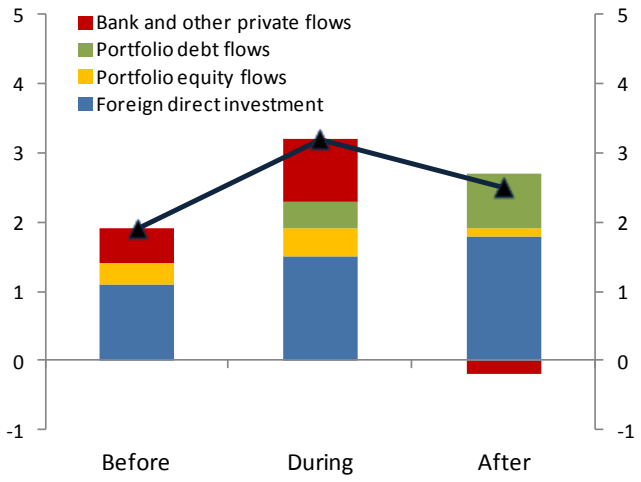
[11] One notable exception is the second half of 2009 when large inflows simultaneously resumed in many countries.

15. ***Accounting for shifts in exposures.*** The stylized facts just summarized show that shifts in cross-border exposures can be highly synchronized and volatile. What are the factors that help explain these features? Global drivers—whose impact can be assessed both in terms of quantities and prices—are important in explaining these shifts, while shallow capital markets in recipient country can amplify the shocks. Moreover, there is some evidence of shock transmission through "imitation"—that is, countries with common characteristics being hit harder. Over a longer horizon, structural shift in global asset allocation is also another driver of shift in cross-border exposures and shock transmission.

- ***Global drivers***. Given the evidence above on the synchronization of sudden stops and the fact that most cross-border claims on EMs are held by AEs, it is perhaps surprising that empirically the role of global factors in driving capital flows is at times found to be relatively small (IMF, 2011b). Indeed, the empirical analysis discussed in Annex IV suggests that global factors could explain only around 25 percent of variations in *total* gross inflows to EMs. The importance of global factors for *portfolio* inflows, however, is likely to be much higher—the estimates in Annex IV put it, on average, at around 50 percent of total variation in portfolio inflows to EMs.[12] Moreover, the importance of global factors tends to shift over time. In particular, capital flows to EMs tend to be large during periods of low global interest rates, low global risk aversion, and high growth differentials between emerging markets and advanced economies (Figure 11). These shifts over time may explain why previous empirical research has not produced a consensus view on the relative importance of push (external) vs. pull (domestic) factors (Box 5).

Figure 11. Net Private Capital Flows to EMs During Periods of Low Interest Rates and VIX, and High Growth Differentials

(percent of GDP)



Source: IMF (2011b), Chapter 4, Figure 4.13.

[12] These estimates are also likely to be biased downward to the extent that country-specific domestic factors are themselves influenced, directly or indirectly, by global factors. Omitting these domestic variables increases the role of global factors significantly, an indirect sign that domestic variables are indeed affected significantly by global factors (Annex IV).

Box 5. The Importance of Global Factors for Capital Inflows to EMs: Literature Review[13]

There seems to be lack of consensus in the empirical literature on the quantitative importance of global factors as drivers of capital flows to EMs. This box briefly summarizes some findings at the opposite extremes of this literature.

The first generation of empirical literature, inspired by the surge of capital flows into EMs in the 1990s, favored the *push* view. Summarizing the early literature, Fernandez-Arias and Montiel, 1996, concluded that falling U.S. interest rates played a dominant role in driving capital flows to developing countries. Fernandez-Arias, 1996, further estimated that the fall in international interest rates explained 86 percent of the increase in portfolio flows in 13 middle income countries between 1989 and 1994. Chuhan and others, 1993, found that global factors such as the fall in U.S. interest rates and the slowdown in the U.S. economy explained about half of the increase in equity and bond flows to nine Latin American countries. For Asian countries, they estimated that external factors accounted for about one-third of portfolio flows into the region.

More recent literature, however, has suggested that *pull factors* and country fundamentals are relatively more important. Using a variance decomposition approach, Mody and others, 2001, concluded that domestic pull factors dominated push factors in explaining a large portion of the forecast variance. More recently, IMF, 2011b, showed that global factors explained 20 percent of the variation in net capital flows into EMs.

Despite these differences in view about the importance of global factors for *total* capital flows into EMs, there has been less divergence in the literature that *push factors* have played a more significant role in explaining certain type of flows, e.g., portfolio bond flows. Summarizing two strands of research carried out at the Bank of England, Ferrucci and others, 2004, noted that push factors, and in particular U.S. short-term interest rates, explained two thirds of the compression in EM bond spreads. The contribution of push factors was found to be less significant for banking flows than for other asset classes but almost as important as pull factors.

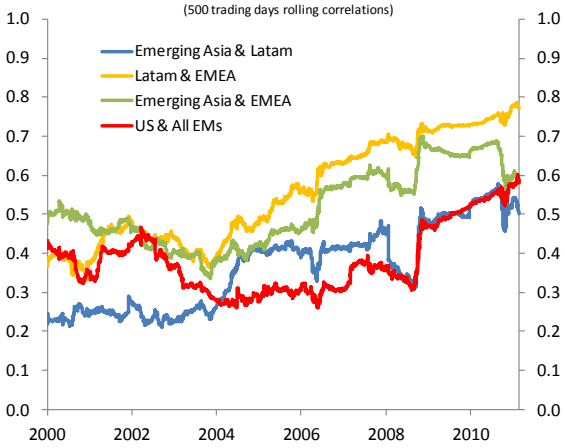
The lack of a consensus view on the relative importance of push and pull factors may simply reflect the fact that their respective roles vary substantially over time and across countries, a point echoed by Lane, 2009.

[13] Prepared by Yanliang Miao.

- ***Asset price co-movements***. Consistent with the evidence of increased global financial linkages, it is not surprising that correlations among a broadening range of asset markets have been increasing over time[14] (Figure 12), with common factors explaining a significant fraction of EM cross-country asset price variation (Fernandéz-Arias and Levy-Yeyati, 2010). Indeed, common factors have become more important over time in driving EM external yields—for instance, the contribution of the first principal component to the total variation in EM external yields, already high in the first few years of the past decade, has grown further in more recent years, reaching almost 80 percent (Figure 13). Moreover, the decomposition of the total EM spillover index shown in Figure 1 indicates EMs have been affected mostly on the *receiving end* (Figure 14), meaning that EMs tend to be on average net receivers of global/AM shocks (Annex V discusses the methodology employed here). Finally, asset prices also show clearly how financial linkages shift over time. These shifts can be especially abrupt at times of crises—the 2008 global crisis is again a case in point—highlighting how the transmission of financial shocks can be highly non-linear. In this regard, global risk aversion (captured here by the VIX index) has become an increasingly important source of volatility for global markets, and EMs in particular, with a spike at the time of the global crisis.[15]

Figure 12.Correlations across equity markets

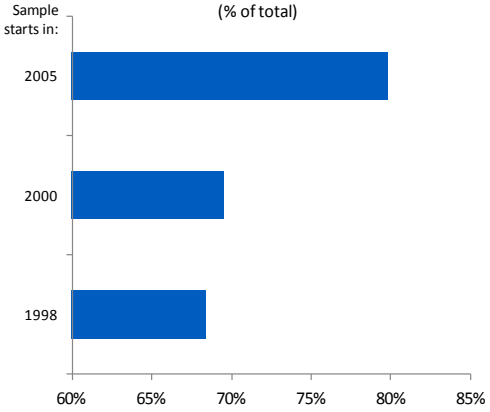
(500 trading days rolling correlations)



Source: Datastream, Bloomberg and IMF staff calculations.

Figure 13. Contribution of First Principal Component to Total Variation of EM External Debt Yield

(% of total)

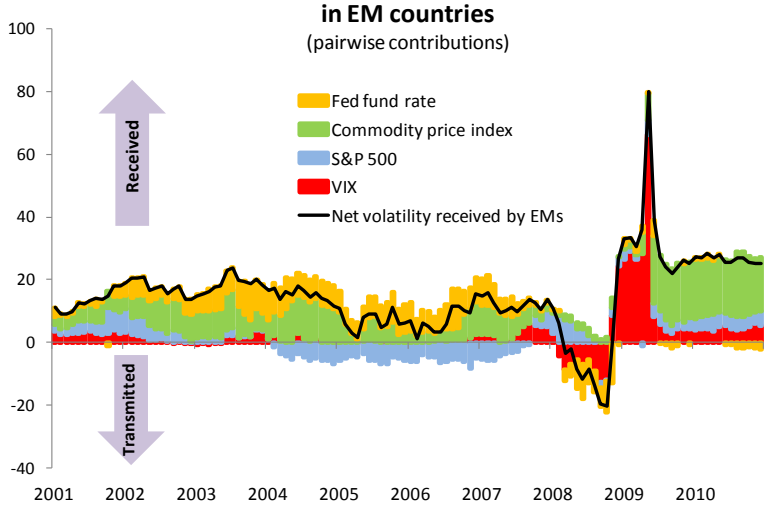


Source: Bloomberg and IMF staff calculations.

[14] See Box 4.1 in IMF, 2007, and Box 3.5 in IMF, 2009b, for a review of empirical evidence on asset price correlations. Rolling correlations are used here even though they are potentially biased in the presence of time-varying volatility; however, the underlying trends in correlations between AEs and EMs tend to be robust to a correction of these biases (IMF, 2009b).

[15] Abundant liquidity in core financial markets has also been found to affect equity returns and real interest rates in emerging markets (IMF 2010e).

Figure 14. Net Volatility Received by Stock Markets in EM countries
(pairwise contributions)



Source: Datastream and IMF staff calculations. See Annex IV for the methodology.

- ***Common characteristics***. The global crisis has also shown that shock could be transmitted through investors' perception of countries' common characteristics. Even countries that are not considered "systemic" *ex ante* in terms of economic size and financial/trade linkages could become the epicenter of a systemic event, as their crisis could serve as a "wake up" call to creditors in core nodes, causing them to pull back from other countries sharing characteristics similar to those at the epicenter of the crisis. Latvia and other Eastern European countries in the 2008 global crisis illustrate this point (Box 6).

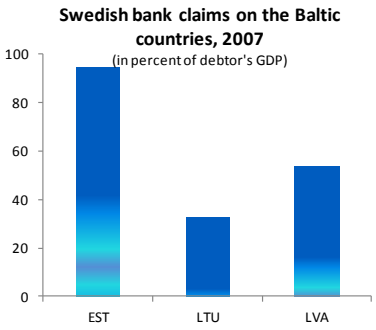
- ***Relative size of capital markets***. Shocks to EMs are amplified by the relatively small size of their capital markets. The fact that cross-border linkages are still largely dominated by claims held in a few AEs and financial centers has a counterpart in the absolute and relative size of domestic capital markets (Figure 15). Whereas EMs represented about a third of world GDP in 2009, their stock markets and bank assets were around one fifth of these asset classes on a global level; debt markets were an even smaller share, less than one tenth when public and private debt markets are combined. Hence, even a small shift in portfolio allocations from AEs to EMs could easily overwhelm EMs' absorptive capacity. For example, a reallocation of 1 percent of assets from AE markets stock, public debt or bank assets corresponds to a shift of between 4 and 6 percent in terms of EM market size, and even more (20 percent) for private debt markets. Given that the larger financial markets in AEs are also generally deeper and more liquid than their counterparts in EMs, the impact of such shifts may be even larger than suggested by differences in size alone.

Box 6. Linkages and Shock Transmission by Association: The Eastern European Experience[16]

This paper focuses mostly on cross-border direct financial linkages. Put simply, two countries are linked if they trade assets directly. This box explores a broader concept of linkages emerging from a combination of actual financial linkages and similarity in policy frameworks and fundamentals.

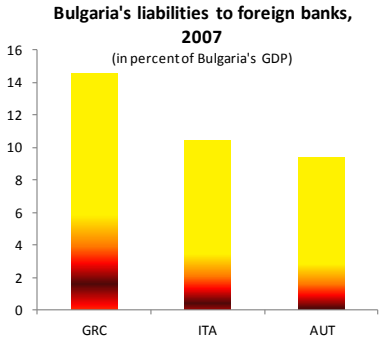
Similarity in policy frameworks and fundamentals were very relevant in Eastern Europe during the 2008 global crisis. For example, Bulgaria, Estonia, Latvia, and Lithuania shared two critical features at the onset of the crisis: a significant presence of Western European banks and a hard peg to the euro (currency boards).[17] These countries also shared common vulnerabilities—rapid credit growth, asset price inflation, and large current account deficits. As a result, despite weak direct and indirect financial linkages between Bulgaria and the Baltics, a large shock to Latvia was seen as potentially disruptive for Bulgaria and other Eastern European countries.

Actual financial linkages obviously explained part of the perception that Eastern European currency boards could come under stress. For example, Estonia, Lithuania, and Latvia all borrowed significant amounts from Swedish banks (Box Figure). The common creditor argument to some extent was at work in the Baltics: localized stress in one of the Baltic countries could have weakened the Swedish banking system and have led Swedish banks to deleverage in the other Baltic countries. However, the direct links between Swedish banks and Bulgaria's lenders, mostly Greece, Italy, and Austria, (Box Figure) were weak: Sweden's claims on Greece, Italy and Austria together only accounted for about 3 percent of Sweden's foreign bank claims in 2007.



Source: BIS.

Beyond direct links, common policy frameworks and vulnerabilities played a role in associating the fate of Bulgaria and the Baltics during the crisis. Intense distress in one country with a currency board and large liabilities to foreign banks could act as a "wake-up" call for investors and domestic depositors who could conclude that other similarly-situated countries may face similar distress. If this belief were to become entrenched, Bulgaria and the Baltics would be closely interconnected even if the (indirect) links between Sweden, on one hand, and Greece, Italy, and Austria, on the other hand, are not very significant.

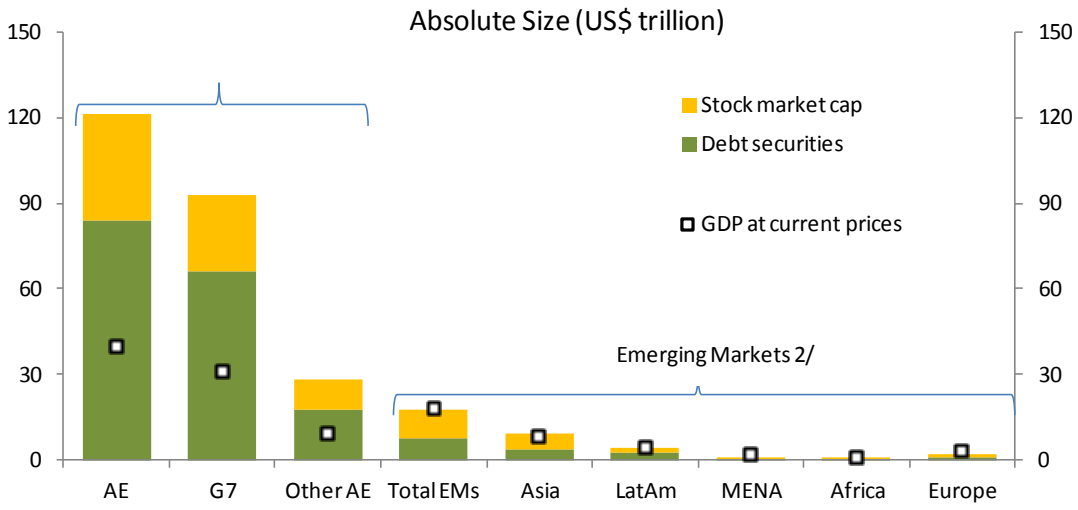


Source: BIS.

