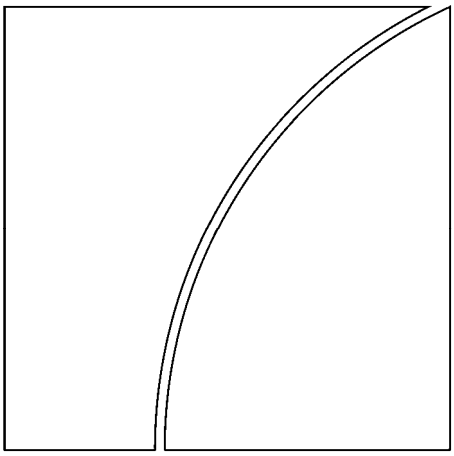
Committee on the Global Financial System



CGFS Papers

No 40

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

Proceedings of the second CGFS workshop held at the BIS in December 2008, chaired by Aviram Levy of the Bank of Italy

June 2010

BANK FOR INTERNATIONAL SETTLEMENTS

Copies of publications are available from:

Bank for International Settlements
Communications
CH-4002 Basel, Switzerland

E-mail: publications@bis.org

Fax: +41 61 280 9100 and +41 61 280 8100

This publication is available on the BIS website (www.bis.org).

ISBN 92-9131-832-9 (print)

ISBN 92-9197-832-9 (online)

Foreword

Since the late 1970s, the Euro-Currency Standing Committee and its successor, the Committee on the Global Financial System (CGFS), have put considerable efforts into collecting and promoting the use of high-quality financial statistics to further the understanding of developments in international financial markets. The BIS International Banking Statistics, collected under the auspices of the CGFS, have become a key resource for the monitoring of banks' funding patterns in the international financial system. This is important, as dislocations in funding markets were a significant issue during the recent financial crisis.

The data gaps revealed by the financial crisis have reinforced the Committee's long-standing view that continued improvement of international financial statistics is warranted. In 2009, a CGFS working group recommended a number of enhancements to the existing credit default swap reporting, which will be fully implemented by June 2011. In March 2010 the Committee set up a group to review proposals for improvements to the BIS International Banking Statistics, and other data collected under the auspices of the CGFS.

The CGFS also seeks to promote the use of BIS statistics for analytical purposes. To this end, the CGFS sponsors workshops to bring together academic and central bank researchers to present their research on questions related to global financial stability. Following the success of the workshop on "Research on global financial stability: the use of BIS international financial statistics" in December 2006, the second workshop was held in Basel in December 2008. I am grateful to Aviram Levy of the Bank of Italy and Linda Goldberg of the Federal Reserve Bank of New York for taking the lead in organising that workshop. While the research reported here represents the views of the authors and not the official view of the CGFS, I hope that this publication encourages the greater use of BIS data in research.

Donald L Kohn
Chairman
Committee on the Global Financial System

List of participants

	First name	Last name	Organisation
1.	Aviram	Levy	Bank of Italy (Chairman of the workshop)
2.	Linda	Goldberg	Federal Reserve Bank of New York (Co-organiser of the workshop and Chairman of the paper selection committee)
3.	Amandine	Afota	Bank of France
4.	Ugo	Albertazzi	Bank of Italy
5.	Pinar	Ayse Yesin	Swiss National Bank
6.	Stephen	Cecchetti	Bank for International Settlements
7.	Michael	Chui	Bank for International Settlements
8.	Ricardo	Correa	Board of Governors of the Federal Reserve System
9.	Helmut	Elsinger	National Bank of Austria
10.	Stefan	Gerlach	Goethe University
11.	Christopher	Graham	Bank of Canada
12.	Geoffrey	Heenan	International Monetary Fund
13.	Carmela	Iazzetta	Bank of Italy
14.	Kei	Imakubo	Bank of Japan
15.	Sonja	Juko	Deutsche Bundesbank
16.	Stefanie	Kleimeier-Ros	Maastricht University
17.	Philip	Lane	Trinity College
18.	Michele	Manna	Bank of Italy
19.	José Manuel	Marques	Bank of Spain
20.	Robert	McCauley	Bank for International Settlements
21.	Patrick	McGuire	Bank for International Settlements
22.	Katja	Neugebauer	University of Tübingen
23.	José Luis	Peydró-Alcade	European Central Bank
24.	Filipa	Sa	Bank of England
25.	Eric	Santor	Bank of Canada
26.	Cédric	Tille	Geneva Graduate Institute
27.	Emili	Tortosa-Ausina	Univeristat Jaume I and Ivie
28.	Kai	Truempler	London Business School
29.	Philip	Turner	Bank for International Settlements
30.	Christian	Upper	Bank for International Settlements
31.	Paul	Van den Bergh	Bank for International Settlements
32.	Karsten	von Kleist	Bank for International Settlements
33.	Goetz	von Peter	Bank for International Settlements
34.	Chun	Zhai	People's Bank of China

Contents

Introduction

Aviram Levy and Linda Goldberg[1]

One of the lessons of the global financial crisis which started in August 2007 is the crucial importance for policy makers and supervisors of having access to a wide range of reliable, timely and detailed financial statistics. In this regard the BIS has been playing a pioneering role in collecting and providing, since long ago, financial statistics which have been actively used to better understand the crisis and international financial trends and linkages. International financial statistics also may soon play an enhanced role as central banks and supervisors move towards a macroprudential approach to financial stability.

The BIS financial statistics consist of three major groups. The first is represented by the international banking statistics, which provide data on stocks and flows, on the currency denomination and maturity structure of cross-border banking assets and liabilities, both on a locational and a nationality basis. The origins of the BIS international banking statistics go back to the mid-1960s and to the need to monitor the emergence of the so-called eurocurrency markets that had sprung up to circumvent domestic regulations. Throughout the current financial crisis, these data have inter alia been used to analyze cross-border sources of funding for banks, in particular the so called "dollar shortage", whose role has been prominent in the early stage of the crisis, and channels for international transmission of disturbances. There is currently ongoing work to expand these statistics.

Turning to the second group of statistics, in the mid-1980s, as a result of the increasing role of the international securities markets in global financial intermediation, the BIS was mandated to collect and publish international debt securities statistics on the basis of data from commercial databases and from central banks. In the early 1990s the BIS also started to collect domestic debt securities statistics.

A third group of financial statistics which is collected and published by the BIS are data on derivatives. Data on OTC derivatives have been available, based on an ad hoc semi-annual survey, since 1998; in 2004 they have been supplemented with data on credit default swaps. Data for exchange traded derivatives, which are provided by the exchanges, are also published by the BIS, with a longer time series. Ongoing work is aiming at expanding these statistics with a view to better and more timely understand the transfer and ultimate distribution of credit risk.

The second CGFS workshop on "*Research on global financial stability: the use of BIS international financial statistics*" was held on 4–5 December 2008 in Basel.[2] The aim of the workshop was to take stock of how BIS international financial statistics have helped academic and central bank researchers to improve our understanding of global financial stability issues and, in particular, of the financial crisis which started in August 2007. In addition to BIS staff, the event was attended by economists and statisticians from thirteen central banks and from the IMF, together with eight academics.

The workshop started with an overview of the new developments in the BIS statistics, followed by presentations and discussions of ten research papers. The presented papers can be broadly classified into three key areas. First, a number of contributions took advantage of the bilateral characteristics of BIS reporting bank claims vis-à-vis other countries to construct

---

[1] The second CGFS workshop was chaired by Aviram Levy of the Bank of Italy. Linda Goldberg of the Federal Reserve Bank of New York co-organised the workshop and chaired the paper selection committee.

[2] The first workshop was held in Basel in December 2006 (see http://www.bis.org/publ/cgfs29.htm).

quantitative measures of financial integration and to analyse the latter's determinants. Second, other studies belong to the growing literature which combines BIS international banking with other international statistics to assess vulnerability of national balance sheets. In particular, the currency composition of the BIS data on international banking claims has proven to be a useful data source for analysing issues related to a country's foreign currency exposures. Third, a few papers were part of a large literature on the lending channel and monetary transmission. Bank lending data allow researchers to examine the role of banks' cross-border intra-bank lending on monetary transmission. This could improve the general understanding of the impact of bank globalisation on monetary transmission mechanism.

The workshop concluded with a roundtable discussion on "What can we learn about the financial crisis from the BIS statistics", chaired by Stephen Cecchetti. The roundtable discussion focused on two issues: what could be learned from the BIS statistics about the current financial crisis and what other data could improve the understanding of the crisis.

It was acknowledged that the BIS statistics are one of the few sources that provide internationally comparable quantity data on international balance sheet data of banks, which has proved be useful in examining the transmission of the crisis. However, other participants noted that the lack of comparable data on fixed-income markets was a key obstacle to a more detailed analysis. In particular, volume data related to securitisation and other off balance sheet items would be valuable additions to the existing BIS data.

Some participants pointed out that BIS consolidated banking data indeed contain very useful information on the asset side of reporting banks' balance sheets. But as the recent crisis unfolded, it also became clear that more information on the composition of bank liabilities would be useful. As one example, in this crisis many international banks have experienced funding problems in both local and foreign currencies. In this context, the addition of currency split of banks' consolidated liabilities would be extremely useful for tracking these funding difficulties. Some participants expressed interest in having the BIS explore which data already collected from constituent banks within BIS reporting countries might be useful to provide to the BIS for understanding past events and preparing for future ones.

Overall researchers, especially those from academia, agreed that the workshop provided an excellent platform to share and exchange views on the use of these statistics. They appreciated the efforts by the BIS statisticians to clarify the conditions and other confidentiality matters for central bank and academic economists to use the data for research.

The long or short of it: determinants of foreign currency exposure in external balance sheets[1]

Philip R Lane and Jay C Shambaugh[2]

Abstract

A major focus of the recent literature on the determination of optimal portfolios in open-economy macroeconomic models has been on the role of currency movements in determining portfolio returns that may hedge various macroeconomic shocks. However, there is little empirical evidence on the foreign currency exposures that are embedded in international balance sheets. Using a new database, we provide stylized facts concerning the cross-country and time-series variation in aggregate foreign currency exposure and its various subcomponents. In panel estimation, we find that richer, more open economies take longer foreign-currency positions. In addition, we find that an increase in the propensity for a currency to depreciate during bad times is associated with a longer position in foreign currencies, providing a hedge against domestic output fluctuations. We view these new stylized facts as informative in their own right and also potentially useful to the burgeoning theoretical literature on the macroeconomics of international portfolios.

JEL Classification: F31, F32

Keywords: Financial globalisation, exchange rates, international portfolio

1. Introduction

The rapid expansion of gross cross-border investment positions has stimulated a new wave of interest in the international balance sheet implications of currency movements. At the same time, recent advances in macroeconomic theory have provided a more nuanced consideration of the general equilibrium characteristics of the portfolio allocation problem than was attained in the earlier wave of "portfolio balance" models (see, amongst others, Devereux and Sutherland 2009a, Devereux and Sutherland 2009b, Tille and van Wincoop 2007 and Engel and Matsumoto 2008). A major concern of this new research programme has been to identify the appropriate currency exposure of optimal portfolios.

However, this literature has been constrained by a lack of empirical evidence concerning the currency exposures that are present in the international balance sheet. In recent work (Lane and Shambaugh 2009), we have compiled and described the currency composition of foreign asset and liability positions for a broad set of countries over 1990-2004. In that work, we established that the currency profiles of international portfolios show tremendous variation, both across countries and over time.

---

[1] Prepared for the IMF/WEF Conference on International Macro-Finance (Washington DC, April 24-25 2008). We thank the anonymous referees, Laura Alfaro, Chris Meissner, Cedric Tille and participants in IMF/WEF Conference on International Macro-Finance (Washington DC, April 24-25 2008), the second annual CEGE conference at UC Davis, the CGFS-BIS Workshop and a seminar at Dartmouth College. Agustín Bénétrix, Vahagn Galstyan, Barbara Pels and Martin Schmitz provided excellent research assistance. Email: plane@tcd.ie; Jay.C.Shambaugh@dartmouth.edu.

[2] IIIS, Trinity College Dublin and CEPR; Dartmouth College and NBER.

Accordingly, our goal in this paper is to synthesize two recent advances in the literature – the expansion of knowledge concerning the data on the currency composition of cross-border portfolios and the advances in theory regarding those positions – to study the cross-country and cross-time variation in aggregate foreign currency exposure. We pursue two broad lines of analysis. First, we provide a decomposition of aggregate foreign currency exposure into its constituent elements. This is important, since much of the theoretical literature has focused on particular dimensions of foreign-currency exposure, whereas the valuation impact of currency movements depends on the aggregate foreign currency position. Second, we conduct a panel analysis of variation in foreign currency exposure in order to identify which country characteristics help to explain the cross-sectional and time-series variation in the level of foreign currency exposure.

In the decomposition, we divide aggregate foreign-currency exposure into two primary subcomponents: the net foreign asset position and the level of foreign currency exposure embedded in a zero net foreign asset position. While some models focus on the latter component, the data suggest that the net foreign asset position is the most important determinant of aggregate foreign currency exposure. In addition, the decomposition shows that the structure of foreign liabilities (across portfolio equity, direct investment, local-currency debt and foreign-currency debt) is a key determinant of foreign currency exposure, with the equity share in liabilities more important than the currency composition of foreign debt liabilities. These findings point to the importance of analyzing the full set of foreign-currency assets and liabilities, rather than focusing on a particular subcomponent of the data.

We next analyse the panel variation in foreign currency exposures. We find that factors such as trade openness and the level of development help to explain the cross-sectional variation in foreign currency exposure: richer, more open economies take longer positions in foreign currency. This means these countries experience gains when their currency depreciates and losses when it appreciates. Once the cross-sectional variation is eliminated by including a set of country fixed effects in the estimation, we find support for a key general prediction of the theoretical literature: an increase in the propensity for a currency to depreciate during bad times is associated with a longer position in foreign currencies, which acts as a hedge against domestic output fluctuations. Our final contribution is to show that there is substantial heterogeneity in the roles of each regressor in explaining the variation in individual subcomponents of foreign-currency exposure: accordingly, it is important to take a broad perspective rather than examining individual components in isolation.

The structure of the rest of the paper is as follows. Section 2 lays out the conceptual framework for the study, while Section 3 briefly describes our dataset. The analysis of the decomposition of foreign-currency exposure into its constituent elements is presented in Section 4, with the main econometric analysis reported in Section 5. Section 6 provides a summary of the main stylised facts established by our analysis and final conclusions are offered in Section 7.

2. Analytical issues

2.1 Conceptual framework

The role played by nominal exchange rate fluctuations in determining the payoffs to cross-border holdings and the pattern of international risk sharing has long been recognised. In what follows, we present a simple framework (adapted from Davis et al 2001) to guide our thinking in terms of the role of currency exposure in determining the composition of portfolios.

Consider a two-period small open economy model. The endowment of the home agent in period 1 is fixed at y_1 but her period-2 endowment y_2 is stochastic. In particular, the process for output is

$$y_2 = \bar{y} + \beta_y S + \varepsilon, \quad (1)$$

where S is the period-2 rate of exchange rate depreciation, β_y is the beta from a regression of y_2 on S and ε is the orthogonal stochastic component.

Consumption only takes place in the second period. There are two assets: a domestic-currency asset D which offers a fixed gross return $R_D = \overline{R}$ and a foreign-currency asset F. The domestic-currency return on the foreign asset is

$$R_F = \alpha_F + \beta_F S + v, \quad (2)$$

where β_F is the beta from a regression of R_F on S and v is the orthogonal stochastic component. With this setup, we can derive the equilibrium holdings of F as a function of β_y, β_F and other factors.

The agent maximises utility over

$$U(c_2) = \left(\frac{1}{1+\delta}\right)\left(\frac{-1}{A}\right) E \exp[-Ac_2], \quad (3)$$

where δ is the discount rate, A is the coefficient of absolute risk aversion and the level of period-2 consumption is

$$c_2 = y_2 + (w_D R_D + w_F R_F), \quad (4)$$

where w_D, w_F are the domestic and foreign portfolio allocations respectively. The joint normality of y_2 and R_F means that we can write the optimality condition as

$$A\mathrm{Cov}(c_2, R_F) = E(R_F) - R_D = RP, \quad (5)$$

where RP is the risk premium. That is, the agent chooses portfolio allocations such that any remaining volatility in consumption that is correlated with the volatility in R_F is compensated through the risk premium.

With an optimal portfolio allocation, we can write consumption in the format equilibrium consumption can be written as

$$c_2 = \alpha + \beta_c R_F + \zeta, \quad (6)$$

where $\beta_c = RP/[A\mathrm{V}(R_F)]$ is the agents desired exposure to the foreign-currency asset and $\mathrm{V}(R_F)$ is the variance of the return on the foreign-currency asset. If the foreign-currency asset offers a risk premium, the agent will want some positive exposure to the foreign-currency asset; if the risk premium is zero, the agent will desire to have a consumption profile that has zero foreign-currency risk.

The agents *endowed exposure* to the foreign-currency asset is β_y. Accordingly, the optimal portfolio allocation to the foreign-currency asset is

$$w_F = \beta_c - \beta_y, \quad (7)$$

$$w_F = \frac{RP}{A\mathrm{V}(R_F)} - \frac{\mathrm{Cov}(y_2, S)}{\mathrm{V}(S)}. \quad (8)$$

Accordingly, the optimal portfolio foreign-currency position is increasing in the risk premium offered on the foreign-currency asset and declining in the volatility of the exchange rate and the degree of absolute risk aversion A. Importantly, it is decreasing in the covariance between the exchange rate and domestic output. If this covariance is negative (such that the currency depreciates when the domestic endowment is low), then the optimal portfolio share

is positive even if the risk premium is zero. In contrast, even if the risk premium is positive, the optimal portfolio foreign-currency position can be negative if the covariance term is sufficiently positive (that is, the currency depreciates when the domestic endowment is high).

While we have analysed the determinants of foreign-currency exposure in a highly-stylised environment, similar themes have been explored in the new wave of macro-finance models in which cross-border portfolio positions are endogenously determined. In particular, several recent contributions have also emphasised the potential role played by nominal assets and liabilities in contributing to international risk sharing.

The mechanism varies across models. For instance, Devereux and Saito (2007) consider a single-good flexible-price world economy in which home and foreign countries are subject to shocks to endowments and inflation. If it is assumed that the covariance between productivity and inflation is negative (as is empirically the case), a striking result is that complete risk sharing can be achieved if asset trade is restricted to home and foreign nominal bonds. Since the return on nominal bonds is procyclical in this setting, risk sharing is accomplished by the home country taking a long position in the foreign currency bond and a short position in the domestic currency bond — the portfolio payoff will be high when the home endowment is low.

A similar result is obtained by Devereux and Sutherland (2009a) who consider independent shocks to output and money stocks. In their symmetric model, domestic residents hold a long position in foreign-currency bonds (financed by an opposite position in domestic-currency bonds). The long position in foreign currency is increasing in the relative importance of endowment shocks versus monetary shocks and also increasing in the persistence of the endowment shock. The intuition is that nominal bonds are better able to deliver risk sharing, the less important are monetary shocks (Kim 2002 also makes this point). Moreover, the importance of risk sharing (and hence the gross scale of positions) is increasing in the volatility and persistence of output shocks.

An alternative account is provided by Engel and Matsumoto (2008) who provide an illustrative model featuring a one-period horizon, sticky prices and home bias in consumption. Sticky prices mean that hedging nominal exchange rate movements offers protection against shifts in the real exchange rate and the terms of trade and a simple foreign-exchange forward position (achievable through holding a long-short portfolio in foreign-currency and domestic-currency bonds) can deliver full risk sharing, making trade in equities redundant.[3] In their baseline model, a portfolio position that delivers a payoff that is proportional to the nominal exchange rate achieves full risk sharing. It is noteworthy that the optimal strategy in this model is to go short in foreign currency. Consistent with our stylised model, the short position is driven by the covariance between the exchange rate and output which is positive here: the exchange rate depreciates during productivity-driven output expansions (there are no nontradables in this model).

The overall message from this line of research is that a portfolio exhibiting exposure to exchange rate movements can play a role in contributing to international risk sharing. A country will wish to go long on foreign currency if the value of the domestic currency tends to positively co-moves with domestic output but may wish to go short if the covariance has the opposite sign.[4] Moreover, nominal currency positions are more useful, the less volatile are

[3] In an infinite horizon model with price adjustment, these authors show that trade in equities is also required to deliver full risk sharing. However, even in that case, only limited equity trade may be required in view of the stabilizing properties of foreign-currency hedges.

[4] As is emphasised by Pavlova and Rigobon (2007), the pattern of comovement between the exchange rate and domestic output will depend on the relative importance of “demand” and “supply” shocks. Accordingly, the covariance may shift over time. We return to this point in our empirical work.

monetary shocks. Finally, the gross scale of positions is increasing in the importance of sharing risk – that is, the more volatile and persistent are wealth shocks.

2.2 Moving from theory to empirics

In terms of empirical approach, we follow Lane and Shambaugh (2009) in defining aggregate foreign currency exposure by

$$FX_{it}^{AGG} = w_{it}^{A} \times \left(\frac{A_{it}}{A_{it} + L_{it}} \right) - w_{it}^{L} \times \left(\frac{L_{it}}{A_{it} + L_{it}} \right), \tag{9}$$

where w_{it}^{A} is the share of foreign assets denominated in foreign currencies, and w_{it}^{L} is defined analogously. FX^{AGG} lies in the range $(-1, 1)$ where the lower bound corresponds to a country that has no foreign-currency assets and all its foreign liabilities are denominated in foreign currencies, while the upper bound is hit by a country that has only foreign-currency assets and no foreign-currency liabilities. Accordingly, FX^{AGG} captures the sensitivity of a country's portfolio to a uniform currency movement by which the home currency moves proportionally against all foreign currencies. This measure explicitly examines the financial or balance sheet currency exposure; the real side impact of currency movements on trade flows is not considered here.

In developing an empirical specification, we rely on an adapted version of the basic specification in equation (8). According to equation (8), the foreign-currency portfolio position should depend on the covariance between output and the exchange rate and the volatility of the exchange rate.[5] Both of these variables enter the baseline empirical specification. In addition, we control for the volatility of domestic and foreign inflation rates, in order to differentiate between volatility in the real exchange rate and volatility in nominal price levels. Moreover, nominal volatility at home plausibly limits the ability of domestic residents to issue domestic-currency assets to foreign investors, while nominal volatility overseas reduces the willingness of domestic investors to hold foreign-currency bonds. (The foreign (global) inflation rate is absorbed in the time dummy in the regressions.)

Next, we include two additional factors. First, we also include trade openness as an additional regressor, since the value of foreign assets in a portfolio is increasing in a country's propensity to consume imports (Obstfeld and Rogoff, 2001). Second, we control for the volatility of output, since the importance of international risk sharing may be greater, the more volatile is the domestic economy (as in several of the models outlined in the preceding discussion).

Accordingly, we arrive at the baseline empirical specification by which the desired net foreign-currency exposure of country i's balance sheet may be expressed as:

$$\begin{aligned} FX_{it}^{AGG*} = {} & \alpha + \phi_t + \gamma \times \mathrm{Cov}(Y_{it}, E_{it}) - \varphi_H \times \mathrm{VOL}(\pi_{it}) \\ & - \varphi_F \times \mathrm{VOL}(E_{it}) + \rho \times OPEN_{it} + \beta \times \mathrm{VOL}(Y_{it}) + \varepsilon_{it} \end{aligned}, \tag{10}$$

where Y_i is GDP growth, E_i is the nominal exchange rate, π_i is domestic inflation and $OPEN_i$ is the level of trade openness.

[5] The approach is partial equilibrium in nature, especially since we do not model the process for the exchange rate. While this is a limitation, it is also well understood that we do not have good models that successfully explain a high proportion of exchange rate variation.

However, a host of factors may inhibit a country's ability to attain its desired net foreign-currency position. The capacity to issue domestic-currency liabilities (whether domestic-currency debt or equity instruments) is limited by a poor-quality domestic institutional environment, especially in relation to the treatment of foreign investors. On the other side, the ability to acquire foreign-currency assets may be limited by capital controls, regulatory prohibitions on institutional investors, or simply the wealth of the country.

Accordingly, we also consider an extended specification which allows institutional frictions to shape the level of aggregate foreign currency exposure. Accordingly, the observed foreign-currency exposure may be characterised by

$$FX_{it}^{AGG} = FX_{it}^{AGG*} - C(F_{it}) \tag{11}$$

where F_i denotes the set of proxies for the limits on the capacity to issue domestic-currency liabilities and acquire foreign-currency assets.

This allows us to write the expanded empirical specification

$$\begin{aligned} FX_{it}^{AGG} = {} & \alpha + \phi_t + \gamma \times \mathrm{Cov}(Y_{it}, E_{it}) - \varphi_H \times \mathrm{VOL}(\pi_{it}) \\ & - \varphi_F \times \mathrm{VOL}(E_{it}) + \rho \times OPEN_{it} + \beta \times \mathrm{VOL}(Y_{it}) - \sigma F_{it} + \varepsilon_{it} \end{aligned} . \tag{12}$$

We consider versions of equations (10) and (12) in our econometric analysis in Section 5 below.

Finally, we note that the theoretical models outlined in this section have focused on the determinants of steady-state portfolios. Some recent work has been successful in describing the dynamics of portfolios in response to various shocks (Tille and van Wincoop 2007, Devereux and Sutherland 2009b). Since our empirical work examines a low-frequency panel of observations on foreign-currency positions (there are four year gaps between observations), we base our interpretation on steady-state factors, rather than seeking to capture the cyclical dynamics of portfolios.

2.3 Components of the net foreign currency asset position

Aggregate foreign currency exposure can be decomposed into two primary subcomponents

$$FX_{it}^{AGG} = \left(\frac{NFA_{it}}{A_{it} + L_{it}} \right) + \left[w_{itDC}^{L} \times \left(\frac{L_{it}}{A_{it} + L_{it}} \right) - w_{itDC}^{A} \times \left(\frac{A_{it}}{A_{it} + L_{it}} \right) \right]. \tag{13}$$

This expression shows that FX^{AGG} is the sum of the net foreign asset position plus the share of foreign liabilities which are in local currency minus the share of foreign assets which are in local currency. Accordingly, if all assets and liabilities are in foreign currency, the aggregate foreign-currency exposure is simply the scaled net foreign asset position. Conversely, if the net foreign asset position is zero, aggregate foreign-currency exposure is the difference in the foreign-currency share between the asset and liability sides of the international balance sheet. Accordingly, we label this second part of the equation and $FX_{it}^{AGG,0}$ rewrite our equation as

$$FX_{it}^{AGG} = \left(\frac{NFA_{it}}{A_{it} + L_{it}} \right) + FX_{it}^{AGG,0},$$

where NFA_{it} is the net foreign asset position (scaled by $A + L$) and $FX_{it}^{AGG,0}$ is the aggregate foreign currency exposure evaluated at a zero net foreign asset position. This decomposition is useful, since much of the theoretical literature has focused on scenarios in

which the net foreign asset position is zero, even if non-zero net foreign asset positions are empirically important in determining aggregate foreign currency exposures.

In turn, it is helpful to make further decompositions of each of these terms

$$FX_{it}^{AGG} = \left[\left(\frac{A_{NRit} - L_{it}}{A_{it} + L_{it}}\right) + \frac{FXR_{it}}{A_{it} + L_{it}}\right] + \left[\left(\frac{PEQL_{it} + FDIL_{it}}{A_{it} + L_{it}}\right) + \left(\frac{DEBTL_{it}^{DC}}{A_{it} + L_{it}}\right) - \left(\frac{A_{NRit}^{DC}}{A_{it} + L_{it}}\right)\right]. \quad (15)$$

That is, FX^{AGG} decomposes into two elements of the net foreign asset position (non-reserve net foreign assets $A_{NR} - L$, plus foreign-exchange reserves FXR) and three elements of $FX^{AGG,0}$ (portfolio equity and direct investment foreign liabilities, plus domestic-currency debt liabilities minus local-currency debt assets), where all terms are scaled by $A + L$. This decomposition has several appealing features. First, it clearly differentiates between the relative contributions of foreign-exchange reserves and non-reserve components in the overall net foreign asset position. Second, it highlights that $FX^{AGG,0}$ is driven by three separate factors: all else equal, a greater share of equities in foreign liabilities reduces reliance on foreign-currency financing, while the foreign-currency position is more positive, the greater is the share of domestic currency in foreign debt liabilities and the smaller is the share of domestic-currency assets in non-reserve foreign assets.[6] In our empirical work, we examine each of these elements in some detail, since diverse strands of the existing theoretical and empirical literatures have typically focused on individual elements rather than the aggregate position.

Lane and Shambaugh (2009) show that the quantitative impact of a uniform currency movement is the product of FX^{AGG} and the gross scale of the international balance sheet

$$NETFX = FX^{AGG} \times IFI, \quad (16)$$

where $IFI = (A + L) = GDP$ is the outstanding gross stock of foreign assets and foreign liabilities. We will examine $NETFX$ in addition to FX^{AGG} and its subcomponents in our empirical analysis.

Finally, we also construct an alternative measure of foreign-currency exposure that only takes into account debt assets and liabilities. While we view the aggregate position as the most comprehensive and useful, some models have specific predictions for the debt-only position (see, amongst others, Coeurdacier, Kollman, and Martin 2007). We calculate

$$FXDEBT_{it}^{AGG} = \frac{FXR_{it} + PDEBTA_{it}^{FC} + ODEBTA_{it}^{FC} - PDEBTL_{it}^{FC} - ODEBTL_{it}^{FC}}{DEBTA_{it} + DEBTL_{it}}, \quad (17)$$

where $PDEBT$ and $ODEBT$ denote portfolio and non-portfolio ("other") debt respectively. The net foreign currency position in the debt portion of the balance sheet is scaled to the size of the debt-only balance sheet (debt assets plus debt liabilities).

[6] The domestic-currency share in non-reserve foreign assets will typically be driven by the domestic-currency share in non-reserve foreign debt assets. The exceptions are those countries that share a currency with other countries, such that a proportion of foreign equity assets will be denominated in domestic currency.

3. Data

The construction of the underlying dataset is described in detail in Lane and Shambaugh (2009).[7] Since the focus in this paper is on aggregate foreign-currency exposure, we confine attention to our method for estimating the foreign-currency and domestic-currency components of foreign assets and foreign liabilities. Since, for this purpose, we do not depend on the composition of the foreign-currency component across different currencies, the calculations here are less taxing than the bilateral currency estimates reported by Lane and Shambaugh (2009).

In relation to foreign assets, foreign-exchange reserves are by definition denominated in foreign currencies. For the portfolio equity and direct investment categories, we make the assumption that an equity position in destination country *j* carries an exposure to the currency of country *j*. In effect, this assumption implies that the home-currency returns on foreign equity assets can be analyzed as consisting of two components: the foreign-currency return, plus the exchange rate shift between the foreign and home currencies. So long as the two components are not perfectly negatively correlated, the home-currency return will be influenced by currency movements such that the equity category indeed carries a currency exposure. Thus, for these two categories, we simply need the quantities on the balance sheet using the External Wealth of Nations dataset reported in Lane and Milesi-Ferretti (2007).

The portfolio debt asset category poses the most severe challenge since many countries issue debt in multiple currencies, while the propensity to purchase bonds issued in particular currencies varies across investors of different nationalities. We make extensive use of the international securities dataset maintained by the BIS, which reports the currency denomination of international bonds for 113 issuing countries.[8] In order to allow for the propensity of investors to buy international bonds that are denominated in their own currency, we exploit the data provided by the United States Treasury, the European Central Bank and the Bank of Japan regarding the currency composition of the foreign assets of these regions. The United States reports the currency denomination of its portfolio debt assets in each destination country; the Bank of Japan data show that Japanese investors purchase (virtually) all of the yen-denominated debt issued by other countries; and the European Central Bank data suggests that investors from the euro area hold 66 percent of the euro-denominated debt issued by other countries. Accordingly, we adjust the currency weights derived from the BIS data to take into account the portfolio choices by the investors from the major currency blocs and employ these adjusted weights in working out the currency composition of the foreign holdings of investors from other countries. This procedure delivers estimates of the foreign- and domestic-currency components of the foreign portfolio debt assets held by each country (in addition to details on the composition of the foreign-currency component). Finally, in relation to non-portfolio debt assets, we are able to exploit the BIS locational banking statistics to obtain a breakdown between home-currency and foreign-currency bank assets.

The treatment of foreign liabilities is largely symmetric. Portfolio equity and direct investment liabilities are assumed to be in the home currency, while the BIS databanks on bank debt liabilities and securities issuance allows us to obtain a breakdown of debt liabilities between the domestic currency and foreign currency components. (For developing countries, we use

[7] The dataset and documentation are available at http://www.philiplane.org/LSAER/LSAERdata.html.

[8] Where the BIS data set lacks data on the currency of issue for a country, we rely on the World Bank's Global Financial Development database of the currency composition of external debt.

the World Bank's Global Development Finance database to obtain the currency breakdown of external debt.)

As discussed in Lane and Shambaugh (2009), it is possible that some exposure is hedged using derivatives. It is important to note that any within-country derivative sales are moot as they simply shift exposure across parties within the country's overall balance sheet. Also, anecdotal evidence and some country studies suggest cross-border hedging is not on the same scale as the asset and liability positions we examine. Finally, Lane and Shambaugh (2009) show that that valuation effects that we derive from the financially-weighted exchange rate indices are strong predictors of actual valuation effects, suggesting our measures are good approximations of actual currency exposure positions.

Our full sample of countries includes 117 countries where we have full data. We eliminate hyperinflation episodes due to their status as outliers, and start a country's data after the conclusion of a hyperinflation (countries with hyperinflations late in the sample are dropped). Many results examine the variation between 1994 to 2004 (1996 to 2004 in the regression analysis). These results use a smaller 102 country sample that has full data from 1994 through 2004.[9]

4. Foreign-currency exposure: decomposition

Table 1 shows some summary statistics for FX^{AGG}, $NETFX$ and $FXDEBT^{AGG}$ for different country groups for 1994 and 2004. The data show a general move towards a more positive FX^{AGG} position between 1994 and 2004. Table 1 also shows considerable cross-group variation. For each period, FX^{AGG} is more positive for the typical advanced economy relative to the typical emerging market economy, while the typical developing country has a negative FX^{AGG} position. These patterns also broadly apply in relation to $NETFX$ but the long position of the typical advanced economy is amplified by the much higher level of international financial integration for this group than for the lower-income groups.

To put these figures in context, a negative $NETFX$ value of minus 16 percent (the typical developing country) means that a uniform 20 percent depreciation against other currencies generates a valuation loss of 3:2 percent of GDP, while the same currency movement generates an 8:4 percent of GDP valuation gain for a country with a positive $NETFX$ value of 42 percent (the typical advanced economy). These wealth effects are considerable and demonstrate why the aggregate foreign-currency exposure against the rest of the world is an important indicator.

Table 1 also shows positions for $FXDEBT^{AGG}$. First, we note the mechanical pattern that debt-only positions are automatically more negative than overall positions. Since FDI and portfolio equity liabilities are in local currency and foreign equity assets are in foreign currency, equity positions on either side of the balance sheet makes FX^{AGG} more positive. Hence, $FXDEBT^{AGG}$ is more negative than the overall FX^{AGG} in all years. A somewhat surprising result is that even advanced countries in 2004 have negative $FXDEBT^{AGG}$

[9] The remaining data come from standard sources. Exchange rate and inflation data are from the International Monetary Fund's International Financial Statistics database, while GDP and trade data are from the World Bank's World Development Indicators database, and the institutional data comes from the World Bank's Worldwide Governance Indicators database (www.govindicators.org). The peg variable is from Shambaugh (2004), capital controls data come from di Giovanni and Shambaugh (2008) and is a binary variable summarizing information from the IMF yearbooks (using the alternative indicators developed by Chinn and Ito (2008) or Edwards (2007) makes nearly no difference and the choice is based on maximising data availability).

positions. This occurs because so many of their assets are either in local-currency debt assets or equity assets, even though they have few foreign currency debt liabilities, the net currency position in foreign bonds is negative.

Table 1

Aggregate foreign currency exposure

	1994		2004	
	Mean	**Median**	**Mean**	**Median**
$FXDEBT^{AGG}$				
All	–0.23	–0.24	–0.03	–0.01
Advanced	0.04	0.08	0.12	0.09
Developing and emerging	–0.30	–0.41	–0.07	–0.09
Developing	–0.41	–0.47	–0.14	–0.19
Emerging	–0.10	–0.06	0.06	0.06
FXT^{AGG}				
All	–0.33	–0.39	–0.12	–0.12
Advanced	–0.12	–0.05	–0.07	–0.04
Developing and emerging	–0.38	–0.51	–0.13	–0.16
Developing	–0.50	–0.57	–0.19	–0.25
Emerging	–0.17	–0.17	–0.01	–0.06
$NETFX$				
All	–0.31	–0.24	0.18	–0.00
Advanced	0.18	0.08	0.54	0.42
Developing and emerging	–0.44	–0.33	0.07	–0.10
Developing	–0.71	–0.58	–0.16	–0.16
Emerging	0.05	–0.03	0.44	0.06

Note: $FX^{AGG} = w^A s^A - w^L s^L$; $NETFX = FX^{AGG} \times IFI$. Sample includes the 102 countries with data from 1994 to 2004.

Source: Lane and Shambaugh (2007).

Table 2 shows summary statistics for the cross-country distribution of FX^{AGG} and its various subcomponents (plus $NETFX$) for 2004 (the final year in the dataset). Across the full sample, the average country has a roughly-balanced foreign-currency position (which implies no foreign currency exposure; balanced changes in the exchange rate would not affect the aggregate balance sheet) but the range extends from minus 72 percent to plus 66 percent. It is important to note that a positive value of FX^{AGG} is not in itself good or bad. Instead, the optimal allocation could depend on the factors noted above. While having a negative FX^{AGG} means losses on the balance sheet if there is a depreciation, it conversely means gains in the case of an appreciation.[10] The typical net foreign asset position is negative, on the order

[10] Lane and Shambaugh (2009) provide an extensive discussion of the distribution and trends in this particular statistic. For context, a negative position of –0.5 suggests that for every 10 percent depreciation of the currency, the country will face valuation losses of 5 percent times the assets plus liabilities divided by GDP. For the typical country, this would mean a loss of 10 percent of GDP.

of 30 percent of assets and liabilities, while the $FX_{it}^{AGG,0}$ terms tends to partly balance this out, since it is typically positive.[11]

Table 2

Foreign currency exposure (FX^{AGG}) and subcomponents

	Mean	Std dev	Minimum	Maximum	Median
FX^{AGG}	–0.03	0.27	–0.72	0.66	–0.03
$(A - L) = (A + L)$	–0.28	0.28	–0.87	0.55	–0.30
$FX^{AGG,0}$	0.25	0.14	–0.03	0.87	0.23
$(A_{NR} - L) = (A + L)$	–0.40	0.26	–0.90	0.14	–0.46
$FXR = (A + L)$	0.12	0.10	0.00	0.55	0.11
$(PEQL + FDIL)/(A + L)$	0.25	0.13	0.03	0.87	0.22
$DEBTL^{DC} = (A + L)$	0.03	0.09	0.00	0.45	0.00
$A_{NR}^{DC} = (A + L)$	–0.03	0.09	–0.42	0.00	0.00
$NETFX$	0.15	0.87	–0.75	6.25	–0.02
$FXDEBT^{AGG}$	–0.12	0.32	–0.85	0.66	–0.12

Summary statistics for 2004.

As for the subcomponents, the non-reserve component of the net foreign asset position of most countries is negative but, by definition, foreign-exchange reserves are always at least slightly positive. Portfolio equity and direct investment are on average about 20 percent of liabilities, giving most countries a built-in set of domestic-currency liabilities. Many countries have no domestic-currency foreign debt liabilities, and even more have no domestic-currency foreign assets.[12] Finally, $NETFX$ is a more skewed variable with a much larger standard deviation as some countries have very large ratios of foreign assets and liabilities to GDP.

We can reorganise the decomposition of FX^{AGG} into a series of bivariate decompositions. At the upper level, we decompose FX^{AGG} between NFA (scaled by $A + L$) and $FX^{AGG,0}$. In turn, we decompose the overall net foreign asset position between non-reserve net foreign assets and foreign-exchange reserves and decompose $FX_{it}^{AGG,0}$ between the equity share in foreign liabilities and the domestic currency share term ($DCSHARE = DEBTL^{DC} - A_{NR}^{DC}$). Finally, the $DCSHARE$ term can be disaggregated into its two constituent parts.

In order to assess the relative contributions of each term in a bivariate decomposition, we report three statistics. Taking the generic pair $Q = N_1 + N_2$, we generate: (i) the R^2 from a

[11] To exhibit a negative value of $FX_{it}^{AGG,0}$ it would require more foreign assets in local currency than foreign liabilities in local currency. Since most countries have some local currency foreign liabilities (due to direct investment and portfolio equity) and few countries have local currency foreign assets, only two countries actually have a negative value of $FX_{it}^{AGG,0}$.

[12] The latter is expressed as a negative number, since it enters the decomposition negatively.

regression of Q on N_1; (ii) the R^2 from a regression of Q on N_2; and (iii) $\rho(N_1, N_2)$ = Correl(N_1, N_2). No technique can purely separate what is driving Q in such a decomposition, but these statistics are helpful in establishing some bounds. We show both the distribution of results for within-country analysis in Figures 1–5 and the pooled estimates in Table 3.

Table 3

Variance decomposition of foreign currency exposure: pooled analysis

	(FX^{AGG}, IFI)	$(NFA, FX^{AGG,0})$	(NFA_{NR}, FXR)	$(EQSH_L, DCSHARE)$	$(DCDEBT_L, A_{NR}^{DC})$
ALL	(0.56,0.34,0.28)	(0.83,0.11,–0.10)	(0.91,0.14,0.08)	(0.94,0.08,0.04)	(0.01,0.16,–0.87)
ADV	(0.47,0.53,0.29)	(0.65,0.03,–0.43)	(0.97,0.02,–0.33)	(0.66,0.47,0.13)	(0.01,0.30,–0.79)
EMU	(0.45,0.62,0.25)	(0.37,0.12,–0.53)	(0.92,0.10,–0.58)	(0.40,0.48,–0.12)	(0.00,0.38,–0.76)
NON-EMU	(0.47,0.76,0.41)	(0.75,0.01,–0.40)	(0.99,0.00,–0.19)	(0.87,0.50,0.41)	(0.36,0.00,–0.78)
EM	(0.37,0.82,0.43)	(0.86,0.23,0.12)	(0.93,0.05,–0.04)	(1.00,0.02,0.12)	(0.48,0.04,–0.84)
DEV	(0.65,0.41,–0.21)	(0.76,0.15,–0.11)	(0.92,0.66,0.62)	(1.00,0.00,–0.03)	(1.00,0.00,)

Each cell reports $(R^2_{N1}, R^2_{N2}, \rho[N1, N2])$ where $Q = N1 + N2$ and R^2_{N1} denotes the R^2 from a regression of Q on $N1$, R^2_{N2} denotes the R^2 from a regression of Q on $N2$, and $\rho[N1, N2]$ is the correlation between $N1$ and $N2$. ($Q = N1 \times N2$ for the pair FX^{AGG}, IFI. Pooled data over 1994 to 2004.

Figure 1 shows the country-by-country decomposition of FX^{AGG} between NFA and $FX_{it}^{AGG,0}$. It shows that both factors independently have high explanatory power for most countries but with the net foreign asset position typically having the higher bivariate R^2. In terms of comovement, the sample is evenly split between cases where the net foreign asset position and $FX^{AGG,0}$ are positively correlated and those where the correlation is negative. In the pooled regressions in Table 3, net foreign assets are much more important, with the R^2 from a regression of FX^{AGG} on $FX_{it}^{AGG,0}$ typically close to zero, with the exception of the emerging market group. This is perhaps the most important result in the decomposition. To a great extent, the foreign currency exposure of a country is determined by its status as a debtor or creditor. Examining models where countries hold balanced net foreign asset positions will miss a large part of what determines currency exposure.

Figure 2 decomposes the net foreign asset position between the non-reserve net foreign asset position and foreign-exchange reserves. The former is clearly the dominant factor. Within countries, a regression of the aggregate net foreign asset position on the non-reserve net foreign asset position has an R^2 close to unity for nearly all countries, while at least half the sample has an R^2 less than 0:5 when the regressor is the level of foreign-exchange reserves. Again, the split between positive and negative correlations between the two elements is relatively balanced, but is 60–40 in favor of positive cases. Thus, despite an extensive literature on reserves holdings, the portfolio balance literature's emphasis on the private sector appears appropriate. Central banks are not systematically offsetting the positions of private actors. The non-reserve NFA drives the overall position.

The pooled regressions in Table 3 emphatically reinforce this point. In the full sample and all subsamples, the R^2 when the non–reserve net foreign asset position is the regressor is at least 0:9 and the only subsample where reserves appear important is the developing world. Table 3 shows a negative correlation of reserves and non-reserve NFA in advanced countries suggesting that reserves could be held as a hedge against losses in the non-reserve balance sheet, but there is no correlation in the emerging countries and developing

countries actually show a positive correlation. This implies that countries with a positive NFA hold more reserves, suggesting that reserves are not a hedge for private positions in poor countries.

Figure 3 powerfully shows that the equity share in liabilities is far more important than the currency composition of debt assets and liabilities in driving the behaviour of $FX_{it}^{AGG,0}$. Especially in non-advanced countries, there is simply far more variation in the importance of FDI and portfolio equity liabilities than in domestic-currency foreign debt liabilities (which is relatively low) or domestic-currency foreign assets (which are almost always zero), meaning that $FX_{it}^{AGG,0}$ will be almost entirely determined by the extent of portfolio equity and direct investment liabilities. In terms of comovements, it is interesting that there is a 60–40 balance in favor of negative cases. In turn, Figure 4 shows the relative contributions of the liability and asset sides to the currency composition factor and shows that the liability side has slightly more explanatory power. The correlation is 80–20 in favor of negative cases as countries with large domestic-currency debt liabilities also have large domestic-currency non-reserve foreign assets.

Finally, Figure 5 shows the decomposition of $NETFX$ between FX^{AGG} and IFI.[13] It is interesting that FX^{AGG} has relatively more explanatory power than IFI: the overall net currency exposure of the economy is driven more by the currency exposure of the international balance sheet than by the gross scale of asset and liability positions relative to the economy. There is a reasonably even split between positive and negative correlations (60–40 in favor of positive). In Table 3, we see that FX^{AGG} is more important than and IFI in the full pooled sample, but their relative importance varies across the various subsamples.

Our analysis is static in nature, looking at exposure to a change in the exchange rate based on holdings at a given point in time. One may worry that a collapsing currency (or fears of one) could lead to a collapsing position if a country is suddenly forced to borrow extensively in foreign currency. This might mean that apparently safe positions are illusory. In fact, a change in the exchange rate typically has little impact on FX^{AGG}. Consider a country with no foreign assets and all foreign currency liabilities. If the exchange rate depreciates, they face valuation losses but FX^{AGG} is –1 throughout. If assets equaled half of liabilities and FX^{AGG} is –0:5, the same applies. Only if there is an extensive amount of domestic currency liabilities on the balance sheet can a depreciation shift FX^{AGG} to a more negative position (by increasing the relative size of the foreign currency liabilities). In fact there is only a slight decrease in FX^{AGG} in the year prior to a sudden stop and FX^{AGG} on average does not change at all in the year of a sudden stop.[14] Thus we do not view this concern as particularly problematic, and instead see our measure as a good indicator of the external balance sheet exposure of countries.

[13] This decomposition is of a slightly different nature in that $NETFX$ is the product of FX^{AGG} and IFI, whereas each of the other decompositions is of a sum.

[14] Thailand and Korea in 1997 do show declining FX^{AGG}, but the decline is small and is balanced by countries that show and increasing FX^{AGG} (perhaps due to being forced to pay back foreign loans when funding dries up).

5. Econometric analysis

5.1 Regression specification

We begin our analysis with the determinants of aggregate foreign currency exposure, before moving on to the subcomponents. Table 4 explores a variety of specifications to explain variation in FX^{AGG}.

We adopt a panel framework

$$Y_{it} = \alpha + \phi_t + \beta' X_{it} + \varepsilon_{it} . \quad (18)$$

We consider four specifications for X. The baseline specification follows the setup described in equation (10) above, which focuses on the types of variables that are identified as potentially important in a 'friction free' environment. We include the following variable: trade openness (trade to GDP ratio); volatility of real GDP per capita; covariance of real per capita GDP and the nominal effective exchange rate; volatility of the nominal effective exchange rate; and volatility of domestic inflation.

The volatility and covariance measures are calculated for the log changes of each variable over a rolling 15 year window (since the real variables are only available on an annual basis for many countries). As was discussed in Section 2.3, the importance of using the balance sheet to hedge domestic risk is increasing in the volatility of domestic wealth (proxied here by GDP per capita). A critical factor in determining whether FX^{AGG} should be long or short is the sign of the covariance term between domestic wealth and the nominal exchange rate, proxied here by the covariance between GDP and the nominal effective exchange rate. The higher is the exogenous component in nominal exchange rate volatility, the more risky are foreign-currency assets while domestic inflation volatility increases uncertainty about the real returns on nominal positions.[15] Finally, a time fixed effect is included in equation (18) to control for global factors, such as time-variation in the volatility of global inflation.

We also consider an expanded specification that seeks to take into account institutional and policy factors that may alter the desired optimal net foreign currency position and/or restrict a country's ability to attain its desired level. These variables include: institutional quality; capital controls; the de facto exchange rate regime; and a marker for being in EMU. A third set of variables is also considered that are viewed as general control variables: GDP per capita; and population size.

The level of GDP per capita is included, since many of the characteristics listed above are plausibly correlated with the level of development and we want to be able to ascertain whether these variables have explanatory power even holding fixed GDP per capita. Country size is a second general control variable, since previous empirical evidence suggests that larger countries are better able to issue domestic-currency liabilities (Lane and Milesi-Ferretti 2000, Eichengreen et al 2003).

The regressions use data from three years: 1996, 2000, and 2004. We opt to leave 4 year breaks rather than use every year because of the serial correlation of some variables and because of the overlapping nature of the 15 year windows.[16] We have 306 observations from a total of 104 countries.[17] It is worth noting that while we present evidence for the full sample

[15] While it is true that if the balance sheet is very large, risky assets could drive exchange rate volatility, the point is if the exchange rate is volatile, this may dampen a country's willingness to hold a large foreign currency portfolio.

[16] Moreover, the World Bank governance data are only available in even years and our data is complete for many countries only starting in 1996.

[17] Not all the countries in the full data set used in the decompositions have all the required covariates.

of countries, the results are strikingly similar even if exclude the set of advanced economies. We explicitly control for EMU, GDP per capita and use country fixed effects in some specifications. These techniques appear sufficient to take into account differences across the advanced, emerging, and developing samples.

We begin by reporting the results from pooled estimation of the baseline specification in column (1) of Table 4; we add the institutional and policy variables in column (2); while we alternatively add the general control variables in column (3); the full set of regressors are included in column (4). In order to isolate the time-series variation in the data, we add country fixed effects in columns (5) and (6); as an alternative (albeit with a drop in the degrees of freedom), we estimate a 'long' first-differences equation columns (7) and (8) which examines the changes in the variables between 1996 and 2004. Due to the need to have all covariates in both 1996 and 2004, we have 98 countries in the differences specifications.

5.2 Results for FX^{AGG}

5.2.1 Pooled estimation

Table 4 provides the results. In the pooled estimation with year effects (the first four columns), we see that greater trade openness is clearly associated with a more positive value of FX^{AGG}: this is true whether more extensive controls are present or not, although the estimated coefficient drops in value once additional controls are included in columns (2)–(4). A positive association between trade openness and foreign currency exposure is consistent with the notion that the role of foreign assets in portfolios is more important, the greater is the share of imports in domestic consumption (Obstfeld and Rogoff 2001).

In relation to the other variables in the baseline specification, the estimated coefficients vary in significance and sign across columns (1)–(4). In terms of significant results, the volatility of the nominal exchange rate has the expected negative sign in column (1) only. The volatility of GDP is significant only in column (4) but with a positive sign. Finally, the covariance of output and the nominal exchange rate enters with a significant positive sign in column (1), but loses significance and the sign flips when more controls are added. Accordingly, the results from the pooled estimation do not provide very stable evidence in terms of the relation between the various volatility indicators and the level of foreign-currency exposure.

Turning to the institutional and policy variables, the results in column (2) indicate that a better institutional environment is associated with a more positive value for FX^{AGG}, while the estimated coefficient on the exchange rate peg is significantly negative – however, neither capital controls nor the EMU dummy is significant in column (2).[18] However, the inclusion of GDP per capita as a control in column (4) alters these results: the only policy variable that is significant is the EMU dummy which enters with a significantly negative coefficient. Rather, the evidence from columns (3) and (4) is that FX^{AGG} is highly correlated with the level of development: richer countries have a more positive level of foreign-currency exposure. We surmise that the ability to issue domestic-currency liabilities and obtain foreign-currency assets is increasing in institutional dimensions that are highly correlated with the level of development. Finally, the estimated coefficient on country size in columns (3) and (4) is positive but not quite significant.

[18] In this specification, the EMU dummy respects any extra impact of EMU beyond its stabilising impact on the nominal effective exchange rate, which is captured by the PEG variable. It turns out that the pattern that EMU has led to a less positive foreign-currency position for euro area countries has been well timed, in that the euro has appreciated against other currencies.

Table 4

Determinants of FX^{AGG}: panel estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	YFE	YFE	YFE	YFE	CFE,YFE	CFE,YFE	Δ	Δ
Trade	0.16	0.10	0.10	0.10	0.00	0.03	0.01	0.05
	(0.04)**	(0.03)**	(0.03)**	(0.03)**	(0.07)	(0.06)	(0.10)	(0.09)
Vol(GDP)	–0.79	0.21	0.68	0.65	0.10	–0.21	0.00	–0.49
	(0.85)	(0.37)	(0.37)+	(0.36)+	(0.61)	(0.61)	(0.74)	(0.82)
Cov(GDP;E)	3.68	0.24	–1.42	–1.66	5.30	5.82	6.30	9.07
	(1.79)*	(1.44)	(1.30)	(1.26)	(3.39)	(3.55)	(2.06)**	(4.53)*
Vol( )	0.22	–0.13	–0.20	–0.26	0.77	0.61	0.91	0.76
	(0.24)	(0.21)	(0.17)	(0.17)	(0.37)*	(0.36)+	(0.40)*	(0.44)+
V ol(E)	–1.69	0.19	0.48	0.49	–1.39	–1.04	–1.77	–1.64
	(0.59)**	(0.50)	(0.47)	(0.44)	(0.72)+	(0.75)	(0.49)**	(0.77)*
Institutions		0.17		0.00		0.03		0.06
		(0.03)**		(0.05)		(0.06)		(0.09)
Capital controls		–0.05		–0.02		0.04		0.04
		(0.05)		(0.04)		(0.04)		(0.05)
Peg		–0.08		–0.03		0.03		0.06
		(0.03)*		(0.03)		(0.03)		(0.04)
EMU		–0.06		–0.14		–0.13		–0.17
		(0.05)		(0.04)**		(0.04)**		(0.04)**
GDP per capita			0.13	0.13		0.15		0.02
			(0.01)**	(0.02)**		(0.10)		(0.14)
POP			0.03	0.03		0.64		0.62
			(0.02)	(0.02)		(0.27)*		(0.29)*
y2000	0.05	0.06	0.05	0.07	0.07	0.03		
	(0.02)**	(0.02)**	(0.01)**	(0.01)**	(0.01)**	(0.02)		
y2004	0.12	0.16	0.13	0.14	0.15	0.08		
	(0.02)**	(0.02)**	(0.02)**	(0.02)**	(0.02)**	(0.04)+		
Constant	–0.20	–0.25	–1.34	–1.33	–0.18	–3.02	0.15	0.10
	(0.06)**	(0.05)**	(0.11)**	(0.21)**	(0.06)**	(1.20)*	(0.02)**	(0.05)*
Observations	306	306	306	306	306	306	99	98
R^2	0.19	0.44	0.56	0.58	0.91	0.92	0.07	0.23

Note: Standard errors clustered at the country level in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%.

To obtain a perspective on the quantitative importance of the coefficients, we can consider the magnitudes of the coefficients on trade openness, GDP per capita and the EMU dummy in column (4). In relation to trade openness, the standard deviation in the sample is 0.48, such that that a one standard deviation in trade openness would generate a move of 0.05 in FX^{AGG}. The standard deviation of the natural log of GDP per capita in the sample is 1.64, thus the coefficient on this variable implies a one standard deviation move implies a move of 0.21 in FX^{AGG}, a very substantial shift. The EMU indicator is a dummy, thus being in EMU suggests an FX^{AGG} which is 0.14 lower than for other countries, which again is a non-trivial magnitude. The results show that in simple conditional correlations, many of the country characteristics highlighted by the literature do not seem to vary with FX^{AGG} in a systematic

manner. On the other hand, models should help to explain why richer and more open countries hold longer foreign currency positions.

