Evidence on Financial Globalization and Crisis: Geographic/Bilateral External Balance Sheets

Filipa Sá

August 3, 2010

CWPE 1038

Evidence on Financial Globalization and Crisis: Geographic/Bilateral External Balance Sheets*

Filipa Sá†
Trinity College, University of Cambridge

August 3, 2010

Abstract

This article reviews the main sources of data on the geographic composition of countries' external balance sheets, covering both international and country-specific sources. It examines the determinants of bilateral financial assets and liabilities and discusses how gravity models, traditionally used in the trade literature, have been applied to explain bilateral financial links. A new dataset is used to derive some stylized facts on how bilateral financial links look like, how they have evolved over time and how they compare with trade links. The role that cross-border financial links play in the international transmission of shocks is discussed, with reference to the 2007-2009 financial crisis.

Keywords: bilateral financial links, international financial network
JEL Classification: F21

*This article was prepared for the Encyclopedia on Financial Globalization, to be published by Elsevier. The author wishes to thank the editor, Stijn Claessens, for helpful comments.

†fgs22@cam.ac.uk

1 Introduction

The last two decades have witnessed a large increase in the size of countries' external balance sheets. This financial globalization phenomenon has been documented in Lane and Milesi-Ferretti (2007), who construct a comprehensive dataset with annual data on total external assets and liabilities for 178 economies in the period from 1970 to 2007.

This dataset can be used to construct a measure of financial integration by computing the ratio of the sum of total foreign assets and liabilities to GDP. Figure 1 reports the evolution of this measure for a group of industrial countries and a group of emerging and developing economies. The figure shows a marked increase in financial integration, especially from the mid-1990s in industrial countries.

The Lane and Milesi-Ferretti dataset fills an important gap by providing data on total external assets and liabilities. However, very little is known about the geographic composition of countries' external balance sheets. A better understanding of this geographic composition would be extremely valuable, especially for analysing how shocks are transmitted across borders.

The next section describes a number of international and country-specific data sources on bilateral financial assets and liabilities. Section 3 examines the determinants of those bilateral financial links and discusses how gravity models, traditionally used in the trade literature, have been increasingly applied to explain cross-border financial transactions and holdings. Section 4 uses a new dataset of bilateral financial links to derive some stylized facts on how those links look like, how they have evolved over time and how they compare with trade links. Section 5 discusses the role of bilateral financial links in the international transmission of shocks, with reference to the 2007-2009 financial crisis. Section 6 concludes.

2 Bilateral data on external assets and liabilities

Countries' external balance sheets contain the following main categories:

- Foreign Direct Investment (FDI), which includes equity participations above 10%.
- Portfolio equity securities, which includes equity participations below 10%.
- Debt, which includes portfolio debt securities (such as bonds and money market instruments) and other debt instruments (such as loans and deposits).
- Foreign exchange reserve assets

While no comprehensive dataset exists for bilateral external assets and liabilities covering a large number of countries over a long period, some data do exist both from international and country-specific sources covering some components of the external balance sheets for some countries.

2.1 Main international data sources

- Foreign Direct Investment

Data on bilateral FDI assets and liabilities are available from two main sources. The OECD International Direct Investment by Country dataset contains annual data on bilateral FDI flows and stocks at book value for OECD countries starting in 1981. The United Nations Conference on Trade and Development (UNCTAD) Foreign Direct Investment dataset also contains annual data on bilateral FDI flows and stocks. Coverage is broader than for the OECD dataset, including data for 196 reporting countries. For many country pairs bilateral data do not start until the 1990s, but for some pairs they are available from the 1970s.

- Portfolio equity and portfolio debt securities

The IMF Coordinated Portfolio Investment Survey (CPIS) contains information on bilateral portfolio investment positions broken down by instrument (equity and debt). Debt instruments are disaggregated into long-term and short-term debt, where short-term debt is defined as having a maturity of up to one year. A pilot survey was conducted in 1997 with only 29 reporting countries. The survey was reintroduced in 2001 and has been conducted on an annual basis in 75 reporting countries.

- Banking assets and liabilities

The BIS collects two datasets on banking assets and liabilities: locational and consolidated banking statistics.

Locational banking statistics contain quarterly data on cross-border assets and liabilities held in all currencies by banks in 35 reporting countries vis-à-vis banks and non-banks located in other countries. It also covers assets and liabilities vis-à-vis residents in foreign currency. The data are disaggregated by instrument: loans and deposits, debt securities and other assets and liabilities (including portfolio equity and direct investment assets). There is also a breakdown by major currency, sector of the counterparty (banks and non-banks) and country of residence of the counterparty (including about 200 counterparty countries). The earliest year for which data are available is 1977, but some countries started reporting at a later date. Consolidated banking statistics are similar but, instead of being broken down by country of residence of the counterparty, are broken down by country of nationality of the reporting bank after netting out intra-group positions. In other words, the consolidated statistics are based on the country where the reporting bank's head office is located and look through inter-office positions to capture exposures to unaffiliated counterparties. For example, if a UK branch of Santander (a Spanish group) lends to UK households in British pounds, locational data would not record this transaction as it would be considered domestic lending. Consolidated data, on the other hand, would register the transaction as an asset of Spain in the UK. Similarly, if a UK branch of Santander lends to a Spanish household, the transaction would be recorded as an asset of the UK in Spain in locational data, but would not be recorded

in consolidated data. Only assets are reported in the consolidated statistics and no information on liabilities is collected.

- Foreign Exchange Reserves

Foreign exchange reserves play an increasingly important role in linking emerging markets and developed economies. Figure 2 shows the total value of foreign exchange reserves held by emerging and developing economies. In the period from 1995 to 2009 foreign exchange reserves increased by a factor of 11, from about half a trillion dollars in 1995 to over 5 trillion in 2009. Around 60% of the total amount of reserves of these economies in 2009 is held in US dollars. Because some countries outside the US issue assets denominated in US dollars, there is no exact correspondence between the currency composition and the geographic composition of foreign exchange reserves. However, it is safe to assume that most reserves held in US dollars are issued by the US.

The data in Figure 2 are obtained from the IMF Currency Composition of Official Foreign Exchange Reserves (COFER) dataset, which contains the total amount of reserves held in five major currencies by a group of advanced economies and a group of emerging and developing economies. For confidentiality reasons, no information on the currency composition of reserves for individual countries is released. The BIS Multilateral Surveillance Statistics contain data on the currency composition of reserves for countries in the G10 since 1994. However, again due to confidentiality, these data are not publicly available.

2.2 Other data sources

- Euro Area accounts

The European Central Bank collects data on the international investment position of the Euro Area. This dataset contains information on stocks of external assets and liabilities of the Euro Area as a whole by asset class (FDI, portfolio debt, portfolio equity, financial derivatives, and other investment). The geographic breakdown is limited to a few countries outside the Euro Area (Brazil, Canada, China, Denmark, Hong Kong, India, Japan, Russia, Sweden, Switzerland, the UK and the US). Information is disaggregated by asset class: direct investment, portfolio investment, financial derivatives, other investment, and reserve assets. Portfolio liabilities are the only category for which no geographic breakdown is available.

- Individual country data sources

Some countries collect their own data on bilateral external assets and liabilities.

The US Treasury International Capital (TIC) reporting system collects a variety of data on US cross-border securities. Data on flows (transactions) are monthly and cover only long-term securities (i.e. securities with a maturity of more than one year). They are collected by country and record purchases by foreigners from US residents and sales by foreigners to US residents of US assets (equity, US Treasury debt, US government agency debt and US corporate bonds) and foreign

assets (bonds and stocks). Data on stocks of both foreign holdings of US securities (US liabilities) and US holdings of foreign securities (US assets) are collected in annual surveys and are broken down by country and type of security: equity, long term debt and short term debt. Long term and short term debt are disaggregated further into Treasury, agency and corporate debt. Information goes back to 1974, but until 2001 only data on long term securities were collected.

The Bundesbank external stock statistics contain monthly data on the geographic composition of short-term and long-term external assets and liabilities of banks in Germany going back to the early 1980s. Similar data are collected for the external positions of enterprises in Germany.

2.3 Custodial centre bias

Data on external financial assets and liabilities are normally constructed following the residence principle. For example, if a German resident invests in a Chinese company and directs the investment via a financial institution located in the UK, the transaction would be recorded as an asset of Germany in the UK and an asset of the UK in China, even though the UK has only acted as an intermediary. This practice tends to attribute excessively large holdings to countries that are major custodial centres, such as the Cayman Islands, Luxembourg and Switzerland. This 'custodial bias' is present to different degrees in various sources of data on bilateral external positions.