[16] Prepared by Sergi Lanau.

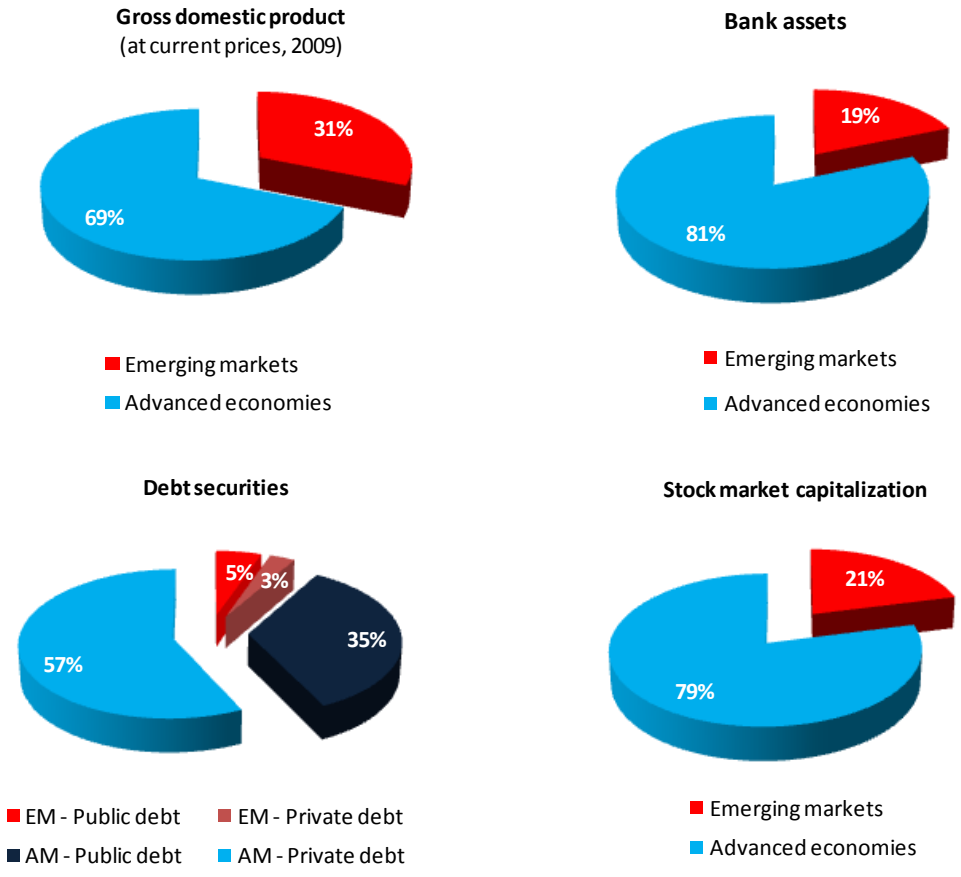
[17] Other pegged regimes in Europe such as those in Bosnia and Herzegovina and Croatia are not considered in this example but would be subject to similar problems.

Figure 15. Absolute and Relative Size of Capital Markets in 2009



1/ AE equals G7 plus Other AE.
2/ Total EMs is the sum of EMs in Asia, LatAm, MENA, Africa and Europe.

Relative Size of Capital Markets (percent of total size)



Source: Global Financial Stability Report, April 2011, Statistical Appendix Table 1; and IMF staff calculations

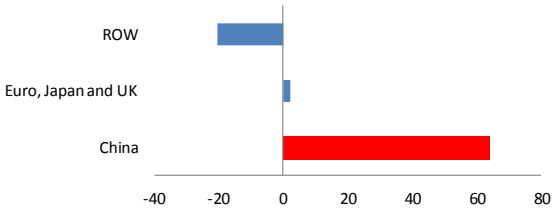
- ***Shift in EM assets***. Given rapid growth of EM holdings of external assets, some large EMs' shift in their asset allocation could eventually have significant repercussion to the global financial markets. This is particularly true for China (Box 7).

Box 7. Long Term Spillovers of China's Portfolio Allocation Shifts[18]

China is projected to contribute to more than one third of global net wealth accumulation between 2010 and 2015, due to continued rapid economic growth and high savings (net wealth accumulation is here defined as net investment plus increase in net foreign assets). The allocation of China's vast new wealth will have increasingly important implications for both the domestic and global financial markets.

Box Figure 1: Estimated Long-Term Impact on Asset Price of China's Current Portfolio Allocations 1/

(in percent)

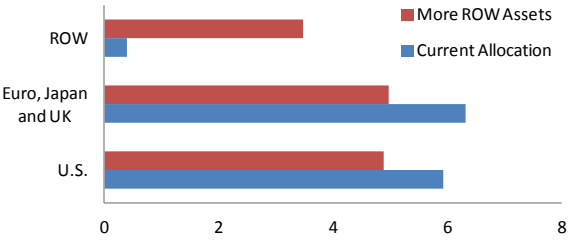


Sources: World Economic Outlook and staff estimates.
1/ Calculations are based on April 2011 WEO.

China's non-reserve asset holdings show high degree of home bias, a result of capital controls and an exchange rate that is substantially below the level that is consistent with medium-term fundamentals, among other factors. If the current configuration of asset holdings (as measured by their portfolio shares) were to persist in the medium term, the demand for Chinese assets would outpace the supply of Chinese assets—whose net supply grows with net investment in the economy. Simple market clearing conditions would imply significant increases in China's asset prices and downward pressures in some offshore markets (Box Figure 1)

Box Figure 2. Asset price response to more reserve accumulation from China

(in percent)



Sources: World Economic Outlook and staff estimates.

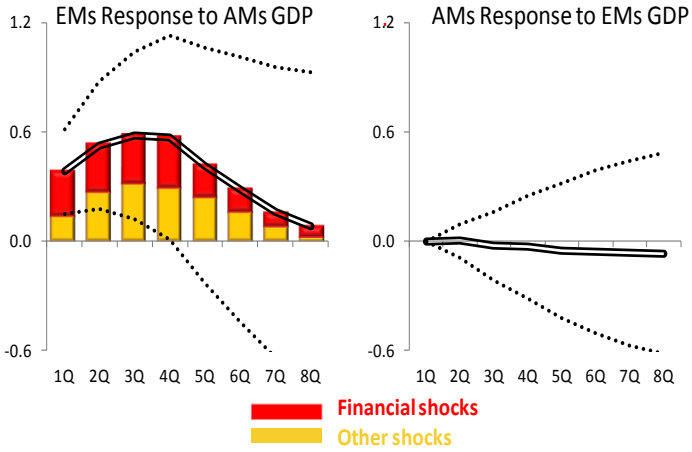
Policy responses could alter the nature of these spillovers. China's central bank could reduce asset price inflation by accumulating more reserves through the sterilized purchase of foreign assets. Staff estimates that further reserve accumulation by China in the order of US$600 billion during 2011-2015 would be needed in addition to the US$2 trillion accumulation under the baseline scenario to keep the real price of Chinese financial assets in line with the real price of U.S. assets. The spillover on third markets would be significant, however, especially if China were to increase its percentage holdings of assets from these third markets relative to the current portfolio allocation (Box Figure 2).

[18] Prepared by Kai Guo. Asset price movements in this box are derived from market clearing conditions under given portfolio preferences by U.S., China, Euro Area, UK, Japan and the rest of the world, which are calibrated using actual portfolio allocations at end-2009. Net savings, net foreign asset accumulations and exchange rates are based on projections and assumptions in the World Economic Outlook database. More details can be found in the forthcoming China Spillover Report.

16. ***Macroeconomic effects of financial linkages***. Financial linkages explain a large portion of the macroeconomic spillovers from AEs to EMs. To gauge the macroeconomic importance of cross-border financial shocks, four pieces of empirical evidence were considered:

- **First, a vector autoregressive** model was estimated on two economic blocs, AEs and EMs. Impulse response functions from this model show that shocks from the AE bloc have a quantitatively important effect on the EM bloc, with the reverse not being the case (Figure 16). This exercise also confirms that an important fraction of growth spillovers can be attributed to financial shocks in the AE bloc.

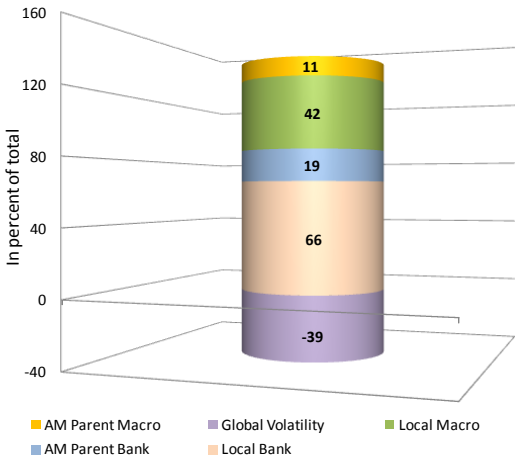
Figure 16. Accumulated Response to GDP Shocks, 1991-2010



Source: IMF staff estimation.
1/ The AE bloc includes the U.S., the euro area, Japan and the United Kingdom; the EM bloc all the G20 EM countries. Real GDP growth was aggregated using PPP weights. The contribution from the financial sector shocks is estimated as the difference in the impulse responses once short-term and long-term interest rates, and equity prices are included in the VAR regression specification as exogenous variables (following the approach in Bayoumi-Swiston, 2009). The dotted lines indicate two-standard errors confidence bands.

- **Second, an empirical model of cross-border bank groups' behavior**. Regression analysis on bank groups illustrated the mechanics of shock transmission within groups, and hence across borders (Figure 17). The empirical evidence discussed in greater detail in Annex VI show that these groups can be important conduits for cross-border macroeconomic shocks. More specifically, the lending behavior of EM subsidiaries is affected by their own leverage and liquidity conditions as well as by the local macroeconomic conditions. However, shocks to the parent's financial conditions (liquidity, capital adequacy, profitability or non-performing loans, as well as macroeconomic conditions in the parent's home country) are also important determinants of the subsidiary's lending behavior in EMs. By contrast, parent-to-

Figure 17. Micro evidence: lending by EM bank subsidiaries 1/



Source: Bankscope and IMF staff calculations.
1/ The impact is calculated as change in new lending (in percent of assets) for an inter-quartile change in each factor, relative to median new lending.

subsidiary effects are less statistically robust when a subsidiary is located in an AE. This reinforces once again the point that EMs tend to be particularly subject to shocks emanating from AEs.[19]

- **Third, pre-crisis interconnectedness and country growth performance in the global crisis**. A test of the role of interconnectedness during the 2008 global crisis was conducted using a variation of regression analysis employed in previous staff work (IMF, 2010e, Table 2). This approach consisted in relating output contraction during the 2008 global crisis to country fundamentals, including external debt, growth in trading partners, international reserve coverage of short-term gross financing needs, and an index of external vulnerability. The variation considered for this paper was to replace the latter with the network indices of interconnectedness and concentration—in-degree and HHI, respectively (Annex II discusses the construction of these indices). Once controlling for other fundamentals, more diversified countries (as measured by higher in-degree) suffered less output contraction than less diversified countries (Table 2).[20] This finding is thus consistent with the risk-diversification argument that higher interconnectedness can help smooth shocks. However, countries with more concentrated exposure (as measured by a higher HHI) suffered a more pronounced output contraction,[21] again consistent with the theoretical prediction that high concentration can be a shock amplifier.

[19] These results lend strong support to enhanced cross-border supervisory cooperation of financial institutions and improve access by regulators to relevant information on cross-border exposures. This area is, however, beyond the scope of this paper.

[20]The regressions use in-degree and HHI calculated for the BIS dataset. Given the limited data sample, it is not possible to quantify how this result is specific to a given region (e.g. Europe). Moreover, the analysis cannot be extended to prior systemic crises given the difficulty of extending these network indices backward in time.

[21] This result points to a different effect from the one described by Calvo and others, 2009. These authors find a non-monotonic effect of financial integration: countries that are moderately integrated are a greater risk of suffering a sudden stop than countries that are only lightly integrated or very integrated with the rest of the world, where financial integration is measured as the ratio of external assets and liabilities. The results described here refer to the distribution (diversification and concentration) of liabilities across source countries after controlling for external debt, which is a component of the measure of financial integration used in that paper.

Table 2. Regressions for percentage change in real output between peak and trough for EMs during the global crisis

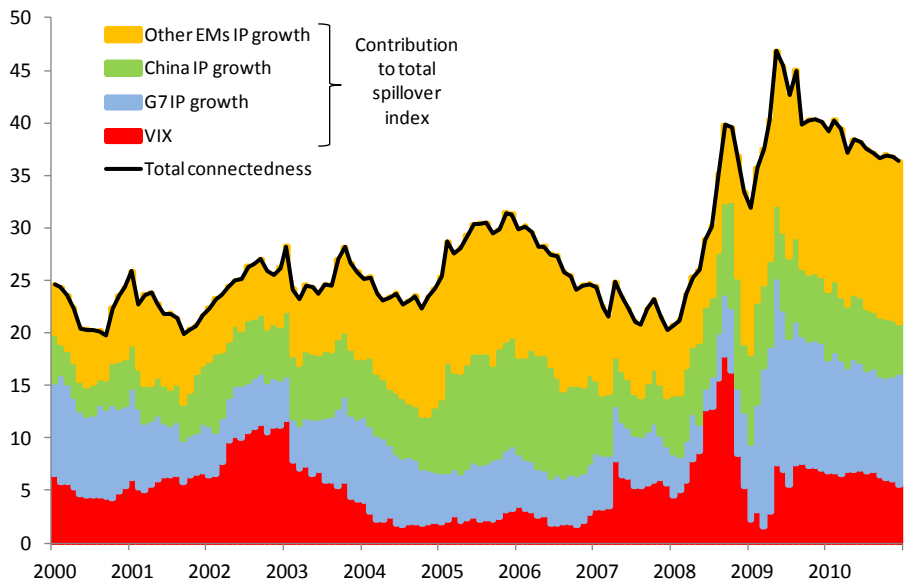
In-degree	14.33*	
	(7.66)	
HHI		-11.64*
		(6.62)
Domestic demand growth in AE trading partners	1.12*	1.36**
	(0.57)	(0.58)
Foreign bank claims (percent of GDP, in logs)	-2.44***	-1.44
	(0.81)	(0.86)
GIR in percent of (short-term debt at residual maturity	3.11***	2.10**
plus current account deficit, in logs)	(0.90)	(0.97)
Observations	40	40
R-squared	0.53	0.53

Source: Database from "How Did Emerging Markets Cope in the Crisis" (IMF 2010), BIS and IMF CPIS.