5.2.2 Time series variation

The time series variation in the data is captured in the regressions reported in columns (5)–(8) of Table 4. The goal is not to study the business cycle fluctuations in FX^{AGG}, since our econometric model mainly only considers observations at four year intervals have observations every four years, while the differences specifications look across an eight year gap. Rather, the goal is to better understand the longer-run determinants by studying lower-frequency shifts in FX^{AGG}. By controlling for country fixed effects, we remove unobservable country characteristics to see which of our model based determinants affects within-country shifts in FX^{AGG}. The advantage to holding fixed the cross-sectional variation in the data is that there may be non-observed country characteristics that influence the cross-country distribution of FX^{AGG} values and reduce our ability to accurately capture the impact of some of our variables of interest; the drawback is that other variables in our specification mostly show cross-sectional variation with little time-series variations and these regressors will play less role in explaining intra-country variation. Thus, a variable losing significance in these specifications does not necessarily signal omitted variable problems, but may simply represent a lack of time series variation to provide identification.

In the time series dimension, we see several new results. The most striking finding is that, once either country fixed effects are included or the data are differenced across time, the covariance term now exhibits the expected positive coefficient. Holding fixed other factors, the value of FX^{AGG} becomes more positive for those countries that have experienced an increase in the covariance between domestic output growth and the nominal exchange rate. The result is borderline insignificant in the fixed effects specifications (p-value 0.11) and significant at the 99 and 95 percent confidence levels in the differences specifications.

This result is not simply driven by a few countries. Figure 6 shows the partial scatter of changes in FX^{AGG} against changes in the covariance of the exchange rate and GDP using the regression in column (8). We see a clear pattern where those countries with increasingly positive covariance take a more positive FX^{AGG} position. Returning to the size of the effect, a one standard deviation move in the size of the change in the covariance term is 0.005.

This implies a one standard deviation shift in the change in the covariance term would come with an increase of 0.045 in FX^{AGG}. The models which predict this relationship do so for the level, not the change, but the result appears only in the time series. There is a considerable amount of cross-sectional variation that remains unexplained. Once it is controlled for with country fixed effects, we see the expected relationship.

Conversely, the trade openness result is not significant and GDP per capita weakens along the time series dimension: it is clear that these variables help to explain the cross-country variation in the data but are less useful in understanding shifts over time in the value of FX^{AGG}. In part, though, this simply reflects the slow moving nature of trade openness. Rich more open countries certainly have more positive FX^{AGG}, but GDP per capita and trade openness are fairly stable over time, and hence changes in these variables are not very helpful in explaining the changing nature of FX^{AGG}. In contrast, population growth now shows up as an important variable. The logic is twofold. Controlling for GDP per capita, a growing population suggests an economy that is growing larger. Thus, when an economy grows larger, there is a more positive FX^{AGG}. If we instead include population and GDP directly, however, population is still positive and significant, suggesting the demographics themselves may matter directly, and that models should include a role for population growth in the optimal portfolio determinants of countries.

The global shift to more positive FX^{AGG} positions documented in Lane and Shambaugh (2009) can be seen in the positive year dummies for 2000 and 2004 (1996 is the excluded dummy) in columns (1) through (5). Once we consider all controls and include country fixed effects in column (6), the year dummies are no longer significant: the regressors explain a substantial component of the shift to a more positive FX^{AGG} position. We also note that the EMU dummy is negative and significant along the time series dimension, such that the euro area countries clearly shifted towards a more negative position upon the formation of the currency union.

5.3 Results for $FXDEBT^{AGG}$

We have repeated similar regressions for the debt-only measure of exposure, $FXDEBT^{AGG}$. Table 5 reproduces the specifications in columns (1), (6) and (8) from Table 4 but with $FXDEBT^{AGG}$ as the dependent variable. The results are nearly identical to those for the overall measure. Without country fixed effects, trade openness and GDP per capita are positive and significant (with nearly the same magnitude). The only substantial difference is that the EMU dummy is cut in half and no longer significant when comparing columns (1) and (2). With the inclusion of country fixed effects, the covariance term is still positive and significant, and is in fact slightly larger. The variance of the exchange rate is negative and population is positive and significant and again the EMU dummy has a slightly smaller size, though in this case it is still statistically significant. Looking at the changes specification, the regressions for the debt measure show coefficients with a similar direction but larger size and significance.

5.4 Results for subcomponents and $NETFX$

We can learn more about the mechanisms behind both the cross-country and time-series variation in the data by examining the various subcomponents of FX^{AGG}; in addition, it is useful to also examine whether the results for FX^{AGG} carry over to $NETFX$. The limitation to this exercise is that the strong patterns of co-variation across the different subcomponents that were identified in Section 3 mean that results for FX^{AGG} may not be easily attributed to the individual subcomponents. For simplicity, we adopt a symmetric approach, whereby we maintain the same set of regressors for each subcomponent of FX^{AGG} and $NETFX$.

To conserve space, we focus on the most general specification which includes the full set of regressors. We report the pooled estimates in Table 6, while the fixed-effects results are contained in Table 7. To assist in comparing results, column (1) in Table 6 repeats column (4) from Table 4, while column (1) in Table 7 repeats column (6) from Table 4.

In relation to the pooled estimates in Table 6, a series of interesting observations arise. In relation to the two primary subcomponents of FX^{AGG}, the positive effect of GDP per capita is clearly operating via the net foreign asset position; in contrast, the EMU dummy affects the $FX^{AGG,0}$ term. At a lower level of decomposition, GDP per capita affects the non-reserve net foreign asset position; in addition, it is associated with higher values for the domestic-currency share of debt liabilities and the domestic-currency share of foreign assets. The EMU dummy has a similar relation with the domestic-currency share of debt liabilities and the domestic-currency share of foreign assets; EMU membership is also associated with a reduction in the level of reserves and a decline in the equity share of liabilities, with both of these effects acting to reduce FX^{AGG}.

Table 5

Determinants of $FXDEBT^{AGG}$

	(1) FX^{AGG}	(2) FX^{AGG} *Debt*	(3) FX^{AGG}	(4) FX^{AGG} *Debt*	(5) FX^{AGG}	(6) FX^{AGG} *Debt*
	YFE	YFE	CFE, YFE	CFE, YFE	Δ	Δ
Trade	0.10	0.15	0.03	0.00	0.05	0.05
	(0.03)**	(0.04)**	(0.06)	(0.09)	(0.09)	(0.13)
Vol(GDP)	0.65	0.87	–0.21	–0.08	–0.49	–0.28
	(0.36)+	(0.50)+	(0.61)	(0.78)	(0.82)	(1.05)
Cov(GDP;E)	–1.66	–1.35	5.82	8.53	9.07	12.29
	(1.26)	(1.87)	(3.55)	(4.81)+	(4.53)*	(6.09)*
Vol(π)	–0.26	–0.23	0.61	1.07	0.76	1.42
	(0.17)	(0.23)	(0.36)+	(0.47)*	(0.44)+	(0.60)*
Vol(E)	0.49	0.22	–1.04	–1.64	–1.64	–2.53
	(0.44)	(0.52)	(0.75)	(0.92)+	(0.77)*	(0.95)**
Institutions	0.00	–0.07	0.03	0.00	0.06	0.04
	(0.05)	(0.06)	(0.06)	(0.07)	(0.09)	(0.11)
Capital controls	–0.02	–0.02	0.04	0.07	0.04	0.08
	(0.04)	(0.06)	(0.04)	(0.05)	(0.05)	(0.07)
Peg	–0.03	–0.04	0.03	0.01	0.06	0.06
	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)	(0.06)
EMU	–0.14	–0.07	–0.13	–0.12	–0.17	–0.16
	(0.04)**	(0.06)	(0.04)**	(0.04)**	(0.04)**	(0.05)**
GDP per capita	0.13	0.14	0.15	0.15	0.02	0.00
	(0.02)**	(0.03)**	(0.10)	(0.15)	(0.14)	(0.21)
POP	0.03	0.02	0.64	0.64	0.62	0.61
	(0.02)	(0.03)	(0.27)*	(0.31)*	(0.29)*	(0.35)+
y2000	0.07	0.04	0.03	0.02		
	(0.01)**	(0.02)+	(0.02)	(0.03)		
y2004	0.14	0.12	0.08	0.09		
	(0.02)**	(0.03)**	(0.04)+	(0.05)+		
Constant	–1.33	–1.50	–3.02	–3.15	0.10	0.12
	(0.21)**	(0.27)**	(1.20)*	(1.60)+	(0.05)*	(0.07)+
Observations	306	306	306	306	98	98
R^2	0.58	0.40	0.92	0.90	0.23	0.19

Robust standard errors in parentheses. + significant at 10%; * significant at 5%; ** significant at 1% .

Table 6

Determinants of subcomponents: pooled estimates

	(1) FX^{AGG}	(2) NFA	(3) $FX^{AGG,0}$	(4) $A_{NR} - L$	(5) FXR	(6) $EQSH_L$	(7) DC_{DL}	(8) DC_{NRA}	(9) $NETFX$
Trade	0.10	0.05	0.05	0.03	0.02	0.06	–0.02	0.01	0.85
	(0.03)**	(0.03)	(0.02)+	(0.03)	(0.01)	(0.03)*	(0.01)**	(0.01)	(0.29)**
Vol(GDP)	0.65	0.53	0.13	0.41	0.12	0.12	0.07	–0.06	1.09
	(0.36)+	(0.37)	(0.18)	(0.28)	(0.15)	(0.17)	(0.05)	(0.03)+	(1.01)
Cov(GDP;E)	–1.66	–2.23	0.57	–2.77	0.54	0.62	–0.48	0.43	–3.18
	(1.26)	(1.62)	(1.09)	(1.48)+	(0.62)	(1.08)	(0.26)+	(0.20)*	(3.75)
Vol(π)	–0.26	–0.30	0.04	–0.32	0.02	0.05	–0.04	0.03	–0.38
	(0.17)	(0.23)	(0.15)	(0.20)	(0.07)	(0.15)	(0.03)	(0.02)	(0.45)
Vol(E)	0.49	0.37	0.12	0.48	–0.10	0.13	0.01	–0.02	0.93
	(0.44)	(0.61)	(0.39)	(0.53)	(0.17)	(0.38)	(0.04)	(0.03)	(1.14)
Institutions	0.00	0.00	0.00	0.01	–0.02	0.00	0.01	0.00	0.09
	(0.05)	(0.05)	(0.02)	(0.04)	(0.02)	(0.02)	(0.01)	(0.01)	(0.11)
Capital controls	–0.02	–0.01	–0.01	–0.03	0.02	–0.01	–0.02	0.02	–0.11
	(0.04)	(0.04)	(0.02)	(0.04)	(0.01)	(0.02)	(0.01)**	(0.01)**	(0.10)
Peg	–0.03	–0.03	0.00	–0.01	–0.02	0.00	0.01	0.00	0.05
	(0.03)	(0.03)	(0.02)	(0.02)	(0.01)	(0.02)	(0.004)+	(0.00)	(0.10)
EMU	–0.14	–0.01	–0.13	0.06	–0.07	–0.06	0.18	–0.25	–0.42
	(0.04)**	(0.04)	(0.05)**	(0.04)	(0.02)**	(0.03)*	(0.03)**	(0.03)**	(0.20)*
GDP per capita	0.13	0.12	0.01	0.12	0.00	0.01	0.01	–0.01	0.20
	(0.03)**	(0.03)**	(0.01)	(0.02)**	(0.01)	(0.01)	(0.003)*	(0.003)*	(0.05)**
POP	0.03	0.02	0.00	0.03	0.00	0.00	0.01	–0.01	0.13
	(0.02)	(0.02)	(0.01)	(0.01)+	(0.01)	(0.01)	(0.004)*	(0.003)**	(0.05)**
y2000	0.07	0.02	0.05	0.02	0.01	0.05	–0.01	0.01	0.07
	(0.01)**	(0.01)	(0.01)**	(0.01)	(0.01)	(0.01)**	(0.003)**	(0.003)**	(0.04)+
y2004	0.14	0.06	0.07	0.04	0.02	0.07	0.00	0.01	0.18
	(0.02)**	(0.02)**	(0.01)**	(0.02)*	(0.01)**	(0.01)**	(0.00)	(0.003)*	(0.06)**
Constant	–1.33	–1.38	0.05	–1.45	0.07	0.05	–0.04	0.04	–2.70
	(0.21)**	(0.23)**	(0.09)	(0.17)**	(0.09)	(0.09)	(0.03)	(0.02)*	(0.61)**
Observations	306	306	306	306	306	306	306	306	300
R^2	0.58	0.50	0.17	0.64	0.15	0.17	0.77	0.86	0.57

Standard errors clustered at the country level in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

The other variables that are individually significant in column (1) – trade openness, the volatility of GDP and the covariance term – are not individually significant for either the net foreign asset position or $FX^{AGG,0}$. However, at a lower level of decomposition, we see that trade openness raises the equity share in foreign liabilities but reduces the domestic-currency share in foreign debt liabilities, which act in opposite directions.[19] The volatility of GDP is only significant in raising the domestic-currency share of non-reserve foreign assets (which mechanically reduces the foreign-currency position). An increase in the covariance between GDP and the nominal exchange rate is associated with a decline in the non-reserve net foreign asset position, a reduction in the domestic-currency share of foreign debt liabilities and the domestic-currency share of non-reserve foreign assets.

[19] In different specifications, Lane and Milesi-Ferretti (2001) and Faria et al (2007) also show that trade openness is positively associated with the equity share in foreign liabilities.

Table 7

Determinants of subcomponents: fixed-effects estimates

	(1) FX^{AGG}	(2) NFA	(3) $FX^{AGG,0}$	(4) $A_{NR} - L$	(5) FXR	(6) $EQSH_L$	(7) DC_{DL}	(8) DC_{NRA}	(9) $NETFX$
Trade	0.03	–0.02	0.05	–0.02	–0.01	0.07	–0.02	0.00	0.54
	(0.06)	(0.07)	(0.05)	(0.06)	(0.02)	(0.04)	(0.01)*	(0.01)	(0.45)
Vol(GDP)	–0.21	–0.16	–0.05	0.18	–0.34	–0.08	0.03	0.00	2.77
	(0.61)	(0.62)	(0.32)	(0.57)	(0.36)	(0.33)	(0.05)	(0.03)	(1.40)+
Cov(GDP;E)	5.82	3.50	2.31	2.38	1.12	1.82	0.36	0.14	2.28
	(3.55)	(2.89)	(1.91)	(2.54)	(1.22)	(1.93)	(0.44)	(0.20)	(10.03)
Vol(π)	0.61	0.74	–0.13	0.41	0.33	–0.20	0.06	0.01	1.19
	(0.36)+	(0.33)*	(0.19)	(0.26)	(0.11)**	(0.18)	(0.04)	(0.02)	(1.03)
Vol(E)	–1.04	–0.71	–0.33	–0.40	–0.32	–0.23	–0.06	–0.05	–0.13
	(0.75)	(0.56)	(0.36)	(0.45)	(0.20)	(0.34)	(0.05)	(0.03)	(1.40)
Institutions	0.03	–0.01	0.04	–0.03	0.02	0.03	0.00	0.01	–0.08
	(0.06)	(0.06)	(0.03)	(0.05)	(0.02)	(0.03)	(0.01)	(0.01)	(0.09)
Capital controls	0.04	0.08	–0.04	0.06	0.02	–0.03	–0.01	0.00	0.03
	(0.04)	(0.04)*	(0.02)*	(0.03)+	(0.01)+	(0.02)	(0.01)	(0.00)	(0.07)
Peg	0.03	–0.02	0.05	–0.02	0.01	0.03	0.01	0.01	0.07
	(0.03)	(0.03)	(0.02)**	(0.02)	(0.02)	(0.01)*	(0.01)	(0.01)	(0.09)
EMU	–0.13	–0.04	–0.10	0.00	–0.04	–0.04	0.16	–0.21	–0.17
	(0.04)**	(0.03)	(0.03)**	(0.03)	(0.01)**	(0.02)+	(0.02)**	(0.02)**	(0.12)
GDP per capita	0.15	0.15	0.00	0.13	0.02	0.03	–0.02	–0.01	0.08
	(0.11)	(0.13)	(0.10)	(0.11)	(0.05)	(0.09)	(0.01)+	(0.02)	(0.27)
POP	0.64	0.59	0.06	0.36	0.22	0.09	–0.04	0.01	0.72
	(0.27)*	(0.27)*	(0.17)	(0.24)	(0.08)**	(0.16)	(0.03)	(0.03)	(0.56)
y2000	0.03	–0.01	0.04	0.01	–0.01	0.03	0.00	0.00	0.06
	(0.02)	(0.03)	(0.02)+	(0.02)	(0.01)	(0.02)+	(0.00)	(0.00)	(0.06)
y2004	0.08	0.02	0.06	0.02	0.00	0.05	0.02	0.00	0.18
	(0.04)+	(0.05)	(0.04)	(0.04)	(0.02)	(0.03)	(0.01)*	(0.01)	(0.10)+
Constant	–3.02	–3.04	0.01	–2.41	–0.62	–0.31	0.31	0.01	–3.30
	(1.20)*	(1.48)*	(1.12)	(1.26)+	(0.49)	(1.03)	(0.16)+	(0.21)	(3.01)
Observations	306	306	306	306	306	306	306	306	300
R^2	0.92	0.92	0.87	0.94	0.85	0.87	0.95	0.97	0.93

Standard errors clustered at the country level in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

The main impact of the institutional/policy variables is seen in columns (7) and (8), which show that capital controls are associated with a reduction in the domestic-currency share of foreign debt liabilities and the domestic-currency share of non-reserve foreign assets, while an exchange rate peg raises the domestic-currency share in foreign debt liabilities. Larger countries have more positive non-reserve net foreign asset positions and a higher domestic-currency share in foreign debt liabilities and non-reserve foreign assets. The pattern that country size is positively associated with a higher domestic-currency share in foreign debt liabilities is consistent with the evidence of Eichengreen et al (2005), who find that original sin is more prevalent for smaller countries.

Turning to the fixed-effects estimates in Table 7, the positive association between the covariance term and FX^{AGG} in column (1) cannot be traced to individual components in columns (2)–(8): although it carries the expected sign for each component (with the exception of the domestic-currency share in non-reserve foreign assets), none of these effects are individually significant. In results not reported, we also ran the first-difference specification as in column (8) of Table 4 and found that the covariance term has a positive coefficient in regressions for both the net foreign asset position and $FX^{AGG,0}$ but it is larger and statistically significant in the latter case.

The pattern for the EMU dummy is very similar to the pooled estimates, with the exception that it is not significant for the equity share in foreign liabilities once country fixed effects are introduced. The positive time-series association between population growth and FX^{AGG} in column (1) is shown to operate via both the reserve and non-reserve components of the net foreign asset position but does not affect $FX^{AGG,0}$ or its subcomponents.

With regard to the variables that are not individually significant in the FX^{AGG} regression in column (1), several turn out to be significant in regressions for particular subcomponents. While the pattern of time-series results for trade openness is qualitatively similar to the pooled estimates, different patterns obtain for the capital controls and exchange rate peg variables. In particular, capital account liberalization is associated with an increase in the net foreign asset position but an offsetting decline in $FX^{AGG,0}$, while moving from a float to a peg is associated with an increase in $FX^{AGG,0}$.

Finally, column (9) in Tables 6 and 7 report the regression results in explaining $NETFX$. The $NETFX$ estimates are broadly similar to those for FX^{AGG} but with some exceptions. In particular, the volatility and covariance terms do not show up as significant in the pooled estimates for $NETFX$, while country size is significant. Along the time series dimension, only the volatility of GDP is individually significant for $NETFX$ but it was not for FX^{AGG} .

6. Summary of stylised facts

Our empirical analysis provides a number of stylised facts regarding the foreign currency exposure of the external balance sheet. From the decompositions, we learn a number of important facts. First, the net foreign asset position of a country is the critical driving component of its aggregate foreign currency exposure. Beyond that, the non-reserve portion of the balance sheet seems to determine the NFA position with the exception of some developing countries. Within the currency composition, the leading factor is the equity share of liabilities. Less than being able to issue debt in ones currency, it is the share of liabilities that are in equity and FDI that determines the currency position.

The panel analysis of FX^{AGG} also provides interesting insights. Richer countries that trade more are more likely to be long in foreign currency, while euro area countries are (controlling for other factors) more likely to be short foreign currency. In the time series, some key findings include an observed increase in the propensity to depreciate during bad times associated with a longer foreign currency position, while an increase in exchange rate volatility is associated with a move to a shorter position.

7. Conclusions

Advances in the theoretical modelling of optimal portfolio allocations have enriched our understanding of the potential risk sharing across countries but also raised questions regarding how country portfolios are actually structured. This paper builds on the data set

developed Lane and Shambaugh (2009) in order to generate a new set of stylised facts regarding the determinants of the aggregate foreign currency exposure embedded in external positions.

In addition, our regression analysis reveals some covariation patterns in the data that may be helpful in evaluating this new set of models. We believe the project generates a number of stylised facts that are both important in their own right and also of interest to the growing theoretical literature. We highlight that the net foreign asset position plays a key role in determining aggregate foreign-currency exposure: looking only at the currency composition of foreign assets and foreign liabilities misses the fact that the dominant factor for many countries is simply the net balance between foreign assets and foreign liabilities. Still, composition plays a role but the equity share in foreign liabilities is quantitatively more important than whether foreign debt liabilities are denominated in domestic currency or foreign currency. Moreover, the pattern is that many of those countries that issue domestic-currency foreign debt liabilities are also significant holders of domestic-currency foreign assets, such that the net impact on aggregate foreign currency exposure is limited.

In our pooled regression analysis with year fixed effects, we find that country characteristics such as trade openness and GDP per capita are helpful in explaining the cross-country variation in FX^{AGG}. However, there is considerable unexplained variation along the cross-sectional dimension, which may help explain why the volatility and covariance measures suggested in the theoretical literature are either weak or incorrectly signed. Once we eliminate the cross-sectional variation by including country fixed effects, we obtain more support for the theoretical priors. Most notably, we find that an increase in the propensity for a currency to depreciate during bad times is associated with a more positive value for FX^{AGG}, such that a long position in foreign currencies helps to hedge against domestic output fluctuations. Our final contribution is to show that there is substantial heterogeneity in the roles of each regressor in explaining the variation in individual subcomponents of FX^{AGG}. Accordingly, in assessing hypotheses about the determinants of foreign-currency exposures, it is important to take a broad perspective rather than examining individual components in isolation.

References

Chinn, M, and H Ito (2008): “A new measure of financial openness”, *Journal of Comparative Policy Analysis*, vol 10(3), pp 309–322.

Coeurdacier, N, R Kollmann and P Martin (2009): “International portfolios with supply, demand and redistributive shocks”, in *NBER International Seminar on Macroeconomics 4*, pp 231–263.

Davis, S, K Nalewaik and P Willen (2001): “On the gains to trade in risky financial assets”, mimeo, University of Chicago.

Devereux, M B and A Sutherland (2009a): “Solving for country portfolios in open-economy macro models”, *Journal of European Economic Association*, forthcoming.

Devereux, M B and A Sutherland (2009b): “Country portfolio dynamics”, mimeo, University of British Columbia.

Devereux, M B and M Saito (2007): “A portfolio theory of international capital flows”, mimeo, University of British Columbia.

Di Giovanni, J and J C Shambaugh (2008): “The impact of foreign interest rates on the economy: The role of the exchange rate regime”, *Journal of International Economics*, vol 74, pp 341–361.

Edwards, S (2007): “Capital controls, capital flow contractions, and macroeconomic vulnerability”, *Journal of International Money and Finance*, vol 26, pp 814–840.

Eichengreen, B, R Hausmann and U Panizza (2005): “The mystery of original sin”, in: B Eichengreen and R Hausmann (eds), *Other people’s money: Debt denomination and financial instability in emerging market economies*, University of Chicago Press.

Engel, C and A Matsumoto (2008): “The international diversification puzzle when goods prices are sticky: It’s really about exchange-rate hedging, not equity portfolios”, *American Economic Journal: Macroeconomics*, forthcoming.

Kim, S (2002): “Nominal revaluation of cross-border assets, terms-of-trade changes, international portfolio diversification, and international risk sharing”, *Southern Economic Journal*, vol 69, pp 327–344.

Lane, P R and G M Milesi-Ferretti (2001): “ External capital structure: Theory and evidence”, in: H Siebert (ed), *The world’s new financial landscape: challenges for economic policy*, Springer-Verlag, pp 247–284.

Lane, P R and G M Milesi-Ferretti (2007): “The external wealth of nations mark II”, *Journal of International Economics*, vol 73, pp 223–250.

Lane, P R and J C Shambaugh (2009): “Financial exchange rates and international currency exposures”, *American Economic Review*, forthcoming.

Obstfeld, M and K S Rogoff (2001): “The six major puzzles in international macroeconomics: Is there a common cause?”, *NBER Macroeconomics Annual 15*, pp 339–390.

Pavlova, A and R Rigobon (2007): “Asset prices and exchange rates”, *Review of Financial Studies*, vol 20(4), pp 1139-1181.

Shambaugh, J C (2004): “The effect of fixed exchange rates on monetary policy”, *Quarterly Journal of Economics*, vol 119, pp 301–352.

Tille, C and E van Wincoop (2007): “International capital flows“, *NBER working paper* no 12856.

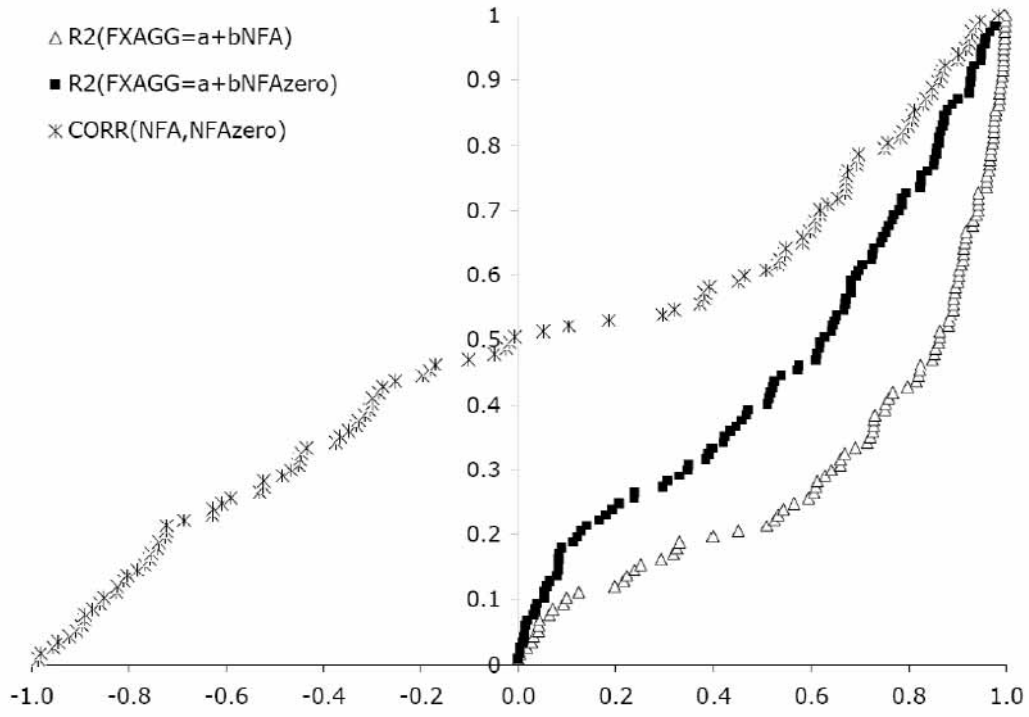


Figure 1: Decomposition $FX^{AGG} = NFA + FX^{AGG,0}$. Cross-country distribution of statistics.

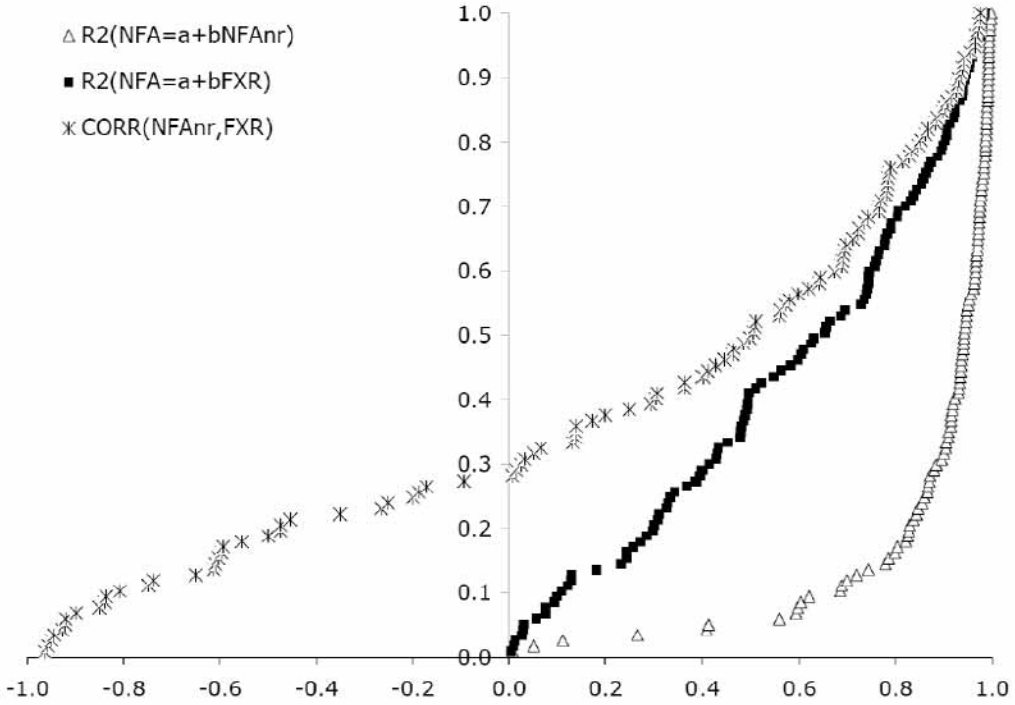


Figure 2: Decomposition of $NFA = NFA_{NR} + FXR$. Cross-country distribution of statistics.

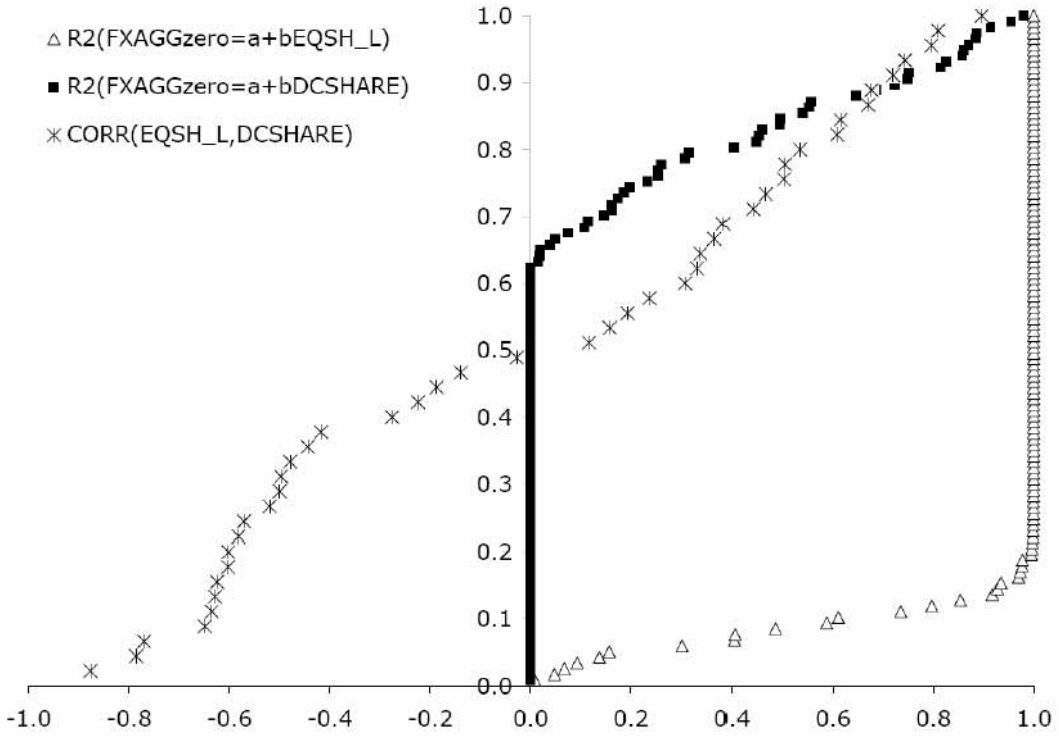


Figure 3: Decomposition $FX^{AGG,0} = EQSH_L + DCSHARE$. Cross-country distribution of statistics.

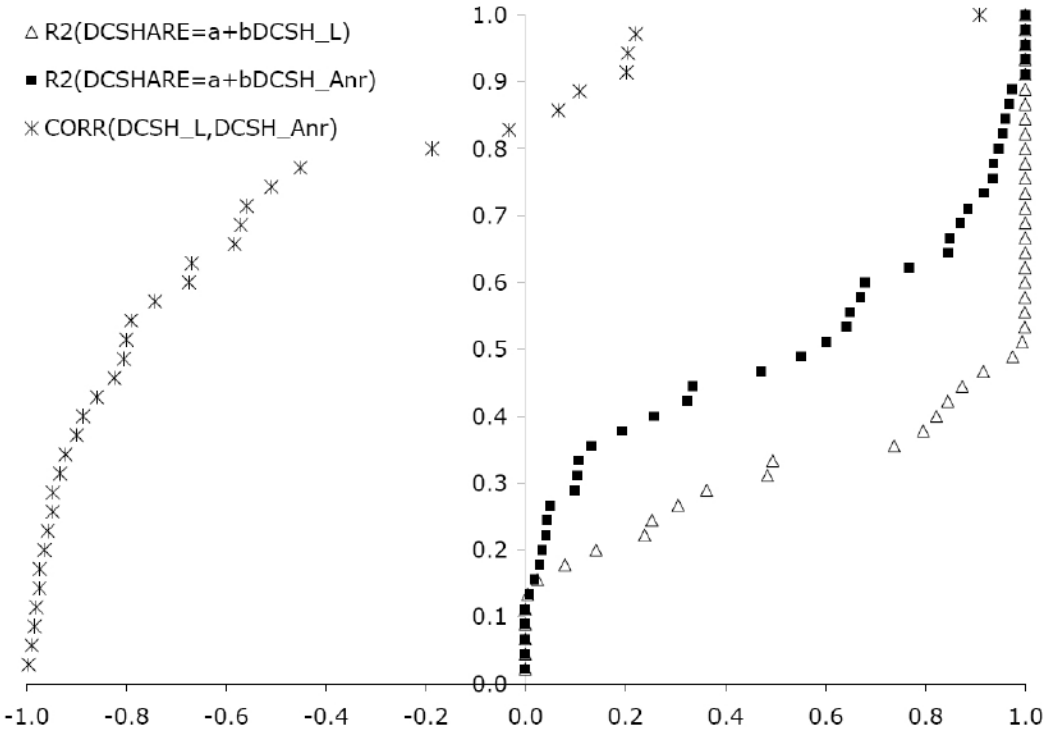


Figure 4: Decomposition of $DCSHARE = DEBTL^{DC} - A^{DC}_{NR}$. Cross-country distribution of statistics.

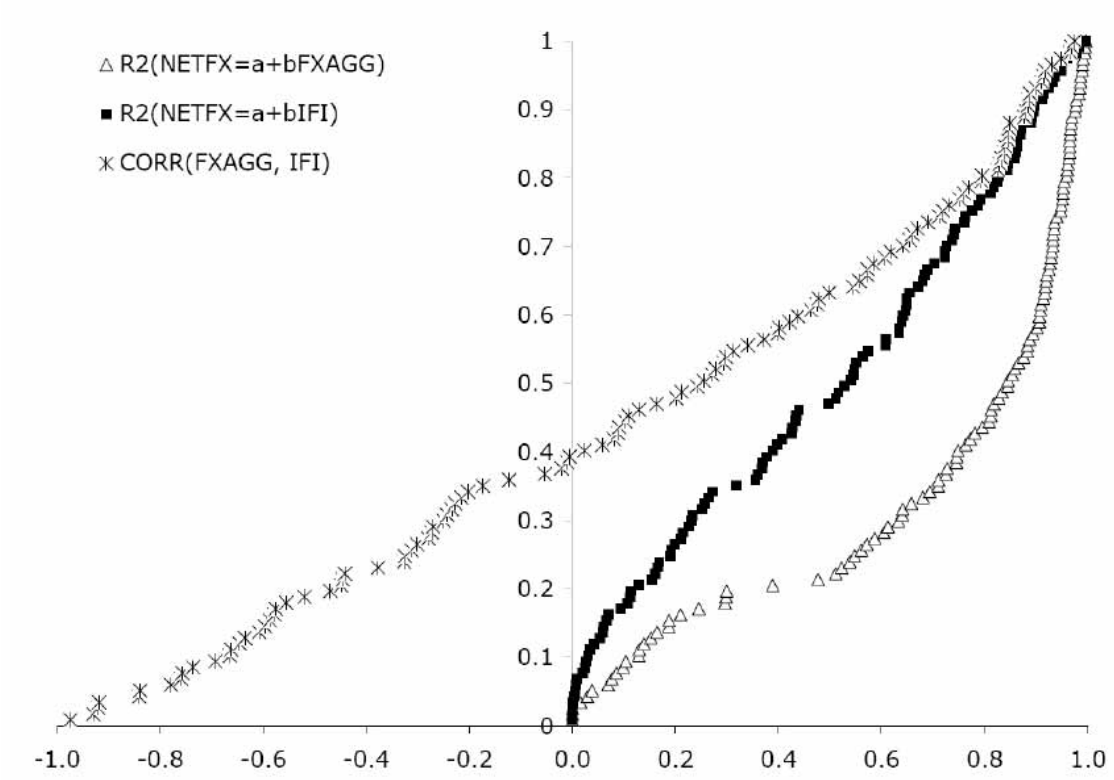


Figure 5: Decomposition of $NETFX = FX^{AGG} * IFI$. Cross-country distribution of statistics.

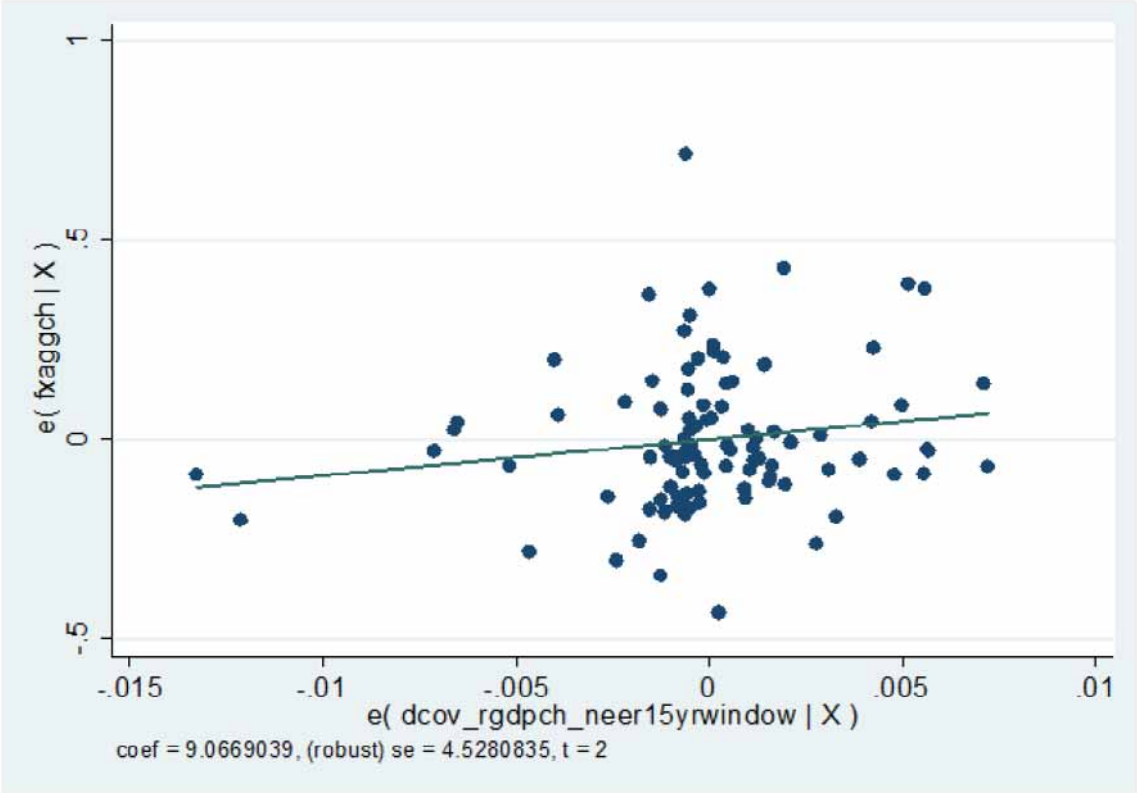


Figure 6: Scatter of Partial Relation between $\Delta COV(GDP, NEER)$ and ΔFX^{AGG}.

The US dollar shortage in global banking[1]

Patrick McGuire and Goetz von Peter

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

JEL Classification: F34, G01, G21

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

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

Global banking activity had grown remarkably between 2000 and mid-2007. As banks' balance sheets expanded, so did their appetite for foreign currency assets, notably US dollar-denominated claims on non-bank entities, reflecting in part the rapid pace of financial innovation during this period. European banks, in particular, experienced the most pronounced growth in foreign claims relative to underlying measures of economic activity.

We explore the consequences of this expansion for banks' financing needs. In a first step, we break down banks' assets and liabilities by currency to examine *cross-currency funding*, or the extent to which banks fund in one currency and invest in another (via FX swaps). After 2000, some banking systems took on increasingly large net on-balance sheet positions in foreign currencies, particularly in US dollars. While the associated currency exposures were

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

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

presumably hedged off-balance sheet, the build-up of large net US dollar positions exposed these banks to *funding risk*, or the risk that their funding positions could not be rolled over.

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

The long and short of banks' global balance sheets

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

While not at the level of individual banks, the BIS international banking statistics can be used to reconstruct the global balance sheet positions for specific national banking systems.[4] Details on how this is done are provided in the box on page ●. The advantages of this data compilation are that it provides (1) the consolidated foreign assets *and* liabilities for each banking system, (2) estimates of the gross and net positions *by currency*, and (3) information on the sources of financing (ie interbank market, non-bank counterparties and central banks). The data cover the Q2 1999 – Q3 2008 period at a quarterly frequency. While this dataset facilitates an analysis of banks' funding patterns, it is important to emphasise that the figures presented here are, at best, estimates. They provide an incomplete picture of the structure of any particular banking system, and in places are based on imperfect underlying data (see box).

Banks' global expansion

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

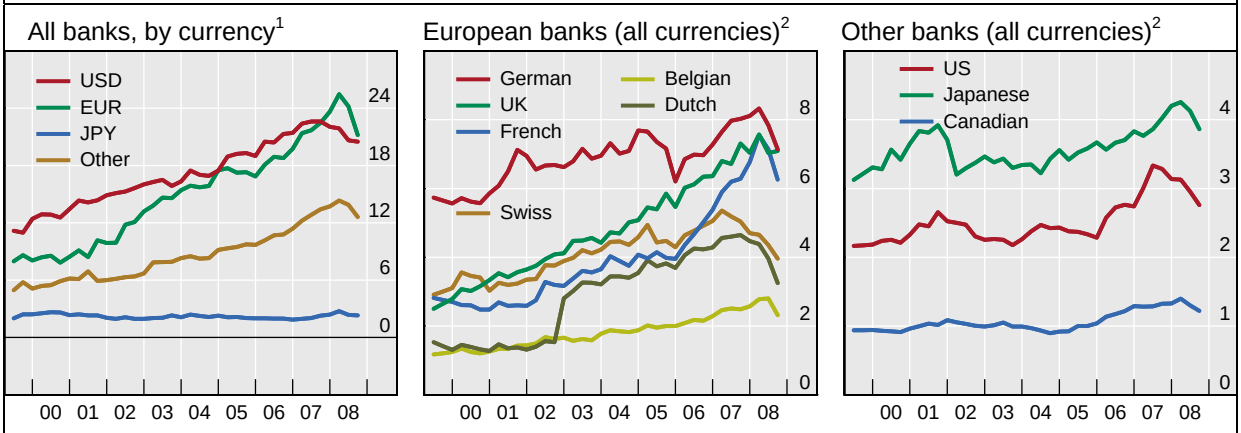
---

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

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

Foreign claims scaled by world GDP

In per cent



[1] Estimated totals for 19 banking systems (see box). [2] Foreign claims excluding claims on residents of the home country booked by banks' foreign offices.

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

Graph 1

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

Banks' foreign currency positions

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

This section examines *cross-currency* funding, or the extent to which banks invest in one currency and fund in another. This requires a breakdown by currency of banks' gross foreign positions, as shown in Graph 2, where positive (negative) positions represent foreign claims (liabilities). For some European banking systems, foreign claims are primarily denominated in

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

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

the home country (or "domestic") currency, representing intra-euro area cross-border positions (eg Belgian, Dutch, French and German banks). For others (eg Japanese, Swiss and UK banks), foreign claims are predominantly in foreign currencies, mainly US dollars.

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

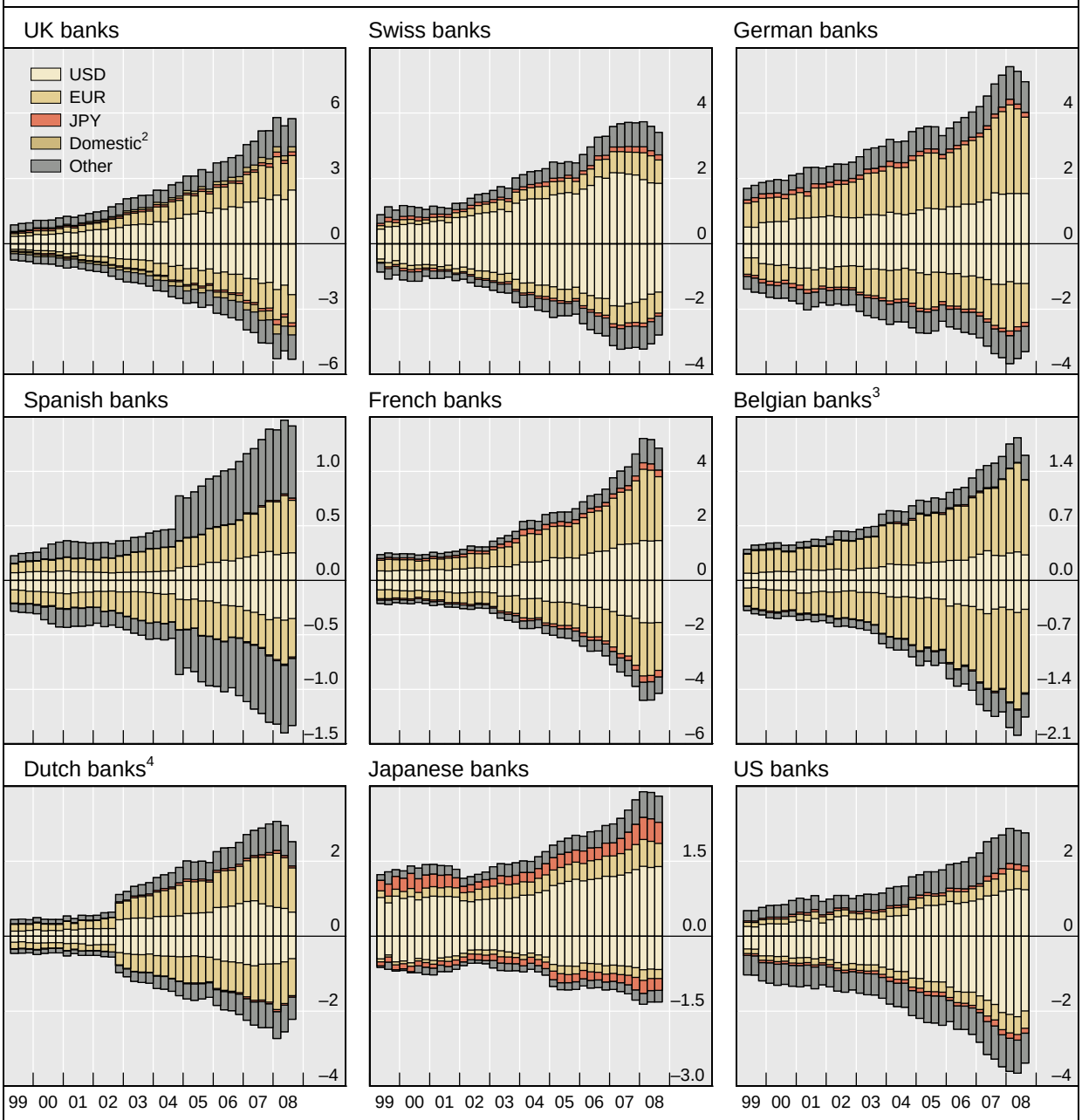
Similarly, German and Swiss banks' net US dollar books approached $300 billion by mid-2007, while that of Dutch banks surpassed $150 billion. In comparison, Belgian and French banks maintained a relatively neutral overall US dollar position prior to the crisis, while Spanish banks had borrowed US dollars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

Taken together, Graphs 2 and 3 thus show that several European banking systems expanded their long US dollar positions significantly after 2000, and funded them primarily by borrowing in their domestic currency from home country residents. This is consistent with European universal banks using their retail banking arms to fund the expansion of investment banking activities, which have a large dollar component and are concentrated in major financial centres. In aggregate, European banks' combined long US dollar positions grew to more than $800 billion by mid-2007 (Graph 5, top left-hand panel), funded by short positions in pounds sterling, euros and Swiss francs. As banks' cross-currency funding grew, so did their hedging requirements and FX swap transactions, which are subject to funding risk when these contracts have to be rolled over.

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

Gross foreign assets and liabilities, by currency[1]

In trillions of US dollars

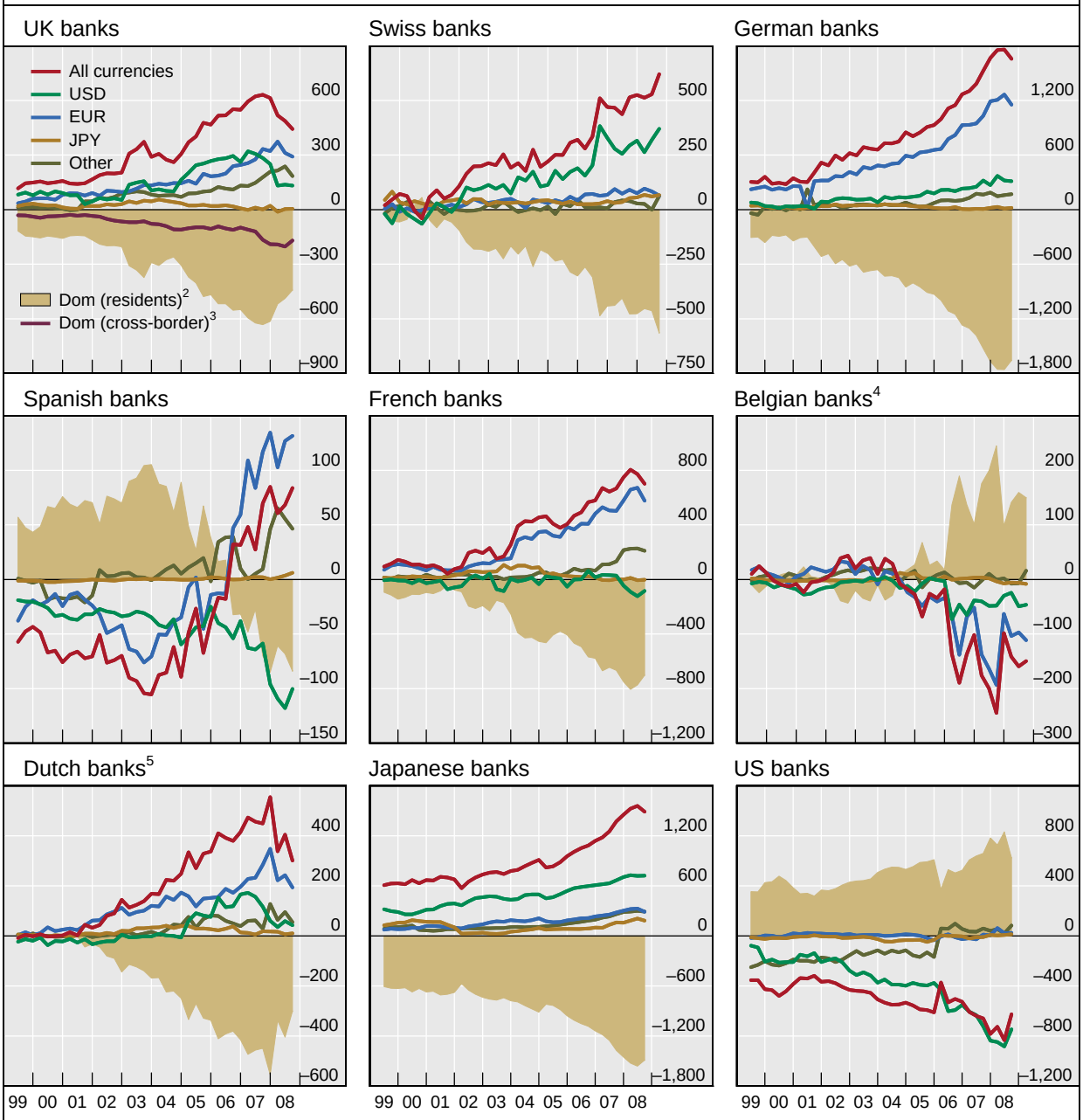


[1] Positive (negative) values are assets (liabilities). [2] For UK banks, gross positions in domestic currency booked by these banks' home offices. [3] Prior to Q4 2005, local liabilities in local currency (LLLC) vis-à-vis some large European countries are estimated. [4] Local positions (LCLC and LLLC)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

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

Net foreign positions, by currency[1]

In billions of US dollars



[1] Net foreign positions are assets minus liabilities. [2] Implied net positions in domestic currency vis-à-vis residents of the home country, inferred from the balance sheet identity (see box). [3] For UK banks, net cross-border positions in domestic currency booked by these banks' home offices. [4] Prior to Q4 2005, local liabilities in local currency (LLLC) vis-à-vis some large European countries are estimated. [5] Local positions (LCLC and LLLC) vis-à-vis advanced economies are available from Q4 2002. The contraction in positions in Q3 2008 in part reflects the sale of some business units of ABN AMRO.

Sources: BIS consolidated statistics (immediate borrower basis); BIS locational statistics by nationality; authors' calculations. Graph 3

Maturity transformation across banks' balance sheets

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

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

These US dollar investments are funded by liabilities to various counterparties. Banks can borrow US dollars directly from the interbank market. They also raise US dollars via FX swaps (with bank or non-bank counterparties), which are even shorter-term on average.[10] In contrast, US dollar funding provided directly by non-banks includes corporate and retail deposits, as well as financing from money market funds, and is thus of varying maturities. If banks' liabilities to non-banks were *all* short-term, then an upper-bound estimate of banks' US dollar funding gap is their *gross* US dollar investment position in non-banks. If, on the other hand, the effective maturity of liabilities to non-banks matches that of their investments in non-banks, then a lower-bound estimate of their funding gap is the *net* position vis-à-vis non-banks. Below we focus on this latter measure.

As shown in Graph 4, there is considerable heterogeneity in the way European banks met their US dollar funding requirements. For example, Dutch, German, Swiss and UK banks had the largest funding gaps by mid-2007 (green line). However, their reliance on the interbank market (blue line), central bank deposits (red line) and FX swaps (shaded area) differed

---

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

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

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

markedly.[11] UK banks maintained largely balanced net interbank US dollar positions, thus implying cross-currency funding, while German banks relied relatively more on interbank funding.