For FDI, data on bilateral assets are collected following the residence principle and are therefore subject to this bias. However, data on liabilities are collected following the ultimate beneficiary owner principle, according to which the source of inward FDI is allocated to the country of ultimate ownership. As a result, data on FDI liabilities do not suffer from a 'custodial bias'.

For portfolio equity and debt, the annual surveys conducted in the US by the TIC reporting system correct for this bias on the assets side. Because the surveys collect data at the level of individual securities, they are able to identify precisely the country of residence of each security issuer. However, the bias remains on the liabilities side, since the chains of intermediation through financial centres frequently make identification of the actual owners of US securities impossible. For other countries that report to the IMF CPIS the problem is even more severe than for the US because, unlike the US, many countries do not conduct comprehensive security-level surveys. Hence, CPIS data reported by these countries will suffer from the 'custodial centre bias' not only on the liabilities side but also on the assets side.

The BIS locational data on banking assets are constructed following the residence principle and therefore suffer from the 'custodial centre bias'. The consolidated data are less affected by this bias because they are based on the nationality of the reporting bank and net out intra-group positions. To the extent that banks use as custodians other banks from the same group, the bias would disappear once intra-group positions are netted out. Which type of data – locational or consolidated – is preferable depends on the question being addressed. Locational data provide an idea of the broad trends in cross-border links. Consolidated data may be preferable for analysing the transmission of shocks between banks, but this depends on whether foreign subsidiaries and branches fund themselves locally or in their country of nationality. For example, suppose that UK

branches of Santander borrow mostly from UK households and lend to China. Consolidated data would treat this as an investment of Spain in China. This may be appropriate to study the effect of a shock in China on Santander as a group. However, it would not be appropriate to study the effect of a shock in the UK for cross-border capital flows. For this question, locational data would be preferable. If the branches and subsidiaries of Santander fund themselves mostly in Spain, then consolidated data would give a more accurate picture.

Ideally, data based both on the residence principle and on the country of ultimate ownership should be available. By comparing the two, the role played by custodial centres in the international financial system could be properly understood.

3 What explains bilateral external financial linkages?

3.1 Theoretical foundation for gravity models in goods trade

Gravity models have long been used to explain bilateral trade in goods. They explain trade flows between countries i and j by their sizes (GDPs) and a variety of variables capturing the geographic and historical proximity between the two counties (distance, common language, common border, and other factors that affect trade barriers).

The theoretical foundation for the use of gravity models in the trade literature is provided by Anderson and van Wincoop (2003), among others. Anderson and van Wincoop develop a model with constant elasticity of substitution (CES) preferences and goods that are differentiated by country of origin. Prices of the same goods differ across locations due to trade costs that are not directly observable. These trade costs include not just transport costs but also information costs, design costs and various legal and regulatory costs. The solution to the model yields a gravity equation of the form:

$$X_{ij} = \frac{y_i y_j}{y^w} (\frac{\tau_{ij}}{P_i P_j})^{1-\sigma} \tag{1}$$

where σ is the elasticity of substitution.

The gravity equation says that the flow of exports from country i to country j (X_{ij}) depends on GDP of the two counties relative to world GDP ($\frac{y_i y_j}{y^w}$) and on the bilateral trade costs between them (τ_{ij}) relative to the product of their multilateral resistance variables (P_i and P_j). The multilateral resistance variables are aggregate measures of each country's trade costs relative to all its trading partners. An increase in the multilateral resistance of the importer (P_j) raises its trade with the exporter. For a given bilateral trade barrier between i and j, higher barriers between j and its other trading partners will reduce the relative price of goods from i and raise imports from i. An increase in multilateral resistance of the exporter (P_i) also raises its trade with j. Higher trade barriers faced by an exporter lower the demand for its goods. For a given bilateral trade barrier between i and j, this raises the level of trade between them.

When going from the gravity equation derived from the Anderson and van Wincoop model to

the data, a key issue is how to measure the unobservable bilateral trade costs. This can be done using a variety of observable variables that affect trade barriers (for example, the distance between the two countries, whether they share a common border or a common language). Therefore, the empirical counterpart of equation (1) would take the following form:

$$\ln(X_{ij}) = -\sum_{m=1}^{M} \phi_m Z_{ij}^m + \eta_i + \gamma_j + \varepsilon_{ij} \tag{2}$$

Unobservable bilateral trade costs are captured by a set of M observable variables Z_{ij}^m. Exporter and importer fixed effects (η_i and γ_j) capture the GDP of the two countries as well as their multilateral resistance variables.

3.2 Theoretical foundation for gravity models in cross-border asset trade

Several recent papers have applied gravity models to explain bilateral financial stocks and flows. Given the increasing popularity of these models in finance, some recent work has been done to develop the theoretical foundations for these models in explaining trade in assets, in a similar way as Andersen and van Wincoop did for trade in goods.

Martin and Rey (2004) develop a general equilibrium model where assets are imperfect substitutes because they hedge against different types of risks. Cross-border asset trade involves some transaction and/or information costs and the supply of assets is endogenous. In their framework, risk-averse agents undertake a number of projects which correspond to different assets and are traded on stock markets. Higher aggregate demand from foreign investors raises the price of these assets and encourages agents to undertake more projects and trade more assets. Therefore, market capitalization is endogenous.

The model by Martin and Rey delivers an equation where transactions in equities from country i to country j depend on the economic masses of the two countries (for example, equity market capitalization) and trading costs between them. Because trading costs are not observable, they need to be measured by a set of variables capturing the geographic, cultural and information proximity between the two countries. Hence, their model delivers a gravity equation analogous to equation (2) from the goods trade literature.

Okawa and van Wincoop (2010) follow a different approach and add information asymmetries to a static portfolio choice model. Investors can hold claims on risky assets from a large number of countries. Asset returns are affected both by country-specific risk and by global risk. There is one risky asset whose return is only related to global risk. In addition to these risky assets, there is also a risk-free asset.

The bilateral information friction between source country j and destination country i is defined as the conditional variance of country i specific risk from the perspective of country j investors divided by the conditional variance of country i specific risk from the perspective of country i investors. Hence, it measures the information disadvantage of foreign investors relative to local investors.

The Okawa and van Wincoop model yields the following gravity equation:

$$X_{ij} = \frac{S_i E_j}{E} \frac{\Pi_i P_j}{\tau_{ij}} \tag{3}$$

Bilateral asset holdings of country j in country i (X_{ij}) are driven by two factors. The first is a size factor: the product of total equity holdings by country j (E_j) and the supply of equity by country i (S_i) divided by the world demand or supply (E). The second factor is a relative friction ($\frac{\Pi_i P_j}{\tau_{ij}}$), where Π_i and P_j are the multilateral resistance variables that measure the average financial frictions for country i as a destination country and country j as a source country.

The intuition for the presence of multilateral resistance variables is similar to the goods trade model. Investors in country j allocate a larger part of their equity holdings to destination countries for which the bilateral financial friction (τ_{ij}) is low in comparison to the average financial friction that it faces relative to all destination countries (P_j). Also, an increase in multilateral resistance of the destination country (Π_i) implies that country i faces high financial frictions with many source countries and must pay a higher return to those countries in order to attract investment. For a given bilateral financial friction τ_{ij}, this means that country i will prefer to attract investment from country j and X_{ij} increases.

This equation is analogous to equation (1) from the Andersen and van Wincoop goods trade model. Its empirical counterpart is equation (2), where Z_{ij}^m is a set of variables capturing unobservable financial frictions (for example, the log distance between i and j). This would be the appropriate estimated equation with cross-sectional data. With panel data the size variables and the multilateral resistance variables will have a time dimension as well. The estimated gravity equation should then include separate destination and source country dummies for each period t:

$$\ln(X_{ijt}) = -\sum_{m=1}^{M} \phi_m Z_{ijt}^m + \eta_{it} + \gamma_{jt} + \varepsilon_{ijt} \tag{4}$$

3.3 Information asymmetries, familiarity effects and trust

Studies that apply gravity models to explain bilateral financial stocks and flows have found that these models perform quite well, typically explaining more than 70% of the variation in cross-border flows and stocks of foreign assets.