- **Fourth, a total spillover index based on real variables.** Against the clear trend of increased financial interconnectedness, it is intriguing that, at least over the last decade, there has been much less clear-cut evidence of an upward trend in interconnectedness between real variables in different regions—Figure 18 shows the analogue of the total spillover index on financial variables shown in Figure 1 for industrial production indices in G7 countries, a group of EMs, China, and the VIX index. This "real" interconnectedness index remained broadly stable in the years leading up to the crisis but jumped with the crisis, and has remained elevated since then.[22] Is there a puzzle from the lack of trend in real interconnectedness *before* the crisis, given that financial interconnectedness was instead on an increasing trend? Insights from network theory offer a (tentative) explanation of this phenomenon. During the period of the "great moderation", shocks could be dispersed across the network because they were relatively small and did not hit core nodes. As a result, interconnectedness among real variables did not display a trend, *even though the underlying plumbing of the financial system was becoming increasingly interconnected*. This last feature, however, increased the system's fragility to a systemic shock, which—when it hit—caused great disruption across the system and a spike in measured real spillovers.

[22] Diebold and Yilmaz, 2010, found a similar result in an application to industrial production indices of 5 large AEs over a long sample. Similarly, Stock and Watson, 2003, found in a sample ending in 2002 that business cycle volatility moderated, and international business cycle became less synchronized, in the most recent two decades, largely owing to smaller common international shocks. This type of results appears consistent with the empirical evidence that, absent large financial or global shocks, cross-border spillovers working via the demand channel are relatively modest—see, for example, IMF, 2007, Chapter 4.

Figure 18. Total Real Spillover Index
(average share of a variable's forecast error variance due to shocks in other variables)



Source: Haver, Datastream and IMF staff calculations. See annex V for details.

17. ***Takeaways***. (i) As financial linkages mainly emanate from AEs, shifts in cross-border exposures are a key channel for the propagation of shocks globally; EMs, in particular, are exposed to such shifts, which can be extremely large, given EMs relatively shallow financial markets; (ii) growing global financial linkages also imply increasing importance of global drivers for EM asset prices movements; (iii) both macro and micro (banking) empirical results show that cross-border financial shocks from AEs and network interconnectedness could have significant macroeconomic impact on EMs; and (iv) empirical evidence also suggests that, conditional on a systemic shock occurring, more interconnected countries suffered a smaller output decline during the crisis; however, countries with more concentrated exposure suffered a more pronounced output contraction.

V. What Explains Cross-Border Linkages?

18. ***Motivation***. This section seeks to explain the strength and drivers of cross-border linkages. By relating the size of cross-border financial linkages to structural and economic features of source and recipient countries, this analysis highlights the determinants of channels through which shocks can potentially be transmitted. Thus, this analysis may help distill some general principles that could underlie a GFSN.

19. ***Does the size of linkages help predict potential shocks?*** To further motivate this section, a simple exercise was carried out whereby the change in bilateral exposure between 2007 and 2008—that is, during the global crisis—was related to a number of underlying determinants, including the size of the initial exposure (Table 3). The key finding was that the size of the initial linkage helped explain the size of deleveraging during the global crisis:

the larger the initial exposure, the larger the subsequent deleveraging.[23] Moreover, EMs experienced larger deleveraging than AEs. These results thus motivate a search for determinants of cross-border linkages, as stronger linkages can in principle lead to deeper deleveraging once a shock hits.

Table 3. Deleveraging regression

Dependent variable: Change in log claims between 2007 and 2008 1,2/

	Portfolio debt		Portfolio equity		BIS bank claims	
	Coeff	P> |t|	Coeff	P> |t|	Coeff	P> |t|
Log of claims in 2007	**-0.09**	0.02	**-0.16**	0.01	**-0.08**	0.01
EM recipient dummy	-0.23	0.15	**-0.17**	0.07	**-0.13**	0.07
EM source dummy	0.20	0.12	**0.26**	0.07	**-0.19**	0.09
Observations	1,262		2,576		1,212	
R-square	0.11		0.17		0.08	

Source: BIS, CPIS, and staff estimates.

1/ Bold denotes significant at 1, 5 or 10 percent level. Other control variables include bilateral exports, financial openness, financial depth, exchange rate depreciation and financial center dummies.

2/ Change in log claims are not corrected by valuation change which could be significant in the case of portfolio equity.

20. ***Methodology and data***. To explain cross-border linkages, regression analysis was used to relate a country's cross-border portfolio and bank liabilities to structural and economic features of source and recipient countries (Annex VII provides the details of this exercise). Consistent with previous literature, the empirical model was based on a "gravity" equation of financial linkages between a source and a destination country, where both source and destination groups included EM and AE countries.[24] A number of time-varying and time-invariant determinants were considered as explanatory variables of the bilateral linkages: geographical and historical "gravity" variables (distance, time difference, common legal system, and common language); economic development (size, income per capita, goods trade), financial developments (financial depth and capital account openness); and regional group dummies. Year fixed effects were also added to control for global trends. The model was estimated for both the 2009 cross-section of bilateral exposures and the panel data from 2001-09 using both country-pair random effects, and source and recipient country fixed effects.

[23] This finding is consistent with existing empirical literature showing that there is a systematic relationship between the scale of pre-crisis exposures and subsequent deleveraging. For example, Galstyan and Lane. 2010, found a relationship between equity holdings and the level of pull back during the global crisis in Emerging Europe. Similarly, Milesi-Ferretti and Tille, 2011, found strong evidence that countries with large gross external positions suffered more severe declines in capital inflows during the crisis.

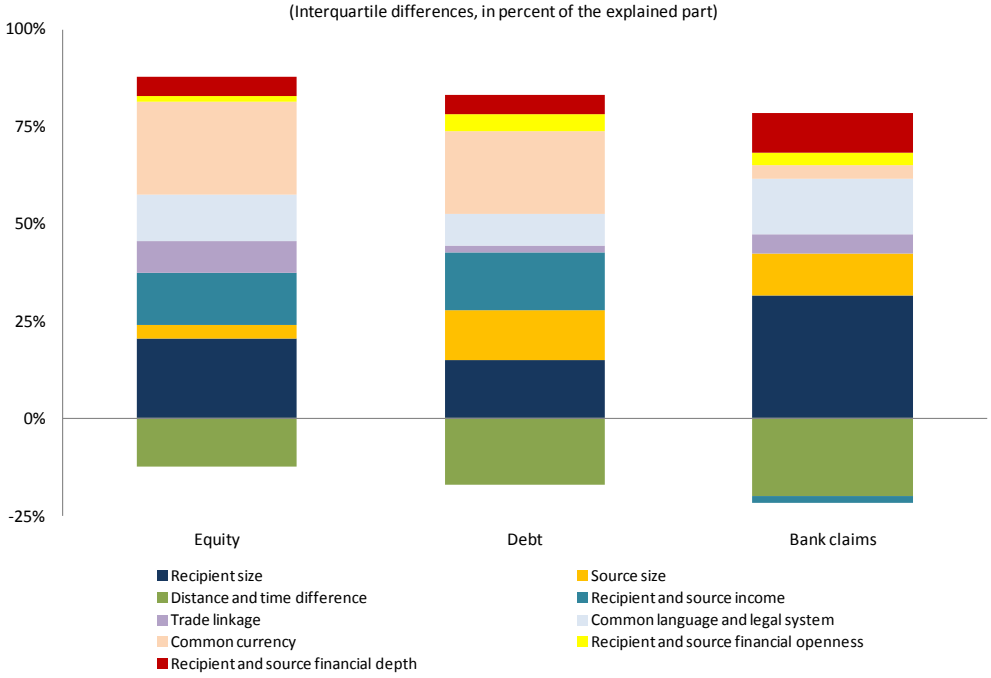
[24] See, for example, Lane and Milesi-Ferreti, 2004; Eichengreen and Luengnaruemitchai, 2006; and Borenszstein and Loungani, 2011.

21. ***Key findings***. Findings were generally in line with the existing literature and broadly consistent across asset classes. More specifically, the key findings can be summarized as follows (Figure 19 and Annex VII):

- **Geography and history**. Geography matters: distance between source and recipient, generally seen as a proxy for information quality, is a statistically significant determinant of cross-border financial linkages, with higher exposure being built up toward countries that are nearer. The effect is present for all asset classes, and is particularly strong for bank claims. Historical and cultural factors also have a role in explaining the strength of linkages: countries with the same legal system and common language tend to have stronger exposure, although there is some differentiation across asset classes in terms of the statistical significance and strength of these factors. Countries that share common language and legal system tend to have stronger cross-border exposures, especially for equity and bank claims.

Figure 19. Explaining bilateral financial exposures

(Interquartile differences, in percent of the explained part)



Source: Staff calculations

- **Economic factors**. Economic size of both source and recipient matters as a determinant of cross-border exposure. Larger countries—both source and recipient ones—have larger cross-border exposures. More developed countries (as measured by overall GDP and per capita GDP, respectively) tend to have larger portfolio exposures. Combined, size and income level explain about 40 percent of the

interquartile differences across all asset classes.[25] Not surprisingly, increased trade integration is also associated with higher cross-border exposures. Finally, a common currency tends to be associated with stronger linkages.

- **Financial factors**. Across asset classes, increased financial development in both source and recipient countries feeds stronger cross-border financial linkages—this effect is strongest for bank claims. In a similar fashion, source and recipient countries that are classified as financial centers also develop stronger cross-border exposures. For source countries, this feature—already identified in previous research, e.g. IMF, 2010c—is stronger for portfolio debt and bank claims exposure. Finally, recipient countries with more open capital accounts tend to have stronger portfolio exposure across all asset classes—the effect of capital account openness is not statistically significant for source countries.

- **Regional groups**. Country group dummies for both source and recipient sides help capture differences in the level of exposures across groups (Table 4). From the recipient side, G-7 countries remain dominant. This result is statistically significant for portfolio debt and equity, but not so for bank claims. EMs in general have lower exposures compared to advanced economies. G-7 dominance as source countries is especially strong across asset classes.

Table 4. Coefficients for country group dummies 1/

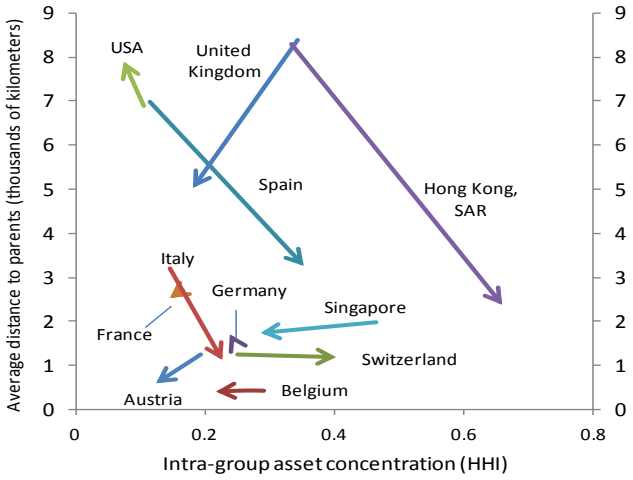
Recipient	Equity	Debt	Bank claims 2/
G-7	**0.57**	**0.68**	0.21
European EMs	**-0.49**	**-0.60**	**-0.46**
Middle east EMs	**-0.44**	0.078	**-0.96**
Asian EMs	0.08	**-0.61**	-0.11
Latin American EMs	**-0.38**	-0.13	**0.31**
Source			
G-7	**1.53**	**1.45**	**1.25**
European EMs	**-1.36**	**-2.1**	**-1.48**
Middle east EMs	**-0.63**	**-1.1**	
Asian EMs	**-0.89**	**-0.41**	
Latin American EMs	**-0.92**	**-1.2**	**-2.23**

Source: BIS, CPIS and staff estimates.
1/ Comparison group is other advanced countries group.
Bold denotes significance at 1, 5 or 10 percent level.
2/ BIS data do not include EM source from Asia or the Middle East.

[25] However, income level has no effect on bank claims exposures.

22. **Interconnectedness of bank groups and geographical distance**. More evidence on the evolution of interconnectedness is derived from the dataset on bank groups introduced earlier. Starting with the concentration of assets associated with *cross-border* banking operations, there has not been a common trend across source countries, although in some notable cases there has been a marked increase in the asset concentration (as for banks with parents from Spain or Hong Kong SAR) of their external operations[26] (Figure 20). However, there has been a much more consistent trend toward a lower average "distance" between subsidiaries and their parent. In other words, cross-border groups have tended to move "closer to home," emphasizing the role of regional agglomeration, similar to the above regression findings.

Figure 20. Banking Groups: Foreign Assets' concentration and Distance to Parent
(by country of residence of parents; averages of 1996-2000 vs. 2006-09)



Source: Bankscope; and IMF staff estimates

23. ***Takeaways***. This section provides some insights on features that could be taken into account in the design of a GFSN. (i) Larger and more developed countries tend to have stronger cross-border linkages. This is reinforced by financial development, both in the recipient and source economies. As a result, the design of a GFSN needs to be mindful of the importance of financially-developed economies, both as sources of shocks as well as possible targets. (ii) Geography matters. Notwithstanding the globalization of financial markets, there are still forces pushing toward geographical "agglomeration", namely a tendency for linkages to be stronger with closer countries. This could limit the benefit of risk-sharing scheme at a regional level, and argues for a global response; and (iii) The role of geographical factors overlaps with that of historical factors, such as a shared language or legal system, which tend to create stronger cross-border exposures. This suggests the existence of "special" linkages, explaining, for example, the large relevance of Spanish banks in Latin America.

VI. CONCLUSIONS

24. This paper shows that cross-border financial linkages have increased dramatically over time, both in terms of growing cross holdings of external assets and co-movements of

[26] Within-group asset concentration (including assets in the parents' home countries) has fallen in many countries in recent years, mostly driven by a reduced scale of domestic operations. UK- and Singapore-based groups, on the other hand, have become more diverse in their external operations, but have expanded the share of their assets at home.

asset prices across asset classes and economies. These linkages are still dominated by a few AEs and financial centers, which form "core nodes" in the system. EMs' cross-border holdings, despite having experienced rapid growth in the last decade, remain relatively small, while the bulk of EMs' liabilities are held by core nodes. EMs, with shallow domestic capital markets, are particularly exposed to large shifts in cross-border exposures. The empirical evidence in this paper suggests that shocks can be highly synchronized across global financial markets and their transmission non-linear, potentially carrying significant real costs to EM economies.