Taken together, these estimates suggest that European banks' US dollar investments in non-banks were subject to considerable funding risk. The net US dollar book, aggregated across the major European banking systems, is portrayed in Graph 5 (bottom left-hand panel), with the non-bank component tracked by the green line. By this measure, the major European banks' US dollar funding gap reached $1.1–1.3 trillion by mid-2007.[12] Until the onset of the crisis, European banks had met this need by tapping the interbank market ($400 billion) and by borrowing from central banks ($380 billion),[13] and used FX swaps ($800 billion) to convert (primarily) domestic currency funding into dollars.

The funding patterns for Japanese and US banks in Graph 4 deserve comment as well. Japanese banks' estimated net US dollar claims on non-banks rose beyond $600 billion by end-2007 and, compared with other banking systems, were skewed towards holdings of US government securities.[14] Japanese banks financed these holdings primarily by borrowing in yen from Japanese residents, although incomplete reporting of liabilities to official monetary authorities makes it difficult to pin these figures down precisely (see footnote 13).

In contrast to Japanese banks, the data show that US banks borrowed roughly $800 billion internationally by end-2007, and channelled these funds to US residents (as implied by the shaded area in Graph 3). A closer look at the underlying data suggests that a large portion of their international liabilities to non-banks were booked by their offices in Caribbean offshore centres as liabilities to non-bank counterparties *located in* the United States (eg firms or money market mutual funds). This could be regarded as an extension of US banks' domestic activity since it does not reflect (direct) funding from non-banks outside the United States. Netting these positions would imply that their US dollar net borrowing from non-banks in the rest of the world is smaller than the green line in Graph 4 suggests (roughly $500 billion at end-2007).

---

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

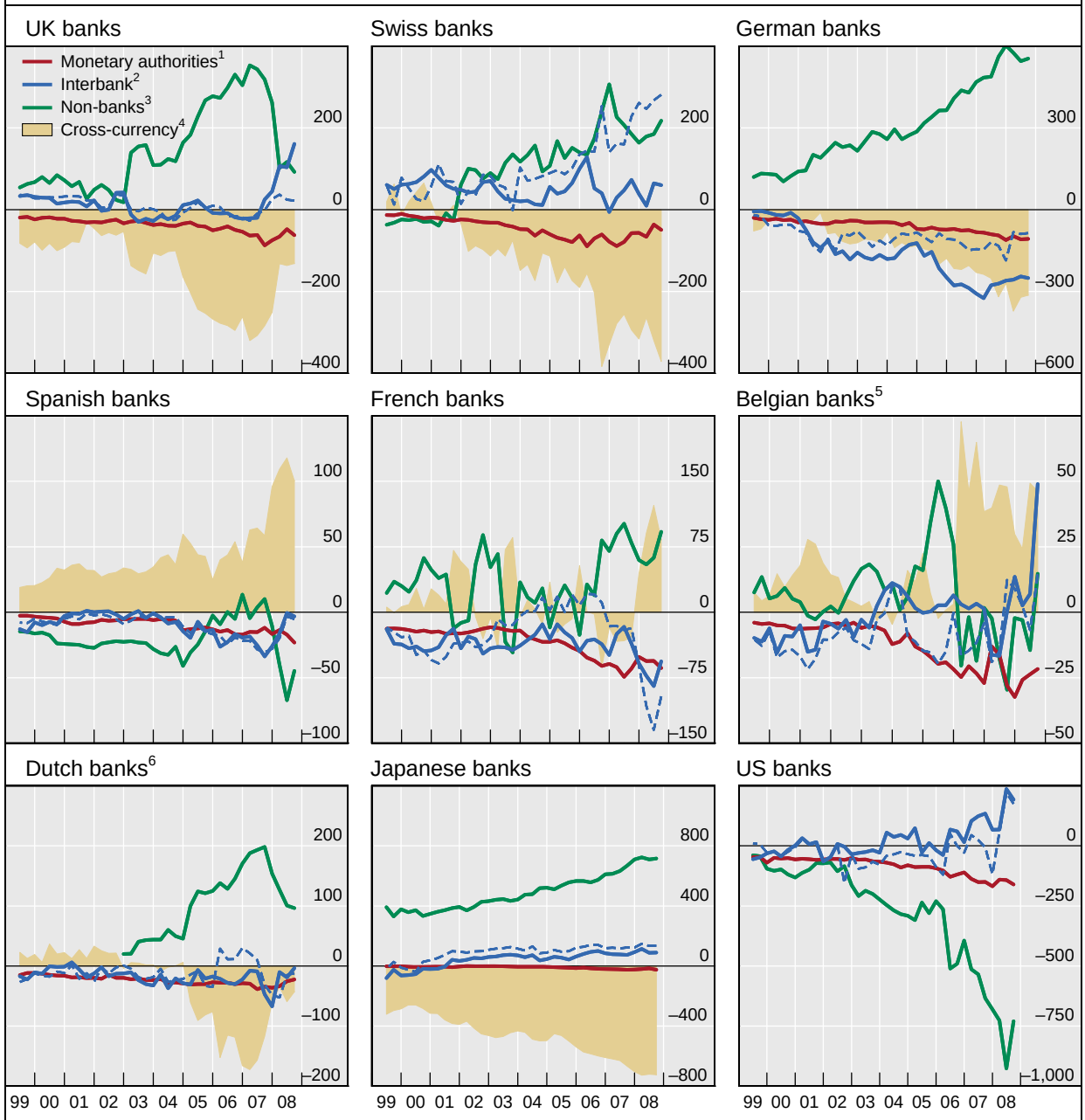
[12] If we assume that European banks' estimated liabilities to money market funds (roughly $1 trillion; see Baba et al in this issue) are also short-term liabilities, then the estimate would be $2.1–2.3 trillion. Were *all* liabilities to non-banks treated as short-term funding, the upper-bound estimate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

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

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

Net US dollar-denominated foreign positions, by counterparty sector

In billions of US dollars



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

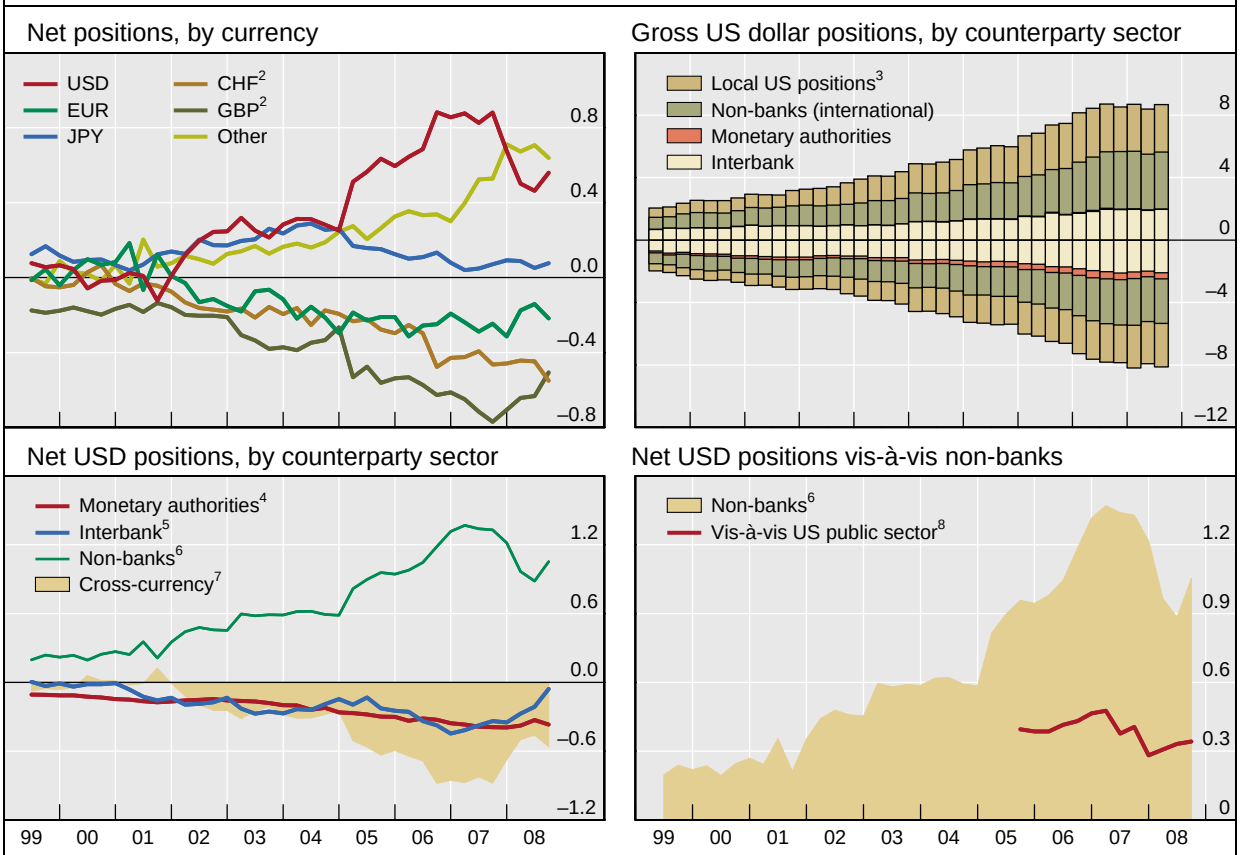
Sources: BIS consolidated statistics (immediate borrower basis); BIS locational statistics by nationality; authors' calculations. Graph 4

The shortage of US dollars

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

European banks' balance sheet positions[1]

In trillions of US dollars



[1] Estimates are constructed by aggregating the on-balance sheet cross-border and local positions reported by Belgian, Dutch, French, German, Italian, Spanish, Swiss and UK banks' offices. [2] Positions booked by offices located in Switzerland (for CHF) and in the United Kingdom (for GBP). CHF and GBP positions reported by offices located elsewhere are included in "Other". [3] US dollar positions vis-à-vis US residents booked by banks' offices in the United States (LCLC and LLLC). No sectoral breakdown is available for these positions. [4] Cross-border positions in all currencies and local positions in foreign currencies vis-à-vis official monetary authorities. Excluding liabilities to Japanese monetary authorities placed in banks located in Japan. [5] The blue line tracks estimated net interbank lending to other (unaffiliated) banks. [6] The net position vis-à-vis non-banks is estimated as the sum of net international positions vis-à-vis non-banks and net local US positions (vis-à-vis all sectors). [7] Implied cross-currency funding which equates gross US dollar assets and liabilities. [8] Consolidated *gross* claims (ultimate risk basis) on the US public sector.

Sources: BIS consolidated statistics (immediate borrower and ultimate risk basis); BIS locational statistics by nationality; authors' calculations. Graph 5

European banks' funding pressures were compounded by instability in the *non-bank* sources of funds on which they had come to rely. Dollar money market funds, facing large redemptions following the failure of Lehman Brothers, withdrew from bank-issued paper,

threatening a wholesale run on banks (see Baba et al in this issue). Less abruptly, a portion of the US dollar foreign exchange reserves that central banks had placed with commercial banks was withdrawn during the course of the crisis.[15] In particular, some monetary authorities in emerging markets reportedly withdrew placements in support of their own banking systems in need of US dollars.

Market conditions made it difficult for banks to respond to these funding pressures by reducing their US dollar assets. While European banks held a sizeable share of their net US dollar investments as (liquid) US government securities (Graph 5, bottom right-hand panel), other claims on non-bank entities – such as structured finance products – were harder to sell into illiquid markets without realising large losses.[16] Other factors also hampered deleveraging of US dollar assets: prearranged credit commitments were drawn, and banks brought off-balance sheet vehicles back onto their balance sheets.[17] Indeed, as shown in Graph 5 (top right-hand panel), the estimated outstanding stock of European banks' US dollar claims actually rose slightly (by $235 billion or 3%) between Q2 2007 and Q3 2008.[18]

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

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

---

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

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

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

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

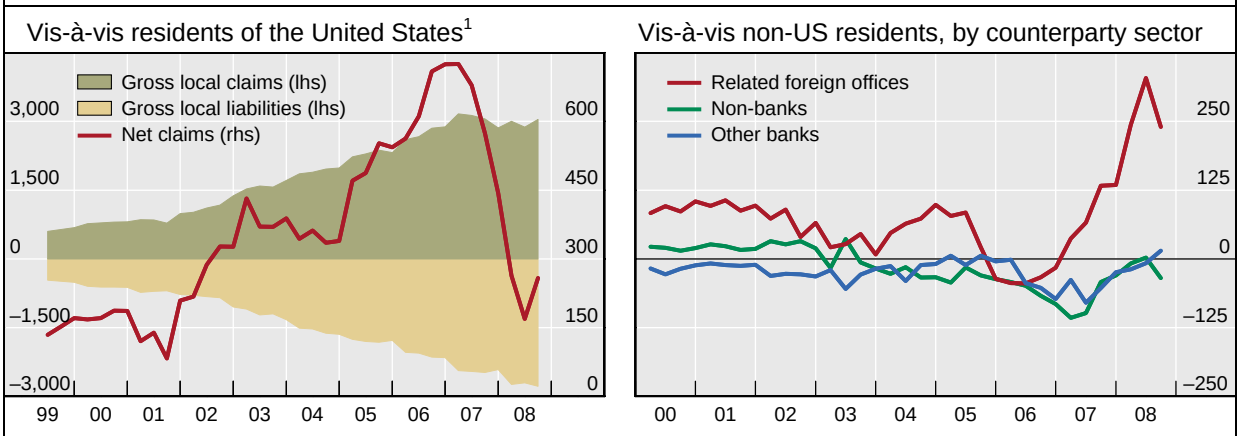
[19] European banks, through their US offices, can borrow against collateral from the Federal Reserve facilities available to depository institutions. A number of European banks have access to additional facilities in their capacity as primary dealers.

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

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

US dollar positions of European banks' US offices

In billions



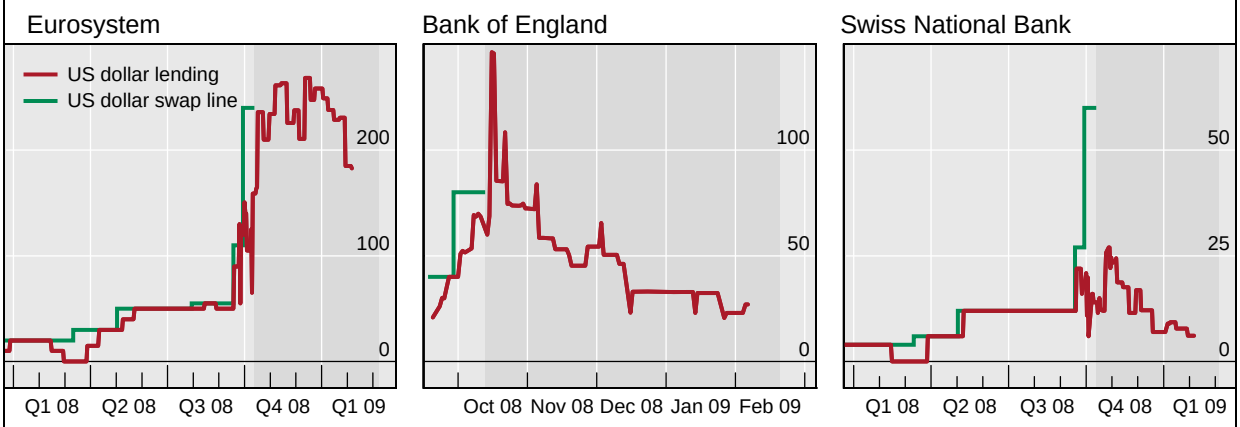
[1] Vis-à-vis counterparties in all sectors.

Sources: BIS consolidated banking statistics (ultimate risk basis); BIS locational banking statistics by nationality. Graph 6

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

Central banks' US dollar swap lines[1]

In billions



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

Source: Central banks. Graph 7

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

Concluding remarks

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

References

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

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

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

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

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

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

Reconstructing banks' global balance sheets

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

The BIS banking statistics

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

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

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

In contrast to the CBS data, the LBSN are collected on the principle of bank *residence*. The "reporting unit" in the LBSN is any bank office (head office, branch or subsidiary) in a particular country or jurisdiction – including major offshore financial centres. Each bank office reports its cross-border (XB) claims *and* liabilities, as well as foreign currency claims and liabilities vis-à-vis residents of that country. Importantly, these positions are broken down by *bank nationality* (ie the parent country of the booking office), as well as by *currency* and counterparty sector.[①] For instance, $XBC^{\$}_{rb}$ represents US dollar cross-border claims booked in reporting country *r* by banks headquartered in parent country *b*. The LBSN, unlike the CBS, do not record the residency of the counterparty, nor the local claims and liabilities (ie vis-à-vis residents) in the domestic currency of the reporting country (LCLC and LLLC).

Construction of the dataset

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

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

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

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

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

A breakdown of banks' consolidated worldwide positions

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

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

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

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

Consistency check and data limitations

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

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

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

In practice, some statistical discrepancies arise because the two sets of statistics are collected in fundamentally different ways. For many banking systems (Belgian, Canadian, Dutch, French, German, Italian, Spanish and UK banks) the match is fairly close. The match is not as satisfactory for Swiss and US banks. Discrepancies arise for three main reasons. First, the set of reporting banks in the CBS differs from that reporting LBSN in various reporting countries.[②] Second, some banking in the CBS differs from that reporting LBSN in various reporting countries.[②] Second, some banking systems have offices in countries that do not report in the LBSN, yet those offices are included in the worldwide consolidated positions reported in the CBS. In addition, some countries report incomplete positions in the LBSN; the United States, for example, does not report foreign currency positions vis-à-vis US residents.

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

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

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

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

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

---

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

Networking financial centres: What BIS international financial statistics tell us[1]

Carmela Iazzetta and Michele Manna[2]

Abstract

This paper deals with the trading in deposits across the national banking systems surveyed in the BIS quarterly banking statistics, from 2000 to 2008. The size of the market on cross-border euro-denominated deposits has overtaken the dollar's, at least as from 2007. While ranks between the two leading currencies are inverted if the deposits between countries that have joined the euro area are netted out, the gap is shrinking over time, from roughly 40% in mid-2000 to 10% in mid-2008. However, the recourse to topological concepts applied to this market seen as a network highlights a different pattern of leadership: the trading in euro-deposits is still mostly centred on euro-area based banks, while the US dollar stands out as a more global currency which is frequently exchanged without the intermediation of US-based banks. As a summary measure, the US banking system does not need to be as close to the centre of the network of the dollar-denominated deposits, as the euro area system is with respect to the euro ones. Based on such criteria, among the other three currencies we examined, the Swiss Franc stands out as a more international currency than the British Pound and the Japanese yen.

JEL Classification: F30, G15, G21

Keywords: networks, financial centres, international role of currencies, interbank deposits

1. Introduction

Recent developments in key segments have added strength to the claim that in financial markets "too big" is not necessarily the same thing as "too interconnected". To mention two examples, since 2007 a number of central banks have acted as lender of last resort, mainly with a view to preventing embattled but central-to-the-market illiquid banks to spread their troubles wide; as to the CDS, in the United States a number of big players have agreed that a clearing center was needed, as a way to making their interlinkages a bit less strong.

In business, being interconnected has to do with size as well with the number and nature of your counterparts. Not only you need an adequate number of them, but in turn they should be reasonably well diversified and connected with important partners, so that through the resulting web of direct and indirect links you cover the most part of the financial system. Network topology offers the instruments to measure how units defining a network are connected and how the object of the network (be that the exchange of deposits, information, etc) is transferred from one unit, we call it a node, to the next. It also crucially yields

---

[1] The views expressed in this paper are our own responsibility and do not necessarily reflect those of Bank of Italy. While the paper is the outcome of a joint effort by the two authors, Carmela Iazzetta worked in particular on sections 3, 5.1 and 5.2 while Michele Manna on sections 2, 4 and 5.3. We owe a big thank to Rita Muccitelli who helped us in compiling the original dataset.

[2] Both authors: Bank of Italy, via Nazionale 91, 00184 Rome, Italy. emails: michele.manna@bancaditalia.it and carmela.iazzetta@bancaditalia.it.

measures of how central each node is to the network and how thinner would the network become if a given node is removed. Closely related, it informs on the distance between pairs of nodes and how frequently a node intermediates others.

What observed above about size and connection is by no means specific to financial markets, and the difference between rank and leadership in a working place is just one of many comparable examples. This boils down to the fact that network topology is an established research in many fields, ranging from biology to physics, from sociology to IT sciences; as a measure of this success, in his survey Newman (2003) covers 429 papers. Even if relatively new to finance – although not unknown and examples include Müller (2003), Soramäki et al (2006) and von Peter (2007) – this offers us a battery of well-known results and test to deploy.

In this paper we apply a number of concepts and measures of network topology onto a dataset compiled with end-quarter outstanding stocks of deposits exchanged by banking systems worldwide, sourced from BIS banking statistics. Deposits are broken down according to their currency of denomination; notably, we will track all five major currencies surveyed in BIS statistics, that is the US dollar (USD), the euro (EUR), the Japanese yen (JPY), the British pound (GBP) and the Swiss franc (CHF). All amounts are reported in dollars and are thus directly comparable. For reasons that will become clear below, for each currency and each data point we will consider three different matrices. As to the time dimension, we selected the observations of second quarter 2000 – as a rule, we avoided year-end data to prevent possible window dressing effects –, same time of the years 2004, 2007 and 2008 as well as the fourth quarter of 2008 (latest available observation at the time of writing). This makes a total of 75 matrices of data on interbank deposits.

Our inquiry is aimed at three objectives. A first goal is about examining the microstructure (if this is the right word when the individual agent is the whole banking system of a country) of each section of the market, by looking separately at the five selected currencies separately. To offer an intuition of the results the application of topology may offer on this type of data, we may verify what is the distance between two banking systems A and B, ie how many other banking systems they need as intermediary to shuttle a deposit from A to A (or vice versa).[3] Or, which banking system is more central to the whole network, in the sense that it holds the shortest average distance to all other $n-1$ systems.

Incidentally, studies on the lending relationships between banks or more generally financial intermediaries have more commonly focused on the chain reaction set in motion by the default of a first participant and the ensuing effects due to credit losses suffered, in part or in full, by the lenders of the defaulted party. Here, we shift the approach by looking at the whole matrix of interbank deposits, both from the point of view of the lender and of the borrower; this is not unusual in topological analyses where it is often not even kept track of the side providing the input (in our case, lending the deposit) and the one receiving it. In economic terms, this adds to the credit risk mentioned above a liquidity risk dimension which highlights how the choice by an agent (a banking system in our specific application) to stop acting as liquidity provider is not harmless, even if this choice does not by itself bring about any immediate loss to be recorded in the balance sheet. This is because it obliges nevertheless its former borrower(s) to seek funding elsewhere, something which may bring about even bigger troubles than a credit loss if it takes place in the midst of a crisis. Said it otherwise, contagion may spread through both an exposure contagion channel, via the credit losses, and the credit line contagion channel, due to spiraling reduction in liquidity (an example of empirical research that tackles both types of contagion is Müller, 2006).

[3] According to topological concepts, the distance between two banking systems which are linked directly, because they exchange deposits, is one.

A second objective is to compare the international standing of the different financial centers and currencies. Along with standard measures based on volumes, we argue in favor of gauging the international role of a currency by observing how frequently deposits denominated in this currency are traded without involving (directly) the domestic banking system. For example, it is straightforward to note the large difference in outstanding stocks in cross-border deposits denominated in dollar vs. the pound (here, one could easily substitute the word deposit with a list of other financial instruments), in a ratio of roughly 5 to 1. However, anticipating some of our results, we believe that a statement on the more far reaching international role of the dollar should better be crafted by observing that the trading in dollar deposits is much less hooked to the US banking system than the trading in pound deposits is to the British one. In a nutshell, going back to one of our initial statement of this introduction, while size matters, the shape of relationships matters more.

Third and finally, against the backdrop of the turmoil in financial markets after-mid 2007, and notably during the second half of 2008, we aim to gather some insights on the policy measures adopted by the central banks and the corresponding market developments through the array of topological measures we compiled in the first two parts of the analysis. One notable aspect of the ongoing crisis management can be identified in the efforts deployed by the monetary authorities in seeking ways for an active international cooperation.[4] One concrete upshot of this cooperation has been the set up of swap lines between the Fed and the ECB (as well as between the former and other central banks). When these lines are activated, the supply of base money in currency X is changed, notably increased, also outside the jurisdiction of the respective home central bank (see the parallel press releases of ECB and US Federal Reserve of 12 December 2007; the move is in line with one of the recommendations put forward in Financial Stability Forum, 2008). Whether this option – a measure that falls under the heading of cross-border collateral arrangements (BIS, 2006) – could make a difference should reasonably depend on the extent to which the trading in X-denominated deposits take place abroad without the direct involvement of the domestic banking system. In parallel, leading central banks became more open to accepting collateral denominated in foreign currencies and possibly issued outside their own jurisdiction (eg Bank of England, 2007).

More broadly, one could argue that the benefits that may be harvested by a central bank that seeks this type of international cooperation – a policy whose flip side could be some degree of limitation in the autonomy enjoyed by the central bank itself in its traditional function of liquidity management – depends crucially on the role played by foreign domestic banking in the trading of its domestic currency. Indeed, it seems evident that the choice by the US Federal Reserve to inject part of its supply of US dollars through European central banks owed to the large trading in this currency which takes place among banks located in Europe, without a direct intermediary role of the US-based banking system.

As a baseline scenario, we expect a strong home bias. To put it in more precise topological terms, we expected the country of issuance of the currency to stand at the center of the network, that is to hold on average a short distance to the other nodes. In fact, this will not always prove to be the case. It is also of interest to examine the role played by foreign financial centers as regards the currency. As a first approximation, if one or more of such centers turned out approximately as central as the domestic one, then there should be more scope for policy makers in developing cross-border collateral arrangements as a tool to make their base money supply more accessible.

[4] See "Declaration on a concerted European action plan of the euro area countries" of 12 October 2008, available at http://www.ue2008.fr/PFUE/lang/fr.

The rest of the paper is organized as follows. Section 2 briefly reviews the literature. Section 3 introduces our dataset. Section 4 sets out the algebra of some key concepts in the topology of networks. Section 5 presents our main results. Section 6 concludes.

2. A brief survey of the literature

A paper on the topology of the cross-border bank deposits exchanged among financial centers cannot help to build on a number of streams of research. To start with, we simply refer the reader to the works by Bordo (1989) and Cassis (2007) for an educated introduction on the literature on economic history and the developments of financial center, a field which is too ample to even attempt here a summary.

The modern modeling of the spread of crises in financial systems is laid down in the well known book by Kindleberger (1978) on the history of financial crises and the work by Diamond and Dybvig (1983). Among more recent contributions, a special reference is owed to Rochet and Tirole (1996), who develop a formal model of system-wide crises with *n* banks enjoying at 'time 0' different endowments, deviating from the single representative bank of previous papers. Allen and Gale (2000) set out the framework for the banking networks by identifying three basic models: (i) the complete structure, where each bank is linked to all other banks; (ii) the incomplete structure, where some of the links are only indirect; and (iii) the disconnected structure, where at least one pair of banks is not linked (either directly or indirectly). Their basic argument is that because of transaction and information costs, banks may refrain from acquiring claims on 'more distant' banks. To our knowledge, no direct equivalent of this piece of research is available when applied to banking systems, in lieu of individual banks. However, the likely increase of such costs in the cross-border trading adds scope to the recourse to intermediaries (the banking systems of major financial centers).

Turning to the application of topology to finance, von Peter (2007) provides an example of applied literature about the way banking centres network among themselves. A wider literature examines networks of individual banks, including Boss et al (2004), Soramäki et al (2006), Cajueiro and Tabak (2007), Iori et al (2007), Iazzetta and Manna (2009) besides the already cited works by Müller. Quite a number of papers deals with the propagation of the crisis across the banking system starting with the assumption of the default of a first bank and simulating the likely contagion through a chain of credit losses ensues: Sheldon and Maurer (1998), Furfine (2003), Blåvarg and Nimander (2002), Wells (2002), Cifuentes (2004), Upper and Worms (2004), van Lelyveld and Liedorp (2006) and Mistrulli (2007) who work on US, Swedish, Chilean, German, Dutch and Italian data. While often these authors do not explicitly frame their work along standard topological elements and definitions, they do apply many of the field's underlying concepts. Most of this work in finance owes, directly or indirectly, to Eisenberg and Noe (2001) who set out the conditions for the existence and uniqueness of a clearing vector for a complex financial system.

Much broader and older is the published record in topology in fields outside economics. In the introduction, we quoted the huge survey by Newman (2003) to whom we could add here Albert and Barabási (2002), Watts (2003), Bollobás (1998) and Albert, Jeong and Barabási (1999) as examples of applications of topology in, respectively, physics, sociology, mathematics and Internet and the World Wide Web.

Finally, the recourse to topological concepts may also offer an alternative approach to the more standard literature on the international role of a currency (see eg ECB, 2009).

3. Our data

Our basic dataset is formed by cross-border deposits exchanged by banks, derived from BIS banking locational statistics (by residence), at five data points: end of second quarter of 2000, 2004, 2007 and 2008 as well as end of fourth quarter 2008. Our data measure outstanding stocks at end-period, broken down in five currencies (USD, EUR, JPY, GBP and CHF).

To introduce some preliminary notation, we denote with ${}^{(a)}w_{i,j}$ the stock of deposits reported on the asset side of its balance sheet by the banking system of country i vis-à-vis the banking system of country j. The mirror of this figure is ${}^{(l)}w_{j,i}$, that is the stock reported in the liability side of country j versus country i. In principle, ${}^{(a)}w_{i,j}$ should be equal to ${}^{(l)}w_{j,i}$. In fact, this is not always the case (as figures do not fully match each other) and we chose to use primarily asset data,[5] though in one instance we deviated from this "rule" (see below). Hence, for ease of notation, we refer to the stock of deposits between i (lender) and j (borrower) simply as $w_{i,j}$, without additional symbols. Moreover, we prefer to avoid introducing a time reference in the notation, to keep it simpler. While the reader should bear in mind that all our statistics are time dependent, starting from the number n of banking systems covered by our database at each reference data, we trust that the exact time can easily be understood from the context.

The BIS statistics are virtually global in scope but are based on a relatively limited number of reporting countries (40 in the latest tally). We should thus split the total size n of our network in two subsets: r reporting countries and $n - r$ non reporting ones. Accordingly, we break down the larger $n \times n$ matrix W of cross-border interbank deposits into four blocs, of dimension $r \times r$, $n \times (n - r)$, $(n - r) \times r$ and $(n - r) \times (n - r)$. With obvious meaning, we will refer to these blocs as *R/R*, *R/NR*, *NR/R* and *NR/NR*:

$$\begin{aligned} w_{i,j} &\in R/R \quad \text{if} \quad i, j = 1, \ldots, r; \\ w_{i,j} &\in R/NR \quad \text{if} \quad i = 1, \ldots, r \text{ and } j = r+1, \ldots, n; \\ w_{i,j} &\in NR/R \quad \text{if} \quad i = r+1, \ldots, n \text{ and } j = 1, \ldots, r; \\ w_{i,j} &\in NR/NR \quad \text{if} \quad i, j = r+1, \ldots, n. \end{aligned} \tag{1}$$

The inputs to the first two blocs are our asset-side $w_{i,j}$'s, while the input to the bloc *NR/R* are obtained from the stocks reported on the liability side (this is the exception we anticipated above). We still miss the inputs to the bloc *NR/NR*, which we derived along two approaches. Firstly, we adopted a basic input-output technique along which, roughly speaking, a non-reporting banking system lends to another non-reporting banking system as, on average, do reporting ones (see Annex 1 for details). One statistics which may worked out by the whole matrix is the market share of non-reporting countries:

$$\frac{\sum_{i=r+1}^{n}\sum_{j=r+1}^{n} w_{i,j} + \frac{1}{2}\left(\sum_{i=1}^{r}\sum_{j=r+1}^{n} w_{i,j} + \sum_{i=r+1}^{n}\sum_{j=1}^{r} w_{i,j}\right)}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}} = 11.0\%, \tag{2a}$$

[5] The alternative choice of attempting to reconcile all bilateral positions would have been far too burdensome (and hardly feasible). As to the preference for assets data versus liabilities data, this owed to the view that the former are generally thought to be of higher quality (at least at the level of individual institutions).

where the figure on the right-hand side of (2a) refers to the stocks outstanding at the end of the second quarter of 2007. As a term of comparison, we worked out the corresponding share based on a measure of international trade of each i-th country, q_i (in turn, we derived the latter from IMF 2007 data on cif import and fob export):

$$\frac{\sum_{i=r+1}^{n} q_i}{\sum_{i=1}^{n} q_i} = 33.0\%. \qquad (2b)$$

There is no reason for results (2a) and (2b) to be equal, even if a full and error-free dataset of both the interbank lending and the international trading were available. To mention one, a chunk of international trade of countries with less developed financial systems – a definition that very roughly correspond to the BIS non reporting countries – may be banked in financially more developed countries. Moreover, the survey focuses on some key currencies and the market share of (2a) refers to countries which are foreign as regards such currencies. That being acknowledged, the sheer dimension of the gap between the two figures hints at some degree of underestimation of the deposits traded by the banking system in the non-reporting countries as derived from the standard input-output technique (this is not surprising given that, by design of this statistics, the trading between two non-reporting banking systems is not surveyed). We thus "augmented" the result in each cell i, j of the bloc NR/NR, as obtained by the first approach, by a factor proportional to the difference between the market share of the two countries as derived from the IMF data and the share in interbank deposits we obtained in the first approach itself (details are in Annex 2).

Finally, in all cases we set equal to zero all data up to US$5 millions. This is mainly because the bulk of the statistics used in topology is obtained by screening whether a given link (the deposit) exists or not, irrespective of its dimension, and we wished to clear the left tail of smaller amounts. That said, we also present some statistics based on weighted data, where the comparison with the unweighted ones appeared to be most meaningful.

To recap, corresponding to each of the five selected dates and for each of the five currencies, we compiled three matrices: (i) a "small matrix", our R/R bloc filled in with actual reported deposits exchanged between the banking systems; (ii) a "large standard matrix", which embodies all four blocs where the data for the bloc NR/NR are estimated along the standard input/output technique; and, (iii) a "large augmented matrix", which differs from (ii) insofar it tries to correct the possible reporting bias. In the paper, results are presented with reference to the latter (iii) matrix, while some additional results on (i) and (ii) are in annex.

The resulting number of banking systems filling our matrices changes with the year and with the currency of denomination of the deposit. Over time, from 2000 to 2008, the number of reporting countries increased from 26 to close to 40 (with some slight variation depending on the currency). As regards the non-reporting countries, their variability is explained more by the currency than by the year: for example, while their number goes from 157 in 2000 Q2 to 151 in 2008 Q4 for the dollar, it ranges between 68 to 75 for the yen.

In compiling the dataset used in the analysis, an issue to be tackled by the researcher is about treating the countries forming the European Monetary Union (EMU) as separate entities, and thus considering say the cross-border deposits between say France and Germany along those of France and the United States, or conversely consider the euro area as one party.

Table 1

Number of reporting and non-reporting countries

	2000 Q2		2004 Q2		2007 Q2		2008 Q2		2008 Q4	
	R	***NR***	***R***	***NR***	***R***	***NR***	***R***	***NR***	***R***	***NR***
USD	26	157	39	153	40	147	40	155	40	151
EUR	26	147	39	150	40	149	40	153	40	153
JPY	26	68	38	69	39	70	39	78	39	75
GBP	26	95	39	99	40	107	40	112	40	98
CHF	26	54	37	84	38	76	38	83	38	80

R/NR: number of reporting/non-reporting countries for which we identified at least one bilateral cross-border banking deposit of at least 6 USD millions.

Arguably, referring to our previous example, the exchange of deposits by the French and German banking systems is not fully comparable to that between the former and the US system: they share the same currency and the same monetary policy authority. Additionally, the settlement of these deposits is supported by the single payment infrastructure of Target-2. For all these reasons, the exchange of deposits between two banks located in the area could be regarded as a domestic transfer, no matter whether the two banks also happen to be located in the same country or not.

That would probably have been our choice, had the paper focused on a dataset ending before the onset of the current crisis. In fact, the experience gained during the latter has highlighted the national dimension of the crisis management, entrenched in consideration of legal nature (such as Article 105 of the Treaty of the European Union) as well as the fact that eventually it is the national taxpayer that funds the rescue measures (where needed) and thus calls the pipe.[6]

Against the above, we present data for the euro area both in an aggregated form, where the resulting statistics is the sum of the raw results for the countries joining the monetary union at the time to which the data is referred to, and in a consolidated form, in which case all intra-euro area cross-border positions are preliminarily netted out (in the table, the two results are presented respectively as “EUR, agg.ed” and “EUR, cons.ed”).

4. Some simple algebra

We introduced above our square matrix W of interbank deposits, of dimension n, also known as the size of the network. A first straightforward result is the derivation of an “adjacency” matrix S whose generic element i, j is:

$$s_{ij} = \begin{cases} 1 & \text{if } w_{ij} > 0 \\ 0 & \text{otherwise} \end{cases} . \qquad (3)$$

[6] In the months of October and November 2008, almost every country has laid down its own scheme of support measures, provided it fulfilled the principles set out in the declaration of the euro area Heads of State and Government of 12 October.

S is a 'directed graph' insofar it tracks whether it is banking system i lending to j or vice versa. However, in many applications in topology we wish to check whether the two banking systems exchange a deposit or not (the two nodes are linked or not), irrespective of the sign of the transaction. We thus introduce also an $n \times n$ matrix B with generic element defined as follows:

$$b_{ij} = \begin{cases} 1 & \text{if } w_{ij} + w_{j,i} > 0 \\ 0 & \text{otherwise} \end{cases} , \tag{4}$$

by design, $b_{i,j} = b_{j,i}$ and B is symmetric.

In topology, the degree of a node is its most basic statistics and the in- and out-degree define respectively the number of active links originating in or terminating at the node at stake. When using data on cross-border interbank deposits, the in-degree (out-degree) of country a banking system is the number of foreign banking systems from which it borrows (to which it lends).

$k_i^{OUT} = u_i^{\mathrm{T}} S u \in [0, n-1]$ out-degree of node i (5a)

$k_i^{IN} = u_i^{\mathrm{T}} S^{\mathrm{T}} u \in [0, n-1]$ in-degree of node i (5b)

$k_i = u_i^{\mathrm{T}} B u \in [1, n-1]$ degree of node i (5c)

where u and u_i are n-sized vectors respectively filled with all 1's and with 1 in the i-th cell and zero elsewhere; S^{T} is the transpose of S.

Out of a number of possible measures used in applied research on network topology (Newman, 2003, Arnold et al, 2006, Iori et al, 2007), we shall focus especially on the concept of distance. We work out the distance from i to j, $d_{i,j}$ through the following simple algorithm:

$d_{i,j} = 1$ if $b_{i,j} = 1$, (6)

else

$d_{i,j} = 2$ if $b_{i,j} = 0$ and $\exists$ at least one a such that $b_{i,a} = b_{a,j} = 1$,

else

$d_{i,j} = 3$ if $\exists$ at least a pair $\{a, a'\}$ such that $b_{i,a} = b_{a,a'} = b_{a',j} 1$,

…

$d_{i,j} = \mathrm{n}$ if $\exists\ n-2\ \{a, a', \ldots, a[n-2]\}$ such that $b_{i,a} = b_{a,a'} = \ldots = b_{a[n-3],a[n-2]} = b_{a[n-2],j} = 1$,

where the last row signals that $d_{i,j}$ may take finite values from 1 to $n-1$, if the dimension of B is n. However, it may also be the case that no such chain of nodes $a, a', \ldots, a[n-2]$ exists, so that i and j happen to be not linked (neither directly nor indirectly). If this happens, the network is disconnected. Had this instance been verified in any of our matrices, we could have chosen between either of two approaches suggested by the related applied literature: one may focus on the subset of the network which is internally connected or use harmonic versions of the distance in which case if no finite distance from i to j can be worked out than the inverse $1/d_{i,j}$ is set equal to zero (of course, this is strictly correct only when n goes to infinite). As a last step in the procedure, a matrix D of distances is compiled using the individual measures $d_{i,j}$'s (if only the largest connected sub-network is taken into consideration, this matrix will have dimension lower than n).

Note that (i) because the B matrix is symmetric, the distance is the same whether we start from i or from j; and (ii) the way we have written algorithm [6] implicitly defines the distance as the shortest number of steps from i to j. For example, given two different paths linking

nodes i and j, one involving one in-between node and the other two such nodes, we shall say that the distance at stake is 2 (and not 3).

We complete this short presentation of the algebra by introducing the concepts of geodesic node and of weighted distance. If our nodes i and j are linked only indirectly, ie $d_{i,j} \in [2, n-1]$, a is geodesic to them if it stands on the shortest path. In algebraic terms

$$d_{i,j} = d_{i,a} + d_{a,j}, \tag{7a}$$

against the alternative of

$$d_{i,j} < d_{i,a} + d_{a,j} \tag{7b}$$

where in (7b) a is not geodesic to i and j. By construction, on the shortest path (note that there may be more than one!) we will find $d_{i,j} - 1$ geodesic nodes. A simple extension of this concept is the geodesic frequency of node a, which is the number of times a is geodesic with respect to all possible pairs i, j in the network, divided by $(n-1)\times(n\times 2)$ if n is the size of the network itself.

The weighted distance between i and j is derived by multiplying the (unweighted) distance obtained through (6) by a loading factor which is one (more than one / less than one) if the sum of the cross-border interbank deposits of banking systems i and j is equal (less / more) than $2/n$ times the total of W:

$$d^{w}_{i,j} = d_{i,j} \times \left[\left(\frac{2}{n} \right) \times \frac{u^{\mathrm{T}} W u}{u_{\mathrm{i}}^{\mathrm{T}} \left(W + W^{\mathrm{T}} \right) u_j + u_{\mathrm{i}}^{\mathrm{T}} \left(W + W^{\mathrm{T}} \right) u_j} \right] \tag{8}$$

Next, we compile a matrix D^w, parallel to D. By way of example, the weighted distance is calculated shorter than its unweighted measure if nodes i and j run relatively large amounts of interbank deposits. In parallel, we also define the valued in- and out-degrees along results (5):

$$v_i^{OUT} = \frac{u_i^{\mathrm{T}} W u}{u^{\mathrm{T}} W u} \in [0.1] \qquad \text{valued out-degree of node } g \tag{9a}$$

$$v_i^{IN} = \frac{u_i^{\mathrm{T}} W^{\mathrm{T}} u}{u^{\mathrm{T}} W u} \in [0.1] \qquad \text{valued in-degree of node } g \tag{9b}$$

$$v_i \equiv \frac{u_i^{\mathrm{T}} (W + W^{\mathrm{T}}) u}{u^{\mathrm{T}} W u} \in [0.1] \qquad \text{valued degree of node } g \tag{9c}$$

Finally, a number of additional statistics can be derived from the matrices D and D^w:

$$h_i = \frac{u_i^{\mathrm{T}} D u}{n-1} \qquad \text{average distance of node } i, \tag{10a}$$

$$h_i^w = \frac{u_i^{\mathrm{T}} D^w u}{n-1} \qquad \text{weighted average distance of node } i, \tag{10b}$$

$$h = \frac{u^{\mathrm{T}} D u}{n(n-1)} \qquad \text{average distance of the network,} \tag{10c}$$

$$h^w = \frac{u^{\mathrm{T}} D^w u}{n(n-1)} \qquad \text{weighted average distance of the network,} \tag{10d}$$

$$F_m = \frac{1(D = m)}{n(n-1)} \qquad \text{mass distance function.} \qquad (10e)$$

5. Our main results

5.1 The size of the cross-border market for interbank deposits

A simple eye-ball inspection of the volumes of outstanding stocks helps to draw a line between the euro and the dollar on one side and the yen, the pound and the Swiss franc on the other side. For example, referring to 2008Q2, the two leading currencies alone accounted for respectively 7.1 and 9.0 thousand of billion of dollars out of 19.2 in total (that makes an overall share of 84%, sum of 37 and 47%; table 2). While the relative position of the two currencies has changed somewhat, with the euro gaining relative ground over time and eventually overtaking the dollar in size (beware that we did not adjust these measures of stocks for the associated exchange rate changes), their combined market share has remained constant at 84-85% across the quarters we selected (except for 2002Q2 when it stood at 81%). The British pound is a distant third with 9% of the total in 2008Q2, while the yen and the Swiss franc follow with market shares of, respectively, 5 and 2%. The bulk of this business is played among the banking systems of the reporting countries. The R/R bloc accounts for some 75-80% of the total.

Looking at the data over time, stocks increased almost fourfold from 2000Q2 to 2008Q2, to suffer quite a setback (-15%) in the second half of 2008 when the on-going crisis in financial markets became more severe. Patterns were not homogeneous across currencies: from 2008Q2 to 2008Q4, the volume of cross-border interbank deposits denominated in dollars fell by 8%, that of euros by 18% (16% in the consolidated version), while deposits in yen increased, even if marginally.

Table 2

Size of the cross-border interbank market

(outstanding stocks in billion of US dollars)

	2000Q2	2004Q2	2007Q2	2008Q2	2008Q4
USD	2,534	4,608	6,381	7,062	6,493
EUR, agg.ed	2,048	3,928	6,956	8,978	7,323
EUR, cons.ed	1,490	2,810	4,997	6,189	5,192
JPY	558	459	541	874	902
GBP	349	818	1,588	1,792	1,222
CHF	200	240	309	469	352
Total	5,689	10,053	15,775	19,175	16,292

Data are referred to the “large augmented matrix” (see section 3). In “EUR, cons.ed” the cross-border deposits denominated in euro among euro area countries are netted out while in “EUR, agg.ed” they are not. The row showing the total uses as input for the euro the aggregated data.

Much of the following analysis will try to uncover whether the international roles of the euro and of the dollar are of similar magnitude, as volume data suggest, or there is still an argument for drawing a line between these two currencies.

To start with, we add a measure of how dispersed are the deposits, next to the “how large”, through Gini coefficients of concentration, derived from the market shares of all reporting and non-reporting countries. Across the board, the market in yen deposits is by far the most

concentrated while, among the three smaller currencies, the market for the Swiss franc deposits comes out as the closest to the one of the two leading currencies. One could thus read, as a rule of thumb, an higher international role of the currency in lower levels of the Gini coefficient. From this standpoint, the downward pattern followed by this statistics when measured on euro denominated deposits (both in the aggregated and in the consolidated version) could be a signal of an increasing role of this currency.

Table 3

Gini coefficient

(measured out of '000s)

	2000Q2	2004Q2	2007Q2	2008Q2	2008Q4
USD	16	15	19	19	18
EUR, agg.ed	13	14	14	12	11
EUR, cons.ed	21	23	23	19	18
JPY	71	60	52	51	52
GBP	37	29	31	33	41
CHF	39	28	19	20	19

Data are referred to the "large augmented matrix" (see section 3). In "EUR, cons.ed" the cross-border deposits denominated in euro among euro area countries are netted out while in "EUR, agg.ed" they are not.

5.2 In- and out-degrees: a look at the microstructure of the market

In chart 1 overleaf we plot the scatter of the in- and out-degrees as well as, on the right-hand side, the corresponding valued degrees obtained through the application of, respectively, equations [5a-b] and [9a-b] on the "large augmented" (see section 3) on euro and on dollar denominated cross border deposits as at 2008Q2.

For each plot, we show also the resulting trend line and the associated equation: a value of its estimated slope coefficient lower (higher) than 1 signals that the lending (borrowing) side of the market is more concentrated than the borrowing (lending) one. Looking at the two plots on the left side, showing the degrees, for both currencies countries tend to cluster in three main areas: (i) in the left-down corner, near the origin; (ii) an area at the center of the plot, close to but possibly below the trend line; and (iii) the right-top corner. Cluster (i) groups the largest number of banking systems, which maintain a roughly even and limited number of counterparts as lenders and borrowers; cluster (ii) is populated by middlish to large-sized economies, such as the Netherlands and Italy but also Kazakhstan and Thailand. Finally, in cluster (iii) we find either the largest world economies (UK, France, China, US) but also some offshore centers. Overall, in both currencies, the slope of the resulting trend line is close to 0.6, that is the market is more concentrated on the lender than on the borrower side. While the broad picture is similar when looking at deposits denominated in dollars and euros, two differences stand out. First, as regards the dollar, cluster (ii) is largely below the trend line, namely it is especially with the middle-of-the-road banking systems (on a global scale) that the different degree of concentration between the two sides of the market becomes most evident. Second, cluster (iii) is clearly more populated and more to the right when deposits denominated in dollar are considered. In plain English, worldwide more banking systems trade deposits denominated in dollars than in euros.

Chart 1

In- and out-degree and value degree. 2008 Q2

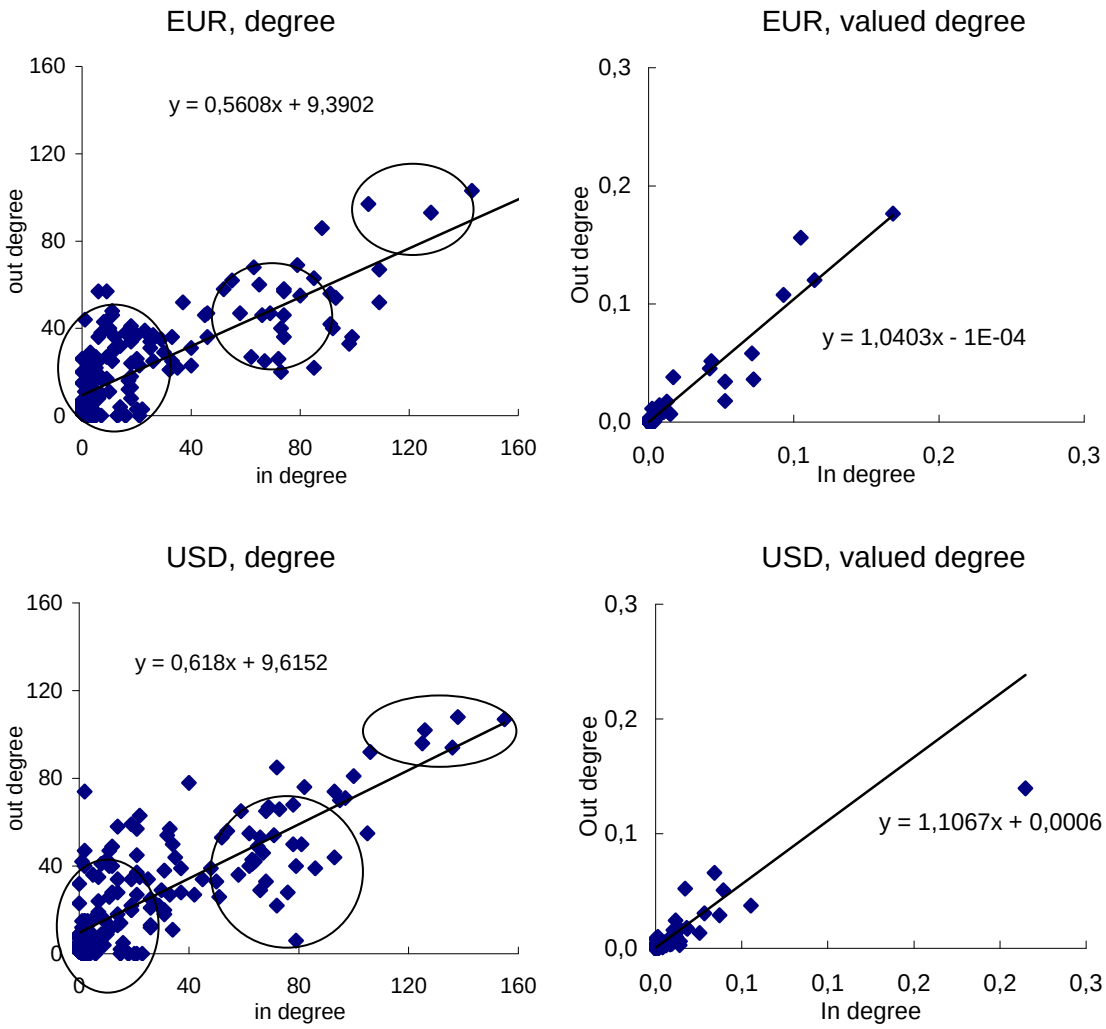


Table 4 brings the analysis one step further by reporting the estimated slope of the resulting trend line for the scatter of each of the currencies and data points. A few findings emerge from the table. For both the euro and the dollar trading, the slope measured on the degree remains well below the unity but only for the euro it has reduced after the onset of the crisis in mid-2007, ie after that time the market became more concentrated on the lending side because relatively fewer banking systems were ready to lend in this currency. Across the board, at all selected dates, the slope coefficient for the cross-border deposits denominated in British pounds is lowest, namely this is the currency with the greatest imbalance between number of lenders and number of borrowers. To the contrary, more balanced is the corresponding relationship we found for the yen. Third, if the slope measured on the degrees is read next to the slope measured on valued degrees most of the deviations from the unity we commented above as regards the two leading currencies disappear. It seems therefore that the imbalance probably involves the participation of a large number of small borrowers, that weigh relatively little on valued measure and as such do not manage to tilt the balance.

Table 4

Degrees and valued degrees: slope of the trend line

	2000 Q2		2004 Q2		2007 Q2		2008 Q2		2008 Q4	
	Degree	Valued degree	Degree	Valued degree	Degree	Valued degree	Degree	Valued degree	Degree	Valued degree
USD	0.73	1.05	0.47	1.15	0.65	0.79	0.,62	1.11	0.68	1.14
EUR	0.73	0.95	0.46	1.05	0.69	0.98	0.56	1.04	0.57	1.06
JPY	1.33	1.19	0.97	0.93	1.05	0.86	1.06	0.85	1.17	0.93
GBP	0.45	1.12	0.28	0.74	0.45	0.81	0.39	0.67	0.44	0.64
CHF	0.82	1.08	0.42	0.99	0.90	1.02	0.55	1.07	0.52	0.92

Data are referred to the "large augmented matrix" (see section 3). Data for the euro area are based on the aggregated version.

5.3 Who stands at the centre of the market?

As argued in the introduction of this paper, size and leadership in a network are not quite the same thing. Expanding the meaning of this general statement, one should not take for granted that for a given currency the corresponding domestic banking system is necessarily at the centre of the network. In Table 5 overleaf, we present for each of the five currencies the share of cross border deposits where on either side of the dealing we find the domestic banking system.

Based on this statistics, a remaining gap emerges between the dollar and the euro even when the euro area is treated as one country. In mid-2008, 44% of the cross-border deposits denominated in USD were dealt through the US banking system, against a share of 77% of the EUR deposits dealt through the euro area banking system (this share raises to 84% is the intra-area cross-border deposits are included). Once more, the Swiss franc seems to enjoy an international standing which is closer to the dollar than the yen and the pound, with the interbank market on deposits denominated in the latter currency turning out to be those most hooked to its own domestic banking system.

Table 5

Trading of deposits through the issuing country, %

	2000Q2	2004Q2	2007Q2	2008Q2	2008Q4
US/ USD	42.8	39.2	42.7	44.2	47.5
EMU/EUR, agg.ed	79.6	81.1	83.0	84.2	82.3
EMU / EUR, cons.ed	72.0	73.5	76.3	77.1	75.0
Japan / JPY	69.5	65.3	63.1	67.4	71.4
UK /GBP	82.6	74.5	81.5	82.1	84.3
Switzerland / CHF	56.9	45.7	46.4	51.7	48.4

Data are referred to the "large augmented matrix" (see section 3). In "EUR, cons.ed" the cross-border deposits denominated in euro among euro area countries are netted out while in "EUR, agg.ed" they are not.

In- and out-degrees measure the existing direct links. It is however with a measure of centrality such as the average distance (formulae [10a] and [10b]) that we may unveil the role a node plays in a network also through its indirect links. Broadly speaking, a node (a banking system) is central to the network if its mean path length to all other nodes is short. As a summary of the distances we worked out for all nodes (banking systems) corresponding

to each matrix, in table 6 we report separately for each currency the ratio of the distance of the related domestic banking system to the average distance for the three banking systems which, corresponding to the selected currency, are closest to the center of the network. A figure of this statistics lower than 1 implies that the domestic banking system is the one closest to the center, a figure approximately equal to 1 means that such banking system is as close as on average the top three systems, and finally a figure clearly higher than 1 implies that it ranks well above the third spot when measured in terms of centrality.

The resulting ratio for the United States fluctuates between 1.2 and 1.3 (with the exception of 2000Q2). This is the only banking system corresponding to which we obtained a result well above 1. In perhaps less technical terms, this signals that only when the cross-border deposits are denominated in US dollars, the domestic banking system is not the pivot of such trading worldwide. In turn, one could conclude that the international role of this currency is so well-established that quite a chunk of related interbank deals take place without involving directly the US banking system. Conversely, the summary statistics for the euro banking system and the euro-denominated cross-border deposits is close to 1. When this result is compared to those reported in table 2, it follows that there is relatively less trading in such deposits without the banking systems of the issuing countries, compared to what has been just described for the US / dollar case. Pushing the interpretation one step ahead, based on this measure the international role of the euro still needs to grow before reaching the dollar's. Finally, the ratio is marginally below 1 for the Swiss franc, between 0.9 and 1 for the Japanese banking system and between 0.8 and 0.9 for the British one.