For example, Portes and Rey (2005) use a gravity model to explain bilateral cross-border equity flows between 14 economies in the period from 1980 to 1996. They find that the model performs at least as well as when applied to goods trade. Lane and Milesi-Ferretti (2008) use a gravity model to explain stocks of bilateral portfolio equity in 2001 using data from the IMF CPIS. They find that bilateral equity holdings are strongly correlated with bilateral trade in goods and services and are also positively associated with measures of proximity. Daude and Stein (2007) focus on the determinants of FDI stocks in OECD countries in the late 1990s and find that differences in time zones have a negative and significant effect in the location of FDI.

The finding that variables such as distance, differences in time zones and cultural affinities may

explain a large proportion of cross-border asset flows and stocks may seem surprising. Unlike goods, assets are not subject to transportation costs. The fact that gravity variables perform at least as well in explaining financial positions as in explaining trade suggests that financial markets are not frictionless, but are segmented by information asymmetries and familiarity effects. Distance and measures of cultural affinities are proxies for those information asymmetries and familiarity effects.

The information required to evaluate financial assets such as corporate bonds and equities is not straightforward. It includes information about the structure of asset markets and their institutions, accounting practices, corporate culture and political events. There is some evidence in the literature on the importance of information for financial transactions. For example, Coval and Moskowitz (2001) show that US mutual funds which invest primarily in companies whose headquarters are located nearby earn substantial abnormal returns. Hau (2001) finds that foreign traders make significant less profit than German traders when they transact on the German stock market. Information asymmetries are one of the explanations given in the finance literature for the home bias puzzle, i.e., the fact that investors allocate a large proportion of their wealth to domestic assets, in spite of the potential benefits from diversifying into foreign assets.

The set of observable variables used in the literature to capture information asymmetries and familiarity effects is varied. Some commonly used variables are distance, indicators for common border, common language and colonial links and the time difference between the source and destination countries. Portes and Rey also include the volume of telephone call traffic between the source and destination countries to measure the overall information flow between them and the number of branches in the destination country of banks headquartered in the source country.

Guiso, Sapienza and Zingales (2009) made a creative addition to the list of variables normally used in the gravity literature by including bilateral trust in gravity models for trade, portfolio investment and FDI. The Eurobarometer surveys ask respondents in each European Union country to report how much they trust the citizens of each of the other countries in the EU. Using this measure of bilateral trust on gravity equations, the authors find that a higher level of bilateral trust can explain cross-country trade beyond what extended gravity models can account for. At sample means, a one-standard-deviation increase in the importer's trust toward the exporter raises exports by 10%. They also find that trust matters more for trade in goods that are differentiated, which can vary greatly in quality. One possible explanation for this finding is that trust helps overcome information asymmetries and contract incompleteness problems, which are more severe for more differentiated goods.

In the gravity model for FDI, the authors use data on bilateral FDI stocks from the OECD and look at the effect of country i's trust towards people of country j on the FDI of country i in country j. They find that the magnitude of the impact of trust on FDI is twice as large as the impact on trade. This is not surprising because FDI are long-term investments and hence are more affected by information asymmetries and contract incompleteness than trade. For that reason, FDI should be very trust intensive.

To look at the effect of trust on portfolio investment, Guiso, Sapienza and Zingales use data

on the geographic breakdown of equity investment of European mutual funds disaggregated by country of origin. Because portfolio investment is mostly composed of traded securities that are heavily monitored and regulated, information asymmetries and contract incompleteness problems should be limited. Moreover, mutual funds are run by sophisticated managers who are likely to have better information about the securities. Nevertheless, the authors find a positive and statistically significant effect of the degree of trust of country i towards country j on the percentage of equity invested by country i in country j.

The gravity model used by Guiso, Sapienza and Zingales is quite broad. It includes the appropriate source country×year and destination country×year fixed effects, as suggested by Anderson and van Wincoop and Okawa and van Wincoop. In addition, it includes the standard gravity variables (log distance, common language, common border, common linguistic roots) as well as a measure of transportation costs, an indicator for same legal origin and a measure of the extent of press coverage of the source country in the destination country (the number of articles in the newspapers of the destination country that mention the source country or its citizens in the headline).

One difficulty in interpreting the results of this study is the possibility of reverse causality: although it is possible that trust promotes trade and investment, it is equally possible that trade and investment lead to more trust. To address these concerns, the authors use instrumental variables estimation. They instrument for trust using its cultural determinants: commonality of religion and an indicator of the somatic distance between two countries, which is based on the frequency of certain traits in the indigenous population (for example height or hair colour). Their IV estimates for the effect of trust are even larger, suggesting that culture is likely to affect trade and investment through other channels besides trust.

4 Stylized facts

4.1 Data

This section examines how bilateral financial links have evolved over time and compares it with the evolution of trade links. It uses a dataset constructed by Kubelec and Sá (2010), which contains data on stocks of bilateral external assets and liabilities for a group of 18 countries, including developed and emerging economies[1]. The dataset covers the period from 1980 to 2005 and distinguishes between four asset classes: FDI, portfolio equity, debt, and foreign exchange reserves.

To construct this dataset, Kubelec and Sá use some of the data sources listed in section 2 and fill in gaps in the data using gravity models of the type described in section 3. In this way they obtain a comprehensive dataset with no missing data for the 18 countries in their sample.

[1] The countries in the sample are: Argentina, Australia, Brazil, Canada, China, France, Germany, Hong Kong, India, Italy, Japan, Korea, Mexico, Portugal, Singapore, Spain, the UK and the US.

4.2 Network of financial linkages

The international financial system can be seen as a network, where nodes represent countries and links represent bilateral financial assets. The Kubelec and Sá dataset provides information on the links and can be used to analyse how the global financial network has changed over time. This section uses network methods to show the key stylized facts that emerge from the data.

4.2.1 Undirected network

Figure 3 looks at the evolution of the global financial network Links are given by the sum of bilateral assets and liabilities divided by the sum of the GDP of the source and host countries:

$$link_{ijt} = \frac{Assets_{ijt} + Liabilities_{ijt}}{GDP_{it} + GDP_{jt}} \tag{5}$$

Since assets and liabilities are symmetrical, the network is undirected, i.e., the link from i to j is the same as the link from j to i. To simplify the diagrams, the smallest links (where the ratio defined above is lower than 0.3%) are not represented. The thickness of the lines indicates the size of the links and the size of the nodes is proportional to the country's financial openness, measured by the sum of its total external assets and liabilities divided by GDP. More interconnected countries are placed more centrally in the network and pairs of countries with stronger links are placed closer to each other.

Table 1 provides some summary statistics about the network: skewness of the distribution of links, average path length and clustering. Skewness is a measure of the asymmetry of a distribution. A positive value indicates that the distribution has a long tail on the right, i.e., there are many observations with small links and few observations with large links. Average path length is the average of the shortest paths between all pairs of nodes in the network. Clustering measures the probability that, given than node i is directly linked to nodes j and k, node j is also directly linked to k.

A few findings emerge:

- The interconnectivity of the global financial network has increased significantly over the past two decades. This can be seen from the increase in the size of the nodes and the increase in number and size of the links.
- The distribution of financial links exhibits a long-tail. High values of skewness indicate that the global financial network is characterized by a large number of small links and a small number of large links.
- The average path length of the global financial network has decreased over time. In 2005 there are less than 1.4 degrees of separation on average between any two nodes.
- The network has become more clustered over time. This is another symptom of the increase in interconnectivity.

4.2.2 Directed network

Figure 4 looks at the evolution of the global financial network from a different perspective. Links are now defined as the ratio of bilateral assets to GDP of the source country:

$$link_{ijt} = \frac{Assets_{ijt}}{GDP_{it}} \tag{6}$$

This network is directed: an arrow pointing from county i to j represents the value of country i's assets in country j, scaled by country i's GDP.

The directed network confirms the findings from the undirected network that there has been a remarkable increase in interconnectivity over time, as shown by the increase in the size of the nodes and the size and number of links.

To analyse which countries are the main sources and destinations of international investment, a number of measures of network centrality are computed for each node. Table 2 reports the ranking of the five most central nodes according to each centrality measure.

The key findings that emerge from the network charts and the centrality measures are as follows:

- The US, the UK and Germany are the main recipients of foreign investment. This can be seen by the number of arrows pointing to these nodes and by the high value of in-degree centrality, which measures the number of links that arrive at a node divided by the maximum number of links.

- Financial centres - Hong Kong, Singapore and the UK - are the main originators of foreign investment, as can be seen by the number of arrows pointing out and the high value of out-degree centrality, which measures the number of links that depart from a node divided by the maximum number of links.