25. Efforts to increase the resilience of the global financial system face a delicate trade-off between the benefits at the country level from increased international risk diversification—a force that pushes toward increasing the system's overall interconnectedness—and the increased systemic risk that this heightened interconnectedness generates at the global level. National defenses, including via self-insurance, may not be able to eliminate the externalities intrinsic in an interconnected financial network. To the extent that national defenses are insufficient to reduce the source of volatility and instability inherent with the global financial system, regional and, especially, global financing mechanisms have a role to play in cushioning the impact of residual volatility on countries and the system at large. The recent global crisis underscores the value of an effective global mechanism to coordinate liquidity injections and other policy responses: in 2008-09, a number of countries with relatively strong fundamentals ("crisis bystanders") were hit later and less severely than countries with weaker fundamentals, and were able to recover from the crisis more rapidly; but they still suffered a deep output contraction. This, combined with the limited opportunities to diversify against the risk of cross-border shocks, points to the significant gains from a global financial safety net that is effective in forestalling localized liquidity runs to turn into systemic crises.

Annex I. Country Groupings

Table I.1 lists the country groupings used in this paper, subject to data availability. Following Lane and Milesi-Ferretti, 2008, financial centers are identified in this paper as those economies with very large external assets and liabilities relative to GDP and a large financial system specializing in the production of intermediary financial services.

Table I.1. Countries Included in the Sample

Emerging Markets 1/

Asia	Europe	Middle-East & Africa	Latin America
China	Albania	Egypt	Argentina
India	Belarus	Georgia	Bolivia
Indonesia	Bosnia & Herz.	Jordan	Brazil
Korea	Bulgaria	Kazakhstan	Chile
Malaysia	Croatia	Morocco	Colombia
Mongolia	Estonia	Pakistan	Costa Rica
Philippines	Hungary	South Africa	Dominican Rep
Sri Lanka	Israel	Tunisia	Ecuador
Thailand	Latvia		El Salvador
Vietnam	Lithuania		Guatemala
	Macedonia		Jamaica
	Montenegro		Mexico
	Poland		Paraguay
	Romania		Peru
	Russia		Uruguay
	Serbia		
	Turkey		
	Ukraine		

G-7 excl UK 2/	Other advanced Economies	
	Oceania	Europe
Canada	Australia	Cyprus
France	New Zealand	Denmark
Germany		Finland
Italy		Greece
Japan		Iceland
US		Norway
		Portugal
		Spain
		Sweden

Financial centers

Asia	Europe	Middle-East & Africa	Latin America
Hong Kong, SAR	Belgium	Lebanon	Panama
Singapore	Ireland		
	Luxembourg		
	Malta		
	Netherland		
	Switzerland		
	UK		

1/ Exclude Lebanon and Panama, which are financial centers.

2/ Excludes the UK, which is a financial center.

Annex II. Network Analysis[27]

This annex first provides a short review of network theory and then describes the methodology and data used in measuring a country's financial interconnectedness with the rest of the world and the concentration of its cross-border exposures.

Insights from network theory

Network analysis. Many of the financial market phenomena described in this paper can be seen—using insights from network theory—as the result of increased interconnectedness in a financial network. Besides the staff work mentioned in the paper, a growing literature has examined the properties of financial networks and their implications for financial stability (see Haldane, 2009, for an excellent overview of the field; there have also been a number of application of network analysis to financial stability issues by staff, see, e.g., IMF, 2009a). In particular, the seminal contribution by Allen and Gale, 2005, showed that—in the absence of financial frictions—more interconnectedness increases risk diversification and makes the network more robust. Subsequent research has shown, however, that in the presence of financial frictions, high levels of interconnectedness may increase systemic risk (Battistion and others, 2009, and Gai and Kapadia, 2008). Finally, a number of papers have used a range of network statistics to describe the financial network and patterns of stress transmission (Garrat and others, 2011, Kubelec and Sa, 2010, von Peter, 2007).

Interconnectedness as a double-edged sword. The key insight of network theory applied to financial stability analysis is that interconnectedness is a double-edged sword. Interconnectedness has the potential of making a network more robust, but it also increases the risk of rare but devastating events. At low levels, an increase in interconnectedness improves the resilience of a network; at high levels, however, it may raise the network's latent fragility and vulnerability to systemic breakdowns. The latent fragility of complex networks is a key rationale for the existence and appropriate design of a GFSN.

"Robust" networks. Recipient countries with a larger number of cross-border links tend to benefit from better risk diversification of sources,[28] as a localized shock hitting a single source country and the ensuing deleveraging can be more manageable. The opposite is true in a network with few links.[29] This diversification argument—formalized by Allen and Gale,

---

[27] Prepared by Ran Bi and Sergi Lanau.

[28] In this context, a link is represented by the stock of claims issued by a recipient country to a source country. The resulting network corresponds to the visual representation of Figure 2.

[29] This narrative assumes that shocks are transmitted through countries as sources reduce their claims on other countries. This is consistent with the view that rapid deleveraging following a shock to a source is the key transmission channel of cross-border shocks, especially at times of systemic distress. However, it abstracts from the specific source of shocks triggering this deleveraging.

2005—means that interconnectedness can improve risk sharing and make the network more *robust*.

"Fragile" networks. A higher degree of interconnectedness can also increase the latent fragility of a financial network. If a highly interconnected source country (a core node) is hit by a large shock, the network might display a tipping-point property, as the shock can be propagated widely via the country's large number of links to the rest of the network. This fragility results from a negative network externality: when an "average" country increases its connections to the network, it does not internalize the risk of increasing the network's fragility to systemic shocks.

Nonlinearities: Asymmetric information and herd behavior. Besides allowing for wider shock propagation, more interconnectedness is also likely to result in incomplete information of the overall financial system. In this context, pure contagion and herd behavior could propagate shocks beyond direct trade and financial linkages. In the presence of incomplete information, financial integration strengthens investors' incentives for herding behavior (Calvo and Mendoza, 1997). Moreover, unusual or unexpected events can trigger the perception of 'immeasurable risk', leading to a flight to quality (Caballero, 2009, interprets the global crisis through this lens).[30] Supporting this point, Caballero and Simsek, 2011, have shown that incomplete information in a complex financial network creates an environment prone to fire sales and liquidity crunches. In this environment, even countries that are not considered "systemic" *ex ante* could be the epicenter of a systemic event, as their crises serve as a "wake up" call to creditors, who could shed assets of other countries sharing similar characteristics. As argued in the *Systemic Crises* paper, it is thus important to go beyond the usual approach of focusing on "systemic" economies to assess systemic risks, as this approach tends to overlook "systemic" stress arising from smaller countries that may not be highly interconnected; *ex post*, such negligence could become costly.

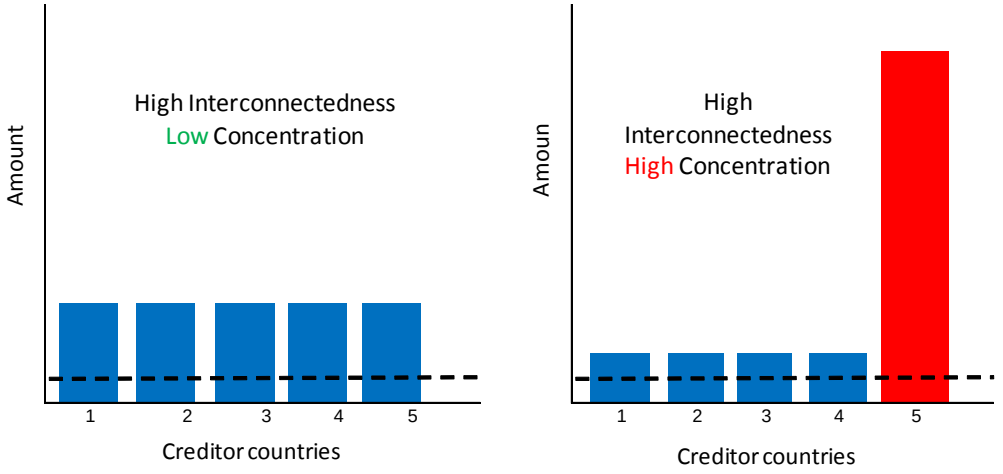
Concentration risk. Additional risks arise when recipient countries have an unusually large concentration of exposures to a few sources. In these circumstances, a large shock hitting a main source could create more severe deleveraging than in an alternative situation where all links were uniform across sources. The importance of this risk has been documented empirically. For instance, during the 2008 global crisis, countries with the largest portfolio holdings in emerging Europe at the end of 2007 experienced the largest portfolio adjustment in 2008 (Galstyan and Lane, 2010).

Interconnectedness versus concentration. Interconnectedness and concentration are compatible concepts. As depicted in a stylized fashion in Figure II.1, the two countries have

[30] Immeasurable risk, also known as Knightian uncertainty, is a situation where agents are unable to attach probabilities to possible outcomes and act under the assumption that the worst-case scenario will materialize with probability one.

the same number of links and hence the same degree of interconnectedness with the network (based on the in-degree index introduced below). However, while the country on the left has uniform dependence across its sources—and therefore low concentration risk—the country on the right depends much more heavily on a single source country (no. 5), raising the risk that a shock in this source country will force the recipient country to deleverage rapidly.

Figure II.1. Stylized Patterns of Network Interconnectedness and Concentration



Measuring interconnectedness and concentration

Empirical measures. Several measures have been developed in the literature to capture different aspects of network interconnectedness (see, for example, the overview in von Peter, 2007). One of these measures, "in-degree", is useful to capture the notion of diversification in a network.[31] For a recipient, this index is constructed as the share of "active" links to its sources to the total number of potential links. Here, a link is considered active if the stock of the recipient's cross-border liabilities is above 0.2 percent of the recipient's GDP. By normalizing a link to the recipient's GDP, this approach emphasizes the importance of a link *from the perspective of a recipient* rather than a source, as frequently done in the literature.[32] Holding constant the total stock of cross-border liabilities, a higher in-degree index simply means that a recipient has *on average* smaller exposures to its sources, abstracting from the cross-source distribution of claims. This distribution is instead at the core of measuring concentration risk via a (normalized) Hefindahl-Hirschman index (HHI). This type of index

[31] This index is also employed in IMF, 2010b, and IMF, 2010c.

[32] For example, IMF, 2010b, constructs an in-degree index as the number of links, as a percentage of total possible links, from a source country to recipient countries, where a link represents the value of financial assets held by the source country on the recipient country (provided that the value of these assets is above 0.01 percent of the *source* country's GDP).

is commonly used as a measure of concentration, for instance in bank loan portfolios or among firms in an industry. This index is normalized to range between zero (no concentration) and one (only one source per recipient).

Specifically, *in-degree* and *concentration* are defined as follows:

- ***In-degree*** is the number of locations a country borrows from. In order to come up with an economically meaningful measure, links smaller than 0.2 percent of the recipient's GDP were disregarded. [33] As the BIS and CPIS datasets cover different numbers of sources, in-degree was normalized by the number of sources so that it always lies in the interval between 0 and 1, making it comparable across different types of claims and datasets:

$$\text{In-degree} = \frac{\#links > \ 0.2\% \ of \ GDP}{\#creditors \ in \ dataset}$$

  Country-level in-degree can be easily aggregated at the regional level. We refer to the resulting statistic as the interconnectedness of region *j*:

$$\text{In-degree}_j = 100 * \frac{\#links > \ 0.2\% \ of \ debtor's GDP \ in \ region}{\#creditors \ in \ dataset * \#debtors \ in \ region_j}$$

  A variant of in-degree is ***out-degree***, which captures the number of recipients a source country is exposed to. The country-level and region-level out-degree are similarly constructed as above, except that the cross-border exposures should be above 0.2 percent of the *source's* GDP to be counted as links.

- ***Concentration*** in lending relationships is measured by the well-known Herfindahl-Hirschman Index (HHI). Let N be the number of creditors in the dataset and let si be the share of creditor i in country j's foreign liabilities. The HHI is defined as:

$$h_j = \sum_{i=1}^{N} s_i^2$$

  and is then normalized to range from 0 to 1:

$$HHI = \frac{H - 1/N}{1 - 1/N}$$

[33] Different cut-offs were considered. Although the *level* of in-degree changed, its *trend* over time was not affected.

Higher values of the HHI indicate higher concentration of sources. The HHI would approach zero if a recipient has uniform exposures across its N sources. Conversely, it would take the value of one if there is only one active source. We aggregate the HHI at the regional level by taking the average value of the index in the region.

This paper studies cross-border claims of 57 emerging markets and 24 advanced economies (listed in Annex I). Networks were constructed for the period 1999-2009 using the two leading databases used throughout this paper. The analysis on the BIS database was restricted to the 24 source economies that reported data consistently throughout the period 1999-2009. Data from the CPIS on cross-border portfolio holdings is available annually for the period 2001-2009. More than 70 countries reported their external assets to this database but the analysis was restricted to those sources that also reported to the BIS statistics consistently.

There are a few caveats when comparing measures based on CPIS and BIS data. First, the two datasets follow different principles to determine the "location" of the source. In general, the CPIS overemphasizes the importance of financial centers compared to the BIS consolidated statistics. This is because sources operating in a financial center are considered residents in the CPIS, whereas they are consolidated back to their country of origin in the BIS consolidated statistics.[34] Second, to the extent that commercial banks hold portfolio investment securities, some overlap may occur. Finally, neither dataset is adjusted for valuation effects.

Interconnectedness and concentration over time. Figure II.2 and II.3 show the in-degree and HH indices over time for EMs and AEs. A few stylized facts stand out:

- Interconnectedness has generally increased in the last decade across EMs and AEs as well as asset classes. This trend was partially reversed with the deleveraging during the 2008 crisis—although it may have already resumed in 2009.

- Interconnectedness is much stronger for AEs than EMs (note the difference in scale used in Figure II.2). Moreover, the smaller AEs tend to be more interconnected.

- In EMs interconnectedness is higher for cross-border bank claims than portfolio claims. There is no clear pattern across asset classes for AEs, though.

- Concentration has generally been on a declining trend in the past decade across EMs and AEs as well as asset classes. The most notable exception was cross-border bank claims in European EMs, for which concentration increased rapidly in the years before the crisis.

[34] The BIS locational statistics would avoid this problem as they are collected on a residence principle but are not publicly available.