This ratio of centrality declines somewhat from 2008Q2 to 2008Q4, with the exception of the statistics measured on euro-denominated deposits. A possible explanation is that one upshot of the crisis was bringing back the business in X-denominated deposits towards the corresponding home banking system. The observed change seems to be too small though to clearly point to any new relevant trend.

Table 6

Relative measure of centrality of the domestic banking system

(ratio of the mean path length of the domestic banking system of the issuing country and the average of the mean path length of the three banking systems with lowest path length for the specified currency)

	2000Q2	2004Q2	2007Q2	2008Q2	2008Q4
US/ USD	1.03	1.31	1.18	1.22	1.20
EMU/ EUR, agg.ed	0.99	1.00	0.97	1.01	1.04
Japan / JPY	0.97	0.97	0.93	0.95	0.93
UK /GBP	0.76	0.87	0.79	0.88	0.84
Switzerland / CHF	0.86	1.01	0.88	0.98	0.97
	2000Q2	2004Q2	2007Q2	2008Q2	2008Q4

Data are referred to the "large augmented matrix" (see section 3). In "EUR, agg.ed" the cross-border deposits denominated in euro among euro area countries are not netted out.

We may also measure how "dense" is the network through its mass distance function (equation [10e]). As a possible application, in Chart 2 overleaf we plot the percentage of pairs of banking system whose distance within each currency network is measured not higher than two.

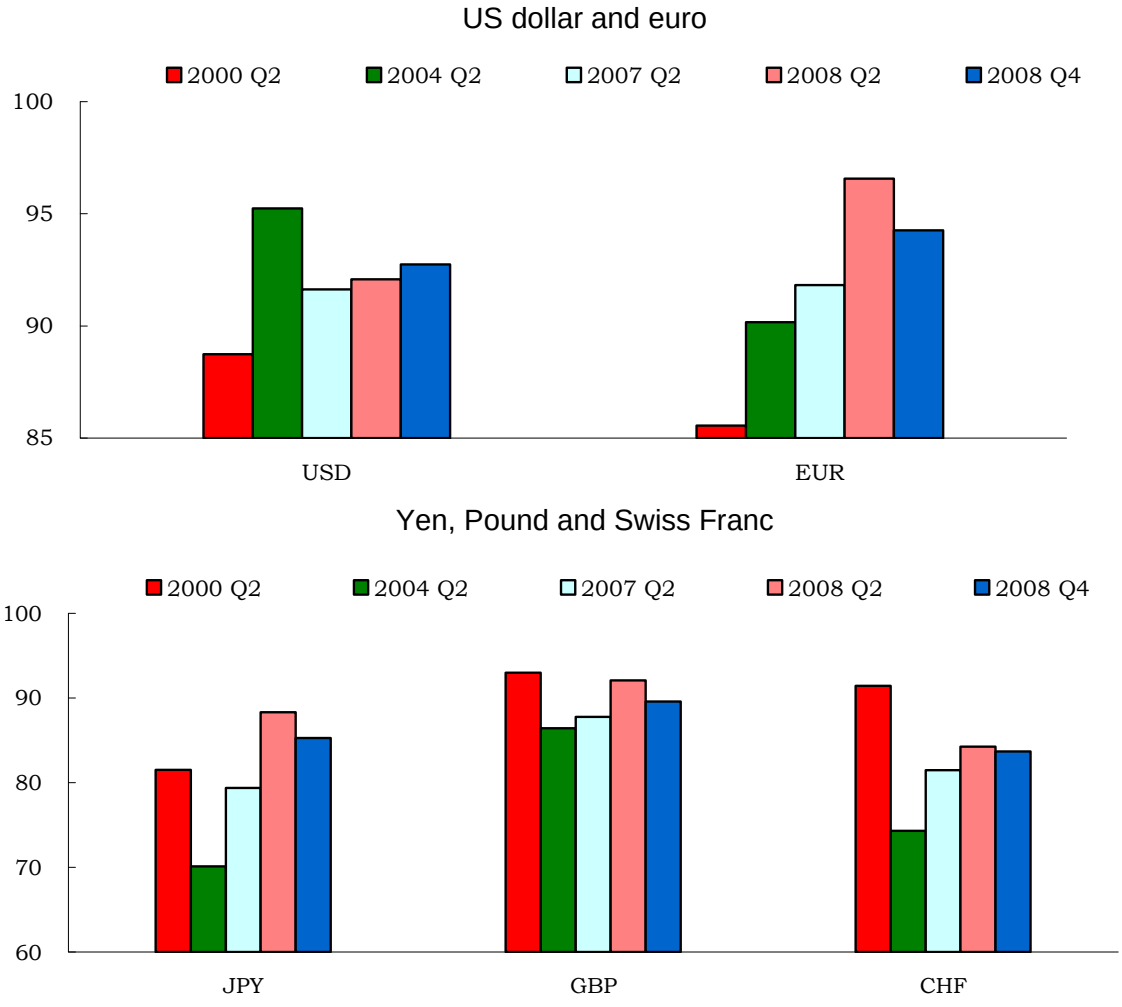
As a first finding, this percentage turns out to be higher for the dollar and the euro than for the other three currencies, that is the web of links for the two leading currencies is more dense. Second, overall, from mid-2000 to mid-2008, the density of banking systems involved

in cross-border deposits dealing is on the rise (although if this trend is occasionally irregular). However, in the second half of 2008, when the crisis in financial markets became more serve, the mass distance function declines for the euro, the yen, the pound and the Swiss franc, while it further increases on the dollar-denominated deposits. This could be taken as a signal of a flight-to-quality towards the dollar combined with the preference for more direct links, perhaps on the ground of reducing liquidity and operational risks.

Charts 2a-b

Mass distance function: results for the distance up to 2

(% of pairs of banking systems for which, in the network of cross border deposits in the specified currency, the related distance is measured as one or two)



6. Concluding remarks

In this paper we used BIS international banking statistics to derive a number a measures on the network defined by the cross-border deposits exchanged by national banking systems worldwide. Data are end-quarter stocks as at the second quarter of 2000, 2004, 2007, 2008 as well as the fourth quarter of 2008 (the latest available observation) and are broken down according to five leading currencies of denomination (USD, EUR, JPY, GBP and CHF).

Measured on outstanding volumes, the overall sum of euro and of dollar deposits are of similar magnitude, in the region of 7 to 9 thousand of billions of US dollars. By comparison, the business in pounds is below 2,000 billion of dollars, that in yen less than 1,000 and that in Swiss franc close to "only" 500 billions.

Both in the euro and in the dollar segments of the market, we count roughly two borrowing banking systems for one lending system. The recourse to valued measures, that is measures which weigh parties according to their market shares, suggests that it is mostly the smaller banking systems (smaller in terms of their dealings in cross-border deposits) that stand on the more populated borrowing side.

If data on the outstanding volume could suggest that the euro and the dollar enjoy a similar status in international markets (actually, the euro has overtaken the dollar in recent quarters), a number of other measures describe a partly different story. To start with, three quarters of the cross-border deposits denominated in euro are traded trough a banking system located in the euro area, while less than half of the dollar-denominated cross-border deposits involve directly the US banking system.

Second, referring to network topology concepts such as distance and centrality, the US banking system is not even the most central to the trading in dollar deposits, while the opposite, more ordinary result holds true for the euro deposits.

The gap flagged by these two findings is partly attenuated if we broaden the analysis beyond the role played by the domestic banking system vis-à-vis each currency. Based on our 2007 and 2008 data, the density of the network of euro deposits (the share of worldwide pairs of banking systems whose distance is one or two) increased much more rapidly than the dollar's. However, in the second half of 2008, at the peak of the crisis, while the trading in US-denominated deposits continued to be on the rise, a reversal was recorded for the euro-denominated ones. At this stage, it is too early to assess whether this latest pattern will prove to be strictly confined to the duration of the crisis or not.

To wrap it up, worldwide it is becoming more common for "foreign" banking systems to exchange deposits in euro, as they already do in dollars, although it is still in the latter currency they do so more frequently without the involvement of the domestic banking system.

Turning to the Japanese yen, the British pound and the Swiss franc, the gap vis-à-vis the two leading currencies does not end with the volume of deposits. More than four fifths of the deposits in pounds are traded via the British banking system (against 45% for the US banking system and the dollar-denominated deposits) and, as a mirror measure, this turns out to be by far the most central system in the related network. Even if it is a declining share, more than 20% of possible pairs of national banking system still need two or more intermediate systems to exchange mutually deposits in yen and francs.

This is about the positive side of the story. But what BIS international financial statistics tell us in policy terms, ie what normative lessons can be drawn from this line of research? In the introduction, we noted that a remarkable feature of the management in the current exceptional market turmoil has been the degree of international cooperation sought by monetary authorities. Notably, the central banks have reached the stage of effectively delegating some of their supply of base money through the set up of bilateral swap lines, followed by open market operations run by "foreign" central banks. The degree to which measures such as this may actually be an effective remedy largely depends on the extent to which a currency is really international, which in our approach boils down to saying that this currency is traded outside the corresponding domestic banking system. Based on our results, this is more the case for the dollar than for the euro, more for the Swiss franc than for the pound and the yen.

References

Albert R and A–L Barabási (2002), “Statistical mechanics of complex networks”. Review of modern physics, 74, pp 47–97.

Albert R, H Jeong and A–L Barabási (1999), “Diameter of the world-wide web”. Nature, 401, pp 130–131.

Allen F and D Gale (2000), “Financial Contagion”. Journal of Political Economy, 108:1, pp 1–33.

Bank of England (2007), press release “Central Bank Measures to Address Elevated Pressures in Short-term Funding Markets”, 12 December, available at http://www.bankofengland.co.uk/.

Bank for International Settlements (2006), Cross-border collateral Arrangements, available at http://www.bis.org.

Blåvarg M and P Nimander (2002), “Inter-bank exposures and systemic risk”. Sveriges Riksbank, Economic Review, pp 19–45.

Bollobás B (1998), Modern Graph Theory. Springer, New York.

Bordo, MD, ed., (1989), Money, History, and International Finance. National Bureau of Economic Research Conference Report.

Boss M, H Elsinger, M. Summers and S. Thurner (2004), ”The Network Topology of the Interbank Market”. Quantitative Finance, 4:6, pp 677–684.

Cajueiro D O and B M Tabak (2007), “The role of banks in the Brazilian Interbank Market: Does bank type matter?”. Banco Central do Brasil Working Paper, no 130.

Cassis Y (2007), Capitals of Capital: A History of International Financial Centres, pp 1780–2005. Cambridge: Cambridge University Press.

Cifuentes R (2004), “Banking Concentration: Implications for Systemic Risk and Safety-Net Design”. In Banking Market Structure and Monetary Policy, ed. L Ahumada and J Fuentes. Central Bank of Chile.

Diamond D W and P H Dybvig (1983), “ Banks Runs, Deposit Insurance, and Liquidity”. Journal of Political Economy, 91, pp 401–419.

European Central Bank (2007), press release “Measures designed to address elevated pressures in short-term funding markets”, 12 December, available at http://www.ecb.int/press/pr/date/2007/html/pr071212.en.html.

——— (2009), Review of the international role of the euro. Germany: Frankfurt

Eisenberg L and T Noe (2001), “Systemic Risk in Financial Systems”. Management Science, 47:2, pp 236–249.

Financial Stability Forum, FSF (2008), Report of the Financial Stability Forum on Enhancing Market and Institutional Resilience, available at http://www.fsforum.org/index.htm

Furfine C H (2003), “Interbank Exposures: Quantifying the Risk of Contagion”. Journal of Money, Credit, and Banking, 35:1, pp 111–128.

Iazzetta C and M Manna (2009), “The topology of the interbank market: developments in Italy since 1990”, Banca d’Italia, Working paper, no 711.

Iori G, G Caldarelli, G Gabbi, G de Masi and O V Precup (2007), "A Network Analysis of the Italian Overnight Money Market", Journal of Economic Dynamics and Control, 32, pp 259–278.

Kindleberger, C P (1978), Manias, Panics, and Crashes: A History of Financial Crises. New York: Basic Books.

van Lelyveld I and F Liedorp (2006), “Interbank Contagion in the Dutch Banking Sector: A Sensitivity Analysis”. International Journal of Central Banking, 2:2, pp 99–133.

Mistrulli P E (2007), “Assessing financial contagion in the interbank market: Maximum entropy versus observed interbank lending patterns”. Banca d’Italia, Working Papers, no 641.

Müller J (2003), “Two Approaches to Assess Contagion in the Interbank Market”. Mimeo, Swiss National Bank.

Müller J (2006), “Interbank Credit Lines as a Channel of Contagion”. Journal of Financial Services Research, 29:1, pp 37–60.

Newman M E J (2003), “The structure and Function of Complex Network”. Society for Industrial and. Applied Mathematic (SIAM) Review, 45:2, pp 167-256.

von Peter G (2007), “International banking centres: a network perspective”. BIS Quarterly Review, December, pp 33–45.

Rochet J-C and J Tirole (1996) “Interbank Lending and Systemic Risk”. Journal of Money, Credit and Banking, 28:4, pp 733–762.

Sheldon G and M Maurer (1998), “Interbank lending and systemic risk”. Swiss Journal of Economics and Statistics, 134:4.2, pp 684–704,

Soramäki K, Arnold J, M L Bech, W E Beyeler and R J Glass (2006), “The Topology of Interbank Payment Flows”. Federal Reserve Bank of New York Staff Reports, no 243.

Upper C and A Worms (2004), “Estimating Bilateral Exposures in the German Interbank Market: Is There a Danger of Contagion?”. European Economic Review, 48:4, pp 827–849.

US Federal Reserve System (2007), press release “Federal Reserve and other central banks announce measures designed to address elevated pressures in short-term funding markets” 12 December, available at http://www.federalreserve.gov/.

Watts D J (2003), Six Degrees: The Science of a Connected Age. Norton, New York.

Annex 1

The derivation of the NR/NR bloc: the standard approach

Given our measure $w_{i,j}$ of the outstanding stock of deposits lent by the banking system of country *i* to the banking system of country *j*, our "standard" algorithm to compile the NR/NR bloc is organized as follows:

[A.1] $$k = \frac{\sum_{i=1}^{r}\sum_{j=1}^{r} w_{i,j}}{\sum_{i=1}^{r}\sum_{j=1}^{n} w_{i,j}}$$

[A.2] $$k_j = \frac{\sum_{i=1}^{r} w_{i,j}}{\sum_{i=1}^{r}\sum_{j=1}^{n} w_{i,j}} \qquad j = r+1, .., n$$

[A.3] $$k_{i,j} = \frac{k_j}{k}\sum_{l=1}^{r} w_{j,l} \qquad i,j = r+1, .., n$$

where *r* and *n* are respectively the number of reporting countries and the total number of surveyed (reporting and non reporting) countries.

Annex 2

The derivation of the NR/NR bloc: the "augmented" approach

First, we work out the share p_j of country *j* out of global imports (cif) and exports (fob):

[A.4] $$p_j = \frac{\exp_j + \mathrm{imp}_j}{\sum_{j=1}^{n}\left(\exp_j + \mathrm{imp}_j\right)}$$

Second, we derive the corresponding share in the market of cross-border banking deposits, as derived from the results obtained in the standard approach:

[A.5] $$q_j = \frac{\left(\sum_{i=r+1}^{n}\sum_{j=r+1}^{n} w_{i,j} + \frac{\sum_{i=1}^{r} w_{i,j} + \sum_{l=r+1}^{n} w_{j,l}}{2} \right)}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{i,j}} \qquad j = r+1, .., n$$

where the $w_{i,j}$'s in [A.4] for pairs where both *i* and j are from *r*+1 to *n* are obtained from [A.3].

Finally, we obtain the "augmented" version of [A.3], as follows:

[A.6] $$w_{i,j}^{AUG} = \max\left(1, \frac{p_j}{q_j}\right) \times w_{i,j} \qquad \text{for i,j = r+1, .., n if} \qquad \min(p_j, q_j) > 0$$

$$= 1 \qquad \text{if} \qquad \min(p_j, q_j) = 0.$$

Table 7

Mass distance function, results for the "large augmented matrix"

2008Q4					
Distance	USD	EUR	JPY	GBP	CHF
1	18.1%	15.0%	9.2%	7.9%	9.3%
2	74.7%	79.2%	76.0%	81.7%	74.4%
3	7.3%	5.7%	14.7%	10.4%	16.3%
4	0.0%	0.0%	0.0%	0.0%	0.0%
average	1.89	1.91	2.06	2.03	2.07
2008Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	18.4%	16.0%	9.5%	8.4%	9.2%
2	73.7%	80.6%	78.8%	83.7%	75.1%
3	7.9%	3.4%	11.7%	7.9%	15.7%
4	0.1%	0.0%	0.0%	0.0%	0.0%
average	1.90	1.87	2.02	2.00	2.07
2007Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	13.7%	11.0%	9.9%	7.7%	9.0%
2	77.9%	80.8%	69.5%	80.0%	72.5%
3	8.3%	8.2%	20.4%	12.2%	18.5%
4	0.0%	0.0%	0.2%	0.0%	0.0%
average	1.95	1.97	2.11	2.05	2.10
2004Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	16.0%	12.3%	7.1%	7.8%	7.1%
2	79.3%	77.9%	63.0%	78.6%	67.2%
3	4.7%	9.2%	26.4%	13.2%	20.4%
4	0.1%	0.6%	3.5%	0.4%	5.2%
average	1.89	1.98	2.26	2.06	2.24
2000Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	12.9%	8.6%	9.3%	6.7%	11.6%
2	75.8%	77.0%	72.2%	86.3%	79.9%
3	11.3%	14.4%	18.5%	7.0%	8.5%
4	0.0%	0.1%	0.0%	0.0%	0.0%
average	1.98	2.06	2.09	2.00	1.97

Table 8

Mass distance function, results for the "standard matrix"

2008Q4					
Distance	USD	EUR	JPY	GBP	CHF
1	13.3 %	11.6 %	8.3 %	6.7 %	9.7 %
2	77.2 %	80.3 %	72.6 %	80.1 %	76.2 %
3	9.5 %	8.2 %	19.0 %	13.1 %	14.1 %
4	0.0 %	0.0 %	0.1 %	0.1 %	0.0 %
average	1.96	1.97	2.11	2.07	2.04
2008Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	14.2 %	11.8 %	8.3 %	7.4 %	9.2 %
2	75.6 %	80.1 %	74.0 %	84.1 %	76.1 %
3	10.2 %	8.0 %	17.6 %	8.4 %	14.7 %
4	0.0 %	0.0 %	0.1 %	0.1 %	0.0 %
average	1.96	1.96	2.10	2.01	2.05
2007Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	13.7 %	11.0 %	9.9 %	11.0 %	9.0 %
2	77.9 %	80.8 %	69.5 %	80.8 %	72.5 %
3	8.3 %	8.2 %	20.4 %	8.2 %	18.5 %
4	0.0 %	0.0 %	0.2 %	0.0 %	0.0 %
average	1.95	1.97	2.11	1.97	2.10
2004Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	12.3 %	8.9 %	8.0 %	8.0 %	8.4 %
2	75.6 %	79.4 %	65.8 %	79.7 %	64.8 %
3	12.1 %	11.6 %	26.0 %	12.3 %	26.5 %
4	0.0 %	0.0 %	0.2 %	0.0 %	0.3 %
average	2.00	2.03	2.18	2.04	2.19
2000Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	12.9 %	8.6 %	9.3 %	6.7 %	11.6 %
2	75.8 %	77.0 %	72.2 %	86.3 %	79.9 %
3	11.3 %	14.4 %	18.5 %	7.0 %	8.5 %
4	0.0 %	0.1 %	0.0 %	0.0 %	0.0 %
average	1.98	2.06	2.09	2.00	1.97

Table 9

Mass distance function, results for the "small matrix"

2008Q4					
Distance	USD	EUR	JPY	GBP	CHF
1	65.1 %	54.4 %	34.7 %	30.0 %	26.9 %
2	34.9 %	45.5 %	64.9 %	64.7 %	66.9 %
3	0.0 %	0.1 %	0.4 %	5.3 %	6.3 %
4	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
average	1.35	1.46	1.66	1.75	1.79
2008Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	65.0 %	56.3 %	36.7 %	32.9 %	28.9 %
2	35.0 %	43.7 %	63.3 %	63.5 %	69.3 %
3	0.0 %	0.0 %	0.0 %	3.5 %	1.8 %
4	0.0 %	0.0 %	0.0 %	0.1 %	0.0 %
average	1.35	1.44	1.63	1.71	1.73
2007Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	65.6 %	51.5 %	34.0 %	33.8 %	27.3 %
2	34.4 %	48.3 %	60.8 %	61.7 %	59.5 %
3	0.0 %	0.1 %	0.3 %	4.5 %	3.3 %
4	0.0 %	0.0 %	5.0 %	0.0 %	9.9 %
average	1.34	1.49	1.76	1.71	1.96
2004Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	67.5 %	50.7 %	29.4 %	34.5 %	26.9 %
2	32.5 %	48.6 %	63.0 %	61.1 %	58.2 %
3	0.0 %	0.7 %	2.4 %	4.3 %	4.6 %
4	0.0 %	0.0 %	5.1 %	0.0 %	0.3 %
average	1.33	1.50	1.83	1.70	1.58
2000Q2					
Distance	USD	EUR	JPY	GBP	CHF
1	81.5 %	71.1 %	56.3 %	50.5 %	48.6 %
2	18.5 %	28.9 %	43.7 %	48.0 %	50.8 %
3	0.0 %	0.0 %	0.0 %	1.5 %	0.6 %
4	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
average	1.18	1.29	1.44	1.51	1.52

International banking centres: a network perspective[1]

Goetz von Peter

Abstract

International banking centres have attracted renewed interest recently, as established centres compete over more dimensions while new centres emerge. Comparative studies often focus on indicators of financial activity in a particular location, but the prominence of an international banking centre also reflects cross-border linkages with banks in other locations. This feature combines these cross-border linkages into a global network and identifies important banking centres using network methods. The range of measures discussed capture the degree to which banking centres can be considered central to the international banking network.

JEL Classification: F34, G21, L14, C45

The rise of international financial centres is a topic of long-standing interest. Their historical formation has been studied from various angles (Kindleberger (1974), Cassis (2006)). The topic is receiving renewed attention as the pre-eminent global financial centres, London and New York, are increasingly complemented by regional centres such as Hong Kong SAR and Singapore, and as new financial centres in the Arab world seek to establish an international presence. The activities of banks within international financial centres often receive special scrutiny under the heading of international banking centres (eg Choi et al (1996, 2003)).

But what exactly is an international banking centre? Banking centres are often defined as an agglomeration of banking activity in a specific location, performing a range of functions or combining a number of markets. But the term “centre” also conveys a notion of space, that of a position in relation to other locations. From that perspective, a banking centre can be viewed as the centre of a network formed by banking linkages between locations.

Drawing on the BIS international banking statistics, this feature applies methods from the literature on networks to identify banking centres that are particularly well placed or play an important role in international banking. The results, it should be stressed, are not intended as overall rankings of banking centres, for while the network perspective captures international balance sheet linkages, the local aspects emphasised in more traditional assessments are also undeniably important. Rather, the feature intends to show how a new and complementary approach might be used in assessing the vitality of international banking centres.

[1] The views expressed in this article are those of the author and do not necessarily reflect those of the BIS. The author is grateful to Claudio Borio, Patrick McGuire, Frank Packer, Nikola Tarashev, Kostas Tsatsaronis, Christian Upper and Philip Wooldridge for helpful comments.

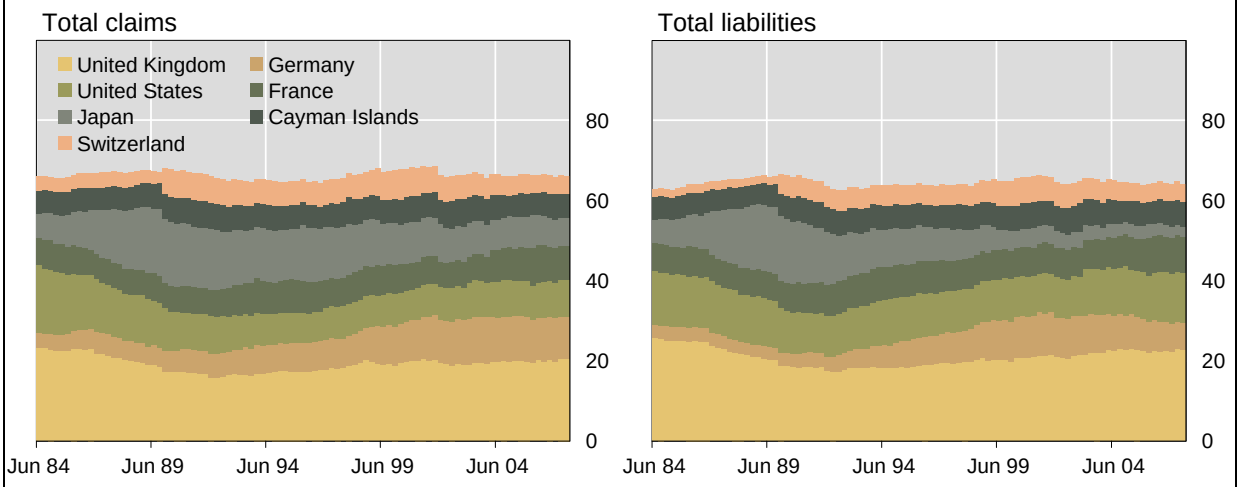
From size to network structure

It is well known that a small number of countries account for a large global share of international banking activity.[2] Graph 1 shows the evolution of market shares in cross-border activity of the largest banking centres. In the second quarter of 2007, banks located in the United Kingdom held 20.4% of international bank assets on their books, and 22.8% of international bank liabilities, largely as a result of international deposit placements. The next largest banking centre is the United States, whose share in liabilities (12.6%) exceeds that in international assets (9.2%), reflecting considerable onlending to the domestic economy. The market share of banks in Japan rose substantially during the 1980s, but reversed thereafter as banks weakened by financial distress withdrew from the international market. The divergences over time in the lower ranks suggest that these positions are more contestable, with banks in Germany, France, the Cayman Islands and Switzerland oscillating in the range of 3–10% of market share.

Market share identifies centres with substantial international banking activity. But what accounts for their size? In what sense are these locations central, and what role do they perform in the international banking system?

Large international banking centres

Market shares in international banking activity, in per cent[1]



[1] Value of total cross-border claims or liabilities booked by banks located in the country identified by the legend, as a share of all BIS reporting banks' total cross-border claims or liabilities vis-à-vis banks and non-banks. Market shares are based on claims and liabilities expressed at constant 2007 Q2 exchange rates.

Source: BIS locational banking statistics. Graph 1

A useful starting point is to observe that market share in international banking activity is evidence that other countries are participating in a financial centre. Banks from foreign countries set up offices in a financial centre to engage in a broad range of financial activities, including information gathering, international borrowing and lending, trading in financial markets, and clearing and settlement of payments and securities (Kindleberger (1974), Gehrig (2000)). In so doing, banks located in the financial centre generate linkages across space, with their headquarters, with foreign offices abroad, or with institutions elsewhere for which they act as correspondent banks.

[2] International banking comprises cross-border activity in all currencies, and operations with domestic residents in foreign currencies. Market share in international banking activity is a standard measure of the size of an international banking centre, and one of many indicators of international financial activity more generally.

The linkages that such an agglomeration of financial activity entails can be regarded as a network.[3] A network consists of a set of nodes connected by links. In the present context, each node represents a banking centre, ie the set of banks located in a particular country or jurisdiction. A link to another centre represents financial claims on entities located there. A network perspective on international banking activity relies on bilateral data. The most comprehensive international banking data with global coverage are the BIS locational statistics. They capture the geography of banking activity in a consistent fashion.[4] Every quarter, banks in 40 reporting countries report their gross stocks of international assets and liabilities, with breakdowns by currency, instrument, and sector (banks versus non-banks). Most importantly for the analysis, positions are reported vis-à-vis 212 countries or jurisdictions. The ability to identify bilateral positions for individual country pairs is a distinct advantage over other international financial data lacking counterparty information.

The network described here includes linkages between banking centres as well as their linkages with non-banks in every location. It is constructed as follows. To keep the focus on banking centres, banks and non-banks within the same country are treated as two separate nodes within the network. (This extends the size of the network to 424 nodes.) The interbank segment, relating banks of different locations to each other, accounts for some 60% of international banking activity, much more than the interbank share in domestic markets.[5] The non-bank segment comprises claims and liabilities booked by banks vis-à-vis every non-bank location. The fact that banks in all reporting countries disclose both assets and liabilities can be exploited to alleviate the problem of an incomplete reporting population.[6]

The pattern and size of linkages in such a network clearly contain a wealth of information. Such information can be used to characterise features of the network as a whole, as in much of the physics literature on networks (Newman et al (2006)). The information can also be used to characterise individual nodes, as in social network analysis concerned with the importance of actors in a group (Wasserman and Faust (1994)). To identify which locations act as international banking centres, this feature builds on the second approach. The idea is to infer, from the pattern of linkages, in what sense a banking centre is central in the international banking network. The results apply to banking centres, and do not extend to financial centres more broadly, partly because links between non-banks are not available in the data.

The analysis takes account of the fact that the international banking network differs from those studied elsewhere in the literature: the network is directed, dense and valued. The

---

[3] Viewing the international banking market as a network also corresponds to the nature of the market. Deals are not made against a central counterparty in a Walrasian market, but through a decentralised web of institutions where bilateral contact plays a central role (eg Stigum (1990)).

[4] The locational banking statistics treat all entities on a residence basis. By contrast, the BIS consolidated banking statistics, while also reporting banks' foreign claims on a residence basis, consolidate reporting banks by their nationality. This mix of residence and nationality principles is appropriate for assessing risk exposure, but less so for network analysis. Hattori and Suda (2007) apply some network measures to the consolidated banking statistics.

[5] Reporting countries generally provide data on banks and other credit institutions with international business, including major investment banks. The interbank data include inter-office claims, ie cross-border positions between offices of the same banking organisation. This geographical relocation of banking activity should not be disregarded.

[6] The procedure overlays reported claims and liabilities, which achieves the following. Banks in Finland, for example, report claims on all other countries including Russia. As a non-reporting country, Russia does not report what entities located there lend to banks in Finland, but this can be inferred from the deposits that banks in Finland report to have obtained from entities in Russia. Positions are observable whenever a reporting bank is on *either* side of the transaction, ie as creditor or as debtor. (Only positions between non-reporting banks and between non-banks remain unobservable.)

network is directed, because a link from Japan to Singapore is not the same as a link in the other direction: the direction indicates which location is holding the claims (ie liabilities of the other location). The network is dense, because 39% of potential links are active, much more than studies find for domestic interbank networks. Moreover, the network is valued, because links are not merely present or absent, but consist of monetary values that vary enormously across space (Gini coefficient 0.94). As a result, at least as important as understanding *where* links are is *how large* the associated exposures are. Since the network literature remains largely silent on valued networks, it is important to employ and extend methods suitable for this case.

Identifying international banking centres by network methods

This section characterises the importance of banking locations according to various network measures that are associated with being an international banking centre (or "global hub"). *Degree, closeness and betweenness* relate to how a centre is connected and positioned in relation to other countries; *intermediation* also takes the size of exposures into account; and *prestige* brings the identity of counterparties into the picture. The measures, derived in the Box, are computed on the entire network (including non-bank locations), but only banking centres are ranked in Table 1.

Degree

To qualify as a global hub, a banking centre should be *well connected* in the international banking network. Being connected to many counterparties enables a banking centre to interact readily with other locations around the globe. This enables hubs to perform a variety of functions, including the global distribution of liquidity (Niehans and Hewson (1976), Johnston (1983)). Connectedness can be quantified by the measure called degree, ie the total number of links that emanate from, or point to, a node.

Banking centres generally establish a presence on both sides of the market. If they borrow from many locations (*in-degree*), they also tend to lend to many locations (*out-degree*; Graph 2, left-hand panel). Interestingly, the most connected hubs, by this measure, take deposit placements from a greater number of locations than they lend to: for instance, banks in the United Kingdom take deposits from 382 locations in the world (90% of all bank and non-bank locations), while lending to 79% of locations. The mid-field settles near 50% on both in- and out-degree, except for Taiwan (China), Korea and Denmark, where banks lend to nearly twice as many locations as they borrow from.

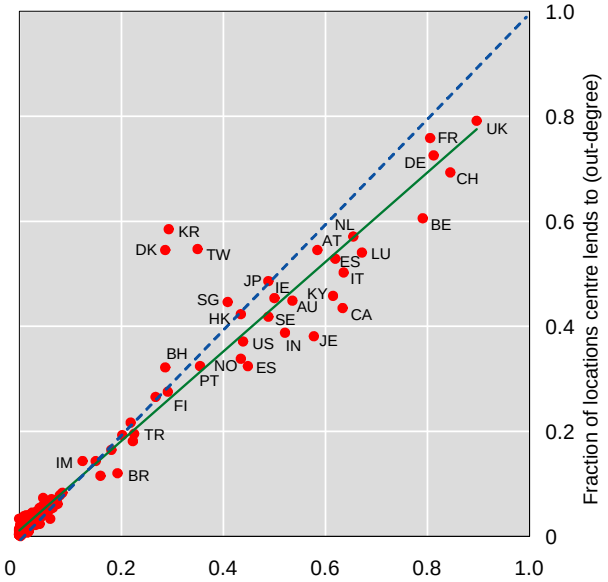
In-degree may be more noteworthy because it reflects the choices of entities abroad to place funds with a centre, whereas out-degree results to a larger extent from a centre's own decisions. The in-degree ranks following the United Kingdom are occupied by Switzerland, Germany, France and Belgium, each chosen as counterparties by over 70% of locations. Some locations are not as well connected as their global market share would suggest. The United States and the Cayman Islands, ranked second and fourth on market share, rank 20th and 11th on in-degree, respectively.[7] By contrast, the banking centres of Canada, Macao and India are highly connected for their size, and post corresponding gains relative to their rank based on market share.

[7] This is partly explained by the caveat that the United States does not report the full country breakdown for all regions. Excluding known unreported countries raises US in-degree to 46% (rank 19). A different way of addressing the issue is to merge the Cayman Islands (reporting a full breakdown) with the United States in a single node; their combined in-degree equals 65% (rank 8).

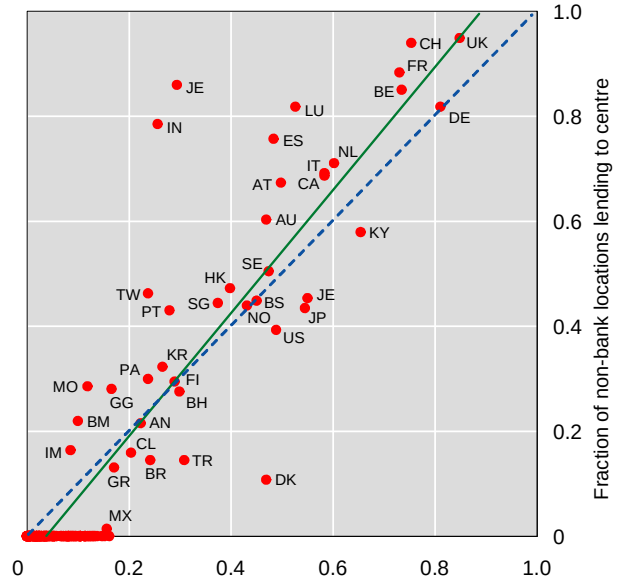
Relations with non-banks contribute materially to the in-degree of several banking centres (Graph 2, right-hand panel). Indeed, the most connected hubs, together with Jersey and Luxembourg, have liabilities to non-banks virtually everywhere in the world. Banks in Jersey and India receive funds disproportionately from non-bank counterparties – they engage in sectoral transformation from non-bank liabilities to interbank claims. By contrast, banking centres below the 45° line derive their degree to a greater extent from the interbank market. This group includes several important emerging markets, such as Brazil, Chile, Mexico and Turkey.

Connectedness of banking centres

In- and out-degree[1]



In-degree by sector of counterparty[2]



The BIS reporting countries are: Australia (AU), Austria (AT), the Bahamas (BS), Bahrain (BH), Belgium (BE), Bermuda (BM), Brazil (BR), Canada (CA), the Cayman Islands (KY), Chile (CL), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Guernsey (GG), Hong Kong SAR (HK), India (IN), Ireland (IE), the Isle of Man (IM), Italy (IT), Japan (JP), Jersey (JE), Korea (KR), Luxembourg (LU), Macao (MO), Mexico (MX), the Netherlands (NL), the Netherlands Antilles (AN), Norway (NO), Panama (PA), Portugal (PT), Singapore (SG), Spain (ES), Sweden (SE), Switzerland (CH), Taiwan, China (TW), Turkey (TR), the United Kingdom excluding islands (UK) and the United States including international banking facilities (US).

Each point represents a banking centre. Its position in the plane shows the fraction of locations with which the banking centre has a direct connection as indicated by the axis labels. The green line represents the least squares regression, while the blue line is a 45° line of equality.

[1] Compares assets (out-degree) and liabilities (in-degree). [2] Separates in-degree into bank and non-bank locations. Graph 2

Table 1

International banking centres

	Market share[1]	Measures of network centrality[2]				
		In-degree	Closeness	Betweenness	Intermediation	Prestige
United Kingdom	22.1 (1)	89.7 (1)	0.82 (1)	12.8 (1)	20.5 (1)	8.59 (1)
United States[3]	12.9 (2)	43.9 (20)	0.60 (24)	1.4 (25)	4.3 (5)	4.46 (2)
France	6.6 (3)	80.5 (4)	0.80 (2)	9.9 (2)	15.7 (2)	3.79 (3)
Cayman Islands	6.1 (4)	61.5 (11)	0.63 (15)	2.7 (12)	1.4 (16)	1.87 (6)
Germany	5.6 (5)	81.2 (3)	0.77 (3)	8.2 (3)	9.5 (4)	2.60 (5)
Switzerland	4.5 (6)	84.5 (2)	0.75 (4)	8.2 (4)	11.0 (3)	3.56 (4)
Ireland	3.6 (7)	50.0 (16)	0.63 (16)	1.6 (21)	0.8 (25)	1.04 (12)
Netherlands	3.5 (8)	65.5 (7)	0.69 (7)	3.6 (6)	2.8 (8)	1.38 (8)
Belgium	2.9 (9)	79.1 (5)	0.70 (5)	5.5 (5)	3.3 (7)	1.75 (7)
Italy	2.8 (10)	63.6 (8)	0.65 (13)	2.6 (14)	1.3 (19)	1.02 (13)
Spain	2.6 (11)	62.0 (10)	0.67 (12)	3.0 (10)	2.1 (12)	1.07 (11)
Japan	2.6 (12)	48.8 (18)	0.65 (14)	2.1 (15)	0.9 (24)	0.81 (17)
Luxembourg	2.5 (13)	67.1 (6)	0.67 (11)	3.1 (9)	1.9 (13)	1.19 (9)
Singapore	2.0 (14)	40.9 (23)	0.63 (18)	1.7 (19)	2.4 (10)	0.97 (15)
Australia	1.7 (15)	53.5 (14)	0.63 (17)	3.3 (7)	2.7 (9)	1.02 (14)
Rank correlation[4]	*1.00*	*0.85*	*0.71*	*0.68*	*0.66*	*0.95*
Largest relative change[5]		Positive				
		CH +4	KO +21	CA +11	AT +14	PA +23
		LU +7	TW +17	TW +14	AW +99	JE +6
		CA +10	DK +13	AU +8	IN +16	CH +2
		IN +16	AT +11	SV +53	PA +27	LU +4
		BE +4	PK +44	KE +60	CH +3	MO +11
		Negative				
		CR –31	MT –28	VN –130	CR –79	HR –8
		SG –9	KZ –42	SK –118	VN –129	IS –8
		IE –9	IE –9	IE –14	SK –117	NO –5
		KY –7	KY –11	KY –8	IE –18	JP –5
		US –18	US –22	US –23	KY –12	IE –5

Aruba (AW), Australia (AU), Austria (AT), Belgium (BE), Canada (CA), the Cayman Islands (KY), Croatia (CR), Denmark (DK), El Salvador (SV), Hungary (HR), Iceland (IS), India (IN), Ireland (IE), Japan (JP), Jersey (JE), Kazakhstan (KZ), Kenya (KE), Korea (KR), Luxembourg (LU), Macao (MO), Malta (MT), Norway (NO), Pakistan (PK), Panama (PA), Singapore (SG), Slovakia (SK), Switzerland (CH), Taiwan, China (TW), the United Kingdom excluding islands (UK), the United States including international banking facilities (US) and Vietnam (VN).

[1] Market shares are calculated on total international bank liabilities excluding liabilities to bank residents. For non-reporting countries, bank liabilities are inferred from the interbank claims of BIS reporting banks (their liabilities to non-banks remain unobserved). [2] In-degree, betweenness and intermediation are expressed in per cent, closeness as an inverse distance, and prestige is normalised to sum to 100. Refer to the Box for details. [3] Calculating the measures on a network restricted to those countries on which the United States fully reports raises the US rank on in-degree (to 19) and closeness (to 22). [4] Kendall rank correlation with the ranking of 212 banking centres on market share. [5] Centres with the largest relative change in their rank, compared to their rank on market share.

Source: BIS.

Closeness

A second network criterion is that a banking centre aspiring to a global position should be *close* to the rest of the world. A suitable measure of closeness, which allows for direct and indirect linkages, is the inverse of the average "distance" from a banking centre to all other locations, where distance refers to the number of links on the shortest path (see Box). Thus one half would be the score of a banking centre that, on average, reaches other locations in two steps. The maximum score of 1 would be attained by a global hub directly connected to all locations.

While large banking centres tend to be strongly connected to each other as well as to the major economies, the closeness measure helps identify those centres with the broadest reach to smaller and more remote countries. The United Kingdom leads the closeness ranking, with a score of 0.82 (implying an average distance to other locations of 1.22; Table 1). However, the topology of international banking does not resemble a pure star network in which a single centre connects all other nodes, since several other banking centres are also well placed to reach remote areas (Graph 3). Four European centres attain scores over 0.7, and five Asian centres one of over 0.6. Indeed, Korea and Taiwan (China) post the largest gains in their ranking, relative to that based on market share, as a result of diversifying their lending across many locations.

The closeness of an international banking centre may be particularly important from the perspective of small and remote countries. Suppose a bank from a small Asian country sets up an office in Hong Kong SAR, for example, in order to access a global pool of liquidity or to finance trade with third parties. The resulting linkage effectively moves the country closer to Hong Kong, in a network sense. This not only raises (marginally) Hong Kong's closeness score, but also raises (perhaps substantially) the small country's score because it is now only two steps away from all of Hong Kong's counterparties. The presence of foreign banks is indeed one of the most cited features of financial centres (Reed (1981), Choi et al (1986, 1996, 2003)). The BIS locational statistics also show that major centres host many foreign banks (Table 2). The broad representation of banks from emerging markets in the United Kingdom helps to explain its remarkable global reach.

Table 2

Representation of foreign banks in international banking centres[1]

	CH	FR	HK	SG	UK
Number of BIS reporting banks[2]	108	268	194	153	337
Headquartered in the reporting country	41	120	19	5	73
Headquartered in another reporting country	53	127	131	126	198
Headquartered outside the reporting area	14	21	44	21	61

[1] Shown here: Switzerland (CH), France (FR), Hong Kong SAR (HK), Singapore (SG) and the United Kingdom (UK). [2] Only the main office of a bank is recorded, regardless of the number of offices the bank maintains in the country. The number of banks headquartered outside the reporting area of 40 BIS reporting countries is indicative of the representation of banks from emerging markets. (The columns add to less than the total number of reporting banks in some cases because of unallocated banks.)

Source: BIS locational banking statistics.

Betweenness

Locations that are not directly linked can reach each other through banks in a third country. The important role such middlemen play in a network is captured by the following criterion: to qualify as a global hub, a banking centre should be in a position to connect other locations with each other. This can be quantified by betweenness, the frequency with which a banking

centre lies on the shortest path between two unconnected locations (see Box). A high score on this criterion can be thought of as measuring a centre's ability to bring together customers from both sides of the market (lenders and borrowers).

Among the largest banking centres, the ranking differs little from that based on market share. Banks in the United Kingdom have a 13% chance of being on the shortest path between any two unconnected locations (non-bank locations included). Banks in Germany, France and Switzerland follow closely, but perhaps for a different reason. The United Kingdom's score reflects London's position as a host to many foreign banks, whereas Germany, France and Switzerland are home to multinational banks generating considerable inter-office activity across borders. The ranking differs more in the mid-field, indicating that betweenness captures an aspect of banking centres quite distinct from their size (the rank correlation with market share is 0.65; Table 1). The gains in ranking witnessed by Canada, Taiwan (China) and Australia suggest that their banking centres are positioned strategically with respect to some region or part of the network.

Intermediation

To qualify as a global hub, a banking centre should also perform an important intermediary role in the international banking network. There can be many intermediaries between any pair of unconnected locations.[8] Since the betweenness measure treats each path (hence each intermediary) as equivalent, regardless of value, it may underestimate the importance of hubs as focal points. The intermediation measure proposed here captures the intensity of links by incorporating the portfolio shares of each banking centre's international claims. The measure calculates the share of each sender's portfolio that a banking centre transports to every recipient, and averages this product of shares across all country pairs (see Box).

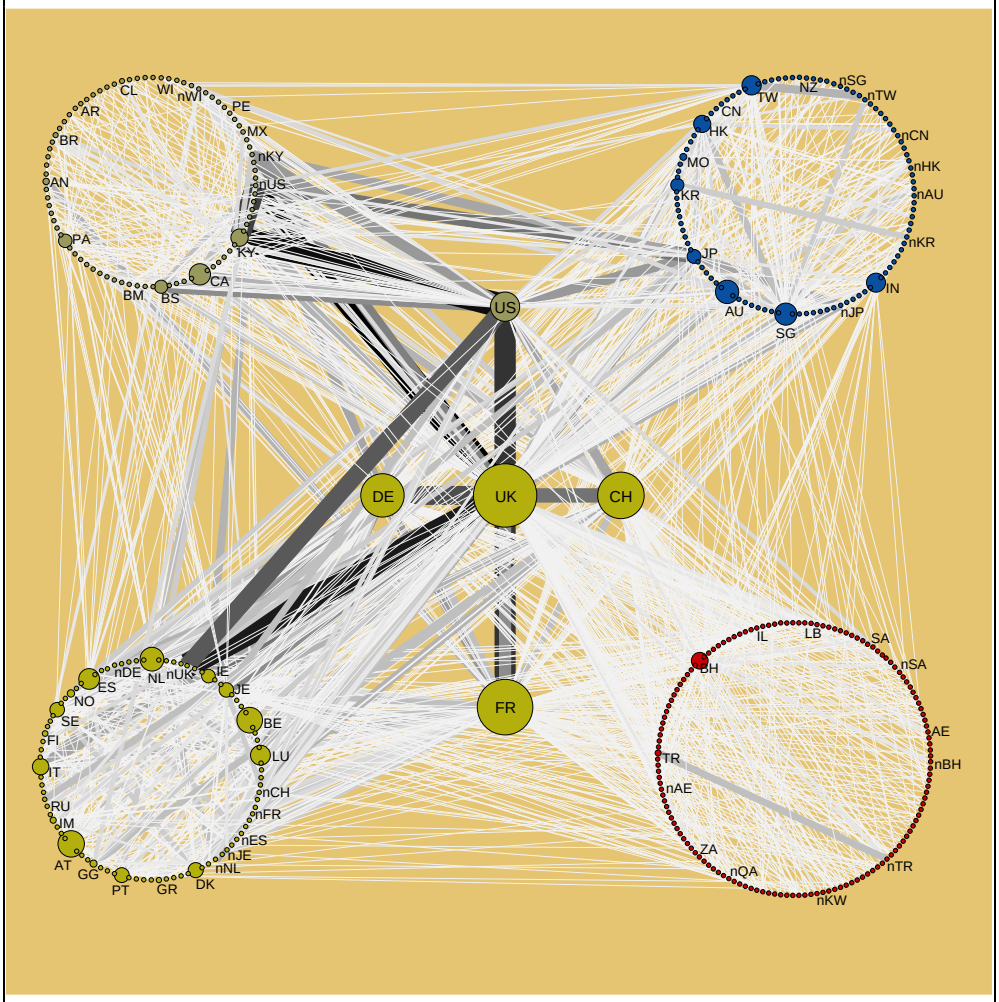
The largest hubs also appear as the most important intermediaries (Table 1). The likelihood that a dollar transferred between any country pair goes through the United Kingdom is highest (20%), followed by France, Switzerland, Germany and the United States. For the large banking centres, the intermediation measure tends to exceed betweenness, which indicates that large hubs are the preferred conduits when there are several paths. This is not because they would send a large share of their portfolio to each recipient, but because they receive such a high portfolio share from many locations. This also explains why intermediation correlates with size: taking deposits enlarges a hub's reported size.

However, not all banking centres perform an intermediation function commensurate with their size. Some large offshore centres score quite low on global intermediation, because they concentrate their positions on a few locations, eg the Cayman Islands on US entities. Conversely, some mid-sized centres attain a high score through a combination of connectedness and specialisation. Specifically, decomposing the intermediation measure by sector shows banks in Switzerland to be the main intermediary between non-bank pairs, while banks in the United Kingdom lead the ranking for pairs with banks on either side. Similarly, calculating intermediation separately for pairs across and pairs within the same continent demonstrates the importance of global and regional hubs. While the largest banking centres are truly global hubs intermediating across all continents, a significant regional role is played by banks in Austria and Denmark (within Europe), Canada and Panama (Americas), Bahrain (Africa and the Middle East), as well as Singapore, Hong Kong

[8] This is a consequence of high density in the international banking network. For the 212 banking locations (plus as many non-bank locations), there are $n(n–1)$, nearly 180,000 pairs in the directed network. Of about 168,000 pairs with no reported link from one location to the other, 91% can be linked through an intermediary, of which there are eight on average.

SAR and Australia (Asia-Pacific).[9] The presence of global and regional banking hubs can be visualised in a network graph (Graph 3). Each banking centre is shown in a size proportional to its intermediation score.

Global and regional hubs in the international banking network



The graph shows the linkages between 212 banking centres and their linkages with 212 non-banks. Each location is represented by a node. The size of the nodes is proportional to the measure of intermediation (Table 1). The colour of the nodes represents the continent (red for Africa and the Middle East, green for the Americas, blue for Asia-Pacific and mustard for Europe). The labelled locations include banks in 40 BIS reporting countries (for the country codes, see Graph 2), plus banks in Argentina (AR), China (CN), Israel (IL), Lebanon (LB), New Zealand (NZ), Peru (PE), Russia (RU), Saudi Arabia (SA), South Africa (ZA), and the West Indies, UK (WI). Non-bank locations, where labelled, carry the prefix "n", eg Kuwait (nKW), Qatar (nQA) and the United Arab Emirates (nAE). The thickness and shading of linkages reflect the value transacted between two locations (calculated as the square root of the sum of bilateral claims). To simplify the graph, linkages with a value less than 2.5% of the portfolios of both locations are not shown. Graph 3

[9] Some of these centres concentrate their portfolios on a set of countries weakly connected to the global hubs. For example, banks in Austria, due to their extensive relations with eastern Europe, advance to rank 1 within Europe. Similarly, banks in Bahrain specialise in attracting petrodollar deposits throughout the Middle East.

Prestige

An aspect that has not received attention in the analysis so far is the identity of the counterparties that relate to a banking centre. This is taken into consideration in the following criterion: a banking centre is an important hub if the centres lending to it are themselves important. The idea that the *prestige* or status of an actor derives from the importance of those nominating him is borrowed from sociology. To compute prestige, each centre receives the same initial score, to which one then adds a term involving the scores of its creditors, weighted by their respective portfolio shares. The prestige scores are then determined simultaneously in a system of equations (see Box).

The results identify as important hubs those centres that also scored highly on other criteria, particularly on market share (Table 2). The United States reclaims the second rank, because having fewer links is offset by the fact that important centres deposit sizeable shares of their portfolios with banks located there. These include the United Kingdom, Jersey, France and the Caribbean offshore centres (notably the Cayman Islands and the Bahamas). The Cayman Islands are highly ranked due to their large bilateral link with entities in the United States. The ranks gained by Jersey, Switzerland and Luxembourg can also be attributed to their large liabilities to major international hubs. Hubs bestow importance on each other due to the intensive bilateral links between them. These "highways" on which international banking flows are channelled are highly persistent from quarter to quarter, judging by the constancy in the ranking of links by size. Accordingly, the major linkages in the international banking network visible in Graph 3 also remain stable over time.

Conclusion

This feature proposes to view the international banking market as a global network in order to identify international banking centres based on the position they occupy in relation to other locations. The range of measures developed from this perspective illustrates that size is only one indicator of a banking centre's multifaceted dimensions. Although the best connected and most central locations are generally also the largest centres, an important network position need not come with size. Where the network measures deviate from market share, they provide complementary information on the role of a centre in the international banking system, eg one of regional intermediation. Just as interestingly, where these measures coincide with size, as for most top-tier banking centres, they may help explain market share: a central position attracts deposits and the participation of foreign banks and thereby contributes to reported size.

The presence of banking hubs is also an important characteristic of domestic banking systems.[10] That such a characteristic would reproduce itself at the global level is perhaps not surprising, in view of the extensive international activities of the largest banks of various nationalities. Policymakers seem aware of the benefits and issues surrounding financial centres. Yet the formal economics and finance literature offers little guidance on the possible implications for efficiency and stability that such a centralised financial structure with cross-border linkages entails.

[10] Recent studies cover Austria (Boss et al (2004)), Italy (Iori et al (2007)) and Switzerland (Müller (2003)). Hubs also characterise payment system networks, eg in Japan (Inaoka et al (2004)) and the United States (Soramäki et al (2007)).

Selected network measures for identifying banking centres

The network can be expressed in matrix form. The typical element B_{ij} records the value of claims of entities located in country *i* on entities in country *j*. The network includes banks and non-banks, treated as separate nodes for each of the countries or jurisdictions (212 currently). Hence each index runs from 1 to $n = 424$. The matrix can be read in two directions: rows of B represent claims of location *i* on location *j*, and columns of B represent liabilities of *j* to each *i*. All diagonal elements B_{ii} are zero, and off-diagonal elements are positive, or zero if there is no associated link. Since linkages between non-reporting banks and between non-banks are not observable, the matrix contains an unobserved block of size $(n-r)^2$, where r is the number of reporting countries ($r = 40$ currently). The network is directed, dense and valued, hence B is not symmetric and contains many non-zero entries, each stating claims in millions of US dollars.

The network measures in this feature relate to individual nodes. Each captures an aspect of network centrality of banking centres. To clarify what information they use, the measures are expressed in terms of two variants of B. The first, N, only records links regardless of their monetary value: $N_{ij} = 1$ if $B_{ij} > 0$, and 0 otherwise, for all *i*,*j*. The second, P, contains portfolio shares, obtained by scaling each centre's claims on other locations by the size of its overall lending to other locations, $P_{ij} = B_{ij} / \sum_k B_{ik}$, for all *i*. *Degree*, *closeness* and *betweenness* use N, whereas *intermediation* and *prestige* rely on P.

Degree is the number of links that emanate from, or point to, a node. The two senses differ in directed networks. There is a direct link from node *i* to *j* if $N_{ij} = 1$. Node *i*'s out-degree is the row sum of N, $\sum_j N_{ij}$, whereas its in-degree is the column sum, $\sum_j N_{ji}$. Dividing by the maximum attainable degree, $(n-1)$, yields degree as reported in Table 1. The histogram of the number of nodes of given degree is known as the degree distribution.