- The countries which are located closer to other nodes in the network are the US, Germany, Hong Kong, Singapore, and the UK. Closeness is the inverse of the average distance between countries, where distance is measured by the number of links on the shortest path.

- The US and the UK are the main countries connecting other nodes. This is captured by betweenness centrality, which measures the frequency with which a country lies on the shortest path between two other countries, and intermediation, which captures the intensity of links by incorporating portfolio shares.

- The US and UK also score highest in terms of prestige. Prestige reflects the importance of the counterparties. A country with high prestige is one that is linked to others that have themselves high prestige. This is computed by assigning to each country the same initial score and adding a term involving the scores of the creditors, weighted by the portfolio shares. The prestige scores are simultaneously determined in a system of equations.

4.3 Comparison with the Trade Network

To compare the financial network with the trade network, Figure 5 represents the undirected trade network, where links are given by the sum of exports and imports divided by the sum of the GDP of the source and host countries:

$$link_{ijt} = \frac{Exports_{ijt} + \text{Im}ports_{ijt}}{GDP_{it} + GDP_{jt}} \tag{7}$$

Data on bilateral trade are from the IMF Direction of Trade Statistics (DOTS).

The thickness of the lines is proportional to the size of the links and the size of the nodes is proportional to the country's trade openness, measured by the sum of total exports and total imports divided by GDP. Countries are placed more centrally in the network if they are more interconnected and pairs of countries with strong links are placed closer to each other.

Table 3 reports measures of skewness, average path length and the clustering coefficient for the trade network.

A few findings emerge:

- Just as for the global financial network, the interconnectivity of the global trade network increased over the last two decades. This can be seen from the increase in the size and number of links. However, the size of the nodes does not change much over time. This suggests that trade openness has not increased as much as financial openness.
- The distribution of trade links also exhibits a long-tail, with a small number of countries having large links.
- The average path length has decreased and the clustering coefficient has increased over time. These are symptoms of an increase in interconnectivity,

These properties are similar to the ones found for the global financial network and suggest that trade links have also contributed to the increase in interconnectivity between countries.

To distinguish between sources and destinations of international trade, Figure 6 looks at the directed trade network, where links are given by the ratio of exports to GDP of the source country:

$$link_{ijt} = \frac{Exports_{ijt}}{GDP_{it}} \tag{8}$$

An arrow pointing from i to j is proportional to the value of country i's exports to country j, divided by the GDP of country i.

Table 4 reports the ranking of the five most central countries in this network in 2005 according to different measures of centrality.

The directed trade network confirms the increased interconnectivity found in the undirected network. It also highlights some additional facts:

- In all years, the trade network exhibits strong intra-continental links, with three clusters: an American cluster (US, Canada and Mexico), an Asian cluster (Singapore, Hong Kong, China, Korea, and Japan), and a European cluster (UK, Germany, France, Spain, Italy, and Portugal). This pattern contrasts with the one found for financial links, where the UK and the US were clearly at the centre of the network, linking to almost all other nodes.

- Germany, China and France are important trade centres and score highly both as exporters and as importers. The US is the main importer, but scores low as an exporter. The opposite is true for Singapore, which is the main exporter, but scores low as an importer.

- Germany appears to be the centre of the European cluster and China appears to be the centre of the Asian cluster. These countries play an important role connecting other nodes, as can be seen by their high scores for betweenness and intermediation.

- The UK occupies a much less central position in the trade network than in the financial network. While for finance the UK had high scores for all centrality measures this is not the case for trade.

The network figures represent snapshots of the finance and trade networks at three points in time: 1985, 1995, and 2005. Another way to look at these networks is to have a dynamic representation of how they evolve over the sample period. This can be done using network animations where time evolves from 1980 to 2005 and each slide represents a year. For the international financial network, links are given by the sum of bilateral assets and liabilities divided by the sum of the GDPs of the two countries. The thickness of the links is scaled by this measure. The size of the nodes is scaled by the country' financial openness, measured as the sum of its total external assets and liabilities divided by GDP. For the international trade network, links are given by the sum of bilateral exports and imports divided by the sum of the GDPs of the two countries. The size of the nodes is proportional to the country's trade openness, measured by the sum of its total exports and imports divided by GDP. As for the snapshots, pairs of countries with stronger links are placed closer to each other in the network.

<Animations 1 and 2 can be found at http://www.econ.cam.ac.uk/teach/filipasa/animations.htm>

The animation of the financial network confirms the increase in interconnectivity suggested by the snapshots. The size of the links increases over time and countries become more financially open over time, as show by the increase in the size of the nodes. The US, the UK and financial centres such as Hong Kong and Singapore occupy a central position in the network.

The animation of the trade network also shows evidence of an increase in interconnectivity. The size of the nodes changes little over time, suggesting that trade openness did not increase as much as financial openness during this period. In all years, countries are arranged in three intra-continental clusters: an American cluster (US, Canada and Mexico), an Asian cluster (Singapore, Hong Kong, China, Korea, and Japan), and a European cluster (UK, Germany, France, Spain, Italy, and Portugal). Australia tends to locate near the Asian cluster.

5 Cross-border financial links and international transmission of shocks

What does the configuration of the international financial network suggest about the stability of the international financial system?

Higher interconnectivity carries a fundamental trade-off. On the one hand, it enhances risk-sharing by allowing countries to better diversify idiosyncratic risks. If a country holds assets abroad and is hit by a country-specific shock, the consequences of the shock are likely to be less severe because, although the profitability of domestic assets is likely to be diminished, the country can still enjoy high returns on its foreign investment. Openness to international capital flows also has other benefits, such as increased efficiency and overall superior growth opportunities. On the other hand, higher connectivity increases the risk of contagion. If a shock hits a highly inter-connected country, its creditors will suffer losses because the profitability of their investment falls and the country may have to default on its foreign debt. This could generate a cascade of losses through the system.

The international financial network is not only highly interconnected but has long-tails, with some countries having multiple and large links. As a result, the international financial system is susceptible to targeted attacks affecting the key financial hubs (most importantly, the US and the UK). Disturbances to those hubs would spread rapidly and generate large losses through the network.

The 2007-2009 financial crisis can be used to analyse the role of cross-border financial links in the international transmission of a US-based shock. There is some evidence that cross-border financial links helped spread the crisis to emerging markets and advanced economies. Figure 7 shows that, after a period of strong growth in 2006 and 2007, international bank loans to emerging and developing countries contracted. Cetorelli and Goldberg (2010) find that international banks played an important role in the transmission of the financial crisis to emerging markets, via three channels. First, there was a reduction in cross-border lending by foreign-owned banks. Second, foreign affiliates had to cut local lending because of a reduction in funding by the parent bank. Third, domestically-owned banks had to cut lending as a result of a reduction in cross-border interbank lending. On the transmission of the crisis to advanced economies, Imbs (2009) finds an increase in business cycle synchronization during the crisis, especially between advanced economies. He shows that the larger synchronization between pairs of countries is associated with larger bilateral financial links between them.

6 Conclusions

This article takes stock of the current state of knowledge on the geographic composition of countries' external balance sheets. It reviews the main sources of data on bilateral financial assets and liabilities, discusses the use of gravity models to explain the determinants of those bilateral holdings

and presents some key stylized facts on the international financial network.

There is still a long way to go to understand the geographic composition of countries' external balance sheets. Increased availability of data on bilateral external positions would help provide a more complete picture of cross-border financial linkages, improving our understanding of the international transmission of shocks. The data gaps are particularly important for emerging markets and custodial centres. Apart from the need for more comprehensive data on bilateral financial holdings, the 'custodial centre bias' needs to be addressed. Ideally, data based both on the residence principle and on the country of ultimate ownership should be available. By comparing the two, the role played by custodial centres in the international financial system could be properly understood.

References

[1] Anderson, J. and van Wincoop, E. (2003). Gravity with gravitas: a solution to the border puzzle. American Economic Review 93(1), 170-192.

[2] Cetorelli, N. and Goldberg, L. (2010). Global banks and international shock transmission: evidence from the crisis. Federal Reserve Bank of New York Staff Reports 446.

[3] Coval, J. and Moskowitz, T. (2001). The geography of investment: informed trading and asset prices. Journal of Political Economy 109(4), 811-841.

[4] Daude, C. and Stein, E. (2007). Longitude matters: time zones and the location of foreign direct investment. Journal of International Economics 71(1), 96-112.