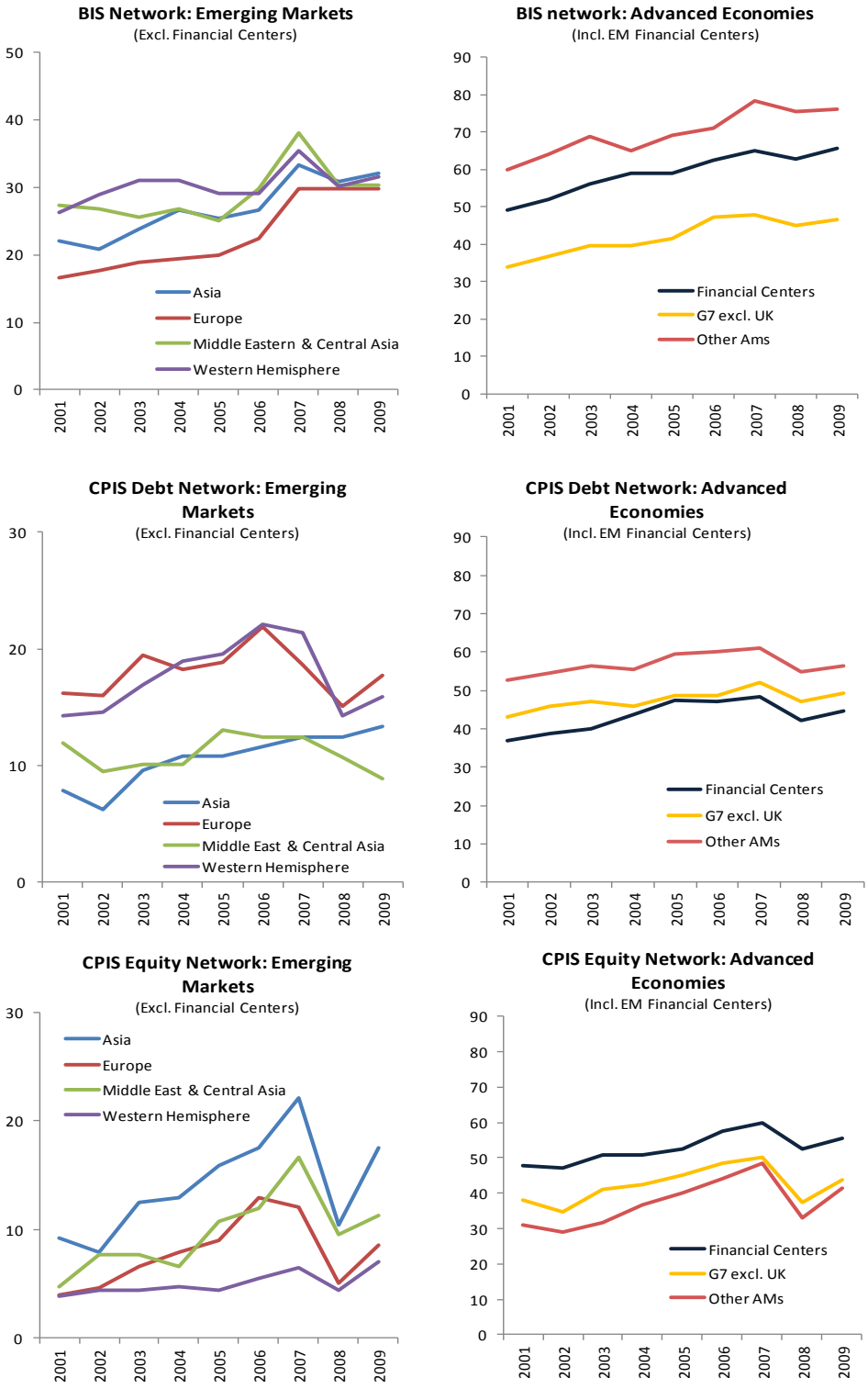
- Concentration across asset classes is still significantly higher in EMs than AEs (again, note the difference in scale in Figure II.3).

Inward* vs. *outward interconnectedness. Figure II.4 shows the other side of the coin, that is, the interconnectedness index applied to the asset, rather than liability, side of a country; this index is called "out-degree" because it captures a country's outward interconnectedness—the extent to which a source country's holdings of cross-border assets are spread out across all the potential recipients. The most striking point is that, whereas AEs' outward linkages are almost as spread out as inward linkages, for EMs outward linkages are still fairly limited (note again the difference in scale). In other words, interconnectedness in EM economies is generally "one way", namely it affects mostly their cross-border liability side.[35] This observation confirms that, from the perspective of EM economies, the pattern and dynamics of cross-border liabilities is likely to be a far more significant source of cross-border linkages.

[35] Data limitations impede calculating the out-degree index for a large number of EM countries. The chart reported here summarizes this index for five EM countries that have reported consistently over a sufficiently long period (Brazil, Mexico, Chile, Panama, and Turkey).

Figure II.2. Network Connectivity, In-degree Index 1/

(in percent)

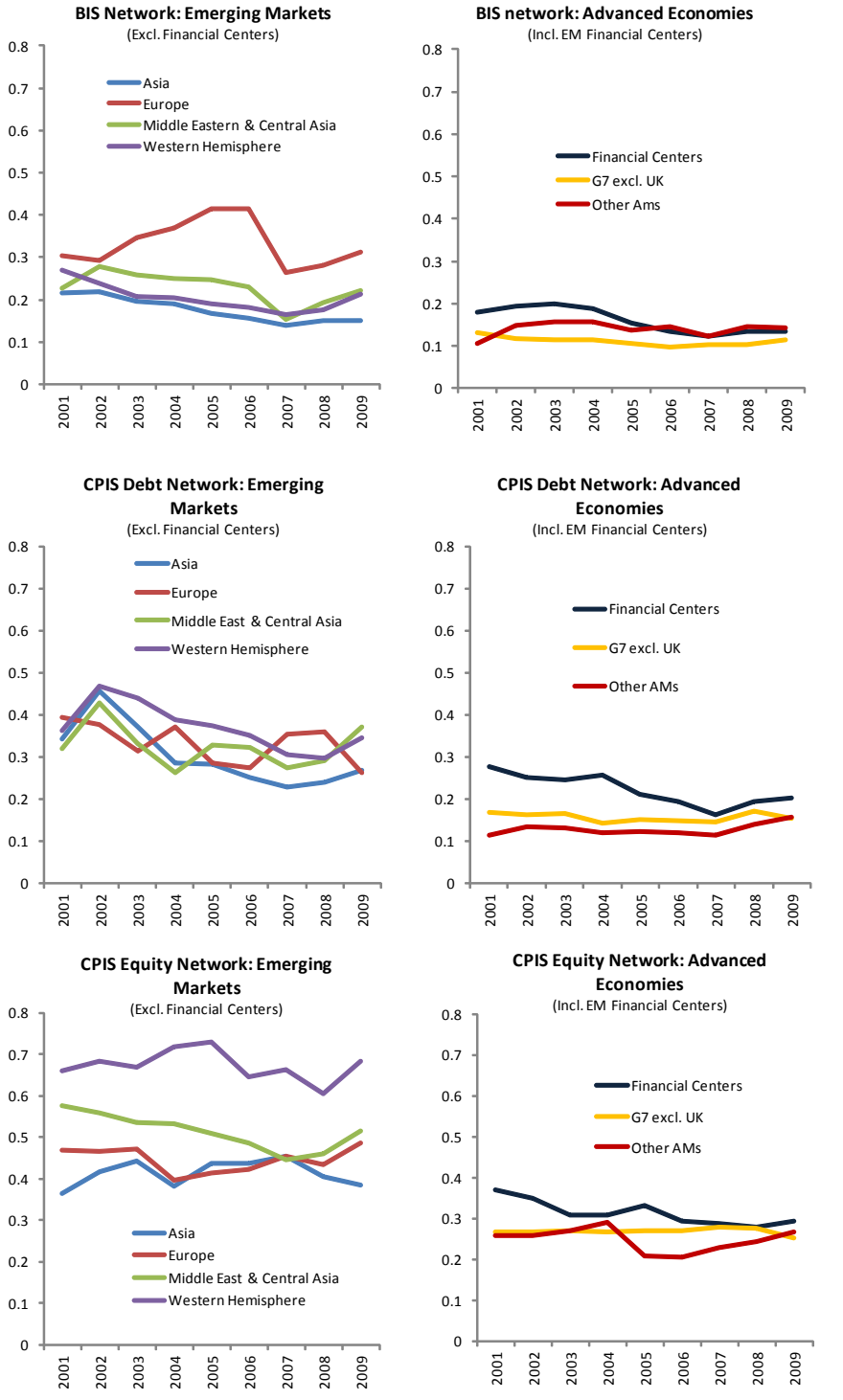


Source: BIS banking statistics, IMF CPIS, and staff calcuations.

1/ In-degree measures the number of locations a country borrows from. A country group's in-degree was calculated as the number of "active" links in percent of total possible links (i.e., the number of creditors in the database). An "active" link is a foreign liability (held by a country in the group) that is no smaller than 0.2 ercent of the debtor's GDP. This exercise was repeated for each of the three asset classes considered (bank claims, portfolio debt and equity).

Figure II.3. Network Concentration - Herfindahl-Hirschman index (HHI) 1/

(normalized between 0=no concentration and 1=maximum concentration)

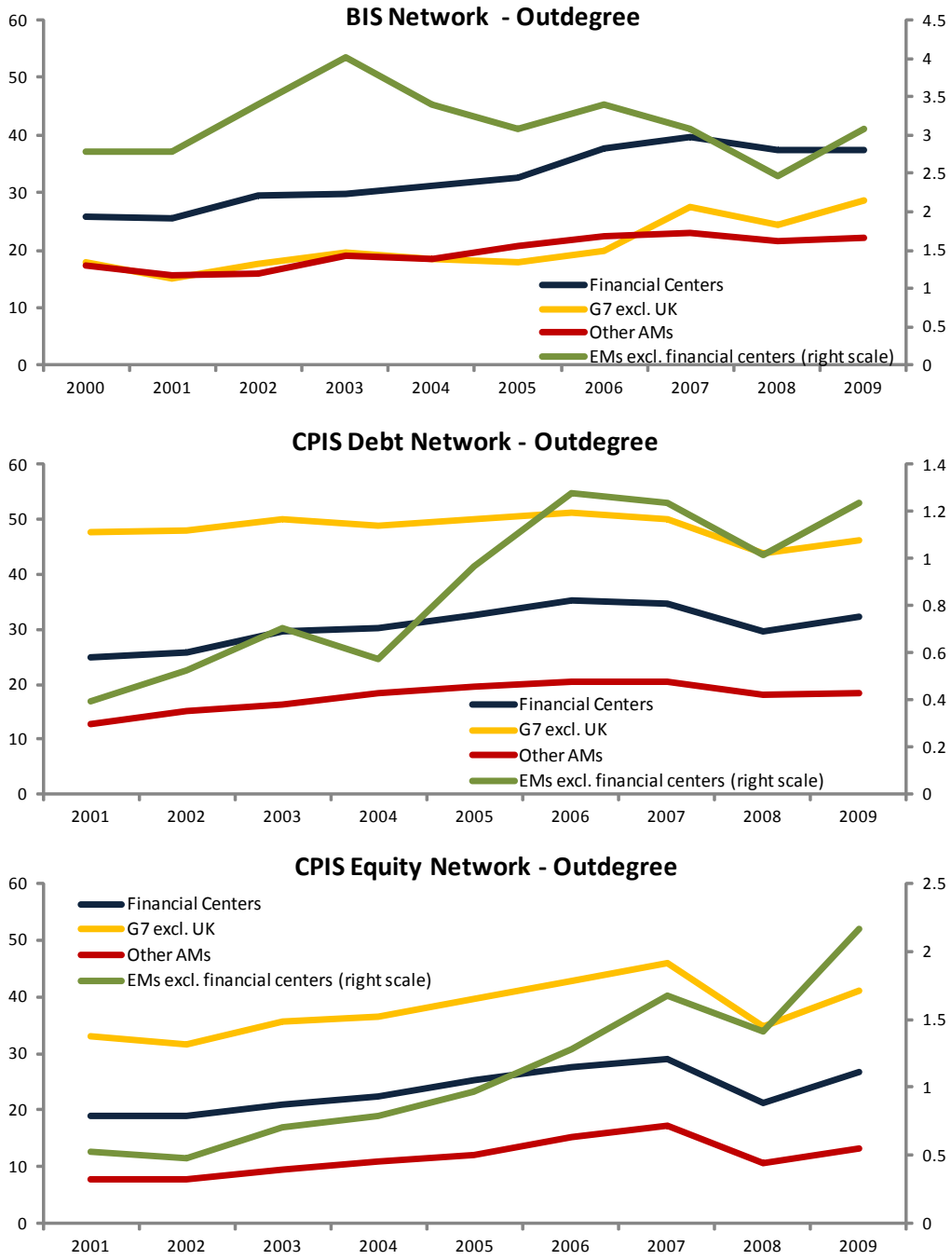


Source: BIS banking statistics, IMF CPIS, and staff calcuations.

1/ HHI measures the concentration in lending relationships. The HHI would approach zero if a country borrows even amounts from each of the creditors. Conversely, it would be one if there is only one active creditor. A country group's HHI is a simple average of the country-level HHI within the group. Foreign claims smaller than 0.2 ercent of the debtor's GDP were excluded. This exercise was repeated for each of the three asset classes considered (bank claims, portfolio debt and equity).

Figure II.4. Network Connectivity - Outdegree 1/

(in percent)



Source: BIS banking statistics, IMF CPIS, and staff calcuations.

1/ Out-degree measures the number of locations a country lend to. A country group's out-degree was calculated as the number of "active" links in percent of total possible links (i.e., the number of debtors in the database). An "active" link is a foreign asset (held by a country in the group) that is no smaller than 0.2 ercent of the creditor's GDP. This exercise was repeated for each of the three asset classes considered (bank claims, portfolio debt and equity).

Annex III. Top Global Sources and Recipients

Table III.1. Top Global Sources 1/

BIS			CPIS: Equity			CPIS: Debt		
Creditor	Freq.	Percent	Creditor	Freq.	Percent	Creditor	Freq.	Percent
Germany	80	9.95	United States	69	9.69	Luxembourg	77	9.99
France	77	9.58	Luxembourg	66	9.27	Germany	68	8.82
Netherlands	77	9.58	United Kingdom	61	8.57	United Kingdom	68	8.82
Switzerland	73	9.08	Netherlands	53	7.44	United States	66	8.56
United States	73	9.08	France	47	6.6	France	64	8.3
United Kingdom	71	8.83	Norway	47	6.6	Japan	62	8.04
Japan	60	7.46	Canada	36	5.06	Netherlands	56	7.26
Italy	58	7.21	Ireland	35	4.92	Ireland	38	4.93
Spain	38	4.73	Japan	34	4.78	Italy	38	4.93
Austria	36	4.48	Germany	29	4.07	Denmark	29	3.76
Sweden	32	3.98	Sweden	27	3.79	Austria	28	3.63
Belgium	20	2.49	Switzerland	22	3.09	Switzerland	25	3.24
Ireland	18	2.24	Denmark	16	2.25	Hong Kong	20	2.59
Greece	17	2.11	Korea	14	1.97	Belgium	14	1.82
Denmark	15	1.87	Australia	13	1.83	Cyprus	13	1.69
Canada	14	1.74	Singapore	13	1.83	Singapore	13	1.69
Australia	13	1.62	Brazil	10	1.4	Norway	11	1.43
Portugal	10	1.24	Estonia	10	1.4	Spain	8	1.04
Brazil	8	1	Austria	9	1.26	Greece	8	1.04
Panama	8	1	Chile	9	1.26	Sweden	8	1.04
Turkey	5	0.62	Hong Kong	9	1.26	Canada	7	0.91
Chile	1	0.12	Italy	8	1.12	Panama	7	0.91
			Greece	7	0.98	Russia	7	0.91
			Finland	6	0.84	Finland	6	0.78
			Belgium	5	0.7	Australia	3	0.39
			Spain	5	0.7	Estonia	3	0.39
			Hungary	5	0.7	Korea	3	0.39
			Lebanon	5	0.7	Thailand	3	0.39
			Poland	5	0.7	Costa Rica	2	0.26
			Cyprus	4	0.56	Venezuela	2	0.26
			Latvia	4	0.56	Bulgaria	1	0.13
			Malaysia	4	0.56	Brazil	1	0.13
			Bulgaria	3	0.42	Egypt	1	0.13
			Egypt	3	0.42	Indonesia	1	0.13
			Portugal	3	0.42	Lebanon	1	0.13
			Panama	2	0.28	Latvia	1	0.13
			Russia	2	0.28	Malta	1	0.13
			Turkey	2	0.28	Malaysia	1	0.13
			Uruguay	2	0.28	New Zealand	1	0.13
			South Africa	2	0.28	Pakistan	1	0.13
			India	1	0.14	Portugal	1	0.13
			Kazakhstan	1	0.14	Turkey	1	0.13
			New Zealand	1	0.14	Uruguay	1	0.13
			Romania	1	0.14	South Africa	1	0.13
			Thailand	1	0.14			
			Venezuela	1	0.14			
Total	**804**	**100.0**		**712**	**100.0**		**771**	**100.0**

Source: BIS; CPIS; and IMF staff calculations.