Closeness and *betweenness* rely on path counts. If *i* links to *k* and *k* links to *j*, the product $N_{ik}N_{kj} = 1$. Hence the sum $\sum_k N_{ik}N_{kj}$ gives the number of paths from *i* to *j* of length two. More generally, the matrix power N^p counts indirect paths of length p. The distance from *i* to *j* is the length of the shortest path, $\delta_{ij} = \min_p [N^p]_{ij} > 0$. It equals one when there is a direct link, two when *i* reaches *j* in two steps via another location, and so on. The average distance from *i* to all other nodes equals $(n-1)^{-1} \sum_j \delta_{ij}$, and *closeness* is its inverse. *Betweenness* focuses on the nodes that the shortest path passes through. Let g_{jk} denote the number of shortest paths between *j* and *k*, and $g_{jk}(i)$ the number of those going through node *i*. The probability that *i* is on a (randomly chosen) shortest path from *j* to *k* equals $g_{jk}(i) / g_{jk}$. *Betweenness* of node *i* is the sum of these probabilities over all pairs excluding *i*, $\sum_{j \neq i} \sum_{k \neq i} g_{jk}(i) / g_{jk}$ divided by the maximum this sum can attain, $(n-1)(n-2)$.

The *intermediation* measure extends betweenness by taking portfolio shares into account. The quantity $[P^2]_{ij} = \sum_k p_{ik} p_{kj}$ is the total probability that a dollar sent by *i* reaches *j* in two steps. Any location *k* for which $p_{ik} p_{kj} > 0$ is an intermediary to the pair (*i*,*j*). The main intermediary is identified as the one transporting the greatest share of the sender's portfolio to the recipient, $h = \arg\max_k p_{ik} p_{kj}$ (provided $[P^2]_{ij} > 0$). This means that a dollar sent by *i* has a higher likelihood of reaching *j* through *h* than through any other banking centre. Conditional on *j* receiving a dollar from *i*, the likelihood that it is through *k* equals $p_{ik} p_{kj} / [P^2]_{ij}$. The intermediation measure for a centre *k* is obtained by summing these probabilities across all pairs (*i*,*j*) and normalising by the total number of pairs $n(n-1)$. Instead of a probability, the main intermediary count gives one point, for each pair, to the main intermediary (and zero to all other intermediaries).

Finally, *prestige* considers in addition the identity of counterparties. The score of a banking centre *i* consists of the scores of *i*'s creditors weighed by their portfolio shares vis-à-vis *i*, $v_i = \sum_j P_{ji} v_j$. This defines a linear system, $v = P'v$, with a non-trivial solution given by the eigenvector associated with the unit eigenvalue. (This is known as Bonacich centrality.) It is preferable to solve the related system $v = \alpha P'v + e \Rightarrow v^* = (I - \alpha P')^{-1} e$, where e is the unit vector embodying exogenous importance. (This avoids countries with a zero score contributing nothing to the centrality of others.) The weight on endogenous factors is chosen as $\alpha = 1/2$, half the unit eigenvalue. Prestige handles valued networks, and takes indirect paths into account through the centrality scores of counterparties.

References

Boss, M, H Elsinger, M Summer and S Thurner (2004): "Network topology of the interbank market", *Quantitative Finance* 4.

Cassis, Y (2006): *Capitals of capital: a history of international financial centres*, *1780–2005*, Cambridge University Press.

Choi, S, A Tschoegl and C Yu (1986): "Banks and the world's major financial centers, 1970–1980", *Weltwirtschaftliches Archiv* 122(1).

——— (1996, 2003): "Banks and the world's major banking centers", *Welt-wirtschaftliches Archiv* 132(4) and 139(3).

Gehrig, T (2000): "Cities and the geography of financial centers", in *Economics of cities: theoretical perspectives*, Cambridge University Press.

Hattori, M and Y Suda (2007): "Developments in a Cross-Border Bank Exposure 'Network'", proceedings of a CGFS workshop held at the Bank for International Settlements.

Inaoka, H, T Ninomiya, K Taniguchi and T Shimizu (2004): "Fractal network derived from banking transactions – an analysis of network structures formed by financial institutions", *Bank of Japan Working Paper* no 04-E-04.

Iori G, G de Masi, O Precup, G Gabbi and G Caldarelli (2007): "A network analysis of the Italian overnight money market", *Journal of Economic Dynamics and Control*, forthcoming.

Johnston, R (1983): *The economics of the euro-market: history, theory and policy*, Macmillan, New York.

Kindleberger, C (1974): "The formation of financial centers: a study in comparative economic history", *Princeton Studies in International Finance,* no 36.

Müller, J (2003): "Two approaches to assess contagion in the interbank market", manuscript.

Newman, M, A Barabási and D Watts (eds) (2006): *The structure and dynamics of networks*, Princeton University Press.

Niehans, J and J Hewson (1976): "The eurodollar market and monetary theory", *Journal of Money, Credit and Banking* 8(1).

Reed, H (1981): *The preeminence of international financial centers*, Praeger Publishers.

Soramäki, K, M Bech, J Arnold, R Glass and W Beyeler (2007): "The topology of interbank payment flows", *Physica* A 379.

Stigum, M (1990): *The money market*, 3rd edition, The McGraw-Hill Companies, Inc.

Wasserman, S and K Faust (1994): *Social network analysis: methods and applications*, Cambridge University Press.

Banking globalization and monetary transmission[1]

Nicola Cetorelli and Linda S Goldberg

Abstract

Globalization of banking influences the monetary transmission mechanism both domestically and with respect to foreign markets. Using quarterly information from all US banks filing call reports between 1980 and 2005, we provide evidence of a specific role of global banks in international transmission of liquidity shocks. Globalized banks activate internal capital markets between the parent banks and their overseas affiliates, using this channel as a way of partially insulating themselves from changes in domestic liquidity conditions. These internal capital markets of global banks directly contribute to the international propagation of domestic liquidity shocks into the lending done by their foreign offices. These results imply a substantially more active lending channel than previously documented, but also imply that the lending channel *within* the United States is declining in strength as banking becomes more globalized, while the transmission abroad is likewise increasing in strength.

JEL Classification: E44, F36, G32

Keywords: international transmission, monetary policy, bank, global, liquidity, lending channel, internal capital markets

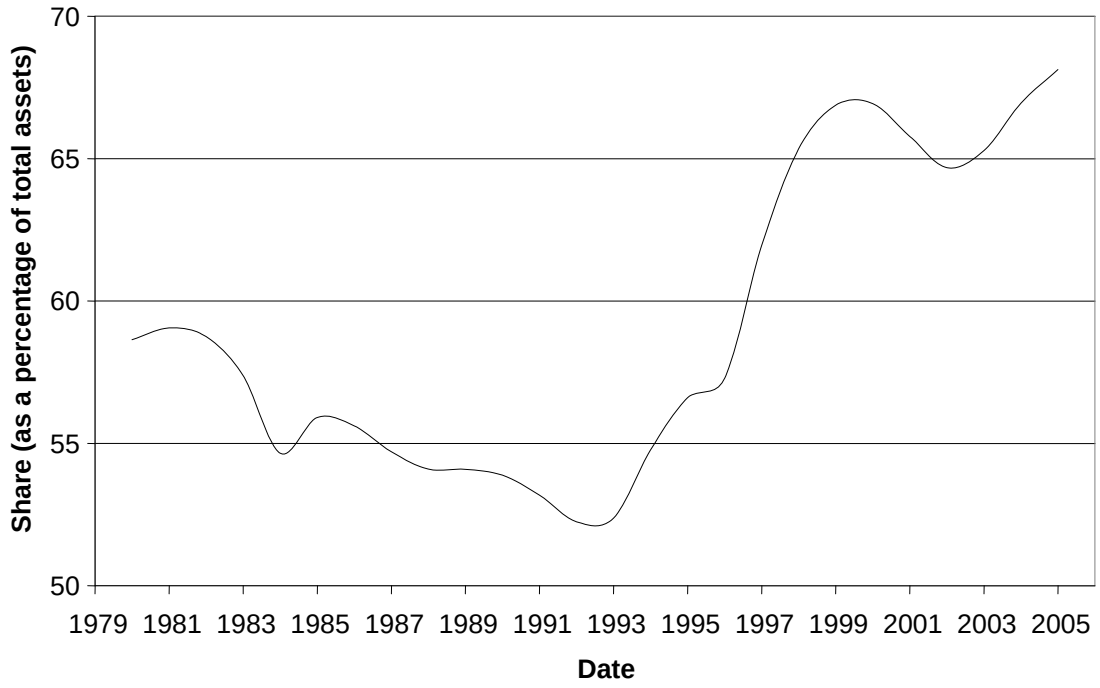
1. Introduction

How does banking globalization affect monetary policy transmission? Reflecting a general trend toward increasingly globalized financial markets, a rising share of total US banking assets has been accounted for by banks with significant operations in foreign countries (Figure 1). In this paper we explore the implications for monetary policy of this first-order transformation of the US banking industry. In particular, we take as a starting point the established evidence that a key channel of monetary policy effectiveness is through the impact on bank lending. We then show that banking globalization affects the transmission mechanism domestically and it introduces a specific *international* propagation mechanism.

---

[1] The views expressed in this paper are those of the individual authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System. We appreciate valuable discussions with Anil Kashyap, Jeremy Stein, Phil Strahan, and Adam Ashcraft and seminar and conference participants at the Bundesbank, IMF, ECB, BIS, and University of Alabama. We also thank Sarita Subramanian, Nikki Candelore, and Victoria Baranov for research assistance. Address correspondences to Nicola Cetorelli or Linda S Goldberg, Federal Reserve Bank of NY, Research Department, 33 Liberty St, New York, NY 10045. email: Nicola.Cetorelli@ny.frb.org, or Linda.Goldberg@ny.frb.org.

Figure 1
Share of total US bank assets in globally-oriented US banks



We conjecture that banks with international operations can respond to a domestic liquidity shock by activating a cross-border, internal capital market between the head office and its foreign offices, thus reallocating funds on the basis of relative needs. Because of this potential access to internal capital markets with foreign offices, global banks are more likely to be insulated from monetary policy. However, this does not necessarily mean that the lending channel is less effective. Indeed, if global banks respond to a liquidity shock through an internal reallocation of funds, their foreign lending may be affected. Hence, banks going global may increase the *international* propagation of domestic monetary policy.

The data we examine, which is quarterly data for all US banks between 1980 and 2005 yielding nearly 1.2 million observations by banks and dates, shows that bank globalization has an independent effect on monetary policy effectiveness at home and abroad. We identify an internal capital market between domestic and foreign operations as a specific mechanism through which global banks react to liquidity shocks. We show that this internal capital market channel, unique to global banks, allows insulation domestically but also enhances international shock transmission.

We test our conjecture with a set of alternative, complementary empirical strategies. We begin by providing indirect, and yet insightful, evidence of the importance of globalness, and then proceed by directly looking for the existence of the internal capital market channel and concluding with specific evidence of the propagation of the shocks to the balance sheet of the foreign offices of global banks.

That banks – as other business organizations – have active internal capital markets is not new, and their effect on the domestic lending channel has been shown, among others, by Campello (2002). Also, evidence on an international transmission channel through banking is

associated with the work, for example, of Peek and Rosengren (1997, 2000).[2] However, and to the best of our knowledge, we are the first to document a systematic relationship between bank globalization and monetary policy, and we are also the first – as we argue below – to provide *direct* evidence of a functioning internal capital market by analyzing actual internal funding flows between banks' head offices and their foreign offices.

While we argue that global banks are more insulated from home liquidity conditions, a legitimate counter argument could be that global banks are especially large banks, as expansion into significant international activity presumably requires a pre-existing large scale of operation. Indeed, Figure 2 shows that most global banks are large banks. Kashyap and Stein (1994, 1995, 2000) already have shown that large banks have potentially unencumbered access to external capital markets and the largest banks, those in the top 5 percent of the asset distribution, are virtually unaffected by monetary policy (Kashyap and Stein 2000). It thus seemed natural to start by expanding on Kashyap and Stein (2000). If all that matters is size, we should find that large banks are insulated from monetary policy shocks irrespective of whether they have global operations or not. Hence, we looked at banks in the top 5 percent of the asset distribution but we separated these large banks into two clusters, based on whether they had or did not have global operations. We find that large, global banks are indeed insulated from monetary policy, but similarly large banks with domestic-only operations are instead found to be more sensitive to monetary policy than previously thought.

Figure 2
Most global banks are large banks

We show that the differences across large banks are robust across various econometric approaches meant to control for potential size heterogeneity even within these two cohorts of large banks. We also show that the results are robust, in fact stronger, to a potential endogeneity bias embedded in the original Kashyap and Stein's identification strategy.

[2] On internal capital markets in banks see also, eg Houston, James and Marcus (1997), Ashcraft (2006), Ashcraft (2008) and Ashcraft and Campello (2007).

Another possible critique to our results and the methodology applied is that potential simultaneous changes in loan demand might contaminate the results. Since large, global banks are likely to face a different loan demand (perhaps more globally-oriented type of firms) than large, non-global banks, it is possible that by splitting the sample of large banks in the two sub clusters, our results may be partially driven by existing systematic differences in loan demand behavior. We handle heterogeneous demand in a way that, in fact, brings with it additional insights: we look at *small* banks that are connected with large banks via bank holding company (BHC) affiliation. Small banks are much more likely to face homogeneous loan demand, and – as already shown by Campello (2002) – they benefit from insulation if they are part of a BHC that also includes a large bank. We expand on Campello's (2002) insight by separating small banks affiliated with large, global banks from those affiliated with large, but non-global banks. Using the data on these banks as instruments, we find that the first group is insulated from monetary policy but the second group is not.

These first two pieces of evidence are very insightful in that they suggest that a larger fraction of the banking system is affected by monetary policy through the lending channel than previously thought: large banks but with a domestic-only dimension, and small banks in BHCs that do not contain large, global banks. However, these are at best only indirect tests of the importance of globalness and they offer no indication of the mechanism through which globalness should allow for insulation.

Our argument presupposes that global banks activate an internal capital market, moving resources between parent and foreign offices in response to domestic monetary policy changes. We provide *direct* evidence that this is indeed what is occurring. US banks are required to report quarterly the value of the net liabilities (or claims) between the head office and the foreign offices. Outright internal borrowing or lending within the banking organization is a major component of these flows. These data provide an unusual opportunity for a direct test of the existence of an internal capital market: data on borrowing and lending *within* an organization, between its different components, is – to the best of our knowledge - hardly ever available.[3] Accordingly, we directly test whether cross-border, internal flows of funds within a banking organization are systematically associated with changes in US monetary policy. The results are both significant and supportive: In times of tighter monetary policy in the United States, internal funds show a greater tendency to flow *from* foreign operations *to* the US head office of a global bank (or flow by a smaller amount to the foreign operations), and vice versa with US expansionary policy. These results are robust to controlling for changes in domestic demand and changes in the opportunity cost of allocating funds abroad.

Further, we show that such cross border, internal capital markets are especially active in banks that may have relatively more difficulties in raising external funds at home: we examined differential responses across banks with high or low capital to asset ratios, with this variable proxying for the ability of an institution to raise additional external liabilities. We find that banks with low capitalization ratios are the ones to mobilize funds more internally in response to domestic shocks.

Finally, we show that this internal capital market channel directly influences the lending activity abroad by US global banks, thus establishing evidence of the international propagation mechanism that we have conjectured. Two types of econometric evidence are provided. First, we perform an analysis of the strength of the relationship between the bank's lending through offices abroad and the parent bank balance sheet. In the spirit of traditional approaches that investigate internal capital market channels, if such capital markets are at

[3] For this reason, evidence on the existence of internal capital markets is typically derived indirectly by looking at the *performance* of one side of an organization in response to a shock to the other side. De Haas and Lelyveld (2009) are a recent application using multinational bank data.

work, the reliance of foreign lending activity on the parent balance sheet should be directly affected by domestic monetary policy. Our tests confirm this prior.

Second, we also test more directly if foreign lending changes with internal capital market transfers within the global banking organization. This lending response does not have to occur. The bank may have margins of adjustments on its balance sheet that could still potentially insulate their foreign lending books. However, we show that for those banks with low level of liquid assets – the potential cushion that could prevent changes in lending – an increase in internal lending *to* the head office in times of monetary policy contraction corresponds to a decrease in their (external) foreign lending. The results both substantiate our main conjecture that globalness matters and identify a specific channel of *international* transmission of US monetary policy to foreign markets.

Taken together, our results show that monetary policy consequences for lending may not be declining in effectiveness overall but, rather, may be increasingly felt abroad and outside of the traditional purview of observation. Again, as had also been argued by Peek and Rosengren (1997, 2000), we find that banks are specifically involved in the international transmission of shocks, and emphasize a direct mechanism for spillovers like those documented in analyses of macroeconomic data, as in Kim (2001), Neumeyer and Perri (2005), and Canova (2005).[4]

Our findings introduce a new dimension to the debate on globalization effects on monetary policy and real activity in the United States. While contributors to this debate focus on issues like whether the Phillips Curve has flattened (for example, Yellen 2006, Bernanke 2006, Ihrig et al 2007, and Sbordone, 2007), we argue that globalization of banking has consequences for the transmission of monetary policy to the real economy and foreign markets through the lending channel, with the internal capital markets at work within global banks playing a key role.

2. Identification strategy

Indirect tests per Kashyap and Stein (2000). The lending channel of monetary policy, exposited in Bernanke and Blinder (1992), maintains that tight money should reduce the volume of reservable deposits held by depository institutions.[5] Bank lending changes due to monetary policy because a bank faces a significant wedge between the cost of acquiring insured, reservable deposits and the cost of acquiring funds such as large denomination CDs, money market funds, and securities. Hence, a contractionary monetary policy that drains bank reserves from the economy and reduces the amount of reservable deposits, may translate into a reduction in bank lending activity if banks are unable to replace each dollar of deposits with other funds.

The Kashyap and Stein (2000) methodology has the merit to have provided a tight identification strategy to test for the existence of a bank lending channel. Their approach is

[4] Kim (2001) provides evidence on international transmission of US monetary policy shocks in the context of a VAR framework. For transmission to emerging markets, Neumeyer and Perri (2005) emphasize the role of world interest rates in emerging market business cycles, and Canova (2005) focuses on transmission of US shocks to Latin America. Other studies highlight the role of exchange rate regime selection in such transmission, as in Di Giovanni and Shambaugh (2008), Frankel, Schmukler and Serven (2004), and Obstfeld, Shambaugh, and Taylor (2005).

[5] Other basic references on the lending channel see Bernanke and Blinder (1988), Bernanke and Gertler (1995), Kashyap and Stein (1994, 1995, 2000). See Stein (1998) for specific modeling of the informational frictions on banks' liability side.

based on the use of bank-level balance sheet information and it relies on the argument that lending by a bank should be sensitive to its holdings of liquid assets if it is unable to substitute sources of funding. Using Call Report data of individual US banks,[6] Kashyap and Stein showed that the sensitivity of lending to holdings of liquid assets for small banks varies significantly with monetary conditions, but this is not the case for large banks that presumably have a greater ability to raise alternative sources of funds from capital markets external to the banking organization.

Since our conjecture is based on balance sheet responses of banks to liquidity shocks, it seems natural to begin our analysis expanding on Kashyap and Stein (2000). As said in the Introduction, we restrict our analysis to banks that in every quarter were in the upper five percent of the asset distribution of all US banks, which is the group of banks that Kashyap and Stein (2000) found to have lending activities insulated from US monetary policy. For the purpose of our study, we want to stay as close as possible to the original methodology, the only innovation being that we break down the population of large banks in those with global operations and those with a domestic-only dimension. Hence, we take the two-step empirical strategy adopted by Kashyap and Stein (2000) and refined by Campello (2002), and begin by estimating cross-sectional sensitivities of lending activity of panels of banks to their overall balance sheet liquidity at each date. The first step of this empirical strategy entails running separate cross-sectional regressions for each data quarter for banks indexed by i within each of the two subsets of banks: the large global banks and the large, non-global, banks. The general stage 1 specification is:

$$\Delta \log(Y_{it}) = \sum_{j=1}^{4} a_{jt} \Delta \log(Y_{it-j}) + \beta X_{it-1} + \text{Controls} + \varepsilon_{it,} \qquad (1)$$

where Y_{it} is either total lending or C&I lending. As mentioned in Kashyap and Stein (2000), C&I lending may offer a more direct insight in the potential impact on real economic activity, but it is also the case that the loan portfolio across banks varies widely, and for that reason focusing on total lending may be more inclusive and less exposed to potential sample biases. X_{it-1} is a measure of a bank's overall balance sheet liquidity and is defined as the log of the ratio of a bank's liquid assets to total assets. A bank's capitalization ratio, its asset size, and the value of its nonperforming loans are included as bank-specific controls. These balance sheet measures are lagged one quarter to avoid econometric issues arising due to simultaneity. The vector of controls also includes indicator variables for the state where the bank's headquarters are located and whether or not the bank's headquarters are in a metropolitan statistical area (MSA). The inclusion of the state and MSA indicator variables allows for different macroeconomic conditions in each period for each geographical area and is intended to capture unobserved variability of loan demand.

The key variable of interest is the estimated coefficient on X_{it-1}, denoted by β_t. Each regression is run at each quarter, thus generating a separate time series of estimated β_t coefficients for each class of banks under consideration.

In the second step of this empirical strategy, the β_t series estimated in the first step are used as dependent variables to determine how lending sensitivity varies with monetary policy:

$$\beta_t = \eta + \sum_{j=1}^{n} \phi_j MP_{t-j} + \delta \text{Controls} + \mu_t, \qquad (2)$$

[6] Banks file quarterly financial data to the FFIEC (Federal Financial Institution Examination Council), with the reports of Condition and Income commonly referred to as Call Report Data.

where MP_{t-j} is an indicator of monetary policy. In our analysis we use three alternative indicators of monetary policy, each of which we describe at greater length in the data section: the Bernanke-Mihov indicator, the nominal Federal Funds rate, and the real Federal Funds rate. As a convention, these indicators of monetary policy are defined in our analysis so that they increase in times of liquidity tightening and decrease in times of looser liquidity conditions. As in Campello (2002), we include 8 lags in the specification. The regression analysis includes as additional controls a time trend, three quarterly indicator variables, and the growth rate in real GDP and its lags. Moreover, for global banks we also add in the second stage a weighted average of foreign interest rates, with weights represented by US global banks' exposures in different countries.[7] This variable may be important for internal capital market allocations of the global banks since it provides perspective on the relative opportunity cost of allocating resources internally or abroad. Presumably, if interest rates abroad move in correspondence with US monetary conditions, the incentive of US parent banks to reallocate funds between parents and foreign affiliates might be mitigated.

If lending by banks is affected by monetary policy, the testing approach maintains that this makes lending more dependent on balance sheet liquidity in times of policy tightening and less dependent in times of monetary policy loosening. Hence, the sum of the coefficients of the monetary policy indicators ϕ_j in the second-step regression would be positive and significant if policy affects bank lending.

We consider a number of robustness tests targeted at isolating the role of bank size versus bank globalization in influencing outcomes. We go into the details of the robustness tests in the results section.

As mentioned in the Introduction, the Kashyap and Stein identification strategy may be exposed to possible issues of endogeneity bias, since banks may change their liquidity holdings in response to macroeconomic conditions. Since global banks may be systematically different from non-global large banks, it is possible that whatever bias arises may apply differently across the two subgroups. We address directly the potential endogeneity of the measure of liquidity in (1). As in Kashyap and Stein (2000), we run stage-1 regressions instrumenting the liquidity to asset ratio by the residual of a regression of the liquidity to asset ratio on the ratio of C&I lending to total lending and the ratio of non-performing loans to total loans, where both regressors should capture a cyclicality component in the measure of liquidity.

We also attempt to tackle the issue of simultaneous changes in loan demand across the subgroups of banks. As stated in the Introduction, we accomplish this by examining the lending by *small* banks, and specifically those small banks affiliated with large banks as part of the same BHC. Small banks are certainly a much more homogeneous group of banks and are likely to face much more similar loan demand. We also know from Kashyap and Stein (2000) that small banks are in general affected by monetary policy, but that small banks part of BHCs with large banks are largely insulated (Campello, 2002). To this end we take these arguments a step further by positing that if globalness matters, the small banks affiliated with large, non-global banks may be more sensitive to domestic liquidity changes than those affiliated with large global banks. Because small banks are a more homogeneous group, even in the face of possible simultaneous changes in demand, any detected difference across the two subgroups of small banks would be more likely to offer evidence that it is globalness (of the large affiliates) that matters.

[7] Given reliable data availability on such interest rates, we focus on the top 20 countries by exposure, which account anyway for the vast majority of total system exposure.

As before, in trying to isolate the global dimension as an important factor we stay as close as possible to the original Campello (2002) specification. This specification is similar to that of (1)-(2), but with a slightly different set of regressors. The main variable of interest this time, X_{it-1}, is the ratio of income from operation to total loans. Controls are the ratio of non-performing loans to total loans, the equity to asset ratio, the log of total assets, the log change in liquid assets, state and MSA dummies. We add as additional control variables the total log of assets of the entire BHC to which the small bank belongs, and its squared term. As in Campello, the log change in liquid assets is instrumented by its lag.

Tests of internal capital markets in global banks and transmission. Normally data on internal transactions within an organization are unavailable in any systematic format. However, US banks are required to report quarterly the aggregate value of internal transactions between the head office and foreign offices ("Net Due To or From Own Related Offices in Other Countries").[8] We construct bank-specific quarterly changes of their net internal positions. A positive value means the head office has increased its debtor position with its foreign offices, hence indicating an inflow of funds, and vice versa. It is important to recognize that this entry truly reflects internal funds reallocations within the banking organization, and it is totally distinct from other balance sheet activity, such as bank investments in foreign or local assets.

If global banks are insulated from domestic liquidity shifts just because of their size, and therefore for their innate ability to access external sources of funds, we should not expect to observe any abnormal behavior in the functioning of cross-border, internal capital markets between parent banks and their foreign offices around times of changes in monetary policy. We test this using the following time-series panel specification over the full group of global banks:

$$\Delta Net\ Due_{i,t} = \alpha + \sum_{j=1}^{4} \varphi_j \Delta Net\ Due_{i,t-j} + \sum_{j=0}^{4} \phi_j \Delta MP_{t-j} + \sum_{j=0}^{4} \gamma_j \Delta GDP_{t-j} + \mu_t \qquad (3)$$

where $\Delta Net\ Due_{i,t}$, the quarterly change in real Net Due funds for bank i at time t, is regressed on its own four lags, on the change in the indicator of monetary policy and its four lags. Real Net Due is constructed by deflating nominal Net Due by the CPI, with 2005 as the CPI base year taking a value of 1. The regression includes the growth rates in real GDP and its four lags to control for general economic conditions.

If the internal capital market is in operation within a global banking organization and is used as at least a partial offset of domestic monetary policy shocks, we should expect to find an increase in the inflow of funds (or a decline in outflows of funds) from foreign operations in times of domestic monetary policy tightening, and the other way around when policy is looser. Evidence of internal capital markets as shock transmitters (or alternatively as buffers) between the parent and foreign affiliates would be reflected in a positive and significant sum of coefficients ϕ_j on the monetary policy indicators.

Two types of robustness checks are run relative to this basic specification. First, we include in equation (3) the composite foreign interest rate mentioned earlier. Again, if investment opportunities abroad move in correspondence with US monetary conditions, the incentive of US parent banks to reallocate funds between parents and foreign affiliates might be mitigated.

Second, it is possible that the movement of funds picked up by the regressions on Net Due flows between affiliated banks may not reflect internal funding needs, but may instead be the

[8] Net Due To or From Own Related Offices in Other Countries is reported in schedule RC-H of Form 030 (Call Report).

result of chasing higher relative return opportunities. So, for instance, a higher federal funds rate may just signify higher return opportunities in the United States, with the foreign operations reallocating their resources accordingly. However, if this were the case, foreign offices would simply increase their own positions in domestic assets on their balance sheet (eg through purchases of US government securities or other). In other words, international portfolio reallocations could be done directly without the affiliate engaging in internal transactions with the head office.

Nonetheless, we test the validity of this objection by running an alternative model specification. We test for a differential response in Net Due flows between banks based on whether they displayed high or low capitalization ratios: if the Net Due flows are just the result of portfolio considerations and not due to internal funding needs, we would expect to see no difference in response between banks with higher and lower capital to asset ratios. On the contrary, under the presumption that banks with lower capitalization may be the ones with more difficulties to access traditional external markets, we would expect to see a higher response exactly from this subgroup of banks. Hence, in separate regressions we test the effect of monetary policy on changes in Net Due for banks with relatively low capital ratios and banks with relatively high capital ratios.

Finally, we analyze the existence of an international propagation mechanism specifically through the internal capital market channel. First, and still in the spirit of Kashyap and Stein (2000) and Campello (2002), we test whether lending of the foreign offices is more or less dependent on the balance sheet strength of the head office as monetary policy conditions vary. In times of US monetary policy contraction, for instance, lending by foreign offices would be expected to rely less on the overall balance sheet strength of the head office. For this test we again rely on the two-step procedure described in equations (1) and (2). In this case, however, the dependent variable in the first step is a measure of the lending activity of the foreign offices of bank i at time t. The lending measures used are, alternatively, the growth in total lending of the foreign offices and the growth in C&I lending of the foreign offices. The main regressor of interest is the liquidity measure of the reporting parent bank.

Second, we look for a direct, empirical relationship between changes in internal funding activity and changes in lending by foreign offices of US banks. Foreign offices may provide internal lending to the parent organization in times of domestic monetary policy contraction, but it is still not necessarily the case that the external lending of the foreign offices should be negatively affected by Net Due transfers: There may be margins of adjustments in the balance sheet that could potentially insulate foreign lending books. The crux of the conjecture is that substitution, and therefore effective international propagation, is most likely to occur if the bank has a constrained balance sheet. Hence, we test the relationship between changes in foreign office lending and changes in Net Due flows for those banks with low levels of liquid assets – the potential cushion that could prevent changes in lending – in times of contractionary or expansionary monetary policy. The model specification is the following

$$\Delta Y_{i,t} = \alpha + \sum_{j=1}^{4} \Delta Net\,Due_{i,t-j} \times \begin{pmatrix} \beta_j + \gamma \Delta MP_{t-j} + \delta_j Low\,Liquidity_{i,t-j} \\ + \eta_j \Delta MP_{t-j} Low\,Liquidity_{i,t-j} \end{pmatrix} + \text{Controls} + \varepsilon_t, \qquad (4)$$

where Y_{it} is a measure of C&I loans or total loans of the foreign offices of bank i at time t. The coefficients β_j, γ_j, δ_j and η_j capture the total effect of a change in internal lending, and the δ's and η's capture the partial effect of *Net Due* on liquidity constrained banks. $Low\,Liquidity_{it}$ is a dummy variable equal to one if bank i at time t had a liquid asset ratio below the median at that date, and zero otherwise. The vector of Controls includes *all* partial terms of interactions (with the same lag structure) and individual variables (and lags), as well as GDP growth (and lags) and the foreign interest rate variable described earlier (and its lags).

3. The data

The sample of banks. The data on banks and liquidity conditions span the period from 1980Q1 through 2005Q4.[9] The core of our analysis utilizes Call Report data available quarterly for every chartered US bank.[10] Table 1 provides descriptive statistics on the four categories of banks used in our analysis: large domestic banks, large global banks, small banks affiliated with a large global bank via common ownership under the same bank holding company (BHC), and small bank in BHCs that contain large banks but no global banks. We define a bank as *global* if it has foreign assets greater than zero.[11] A large bank is defined as any bank that is in the 95th percentile or higher of banks sorted by asset size, with this categorization performed in every quarter of the sample period. Following Campello (2002), a small bank is defined as any bank that is in the 90th percentile or lower. Leaving out the intermediate group of banks between the 90th and 95th percentile is justified to impose a cleaner separation between small and large banks.

The main balance sheet data presented covers the number of bank-quarter observations in the sample, median values for bank size, loan to asset ratios, C&I lending to assets, and bank liquidity, capitalization and nonperforming loan shares. Three reference dates are shown (1985, 1995, and 2005), indicative of the respective decades covered by the full dataset.

The overall sample consists of more than 1.1 million bank-quarters of data for US banking. Over time, the large global and large domestic banks have evolved to become larger on average and to represent more of the total assets of the banking sector. While large global banks are fewer in number, by 2005 they account for almost 70 percent of US banking system assets. Large domestic banks are more numerous but characterized by a substantially smaller median bank size. Those small banks that are affiliated with large BHCs currently account for less than one percent of banking system assets. Compared with other large banks, the global banks tend to have less liquid assets, lower capitalization, and higher nonperforming loan shares. While both types of large banks have similar loan to asset ratios, commercial and industrial loans play a larger role in the business base of global banks.[12] These observations about differences in portfolios across the large banks are consistent with lessons from Berger et al (2005), wherein it is argued that bank size is correlated with the bank business model: larger banks tend to lend at a greater distance, interact more at arms-length with their borrowers, and have shorter and less exclusive relationships with these borrowers. In addition to total lending and C&I lending, a third type of lending data is specific to the global banks. Data on loans of foreign offices of US global banks captures loans extended directly by offices in countries where they are physically located.[13] These figures do not include possible lending activity of the domestic offices to clients residing abroad which already was captured in the parent bank consolidated lending data.

---

[9] We purposefully exclude data for later quarters since any inference would be confounded by the concomitance with the financial crisis, which officially started in 2007Q3. These data are being explored in a separate study.

[10] The specific details on the FFIEC 031 Consolidated Reports of Condition and Income for a Bank with Domestic and Foreign Offices and FFIEC 041 Consolidated Reports of Condition and Income for a Bank with Domestic Offices Only are available at http://www.ffiec.gov/forms031.htm and http://www.ffiec.gov/forms041.htm.

[11] Using an even larger threshold for "global" does not alter our results.

[12] The patterns are the same when small banks affiliated with global BHCs are compared with small banks affiliated with domestic BHCs.

[13] These data are from schedule RC-C of the Call Reports filed by banks: item RCFN 2122 for total loans and RCFN 1763+1764 for C&I loans.

Table 1

Basic balance sheet information for US banks

	All banks	Large domestic banks	Large global banks	Small banks in domestic BHCs	Small banks in global BHCs
Total no of bank observations (1908Q1–2005Q4)	1,162,969	43,921	14,252	41,339	47,640
Median values for bank asset size (thousands 2005 USD)					
1985	62,269	996,951	5,123,663	93,897	102,967
1995	73,906	1,775,889	10,358,585	142,711	134,766
2005	105,223	2,236,512	22,300,000	213,294	213,157
Share of each bank group in total assets (%)					
1985	100.0	16.6	56.0	1.4	2.2
1995	100.0	22.6	56.1	1.0	0.9
2005	100.0	17.9	67.9	0.4	0.3
Median total loans/ assets (%)	55.6	61.1	60.4	57.1	55.5
Median C&I loans/ assets (%)	17.3	22.8	35.4	18.4	21.0
Median bank liquid assets/ total assets (%)	28.0	26.5	20.1	16.6	27.1
Median capitalization ratio (%)	8.7	7.2	6.4	8.0	7.6
Value of nonperforming loans / total loans	1.0	1.0	1.1	1.6	0.8

Data is from quarterly Call Report forms for all banks from 1980Q1 to 2005Q4. A bank is defined as global in a quarter if it reports positive foreign assets. A bank is defined as domestic if all its activity comes from offices located domestically. Large banks are those with total assets above the 95th percentile of the total asset distribution in each quarter. Small banks are those with total assets below the 90th percentile of the total asset distribution in each quarter. Small banks in domestic BHCs are small banks affiliated in BHCs with at least one large, domestic bank and no global banks. Small banks in global BHCs are small banks affiliated in BHCs with at least one large global bank.

Another form of data specific to global bank and central to our analysis is Net Due with foreign offices.[14] The Net Due data reflects *direct* flows between a parent with its branches and subsidiaries abroad. Positive values mean the head office owes to the foreign offices, and vice versa (see Data Appendix for more details).

Table 2 presents some features of the foreign loan and Net Due data, focusing on the means, medians and number of observations of these bank-specific series. First, consistent large difference between means and medians arise because the distributions of lending and Net Due activity are highly skewed, with overall quantities dominated by a few large players as was also shown for the global bank asset distribution. Second, the Net Due observations are split across “net due to” and “net due from”. Since the mid 1990s, the balances from

[14] We construct these as the difference between schedule RC-H Net due *to* own foreign offices, Edge and Agreement subsidiaries, and IBFs and Net due *from* own foreign offices, Edge and Agreement subsidiaries, and IBFs (RC-H 2941-2163).

affiliates to US parents have substantially exceeded balances in the opposite direction.[15] Third, while both total and C&I foreign lending have risen, the median bank is not engaged in this activity. Foreign lending activity is dominated by very large global banks. Data screens on the bank sample are described in the Appendix.

Table 2

Net due flows and foreign loans

(millions 2005 USD)

		1985q4	1995q4	2005q4
Net Due flows				
Net Due To	Median	$62.3	$299.2	$657.3
	Mean	$304.3	$955.7	$3,856.1
	Number of observations	60	103	62
Net Due From	Median	$43.3	$3,934	$852
	Mean	$458.3	$332.5	$984.0
	Number of observations	187	67	45
(Net Due To – Net Due From)				
	Median absolute value	$47.3	$141.9	$74.4
	Mean absolute value	$420.9	$710.1	$2,648.2
	Number of observations	247	170	107
Loans of Foreign Offices				
Total loans	Median value across banks	$19.3	$27	$0
	Mean value across banks	$1,599.7	$1,978.0	$3,129.8
	Number of observations	247	170	107
	Share of total bank lending	0.15	0.11	0.07
C&I loans	Median value across banks	$4.8	$0	$0
	Mean value across banks	$866.4	$942.2	$1,236.9
	Number of observations	247	170	107
	Share of total C&I lending	0.08	0.05	0.03
Abs(Net due)/ total foreign loans				
	Median value across banks	0.70	1.01	0.98
	Aggregate ratio	0.26	0.35	0.84

Net due to/from indicate the position of the domestic offices of a bank relative to all of the bank's Edge and Agreement subsidiaries, foreign branches, consolidated foreign subsidiaries, and branches in Puerto Rico and US territories and possessions (schedule RC-H from form FFIEC 031 – Call Report). A positive net due *to* indicates that the head office owes funds to its foreign offices. A positive net due *from* indicates that the head office is owed funds from its foreign offices. Foreign loans are the total loans booked by the foreign offices of US global banks.

[15] Note, however, that our conjecture and the related identification strategy does not rely on trends in the data, but focuses on quarterly changes in internal flows in response to changes in monetary policy.

Macroeconomic Liquidity. As in Kashyap and Stein (2000), the proxies for (changes in) market liquidity are measures of monetary policy. Three measures of US liquidity are used in our analysis: a nominal Federal Funds rate, a real Federal Funds rate (the nominal rate adjusted for CPI inflation), and the Bernanke and Mihov (1998) measure. The quarterly effective Federal funds rate is calculated from monthly data from the Federal Reserve Board. The Bernanke-Mihov measure is constructed via a "semi-structural VAR" model of the market for bank reserves and can reflect tighter liquidity conditions that are generated from policy instruments other than the Funds rate.[16] In all cases, our empirical specifications introduce these variables so that an increase in the monetary measure is interpreted as a tightening of US liquidity conditions.

Some specifications include a control variable for foreign monetary conditions, which we construct as a weighted average of short-term money market or policy rates in the countries in which US banks have local claims.[17] In Net Due specifications, since these variables are intended to proxy for the liquidity conditions in countries in which each bank maintains local claims, the foreign monetary variables use bank specific weights.

Real Macroeconomic Activity. The first-stage regressions on bank lending contain controls such as indicator variables for the state where the banks' headquarters are located and the MSA indicator variable to capture unobserved variability in loan demand. Some of the second stage regressions include real GDP growth of the United States as a control variable. In addition, in the regressions that contain foreign loans as the dependent variable have bank-specific foreign GDP growth as an additional control variable. This variable is intended to capture unobserved variability in the markets in which banks have claims abroad, and is constructed by weighting country real GDP growth by the distribution of a bank's local claims across foreign markets (lagged one period).

4. Empirical Findings

As stated earlier, we begin with an indirect test of the importance of globalness. Recall from Kashyap and Stein (2000) that large banks were found to be insulated from monetary policy. What happens if we simply break down the sample of large banks based on whether a large

[16] Ilian Mihov kindly updated and revised his measure in 12/06 using data through the end of 2005. The differences in definition and construction across these measures generate positive but not necessarily tight correlations among them. The tightest correlations are among the nominal and real Federal Funds rate series at 0.71, which have a common policy base but differ in terms of correction for slower moving inflation. The real rate is consistently lower in value and trends downward by less through these decades as average inflation has declined. The trajectory of the Bernanke-Mihov measure is more tightly correlated with the nominal Federal Funds rate (0.41) than the real rate (0.14), perhaps not surprising since the nominal rate enters the VAR used in constructing the Bernanke-Mihov measure. Despite this pattern in correlations reflecting changing liquidity conditions, the B-M and real rates have more comparable direct signals regarding absolute liquidity conditions, namely, whether policy is monetary policy is loose or tight at any point in time. The Kashyap and Stein (2000) study uses a narrative measure of monetary policy, the Boschen-Mills (1995) index, the Federal Funds rates, and the Bernanke and Mihov measure. Kashyap and Stein (2000) do not use a real Federal Funds rate.

[17] The short-term monetary rates are generally drawn from International Financial Statistics. Item 60B is typically a money market rate or a call money rate; where unavailable, item 60C Treasury Bill rates are utilized. Weights are based on the quarterly data on local claims by country of all US banks reporting foreign exposures. Adjustments are made to exclude periods when specific countries are in crisis, as summarized in Appendix Table 2, and quarters in which real interest rates exceed 25 percent or are below negative 25 percent. India, one of the twenty countries, is excluded from the weighting due to the volatility of data on short-term market rates. Real rates are constructed by deflating using quarterly CPI inflation data relative to one year previous levels. These countries span more than 95 percent of foreign exposure.

bank has global operations or not? If globalness is irrelevant, nothing should happen. Banks in both groups should still display insensitivity to monetary policy.

Table 3 presents results from equation (2) regressions, where the dependent variable is the time series of estimated coefficients on the liquidity-to-asset ratio in quarterly cross-sectional instrumental variable regressions based on equation (1) specifications. The estimates reported in the table are of the sum of ϕ_j coefficients on the monetary policy and its lags.[18]

The upper panel results are based on equation (1) regressions run with OLS, while the bottom panel results are based on equation (1) regressions run with the IV specification illustrated earlier. In both cases total lending is the dependent variable. Table A2 in appendix shows the equivalent results using C&I lending instead. Each specification is run with or without GDP growth controls, as indicated by column headings in the table. For the group of global banks we also provide results from second stage regressions where we added the foreign interest rate controls. Results highlighted in bold are statistically significant at least at the 10 percent level and indicate an active lending channel for monetary policy.

The lending channel of US monetary policy is not statistically significant in any specifications for the group of global banks. The results are robust to whether or not specifications introduce controls for domestic GDP growth (column 4), and foreign interest rates (column 5). The results are consistent across all three metrics of US monetary policy. However, large non-global banks seem less insulated than expected from prior studies, as indicated by the significant sums of estimated coefficients in both OLS and IV specifications.

These results provide indirect evidence that globalness may in fact be a factor in providing bank lending with insulation from monetary policy. Of course this evidence is only suggestive at best, and for a number of reasons. First, it may still be the case that global banks are significantly larger than non-global banks, even within the same top five percent cluster of the population. For instance, it is certainly the case that global banks heavily populate the top one percent cluster (see Figure 3). This argument has questionable merit, however, since the original findings by Kashyap and Stein (2000) showed insulation even in a sample excluding the top one percent banks. In any case, we perform robustness tests to further take into account the size issue. Accordingly, an additional set of regressions curtail the dataset to banks within the 95th and the 99th percentile. This refinement, with results in Table 4, continues to show that large global banks (now excluding the very largest), have lending patterns that are insulated from monetary policy, while large, non-global banks within the same sub cluster continue to display a certain degree of lending sensitivity.[19] In addition, we ran weighted least squares regressions for global banks in the first stage, using as weights the size distribution of the large, non-global banks. This approach in essence statistically penalizes the largest of the global banks and over-emphasizes the contribution to the results of the smallest ones. The results, in the last column of Table 4, confirm that the lending channel for policy effects is still insignificant in global banks, and that size per se may not be the leading factor explaining the difference in results across the respective types of banks.

[18] For reference, in Appendix Table A2 we present sample second stage regressions presenting the breakdown of the estimated coefficients of the monetary policy variable and its lags.

[19] Only non-global banks in the top 1 percent are found to be wholly insulated (results not reported).The lack of statistical significance may be due to the relatively small sample size for this category of banks in the top 1 percent group.

Table 3

Lending channel for large domestic and large globally-oriented banks

Total lending: Summed monetary variable effect on first-stage regression betas

	OLS specifications				
	Domestic banks		**Global banks**		
	no gdp controls (1)	with gdp controls (2)	no gdp controls (3)	with gdp controls (4)	gdp & foreign rate controls (5)
Federal funds rate (nominal)	**0.0007 [0.006]**	**0.0008 [0.001]**	–0.0013 [0.161]	–0.0015 [0.154]	–0.0006 [0.591]
Federal funds rate (real)	0.0006 [0.113]	**0.0012 [0.006]**	0.0003 [0.766]	–0.0004 [0.974]	0.0002 [0.893]
Bernanke-Mihov index (negative*100)	**0.0003 [0.044]**	0.0003 [0.123]	0.0001 [0.898]	0.0003 [0.970]	0.0005 [0.424]
	IV specifications				
	Domestic banks		**Global banks**		
	no gdp controls (1)	with gdp controls (2)	no gdp controls (3)	with gdp controls (4)	gdp & foreign rate controls (5)
Federal funds rate (nominal)	**0.0007 [0.036]**	**0.0007 [0.025]**	–0.0002 [0.827]	–0.0005 [0.595]	0.0002 [0.897]
Federal funds rate (real)	0.0003 [0.522]	**0.0009 [0.007]**	0.0014 [0.212]	–0.00005 [0.965]	–0.0003 [0.875]
Bernanke-Mihov index (negative*100)	**0.0004 [0.067]**	0.0003 [0.240]	0.0002 [0.803]	0.0004 [0.606]	0.0008 [0.284]

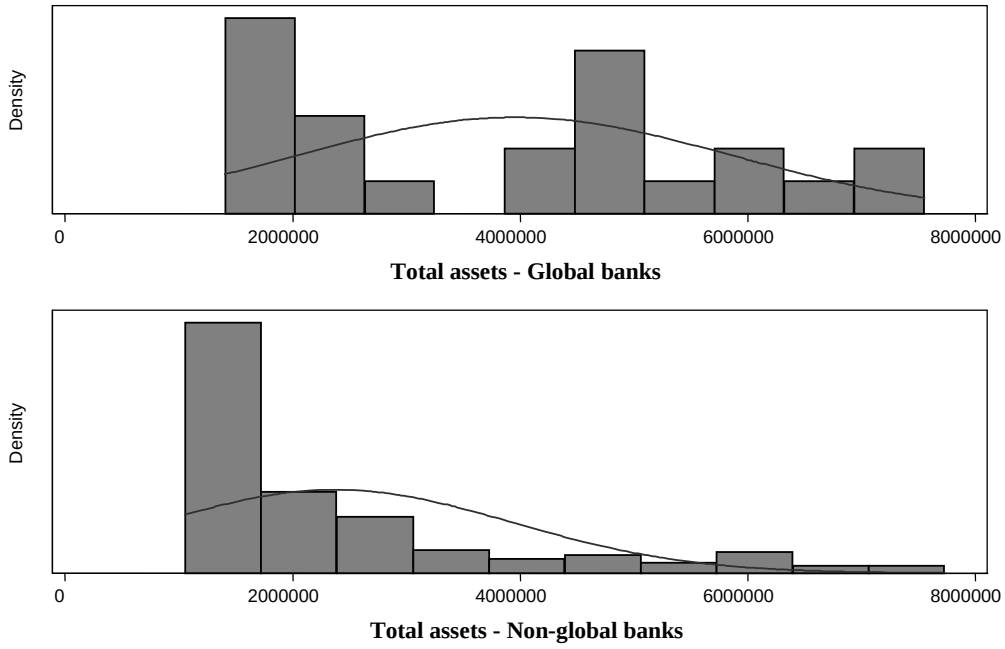
This table presents results from equation specification (2). The dependent variable is the time series of estimated coefficients of the liquidity to asset ratio from quarterly cross-sectional regressions based on specification (1), where the dependent variable was growth in total bank loans. The reported figures in the columns are from the sum of the estimated coefficients on the eight lags of each respective monetary policy variables. The Bernanke-Mihov index has been modified from the original so that all three monetary policy indicators signal tightening when they increase. Reported in brackets is the probability that the sum of the coefficients is significantly different from zero. The upper panel reports results based on first-stage OLS regressions. In the lower panel instrumenting the liquidity to asset ratio with the series of the residuals of a regression of such variable on the C&I to total lending ratio and the ratio of non performing to total loans. The first two columns reports results for the group of large, domestic banks, ie banks above the 95th percentile in asset size and reporting no foreign assets. The last three columns report results for the group of large, global banks, ie large banks with positive foreign assets. Columns 1 and 3 refer to second-stage specifications without GDP controls, while columns 2, 4 and 5 to specifications including GDP controls. Column 5 also includes foreign rate controls. Bold indicates statistical significance at least at the 10 percent level. Sample period: 1980:Q1-2005:Q4. Standard errors are computed with an 8-lags Newey-West correction for autocorrelation and heteroskedasticity.

Another possible criticism of our results is that perhaps it is not globalness per se driving the differences across domestic and global banks, but rather a difference in the customer base of these banks. Certainly, global banks cater to more internationally-oriented businesses, which may have a different type of reaction to domestic macroeconomic conditions. However, this factor does not seem to be driving our results. We try to capture the impact of globalness on a set of banks which are more likely to face a homogeneous demand schedule: small, domestic banks. As said in section II, we capitalize on the Campello (2002) findings that insulation achieved in external capital markets by large institutions is extended to their small bank affiliates within the United States. These small banks operate in similar

lending markets, with a more homogenous population of borrowers. If globalness of the large affiliates of small banks is an irrelevant factor, we should expect to replicate Campello (2002)'s results for small banks affiliated with large banks, with results across these banks similar irrespective of whether affiliated large banks have a global or non-global dimension. The results on small banks in BHCs with large banks are reported in Table 5.[20]

Figure 3

Asset distribution, 95th-99th percentile, 2005q4. Global vs. non-global banks



The first set of columns in table 5 refer to estimated coefficients from the regressions run on the subset of small banks affiliated with large, domestic banks, while the second set of columns refer to regressions run on the subset of small banks affiliated with large, global banks. The second set of columns shows that small banks affiliated with large, global banks appear to be insulated from liquidity shocks. In all cases, with any indicator of monetary policy, looking at total lending or just C&I lending, and including or excluding GDP controls, the estimated sums of coefficients are never positive and significant. In fact, they are actually negative and significant in three of the regressions with total loans as dependent variable.

By contrast, the results for small banks affiliated with large, domestic banks are markedly different. In eleven of the twelve alternative specifications the sums of coefficients from the second stage regressions are positive and statistically significant, indicating that these small

[20] However, the sample size of these sub groups of small banks implies a constraint in this empirical exercise: Because of the underlying process of industry consolidation occurring over the sample period, by the time we are in the mid 1990s the two sub-samples become relatively small. After 1996q4, for instance, the sub group of small in BHCs with a large, global bank shrinks below 100 observations. Given the number of regressors in the first-stage estimation (balance sheet variables, quarterly dummies and state dummies), we decided to truncate the sample size at 1996q4 for the analysis on the small banks. Since this exercise only has the specific task of addressing the issue of demand heterogeneity, and not of providing a full fledge analysis on small banks' funding patterns, such as Campello (2002), we feel that this constraint is acceptable. We ran further tests on the sub group of small banks in BHCs with large, domestic-only banks, which has relatively more observations than the other sub group. Truncating their sample at 2000q4, the quarter after which this sample size goes below 100, the results are consistent with those reported.

banks actually need to rely more on their own internal funds in times of liquidity shortage. The implication is that the small banks affiliated with domestic-only BHCs appear to remain exposed to changes in US liquidity conditions, an indication that the large banks in their organizations may not be sufficiently shielded to be able to activate a meaningful reallocation of resources to their small affiliates through the organization's internal capital market.

Table 4

Lending channel for large domestic and large globally-oriented banks: Robustness checks

Total lending: Summed monetary variable effect on first-stage regression betas

	OLS specifications				
	Domestic banks		**Global banks**		
	No top 1 percent		No top 1 percent		WLS 95–99 percent
	no gdp controls (1)	with gdp controls (2)	no gdp controls (3)	with gdp controls (4)	with gdp controls (5)
Federal funds rate (nominal)	**0.0011 [0.002]**	**0.0012 [0.0002]**	–0.0027 [0.475]	–0.0035 [0.378]	–0.0029 [0.424]
Federal funds rate (real)	**0.0007 [0.086]**	**0.0013 [0.004]**	0.0010 [0.778]	–0.0008 [0.856]	0.0012 [0.768]
Bernanke-Mihov index (negative*100)	**0.0003 [0.048]**	0.0003 [0.144]	–0.0016 [0.436]	–0.0016 [0.455]	–0.0013 [0.540]
	IV specifications				
	Domestic banks		**Global banks**		
	No top 1 percent		No top 1 percent		WLS 95–99 percent
	no gdp controls (1)	with gdp controls (2)	no gdp controls (3)	with gdp controls (4)	with gdp controls (5)
Federal Funds Rate (nominal)	**0.0015 [0.000]**	**0.0015 [0.000]**	–0.0033 [0.239]	–0.0038 [0.206]	–0.0035 [0.233]
Federal Funds Rate (real)	0.0010 [0.118]	**0.0016 [0.008]**	0.0002 [0.928]	–0.0043 [0.252]	–0.0041 [0.280]
Bernanke-Mihov index (negative*100)	**0.0008 [0.011]**	**0.0006 [0.048]**	0.0004 [0.808]	0.0014 [0.517]	0.0016 [0.465]

This table presents robustness tests on the same equation specifications of table 3. The dependent variable is the time series of estimated coefficients of the liquidity to asset ratio from quarterly cross-sectional regressions based on specification (1), where the dependent variable was growth in total bank loans. The reported figures in the columns are from the sum of the estimated coefficients on the eight lags of each respective monetary policy variables. The Bernanke-Mihov index has been modified from the original so that all three monetary policy indicators signal tightening when they increase. Reported in brackets is the probability that the sum of the coefficients is significantly different from zero. The upper panel reports results based on first-stage OLS regressions. In the lower panel instrumenting the liquidity to asset ratio with the series of the residuals of a regression of such variable on the C&I to total lending ratio and the ratio of nonperforming to total loans. The first two columns report results for large, domestic banks, excluding banks in the top 1 percent in asset size. Columns 3 and 4 report equivalent results for large, global banks. The fifth column report results for large, global banks based on a WLS regression, with weights determined using the size distribution of large, domestic banks. Bold indicates statistical significance at least at the 10 percent level. Sample period: 1980:Q1-2005:Q4. Standard errors are computed with an 8-lags Newey-West correction for autocorrelation and heteroskedasticity.

Table 5

Results for small affiliated with large domestic or globally-oriented banks

Summed monetary variable effect on first-stage regression betas

	Total bank lending			
	Small in domestic banks		**Small in global banks**	
	no gdp controls (1)	with gdp controls (2)	no gdp controls (3)	with gdp controls (4)
Federal funds rate (nominal)	**0.2909** **[0.047]**	**0.5203** **[0.026]**	–0.1390 [0.764]	–0.0207 [0.970]
Fed funds rate (real)	**0.8440** **[0.000]**	**0.9411** **[0.001]**	–1.0854 [0.233]	–1.0579 [0.282]
Bernanke-Mihov index (negative*100)	0.1278 [0.122]	**0.2495** **[0.016]**	–0.1084 [0.604]	–0.0145 [0.953]
	Total C&I lending			
	Small in domestic banks		**Small in global banks**	
	no gdp controls (1)	with gdp controls (2)	no gdp controls (3)	with gdp controls (4)
Federal funds rate (nominal)	**1.4342** **[0.029]**	**1.0752** **[0.087]**	–1.1977 [0.131]	–0.3404 [0.471]
Fed funds fate (real)	**2.5028** **[0.050]**	**2.6469** **[0.027]**	**–1.5803** **[0.057]**	–1.8704 [0.142]
Bernanke-Mihov index (negative*100)	**0.7712** **[0.035]**	**0.6619** **[0.057]**	**–0.6966** **[0.075]**	**–0.4937** **[0.042]**

This table presents results similar to those of Table 3, but based on Campello (2002): the object of analysis are small banks (asset size below the 90th percentile) affiliated to either large, domestic banks or large, global banks as part of the same BHC. The dependent variable is the time series of estimated coefficients on the net income to loan ratio in quarterly cross-sectional regressions where the dependent variable was either growth in total bank loans or total C&I loans. The reported figures in the columns are from the sum of the estimated coefficients on the eight lags of each respective monetary policy variables. The Bernanke-Mihov index has been modified from the original so that all three monetary policy indicators signal tightening when they increase. Reported in brackets are the probabilities that the sum of the coefficients is significantly different from zero. The upper panel reports results from estimations where the dependent variable in the first-stage regressions was total lending growth. The lower panel reports results from estimations where the dependent variable in the first-stage regressions was total C&I lending growth. The first two columns reports results for the group of small banks members of BHCs where there is at least one large domestic bank and no global banks. The last two columns report results for the group of small banks members of BHCs where there is at least one large global bank and no other large, domestic bank. Odd columns refer to second-stage specifications without GDP controls, while even columns to specifications including GDP controls. Bold indicates statistical significance at least at the 10 percent level. Due to sample size constraint, the sample period is 1980:Q1-1996:Q4. Standard errors are computed with an 8-lags Newey-West correction for autocorrelation and heteroskedasticity.