[5] Guiso, L., Sapienza, P. and Zingales, L. (2009). Cultural biases in economic exchange? The Quarterly Journal of Economics 124(3), 1095-1131.

[6] Hau, H. (2001). Location matters: an examination of trading profits. Journal of Finance 56(5), 1959-1983.

[7] Imbs, Jean (2009). The first global recession in decades. Available at http://www.parisschoolofeconomics.eu/IMG/pdf/BdF-PSE-IMF_paper_IMBS.pdf

[8] Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. Bank of England Working Paper 384.

[9] Lane, P. and Milesi-Ferretti, G. M. (2007). The external wealth of nations mark II: revised and extended estimates of foreign assets and liabilities, 1970-2004. Journal of International Economics 73(2), 223-250.

[10] Lane, P. and Milesi-Ferretti, G. M. (2008). International investment patterns. The Review of Economics and Statistics 90(3), 538-549.

[11] Martin, P. and Rey, H. (2004). Financial super-markets: size matters for asset trade. Journal of International Economics 64(2), 335-361.

[12] Okawa, Y. and van Wincoop, E. (2010). Gravity in International Finance. Hong Kong Institute for Monetary Research Working Paper 07/2010.

[13] Portes, R, and Rey, H. (2005). The determinants of cross-border equity flows. Journal of International Economics 65(2), 269-296.

Relevant Websites:

http://www.philiplane.org/EWN.html

Lane and Milesi-Ferretti 'External Wealth of Nations' dataset

http://stats.oecd.org

OECD statistics

http://www.unctad.org/Templates/Page.asp?intItemID=1923&lang=1

UNCTAD Foreign Direct Investment dataset. Contains information on total external FDI assets and liabilities. Bilateral data are provided by UNCTAD on request.

http://www.imf.org/external/np/sta/pi/cpis.htm

IMF Coordinated Portfolio Investment Survey (CPIS)

http://www.bis.org/statistics/bankstats.htm

BIS banking statistics

http://www.imf.org/external/np/sta/cofer/eng/index.htm

IMF Currency Composition of Official Foreign Exchange Reserves (COFER) dataset

http://www.ustreas.gov/tic/

US TIC data

http://sdw.ecb.int

ECB Statistical Data Warehouse

http://www.bundesbank.de/statistik/statistik_aussenwirtschaft.en.php

Bundesbank external sector statistics

http://www.econ.cam.ac.uk/teach/filipasa/publications.htm

Kubelec and Sá 'Geographical composition of national external balance sheets' dataset

Appendix. Definitions

Average path length

Average of the shortest paths between all pairs of nodes in a network. For example, if node i is directly linked to node k, the shortest path between the two nodes has length one. If node i is linked to k via j, the shortest path between i and k has length two. Average path length is the average of this measure for all pairs of nodes.

Clustering

A measure of the probability that, given that node i is directly linked to nodes j and k, node j is also directly linked to k. The clustering coefficient is given by $\frac{\sum_{i,j\neq i,k\neq j,k\neq i} N_{ij}N_{ik}N_{jk}}{\sum_{i,j\neq i,k\neq j,k\neq i} N_{ij}N_{ik}}$, where N_{ij} is equal to one if there is a link between nodes i and j and zero otherwise.

Gravity models

Empirical models that explain financial transactions or holdings between two countries by their sizes (GDPs) and a variety of variables capturing information asymmetries or familiarity effects between them. These models have traditionally been used to explain trade flows, but have increasingly been applied to explain financial transactions or holdings. Their empirical specification for cross-sectional data takes the form:

$$\ln(X_{ij}) = -\sum_{m=1}^{M} \phi_m Z_{ij}^m + \eta_i + \gamma_j + \varepsilon_{ij}$$

where X_{ij} are financial assets of country i in country j, Z_{ij}^m is a set of variables that capture information asymmetries or familiarity effects (for example, log distance or common language) and η_i and γ_j are source and destination country fixed effects.

Home bias puzzle

The finding that investors allocate a large proportion of their wealth to domestic assets, in spite of the potential benefits from diversifying into foreign assets.

International financial network

A representation of the international financial system where each country is represented by a node and bilateral financial holdings or transactions are represented by links between pairs of countries.

Network centrality

Measures of the importance of different nodes in a network. Different definitions exist:

- **In-degree** is the number of links that point to a node divided by the total possible number of links.
- **Out-degree** is the number of links departing from a node divided by the total possible number of links.
- **Closeness** is the inverse of the average distance from node i to all other nodes. The definition of distance relies on path counts. If node i links to k and k links to j, then the path from i to

j has length two. The distance between i and j, δ_{ij}, equals the length of the shortest path. The average distance from i to all other nodes is given by $\frac{\sum_j \delta_{ij}}{n-1}$. Closeness is the inverse of this measure.

- **Betweenness** focuses on the nodes that the shortest path goes through. Let g_{jk} denote the number of shortest paths between j and k, and $g_{jk}(i)$ denote the number of such paths that go through node i. The probability that node i is on the shortest path from j to k is given by $\frac{g_{jk}(i)}{g_{jk}}$. Betweenness of node i is the sum of these probabilities over all nodes excluding i, divided by the maximum that the sum can attain: $\frac{\sum_{j \neq i} \sum_{k \neq i} g_{jk}(i)/g_{jk}}{(n-1)(n-2)}$.

- **Intermediation** extends the betweenness measure taking into account the value of the links. The probability that a dollar sent by i reaches j in two steps is given by $\sum_k P_{ik} P_{kj}$, where P_{ik} is the share of country i's total external assets that are invested in country k. The probability that a dollar sent by i reaches j through k is given by $\frac{P_{ik} P_{kj}}{\sum_k P_{ik} P_{kj}}$. The intermediation measure for node k is obtained by summing these probabilities for all pairs (i, j), divided by the total number of pairs $n(n-1)$.

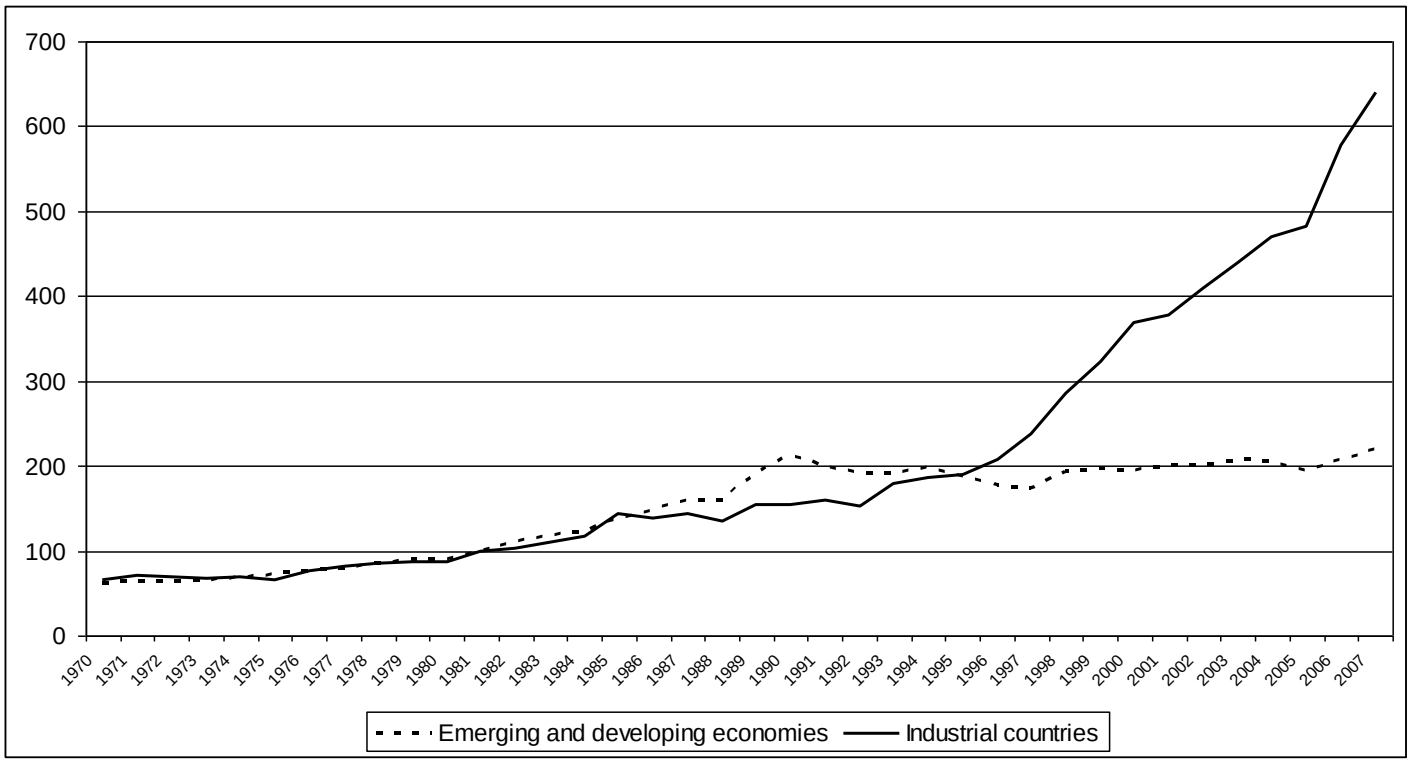
- *Prestige* considers the identity of the counterparties. The prestige of country i (ν_i) is obtained by taking the prestige of its creditors, weighted by their portfolio shares with i, i.e., $\nu_i = \sum_j P_{ji} \nu_j$. This defines a linear system $\nu = P' \nu$, where P is the matrix of portfolio shares. The solution to this system is the eigenvector associated with the unit eigenvalue.