1/ Top sources were identified as follows. First, for each recipient country, cross-border sources were ranked according to the size of their bilateral claims to construct a list of the country's top ten sources. Then, all top sources were ranked based on the frequency they recurred across the lists of country top-sources. This exercise was repeated for each of the three asset classes considered (bank claims, portfolio debt and equity).

Table III.2. Top Global Recipients 1/

BIS			CPIS: Equity			CPIS: Debt		
Debtor	Freq.	Percent	Debtor	Freq.	Percent	Debtor	Freq.	Percent
UK	22	9.58	United States	54	9.93	United States	52	9.56
United States	22	9.58	UK	51	9.38	UK	50	9.19
Germany	20	8.71	Luxembourg	45	8.27	Germany	47	8.64
France	19	8.27	France	42	7.72	France	46	8.46
Netherlands	18	7.84	Germany	36	6.62	Netherlands	45	8.28
Ireland	12	5.22	Ireland	36	6.62	Ireland	32	5.88
Italy	12	5.22	Switzerland	27	4.96	Luxembourg	28	5.15
Spain	11	4.78	Japan	24	4.41	Spain	23	4.23
Luxembourg	11	4.78	Netherlands	24	4.41	Italy	21	3.86
Canada	8	3.48	Australia	17	3.13	Australia	16	2.95
Japan	6	2.61	Spain	17	3.13	Brazil	16	2.95
Belgium	5	2.17	Canada	15	2.76	Japan	14	2.58
Brazil	4	1.74	Brazil	12	2.21	Austria	13	2.40
Korea	4	1.74	Italy	12	2.21	Greece	12	2.20
Poland	4	1.74	China	11	2.02	Belgium	9	1.65
Austria	3	1.30	Hong Kong	10	1.84	Sweden	9	1.65
Switzerland	3	1.30	Russia	9	1.65	Canada	8	1.47
Chile	3	1.30	Belgium	7	1.29	Korea	7	1.28
China	3	1.30	Korea	7	1.29	Switzerland	6	1.10
Hungary	3	1.30	Singapore	7	1.29	Denmark	6	1.10
Mexico	3	1.30	Sweden	7	1.29	Norway	6	1.10
Argentina	2	0.87	Austria	4	0.74	Hong Kong	5	0.92
Australia	2	0.87	Greece	4	0.74	India	5	0.92
Denmark	2	0.87	Mexico	4	0.74	Finland	4	0.73
Finland	2	0.87	Argentina	3	0.55	Hungary	4	0.73
Hong Kong	2	0.87	Cyprus	3	0.55	Mexico	4	0.73
Norway	2	0.87	Hungary	3	0.55	Poland	4	0.73
Romania	2	0.87	India	3	0.55	Portugal	4	0.73
Sweden	2	0.87	Malaysia	3	0.55	Argentina	3	0.55
Bulgaria	1	0.43	Panama	3	0.55	Chile	3	0.55
Costa Rica	1	0.43	Poland	3	0.55	Malaysia	3	0.55
Dominican Rep.	1	0.43	Portugal	3	0.55	Russia	3	0.55
Estonia	1	0.43	Turkey	3	0.55	Singapore	3	0.55
Greece	1	0.43	Bulgaria	2	0.37	China	2	0.37
Guatemala	1	0.43	Chile	2	0.37	Colombia	2	0.37
Croatia	1	0.43	Denmark	2	0.37	Cyprus	2	0.37
India	1	0.43	Egypt	2	0.37	Sri Lanka	2	0.37
Lithuania	1	0.43	Estonia	2	0.37	Lithuania	2	0.37
Latvia	1	0.43	Finland	2	0.37	Peru	2	0.37
New Zealand	1	0.43	Indonesia	2	0.37	El Salvador	2	0.37
Panama	1	0.43	Jordan	2	0.37	Thailand	2	0.37
Peru	1	0.43	Norway	2	0.37	Venezuela	2	0.37
Portugal	1	0.43	Peru	2	0.37	South Africa	2	0.37
Russia	1	0.43	Romania	2	0.37	Bolivia	1	0.18
Singapore	1	0.43	Thailand	2	0.37	Egypt	1	0.18
Serbia	1	0.43	Uruguay	2	0.37	Estonia	1	0.18
Turkey	1	0.43	Ecuador	1	0.18	Guatemala	1	0.18
			Israel	1	0.18	Indonesia	1	0.18
			Lebanon	1	0.18	Iceland	1	0.18
			New Zealand	1	0.18	Jamaica	1	0.18
			Pakistan	1	0.18	Macedonia	1	0.18
			Serbia	1	0.18	New Zealand	1	0.18
			Ukraine	1	0.18	Panama	1	0.18
			Venezuela	1	0.18	Philippines	1	0.18
			Vietnam	1	0.18	Romania	1	0.18
						Tunisia	1	0.18
						Turkey	1	0.18
Total	**230**	**100.0**		**544**	**100.0**		**545**	**100.0**

Source: BIS; CPIS; and IMF staff calculations.

1/ Top recipients were identified as follows. First, for each source country, cross-border recipients were ranked according to the size of their bilateral claims to construct a list of the country's top ten recipients. Then, all top recipients were ranked based on the frequency they recurred across the lists of country top-recipients. This exercise was repeated for each of the three asset classes considered (bank claims, portfolio debt and equity).

Annex IV. Importance of Global Factors in Driving Capital Inflows to EMs[36]

This annex investigates the quantitative importance of global factors and country-specific fundamentals in driving cross-border capital inflows to EMs. The conservative estimates discussed below suggest that global factors could explain at least 25 percent of variations in *total* gross inflows; for *portfolio* inflows, however, global factors are likely much more important (above 50 percent). Moreover, the relative importance of global factors is likely to shift over time, reflecting in particular global financial and liquidity conditions.

These shares were calculated using the same panel framework as in IMF, 2011e, which included both global and domestic variables as determinants of capital inflows. One problem in computing the contribution of global factors in this framework is that the overall variance of inflows (in log levels) in a panel of 48 EMs is largely driven by cross-country variation of inflows. The latter is often a result of country specific factors (e.g. political conditions or idiosyncratic developments such as privatization or lumpy investment projects) that are likely to drive capital flows without being directly linked to differences in domestic *macroeconomic* conditions—that is, the domestic pull factors that one would like to isolate here.[37] To correct for this potential bias, the total variance of underlying flows was broken down into two components, variance across countries and over time. The contribution of *global* factors was then computed as the ratio of their variance to the variance of gross capital inflows *over time*.

In this framework, global factors (U.S. long term interest rates and the VIX risk index) explained on average around 25 percent of the cross-time variation of gross total capital inflows to EMs; for *portfolio* inflows, the estimated share rose to 54 percent. These shares were computed by treating domestic variables as completely unaffected by global variables, while in practice they are likely to be influenced by the latter. When domestic variables were omitted from the estimated regressions, the share of cross-time variation explained by global factor rose to 65 and 87 percent, respectively, for total and portfolio inflows—an indirect sign that domestic variables are indeed affected significantly by global factors. These estimates can be thought of as an upper bound for the role of global factors for capital inflows.

---

[36] Prepared by Yanliang Miao.

[37] Using outright variance decomposition from panel regressions, the variance of global factors accounts for a mere 5 percent of total sample variation. This estimate is likely to have a significant downward bias, however, for the reason discussed in the text.

Robustness checks were performed by estimating the same regressions discussed in the previous paragraph for seven countries separately (Table IV.1). The results confirmed that global factors explain on average a fifth of the variation of total inflows for the seven countries. For portfolio inflows, the average share increased to 48 percent. Thus, these estimates were broadly aligned with the average shares derived from the panel approach.

Table IV.1: Share of Global Factors in Explaining Gross Capital Inflows

Country	Aggregate Inflows	Portfolio Inflows
Brazil	30	59
Indonesia	18	88
Korea	17	37
Peru	5	17
South Africa	22	5
Thailand	20	88
Turkey	11	41

As a further robustness check, the methodology used in IMF, 2011b, was applied to the current sample of 48 EMs for both gross and net flows (normalized as a percent of GDP). More specifically, this entailed three steps:

- **Step 1**. For each period *t*, capital flows were decomposed into two parts, Y(i,t)=a(t) + error(i, t), where error(i, t) denotes the part attributable to country-specific factors and a(t) the part driven by global factors that are constant across countries but vary over time. The term a(t) is estimated for each period *t* as a cross-section average of flows. The Residual Sum of Squares (RSS) was then calculated for each period.

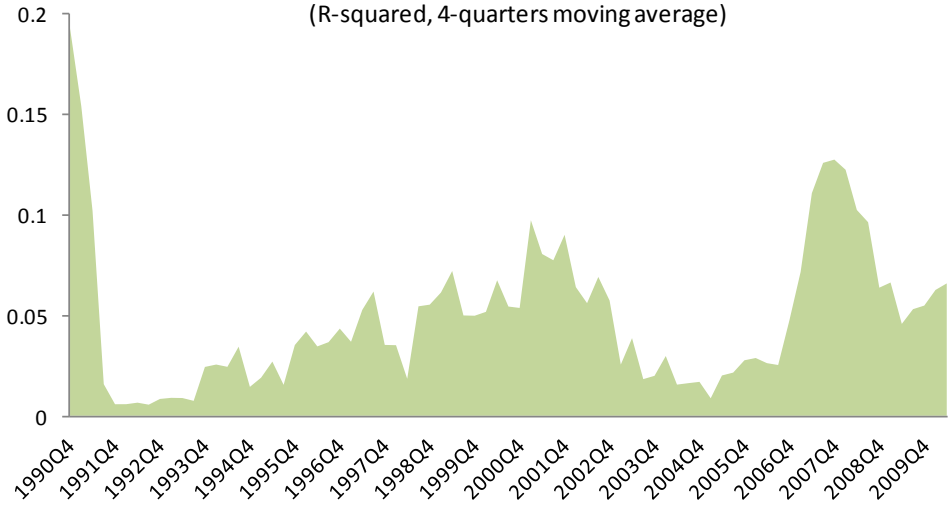
- **Step 2**. The Total Sum of Squares (TSS) was derived for each period as the cross-country sum of squared differences of flows from their sample mean.

- **Step 3**. The R-squared was calculated as 1-(RSS/TSS) for each period. This yielded the share of variance attributable to global factors.

The results are shown in Figure IV.1 and IV.2 for net and gross inflows, respectively. Global factors explained an important, though relatively small, share of total capital inflows—less than 20 percent for net inflows and less than a third for total gross inflows. This exercise, however, underscored how relative importance of global factors shifts over time and across different types of flows.

Figure IV.1 Net Inflows to EMs: the Role of Global Factors

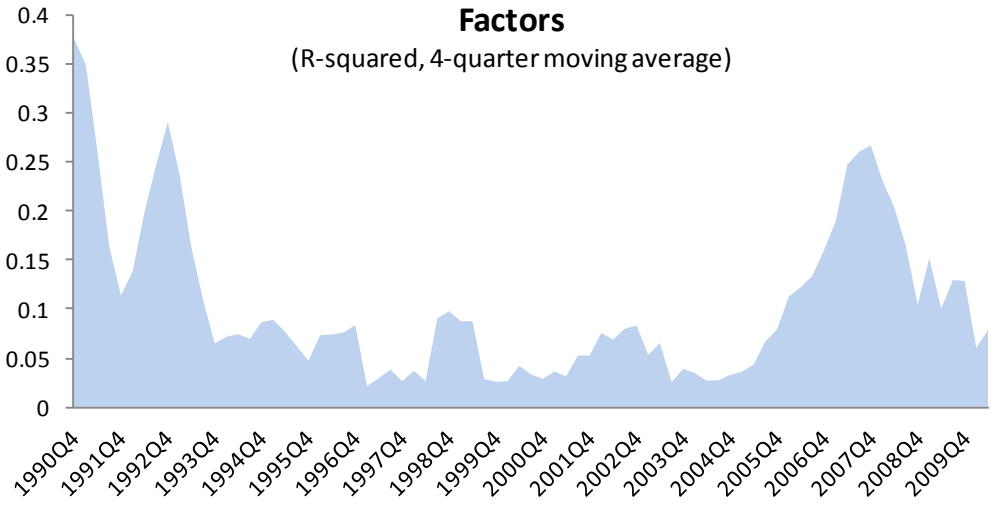
(R-squared, 4-quarters moving average)



Source: IMF, IFS and staff calculations.

Figure IV.2. Gross Inflows to EMs: the Role of Global Factors

(R-squared, 4-quarter moving average)



Source: IMF, IFS and staff calculations.

Annex V. Construction of a Total Spillover Index[38]

This annex discusses the derivation of "total spillover index" following the methodology introduced by Diebold and Yilmaz (2009, 2010, and 2011).

This index is derived in two steps from the forecast variance decomposition at a given horizon in an *N*-variables vector autoregression (VAR) model. First, for each variable *i* in the model, the share of its forecast error variance decomposition at a given horizon coming from shocks to variable *j* is added for all $i \neq j$. This yields the "*Total directional connectedness from other variables*" for variable *i*. Then, the "*Total directional connectedness from other variables*" are added across all variables, $i = 1,..., N$, to generate the total spillover index. Intuitively, this index captures the average share of forecast variance explained by shocks in other parts of the system. To build the time series of the total spillover index, the exercise was repeated by rolling the VAR estimation over sample windows.

For the application on financial variables shown in the paper, an unrestricted VAR was estimated over the period 1990:01 to 2010:12. The estimated model included five variables[39]: the VIX index, the first difference of the log real S&P 500 index, the first difference of the log real commodity price index, the U.S. federal funds rate, and the aggregate real return of EMs stock markets, which is constructed from the z-scores associated with the first principal component of a sample of EMs real stock returns.[40] The VAR's number of lags (two) was determined using the sequential modified likelihood ratio test, the Akaike-Schwarz based lower maximum likelihood criteria. The Portmanteau autocorrelation test, the normality test, and the White heteroskedasticity test performed on the residuals were used as specification tests. A recursive Cholesky orthogonalization of the error terms for the variance decomposition analysis was then used to identify structural shocks[41]. Finally, error forecast

---

[38] Prepared by J. Noah Ndela.