The combined results indirectly suggest that the global dimension of banks matters for the transmission mechanism of monetary policy. However, the results are interesting in their own right. They highlight more complex dynamics in banks' response to liquidity shocks. Additionally, they indicate that, in fact, the domestic scope of the lending channel may be larger than previously thought if large, non-global banks are not as insulated from policy, and by extension if small banks affiliated with them are also less insulated.

Internal capital markets of global banks. We conjecture a specific mechanism through which global banks may achieve insulation, by operating an internal capital market that potentially allows them to reshuffle resources between domestic and foreign operations depending on the relative liquidity needs within the banking organization. Confirming this conjecture requires more direct testing. Hence, the next set of tests examines whether this channel is active and used to respond to changes in US monetary policy. We test equation specification (3), on the "Net Due" from foreign operations to the parent. In all regressions the dependent variable is the change in Net Due flows between a bank domestic headquarter and its foreign offices, with the Net Due flows expressed in constant 2005q4 dollars. Specifications differ in the monetary variable used and in the controls included in regressions. Recall that, by construction, an *increase* in Net Due means that the domestic offices are receiving more funds from their foreign offices or sending fewer resources abroad.

The results summarized in the first column, upper panel of Table 6 show a pattern of funds flow internal to the banking organization which is both statistically significant and consistent with the expected direction of results. Column 1 shows that Net Due flows from foreign affiliates to the head office in the United States increase significantly (or outflows decline significantly) when liquidity conditions tighten in the United States, and vice versa. This finding is robust across all three indicators of US liquidity and monetary policy. For robustness, we add to the basic specification the composite foreign interest rate with the same lag structure as the monetary policy variables and observe in column 2 that the inclusion of this control does not alter the basic result.

Columns 3 and 4 present tests for asymmetry in the internal capital market response to US liquidity when conditions tighten or loosen. The transmission of US liquidity conditions onto Net Due flows is bi-directional. Funds flow into the parent bank at a faster pace (or flow out from the parent at a slower pace) when domestic monetary policy is tighter (column 3), and funds flow out to the affiliates (or into the parent from the affiliate at a slower pace) when domestic monetary policy is more expansionary (column 4). Tests performed for equality across the asymmetric coefficients (not reported) show that none of the specifications yield a statistically significant difference between estimated size of Net Due response to tightening versus loosening of credit conditions. The empirics reject the notion that the response of internal capital markets between US banks and their foreign affiliates is active only in one direction of US monetary policy change.

Finally, the first two columns of the lower panel show results from splitting the sample in observations with capital to asset ratios below the median in each quarter and those with a ratio above the median. As discussed earlier, we would expect that the internal funding channel would be especially activated by banks that may be relatively more impaired in raising funds in traditional external markets. The significant results on the lower-capitalization dummy show that global banks with lower capitalization ratios tend to use the Net Dues channel more aggressively. This finding adds to the evidence already provided that global banks use their global nature and rely on internal capital market transfers to and from their foreign operations to offset liquidity changes arising from domestic monetary policy. The final two columns show that the magnitude of the internal capital market response scales up significantly for the larger global banks, as expected given the skewed distribution in bank asset and Net Due size for global banks.

Table 6

Internal lending between parent banks and foreign affiliates

	Baseline (1)	Baseline with foreign rate controls (2)	Baseline with potential asymmetry of effects when	
			Tighter money (3)	Looser money (4)
Federal funds rate (nominal)	**74,268 [0.026]**	**80,162 [0.020]**	**131,158 [0.043]**	**82,441 [0.000]**
Fed funds rate (real)	**75,715 [0.044]**	**104,688 [0.010]**	**82,266 [0.024]**	**164,481 [0.020]**
Bernanke-Mihov index (negative*100)	**14,633 [0.083]**	**17,918 [0.010]**	23,969 [0.230]	**24,231 [0.043]**

	Capitalization rate		Bank size	
	Low	High	Below median	Above median
Federal funds rate (nominal)	**157,352 [0.008]**	–15,562 [0.489]	1,882 [0.698]	**152,704 [0.023]**
Fed funds fate (real)	**163,302 [0.017]**	–20,615 [0.288]	–2,025 [0.634]	**152,473 [0.043]**
Bernanke-Mihov index (negative*100)	**28,300 [0.078]**	2,598 [0.787]	3,039 [0.362]	**30,605 [0.085]**

This table presents results from regressions where the dependent variable is the quarterly real change in net due flows from foreign affiliates to the head office. A positive change indicates a net inflow of funds from foreign operations. The dependent variable is in real 2005q4 dollars. The reported figures in the columns are from the sum of the estimated coefficients on the eight lags of each respective monetary policy variables. The Bernanke-Mihov index has been modified from the original so that all three monetary policy indicators signal tightening when they increase. In the upper panel, column one reports results from the baseline specification of equation (3). Column 2 reports results of the baseline specification where foreign rate controls were also included. Column 3 and 4 splits the sample in period of monetary tightening and monetary expansion, respectively. Tests of the equality of each pair of estimates from column 3-4 were run but they are not reported. In the lower panel, columns 1 and 2 split the sample between observations with a capital to asset ratio below and above the median, respectively. Column 3 and 4 instead split the sample in observations below and above the median in asset size. Reported in brackets are the probabilities that the sum of the coefficients is significantly different from zero. Bold indicates statistical significance at least at the 10 percent level. Sample period: 1980:Q1-2005:Q4. Robust standard errors and clustered by bank id.

International transmission through global banks. The fact that global banks activate internal capital markets with their foreign offices in response to domestic liquidity changes has direct implication for a potential international propagation mechanism. What happens to the lending of the foreign offices of global banks when domestic monetary policy changes? Two types of evidence are provided. First, and as described in section II, we test whether foreign lending is more or less dependent on the strength of the balance sheet of the home office as conditions of US monetary policy vary. The regression specifications in Table 7 cover growth in total lending of foreign offices, shown in the first set of columns, and C&I lending of foreign offices, shown in the second set of columns. As in Table 3, the reported results are the summed effects across quarters of a change in US monetary variables, with the cells of the table drawn from regression specifications that are inclusive or exclusive of controls for real GDP growth. Regressions are run with an OLS specification in the upper panel. We also run the first stage regressions instrumenting the liquidity-to-asset ratio, the same way we did earlier, and report the results in the lower panel. The results in Table 7 are highly consistent

across specifications. The estimated sums of coefficients are negative and significant in most regressions. The implication is that foreign lending activity of US bank affiliates abroad can rely *less* on the overall strength of the home office in times of tighter monetary conditions in the United States, and rely more on the US parent in times of looser US liquidity.

Table 7

Monetary policy and foreign lending

Summed monetary variable effect on first stage betas

	OLS specifications			
	Total foreign lending		**Total foreign C&I lending**	
Monetary variable	Without gdp controls (1)	With gdp controls (2)	Without gdp controls (3)	With gdp controls (4)
Federal funds rate (nominal)	**–0.0104 [0.011]**	**–0.0114 [0.004]**	**–0.0190 [0.000]**	**–0.0176 [0.004]**
Fed funds fate (real)	**–0.0108 [0.058]**	**–0.0134 [0.009]**	**–0.0144 [0.010]**	**–0.0137 [0.025]**
Bernanke-Mihov index (negative*100)	–0.0032 [0.325]	–0.0034 [0.244]	**–0.0053** [0.085]	–0.0039 [0.239]
	IV specifications			
	Total foreign lending		**Total foreign C&I lending**	
Monetary variable	Without gdp controls (1)	With gdp controls (2)	Without gdp controls (3)	With gdp controls (4)
Federal funds rate (nominal)	**–0.0108 [0.002]**	**–0.0123 [0.001]**	**–0.0201 [0.000]**	**–0.0193 [0.000]**
Fed funds rate (real)	–0.0071 [0.190]	**–0.0102 [0.052]**	**–0.0159 [0.001]**	**–0.0191 [0.000]**
Bernanke-Mihov index (negative*100)	**–0.0073 [0.027]**	**–0.0072 [0.038]**	–0.0059 [0.113]	–0.0041 [0.267]

This table presents results based on specification similar to those of table 3. Here the focus is on the activity of the foreign offices of global banks. In these regressions the dependent variable is the time series of estimated coefficients of the liquidity to asset ratio from quarterly cross-sectional regressions where the dependent variable was either growth in total loans or total C&I loans of the foreign offices of global banks. The reported figures in the columns are from the sum of the estimated coefficients on the eight lags of each respective monetary policy variables. The Bernanke-Mihov index has been modified from the original so that all three monetary policy indicators signal tightening when they increase. Reported in brackets are the probabilities that the sum of the coefficients is significantly different from zero. The first two columns report results from estimations where the dependent variable in the first-stage regressions was total lending growth of foreign offices. The last two columns report results from estimations where the dependent variable in the first-stage regressions was total C&I lending growth of foreign offices. Odd columns refer to second-stage specifications without GDP controls, while even columns to specifications including GDP controls. In the upper panel the first stage regressions were run with OLS. In the lower panel instrumenting the liquidity to asset ratio with the series of the residuals of a regression of such variable on the C&I to total lending ratio and the ratio of non performing to total loans. Bold indicates statistical significance at least at the 10 percent level. Sample period: 1980:Q1-2005:Q4. Standard errors are computed with an 8-lags Newey-West correction for autocorrelation and heteroskedasticity.

Finally, we present more direct evidence on the possible substitution between internal and external lending by foreign offices of global banks, evidence that more cleanly indicates the existence of an effective international propagation of domestic liquidity shocks via the internal capital market channel we have conjectured. As said earlier, we would expect substitution between internal and external lending for those banks with a constrained balance sheet. Table 8 presents estimation results from equation specification (4), reporting just the sum of coefficients for the terms needed to evaluate the total impact on low liquidity banks. Of course, the full spectrum of other regressors mentioned in section II are also present in the same regression specifications. As the table shows, changes in Net Due *per se* have a small impact on external foreign lending. This is not surprising since the dynamics governing the internal transfer of funds within the banking organization are probably driven more by overall managerial strategies not necessarily related to external foreign lending. The table also shows that changes in Net Due in times of monetary policy tightening are actually associated with a positive impact on foreign lending. This effect is likely capturing an increase in foreign investment that takes place in response to changes in domestic macroeconomic conditions. To the extent that tighter money mirrors deterioration in domestic market activity, then a global bank with a relatively unconstrained balance sheet can receive support from its foreign operations while simultaneously increase foreign activity. The table also shows, however, that liquidity constrained banks instead substitute foreign external lending with cross-border internal lending, a direct indication that the internal capital market of global banks with their foreign offices represent an effective and potent channel of international propagation of domestic bank shocks to foreign markets.

5. Economic effects of banking globalization

The evidence suggests that global banks activate an internal capital market in response to monetary policy, and that through this channel domestic shocks are transmitted internationally to affect lending of the foreign offices. How large are these effects? As in the economic significance analysis in Kashyap and Stein (2000), we take for instance the impact of a 100 basis points change in the Federal Funds rate and apply this to a bank to provide quantitative comparisons. From Table 6 we learn that over the whole sample period the response by a median global bank would have been to increase internal borrowing by $74.3 million (in 2005q4 dollars) over four quarters, or $80.2 million, according to the specification with foreign interest rate controls. This number per se is not small, considering that over the same period, the median change – up or down – over four consecutive quarters would have been $179.5 million (median = $44.9 x 4 quarters). What matters, however, is to assess the hypothetical Net Due response magnitude in relation to the potential balance sheet impact on the median bank of the original liquidity shock.

In the absence of this cross-border, internal capital market, our argument is that global banks would have exhibited lending growth sensitivity to monetary policy presumably similar to that of large, domestic banks. Hence, we run a counterfactual exercise, estimating the potential loss in loan growth for large, domestic banks, and then apply that loss to the global banks. We then assess whether the estimated increase in internal lending is comparable to the fictional loss that otherwise would have occurred from the liquidity shock. If the orders of magnitude of these terms are comparable, we take this as an indication that the internal capital market channel is a significant component of global banks' overall balance sheet strength.

Table 8

Net Due Effects on Foreign Lending in Response to Monetary Policy

	Total foreign lending		
Regression coefficients	**Federal funds rate (nominal)**	**Fed funds rate (real)**	**Bernanke-Mihov index (negative*100)**
Net Due	–0.018 [0.246]	0.009 [0.564]	**–0.049** **[0.003]**
Net Due x Monetary policy	**0.289** **[0.000]**	**0.253** **[0.000]**	**0.121** **[0.000]**
Net Due x Low Liquidity	**–0.105** **[0.000]**	**–0.136** **[0.000]**	**–0.069** **[0.008]**
Net Due x Mon policy x Low Liquidity	**–0.271** **[0.000]**	**–0.198** **[0.000]**	**–0.111** **[0.000]**
	Total foreign C&I lending		
	Federal funds rate (nominal)	**Fed funds rate (real)**	**Bernanke-Mihov index (negative*100)**
Net Due	0.007 [0.332]	**0.015** **[0.048]**	**–0.019** **[0.019]**
Net Due x Monetary policy	**0.203** **[0.000]**	**0.130** **[0.000]**	**0.093** **[0.000]**
Net Due x Low Liquidity	**–0.036** **[0.0018]**	**–0.044** **[0.003]**	–0.0077 [0.610]
Net Due x Mon policy x Low Liquidity	**–0.174** **[0.000]**	**–0.085** **[0.000]**	**–0.069** **[0.000]**

This table presents results from regressions of equation specification (4). They capture the direct effect on lending of foreign offices of a change in net due in response to a change in monetary policy. The reported coefficients focus on the effect on low liquidity banks. The dependent variable is either the quarterly change in foreign total lending or foreign C&I lending. Each column is a separate regression for each of the three measures of monetary policy. The reported numbers are from each respective sum of estimated coefficients, as indicated by each row legend. Net Due is in real 2005q4 dollars. Low liquidity is a dummy equal to one if a global bank has a value of liquidity to asset ratio below the median in a quarter. All other regressors from equation (4) were included but the results are not shown. Reported in brackets are the probabilities that the sum of the coefficients is significantly different from zero. Sample period: 1980:Q1-2005:Q4.

To run the counterfactual, we take the same 100 basis point change in federal funds rate and then look for the strongest estimated impact on large, domestic banks (a type of worst-case scenario). From Table 4, we see that the largest estimated coefficient is obtained from the IV specification with GDP controls and excluding the largest, top 1 percent domestic banks. This coefficient is 0.0015. To calculate the impact on lending growth, we evaluate the effect at the median point in the liquidity-to-asset ratio distribution, which is equal to 0.23 (in logs equal to –1.47). Hence, the median loss in total lending growth would be equal to 0.22 percentage points (0.0015 × –1.47) quarterly.[21] Thus, the 100 basis point change in

[21] This exercise is similar to those in Kashyap and Stein (2000).

monetary policy reduces the slope of the path in lending growth for large, domestic banks, leading to 0.22 percentage points less growth each quarter.[22] We now apply this estimate of the loss in potential growth to the global banks, and see if the internal inflow of funds is sufficiently large to "fill the gap".

Over the whole sample period, at the average bank/quarter point, a global bank had booked loans of approximately $8.3 billion (again, in 2005q4 value). Because the response in internal funding is expected over four consecutive quarters, we calculate the hypothetical loss in lending growth from this average point over four consecutive quarters as: $8.3 billion x 0.0022 x 4, which is approximately equal to $73 million. Hence, the estimated inflow of funds over the same time period for the median global bank observation of between $74 and $80 million seems to be quite exactly able to fill the funding gap and therefore maintain the balance sheet insulation of the global banks. Of course, this exercise generated numbers for a median bank observation. The same insights apply to global banks of any size: for example, the larger global banks would generate substantially larger Net Due effects (as shown in the lower panel of Table 6) and have comparably scaled up effects on total lending.

Next, how do we gauge the size of the international propagation channel? This exercise is relatively more straightforward because we can use the results from Table 8 to gauge the direct relationship between changes in internal lending and corresponding changes in external foreign lending. Take again the experiment of a 100 basis points change in the Federal Funds rate. From Table 8, the total effect of a change in internal lending due to such change in monetary policy for liquidity constrained banks is equal to a coefficient of – 0.08. To assess the economic impact, we turn this number into an elasticity, evaluating the effect at the mean of the distribution. The mean quarterly change in total foreign lending, up or down, for liquidity constrained global banks over the sample period was about $75 million. The corresponding mean quarterly change in Net Due was about $332 million. Hence the corresponding elasticity of foreign lending to net due in response to a 100 basis points change in the Federal Funds rate is equal approximately to 35 percent (0.08·(332/75)). Hence, each dollar of extra internal lending that a constrained global bank receives from its foreign offices corresponds to about 35 cents of reduced foreign external lending. Hence, even the magnitude of the international propagation channel seems very significant.

6. Conclusions

Globalization of banking has a deep and pervasive impact on the domestic and international transmission of US monetary policy. Tests using bank-specific data over the period between 1980 and 2005 show differences in the lending channel across large banks. While large banks are typically considered to have lending activity that is insulated from US monetary policy, once global banks are separated from this group of large banks, the remaining domestically-oriented banks have significant lending sensitivity to monetary policy. The insulation of large global banks to policy or liquidity changes in the United States is aided by a functioning internal capital market between globalized parents in the United States and their foreign offices.

[22] Their median growth in total lending over the whole period was 2.2 percent, hence the loss would amount to about 10 percent of such median value. While it could be argued that this effect is relatively small in economic magnitude, the scale is not surprising: these are still relatively very large banks with better than average access to financial markets external to the banking organization. Yet, the testing shows that, despite access to such external markets, insulation of large bank lending to US monetary policy is not complete when these banks do not have international operations.

The consequences are statistically and economically significant. On the one hand, by documenting that large but non-global banks are less insulated than previously evaluated we suggest a stronger impact of monetary policy via the lending channel than had previously been expected. On the other hand, the mechanisms we identify imply that, under increasing banking globalization, the impact of monetary policy on domestic bank lending and on the US economy as a whole is more attenuated, while at the same time the domestic shock is transmitted more broadly to foreign markets through affiliated banks. A continuing process of increasing banking globalization suggests that the lending channel within the United States could be declining in strength, with international transmission rising for policy and shocks originating in the United States.[23]

Our work underscores the importance of understanding the dynamics of international, intra-bank funding and should therefore assist in the undertaking of effective policy making. As a case in point, the response of US global banks in the aftermath of the liquidity crisis during the summer of 2007 and through 2009 indicates the significant use of internal funds by global banks during such an event. Hence a banking system that grows increasingly global may have enhanced resilience and self-adjustment in times of local liquidity crises. However, also as observed in the financial crisis, the broader international propagations of shocks perhaps shows the importance of some forms of coordinated intervention by national policy authorities.

As a concluding remark, in principle the importance of the internal capital markets across globalized parents and their foreign affiliates may be predicated on the regulatory and macroeconomic regimes at home and abroad. The strength of the channels we identify may be conditioned on the policy regimes in place in foreign markets, both with respect to exchange rate management and with respect to bank capital and liquidity management. These issues warrant further careful study. For example, one could ask whether the global liquidity management by banks considers whether and how the cost of capital in foreign markets moves in step with the US federal funds rate. Future research using bank-level data on foreign exposures could explore if those branches and subsidiaries in countries in where currencies are not pegged to the dollar are the ones that play dominant liquidity buffer roles. Indeed, existing studies using macroeconomic data already identify differences in monetary regimes on monetary policy transmission across markets that are associated with exchange rate regime. Overall, an open question is whether the globalization consequences for the lending channel could differ depending on whether the constellation of partners in banking contains countries that directly tie their monetary policies to those of the United States.

[23] This work is closely related to others that have also suggested a reduced potency for monetary policy as a result of evolution of the banking industry, eg Morgan, Rime and Strahan (2004), Ashcraft (2006) and Loutskina and Strahan, (2009).

References

Ashcraft, A (2008): "Are Bank Holding Companies a Source of Strength to Their Banking Subsidiaries?" *Journal of Money, Credit, and Banking*, vol 40, issue 2–3, pp 273–94, March/April.

Ashcraft, A (2006): "New Evidence on the Lending Channel," *Journal of Money, Credit, and Banking*, vol 38, issue 3, pp 751–76, April.

Ashcraft, A and M Campello (2007): "Firm Balance Sheets and Monetary Policy Transmission" *Journal of Monetary Economics*, vol 54, issue 6, pp 1515–28, September.

Berger, A, N H Miller, M A Petersen, R G Rajan (2005): '"Does Function Follow Organizational Form? Evidence from the Lending Practices of Large and Small Banks", *Journal of Financial Economics,* vol 76, pp 237–69; May.

Bernanke, B (2006): "Remarks on Global Economic Integration: What's New and What's Not?" At the Federal Reserve Bank of Kansas City's Thirtieth Annual Economic Symposium, Jackson Hole, Wyoming, August 25.

http://www.federalreserve.gov/boarddocs/speeches/2006/20060825/default.htm

Bernanke, B and A Blinder (1988): "Credit, Money, and Aggregate Demand", *American Economic Review, Papers and Proceedings*, vol 78, no 2, pp 435–39, May.

Bernanke, B and M Gertler (1995): "Inside the Black Box: The Credit Channel of Monetary Transmission", *Journal of Economic Perspectives*, vol 9, no 4, pp 27–48, Fall.

Bernanke, B and I Mihov (1998): "Measuring Monetary Policy" *Quarterly Journal of Economics*, 113 (3), pp 869–902, August.

Boschen, J and L Mills (1995): "The Relation between Narrative and Money Market Indicators of Monetary Policy" *Economic Inquiry* (33), pp 24–44.

Campello, M (2002): "Internal Capital Markets in Financial Conglomerates: Evidence from Small Bank Responses to Monetary Policy". *Journal of Finance*, v 57, issue 6, pp 2773–2805, December.

Canova, F (2005): "The Transmission of US Shocks to Latin data." *Journal of Applied Econometrics*. vol 20, pp 229–51.

De Haas, R and I Lelyveld (2009): "Internal Capital Markets and Lending by Multinational Bank Subsidiaries". *Journal of Financial Intermediations* (forthcoming).

Di Giovanni, J and J Shambaugh (2008): "The Impact of Foreign Interest Rates on the Economy: The Role of the Exchange Rate Regime" *Journal of International Economics*, vol 74, issue 2, pp 341–361, March.

Frankel, J, S Schmukler, and L Serven (2004): "Global Transmission of Interest Rates: Monetary Independence and the Currency Regime." *Journal of International Money and Finance* vol 23, no 5, pp 701–34, September.

Houston, J, D Marcus, and C James (1997): "Capital market frictions and the role of internal capital markets in banking?", *Journal of Financial Economics* 46(2), pp 135–164.

Ihrig, J, S Kamin, D Lindner, and J Marquez (2007): "Some simple tests of the globalization and inflation hypothesis", International Finance Discussion Papers 891. Washington: Board of Governors of the Federal Reserve System.

Kashyap, A and J Stein (2000): "What Do A Million Observations on Banks Say About the Transmission of Monetary Policy?," *American Economic Review*, 90(3), pp 407–28.

Kashyap, A and J Stein (1994): "Monetary policy and bank lending", in: N G Mankiw, ed, *Monetary Policy* (University of Chicago Press, Chicago) pp 221–56.

Kashyap, A and J Stein (1995): "The Impact of Monetary Policy on Bank Balance Sheets,"*Carnegie-Rochester Conference Series on Public Policy*, vol 42, pp 151–95.

Kim, S (2001): "International Transmission of US Monetary Policy Shocks: Evidence from VAR's" *Journal of Monetary Economics,* vol 48, pp 339–72.

Loutskina, E and P E Strahan (2009): "Securitization and the Declining Impact of Bank Finance on Loan Supply: Evidence from Mortgage" *Journal of Finance*,.

Morgan, D P, B Rime, and P E Strahan (2004): "Bank integration and state business cycles," *Quarterly Journal of Economics* 119, pp 1555–84.

Neumeyer, P and F Perri (2005): "Business cycles in emerging economies: the role of interest rates" *Journal of Monetary Economics,* vol 52, pp 345–80.

Obstfeld, M, J Shambaugh, and A Taylor (2005): "The Trilema in History: Tradeoffs among Exchange Rates, Monetary Policies, and Capital Mobility" *Review of Economics and Statistics*. vol 3, pp 423–438, December.

Peek, J and E Rosengren (1997): "The International Transmission of Financial Shocks: The Case of Japan" *American Economic Review*, 87 (4), pp 495–505, September.

Peek, J and E Rosengren (2000): "Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States" *The American Economic Review*, vol 90, no 1, pp 30–45, March.

Sbordone, A (2007): "Globalization and Inflation Dynamics: The Impact of Increased Competition", NBER Working Paper 13556.

Stein, J (1998): "An Adverse Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy", *Rand Journal of Economics* 29, pp 466–486, Autumn.

Yellen, J (2006): "Monetary Policy in a Global Environment**"** Speech at The Euro and the Dollar in a Globalized Economy Conference, U C Santa Cruz, Santa Cruz, CA, May 27. http://www.frbsf.org/news/speeches/2006/060527.pdf.

Data appendix

Data screens. For our regression analysis we apply a number of screens to the data. These screens follow closely those of Kashyap and Stein (2000) and Campello (2002). We drop bank quarters in which mergers or changes in "high holder" within a BHC occur. We drop bank quarters where asset growth was above 100 percent and total loan growth was above +50 percent or below –50 percent. In regressions where we focus on C&I lending, we remove similar outliers in the C&I lending growth distribution. Finally, for regressions analyzing the lending of foreign offices we dropped outliers at the 1st and 99th percentile of either the series of growth in total and C&I lending of foreign offices.

Net Due. Net due to and Net due from items are located on schedule RC-H--Selected Balance Sheet Items for Domestic Offices of the CALL report (FFIEC 031, page 24)

Item Number 2941: *NET DUE TO OWN FOREIGN OFFICES, EDGE AND AGREEMENT SUBSIDIARIES, AND IBFS*. Data Description: The position of the domestic offices of the bank relative to all of the bank's Edge and Agreement subsidiaries, foreign branches, consolidated foreign subsidiaries, and branches in Puerto Rico and US territories and possessions. All intra-bank transactions of the domestic offices with these other offices of the bank, including investments (both equity and debt) in consolidated subsidiaries (foreign and domestic), are reflected here, since all other items are reported on a fully consolidated basis and excludes all intra-bank transactions. A single net amount for all the intra-bank due to and due from positions of the domestic office is calculated and entered either in "Net Due from Own Foreign Offices, Edge and Agreement Subsidiaries, and IBFs (2163)" or this item, depending on whether the single net amount is a net due from or a net due to balance.

Item Number 2163: *NET DUE FROM OWN FOREIGN OFFICES, EDGE AND AGREEMENT SUBSIDIARIES, AND IBFS*. Data Description: The position of the domestic offices of the bank relative to all of the bank's Edge and Agreement subsidiaries, foreign branches, consolidated foreign subsidiaries, and branches in Puerto Rico and US territories and possessions. All intra-bank transactions of the domestic offices with these other offices of the bank, including investment (both equity and debt) in consolidated subsidiaries (foreign and domestic), are reflected here, since all other items are reported on a fully consolidated basis and exclude all intra-bank transactions. A single net amount for all the intra-bank due to and due from positions of the domestic offices is calculated and entered either in "Net Due to Own Foreign Offices, Edge and Agreement Subsidiaries, and IBFs (2941)" or this item, depending on whether the single net amount is a net due from or a net due to amount.

Table A1

Lending channel for large domestic and large globally-oriented banks

Breakdown of coefficients on monetary policy variables
IV specification in first-stage regressions

	Total lending					
	Domestic banks			**Global banks**		
	Federal funds rate (nominal)	**Federal funds rate (real)**	**Bernanke-Mihov index (negative*100)**	**Federal funds rate (nominal)**	**Federal funds rate (real)**	**Bernanke-Mihov index (negative*100)**
ΔM_{t-1}	**–0.002 [0.078]**	–0.0009 [0.348]	**–0.003 [0.004]**	**–0.009 [0.017]**	–0.004 [0.320]	–0.003 [0.156]
ΔM_{t-2}	**0.004 [0.083]**	**0.004 [0.001]**	**0.005 [0.004]**	**0.011 [0.026]**	0.005 [0.422]	0.005 [0.220]
ΔM_{t-3}	–0.0009 [0.794]	–0.002 [0.129]	**–0.002 [0.085]**	0.007 [0.383]	0.003 [0.468]	0.0006 [0.826]
ΔM_{t-4}	–0.003 [0.429]	–0.002 [0.170]	0.0001 [0.959]	–0.009 [0.380]	–0.007 [0.132]	0.0001 [0.981]
ΔM_{t-5}	0.004 [0.254]	0.002 [0.253]	0.0005 [0.707]	0.002 [0.790]	–0.002 [0.432]	–0.002 [0.483]
ΔM_{t-6}	–0.004 [0.173]	–0.001 [0.418]	–0.0007 [0.635]	–0.008 [0.173]	–0.003 [0.489]	–0.001 [0.553]
ΔM_{t-7}	**0.003 [0.018]**	0.002 [0.330]	0.0003 [0.825]	**0.009 [0.076]**	0.005 [0.314]	0.001 [0.667]

This table presents the breakdown of the individual coefficients on the monetary policy variables from the corresponding regression results presented in Table 3, lower panel. The results here are those from regressions on total lending and they correspond to the specification with GDP controls for domestic banks (column 2) and that with GDP and foreign rates controls for global banks (column 5).

Table A2

Lending channel for large domestic and large globally-oriented banks

Total C&I lending: Summed monetary variable effect on first-stage regression betas

	OLS specifications				
	Domestic banks		**Global banks**		
	no gdp controls (1)	with gdp controls (2)	no gdp controls (3)	with gdp controls (4)	gdp & foreign rate controls (5)
Federal funds rate (nominal)	**0.0012 [0.017]**	**0.0012 [0.032]**	–0.0009 [0.4586]	–0.0012 [0.278]	–0.0025 [0.174]
Federal funds rate (real)	0.0008 [0.104]	**0.0012 [0.039]**	–0.0002 [0.9036]	0.0001 [0.945]	–0.0012 [0.459]
Bernanke-Mihov index (negative*100)	0.0000 [0.944]	–0.0001 [0.763]	–0.0004 [0.7377]	–0.0007 [0.473]	–0.0009 [0.304]
	IV specifications				
	Domestic banks		**Global banks**		
	no gdp controls (1)	with gdp controls (2)	no gdp controls (3)	with gdp controls (4)	gdp & foreign rate controls (5)
Federal funds rate (nominal)	**0.0028 [0.000]**	**0.0028 [0.000]**	–0.0011 [0.427]	–0.0014 [0.278]	–0.0032 [0.231]
Federal funds rate (real)	**0.0024 [0.002]**	**0.0030 [0.001]**	–0.00001 [0.994]	0.0003 [0.885]	–0.0033 [0.141]
Bernanke-Mihov index (negative*100)	**0.0010 [0.063]**	0.0010 [0.112]	–0.0010 [0.434]	–0.0012 [0.241]	–0.0018 [0.124]

This table presents results from equation specification (2). The dependent variable is the time series of estimated coefficients of the liquidity to asset ratio from quarterly cross-sectional regressions based on specification (1), where the dependent variable was growth in bank C&I loans. The reported figures in the columns are from the sum of the estimated coefficients on the eight lags of each respective monetary policy variables. The Bernanke-Mihov index has been modified from the original so that all three monetary policy indicators signal tightening when they increase. Reported in brackets is the probability that the sum of the coefficients is significantly different from zero. The upper panel reports results based on first-stage OLS regressions. In the lower panel instrumenting the liquidity to asset ratio with the series of the residuals of a regression of such variable on the C&I to total lending ratio and the ratio of nonperforming to total loans. The first two columns reports results for the group of large, domestic banks, ie banks above the 95th percentile in asset size and reporting no foreign assets. The last three columns report results for the group of large, global banks, ie large banks with positive foreign assets. Columns 1 and 3 refer to second-stage specifications without GDP controls, while columns 2, 4 and 5 to specifications including GDP controls. Column 5 also includes foreign rate controls. Bold indicates statistical significance at least at the 10 percent level. Sample period: 1980:Q1-2005:Q4. Standard errors are computed with an 8-lags Newey-West correction for autocorrelation and heteroskedasticity.

Is there a cross-border bank lending channel? Evidence from US banks' international exposure[1]

Ricardo Correa and Charles Murry[2]

Abstract

This paper uses detailed information on US banks' foreign claims to identify changes in the supply of cross-border funds due to the stance in US monetary policy. We show evidence that during a monetary tightening, US banks significantly reduce their holdings of cross-border claims on foreign residents, supporting the existence of a cross-border bank lending channel. The result is stronger for banks with foreign offices. In addition, we test for the relevance of a balance sheet channel at the country level. We find that this mechanism is not significant, as we observe larger reductions in cross-border lending to "safer" countries than to those defined as "risky".

JEL Classification: E51, F34, F36, G21

Keywords: Bank lending channel, cross-border lending, international banking

1. Introduction

The financial market turmoil that began in mid-2007 has magnified the effects of economic globalization and leaves questions about how policy reactions in one country can affect other economies around the world. A problem that started with the sub-prime mortgage market in the US spread to other markets, and in particular, exerted significant pressure on big diversified financial institutions. It is now clear that policy decisions should be considered with the anticipation that their impact will have similar global ramifications. In particular, the monetary policy decisions in one country will have global repercussions because of the financial integration that has occurred over the past 20 years. In this paper, we examine the international effect of the bank lending channel. Actions taken by monetary authorities in countries with global banks potentially have an impact on the amount of cross-border lending these banks provide. We test if the supply of US banks' loans to foreigners decreases during a monetary tightening, or in other words, a cross-border bank lending channel.

The literature on the credit channel has identified two mechanisms through which financial frictions magnify the effect of monetary policy: the bank lending channel (Bernanke and Blinder (1988), Kashyap and Stein (1995), and Stein (1998)) and the balance sheet channel (Bernanke and Gertler (1995) and Bernanke, Gertler, and Gilchrist (1996)). The lending channel operates through changes in aggregate loan supply and predicts that a monetary tightening will decrease the quantity of bank loans available. Using bank-level characteristics

[1] We thank Ugo Albertazzi, John Driscoll, Linda Goldberg, Seung Lee, Tara Rice, Skander Van den Heuvel, and participants at the CGFS workshop on "Research on global financial stability: The use of BIS financial statistics" and the Federal Reserve's international finance workshop for their valuable comments and suggestions. This paper represents the authors' opinions and not necessarily those of the Board of Governors, the Federal Reserve System, or other members of its staff. Corresponding author is Ricardo Correa, ricardo.correa@frb.gov; Mail Stop 44, Federal Reserve Board, Washington DC, 20551, 202-452-2213.

[2] Federal Reserve Board; University of Virginia.

to identify shifts in the supply of credit, a series of studies find that smaller banks with less liquid balance sheets—higher external finance premiums—are more sensitive to changes in monetary policy (Campello (2002) and Kashyap and Stein (2000)). The balance sheet channel operates through changes in the asset composition of banks. During periods of monetary tightening, banks are found to shift their lending from "riskier" to "safer" alternatives because of increased agency costs (Bernanke and Gertler (1989)).

At the international level, the transmission of shocks between countries has been studied using the framework of financial contagion (Allen and Gale (2000)). Peek and Rosengren (1997, 2000) analyze the effect of the Japanese banking crisis in the 1990s on Japanese banks' lending in the United States and Schnabl (2008) studies the effect of the Russian crisis in 1998 on foreign banks' lending in Peru. Both studies find that there are significant financial and real repercussions on the country that experiences the contagion effect.

In the work that is most related to ours, Cetorelli and Goldberg (2008) bridge these two strands of the literature by studying the relation between financial globalization and the lending channel of monetary policy. The authors focus on the mitigating effect of banks' internal markets on the monetary transmission mechanism. They find that globally diversified financial institutions are able to smooth domestic monetary shocks by relying on the resources provided by foreign affiliates.

Like Cetorelli and Goldberg (2008), we use the fact that global banks are able to respond to a change in domestic monetary policy by rebalancing their global portfolio of claims. However, our paper differs from their study by focusing on the effects of monetary policy on the amount of cross-border lending to foreign residents. A tighter monetary policy increases banks' external financing costs, and under certain conditions, has an effect on banks' supply of loans to domestic and foreign residents. We use a detailed dataset of US banks' foreign claims by country to identify changes in the supply of cross-border funds due to shifts in the monetary policy stance. This information allows us to control for differences in the composition of borrowers across countries and for each country's demand for credit. In particular, we address the following questions: Is there a cross-border bank lending channel? Do banks shift their cross-border lending from borrowers located in "riskier" countries to those in "safe" countries (a cross-border balance sheet channel) during a monetary tightening?

Our empirical results show that there is a statistical and economically significant reduction in the level of cross-border claims during monetary policy contractions. At the bank level, we use Kashyap and Stein's (2000) two-step method and find that a 100 basis point increase in the nominal federal funds reduces the growth rate of cross-border claims by 4 percentage points. This is a considerable change, in particular, when compared to the median growth rate of zero for this type of claims.

The use of aggregate data at the bank level may bias the estimated parameters measuring the relation between monetary policy and cross-border lending. A significant concern in estimating the link between monetary policy and bank credit is the identification of changes in the demand for credit from those that determine the supply of bank funds (Black and Rosen (2008)). To properly identify a cross-border credit channel, we have to control for changes in the demand for credit abroad. We deal with this measurement problem by using information on detailed bank-country lending patterns reported by US banks. These data allows us to include fixed-effects and credit demand proxies at the bank-country level in the empirical specifications. As in the bank-level estimations, we find that a 100 basis point increase in the nominal funds rate decreases cross-border claims by 4 percent. This represents a significant shift in the supply of foreign funds for countries that depend on external financing. This evidence points to the existence of a cross-border lending channel.

In a second set of tests, we assess if there is also a functioning balance sheet channel in cross-border lending, that is, a compositional change in US banks' holdings of claims from residents of "riskier" to residents of "safer" countries during periods of monetary tightening.

We find that banks keep their exposure to residents of "riskier" countries at constant or slightly higher levels in monetary contractions, but retract their exposure from countries considered "safer". This result deviates from the evidence in studies using bank lending to firms (Black and Rosen (2008)). However, it reinforces the fact that banks reduce their overall supply of cross-border funds, as most of their foreign claims are to residents of countries considered "safe".

The results of this paper complement the evidence in Ammer, Vega, and Wongswan's (2008) study on the effect US monetary policy surprises on foreign firms' equity prices. These authors show that the stock price of foreign credit-constrained and bank-dependent firms reacts significantly to monetary surprises. They attribute part of this price reaction to the workings of a credit channel. Our findings describe the direct channel through which monetary policy affects these foreign bank-dependent firms.

The remainder of the paper is organized as follows. Section 2 describes the hypothesis and methodology used to test the cross-border bank lending channel. Section 3 details the data and sources used in the empirical specifications. In section 4, we discuss the empirical results and section 5 concludes.

2. Hypothesis and methodology

2.1 Two-step estimations of the effect of monetary policy on foreign claims

The first test to assess the linkage between US monetary policy and banks' foreign claims is based on the two-step methodology used by Kashyap and Stein (2000) and Campello (2002). Their approach takes advantage of detailed bank-level data to measure the change in the sensitivity of lending to the banks' balance sheet strength across the monetary cycle. Their main hypothesis is that banks with limited access to uninsured sources of finance will decrease lending during periods of monetary tightening. We use the same method to test whether monetary policy has an effect on US banks' holdings of claims on foreign residents. In particular, we are interested in the value of cross-border claims across the monetary cycle, as they are more likely to depend on the parent bank's balance sheet.

In the first step, we estimate the following equation for each cross-section of banks (ie bank data available each quarter):

$$\Delta \log(y)_{it} = \mu + \sum_{k=1}^{4} \alpha_k \Delta \log(y)_{it-k} + \beta Liquidity_{it-1} + \delta Capitalization_{it-1} + \varphi Nonperforming_{it-1} + \lambda \log(Assets)_{it-1} + \sum_{k=1}^{12} \psi_k FRB_{ik} + \varepsilon_{it} \quad (1)$$

where i is a bank and t represents time. Our measures of foreign claims (y) include all claims originated by a bank in an office outside the destination country (cross-border claims) and claims issued by foreign-offices of a bank on local residents of the host country (foreign-office claims). The coefficients of interest are the β's on the $Liquidity$ variable, our measure of balance sheet strength.[3] These coefficients determine the sensitivity of the banks' international activity to their own liquid assets. The outcome of this estimation is a β for each time-period (ie quarter) of data in our sample.

[3] Liquidity is the ratio of the banks' securities, trading assets, federal funds sold, and securities purchased under agreement to resell to total assets.

In this empirical specification we control for other bank-level characteristics like the ratio of total capital to risk-weighted assets (*Capitalization*), the ratio of non-performing loans to total loans (*Nonperforming*), the logarithmic value of total assets, and dummies for each Federal Reserve district. The last set of indicator variables control for loan demand conditions in the districts where the headquarters of the banks are located.

In the second step, we use the estimated β's from (1)—for each time period and type of foreign claim—and regress them on our measure of monetary policy (r).[4] That is, we estimate:

$$\beta_t^y = \delta + \sum_{k=0}^{4} \phi_k r_{t-k} + \kappa Trend_t + \sum_{j=1}^{3} \nu_j Quarter_t + u_t \qquad (2)$$

In this case, the coefficients of interest are the ϕ's that accompany the monetary policy measure.[5] The significance of these coefficients is the test of the hypothesis that monetary policy has an effect on foreign lending. If the sum of these coefficients is positive and significant, it indicates that during periods of monetary tightening banks depend on the strength of their balance sheet to maintain the supply of foreign credit. This would provide positive evidence of a cross-border bank lending channel. We also estimate an expanded version of (2) adding the current growth rate of real GDP and its four lags and conduct the same test.

This method provides some insight on the relation between monetary policy and foreign lending. The downside of this approach is that we are not able to control for the effect of bank-borrower relationships or changes in foreign demand of US loanable funds. The next method addresses these issues.

2.2 Estimations of the effect of monetary policy controlling for host-country conditions

To determine the effect of monetary policy on US banks' foreign claims, we use a second set of tests that identify the changes in loan supply by using detailed bank-country information. As mentioned before, we focus on outstanding cross-border claims to foreign residents broken down by the location of the ultimate obligor. The main issue in this test is to control for changes in loan demand in the country of the ultimate obligor. Black and Rosen (2008) use commitment loans as a proxy for loan demand using US bank lending data. They compare the reaction of this type of loans to monetary policy and contrast it to the change in the value of spot loans. The authors argue that in the short run, banks' ability to control the amount of commitment lending is limited by the contractual arrangement between the bank and the borrower. Thus, this type of bank lending is used as a baseline for loan demand.[6]

We estimate a modified version of this method applied to cross-border lending. In particular, we assume that foreign-office claims on local residents are a good proxy for each foreign country's credit demand. This type of claims is less volatile than cross-border claims and it is not significantly correlated with the US market cycle (Goldberg (2007)). US banks' foreign subsidiaries and branches are more likely to establish lending relationships with their

[4] A higher value for *r* indicates a tighter monetary stance.

[5] We add as controls a time trend (*Trend*) and quarterly dummies (*Quarter*).

[6] Kashyap, Stein, and Wilcox (1993) use commercial paper as a baseline for loan demand. The authors analyze the change in bank lending due to monetary policy against this benchmark.

borrowers reducing the potential effect of informational asymmetries. In addition, foreign offices of US banks' are able to—mainly if they are structured as subsidiaries—collect deposits from foreign residents. If monetary policy is not perfectly correlated between the US and the host country, this will allow foreign offices to take advantage of their local deposits to satisfy the demand for credit. Lastly, we control for changes in the foreign offices' supply of credit explained by internal transfers from the parent bank. This allows us to measure the local demand for credit net of the effect of internal capital markets.

In our empirical tests, we estimate the following equation:

$$y_{ijt} = \alpha + \sum_{k=0}^{4} \beta_k r_{t-k} + \lambda Foreign\,Credit\,Demand_{jt} + \delta \Delta \log(USRGDP) + \gamma X_{it} + \rho Z_{jt} + \theta_{ij} + \varepsilon_{ijt} \quad (3)$$

where i represents a country, j a bank, and t is time; y is the value of cross-border claims; r is a measure of monetary policy; $Foreign\ Credit\ Demand$ is a proxy for the local demand for credit; X_{it} are country-specific controls; Z_{jt} are bank-specific controls; θ are bank-country fixed effects; and ε is the error term.

As in the two-step method discussed before, we are interested in the coefficients on the monetary policy proxy, the β's. They measure the significance of the cross-border bank lending channel. Negative coefficients imply a reduction in outstanding cross-border claims due to a monetary tightening in the US. This effect is estimated using the variation in the value of foreign claims within each bank-country relationship. We use a detailed dataset of bank-level lending to each foreign country to control for bilateral unobserved factors that potentially have an effect on cross-border lending. Some of these unobserved factors include the profile of the firms or banks that borrow from specific US financial institutions in a given country. In particular, we want to control for potential linkages between the borrowers and the US economy (ie exporters). As long as these characteristics do not vary across time, they will be taken into account by the bank-country fixed effects.[7] This method helps us identify changes in the supply for credit from variations in demand due to the composition of the borrowers in a relationship with each specific bank.

In addition to the factors that affect the foreign demand for credit, we also control for the US business cycle by including the change in real GDP (*USRGDP*) in our estimations. Better lending conditions in the US may force banks to lend to their domestic customers rather than their foreign borrowers. At the host-country level, we include a variable to measure changes in the bilateral exchange rate with the US Cross-border claims are denominated in US dollars. This regressor allows us to differentiate variations in cross-border claims due to changes in the value of the currency as opposed to shifts in the volume of credit.

At the bank level, we use three measures, also included in the previous test, to capture the "health" of the banks' balance sheet: *Liquidity, Nonperforming, and Capitalization*. In addition, we add an indicator variable that equals 1 if the bank has an office in the host country reporting positive claims. Financial institutions may adjust the level of their cross-border claims differently if they have offices in the country of the ultimate obligor. Lastly, we adjust for changes in foreign claims due to bank mergers with an indicator variable equalling 1 in the quarter that the deal involving the bank takes place.

[7] Correa (2008) finds that differences in language between the host and home countries after a cross-border acquisition have a negative effect on the target bank's performance after a deal. This is an example of a transaction cost that does not vary in time but that could affect the level of cross-border lending.

Using the same specification, we conduct an additional test differentiating the monetary policy reaction for banks that have foreign offices and are active in cross-border lending from those that do not have foreign offices but lend to foreign residents. We want to check whether *global banks* are less sensitive to the US monetary cycle. Cetorelli and Goldberg (2008) find that banks with offices in foreign countries react less to monetary policy changes than small local banks.

Lastly, to assess the importance of a balance sheet effect, we test if cross-border lending to residents in "riskier" countries is more sensitive to US monetary policy than lending to residents of "safer" countries. We evaluate this difference by interacting the monetary policy proxy with a measure of the countries' riskiness.

3. Data

The Federal Financial Institutions Examination Council (FFIEC) requires US banks to report their exposure to foreign residents every quarter in the Country Exposure Report (CER).[8] Commercial banks and bank holding companies that have claims on non-US residents of $30 million or more, disclose their exposures broken down by the location of the immediate and ultimate guarantor and the type of claim they hold. In our analysis, we focus on the amounts outstanding of US banks' cross-border claims and foreign-office claims on local residents on an ultimate-risk basis.

Claims reported on an ultimate-risk basis account for any legally binding third-party risk transfers and are allocated according to the location of the ultimate guarantor. This allows us to exclude, for example, US banks' claims on affiliates of US companies abroad, which from a bank-firm relationship standpoint, are closer to a domestic rather than a cross-border loan. Financial institutions report as cross-border claim on the CER, all claims on foreign residents that are made by offices of US banks not located in the same country of the ultimate obligor. In contrast, foreign-office claims on local residents are originated at foreign branches or consolidated subsidiaries of US banks on counterparties located on the same country as the foreign office.

Figure 1 shows the amounts outstanding of cross-border and foreign-office claims between the end of March 1997 and end-June 2008—the sample period used in the estimations. Cross-border claims are larger than foreign-office claims throughout the period. Nevertheless, both types of claims have increased in the past 10 years and at a faster rate in the last two years.[9] The distribution of these claims across country groups, shown in Figure 2, is tilted towards G-10 developed countries, although claims on emerging market economies (EMEs) have also increased in recent years. We use the heterogeneity in the borrowers' characteristics of residents in these countries and their interaction with US banks as part of the identification strategy described in the previous section.

[8] For a detailed description of the Country Exposure Report (FFIEC 009) and its latest revision in 2006 see Correa and Davies (2008).

[9] US banks' foreign claims, although significant, are ranked seventh amongst the Bank for International Settlements' Consolidated Banking Statistics reporting countries as of end-June 2008.

Figure 1

Foreign claims of US banks, by type of claim

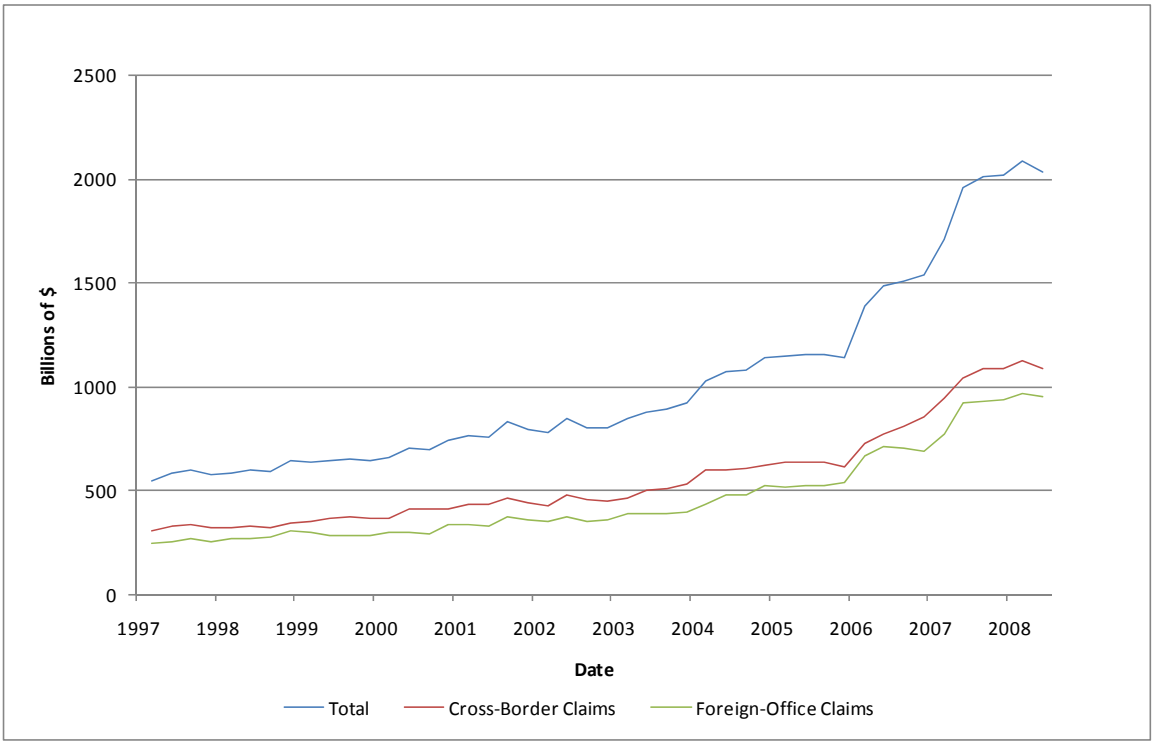
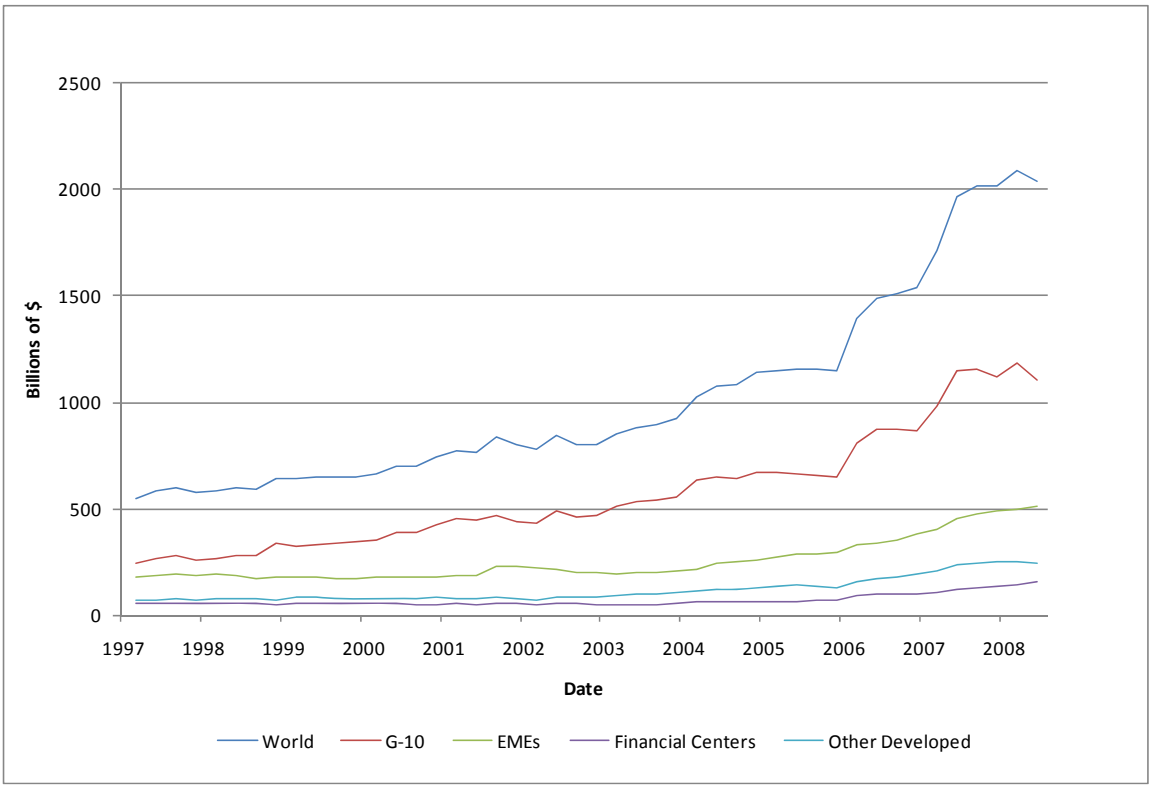


Figure 2

Total foreign claims of US banks, by country group



Apart from using the linkages between US lenders and foreign borrowers to identify changes in the supply of cross-border claims, we use two measures that proxy for the domestic

demand for credit. The first measure is the sum of the orthogonal component of foreign-office claims, after extracting the flows between the foreign office and the other affiliates of the bank including the holding company, across US banks in each country. Foreign-office claims are less sensitive to US conditions, as these branches or subsidiaries usually establish local relationships with their borrowers and, in some cases, are able to issue liabilities in the foreign country. In using the orthogonal component of the value of foreign-office claims, we are assuming that changes in their lending activity are due to domestic demand conditions rather than supply factors driven by US monetary policy.[10]

The second measure of local credit demand is the value of deposit money banks' claims on the private sector in the host country.[11] These data is published by the International Monetary Fund in its International Financial Statistics. We assume that a large portion of the changes in the outstanding claims on the private sector are driven by the host-countries' credit demand conditions.

For our empirical estimations we construct two samples. The first one includes aggregates of US banks' foreign claims at the bank level. The second sample details US banks' claims in all bank-country relationships by quarter.[12] To reduce the effect of outlier observations, we restrict the sample of banks and bank-country relationships according to a few selection criteria. To be included in either sample, a bank (bank-country pair) needs to have reported foreign claims for at least six consecutive quarters. In addition, for those estimations that include the growth rate of foreign claims, we exclude observations with values that are below the 1st percentile or above the 99th percentile. In the bank-country pair estimations, we exclude countries without any US banks' foreign-office claims.