Skewness

A measure of the asymmetry of a distribution. It is defined as $\frac{E(X-\mu)^3}{(E(X-\mu)^2)^{3/2}}$, where X is a random variable and μ is its mean. A normal distribution is symmetric and has a skewness of zero. A positive value for skewness indicates that the distribution has a long-tail on the right, i.e., there are many observations with small values of and few observations with large values of X.

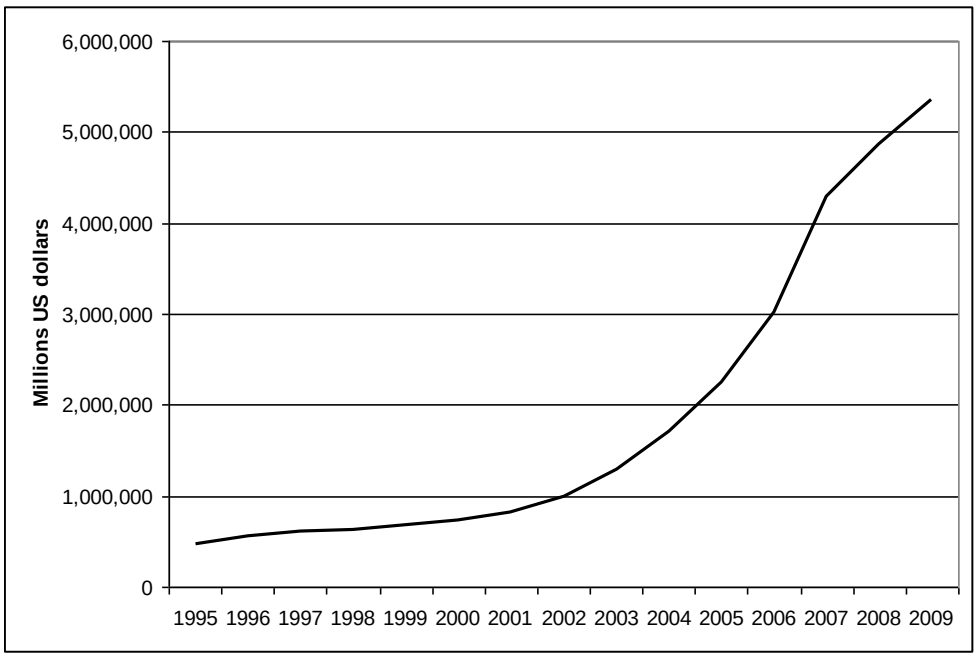
Tables and figures

Figure 1 International financial integration: 1970-2007



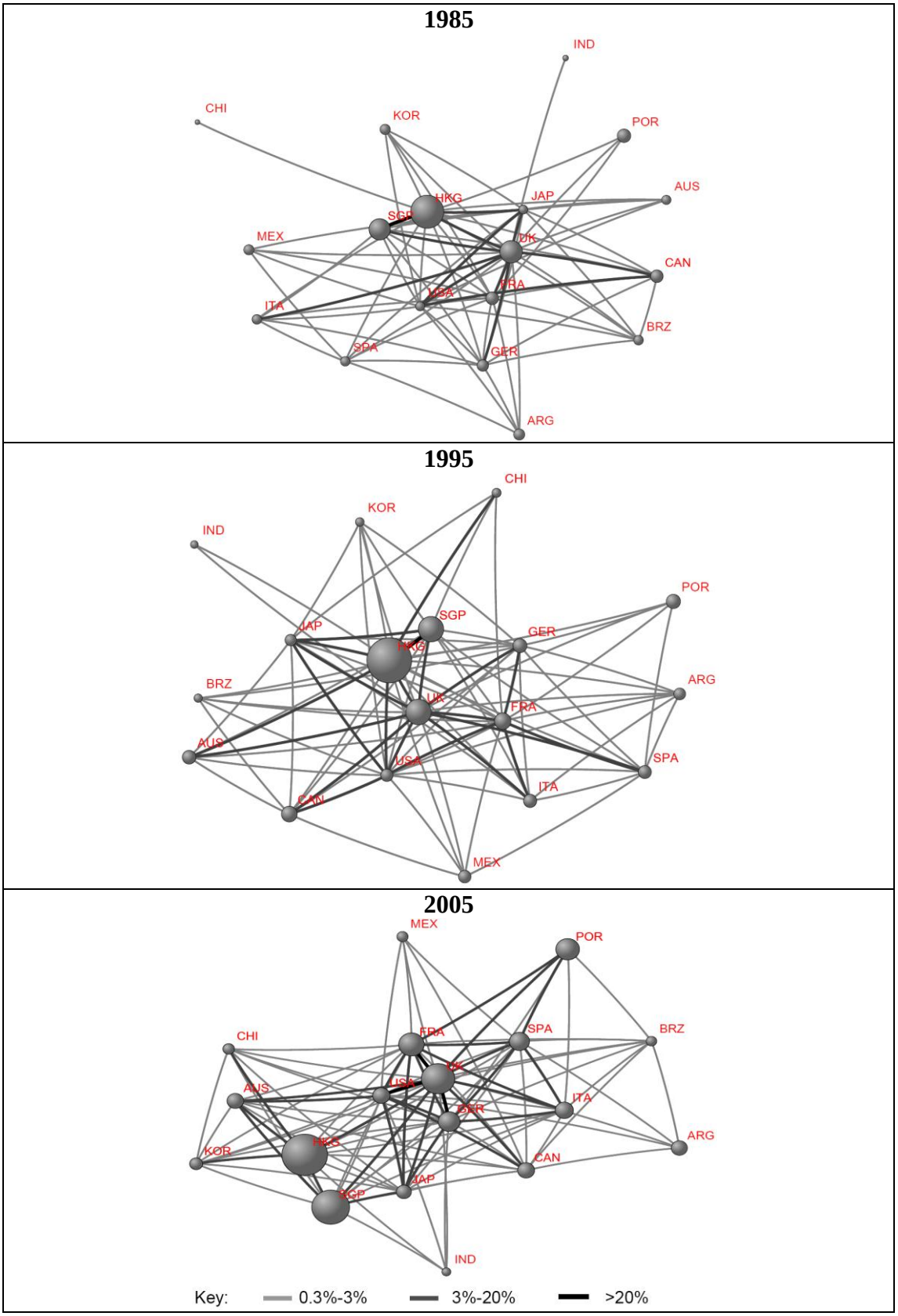
NOTE: International financial integration measured as the ratio of the sum of foreign assets and liabilities to GDP (in percentage). Luxembourg is excluded from the group of industrial countries (data for this country only start in 1990).
SOURCE: Author's calculations using the Lane and Milesi-Ferretti 'External Wealth of Nations' dataset.

Figure 2 Foreign exchange reserves of developing and emerging economies: 1995-2009



SOURCE: IMF COFER dataset.