[39] The selection of variables aims primarily at identifying factors (such as liquidity, information risk, and macroeconomic policy) that drive asset prices at the global level.

[40] To construct the aggregate real return of EMs stock markets, data was collected for the period 1990:01 to 2010:12 on stock indexes in local currency for the following sample: Argentina, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Ecuador, Egypt, Estonia, Hungary, Indonesia, Jamaica, Kazakhstan, Lebanon, Lithuania, Malaysia, Mexico, Morocco, Pakistan, Poland, Romania, Russia, Serbia, South Africa, Tunisia, Turkey, Ukraine, Venezuela, and Vietnam. A real stock index was calculated for each country by deflating the nominal stock index with the monthly CPI index. The stock market real return is calculated as the first difference of the log real stock index. Principal component analysis generated *principal components* and *z-scores*. The first principal component, explaining 40 percent of the overall variability, identified the global factor and its z-scores series represented the aggregate real return of EMs stock markets.

[41] An alternative structural identification was also considered but yielded similar results.

variance at a 6 months horizon-step ahead was used to construct a full-sample "*Connectedness table*" (Table V.1).

The lines of the table (except the last line and excluding the last column "total connectedness from others") provide the variance decomposition for each variable at a 6 months horizon; by construction, this sum equals to 100 percent. The last column of the table sums off-diagonal elements and provides information about the relative importance of other random innovations in affecting a specific variable in the model. For instance, for the S&P 500, the value of 64 indicates that 64 percent of its 6-month-ahead error forecast variance is due to shocks to the other variables included in the VAR. This total contribution from other innovations is denoted "*Total directional connectedness from other variables*". Similarly, the last line of the table gives the "*total directional connectedness to other variables*"; this is the sum across variables of the contribution of a specific innovation to the variation of other variables and identifies the "connectedness" the variable associated with that innovation provides to the other variables in the model.

Table V.1. Connectedness

	VIX	S&P 500	Commodity Price Index	Fund Rate	EM real stock return	Total directional Connectedness from others
VIX	95.16	1.26	2.66	0.22	0.70	4.84
S&P 500	61.00	36.43	0.87	1.47	0.23	63.57
Commodity Price Index	20.76	1.11	77.20	0.07	0.85	22.80
Fund Rate	25.39	0.25	1.61	71.73	1.02	28.27
EM real stock return	2.27	4.36	1.21	2.04	90.12	9.88
Total directional Connectedness to others	109.42	6.99	6.35	3.80	2.79	129.35

Source: Datastream and IMF staff calculations.

In the full sample, the total spillover index equals to 25.87. This is the sum (highlighted in yellow) of either the "Total directional connectedness from others variables" (4.84+63.57+22.80+28.27+9.88=129.35) or that of the "total directional connectedness to others variables" (109.42+6.99+6.35+3.80+2.79=129.35) normalized by the number of variables in the model, 5 in this case[42].

To construct the series of the total spillover index, depicted in Figure 1, a VAR model was estimated rolling windows of 60 months; each estimated model then was used to construct a

[42] Total spillover index = 129.35/5 = 25.87

total spillover index over that specific subsample, which is recorded as an observation at the end date of the rolling sample period.

The paper also showed a "real" total spillover index (Figure 18). This was constructed for a VAR model including the monthly growth rates of industrial output for G7 countries; China; a group of EMs; and the VIX index.

The net connectedness of a given variable *i* is computed as the difference between the total directional connectedness it receives from others variables and the total directional connectedness it transmits to those variables. For example, in the full sample (see table IV.1), the net connectedness of the aggregate real return of EMs stock markets is 9.88-2.79=7.09[43]. By computing this difference throughout the rolling VAR estimation, the series of the net connectedness (or net volatility) can be constructed. This was shown in Figure 14 for the aggregate real return of EM stock markets.

[43] A positive value of the net connectedness implies the variable is net receiver, and a negative value means it is net transmitter.

Annex VI. Evidence from Cross-Border Banking Groups[44]

This annex first describes the construction of the underlying dataset used in the analysis of the behavior of cross-border banking groups and then summarizes the empirical results discussed in the paper. The focus of the analysis was on the operations of *commercial banking groups;* this analysis thus complements previous staff work on financial interconnectedness from the perspective of Large Complex Financial Institutions (IMF, 2010c).

Construction of Banking Groups

As described in Porter and Serra, 2011, one of the main contributions of this exercise was to construct a novel dataset on cross-border banking groups. This dataset covers the ownership structure of *every* banking/financial group with at least one foreign subsidiary between 1995 and 2009 on an ultimate ownership basis.[45] The dataset was built starting from ownership and subsidiary data available in Bankscope since 2002, and then by extending it back to 1995 using the information provided in Bankers' Almanac as well as resorting to parent banks' annual reports, working papers on foreign banking activity, and handbooks of banking history. The final ownership dataset included a matching of every ultimate owner to its domestic and foreign subsidiaries, and the ultimate owner's home country and shareholdings between 1995 and 2009. Balance sheet data and financial soundness indicators, as well as macroeconomic and financial data, were matched to subsidiaries and parent banks using Bankscope and Bloomberg, respectively.

Ownership and Diversification Patters

With the individual banking group structures established, it was possible to describe the importance of cross-border banking groups in EMs, as well as describe their group-level structure and diversification.

- The *importance of cross-border banks in EMs* was calculated using these banks' assets in percent of the assets for all banks in the domestic banking system.

- The *diversification of banking groups* was calculated using the Herfindahl-Hirschman index (HHI) (see Annex II). This provided an index of group concentration across

[44] Prepared by Nathan Porter and Cesar Serra.

[45] The term subsidiary is used here to also include branch data reported in Bankscope. Using ultimate ownership basis allowed avoiding spurious testing by not using the direct ownership structure reported by parent banks, which commonly set aside a different subsidiary outside the home country or an acquired foreign bank to be a holding or manage other foreign subsidiary.

locations. This was calculated separately for all subsidiary locations (including domestic ones) as well as for only those subsidiaries outside the parent country.

- The geographic *span of a banking group* was measured by the average distance of group assets from the parent country. This was calculated as the average distance of each subsidiary location in kilometers, weighted by the assets of that subsidiary.

Regression Analysis

Panel regression analysis of subsidiaries-parent links was used to understand the potential channels through which shocks affecting parent banks spill over to their subsidiaries.[46] Given the relatively minor role EM parents play in EM banking sectors, the analysis was focused on links that involve AM parents and subsidiaries in EMs. The estimated relationship aimed to explain subsidiary-level new lending (relative to subsidiary assets) through both local and parent-country (and global) macroeconomic factors, as well as the financial soundness of both the parent and subsidiary. Financial soundness was captured through solvency (capital adequacy and the volatility of the parent's equity price), leverage (equity/assets), liquidity (liquid assets/assets), credit quality (nonperforming loan ratio), and profitability (return on equity). Local macroeconomic conditions were controlled for with the inclusion of local GDP growth and the appreciation of the bilateral US$ exchange rate, while parental and global macroeconomic conditions were controlled for with the parent country growth and the VIX index. To overcome their potential endogeneity, all the bank-specific variables were lagged.

The financial conditions of both the parent and subsidiary significantly were found to affect new lending (Table VI.1). Excessive leverage (low equity-to-assets), and low liquidity, in the local subsidiary significantly reduce the ability of that subsidiary to extend new loans. However, recent local profitably has at most a marginal impact on lending. Importantly, however, parental liquidity and capital adequacy also significantly affect the ability of the bank to extend loans, with parental profitability again marginally important. Lower parental liquidity inhibits the ability of subsidiaries to extend new loans, suggesting an important channel for liquidity shocks. This could operate through the ability of the local bank to borrow from the parent, or the need for the parent to borrow from the subsidiary (in line with Cetorelli and Goldberg, 2010), higher counter-party concerns in the local interbank market affecting access of the subsidiary, or even the within-group currency mismatches (Fender and McGuire, 2010). Stronger parental capital adequacy is associated with lower subsidiary lending. This may reflect the fact that, *conditional on a healthy subsidiary* (high liquidity and low leverage), a parent with a stronger capital may be able to lend separately into the local

[46] Subsidiaries are defined as foreign affiliates owned with at least 50 percent shareholding by a banking group. The results on the regressions were robust to an an alternative cutoff of at least 40 percent shareholding, with no other shareholder owning more than 40 percent.

market, or withdraw capital from the local subsidiary conditionally affecting local lending. While significant, the empirical impact of this is, nonetheless, small. Macroeconomic conditions and aggregate volatility are also both important for subsidiary lending, with higher local and parental growth and lower aggregate volatility associated with more new lending.

Figure 17 in the paper summarizes these results. Aggregating these potential channels highlights the importance of the health of the subsidiary, but also suggests important liquidity connections between parent and subsidiary banks. Shocks that raise local growth or change the financial conditions of the subsidiary from the 25^{th} to the 75^{th} percentile of the distribution increase new lending by 80 percent or 124 percent of its median value, respectively. Shocks of similar magnitude that strengthen the financial conditions of the parent bank raise lending in 35 percent, reflecting the importance of improved parental liquidity.

Table VI.1. Regression Analysis: Emerging Market Subsidiaries and Advanced Market Parents

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Δ Subsidiary Loans/Assets(-1)					
Subsidiary						
Equity/Assets (-1)	0.720***	0.735***	0.782***	0.434***	0.658***	0.649***
	(7.51e-06)	(3.83e-06)	(0.00164)	(0.00997)	(3.66e-05)	(4.55e-05)
Liquid Assets/Assets (-1)	0.183***	0.176***	0.193***	0.144***	0.140***	0.139***
	(1.76e-06)	(5.05e-06)	(0.00378)	(0.00387)	(0.000170)	(0.000209)
ROE (-1)	-0.000757	-0.000758	-0.000737	0.0178**	-0.000682	-0.000635
	(0.423)	(0.423)	(0.432)	(0.0198)	(0.472)	(0.498)
Parent						
Liquid Assets/Assets (-1)	0.246***	0.208***	0.105	0.649***	0.256***	0.266***
	(0.00290)	(0.00855)	(0.221)	(2.17e-06)	(0.000765)	(0.000426)
ROE (-1)	0.119*	0.119*	0.0943	0.0332	0.0406*	0.0425*
	(0.0680)	(0.0614)	(0.100)	(0.383)	(0.0911)	(0.0795)
Tier1 Cap Ratio (-1)	-0.0121***		-0.0159**	-0.0111*	-0.0110***	-0.0146***
	(0.00376)		(0.0265)	(0.0724)	(0.00769)	(0.000634)
Overall Cap Ratio (-1)		-0.00912**				
		(0.0126)				
Coef Var Stock Price			-0.230***			
			(0.00169)			
NPL/Loans (-1)				-1.609**		
				(0.0453)		
Macro Local						
Real GDP growth					1.542***	1.348***
					(0)	(0)
Appreciation	1.88e-06**	1.71e-06**	0.000551***	0.000456	-2.47e-06***	-2.42e-06***
	(0.0140)	(0.0276)	(0.00679)	(0.480)	(0.000856)	(0.000963)
Macro Parent and Global						
Real GDP growth					1.275***	0.626**
					(1.51e-05)	(0.0312)
VIX						-0.00446***
						(2.77e-05)
Constant	0.0116	0.0290	0.108*	-0.0288	-0.0546	0.0911*
	(0.797)	(0.546)	(0.0937)	(0.625)	(0.213)	(0.0606)
Observations	3,403	3,404	1,744	1,940	3,403	3,403
R-squared	0.053	0.052	0.062	0.042	0.112	0.117
Number of id	503	504	266	380	503	503

Robust pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: IMF staff calculations.

Annex VII. Explaining Bilateral Financial Exposures[47]

After a brief summary of related relevant literature, this annex summarizes the analysis of the determinants of cross-border linkages.

There is by now an extensive literature on the determinants of cross-border portfolio flows and holdings; a literature review is thus necessarily incomplete. Using data on portfolio equity flows, Portes and Rey, 2005, showed in a seminal paper that proxies for informational asymmetries, together with the size of host countries' stock markets, were key determinants of international equity flows. Rose and Spiegel, 2004, highlighted the positive association between bilateral trade and bilateral bank lending, while Lane and Milesi-Ferretti, 2008, found that there was a strongly positive association between bilateral trade and portfolio equity allocations. These authors also found that bilateral portfolio equity holdings were significantly correlated with informational/cultural linkages, such as common language and legal origins. Finally, it is worth mentioning the finding by Galstyan and Lane, 2010, in their study of the dynamics of portfolio equity holdings in Emerging Europe during the 2008 crisis, namely the presence of a systemic positive relation between the scale of pre-crisis equity holdings and the subsequent pull back during the global crisis.[48] One contribution of this paper is to revisit some of these studies, applying a common approach to different asset classes (bank lending and portfolio debt and equity claims).

To investigate cross-border financial investment and its determinants, a standard approach is to estimate a "gravity" equation augmented by a number of control variables:[49]

$$ln\,(y_{ijt}) = \alpha + \beta_1 ln(size_{it}) + \beta_2 ln(size_{jt}) + \beta_3 ln(distance_{ij}) + w_{it} + x_{jt} + z_{ijt} + \varepsilon_{ijt}$$

where i denotes the source; j denotes the recipient; t denotes the year (2001 to 2009); y_{ijt} is country i's cross-border holdings of country j's financial assets at time t; w_{it} is a vector of source country-specific explanatory variables; x_{jt} is a vector of recipient country-specific explanatory variable; and z_{ijt} is a vector of bilateral explanatory variables.

Three types of asset holdings—the dependent variable in the analysis—were investigated: portfolio debt securities, portfolio equity securities and bank claims.[50] Portfolio debt and

[47] Prepared by Mali Chivakul.

[48] However, geographic proximity between source and recipient countries tended to be a stabilizing factor.

[49] A number of studies have employed this framework, e.g. Lane and Milesi-Ferreti, 2004; Eichengreen and Luengnaruemitchai, 2006; and Borenszstein and Loungani, 2011.

[50] The dependent variable was specified as ln (1+x), where x is either portfolio debt, equity or bank claims, so as to explicitly account for the large number of observations equal to zero especially in the CPIS database.

equity securities holdings were taken from the CPIS database, and cross-border bank claims from the BIS (BIS banks' foreign claims, Table 9a). The data sample covered 81 countries, 27 advanced economies and 54 emerging markets (as listed in Annex I)[51].

For bilateral explanatory variables, a range of gravity-type time-invariant variables to proxy for information costs besides distance were included: the time zone difference, a common language dummy, a common currency dummy, and a common legal system dummy. Bilateral trade was also included to capture trade linkages. To take into account the level of financial development, a financial depth variable for both recipient and source countries was added. Financial depth was proxied by stock market capitalization to GDP ratio in the portfolio equity regression, total outstanding bond to GDP to GDP ratio in the portfolio debt regression, and private sector credit to GDP ratio in the bank claims regression. Other recipient and source country specific variables were per capital GDP, an international financial center dummy, and regional dummies.