Table 1 shows descriptive measures of the sample. The number of banks per quarter averages about 42, with a smaller number of banks reporting in recent years due to banking sector consolidation. More than 50 percent of these banks can be described as *global banks*—the bank reports foreign-office claims on local residents at any point in the sample period. The number of vis-à-vis countries in the sample fluctuates between 72 to 87 countries per quarter. This leaves us with an average of about 800 observations in each time period.

Additional bank-level information comes from the Consolidated Report of Condition and Income (Call Report) collected by the FFIEC. Table 2 shows descriptive statistics for the sample of banks used in the estimations. Banks in the sample are large, as shown by the median real assets of 32 billion (in 2000 US dollars). Although average foreign claims represent about one-third of mean total loans, a comparison of the medians yields a significant larger difference. This discrepancy shows the heterogeneity across banks in terms of their exposure to foreign residents. Nevertheless, it is also worth noting that the median bank has about 12 country relationships. The median value of foreign claims in each bank-country relationship is 45 million dollars (2000 US dollars), with 37 million represented in cross-border claims.

---

[10] Cetorelli and Goldberg (2008) find that foreign offices rely less on the parent company during periods of monetary tightening. Goldberg (2007) finds that foreign-office claims on local residents are less volatile and less correlated with US business cycle variables than cross-border claims.

[11] Claims on the private sector are reported in line 22d in the International Financial Statistics.

[12] Foreign claims by reporting banks are aggregated at the "high-holder" level. Some banks that are affiliated to bank holding companies report their foreign claims separately in certain quarters. Aggregating the data at the "high-holder" level reduces the number of banks in our sample, but also ensures that we do not have random entrants in our sample and significant variations at the bank holding company level.

Table 1

Sample description

Quarter	Banks	% global banks	Countries	% inv grade	Observations
1997q1	49	53%	72	67%	849
1997q2	48	54%	73	67%	874
1997q3	48	54%	73	67%	912
1997q4	48	54%	74	64%	932
1998q1	50	52%	75	62%	982
1998q2	52	50%	75	59%	997
1998q3	51	49%	77	58%	937
1998q4	50	48%	78	58%	940
1999q1	52	46%	79	58%	946
1999q2	53	43%	79	58%	898
1999q3	52	44%	78	56%	882
1999q4	49	45%	79	56%	859
2000q1	51	43%	80	57%	861
2000q2	51	45%	79	61%	869
2000q3	51	45%	81	61%	897
2000q4	50	44%	81	60%	845
2001q1	47	47%	82	59%	825
2001q2	48	46%	81	59%	820
2001q3	46	46%	81	58%	810
2001q4	44	48%	80	60%	777
2002q1	44	48%	79	60%	772
2002q2	40	53%	79	59%	747
2002q3	41	51%	79	60%	750
2002q4	41	51%	79	60%	745
2003q1	41	51%	79	60%	761
2003q2	40	53%	79	60%	763
2003q3	40	53%	79	60%	757
2003q4	40	53%	80	61%	765
2004q1	42	55%	80	62%	763
2004q2	41	54%	80	62%	734
2004q3	41	51%	80	62%	753
2004q4	40	53%	79	63%	754
2005q1	39	54%	80	63%	760
2005q2	38	53%	80	63%	748
2005q3	38	53%	80	63%	746
2005q4	38	53%	81	63%	753
2006q1	35	60%	82	64%	767
2006q2	34	59%	82	65%	772
2006q3	33	64%	83	64%	733
2006q4	33	64%	83	66%	735
2007q1	33	64%	86	64%	740
2007q2	33	64%	86	64%	742
2007q3	31	61%	86	64%	662
2007q4	31	61%	87	64%	665
2008q1	31	61%	86	64%	657
2008q2	30	63%	86	61%	646

The sample includes all banks reporting in the Country Exposure Report from the first quarter of 1997 through the second quarter of 2008. The average number of banks is 42, with fewer banks reporting more recently. Global banks are banks that report foreign-office claims on local residents at any point in the sample period.

Table 2

Descriptive statistics

Panel A: Descriptive statistics by bank

	Obs	Mean	Median	Std. dev.
Total assets (2000 $ millions)	1741	107,735	32,011	235,043
Total loans (2000 $ millions)	1739	50,549	14,201	97,359
Total foreign claims (2000 $ millions)	1741	17,551	314	73,014
Cross-border claims (2000 $ millions)	1741	8,915	255	30,396
Foreign-office claims (2000 $ millions)	1741	8,637	0	46,491
Total foreign claims to loans (%)	1739	35.70	12.17	55.82
Total cross-border claims to loans (%)	1739	28.43	8.63	45.28
Number of bank-country relationships	1958	18.85	12.00	19.09
Liquid assets to total assets (%)	1737	27.56	23.95	15.74
Total capital ratio (%)	1741	12.29	12.09	8.01
Nonperforming loans to total loans (%)	1735	0.61	0.00	2.71

Panel B: Descriptive statistics by bank-country relationship

	Obs	Mean	Median	Std. dev.
Total foreign claims (2000 $ millions)	36902	1,014	45	4,662
Cross-border claims (2000 $ millions)	36902	515	37	2,012
Foreign-office claims (2000 $ millions)	36902	499	0	3,488
Net due to own related offices (2000 $ millions)	36902	82	0	3,429

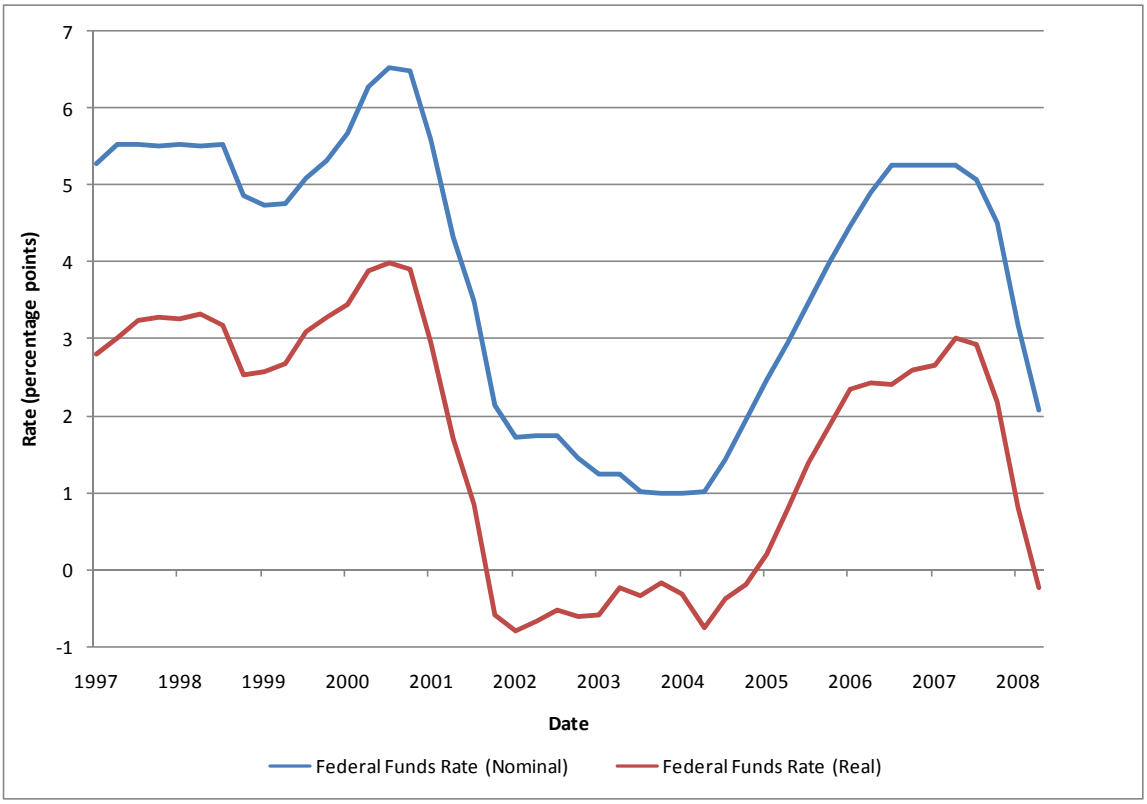
Panel A summarizes descriptive statistics of relevant variable for the sample of banks used in the main estimations aggregated at the bank level. Panel B summarizes descriptive statistics for all of the bank-country observations in our estimation. For instance, the mean bank-country amount of total foreign claims (one bank's exposure to one country) is $1,014 million. There is considerable skewness due to the fact that there are a few very strong bank-country relationships that arise for historical and/or institutional reasons.

As measures of monetary policy, we use the effective federal funds rate (or nominal funds rate) and the real funds rate. The latter is equal to the nominal funds rate minus current inflation, proxied by the quarterly growth rate in core CPI (consumer price index net of food and energy prices).[13] Although both measures are highly correlated, as shown in Figure 3, our preferred measure is the real funds rate, as the credit channel implies that loan supply is related to real interest rates. Previous studies have used alternative measures of monetary policy like the Bernanke and Mihov (1998) and Boschen and Mills (1995) indexes. These measures were better estimators of monetary policy, compared to the federal funds rate, during the highly-volatile Volcker disinflation period. Our sample starts more than a decade after this period, which makes the use of the federal funds rate as an indicator for monetary policy stance more appropriate.

[13] We assume that the best measure of expected inflation is current inflation.

Figure 3

Monetary policy indicators



In some of our tests, we compare the change in foreign claims to different countries according to their "riskiness". As a proxy for creditworthiness, we use the countries' sovereign rating. We collect rating information from Moody's and Standard and Poor's. The last column in Table 1 displays the percentage of countries with investment grade ratings by quarter.[14] About 60 percent of the countries with US banks' exposures have investment grade.

Additional country-specific controls like nominal exchange rates and real per capita GDP are from the IMF's International Financial Statistics and the World Bank.

4. Results

4.1 Two-step estimations of the effect of monetary policy on foreign claims

The first set of tests to measure the effect of monetary policy on US banks' foreign claims relies on the well-established two-step method used by Kashyap and Stein (2000). We modify this test by replacing the sensitivity of loans to banks' liquidity for the sensitivity of foreign claims to internal funds in the second step of the estimation. Then, we evaluate how this sensitivity is correlated with changes in the monetary policy stance.

[14] A country is considered to have investment grade if its sovereign debt has ratings equal or above BBB- by Standard and Poor's or Baa3 by Moody's.

Table 3 shows the sum of the coefficients and standard errors on the monetary policy measure from the second stage estimations outlined in (2). The table is divided into two panels. Panel B differs from Panel A, in that it includes the change in log real GDP and its four lags (not shown) as regressors in the second stage of the estimation. We use the effective (nominal) federal funds rate and the real federal funds rate, our preferred measure, as monetary policy indicators. Higher values indicate tighter monetary policy.

Table 3

Two-Step Estimation of the Impact of Monetary Policy on Banks' Foreign Lending

This table presents results from the two-step estimation methodology developed in Kashyap and Stein(2000). In the first step (results not shown), we estimate the sensitivity of the banks' international activity to their own liquid assets represented by the parameter β from the following model:

$$\Delta \log(y)_{it} = \mu + \sum_{k=1}^{4} \alpha_k \Delta \log(y)_{it-k} + \beta Liquidity_{it-1} + \delta Capitalization_{it-1} + \varphi Nonperforming_{it-1} + \lambda \log(Assets)_{it-1} + \sum_{k=1}^{12} \psi_k FRB_{ik} + \varepsilon_{it}$$

where y is the value of foreign claims in US dollars, i indexes countries, t indexes time. The second step uses the estimated β's from the previous model to estimate the following equation:

$$\beta_t^y = \delta + \sum_{k=0}^{4} \phi_k r_{t-k} + \kappa Trend_t + \sum_{j=1}^{3} \nu_j Quarter_t + u_t,$$

where r is a measure of monetary policy. The parameter of interest is ϕ and it is shown in Panel A for different measures of monetary policy and foreign claims. Panel B shows results for the same parameter, but adding controls for the current growth rate of GDP and its four lags in the second step of the empirical specification.

Panel A: Excluding GDP controls

Monetary policy indicator	Total foreign claims	Cross-border claims	Foreign-office claims
Federal funds rate (nominal)	0.104**	0.1009**	0.0425
	[0.0466]	[0.0489]	[0.0679]
Federal funds rate (nominal)	0.1224**	0.1147**	0.0368
	[0.0551]	[0.0488]	[0.0706]

Panel B: Including GDP controls

Monetary policy indicator	Total foreign claims	Cross-border claims	Foreign-office claims
Federal funds rate (nominal)	0.1039**	0.1007*	0.0449
	[0.0485]	[0.053]	[0.0653]
Federal funds rate (nominal)	0.1366**	0.135**	0.0338
	[0.0519]	[0.0589]	[0.0543]

Newey-West robust standard errors in brackets: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In Panel A, the coefficients on both monetary policy indicators are positive and significant for total foreign claims and cross-border claims. This finding is consistent with a cross-border bank lending channel. As monetary policy gets tighter, only banks with liquid balance sheets are able to continue lending to their foreign borrowers. In contrast, the coefficients for

foreign-office claims on local residents are positive but not significantly different from zero. The latter result is not surprising. Cetorelli and Goldberg (2008), using data for a longer time period, find that lending by foreign affiliates of US banks is less reliant on the parent banks' balance sheet during periods of monetary tightening. As mentioned before, foreign offices—in some cases—are able to collect deposits on foreign residents, making them less dependent on the parent bank's funding.

The results in Panel B are consistent with the findings in Panel A. The sum of coefficients for the nominal federal funds rate do not differ significantly from the values observed when GDP growth is excluded. The effect of monetary policy on cross-border lending becomes even stronger in this specification when the real federal funds rate is used as proxy for the policy indicator. The change in foreign-office claims remains not significant after we include GDP controls.

Although these results are consistent across specifications, there could be unmeasured effects that may be driving the correlation between cross-border claims and monetary policy. The most relevant are the characteristics of banks' foreign borrowers and the fluctuation of the foreign demand for credit. In the next set of tests, we control for these factors.

4.2 Cross-border claims and monetary policy at the bank-country level

In this section, we describe a series of tests of the cross-border bank lending hypothesis that use controls at the bank-country level and take into account cyclical movements in the foreign demand for credit. We estimate (3) using detailed bank-country foreign claim information. We want to assess whether US banks' cross-border claims react to monetary policy. To identify credit supply movements from changes in credit demand, we exploit information on US banks' foreign-office claims as a proxy for local demand conditions. In addition, all estimations have bank-country fixed effects to control for unobserved lender-borrower characteristics. The test relies on the variation within each bank-country relationship and its correlation to US monetary policy.

Table 4 shows results from the main specification.[15] The dependent variables are the logarithmic transformation of real cross-border claims. In columns (1) and (3), foreign credit demand is proxied by the value of US banks' foreign-office claims on local residents. The value of domestic deposit banks' claims on the private sector is included as the control for foreign credit demand in columns (2) and (4). The first two columns use the nominal federal funds rate as the monetary policy indicator and the last two use the real federal funds rate. We use all bank-country relationships with positive cross-border claims.

The last two rows in the table report the sum of coefficients on the monetary policy indicator and its standard errors—clustered by bank. Our main hypothesis states that a cross-border bank lending channel exists if the sum of these coefficients is negative. A tightening in monetary policy in the US reduces the supply of credit to foreign residents through cross-border lending. The sum of coefficients in all specifications is negative and significant. This implies that we are not able to reject our hypothesis that banks reduce their level of cross-border claims in tight money periods. This result confirms the findings in the two-step method estimations, after controlling for the creditor country's demand for credit.

[15] All specification include (not shown) an indicator variable for mergers, and three bank-specific variables—defined in section 3—to control for the banks' balance sheet "health": *Capitalization*, *Liquidity*, and *Nonperforming*.

Table 4

Cross-border claims and the bank lending channel

This table presents the results for the following equation:

$$y_{ijt} = \alpha + \sum_{k=0}^{4} \beta_k r_{t-k} + \lambda Foreign\,Credit\,Demand_{jt} + \delta \Delta \log(USRGDP) + \gamma X_{it} + \rho Z_{jt} + \theta_{ij} + \varepsilon_{ijt}$$

where i indexes countries, j indexes banks, and t denotes time. The sample consists of all country-bank relationships from the Country Exposure Report for the period 1997Q1-2008Q2. r is a measure of monetary policy. *Foreign Credit Demand* is proxied by an adjusted measure of foreign-office claims on local residents and by the value of private credit of deposit taking institutions. *USRGDP* is represents the value of US real GDP; X_{it} is the bilateral exchange rate between the US and the foreign country; Z_{jt} are bank-specific controls including the value of non-performing loans, liquidity, capitalization, and indicator variables equalling 1 if the bank has an office in the host country or if it merged with another bank in the sample at time t; θ are bank-country fixed effects.

Monetary policy indicator:	**Nominal funds rate**		**Real funds rate**	
	(1)	**(2)**	**(3)**	**(4)**
Federal funds rate (t)	–0.114***	–0.095***	–0.089***	–0.076***
	[0.028]	[0.024]	[0.022]	[0.021]
Federal funds rate ($t-1$)	0.089***	0.079***	0.045*	0.038
	[0.029]	[0.027]	[0.026]	[0.025]
Federal funds rate ($t-2$)	0.018	–0.009	0.042	0.026
	[0.033]	[0.031]	[0.027]	[0.027]
Federal funds rate ($t-3$)	0.106**	0.102***	0.078**	0.065*
	[0.040]	[0.038]	[0.036]	[0.033]
Federal funds rate ($t-4$)	–0.138***	–0.114***	–0.118***	–0.091**
	[0.045]	[0.038]	[0.044]	[0.037]
GDP growth	–0.022	–0.029	–0.025	–0.028
	[0.022]	[0.022]	[0.022]	[0.021]
Foreign credit demand	0.010	0.170***	0.010	0.171***
	[0.007]	[0.060]	[0.007]	[0.061]
Exchange rate	0.000	0.001	0.000	0.001
	[0.001]	[0.001]	[0.001]	[0.001]
Dummy foreign-office claims	–0.619***	–0.623***	–0.620***	–0.624***
	[0.160]	[0.165]	[0.159]	[0.164]
Proxy for foreign credit demand	Foreign office claims	Claims on private sector	Foreign office claims	Claims on private sector
Bank-country fixed effects?	Yes	Yes	Yes	Yes
Observations	33134	32737	33134	32737
Sum of monetary policy coefficients	–0.039**	–0.037**	–0.041**	–0.039**
	[0.017]	[0.017]	[0.02]	[0.019]

Robust standard errors clustered by bank in brackets: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The coefficients on the control variables have the expected signs. The proxies for foreign credit demand have a positive but not robustly significant coefficient. This measure captures the variation in cross-border claims due to changes in credit demand. Its positive coefficient implies that changes in cross-border claims depend on the local demand for credit. In contrast, US GDP growth has a negative coefficient, but not significantly different from zero.

Faster GDP growth increases US firms' demand for credit as their investment opportunity set becomes larger. These borrowers compete with foreign residents for the banks' supply of funds. This is reflected on the negative correlation between US GDP growth and cross-border claims. We include two additional variables to control for changes in the bilateral nominal exchange rate and the banks' presence in foreign countries. The latter variable is negative and significant in most specifications. Banks with local offices in a country are less likely to lend from offices located in the US or a country different from the location of the ultimate obligor.

In Table 5, we test whether banks with foreign offices (global banks) are less likely to reduce their level of cross-border claims during periods of US monetary tightening. Cetorelli and Goldberg (2008) find that global banks use their internal capital markets to smooth the effect of monetary policy changes. The last two rows of the table show the sum of coefficients on the monetary policy indicators for global banks. We find that this sum is negative and significant in all specifications. Global banks reduce cross-border claims by larger margins during monetary contractions when compared to local banks (banks without foreign offices). There is an explanation for this result that follows from the findings in Cetorelli and Goldberg (2008). Banks with foreign offices are able to contract their cross-border lending during a monetary tightening and rely on foreign offices to satisfy the demand for credit of their foreign clients. Why would they shift their supply of foreign funds and redirect it to local residents? During monetary contractions, firms rely on commitment loans to finance their projects as the supply of spot loans decreases (Black and Rosen (2008)). If large banks have to comply with these contractual arrangements, and their sources of funding are limited, they substitute cross-border for domestic lending to satisfy local borrowers. Overall, global banks have a neutral response to monetary policy, but cross-border lending is affected. If banks' foreign offices have limited resources, they may have to cut the supply of credit to marginal clients to be able to fund borrowers previously being financed with cross-border funds.

Additional sensitivity analyses using system GMM were also conducted. Although the results are similar, the models estimated reject the null hypothesis that the overidentifying restrictions are valid.

4.3 Economic significance

The empirical results show that there is a statistically significant effect of US monetary policy on the level and growth of foreign claims, in particular, cross-border claims. In this section, we will assess whether the changes in cross-border lending are economically significant.

We start with the findings using the two-step estimation approach. In the first example, we use the set of coefficients shown in Panel B of Table 3 on the nominal federal funds rate. These estimations include as regressors the GDP growth rate and its lags. We focus on the effect of monetary policy on total foreign claims and cross-border claims. The sum of coefficients for the monetary policy indicator for each type of claim is 0.104 and 0.101, respectively. We compare two banks: the first one has a liquidity ratio equal to the 10^{th} percentile of the distribution (11.1 percent) and the second equals the value at the 90^{th} percentile (51.1 percent). An increase of 100 basis points on the federal funds rate implies a difference of 4.2 percentage points on the growth rate of total foreign claims. This is a significant difference, in particular, if we compare it to the median growth rate of 1 percent for total foreign claims. For cross-border claims, the difference in growth rates is similar at 4 percentage points. In this case, the median growth rates for this claims is equal to zero.

Table 5

Cross-border claims and the bank lending channel: global vs local banks

This table presents results of tests on the hypothesis that banks with foreign offices (global banks) are less likely to reduce their level of cross-border lending during times of US monetary tightening. The model is identical to the model in Table 4, except for an added interaction between monetary policy proxy (*Federal Funds Rate*) and a dummy variable equalling 1 for banks that do not have foreign offices (*Dummy Local Bank*). Presented at the bottom of the table is the sum of the monetary policy coefficients for global banks.

Monetary policy indicator:	**Nominal funds rate**		**Real funds rate**	
	(1)	**(2)**	**(3)**	**(4)**
Federal funds rate (t)	–0.153***	–0.131***	–0.123***	–0.109***
	[0.029]	[0.025]	[0.023]	[0.022]
Federal funds rate ($t-1$)	0.112***	0.097***	0.060**	0.050*
	[0.032]	[0.029]	[0.028]	[0.027]
Federal funds rate ($t-2$)	0.026	0.001	0.056*	0.041
	[0.038]	[0.036]	[0.031]	[0.032]
Federal funds rate ($t-3$)	0.139***	0.134***	0.101**	0.087**
	[0.046]	[0.043]	[0.043]	[0.039]
Federal funds rate ($t-4$)	–0.181***	–0.155***	–0.155***	–0.126***
	[0.051]	[0.043]	[0.050]	[0.043]
Federal funds rate (t) × Dummy local bank	0.230***	0.211***	0.212***	0.199***
	[0.060]	[0.058]	[0.055]	[0.055]
Federal funds rate ($t-1$) × Dummy local bank	–0.123*	–0.098	–0.083	–0.067
	[0.064]	[0.064]	[0.054]	[0.055]
Federal funds rate ($t-2$) × Dummy local bank	–0.065	–0.067	–0.103**	–0.101**
	[0.066]	[0.065]	[0.047]	[0.048]
Federal funds rate ($t-3$) × Dummy local bank	–0.164**	–0.157**	–0.112*	–0.105*
	[0.076]	[0.072]	[0.062]	[0.058]
Federal funds rate ($t-4$) × Dummy local bank	0.238**	0.220**	0.214**	0.196**
	[0.092]	[0.084]	[0.086]	[0.078]
GDP growth	–0.020	–0.026	–0.023	–0.026
	[0.022]	[0.022]	[0.022]	[0.021]
Foreign credit demand	0.009	0.165***	0.010	0.166***
	[0.007]	[0.060]	[0.007]	[0.060]
Exchange rate	0.000	0.001	0.000	0.001
	[0.001]	[0.001]	[0.001]	[0.001]
Dummy foreign-office claims	–0.618***	–0.622***	–0.620***	–0.623***
	[0.158]	[0.162]	[0.157]	[0.162]
Proxy for foreign credit demand	Foreign office claims	Claims on private sector	Foreign office claims	Claims on private sector
Bank-country fixed effects?	Yes	Yes	Yes	Yes
Observations	33134	32737	33134	32737
Sum of monetary policy coefficients for global banks	–0.057***	–0.054***	–0.06***	–0.057***
	[0.018]	[0.018]	[0.021]	[0.021]

Robust standard errors clustered by bank in brackets: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The second set of results from our estimations show the levels of cross-border claims at the bank-country level after changes in the monetary policy indicator. In this case, we focus on the coefficients from the first column in Table 4. Again, we quantify the change in US banks' cross-border claims to a 100 basis points increase in the federal funds rate (nominal). The sum of coefficients on the monetary indicator implies a 4 percent drop in cross-border claims in 2000 dollars due to the change in policy. Using the median value for cross-border claims (37 million) and the median number of bank-country relationships (12), we can infer that the total decrease in cross-border claims is equal to 17 million (21 million current dollars). This value represents about half the change in net intrabank flows documented in Cetorelli and Goldberg (2008), as a product of a monetary tightening. In addition, the reduction in cross-border claim would cover about one-third of the loss in lending growth of domestic banks estimated by these authors.

As it is shown by these numbers, the effect of monetary policy on cross-border lending is not negligible. During periods of tightening, global banks can either move their resources within the organization or reduce cross-border claims to minimize the effect of higher costs of funding. Our results show that the latter channel is not negligible.

4.4 Is there a balance sheet channel?

In addition to the bank lending channel, the literature on the credit channel defines another mechanism through which monetary policy affects the financing of firms. The balance sheet channel states that tight monetary policy weakens the creditworthiness of small firms and reduces their capacity to access external financing from any source (Bernanke and Gertler (1995)). As a robustness check, we test whether the results we observe on cross-border claims are driven by the bank lending channel or if a country-level version of the balance sheet channel is significant as well. For this purpose, we collect information on the sovereign ratings of each country in the sample for every quarter.[16] We assume that countries that do not have an investment grade rating are risky and therefore, firms and financial institutions headquartered within their borders will have difficulties finding external financing from US banks during periods of monetary tightening. This will only be true if US monetary policy, indeed, decreases the creditworthiness of borrowers in these countries.

In Table 6 we examine the significance of a balance sheet channel. The estimation equation has the same structure as in (3), but with an additional indicator variable equaling one if the vis-à-vis country has an investment grade rating, and the interactions between this variable and the monetary policy proxy. Our hypothesis is that US banks will redirect their cross-border claims from countries without investment grade rating to those with investment grade rating during periods of monetary tightening. We test this hypothesis by checking the sign and significance of the sum of coefficients for the monetary policy indicator and its interaction with the investment grade dummy ($Dummy\ IG$). The last two rows in the table show the value of the sum of these coefficients and their standard error. In all specifications, the sum is negative and significant. This result makes us reject the hypothesis that banks redirect their exposures to "safer" borrowers. That is, there is no balance sheet channel at the cross-border level. So, the decreases in lending in the previous section are attributed to a shift in the supply of cross-border claims, or the bank lending channel.

[16] Borensztein, Cowan, and Valenzuela (2007) find that sovereign ratings are strong determinant of corporate credit ratings.

Table 6

Cross-border claims and the bank lending channel

This table presents the results from tests on the significance of an international balance sheet channel. The estimation specification is identical to that in Table 4, except for an added dummy variable, *Dummy IG,* and interaction terms between this dummy variable and the monetary policy variables. *Dummy IG* takes on a value of 1 if a bank has a claim on a country with sovereign debt rated as investment grade. Presented at the bottom of the table is the sum of monetary policy coefficients for investment grade countries.

Monetary policy indicator:	**Nominal funds rate**		**Real funds rate**	
	(1)	**(2)**	**(3)**	**(4)**
Federal funds rate (t)	0.008	0.009	0.015	0.015
	[0.058]	[0.056]	[0.047]	[0.045]
Federal funds rate ($t-1$)	0.024	0.031	0.015	0.020
	[0.053]	[0.052]	[0.035]	[0.034]
Federal funds rate ($t-2$)	0.001	–0.027	0.005	–0.013
	[0.057]	[0.053]	[0.045]	[0.042]
Federal funds rate ($t-3$)	–0.046	–0.039	–0.035	–0.039
	[0.062]	[0.064]	[0.054]	[0.052]
Federal funds rate ($t-4$)	0.086	0.090	0.083	0.089
	[0.085]	[0.082]	[0.080]	[0.076]
Federal funds rate (t) × Dummy IG	–0.176**	–0.155**	–0.145**	–0.129**
	[0.067]	[0.070]	[0.056]	[0.058]
Federal funds rate ($t-1$) × Dummy IG	0.095	0.076	0.041	0.027
	[0.071]	[0.073]	[0.047]	[0.047]
Federal funds rate ($t-2$) × Dummy IG	0.033	0.037	0.056	0.061
	[0.059]	[0.057]	[0.047]	[0.047]
Federal funds rate ($t-3$) × Dummy IG	0.203***	0.191***	0.147***	0.136***
	[0.061]	[0.063]	[0.044]	[0.045]
Federal funds rate ($t-4$) × Dummy IG	–0.307***	–0.286***	–0.266***	–0.245***
	[0.075]	[0.078]	[0.068]	[0.071]
Dummy investment grade (Dummy IG)	1.039***	0.923***	0.724***	0.637***
	[0.086]	[0.101]	[0.087]	[0.074]
GDP growth	–0.028	–0.035	–0.032	–0.036*
	[0.022]	[0.022]	[0.022]	[0.022]
Foreign credit demand	0.010*	0.146**	0.010*	0.148**
	[0.006]	[0.056]	[0.006]	[0.057]
Exchange rate	–0.001	0.000	–0.001	0.000
	[0.001]	[0.001]	[0.001]	[0.001]
Dummy foreign-office claims	–0.551***	–0.554***	–0.554***	–0.556***
	[0.150]	[0.155]	[0.149]	[0.154]
Proxy for foreign credit demand	Foreign office claims	Claims on private sector	Foreign office claims	Claims on private sector
Bank-country fixed effects?	Yes	Yes	Yes	Yes
Observations	31074	30688	31074	30688
Sum of monetary policy coefficients	–0.079***	–0.074***	–0.083***	–0.078***
for countries with Investment Grade	[0.014]	[0.014]	[0.016]	[0.016]

Robust standard errors clustered by bank in brackets: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

There is one caveat to this analysis. The empirical specifications exclude shifts in the banks' overall lending to borrowers in the US On the one hand, these creditors are probably the safest for the bank, as information asymmetries are reduced at shorter distances between the borrower and the lender (Degryse and Ongena (2005)). On the other hand, these borrowers are more likely to suffer from the tightening in monetary policy. At the aggregate level, studies have found that lending by large and global banks are less sensitive to monetary policy changes than small or domestic banks (Kashyap and Steing (2000); Cetorelli and Goldberg (2008)). This result would be consistent with a rebalancing of the banks' lending portfolio from foreign to domestic borrowers. Testing this hypothesis is beyond the scope of this paper, but it would be worth investigating in future studies.

As a robustness check for the balance sheet channel, we also use the level of GDP per capita as a proxy for creditworthiness. Countries with GDP per capita above the median in each year were classified as less risky. Results from these estimations (not shown) are consistent with the findings using sovereign ratings.

5. Conclusions

The financial turmoil that started in the summer of 2007 showed the interconnectedness of financial markets across borders. Actions taken by central banks in some countries had effects on the financial sectors of others. This paper analyzes one dimension of the diffusion of shocks across countries. We focus on the cross-border transmission of monetary policy through the banking sector. Using a detailed dataset on US banks' foreign claims, we find that there is a significant reduction in the level of cross-border claims during periods of monetary tightening in the US The contraction in lending is more significant for banks with foreign offices. In contrast, we do not find evidence on the relevance of a balance sheet channel at the country level. In periods of tight money, US banks reduce their cross-border holdings of claims on residents of countries with an investment grade rating in larger proportions than from those without this type of rating.

The evidence shown in this paper is relevant from a policy-making perspective. As financial integration becomes the norm, individual countries have to develop more robust domestic financial markets. Firms that depend on cross-border lending need strong domestic financial systems in order to substitute foreign debt for domestic debt during periods of monetary tightening abroad. Without these alternatives, the contraction of foreign funds is transformed into less domestic investment and significant effects on the real side of the economy.

References

Allen, Franklin and Douglas Gale, 2000, Financial contagion, *Journal of Political Economy* 108, 1-33.

Ammer, John, Clara Vega, and Jon Wongswan, 2008, Do fundamentals explain the international impact of US interest rates? Evidence at the firm level, International Finance Discussion Papers No. 952.

Bernanke, Ben S. and Alan S. Blinder, 1988, Credit, Money, and Aggregate Demand, *American Economic Review* 78, Papers and Proceedings of the 100th Annual Meeting of the American Economics Association, 435-39.

Bernanke, Ben S. and Mark Gertler, 1989, Agency costs, net worth, and business fluctuations, *American Economic Review* 79, 14-31.

Bernanke, Ben S. and Mark Gertler, 1995, Inside the black box: The credit channel of monetary transmission, *Journal of Economic Perspectives* 9, 27-48.

Bernanke, Ben S., Mark Gertler, and Simon Gilchrist, 1996, The financial accelerator and the flight to quality, *The Review of Economics and Statistics* 78, 1-15.

Bernanke, Ben S. and Ilian Mihov, 1998, Measuring monetary policy, *Quarterly Journal of Economics* 113, 869-902.

Black, Lamont K. and Richard J. Rosen, 2008, The effect of monetary policy on the availability of credit: How the credit channel works, *FRB of Chicago Working Paper* No. 2007-13.

Borensztein, Eduardo, Kevin Cowan, and Patricio Valenzuela, 2007, Sovereign ceilings "lite"? The impact of sovereign ratings on corporate ratings in emerging market economies, IMF Working Papers 07/75.

Boschen, John and Leonard Mills, 1995, The relation between narrative and money market indicators of monetary policy, *Economic Inquiry* 33, 24-44.

Campello, Murillo, 2002, Internal capital markets in financial conglomerates: Evidence from small bank responses to monetary policy, *Journal of Finance* 57, 2773-2805.

Cetorelli, Nicola and Linda S. Goldberg, 2008, Banking globalization, monetary transmission, and the lending channel, *NBER Working Paper* No. W14101.

Correa, Ricardo, 2008, Cross-border bank acquisitions: Is there a performance effect? *Journal of Financial Services Research*, forthcoming.

Correa, Ricardo and Sally Davies, 2008, Recent changes to the US country exposure report, Federal Reserve Bulletin, forthcoming.

Degryse, Hans A. and Steven Ongena, 2005, Distance, lending relationships, and competition, *Journal of Finance* 60, 231-266

Goldberg, Linda S. (2007) The international exposure of US banks: Europe and Latin America compared, in Sebastian Edwards ed.: *Capital Controls and Capital Flows in Emerging Economies: Policies, Practices, and Consequences* (The University of Chicago press), 203-232.

Kashyap, Anil K. and Jeremy C. Stein, 1995, The impact of monetary policy on bank balance sheet, *Carnegie-Rochester Series on Public Pol*icy 42, 151-195.

Kashyap, Anil K. and Jeremy Stein, 2000, What do a million observations on banks say about the transmission of monetary policy? *American Economic Review* 90, 407-428.

Kashyap, Anil K., Jeremy C. Stein, and David W. Wilcox, 1993, Monetary policy and credit conditions: Evidence from the composition of external finance, *The American Economic Review* 83, 78-98.

Peek, Joe and Eric Rosengren. 1997. The international transmission of financial shocks: The case of Japan, *American Economic Review* 87, 495-505.

Peek, Joe and Eric Rosengren, 2000, Collateral damage: Effects of the Japanese bank crisis on real activity in the United States, *American Economic Review* 90, 30-45.

Schnabl, Philipp, 2008, Financial globalization and the transmission of credit supply shocks: Evidence from an emerging market, unpublished manuscript.

Stein, Jeremy C., 1998, An adverse selection model of bank asset and liability management with implications for the transmission of monetary policy, *Rand Journal of Economics* 29, 466-486.

Foreign asset risk exposure, degree of internationalization, and performance: An analysis of Canadian banks

Eric Santor and Walid Hejazi[1]

Abstract

The international business literature measures links between the degree of internationalization (DOI) of a firm's activities and its performance. The results of this literature are mixed. The authors extend the analysis to Canadian bank-level data, and take into account the riskiness of each bank's foreign-asset exposure. The estimating procedure also accounts for possible endogeneity that may underlie the DOI-performance relationship. The results establish a casual relationship between DOI and performance, but find that the nature of this relationship varies by bank and also depends upon the riskiness associated with each bank's foreign asset exposures. These causal relationships are robust to the introduction of two formal risk measures, notably credit ratings and equity price volatility. The authors discuss policy implications of their analysis.

JEL Classification: F23, G21

Keywords: Foreign asset, risk exposure and degree of internationalization

1. Introduction

Financial product innovation, regulatory reform, advances in information technology, and the tremendous growth in international trade have all contributed to the evolving role of banks within the international financial system. A popular perception of this process is that banks' activities are increasingly international, and Canadian financial institutions are no exception. The consequences of internationalization for bank performance, however, are largely unknown. A simple question therefore arises: Does greater internationalization lead to better performance for Canadian banks?

The international business literature offers a framework in which to measure the link between the degree of a bank's internationalization and its performance.[2] The idea is that, as firms increase the share of their operations abroad, thus increasing their degree of internationalization (DOI), they may experience higher levels of performance. DOI can be measured in terms of the share of total sales, assets, income, or employees located outside a company's home country. Performance can be measured as Tobin's Q, return on assets (ROA), return on equity (ROE), return on investment, or profitability.

In a related literature, DOI is related to excess market valuation (ie Tobin's q). Errunza and Senbet (1981, 1984) are amongst the earliest studies to present evidence showing that excess value increases with the extent of international activity. Rather than just the foreign

[1] Bank of Canada; Rotman School of Management, University of Toronto.

[2] See Contractor, Kundu, and Hsu (2003) for an excellent survey.

sales ratio to capture multinational operations, Errunza and Senbet (1984) extend the analysis to include other measures as well. The evidence has been interpreted as "global diversification" that comes with DOI completes the market for investors who otherwise face barriers to international capital flows. Therefore, [US] multinationals earn monopolistic rents over purely domestic firms.

In this paper we have two objectives. First, we argue that the above framework must be implemented carefully. The methodology often used implicitly assumes that internationalization is the "cause" of observed firm value or firm performance – that is, it is implicitly assumed that increasing DOI has a direct impact on firm performance. Although it is true that, in part, the causality may move from DOI to performance, the aforementioned assumption ignores a very important aspect of the theory in international business that firms go abroad to exploit firm-specific advantages. That is, firms develop techniques and products that give them some competitive advantage, which then allows the innovating firm to perform well in the domestic market. These firms then move abroad through foreign direct investment (FDI) and other modes to exploit these firm-specific advantages.[3] Since it is the firms that are doing well domestically that are most likely to move abroad, we expect to see superior performance before they move abroad. To not explicitly account for this initial success may result in too much significance being attributed to DOI.

Our second objective is to better account for risk in the analysis. Implicitly assumed in studies that use DOI as a predictor of firm performance is the idea that a positive relationship is somehow sufficient to justify the movement abroad. In other words, the positive relationship is taken to imply that the move abroad has "paid off." Although this may seem obvious, one must also take into account the risk associated with the firms' operations abroad and how they compare with their domestic operations. If the movement abroad increases the risk profile of a particular firm's operations, then an increase in performance is a minimum that would be expected by shareholders. The question is whether the increase in performance is sufficient to compensate shareholders for the increased risk.

Using quarterly data on Canada's largest banks over the period 1994 to 2004, we test the link between performance and DOI. We use a statistical methodology that measures the relationship between DOI and performance, but one that, for example, ensures that any positive relationship documented is not simply driven by the possibility that firms performing well are those which increase their operations abroad (DOI), as opposed to the superior performance being driven by the increases in DOI. Conversely, we ensure any relationships documented are not simply reflective of the possibility that poor performing firms do not pursue markets abroad. The analysis uses both market and non-market based measures of performance. The non-market based measures of performance are ROA and ROE. As in Errunza and Senbet (1981, 1984), we also use a market based measure of performance, namely Tobin's q.

Our results indicate that once corrections are made for past performance, endogeneity, the risk profile of each bank's foreign holdings, and formal measures of risk, there are indeed positive causal links between DOI and performance. Furthermore, the risk profile of each bank's activities abroad play a significant role in this relationship, even after controlling more formally for risk by including each bank's equity price volatility and credit rating.

Since the causal links identified are found to be a function of the riskiness associated with each bank's foreign holdings, this indicates that much of the increase in performance that comes with increased amounts of foreign activity is in fact compensation for the higher risk associated with foreign claims. The implications for bank managers and their boards are clear. If one believes that internationalization somehow improves firm performance, then

[3] That is, firms can exploit the firm-specific advantages they have over local firms in foreign jurisdictions.

corporate strategists may be led to believe that expanding abroad will lead to improvements in firm value. On the other hand, to the extent that firm values are high to begin with because of firm-specific advantages, corporate strategists will realize that internationalization is a reflection of underlying firm-specific advantages and hence high market values. Our results suggest that if firms decide to move abroad to improve performance, and their decision is based only on a positive observed relationship between DOI and performance, then such a strategy may not result in improved performance.

Furthermore, the link between DOI and firm performance must also take into account the risk profile of the companies' operations. If the expansion of multinational activities abroad does not result in greater risk in the firm's operations, then a positive impact of DOI on performance can be interpreted as a good outcome for the firm. On the other hand, if the movement abroad increases the risk exposure of the firm, then the increase in performance must be sufficient to compensate for the increased risk. In other words, if the performance of Canadian banks is to be assessed, the assessment must explicitly account for the risk profile of the banks' international operations. We suspect that similar results hold for firms in other industries, although the necessary data are not available, nor are the risk profiles as easily assessed as is the case for Canadian banks.

The implications for regulators is that although DOI is correlated to bank performance, they must be careful not to encourage more international activity for the purpose of improving performance. Consequently, regulators must take into consideration the potential impact of how banks allocate their portfolios between domestic and foreign claims, as well as the composition of those foreign claims vis-à-vis risk. Understanding these aspects of Canadian banks' behaviour will assist regulators to ensure safe and efficient financial markets.

The rest of this paper is organized as follows. Section 2 provides a literature review. Section 3 provides a framework to test the DOI–performance relationship, which accounts for initial performance and risk. Section 4 describes the data (that is, it describes Canadian banking). Section 5 reports empirical evidence using quarterly data for the period 1994 to 2004. Section 6 concludes and describes the policy implications of our analysis.

2. Literature review

The hypothesized positive relationship between performance and DOI goes back at least to Vernon (1971); many studies have followed. It is generally hypothesized that internationalization is good for firms and leads to better performance, for several reasons (Contractor, Kundu, and Hsu 2003; Dunning 1977, 1981). First, going international implies that firms can spread fixed costs, such as operating overhead and research and development (R&D) expenditures, through greater scale and scope (Markusen 1984; Kobrin 1991). Second, internationalization allows firms to learn about domestic markets from their international market experience, thus improving performance (Kobrin 1991). Third, operating in foreign jurisdictions allows firms to access factors at lower cost (Helpmann 1984; Porter 1990; Jung 1991). This is particularly true for instances of FDI and other modes of direct involvement in foreign markets. Fourth, internationalization allows firms to cross-subsidize their domestic operations and provides greater opportunities for price discrimination and tax and price arbitrage.

Of course, when operating in foreign markets, firms may acquire a phenomenon known as the Liability of Foreignness, which can be defined as "The inherent disadvantage foreign firms experience in host countries because of their non-native status" (Peng (2005)) . These liabilities stem from formal and informal institutions in different countries (eg regulatory, language, and cultural differences), and the fact that customers may discriminate against foreign firms. As a result, MNEs must work to overcome these liabilities.

There are studies that have addressed the liability of foreignness for banks. For example, Nachum (2002) examines the reasons underlying the observation that foreign financial

services firms operating in the City of London do not suffer the liability of foreignness to the extent suggested by theory. Using data on a sample of 296 foreign financial services firms it is shown that the competitive performance of foreign banks are attributable to their firm-specific advantages which British banks do not necessarily possess. Nachum encourages further research to test whether the extent to which this situation is unique to the City of London. In contrast to these results, Zaheer (1995) shows using a sample of 24 major Western and Japanese banks in New York and Tokyo that there is a liability of foreignness, and also demonstrates the role of a firm's administrative heritage in providing a competitive advantage to the foreign affiliates.

Despite these liabilities associated with being foreign, multinationals have expanded into foreign markets to a great degree, although the research of Rugman and his colleagues has demonstrated that this has been in large part regional (Rugman (2005), Rugman and Verbeke (2004), and Rugman and Collinson (2008)). Nevertheless, although theory implies a positive relationship, the empirical evidence of the effects of DOI on performance is mixed (Hsu and Boggs 2003). For example, Sullivan (1994) lists 17 studies that test the relationship between DOI and financial performance, six of which find a positive relationship and five negative. The remaining six find no relationship. This reflects the consensus in the literature that the empirical results are highly dependent on the sample, the measures of DOI, and the measures of performance used.

In a closely related area, DOI is linked to excess market valuation, and to the idea of international diversification. As noted above, Errunza and Senbet (1981, 1984) are amongst the earliest studies to present evidence showing that excess value increases with the extent of international activity (DOI), which they define in several ways. They relate excess valuation to measures of DOI, volatility in stock returns, and industrial concentration, and their evidence has been interpreted as an indication that global diversification completes the market for investors who otherwise face barriers to international capital flows. Therefore, US multinationals earn monopolistic rents over purely domestic firms. Other studies that also find a positive relationship between international diversification and excess market valuation include Fatemi (1984) and Kim and Lyn (1986).

In a more recent paper, Gande, Schenzler and Senbet (2008) demonstrate that "global diversification is inherently different from industrial diversification." That is, DOI, or doing business in the global economy, allows investors access to investments that are not available domestically, or not available in countries with restrictions on portfolio holdings. In other words, multinational firms provide international diversification opportunities, and this enhances their share prices at home relative to those of national firms.

But even in this literature, the evidence on the link between DOI and performance, measured as excess market value, is mixed. For example, Morck and Yeung (1991) find a positive association between firm value and internationalization only for firms with firm-specific intangible assets, which is consistent with the view that global diversification enhances firm value because it allows firms to exploit their firm-specific skills on a global level.

In addition to testing this link, the literature has moved in two distinct directions. First, to address a measurement issue, Sullivan (1994) attempts to more reliably measure the DOI of a firm by developing a novel index measure of internationalization that combines five different performance criteria with two structural and two attitudinal measures into a composite index of internationalization. As Ramaswamy, Kroeck, and Renforth (1996) show, there are several limitations to the empirical and theoretical underpinnings of Sullivan's work, arguing that the composite index proposed by Sullivan did not take into account the full complexity of internationalization. As such, many studies continue to use a one-dimensional measure of DOI: the share of either assets, revenues, profits, or employment that locates abroad. Errunza and Senbet extend the analysis to include other measures in addition to just the foreign sales ratio to capture multinational operations.

There is also a growing literature that focuses on the shape of the relationship between DOI and performance. Contractor, Kundu, and Hsu (2003) list studies that test the relationship between performance and DOI: seven of the studies listed find a positive relationship, four a negative relationship, and four no relationship. Two studies listed find a U-shaped relationship, and eight find an inverted U-shaped relationship.

Contractor, Kundu, and Hsu (2003) and Lu and Beamish (2004) provide a theoretical model for curvilinear relationships between DOI and performance, thus constituting a significant contribution to this literature. The three stage model of Contractor et al (2003) explains multinational performance as follows. Firms undertaking international expansion in the initial phase confront huge costs of foreignness that makes the firm unprofitable. As such, the slope of the DOI-performance relationship is negative initially. Once the initial learning has been accomplished, it becomes possible for the multinational to exploit potential scale and scope economies, thus improving performance. The slope of the DOI-performance relationship becomes positive in this intermediate range. The third stage involves firms expanding beyond the efficient or optimal level, thereby causing the multinational to experience negative incremental returns. The slope of the DOI-performance relationship becomes negative again in this third stage. Therefore, Contractor, Kundu, and Hsu (2003) and Lu and Beamish (2004) provide theoretical models for curvilinear relationships between DOI and performance.

Eden and Thomas (2004) add a time dimension to the discussion, by arguing that the relationship between DOI and performance will differ in the short run and in the long run. They therefore argue that the net benefits from multinationality are likely to higher in the longer term, and hence give an optimistic outlook to US manufacturing firms.

Our objectives are twofold. First, we reconsider the basic relationship between DOI and performance. More specifically, we address the direction of causality; that is, implicit in many studies is the idea that the DOI results in superior performance. By using an instrumental variables approach as well as conditioning on lagged performance, we are able to test whether superior performance is driving DOI, rather than the converse. This is similar to a stream of research undertaken in international trade. For example, Bernard and Jensen (1999) use data on U.S. manufacturing plants to establish that exporting does not lead to higher productivity ex post, but rather that the firms that are more productive ex ante are those that export. In other words, exporting can be viewed as a selection process. A similar situation may apply here. It is the case in Bernard and Jensen's sample that more productive firms seek export markets, and hence it is high productivity that explains exporting, not exporting that explains productivity. The practice of exporting is therefore as much a reflection of a firm's productivity as it is a determinant of the firm's productivity. We wish to import this idea into the DOI performance literature. Our unique data set positions us well to test this hypothesis.

Our second objective relates to bringing risk formally into the analysis. Many studies simply consider the degree to which a firm's activities are located abroad, but do not measure the riskiness of those foreign activities.

Rugman (1976) was the first to point out that international diversification reduces risk for the multinational firm. He shows that it is possible for the multinational to reduce risks to their profits by engaging in foreign operations, and demonstrates empirically that the international diversification extend to a multinational significant risk reduction advantages which are not available to a non-multinational. Hsu and Boggs (2003) take into account the breadth of countries included in a firm's foreign operations. Capar and Kotabe (2003) measure the impact of international diversification on the performance of 81 German service firms. Kim, Hwang, and Burgers (1993) explain Bowman's paradox (1980) regarding the simultaneous presence of higher returns and lower risk – a scenario that seems inconsistent with modern portfolio theory derived in finance. The argument underlying this paradox is that global diversification provides firms doing business in the global economy opportunities that are not

available to domestic firms, and this explains the simultaneous presence of high returns and low risks. By analyzing data for 125 multinationals, Kim, Hwang, and Burgers document the importance of global market diversification in the joint management of risk and return. The measures of global diversification capture the number of foreign markets being operated in, as well as the pattern of a firm's industries across those countries.

Errunza and Senbet (1981, 1984) have taken risk into account in explaining excess market returns using the volatility in stock returns. Their results indicate that global diversification completes the market for investors who otherwise face barriers to international capital flows – and hence the move abroad may lower the risk involved. We have taken a different approach to measuring the riskiness of a firm's foreign operations. We are able to break down the DOI measures, by country, into the least risky government securities, low risk interbank deposits, and more risky private loans. The DOI measures are also grouped according to whether the country where the investment occurs is developed or less developed. In addition to breaking these assets down into risk classes, we also use measures of equity price volatility for each bank in the sample as well as bank credit ratings. We are therefore better able to capture the risk profile of a firm's foreign operations.

A small literature investigates the performance of Canadian banks. D'Souza and Lai (2004) estimate the effects of scope, scale, and concentration on Canada's six largest banks. They find that banks with greater concentration in their business lines are less efficient. Interestingly, for some model specifications, the effect of size on performance (as measured by return on equity) is negative. Using a different methodology, Allen and Liu (2005) estimate cost functions for Canadian banks and find that larger banks are more efficient. Neither study considers the impact of DOI on performance.

3. Framework for testing the DOI–performance relationship

The international business literature posits that there could be substantial benefits from becoming more international. Specifically, greater internationalization allows firms to spread fixed costs, learn about domestic markets from their international market experience, access factors at lower cost, and cross-subsidize their domestic operations and provide greater opportunities for price discrimination and tax and price arbitrage, thus leading to better performance.

To measure the effects of internationalization on the performance of Canadian banks, the following simple regression framework utilized by, for example, Contractor, Kundu, and Hsu (2003) can be implemented:

$$PERF_{it} = \beta_0 + \beta_1 DOI_{it} + \beta_2 SIZE_{it} + \beta_3 X_{it} + \varepsilon_{it}, \quad (1)$$

where i indexes over the bank and t indexes over time, and $PERF$ is a measure of each bank's performance, measured as return on assets (ROA), return on equity (ROE), and Tobin's q.[4] $SIZE$ is the size of the bank by assets, and DOI is a measure of the degree of internationalization, the definition of which is discussed below. The X's can include other variables, such as squared terms to test for non-linearities in the relationship, and macroeconomic variables such as the US and Canadian real GDP growth rate and the

[4] There are other measures of bank-level performance that could be considered, such as productivity or firm-specific returns relative to industry or market benchmark returns. In the case of banks, other measures, such as interest income margins and loan production, can also be considered. In keeping with the literature, we restrict our analysis to the most commonly used performance measures: ROA, ROE, and Tobin's q.

Canadian real overnight interest rate and the real US Federal Funds Rate. The relationship between DOI on bank performance is captured by β_1.

Our initial measure of DOI used here is the ratio of foreign assets to total assets for each bank. This measure can be disaggregated to account for the composition of foreign-asset exposures. Specifically, in the case of banks, foreign-asset exposures can be split into deposits, loans, and securities:

$$PERF_{it} = \beta_0 + \beta_1 DEP_{it} + \beta_2 LOA_{it} + \beta_3 SEC_{it} + \beta_4 SIZE_{it} + \beta_5 X_{it} + \varepsilon_{it}, \quad (2)$$

where DEP, LOA and SEC are, respectively, the ratio of foreign (inter-bank) deposits to total assets, foreign loans to total assets, and foreign securities to total asset. The justification for this disaggregation by asset type follows those categories determined by the BIS consolidated banking statistics. The BIS banking statistics are collected by the BIS from national authorities (ie central banks, supervisors, etc) in order to provide information on the "measurement of commercial banks' consolidated country risk exposures," (BIS 2006).[5] A key element of this data is the disaggregation into the asset types described above.

By disaggregating foreign exposures into these asset classes, the measure of DOI can also account for the risk in the bank's portfolio, since loans to private entities would, on average, be more risky than securities, such as US Treasury bills.[6] Similarly, interbank deposits are generally considered low risk, given their limited duration, transparency of bank creditworthiness, and the long-term relationships that exist among banks.

There may also be significant differences between foreign exposures booked in developed markets, such as the United States and those in Europe, and assets booked in less developed countries such as those in Latin America and East Asia. For example, banks' portfolio choices could include the holding of large quantities of US Treasury bills, which are risk-free, and/or more speculative assets, such as loans to private firms operating in less-developed countries. To this end, equation (1) can be augmented to account for the allocation of assets across developed and emerging markets:

$$PERF_{it} = \beta_0 + \beta_1 DOI\_DC_{it} + \beta_2 DOI\_LDC_{it} + \beta_3 SIZE_{it} + \beta_4 X_{it} + \varepsilon_{it}, \quad (3)$$

where DOI_DC and DOI_LDC are exposures to developed countries and less-developed countries, respectively. As in equation (2), the allocation of Canadian bank assets within developed countries and developing countries can also be considered.

Although decomposing each bank's foreign holdings into different classes may adjust for risk somewhat, the amount of risk inherent in those foreign holdings would depend on the loan characteristics and the correlation of the foreign and domestic loan portfolios as well as the credit ratings of the loans. Therefore, we also consider explicit measures of risk. Specifically, we add to our regression two measures of risk: equity price volatility and credit ratings.

$$PERF_{it} = \beta_0 + \beta_1 DOI_{it} + \beta_2 SIZE_{it} + \beta_3 Vol_{it} + \beta_4 X_{it} + \varepsilon_{it}, \quad (4)$$

$$PERF_{it} = \beta_0 + \beta_1 DOI_{it} + \beta_2 SIZE_{it} + \beta_3 SP_{it} + \beta_4 X_{it} + \varepsilon_{it}, \quad (5)$$

---

[5] The BIS reports the aggregate banking statistics for each country. We draw our data from the underlying bank-by-bank data that underlies this data.