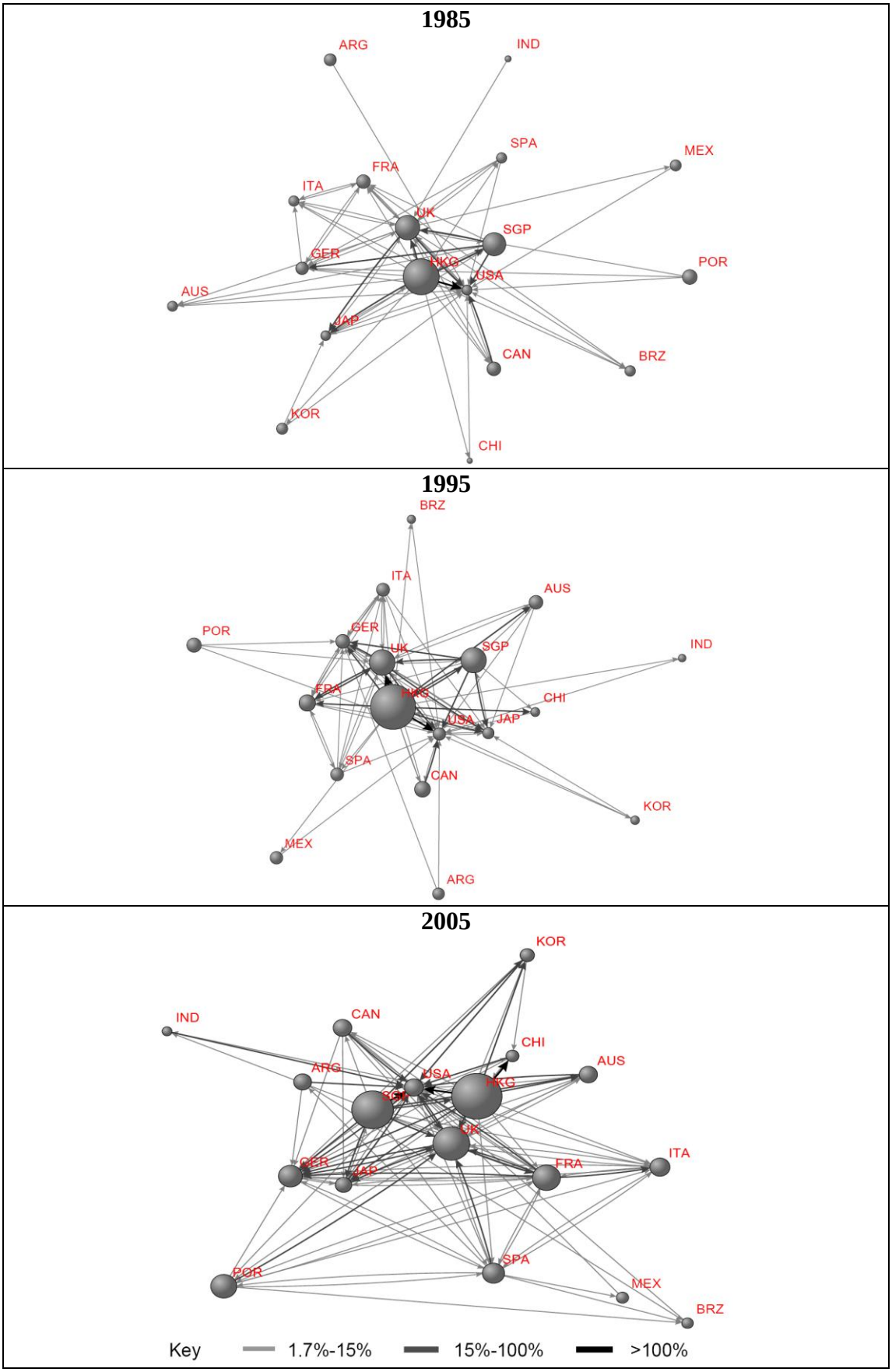
Figure 3 International financial network – undirected



NOTE: Links are given by the sum of bilateral assets and liabilities divided by the sum of the GDPs of the source and host countries. The size of the nodes is proportional to the country's financial openness, measured by the sum of its total external assets and liabilities divided by GDP. More interconnected countries are placed more centrally in the network and pairs of countries with stronger links are placed closer to each other. Figures are drawn in Pajek (Program for Analysis and Visualization of Large Networks).

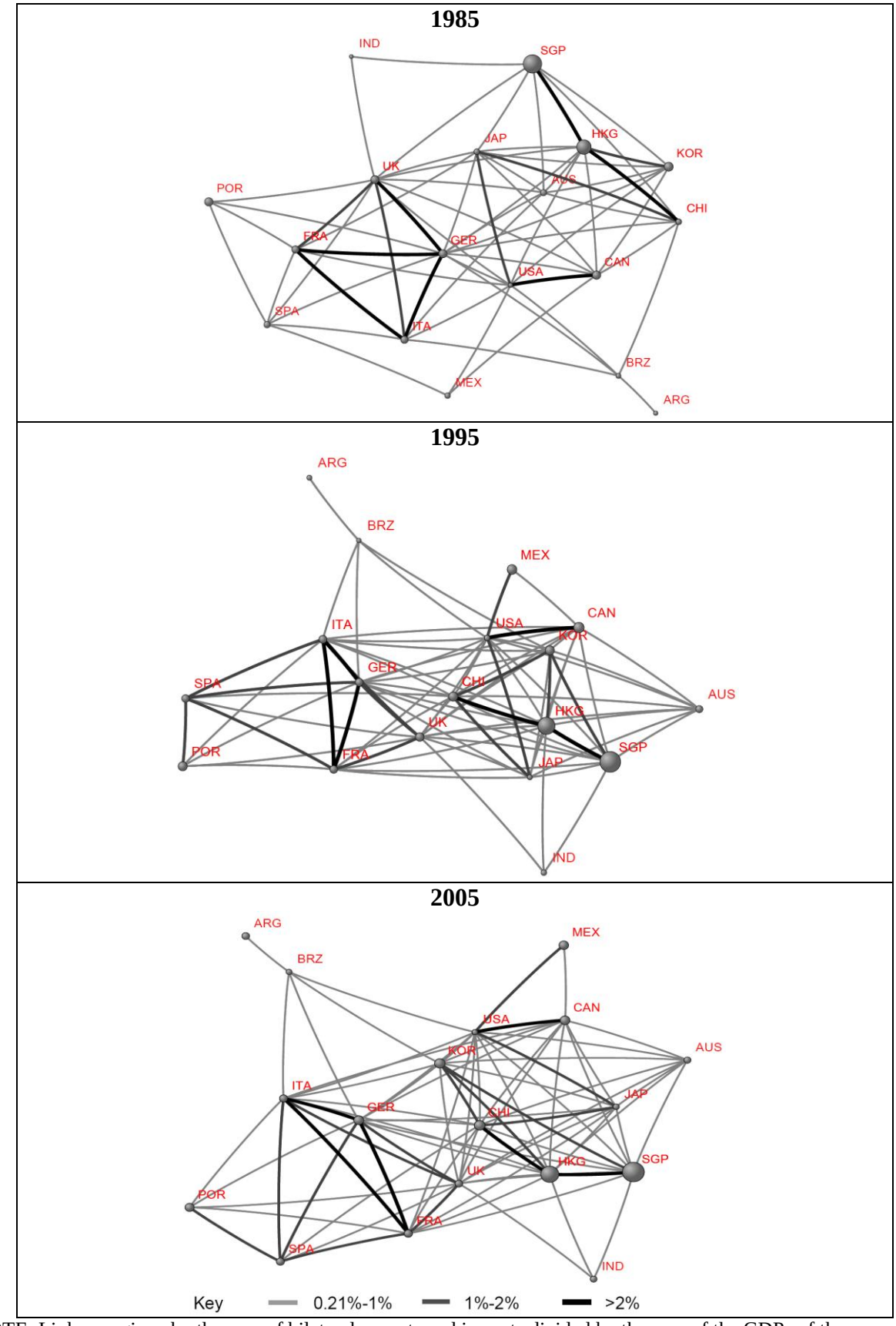
SOURCE: Adapted with permission from Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. *Bank of England Working Paper* 384.

Figure 4 International financial network – directed



NOTE: Links are given by the ratio of bilateral assets to GDP of the source country. The size of the nodes is proportional to the country's financial openness, measured by the sum of its total external assets and liabilities divided by GDP.
SOURCE: Adapted with permission from Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. *Bank of England Working Paper* 384.