A pooled OLS specification was first considered. However the Breusch-Pagan Lagrange Multiplier test suggested that a country pair random effects specification was superior. Table VII.1 shows the baseline results obtained from this specification.[52] These results were summarized in Figure 19 of the paper.

Robustness checks were performed by running the three baseline regressions using fixed effects for source and recipient countries (forcing us to drop time-invariant source and recipient variables that do not vary over time such as country grouping dummies). The results for the main variables of interest were robust to this change in specification.

Table VII.2 summarizes data sources.

[51] Actual sample size varied with data availability for each regression.

[52] A country-pair fixed effects specification was not considered because it would have required dropping time-invariant country pair variables, which are of particular interest in this context.

Table VII.1. Determinants of Bilateral Financial Asset Holdings, 2001-09

	Equity securities	Debt securities	BIS bank claims
Log GDP, recipient	0.572***	0.604***	0.727***
	(0.024)	(0.052)	(0.035)
Log GDP, source	0.122***	0.532***	0.372***
	(0.027)	(0.065)	(0.051)
Log GDP percapita, recipient	0.0764	0.227***	0.00349
	(0.050)	(0.081)	(0.062)
Log GDP percapita, source	0.430***	0.478***	-0.18
	(0.051)	(0.087)	(0.123)
Log exports from recipient to source	0.0784***	0.0364***	0.0613***
	(0.008)	(0.013)	(0.011)
Financial openness, recipient	0.0612***	0.109***	0.0744***
	(0.021)	(0.042)	(0.028)
Financial openness, source	-0.0320*	0.101**	-0.035
	(0.017)	(0.046)	(0.050)
Financial depth indicator, recipient	0.243***	0.235***	0.696***
	(0.036)	(0.055)	(0.075)
Financial depth indicator, source	0.171***	0.126**	0.135*
	(0.028)	(0.053)	(0.081)
Time difference	0.0582***	-0.0307	0.00122
	(0.014)	(0.023)	(0.021)
Log distance	-0.597***	-0.702***	-0.763***
	(0.056)	(0.088)	(0.081)
Common legal system	0.179***	0.173*	-0.0151
	(0.069)	(0.101)	(0.096)
Common languange	0.622***	0.420***	0.879***
	(0.119)	(0.161)	(0.130)
Common currency	1.618***	1.542***	0.226
	(0.161)	(0.136)	(0.139)
Financial center dummy, destination	0.764***	0.0669	0.621***
	(0.107)	(0.120)	(0.129)
Financial center dummy, source	0.483***	1.460***	1.136***
	(0.097)	(0.116)	(0.097)
G7 dummy, recipient	0.573***	0.689***	0.218
	(0.134)	(0.170)	(0.143)
EMEUR dummy, recipient	-0.493***	-0.606***	-0.461***
	(0.118)	(0.235)	(0.156)
Middle east EM dummy, recipient	-0.444***	0.0784	-0.967***
	(0.153)	(0.314)	(0.180)
Asian EM dummy, recipient	0.0876	-0.611**	-0.115
	(0.169)	(0.256)	(0.158)
Latin American EM, recipient	-0.385***	-0.132	0.316**
	(0.130)	(0.200)	(0.142)
G7 dummy, source	1.532***	1.452***	1.259***
	(0.119)	(0.180)	(0.130)
EMEUR dummy, source	-1.362***	-2.199***	-1.485***
	(0.113)	(0.247)	(0.262)
Middle east EM dummy, source	-0.634***	-1.180***	
	(0.146)	(0.360)	
Asian EM dummy, source	-0.898***	-0.416*	
	(0.142)	(0.244)	
Latin American EM, source	-0.921***	-1.282***	-2.234***
	(0.124)	(0.225)	(0.230)
Constant	-1.798**	-4.068***	6.393***
	(0.786)	(1.412)	(1.383)
Observations	22,631	10,711	10,498
Number of country pairs	3,511	1,396	1,504
R2	0.664	0.715	0.695

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Source: BIS, CPIS and staff estimates.

Table VII.2. Data Description

Variable	Definition	Source
Bilateral portfolio equity holdings	Portfolio equity instruments issued by recipient country residents and held by source country residents	1997-2009 Coordinated Portfolio Survey (CPIS)
Bilateral portfolio debt holdings	Portfolio debt instruments issued by recipient country residents and held by source country residents	1997-2009 CPIS
Bilateral foreign bank claims	BIS banks' foreign claims (cross-border +local claims) on a country.	BIS
Source country imports	Import of goods by source countries from recipient countries	IMF, Direction of Trade Statistics
Distance	Simple distance in km between the most populated cities	CEPII dataset http://www.cepii.fr/anglaisgraph/bdd/gravity.htm
Common currency	Dummy variable taking the value of 1 if source and host country share a common currency. Data are up to 2006. 2006 values are used for 2007-2009.	CEPII dataset http://www.cepii.fr/anglaisgraph/bdd/gravity.htm
Common language	Dummy variable taking the value of 1 if source and host country share a common official or primary language	CEPII dataset http://www.cepii.fr/anglaisgraph/bdd/gravity.htm
Common legal origin	Dummy variable taking the value of 1 if source and host country have a legal system with a common origin (common law, French, German or Scandinavian)	CEPII dataset http://www.cepii.fr/anglaisgraph/bdd/gravity.htm
GDP	Nominal GDP in current U.S. dollars	IMF/WEO
GDP per capita	Nominal GDP per capita in current U.S. dollars	IMF/WEO
Financial openness	Chinn-Ito index measuring a country's degree of capital account openness. Dummy used for 2009 is from 2008.	Chinn-Ito 2008 Update
Financial center dummy	Dummy variable taking the value of 1 if the country or territory is an international financial center	
Financial depth indicator	Stock market capitalization to GDP ratio (equity regression), Outstanding bond to GDP ratio (debt regression) and Private sector credit to GDP ratio (bank claims regression.	World Bank Financial Structure Database
GDP	Nominal GDP in current U.S. dollars	IMF/WEO

References

Allen, F. and D. Gale, 2000, "Financial Contagion", *Journal of Political Economy,* Vol. 108, No. 1 pp. 1–33.

Battiston, S., D. Gatti, M. Gallegati, B.C.N. Greenwald, and J.E. Stiglitz, 2009, "Liasons Dangereuses: Increasing Connectivity, Risk Sharing, and Systemic Risk," NBER Working Paper No.15611 (Cambridge, Massachusetts: National Bureau of Economic Research).

Bayoumi, T., and A. Swiston, 2007, "The Ties that Bind: Measuring International Bond Spillovers Using Inflation-Indexed Bond Yields," IMF Working Paper 07/128 (Washington: International Monetary Fund).

———, 2009, "Foreign Entanglements: Estimating the Source and Size of Spillovers across Industrial Countries," *IMF Staff Papers*, International Monetary Fund,Vol. 56, No. 2.

Bordo, M.D. and J.S. Landon, 2010, "The Global Financial Crisis of 2007-08. Is it Unprecedented?" NBER Working Paper No. 16589 (Cambridge, Massachusetts: National Bureau of Economic Research).

Borensztein, E. and P. Loungani, 2011, "Asian Financial Integration: Trends and Interruptions," IMF Working Paper 11/4 (Washington: International Monetary Fund).

Calvo, G., A. Izquierdo, L.-F. Mejía, 1998, "Systemic Sudden Stops: The Relevance of Balance-Sheet Effects and Financial Integration," NBER Working Paper No. 14026 (Cambridge, Massachusetts: National Bureau of Economic Research).

Chuhan, P., S. Claessens, and N. Mamingi, 1993, "Equity and Bond Flows to Latin America and Asia: The Role Global and Country Factors," IECIF Policy Research Working Paper No. 1160 (Washington: World Bank).

Diebold, F.X. and K. Yilmaz, 2009, "Measuring Financial Asset Return and Volatility Spillovers, With Application to Global Equity Markets," *Economic Journal*, Vol. 119, pp. 158-171

———, 2010, "Better to Give than to Receive: Predictive Directional Measurement of Volatility Spillovers," *International Journal of Forecasting*, forthcoming.

———, 2011, "Predictive Measurement of Connectedness in Financial and Macroeconomic Environments," forthcoming.

Eichengreen, B. and P. Luengnaruemitchai, 2006. "Bond Markets as Conduits for Capital Flows: How Does Asia Compare?" NBER Working Paper No. 12408(Cambridge, Massachusetts: National Bureau of Economic Research).

Fender, I., and P. McGuire, 2010, "Bank Structure, Funding Risks and the Transmission of Shocks Across Countries: concepts and measurement," BIS Quarterly Review September, pp. 63-79

Fernandez-Arias, E., 1996, "The New Wave of Private Capital Inflows: Push or Pull?" J*ournal of Development Economics*, Elsevier, Vol. 48 No.2(March), pp. 389–418.

Fernández-Arias, E. and E. Levy-Yeyati, 2010, "Global Financial Safety Nets: Where Do We Go from Here?" CIF Working Paper No. 06/2010 (Universidad Torcuato di Tella).

Fernandez-Arias, E. and P. J. Montiel, 1996, "The Surge in Capital Inflows to Developing Countries: An Analytical Overview," *World Bank Economic Review*, Vol. 10 No. 1 (January), pp. 51–77.

Ferrucci, G., V. Herzberg, F. Soussa, and A. Taylor, 2004, "Understanding Capital Flows to Emerging Market Economies," *Financial Stability Review*, London, June.

Galstyan, V., and P. R. Lane, 2010, "The Dynamics of Portfolio Holdings in Emerging Europe", IIIS Discussion Paper No. 346.

Gai, P. and S. Kapadia, 2010, "Contagion in Financial Networks," *Bank of England Working Paper No. 383*.

Garratt, R., L. Mahadeva, and K. Svirydzenka, 2011, "Mapping Systemic Risk in the International Banking Network," *Bank of England Working Paper No. 413.*

Haldane, A.G., 2009, "Rethinking the Financial Network", Speech delivered at the Financial Student Association, Amsterdam.

Holmström, B. and J. Tirole, 1998, "Private and Public Supply of Liquidity," *Journal of Political Economy*, Vol., 106, pp. 1–40.

International Monetary Fund, 2007, *World Economic Outlook, April 2007: A Survey by the Staff of the International Monetary Fund*, World Economic and Financial Surveys (Washington).

———, 2009a, "Assessing the Systemic Implications of Financial Linkages", in *Global Financial Stability Report: Responding to the Financial Crisis and Measuring Systemic Risks*, World Economic and Financial Surveys, April 2009.

———, 2009b, "Detecting Systemic Risk", in *Global Financial Stability Report: Responding to the Financial Crisis and Measuring Systemic Risks*, World Economic and Financial Surveys, April 2009.

———, 2010a. "The Fund's Role Regarding Cross-Border Capital Flows", IMF Policy Paper (Washington). Available via the Internet: www.imf.org/external/np/pp/eng/2010/111510.pdf

———, 2010b, "Integrating Stability Assessments Under the Financial Sector Assessment Program into Article IV Surveillance", IMF Policy Paper (Washington). Available via the Internet: http://www.imf.org/external/pp/longres.aspx?id=4477

———, 2010c, "Understanding Financial Interconnectedness", IMF Policy Paper (Washington). Available via the Internet: www.imf.org/external/np/pp/eng/2010/100410.pdf

———, 2010d. "How Did Emerging Markets Cope in the Crisis?", IMF Policy Paper (Washington). Available via the Internet: http://www.imf.org/external/pp/longres.aspx?id=4459.

———, 2010e, "Global Liquidity Expansion: Effects on Receiving Economies and Policy Response Options" in *Global Financial Stability Report: Meeting New Challenges to Stability and Building a Safer System*, World Economic and Financial Surveys, April 2010.

———, 2011a, "New Growth Drivers for Low–Income Countries - The Role of BRICs", Policy Paper (Washington DC). Available via the Internet: https://www.imf.org/external/np/pp/eng/2011/011211.pdf

———, 2011b, *World Economic Outlook April 2011: A Survey by the Staff of the International Monetary Fund,* World Economic and Financial Surveys (Washington).

———, 2011c, "Assessing Reserve Adequacy", IMF Policy Paper (Washington DC). Available via the Internet: www.imf.org/external/np/pp/eng/2011/021411b.pdf

———, 2011d, "Strengthening the International Monetary System: Taking Stock and Looking Forward", IMF Policy Paper (Washington DC). Available via the Internet: http://www.imf.org/external/pp/longres.aspx?id=4548

———, 2011e, "Recent Experiences in Managing Capital Inflows—Cross-Cutting Themes and Possible Policy Framework", IMF Policy Paper (Washington DC). Available via the internet: http://www.imf.org/external/pp/longres.aspx?id=4542

———, 2011f, "Monitoring Financial Interconnectedness, Including the Data Template for Global Systemically Important Financial Institutions, IMF Policy Paper," upcoming IMF Policy Paper (Washington DC).

Kubelec, K and F. Sa, 2010, "The Geographical Composition of National External Balance Sheets: 1980-2005", *Bank of England Working Paper No. 384*

Lane, P. R., 2009, "The Global Crisis and Capital Flows to Emerging Markets," in Macroeconomic Stability and Financial Regulation: Key Issues for the G20 (edited by Mathias Dewatripoint, Xavier Freixas and Richard Portes), VOX e-book.

Lane, P. R. and G. M. Milesi-Ferretti, 2007, "The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004," *Journal of International Economics*, Vol. 73 (November) pp. 223–250.

———, 2008, "International Investment Patterns", *The Review of Economics and Statistics*, Vol. 90 No.3, pp. 538–49.

Magud, N., C. M. Reinhart, and K. S. Rogoff, 2011, "Capital Controls: Myth and Reality – A Portfolio Balance Approach," NBER Working Paper No. 16805 (Cambridge, Massachusetts: National Bureau of Economic Research).

Mody, A., M. P. Taylor, and J. Y. Kim, J.Y. 2001, "Modeling Fundamentals for Forecasting Capital Flows to Emerging Markets," *International Journal of Finance and Economics*, Vol. 6, pp.201–206.

Milesi-Ferretti, G. M., F. Strobbe, and N. Tamirisa, 2010, "Bilateral Financial Linkages and Global Imbalances: A View on the Eve of the Financial Crisis", IMF Working Paper 10/257 (Washington: International Monetary Fund).

Porter, N. and C. Serra, 2011, "Cross-border Spillovers Within Banking Groups", forthcoming IMF Working Paper (unpublished; Washington: International Monetary Fund).

Portes, R., and H. Rey, "The Determinants of Cross-Border Equity Flows," *Journal of International Economics, Vol.* 65 No. 2 (2005), pp. 269–296.

Rose, A. K., and M. Spiegel, 2004, "A Gravity Model of Sovereign Lending: Trade, Default and Credit," *Staff Papers*, International Monetary Fund, Vol 51:S, 64–74.

Stock, J. H. and M. W. Watson, 2003, "Understanding Changes in International Business Cycle Dynamics," NBER Working Paper No. 9859 (Cambridge, Massachusetts: National Bureau of Economic Research).

von Peter, G., 2007, "International Banking Centres: A Network Perspective," BIS Quarterly Review, December, pp. 33-45.