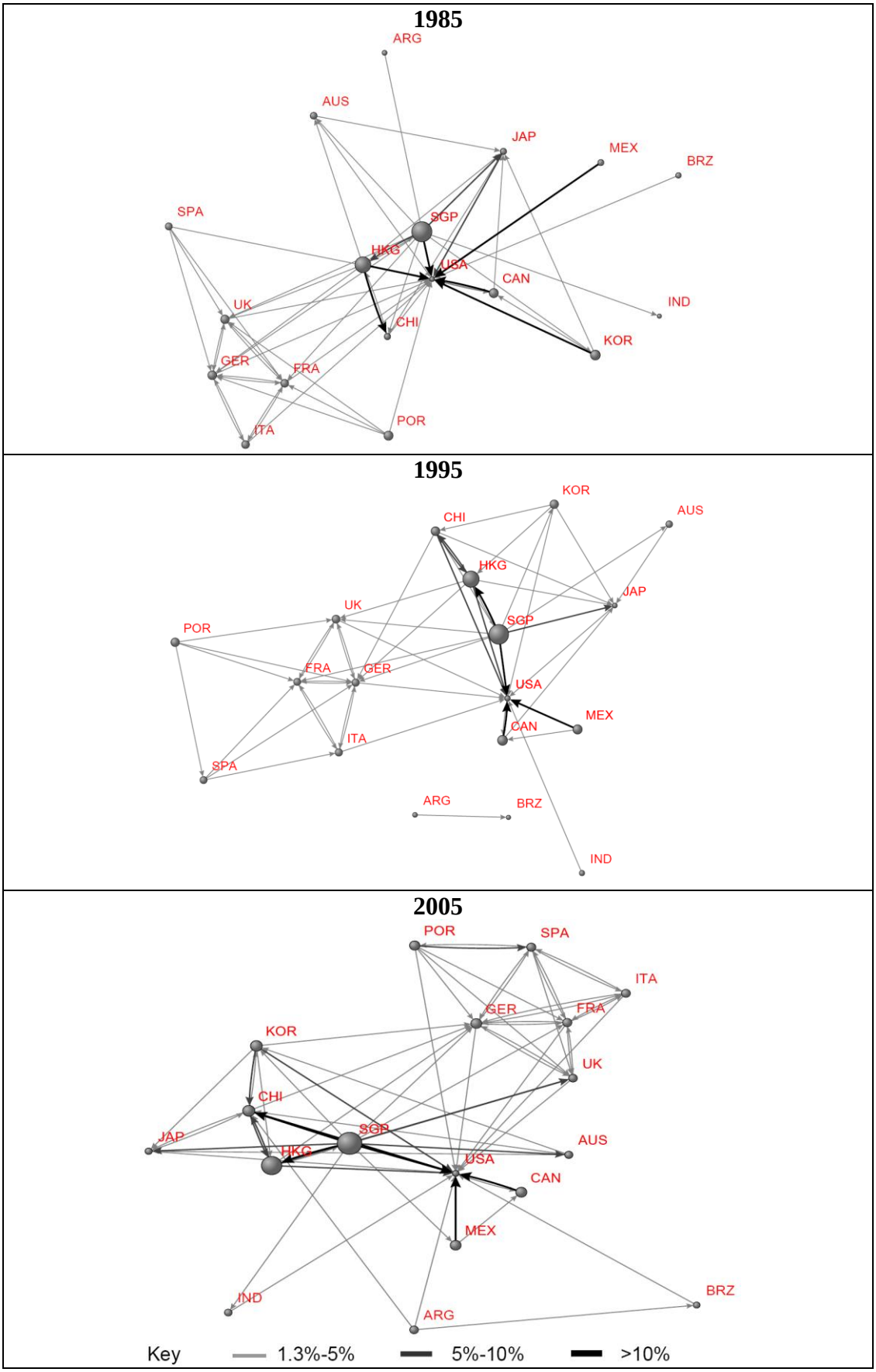
Figure 5 International trade network – undirected



NOTE: Links are given by the sum of bilateral exports and imports divided by the sum of the GDPs of the source and host countries. The size of the nodes is proportional to the country's trade openness, measured by the sum of its total exports and imports divided by GDP.

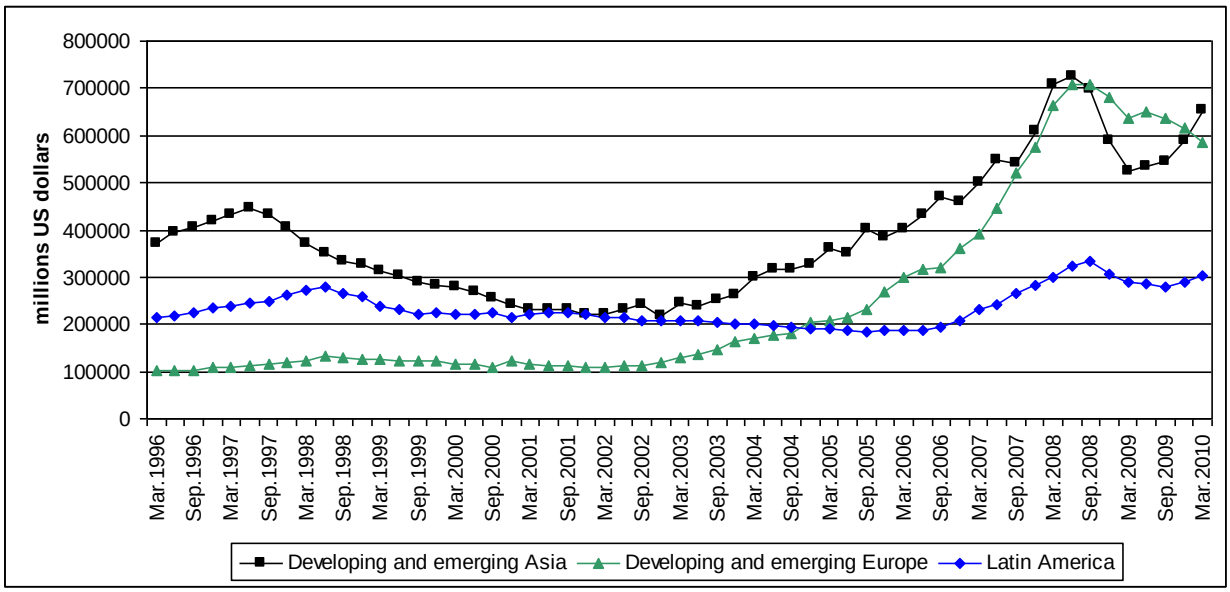
SOURCE: Adapted with permission from Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. *Bank of England Working Paper* 384.

Figure 6 International trade network – directed



NOTE: Links are given by the ratio of bilateral exports to GDP of the source country. The size of the nodes is proportional to the country's trade openness, measured by the sum of its total exports and imports divided by GDP.
SOURCE: Adapted with permission from Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. *Bank of England Working Paper* 384.

Figure 7 External loans to developing and emerging countries



SOURCE: BIS Locational Banking Statistics, external loans of reporting banks vis-à-vis individual countries.

Table 1. Summary statistics for the international financial network

	1985	**1995**	**2005**
Skewness	7.62	7.96	3.25
Average path length	1.55	1.44	1.37
Clustering coefficient	0.71	0.83	0.84

SOURCE: Adapted with permission from Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. *Bank of England Working Paper* 384.

Table 2. Ranking of five most central countries in the international financial network in 2005

In-degree	**Out-degree**	**Closeness**	**Betweenness**	**Intermediation**	**Prestige**
US	Hong Kong	US	US	US	US
Germany	Singapore	Germany	UK	UK	UK
UK	UK	Hong Kong	Spain	Germany	Germany
France	France	Singapore	Germany	Spain	France
Japan	Spain	UK	France	France	Japan

SOURCE: Adapted with permission from Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. *Bank of England Working Paper* 384.

Table 3. Summary statistics for the international trade network

	1985	1995	2005
Skewness	3.44	5.91	3.78
Average path length	1.70	1.59	1.44
Clustering coefficient	0.60	0.76	0.78

SOURCE: Adapted with permission from Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. *Bank of England Working Paper* 384.

Table 4. Ranking of five most central countries in the international trade network in 2005

In-degree	Out-degree	Closeness	Betweenness	Intermediation	Prestige
US	Singapore	US	China	US	US
Germany	Germany	Singapore	Germany	Germany	China
China	China	Germany	Hong Kong	China	Germany
France	France	China	Singapore	UK	UK
UK	Spain	France	US	France	France

SOURCE: Adapted with permission from Kubelec, C. and Sá, F. (2010). The geographical composition of national external balance sheets: 1980-2005. *Bank of England Working Paper* 384.