[6] Because sovereign credit ratings are usually an upper bound on corporate ratings from the same country, this is a reasonable claim. On the other hand, if higher holdings of securities reflects greater capital market activity, this could reflect higher risk, although there is little conclusive evidence in the literature that business line diversification reduces overall risk (Stiroh, 2004).

where Vol meaures volatility, and is based on the volatility of bank equity prices over a 65-day window calculated quarterly. SP is the S&P credit rating, and a numeric value is assigned to each letter grade. There is little variation over the sample, as 3 banks showed no change in rating over the sample: one bank showed 1 downgrade, one bank showed 2 downgrades, and one bank showed 1 downgrade and 1 upgrade (Moody's shows even less variance).

3.1 Econometric concerns

The estimation of such equations is complicated by problems of simultaneity and endogeneity. Simply, the causality between DOI and performance can go in both directions: higher DOI may lead to better performance, whereas better performance may lead to higher DOI as firms move abroad to exploit the firm-specific advantages developed in the home market. That is, it is unclear whether superior performance is the result of the move abroad, or whether the move abroad is the result of superior performance. It is, of course, possible that superior ex ante performance leads to more DOI, which may further improve performance. As DOI increases, banks have access to a greater set of portfolio choices, and thus portfolio diversification across many operational jurisdictions may allow banks to obtain higher returns with less risk, as compared with banks that are limited to a domestic market.

Empirically, the estimation of an equation such as (1) may overestimate the benefits of DOI due to unobserved heterogeneity. For instance, the ability of the bank to operate in foreign jurisdictions may reflect the underlying quality of its managers. Thus, the effect of DOI is difficult to identify in the presence of unobservable firm-level management quality. The estimation of (1) is also complicated by the fact that reported measures of performance may exhibit significant serial correlation, since banks may smooth reported earnings for market, tax, and capital-adequacy reasons.

We can account for these problems in several ways. First, we exploit the cross-sectional time-series properties of the data to account for firm-specific effects. Thus, (1) can be estimated using a standard fixed-effects model:

$$PERF_{it} = \beta_0 + \beta_i + \beta_1 DOI_{it} + \beta_2 SIZE_{it} + \beta_3 X_{it} + \varepsilon_{it},, \quad (6)$$

where β_i is a firm-specific fixed effect and captures mean differences in firm-specific performance which are unrelated to the factors included in the model, such as managerial quality. Inclusion of these firm fixed effects allows for a more precise estimation of the other parameters in the model. However, inclusion of fixed effects does not necessarily solve the problem of endogeneity of the right-hand-side variables. Note also that equation (6) would also have a measure of risk, measured as volatility or credit ratings, as an additional factor. As shown in Figure 1, there is considerable variation in volatility of equity prices.

The nature of bank's portfolio and earnings behaviour also need to be addressed with the appropriate econometric technique. First, it may be the case that banks smooth their earnings over the reporting year. That is, banks may time loan-loss provisions, mark-to-market charge-offs, and other items that may affect reported earnings so as to smooth earnings. Likewise, earnings may be smoothed to account for regulatory capital requirements and tax liabilities. Second, as noted above, the asset allocation decision (towards foreign claims, for instance) may be endogenous. Moreover, Santor (2008) has shown that these allocation decisions may show considerable persistence. This is due to the fact that there may be fixed costs of commencing foreign claims, and adjustment costs associated with their disposal. Both of these issues need to be addressed in the empirical analysis.

To address the first issue, it is necessary to include lagged dependent variables on the right-hand side to account for the smoothing of earnings. Second, it is necessary to instrument for the endogenous right-hand side variables, such as the degree of DOI, with sufficiently lagged instruments. Fortunately, estimation with lagged dependent variables and other

endogenous right-hand side variables can be accommodated within an Arellano-Bond generalized method of moments (GMM) estimation procedure (Arellano and Bond, 1991). In this case, lagged dependent variables are included on the right-hand side. The data are first differenced, and the lagged dependent and other endogenous right-hand-side variables are instrumented with their lagged levels. Specifically, we include four lags of the dependent variable, to account for earnings smoothing that may occur over the fiscal year. In terns of the endogenous right-hand side variables, we use twelve lags to account for the persistence of foreign claims (this is based on the fact that persistence of foreign claims is often in the order of four quarters). A series of Hausman tests will be implemented to determine whether the appropriate methodology is OLS, Fixed Effects or Random Effects. Adjustments will also be made for the presence of autocorrelation, heteroskedasticity and the inclusion of lagged dependent variables.

4. Data and descriptive statistics

We use confidential firm-level data on Canadian banks. The data are available quarterly by bank, but must be reported here in an aggregated form to prevent identification of individual banks in the sample. There are 51 banks operating in Canada, of which 12 are domestic and 49 are subsidiaries of foreign banks. The largest six banks operating in Canada are both Canadian (domestic) and also have the largest foreign operations as a share of total operations (DOI). As indicated above, these "Big Six" banks are the core of Canada's banking system, accounting for about 90 per cent of bank assets in Canada. These major banks have highly developed branch networks and a network of more than 12,500 ABMs. Of course, the assets of the parents for many of the foreign banks operating in Canada are significantly larger than the assets of the Big Six Canadian banks, but the analysis here focuses on the assets of affiliate operations in Canada and the assets abroad controlled by these Canadian affiliates.

There are essentially three groups of banks in our analysis: Canadian Big Six Banks, other Canadian Banks, and foreign banks operating in Canada. We only have information on the Canadian operations of foreign banks operating in Canada, as well as any operations abroad which are controlled by the Canadian affiliate. We would not have any information on the parent, or other affiliates of those banks. In any event, we have a limited view of these banks. We have therefore taken foreign banks out of our analysis. Furthermore, since 96% of the foreign operations of Canadian Banks are controlled by the Big Six Canadian Banks, we have limited our analysis to the Big Six Canadian Banks.[7]

The data on foreign-claim exposures are taken from the Consolidated Quarterly Banking Statistics report compiled by the Bank of Canada. Every bank that operates in Canada is required to provide quarterly statistics of their total asset exposure to each foreign jurisdiction in which it operates, on a fully consolidated basis.[8] This covers all claims, including deposits to other financial institutions; loans to financial institutions and firms; and securities, both government and corporate, made outside and inside Canada. These foreign claims of domestic Canadian banks are adjusted to account for exchange rate revaluations. The data cover all Canadian banks' exposures to over 150 jurisdictions from 1994 to 2004. Additional

[7] It should be noted that when the analysis is conducted with all Canadian banks included, the results for the Big Six banks are unaffected. However, the causal link between DOI and performance documented here for the Big Six banks do not extend to small Canadian banks with limited foreign exposures.

[8] Consolidation is conducted as per guidelines in the *Canadian Institute of Chartered Accountants Guide*.

bank balance-sheet data are collected, including assets, market capitalization, and other bank-specific characteristics.

Table 1 reports the sample period averages for bank-level characteristics over the period 1994–2004. For the entire sample, mean bank assets were $36.5 billion and mean bank capital was $1.7 billion.[9] The average ROA and ROE of the sample was 0.45 per cent and 5.4 per cent, respectively. Most banks had some foreign claims: on average, total foreign claims constituted 22.0 per cent of total assets. These assets were split into deposits, loans, and securities, representing 7.3 per cent, 11.5 per cent, and 3.2 per cent of total assets, respectively. The division between claims on private entities and public entities is stark: most claims were to private entities (private claims were nine times greater than public claims).

Table 1

Descriptive statistics: all banks, 1994–2004

	All banks		Big Six	
	Mean	Median	Mean	Median
	(1)	(2)	(3)	(4)
Assets ($ billion constant 1997)	36.5	1.1	222.0	238.1
Bank capital ($ billion constant 1997)	1.7	0.1	10.2	11.0
ROA (%)	0.45	0.52	0.66	0.68
ROE (%)	5.4	6.4	14.1	14.7
Foreign claims/assets (%)				
Total claims	22.0	22.5	32.7	32.7
Deposits	7.3	2.5	5.8	5.8
Loans	11.5	7.1	16.9	15.5
Securities	3.2	0.0	10.0	9.2
Private claims	19.8	20.2	27.0	26.5
Public claims	2.2	0.0	5.7	5.9

Note: Data as reported to the Bank of Canada quarterly reports 1994 to 2004. Assets are total assets; Bank capital, return on assets and return on equity are calculated from banks' balance sheet data. Total foreign claims are broken down into deposits, loans and securities as per the BIS consolidated banking statistics. Private claims are foreign claims on private entities; Public claims are foreign claims on sovereigns or government-owned entities.

Source: Bank of Canada.

The descriptive statistics for the Big Six Canadian banks are provided in columns (3) and (4). The average size was $222.0 billion in assets, with average bank capital of $10.2 billion. These banks had higher ROA and ROE, 0.66% and 14.1%, respectively and are significantly more international. On average, total foreign claims were 32.7 per cent of total assets:

[9] All figures are in constant 1997 Canadian dollars. Canadian banks are neither large nor small by international standards. The largest Canadian bank, as measured by bank capital, ranks in the top 60 banks globally. Furthermore, even though our formal analysis only covers the big six Canadian banks, we report descriptive statistics for all Canadian banks.

deposits were 5.8 per cent, loans 16.9 per cent, and securities 10.0 per cent of assets. The ratio of public and private claims is roughly 1:5 – that is, Canada's Big Six banks have 5 times more private claims abroad than public claims. Even within the most internationally active banks, there is considerable variation. Over the sample period, foreign exposures varied by as much as 15 per cent of total assets. The descriptive statistics therefore suggest, at a glance, that Canadian banks are extensively international.[10]

Focusing on the Big Six Canadian banks, claims were held against an average of 80 countries in 1994. The number of jurisdictions in which Canadian banks held claims rose slowly through the 1990s to an average of 86 countries by 2004. The size and extent of these foreign claims was considerable: total foreign claims, in constant 1997 dollars, were over $264.6 billion in 1994.[11] Total foreign claims peaked in 2001 at $577.6 billion, and then fell to $448 billion in 2004 (Figure 2). As a percentage of total assets, however, the trend in foreign assets was quite stable. Figure 3 shows that foreign-asset exposures in 2004 constituted 29 per cent of total assets for Canadian banks. This is slightly lower than the reported levels in the 1990s and considerably lower than the average of around 40 per cent in the 1980s.

The composition of foreign-asset exposures is also important to consider. Focusing only on deposits and loans, the proportion of deposits to total assets fell from 6.8 per cent to only 4.5 per cent from 1994 to 2004 (Figure 3), and the proportion of loans to total foreign assets fell from 18.4 per cent to only 11.5 per cent. At the same time, securities rose as a proportion of foreign assets from 6.0 per cent to 12.8 per cent. Since foreign securities are heavily weighted in U.S. public securities, one could argue that the banks became less exposed to foreign risk (at least, if one considers US Treasury bills to be the most risk-free security in existence).

Figure 4 shows foreign-asset exposures by region. Overall, exposures to the United States were $120.8 billion in 1994, or 45.8 per cent of total foreign exposures, and subsequently rose to $210.8 billion in 2004, or 47.5 per cent of total foreign assets. Much of this rise is attributable to increased holdings of securities.[12] Exposures to other industrialized countries also rose over time, from $105.1 billion (39.8 per cent of foreign exposures) to more than $163.2 billion (36.8 per cent of foreign exposures). Latin American exposures rose from $22.2 billion in 1994 to $50.8 billion in 2004, constituting roughly 8.4 and 10.6 per cent of foreign exposures. Exposures to East Asia remained steady between $10.4 billion and $11.5 billion during the sample period, indicating a fall as a proportion of total foreign assets from 4.0 per cent to 2.6 per cent.[13]

Figure 5 shows the ratio of private claims and public claims to total assets for all banks. Over the 1994 to 1996 period, public claims fell from approximately 7% to below 5%, where they remained for a few years, but since 1998, there has been a slow increase whereby in 2002, public claims have returned to about 7% of total claims. Private claims, on the other hand, are far more important, ranging from 25% to 30% of total claims. In 1994, foreign private

---

[10] Overall, banks operating in Canada reported claims to over 159 countries.

[11] The six largest banks account for 92 per cent of the assets and 96 per cent of all foreign exposures. Interestingly, for the United States, Goldberg (2001) finds that the 10 largest banks account for 86 per cent of foreign exposures. In this respect, the Canadian experience is very similar to that of the United States.

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

[13] The level of exposures to Africa and the Middle East are negligible.

claims accounted for 25% of all claims, and this increased to 31% in 1998, and then fell to 22% in 2004.

In addition to ROA and ROE, we also use Tobin's q as a measure of performance. Figure 6 provides measures of Tobin's q over the sample for each of the Big Six banks. The average value for Tobin's q over the entire period is 1.03. The Figure clearly indicates an upward trend in Tobin's q over the period being analyzed. Furthermore, some banks are performing persistently better than others on this market based measure of performance.

We also provide descriptive statistics for the formal risk measures. Table 2 provides information on the volatility of bank equity prices over the sample period, as well as an indication of how infrequently bank credit ratings change. The volatility is defined as the daily volatility of the equity prices within each quarter, which is the frequency of the analysis undertaken. Credit ratings are from S&P and a numeric value is assigned to each letter grade. There is little variation over the sample, as 3 banks showed no change in rating over the sample: one bank showed 1 downgrade, one bank showed 2 downgrades, and one bank showed 1 downgrade and 1 upgrade (Moody's shows even less variance).

Table 2

Volatility and credit rating

	Mean	**Median**
Equity price volatility	8.10	7.24
Credit rating	A+ to AA–	

Volatility is based on the volatility of bank equity prices over a 65-day window calculated quarterly.

Credit rating is from S&P. A numeric value is assigned to each letter grade. There is little variation over the sample, as 3 banks showed no change in rating over the sample: one bank showed 1 downgrade, one bank showed 2 downgrades, and one bank showed 1 downgrade and 1 upgrade (Moody's shows even less variance).

5. Regression results

The descriptive statistics discussed in the previous section reveal that Canadian banks have significant foreign-asset exposures, and that the composition of those exposures continues to evolve over time. In particular, there is considerable variation in the type of assets being held and the region in which they are booked, both of which affect risk exposure. The empirical questions we answer relate to whether the DOI has an effect on performance, and how these effects depend upon the composition of DOI.

We begin with the basic specification as described in equation (1) and build up to the more general models which allow for company fixed effects and the decomposition of DOI as described above, as well as include a formal measure of risk. We end by estimating a model that allows for company (bank) fixed effects and a formal risk measure, a decomposition of DOI, and also account for endogeneity.

In order to proceed, however, it is important to first identify the correct methodology. Hausman tests were conducted to determine if Fixed Effects is the appropriate model (as opposed to Random Effects, GLS or simple OLS). The null hypothesis of this test is that Random Effects is preferred over Fixed Effects. The test statistic is distributed as a $\chi^2_{(14)}$. The statistic is calculated at 39.48, with a p-value of 0.0003. We therefore reject the null, in favour of a fixed effects specification. The same results obtains when comparing FE to GLS:

the test statistic is 66.22, with a p -value of 0.0000; and when comparing Fixed Effects to OLS: the test statistic is 34.32, with a p-value of 0.0018. We also test whether Fixed Effects itself is appropriate by estimating an IV model, with DOI instrumented by its lagged values. A Hausman test (p-value of 0.9871) shows that the IV estimates are not systematically different than the Fixed Effects estimates.

Furthermore, we have also undertaken formal tests for heteroskedasticity. We use the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity, which has a null hypothesis H0: constant variance. The test statistic is distributed as $\chi^2_{(1)}$ and it equals 7.95 with a p-value = 0.0048. We therefore reject the null hypothesis of constant variance, and hence adjust for the presence of heteroskedasticity in our regression results.

In light of these results, we focus on the methodology that is supported empirically, namely a Fixed Effects specification. We have opted to also present GMM results, as this specification is justified on theoretical grounds due to the introduction of lagged dependent variables as regressors. The inclusion of lags of the dependent variable on the right-hand side requires estimation by GMM in first differences (Arellano and Bond, 1991). Specifically, Arellano and Bond suggest that lagged levels can be used as instruments for the endogenous right-hand side variable, allowing for a potentially large set of instrumental variables. These results are therefore not directly comparable to the Fixed Effects results, and hence should be viewed as a robustness test.

Table 3 reports the Fixed Effects estimation results, with ROA and ROE as the dependent variables. The measures include the following measures of DOI: the ratio of foreign claims to total assets; the ratio of foreign deposits to total assets; the ratio of foreign loans to total assets; the ratio of foreign securities to total assets; the ratio of foreign private claims to total assets; the ratio of foreign public claims to total assets; the ratio of Developed country foreign claims to total assets; and the ratio of LDC foreign claims to total assets. Also included in the regressions are the US Federal Funds Rate, US real GDP growth, and (unreported) year dummies.[14]

The results robustly show that even after accounting for endogeneity and accounting for past performance levels, measured as either ROA or ROE, larger firms perform less well, but DOI is positively related to performance. We also included squared terms for DOI to test for non-linearities. These were statistically insignificant.[15]

The results from Table 3 indicate therefore that once we adjust for autocorrelation, heteroskedasticity, and endogeneity, and also allow for company fixed effects, increased DOI results in significantly higher performance. The improvement in ROA is much higher than that for ROE.

As discussed above, the links between DOI and performance may be a function of the investments undertaken abroad. Table 3 also provides regression results which break the DOI into three asset types: foreign (inter-bank) deposits, foreign loans and foreign securities. These results indicate that it is foreign loans that are driving the higher performance levels measured as both ROA and ROE. When the DOI exposures are broken down into foreign private claims versus foreign public claims, it is the foreign private claims that are driving the higher returns, and not the foreign public claims. When the DOI is broken down into those

[14] We have re-estimated the regressions using only US interest rates and the results are qualitatively the same as the case where both Canadian and US interest rates are in the regression. This approach (only including US interest rates) is consistent with the evidence demonstrating that it is US variables that are important for driving Canadian banking performance (Missina, Tessier and Dey, 2006).

[15] Inclusion of long-term rates did not alter the results. Also, controlling for foreign macroeconomic conditions with world real GDP growth did not change the results.

claims in developed versus less developed countries, both contribute to higher returns, although the effect from less-developed countries is significantly higher.

Table 3

Fixed effects, ROA and ROE as dependent variables, and includes equity price volatility

	Panel A				Panel B			
	ROA				ROE			
Foreign claims/ Assets	1.305** (0.406)				0.194** (0.072)			
Foreign deposits/ Assets		1.445 (1.127)				0.224 (0.199)		
Foreign loans/ Assets		1.351** (0.556)				0.219** (0.098)		
Foreign securities/ Assets		1.188 (0.753)				0.146 (0.133)		
Foreign private claims/Assets			1.304** (0.418)				0.199** (0.074)	
Foreign public claims/Assets			1.323 (1.023)				0.151 (0.180)	
DC foreign claims/Assets				1.150** (0.413)				0.176** (0.073)
LDC foreign claims/Assets				2.627** (0.940)				0.383** (0.166)
Size	–0.942** (0.164)	–0.923** (0.194)	–0.943** (0.171)	–0.977** (0.164)	–0.121** (0.029)	–0.114** (0.034)	–0.119** (0.030)	–0.127** (0.029)
Equity price Volatility	0.003 (0.005)	0.003 (0.005)	0.003 (0.005)	0.003 (0.005)	–0.001 (0.001)	–0.001 (0.001)	–0.001 (0.001)	–0.001 (0.001)
Federal funds rate	0.038* (0.020)	0.038* (0.020)	0.038* (0.020)	0.038* (0.020)	0.009** (0.004)	0.009** (0.004)	0.009** (0.004)	0.009** (0.004)
US GDP growth	0.007 (0.010)	0.007 (0.010)	0.007 (0.010)	0.007 (0.010)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
F	5.86	5.09	5.45	5.70	6.70	5.83	6.23	6.42
N	246	246	246	246	246	246	246	246

** and * indicate significance at the 5 per cent and 10 per cent levels respectively. Robust standard errors are in parentheses.

Note: Regression: $PERF_{it} = \beta_0 + \beta_1 DOI_{it} + \beta_2 SIZE_{it} + \beta_3 Vol_{it} + \beta_4 X_{it} + \varepsilon_{it}$ where *DOI* is the measure of foreign exposure; *PERF* is measured by return-on-assets (Panel A) or return-on-equity (Panel B), *SIZE* is measured by total assets, and *Vol* is equity price volatility. Also included in the regressions are year dummies, the US Federal Funds Rates and real US GDP growth. Sample period is 1994–2004.

The regressions also include size of each bank, and here the results indicate that larger banks have lower performance levels, controlling for everything else. The formal measures of risk included, namely Equity Price Volatility is statistically insignificant. The results obtained when Credit Ratings are used are qualitatively the same.

Table 4 estimates the same regression as that reported in Table 3, but rather than use a Fixed Effects specification, a GMM specification is used. The results here are qualitatively the same as those reported in Table 3.

Table 4

GMM, ROA and ROE as dependent variables, and includes equity price volatility

	Panel A				**Panel B**			
	ROA				**ROE**			
Panel A: ROA_{t-1} Panel B: ROE_{t-1}	0.266** (0.036)	0.265** (0.034)	0.266** (0.036)	0.260** (0.038)	0.230** (0.058)	0.230** (0.058)	0.230** (0.058)	0.226** (0.059)
Panel A: ROA_{t-2} Panel B: ROE_{t-2}	0.042 (0.028)	0.043 (0.028)	0.044 (0.029)	0.040 (0.028)	0.059* (0.031)	0.059* (0.031)	0.059* (0.031)	0.056 (0.031)
Panel A: ROA_{t-3} Panel B: ROE_{t-3}	–0.106** (0.044)	–0.106** (0.044)	–0.105** (0.044)	–0.105 (0.044)	–0.013 (0.052)	–0.013 (0.051)	–0.012 (0.051)	–0.013 (0.052)
Panel A: ROA_{t-4} Panel B: ROE_{t-4}	0.051 (0.075)	0.051 (0.074)	0.053 (0.075)	0.049 (0.075)	0.037 (0.100)	0.037 (0.099)	0.039 (0.102)	0.036 (0.101)
Equity price Volatility	0.003 (0.007)	0.003 (0.008)	0.003 (0.007)	0.003 (0.007)	–0.001 (0.001)	–0.001 (0.001)	–0.001 (0.001)	–0.001 (0.001)
Foreign claims/ Assets	1.050** (0.508)				0.144* (0.086)			
Foreign deposits/ Assets		0.933** (0.300)				0.180** (0.045)		
Foreign loans/ Assets		0.980** (0.347)				0.155** (0.055)		
Foreign securities/ Assets		1.120 (1.291)				0.112 (0.224)		
Foreign private claims/Assets			0.975* (0.533)				0.138 (0.095)	
Foreign public claims/Assets			1.643* (0.975)				0.186 (0.143)	
DC foreign claims/Assets				0.926** (0.467)				0.130 (0.081)
LDC foreign claims/Assets				1.936** (0.785)				0.281** (0.115)
AR(1) (*p*-value)	0.104	0.103	0.105	0.105	0.055	0.055	0.055	0.056
AR(2) (*p*-value)	0.196	0.188	0.209	0.185	0.181	0.181	0.209	0.167
N	216	216	216	216	216	216	216	216

** and * indicate significance at the 5 per cent and 10 per cent levels respectively. Robust standard errors are in parentheses.

Note: Regression: $PERF_{it} = \beta_0 + \beta_1 PERF_{it-k} + \beta_2 DOI_{it} + \beta_3 SIZE_{it} + \beta_4 Vol_{it} + \beta_5 X_{it} + \varepsilon_{it}$ where *DOI* is the measure of foreign exposure; *PERF* is measured by return-on-assets (Panel A) or return-on-equity (Panel B), *SIZE* is measured by total assets, and *Vol* is equity price volatility. Also included in the regressions are year dummies, the US Federal Funds Rates and real US GDP growth. Sample period is 1994–2004. Estimation is by Arellano-Bond GMM with four lags of the dependent variables and twelve lags of the endogenous independent variables as instruments. AR(1) and AR(2) *p*-values of the null hypothesis of no-autocorrelation reported.

The analysis thus far has utilized ROA and ROE as the measures of performance. Now we turn to an analysis where Tobin's q is used as a measure of performance. Tables 5 and 6 reported the Fixed Effects model, but in Table 5, the formal measure of risk used is Equity Price Volatility and in Table 6, the formal measure of risk is Bank Credit Ratings. The two tables are otherwise the same. The evidence that emerges out of these results is that when this market based (Tobin's q) measure of performance is used, there is at best weak evidence of a link between DOI and performance. To the extent there is a link, that link is coming from investments in less developed countries, and possibly through foreign private claims or foreign deposits.

Table 5

Fixed effects, Tobin's q as dependent variable and includes equity price volatility

	Tobin's q			
Foreign claims/ Assets	0.028* (0.017)			
Foreign deposits/ Assets		0.055 (0.046)		
Foreign loans/ Assets		0.032 (0.023)		
Foreign securities/ Assets		0.013 (0.031)		
Foreign private claims/ Assets			0.033* (0.017)	
Foreign public claims/ Assets			–0.018 (0.042)	
DC foreign claims/ Assets				0.019 (0.017)
LDC foreign claims/ Assets				0.108** (0.038)
Size	–0.006 (0.007)	–0.004 (0.008)	–0.004 (0.007)	–0.009 (0.007)
Equity Price Volatility	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Federal funds rate	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
US GDP growth	–0.000 (0.000)	–0.000 (0.000)	–0.000 (0.000)	–0.000 (0.000)
F	49.12	42.73	46.04	47.10
N	246	246	246	246

** and * indicate significance at the 5 per cent and 10 per cent levels respectively. Robust standard errors are in parentheses.

Note: Regression: $TQ_{it} = \beta_0 + \beta_1 DOI_{it} + \beta_2 SIZE_{it} + \beta_3 Vol_{it} + \beta_4 X_{it} + \varepsilon_{it}$ where *DOI* is the measure of foreign exposure, *SIZE* is measured by total assets, *TQ* is Tobin's q, and *Vol* is equity price volatility. Also included in the regressions are year dummies, the US Federal Funds Rates and real US GDP growth. Sample period is 1994–2004.

Unlike the case when ROA and ROE are used, when Tobin's q is used as the measure of performance, Credit Ratings are statistically significant, but Equity Price Volatility is not. Another difference relates to size: here, there is no statistically significant link between size and performance.

Table 6

Fixed effects, Tobin's q as dependent variable and includes bank credit rating

	Tobin's q			
Foreign claims/ Assets	0.021 (0.017)			
Foreign deposits/ Assets		0.084* (0.046)		
Foreign loans/ Assets		0.025 (0.023)		
Foreign securities/ Assets		–0.011 (0.032)		
Foreign private claims/ Assets			0.025 (0.017)	
Foreign public claims/ Assets			–0.011 (0.041)	
DC foreign claims/ Assets				0.002 (0.017)
LDC foreign claims/ Assets				0.144** (0.039)
Size	0.002 (0.007)	0.008 (0.008)	0.003 (0.007))	0.003 (0.007)
Bank credit rating	0.005** (0.001)	0.005** (0.002)	0.004** (0.002)	0.007** (0.002)
Federal funds rate	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
US GDP growth	–0.000 (0.000)	–0.000 (0.000)	–0.000 (0.000)	–0.000 (0.000)
F	50.67	44.57	47.28	50.44
N	246	246	246	246

** and * indicate significance at the 5 per cent and 10 per cent levels respectively. Robust standard errors are in parentheses.

Note: Regression: $TQ_{it} = \beta_0 + \beta_1 DOI_{it} + \beta_2 SIZE_{it} + \beta_3 CR_{it} + \beta_4 X_{it} + \varepsilon_{it}$ where *DOI* is the measure of foreign exposure, *SIZE* is measured by total assets, *TQ* is Tobin's q, and *CR* is the credit rating. Also included in the regressions are year dummies, the US Federal Funds Rates and real US GDP growth. Sample period is 1994–2004.

Finally, a set of regressions are estimated with ROA and ROE as the dependent variables, and Tobin's q as a right hand side variable. Given that ROA, ROE and Tobin's q are measures of performance, then one would obviously expect Tobin's q to be highly significant. The evidence clearly shows this to be the case. That is, Tobin's q is positive and highly significant. But what is interesting is that the measures of *DOI* are qualitatively unaffected in the presence of Tobin's q. This indicates that there is significant information in *DOI* that predicts ROA and ROE above and beyond what is contained in Tobin's q, and this is certainly consistent with the results that find that *DOI* predicts ROA and ROE better than they do Tobin's q.

Table 7

Fixed effects, ROA and ROE as dependent variables, and includes Tobin's q as a regressor

	Panel A				Panel B			
	ROA				ROE			
Foreign claims/ Assets	1.121** (0.392)				0.149** (0.068)			
Foreign deposits/ Assets		1.092 (1.085)				0.134 (0.188)		
Foreign loans/ Assets		1.143** (0.535)				0.166** (0.093)		
Foreign securities/ Assets		1.010 (0.724)				0.129 (0.125)		
Foreign private claims/Assets			1.091** (0.403)				0.145** (0.070)	
Foreign public claims/Assets			1.415 (0.980)				0.190 (0.170)	
DC foreign claims/Assets				1.035** (0.399)				0.143** (0.069)
LDC foreign claims/Assets				1.901** (0.921)				0.235 (0.159)
Size	–0.886** (0.154)	–0.882** (0.183)	–0.899** (0.160)	–0.903** (0.155)	–0.118** (0.027)	–0.114** (0.032)	–0.119** (0.028)	–0.120** (0.027)
Tobin's q	6.846** (1.559)	6.846** (1.568)	6.889** (1.568)	6.602** (1.577)	1.455** (0.270)	1.454** (0.271)	1.460** (0.271)	1.463** (0.273)
Federal funds rate	0.034* (0.020)	0.034* (0.020)	0.035* (0.020)	0.034* (0.020)	0.009** (0.004)	0.008** (0.003)	0.009** (0.003)	0.008** (0.003)
US GDP growth	0.009 (0.010)	0.009 (0.010)	0.009 (0.010)	0.009 (0.010)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)
F	7.71	6.69	7.18	7.27	9.57	8.31	8.90	8.97
N	246	246	246	246	246	246	246	246

** and * indicate significance at the 5 per cent and 10 per cent levels respectively. Robust standard errors are in parentheses.

Note: Regression: $PERF_{it} = \beta_0 + \beta_1 DOI_{it} + \beta_2 SIZE_{it} + \beta_3 TQ_{it} + \beta_4 X_{it} + \varepsilon_{it}$ where DOI is the measure of foreign exposure; $PERF$ is measured by return-on-assets (Panel A) or return-on-equity (Panel B), $SIZE$ is measured by total assets, and TQ is Tobin's q. Also included in the regressions are year dummies, the US Federal Funds Rates and real US GDP growth. Sample period is 1994–2004.

Summary

The consistent message that that emerges from the analysis is that once we allow for firm fixed effects and correct for endogeneity, higher DOI cause higher levels of ROA and ROE. Furthermore, the kinds of investments undertaken in large part drive these results. In particular, the following positions cause better performance when measured on both an ROA and ROE basis: foreign loans, foreign private claims (not public claims), as well as claims held in developed and less developed countries, although the impact on ROA and ROE from less-developed countries is significantly higher when compared to the developed country effect.

To the extent that these holdings can be classified by risk, the evidence may be considered consistent with modern finance theory. The improved performance is found not to be driven

by investments in low risk foreign securities, but rather is driven by holdings of foreign loans and foreign deposits, which ex ante are relatively more risky. Also consistent with modern portfolio theory is the result that higher returns accompany the higher risks associated with undertaking activities in developing countries.

6. Conclusions and policy implications

It is important that any relationship found between DOI and performance not be interpreted as causal without careful statistical testing. We have argued that although, in principle, the causality may run in both directions, international business theory would predict that the principal direction of causality would run from performance to DOI. Those firms that are innovative and doing well domestically will have superior performance and hence would be likely to move abroad.

We have analyzed confidential data on the performance of Canadian banks operating domestically and abroad. The international operations of these banks were broken down by the region and riskiness of the activity. Our analysis finds a causal relationship between the performance of banks operating in Canada and the share of their activities abroad (DOI). The results indicate that for the Big Six Canadian banks, increases in DOI increase performance, measured as either ROA or ROE. The evidence is much weaker when Tobin's q is used as a measure of performance. These results hold after careful consideration is given to possible endogeneity – that is, these effects can be said to be causal in nature.

We have been able to break down the foreign activity into developed versus developing countries, and to break down the type of investment from the least risky types, such as US government securities, to the most risky, such as loans to businesses in developing countries. A lesson that comes out of this analysis relates to the importance of the risk profile of the foreign holdings. Consistent with modern portfolio theory, we demonstrate that increased holdings of foreign government securities, composed largely of US government-backed securities does not yield higher returns for the Big Six Canadian banks. In contrast investments in foreign deposits or foreign loans does raise returns for the Big Six Canadian banks and this is as expected given the higher associated risk. For both ROA and ROE, the impact of the share of foreign holdings located in developing countries results in a significantly higher returns relative that derived from locating in developed countries. This establishes therefore that it is not just the degree of international operations that is needed to test the relationship between DOI and performance, but a breakdown of those foreign operations, to determine the level of risk involved.

These results are very important, because they highlight one of the basic principles of finance: the higher the risk associated with an investment project, the higher should be its expected return. We have shown that firms can expand internationally in a relatively risk-free way, or they can take on significantly higher risk. Tests of the DOI–performance relationship that do not address this issue average these two effects. Having access to these confidential data on the operations of Canadian banks allowed us to measure the DOI–performance relationship in such a way as to take into account these issues of risk. These results are robust to the introduction of market based measures of risk, namely Equity Price Volatility or Credit Ratings.

The policy implications of our analysis are clear. The positive relationship between DOI and performance does not imply that firms with lagging performance should attempt to increase DOI in order to boost their performance. On the contrary, firms that are doing well domestically are best placed to do well globally. For that reason, we expect to see superior performance before firms move abroad. To not explicitly account for this initial success may result in too much significance being attributed to DOI. Our analysis clearly establishes that

those firms that are performing well domestically early on, as measured by high initial performance, have a significant positive relationship between DOI and performance, thus confirming one of the main theoretical predictions of international business.

References

Allen, J and W Engert (2007): "Efficiency and competition in Canadian banking", *Bank of Canada Review*, Summer, pp 33-45. (http://www.bankofcanada.ca/en/review/rev_summer2007.html)

Allen, J and Y Liu (2005): "Efficiency and economies of scale of large Canadian banks." *Bank of Canada Working Paper No 2005-13*.

Arellano, M and S Bond (1991): "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations", *Review of Economic Studies*, vol 58, pp 277–97.

Bank for International Settlements (2006): "Guidelines to the international consolidated banking statistics", *November*.

Bernard, A B and J B Jensen (1999): "Exceptional exporter performance: Cause and effect, or both?", *Journal of International Economics*, vol 47, pp 1–25.

Bowman, E H (1980): "A risk/return paradox for strategic management", *Sloan Management Review*, 21, pp 17–31.

Capar, N and M Kotabe (2003): "The relationship between international diversification and performance in service firms," *Journal of International Business Studies*, vol 34, pp 345–55.

Contractor, F J, S Kundu and C Hsu (2003): "A three-stage theory of international expansion: The link between multinationality and performance in the service sector", *Journal of International Business Studies*, vol 34, pp 5–18.

D'Souza, C and A Lai (2003): "Does diversification improve bank efficiency?", in *The evolving financial system and public policy*, pp 105–127, Proceedings of a conference held by the Bank of Canada, December 2003, Ottawa: Bank of Canada.

Dunning, J H (1977): "Trade, location of economic activity and MNE: A search for an eclectic approach", in B Ohlin, P O Hesselborn and P M Wijkman, (eds), *The international allocation of economic activity*, pp 345–418, London: Macmillan.

Dunning, J H (1981): *International production and multinational enterprise*. Boston: Allen and Unwin.

Eden, L and D E Thomas (2004): "What is the shape of the multinationality-performance relationship?", *Multinational Business Review*, vol 12, 1, pp 89–110.

Errunza, V R and L W Senbet (1981): "The effects of international operations on the market value of the firm: Theory and evidence", *Journal of Finance*, vol 36(2), pp 401–417.

Errunza, V R and L W Senbet (1984): "International corporate diversification, market valuation, and size-adjusted evidence", *Journal of Finance*, vol 39(3), pp 727–743.

Fatemi, A M (1984): "Shareholder benefits from corporate international diversification", *Journal of Finance*, vol 39, pp 1325–1344.

Gande, A, C Schenzler and L W Senbet (2008): "Valuation effects of global diversification", (March 2008), Available at SSRN: http://ssrn.com/abstract=1108098.

Goldberg, L (2001): "When is US bank lending to emerging markets volatile?", *Federal Reserve Bank of New York,* Photocopy.

Helpmann, E (1984): “A simple theory of international trade with multinational corporations”, *Journal of Political Economy*, vol 94, pp 451–71.

Hsu, C and D J Boggs (2003): “Internationalization and performance: Traditional measures and their decomposition,” *Multinational Business Review*, 11, pp 23–49.

Jung, Y (1991): “Multinationality and profitability”, *Journal of Business Research*, 23, pp179–87.

Kim, W, P Hwang and W P Burgers (1993): “Multinationals’ diversification and the risk-return trade-Off”, *Strategic Management Journal*, 14, pp 275–86.

Kim, W S and E O Lyn (1986): “Excess market value, the multinational corporation and Tobin’s q ratio”, *Journal of International Business Studies*, vol 17, pp 119–126.

Kobrin, S J (1991): “An empirical analysis of the determinants of global integration”, *Strategic Management Journal*, 12, pp 17–37.

Lu, J W and P W Beamish (2004): “International diversification and firm performance: The S-curve hypothesis”, *Academy of Management Journal*, 47, pp 598–609.

Markusen, J R (1984): “Multinationals, multi-plant economies and the gains from trade”, *Journal of International Economics*, vol 16, pp 205–26.

Missina, M, D Tessier and S Dey (2006): “Stress testing the corporate loans portfolio of the Canadian banking sector”, *Bank of Canada Working Paper No 2006-47*.

Morck, R and B Yeung (1991): “Why investors value multinationality”, *Journal of Business*, vol 64, pp 165–187.

Nachum, L (2002): “Liability of foreignness in global competition? Financial service MNEs in the City of London”, ESRC Centre for Business Research, *University of Cambridge Working Paper 229*.

Palmer, D (2000): “US bank exposure to emerging market countries during recent financial crises”, *Federal Reserve Bulletin* (February) pp 81–96.

Peng, M W (2005): *Global strategy*, South Western Publishers, Stamford, CT.

Porter, M E (1990): *The Competitive Advantage of Nations,* New York: The Free Press.

Ramaswamy, K, G Kroeck and W Renforth (1996): “Measuring the degree of internationalization of a firm: A comment”, *Journal of International Business Studies*, 27, pp 167–77.

Rugman, A M (1976): "Risk reduction by international diversification", *Journal of International Business Studies*, vol 7(2), pp 75–80.

Rugman, A M (2005): *The regional multinationals*. Cambridge, UK, Cambridge University Press.

Rugman, A M and S Collinson (2008): “The regional nature of Japanese multinational business", *Journal of International Business Studies*, 39(1).

Rugman, A M and A Verbeke (2004): “A perspective on regional and global strategies of multinational enterprises”, *Journal of International Business Studies*, vol 35(1), pp 3–18.

Santor, E (2008): “Contagion and the composition of Canadian banks’ foreign asset portfolios: Do financial crises matter?,” Proceedings of a CGFS workshop held at the BIS in December 2006, BIS Working Paper forthcoming.

Serres, A et al (2006): “Regulation of financial systems and economic growth in OECD countries: An empirical analysis”, *OECD Economic Studies 43*.

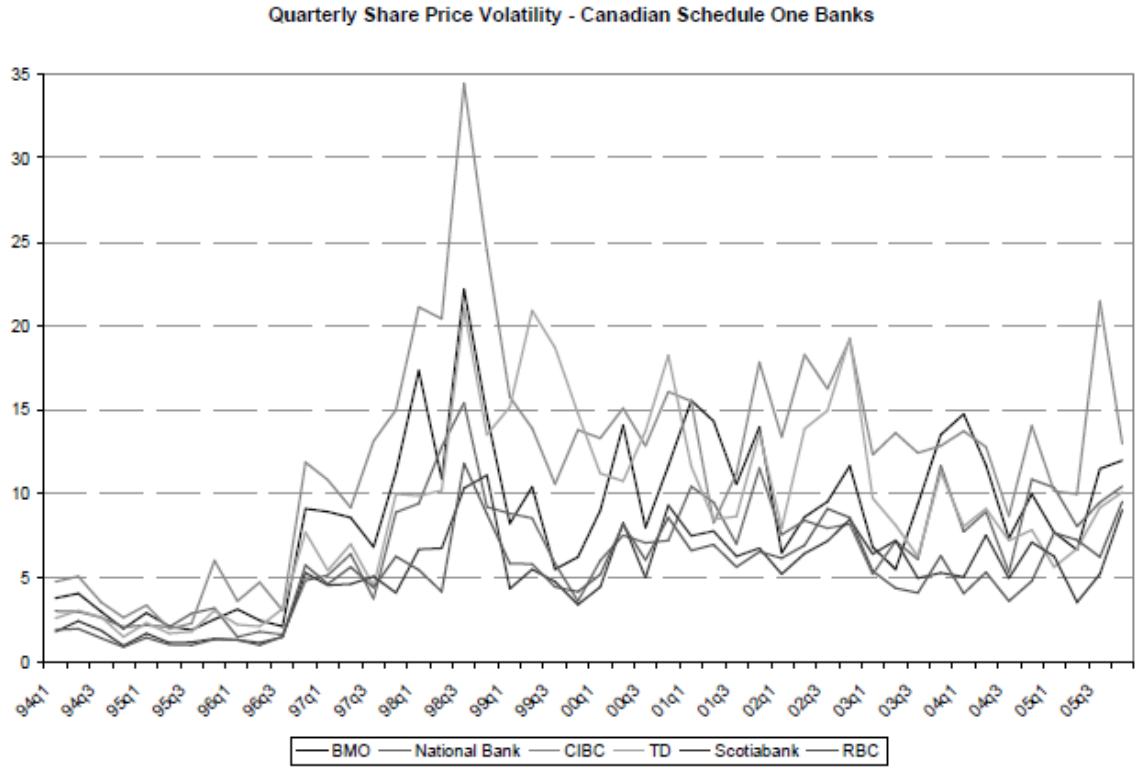
Stiroh, K (2004): “Diversification and banking: Is noninterest income the answer?”, *Journal of Money, Credit and Banking*, vol 36, pp 853–882.

Sullivan, D (1994): "Measuring the degree of internationalization of a firm", *Journal of International Business Studies*, vol 25, pp 325–42.

Vernon, R (1971): *Sovereignty at bay: The multinational spread of US enterprises*. New York: Basic Books.

Zaheer, S (1995): "Overcoming the liability of foreignness", *Academy of Management Journal*, vol 38(2), pp 341–363.

Figure 1



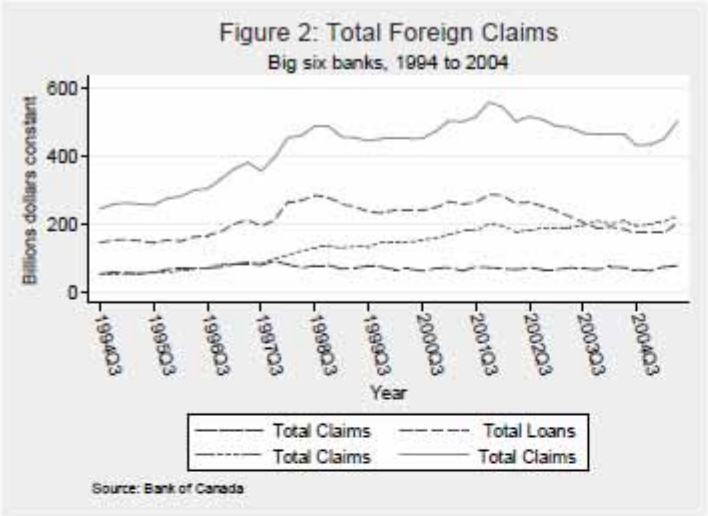


Figure 2: Total Foreign Claims
Big six banks, 1994 to 2004
Billions dollars constant
600
400
200
0
1994Q3
1995Q3
1996Q3
1997Q3
1998Q3
1999Q3
2000Q3
2001Q3
2002Q3
2003Q3
2004Q3
Year
Total Claims
Total Loans
Total Claims
Total Claims
Source: Bank of Canada

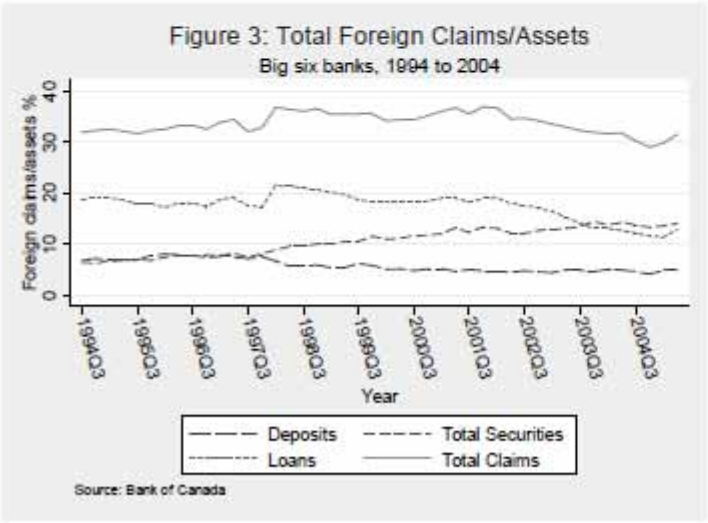


Figure 3: Total Foreign Claims/Assets
Big six banks, 1994 to 2004
Foreign claims/assets %
40
30
20
10
0
1994Q3
1995Q3
1996Q3
1997Q3
1998Q3
1999Q3
2000Q3
2001Q3
2002Q3
2003Q3
2004Q3
Year
Deposits
Total Securities
Loans
Total Claims
Source: Bank of Canada

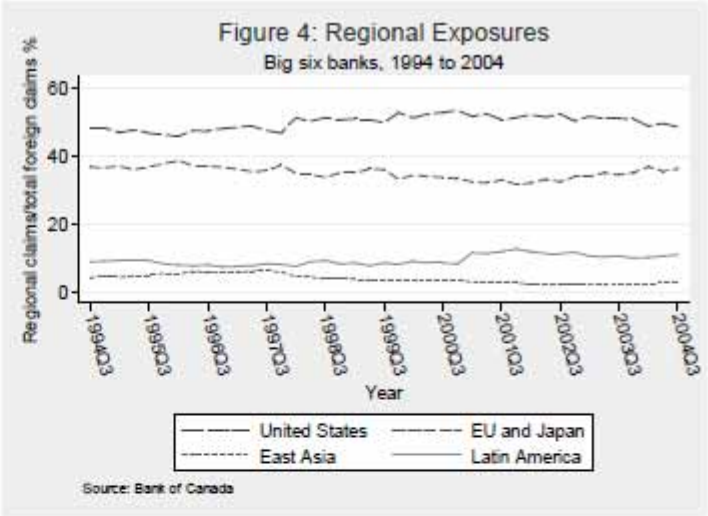


Figure 4: Regional Exposures
Big six banks, 1994 to 2004
Regional claims/total foreign claims %
60
40
20
0
1994Q3
1995Q3
1996Q3
1997Q3
1998Q3
1999Q3
2000Q3
2001Q3
2002Q3
2003Q3
2004Q3
Year
United States
EU and Japan
East Asia
Latin America
Source: Bank of Canada

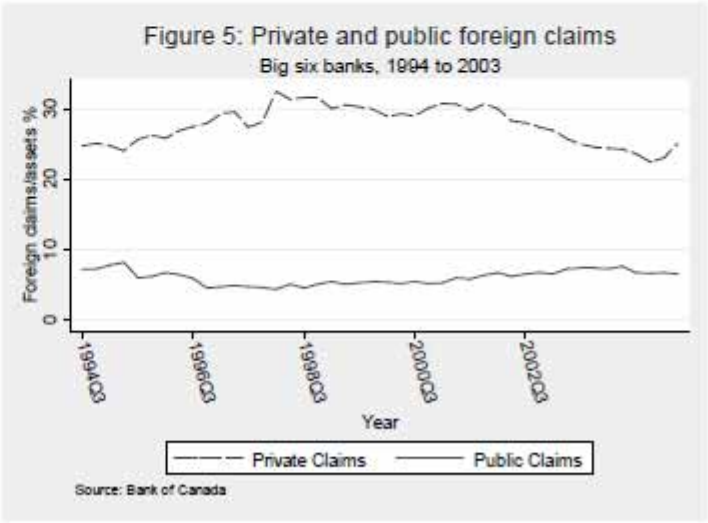


Figure 5: Private and public foreign claims
Big six banks, 1994 to 2003
Foreign claims/assets %
30
20
10
0
1994Q3
1996Q3
1998Q3
2000Q3
2002Q3
Year
Private Claims
Public Claims
Source: Bank of Canada

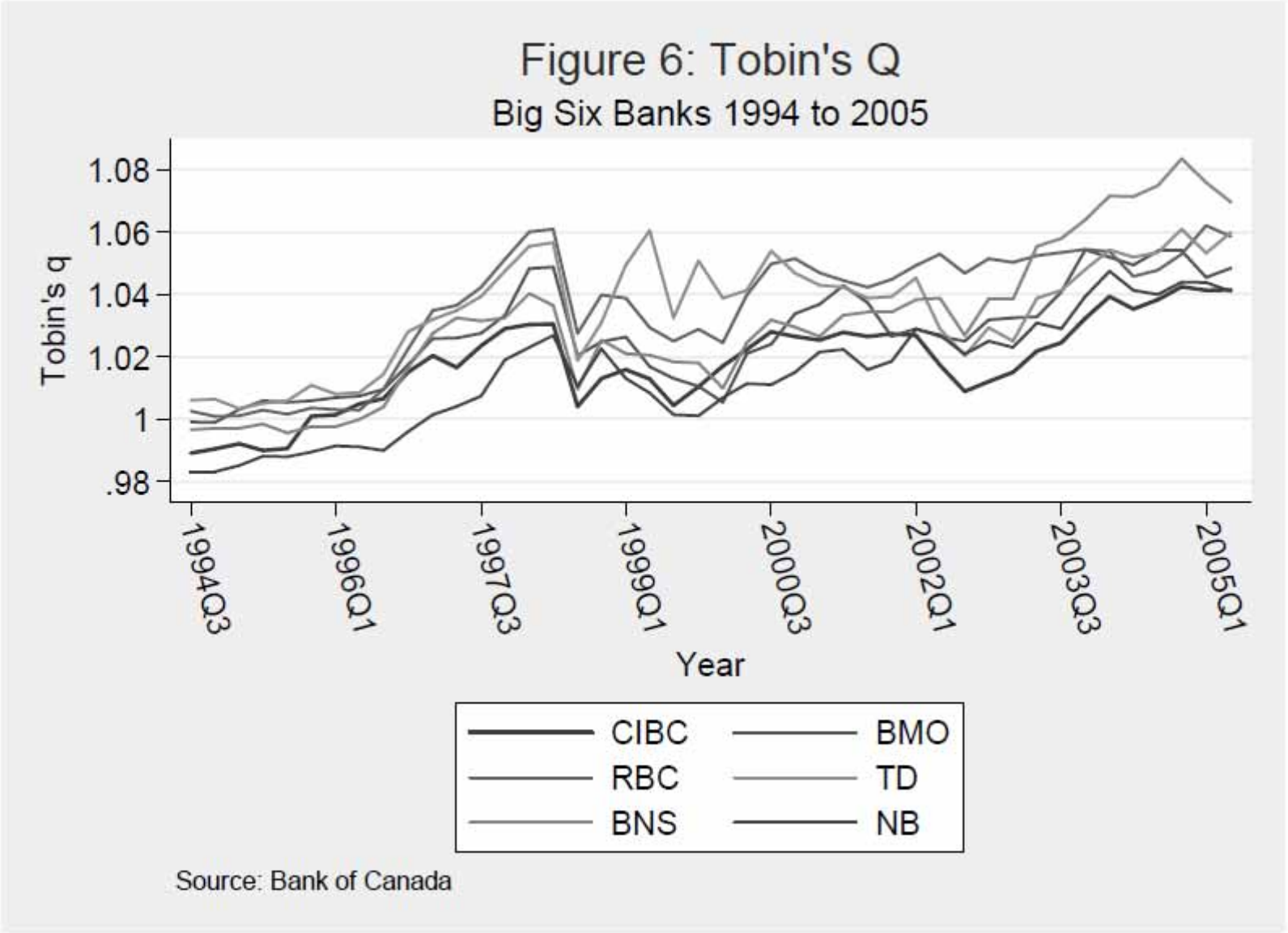


Figure 6: Tobin's Q
Big Six Banks 1994 to 2005
Tobin's q
1.08
1.06
1.04
1.02
1
.98
1994Q3
1996Q1
1997Q3
1999Q1
2000Q3
2002Q1
2003Q3
2005Q1
Year
CIBC
BMO
RBC
TD
BNS
NB
Source: Bank of Canada

What lies beneath the euro's effect on financial integration? Currency risk, legal harmonization, or trade?[1]

Sebnem Kalemli-Ozcan, Elias Papaioannou and José Luis Peydró[2]

Abstract

Although recent research shows that the euro has spurred cross-border financial integration, the exact mechanisms remain unknown. We investigate the underlying channels of the euro's effect on financial integration using data on bilateral banking linkages among twenty industrial countries in the past thirty years. We also construct a dataset that records the timing of legislative-regulatory harmonization policies in financial services across the European Union. We find that the euro's impact on financial integration is primarily driven by eliminating the currency risk. Legislative-regulatory convergence has also contributed to the spur of cross-border financial transactions. Trade in goods, while highly correlated with bilateral financial activities, does not play a key role in explaining the euro's positive effect on financial integration.

1. Introduction

The introduction of the single European currency has been one of the most important developments in the international markets over the past century. The sixteen European countries that have so far abandoned their national monies and adopted the euro did so expecting that monetary union and the accompanying integration policies would shield their economies from adverse shocks, smooth consumption, and promote non-inflationary growth. On its tenth anniversary, the debate on the costs and benefits of the euro is as intense as ever.

Given the difficulty of measuring the growth benefits of the euro with limited time-series data, the literature has focused on quantifying the effects of the euro on goods trade (see Rose (2009), and Baldwin (2006) for surveys). Examining the effect of the single currency not only on trade, but also on financial integration is fundamental as the free movement of capital across borders is a key prerequisite for the functioning of a currency area (Mundell (1961)). Thus, following the construction of new datasets on cross-border investment for a large number of countries (CPIS data from the IMF), recent studies examine the euro's impact on

[1] Essential parts of this paper were prepared while Sebnem Kalemli-Ozcan was visiting the European Central Bank as 2008 Duisenberg Fellow. She thanks the economists at the Bank for providing a stimulating research environment. We thank Dimitrios Rakitzis for excellent research assistance. Fabio Fiorello from the European Commission and Ana Monteiro from the Legal Department of the ECB helped us gathering and understanding the data related to the implementation of European financial laws. We also thank Simone Manganelli, Philipp Hartmann, Phil Lane, Marco Pagano, Mark Spiegel, Axel Weber, Charles Engel, conference participants at the 5th ECB Central Banking Conference on the Euro at Ten, and two anonymous referees for helpful comments and suggestions. The views expressed in this paper are those of the authors and do not reflect the views of the European Central Bank or the Eurosystem.

[2] University of Houston and NBER; Dartmouth College and CEPR; and European Central Bank.

international capital flows (see Lane (2006b, 2009) and Papaioannou and Portes (2001, 2010) for reviews).[3] These studies augment an otherwise standard gravity equation of financial holdings/flows with an indicator variable that takes on the value one when the two countries are members of the euro area (and zero otherwise). This approach is certainly the natural first step in analyzing whether financial integration is higher among the euro area countries compared to other economies. Yet, this approach does not identify the sources of the euro's effect on financial integration. As Baldwin (2006) forcefully emphasizes in the similar context of the euro's impact on goods trade, it is vital that we investigate the underlying roots of this effect. For example, is the documented positive effect of the euro on financial integration driven by elimination of the currency risk among member countries? Or is it an outcome of various financial sector legislative-regulatory reforms that European countries undertook simultaneously with the euro's introduction? What if the positive effect of the euro on financial integration is simply due to increased goods trade?

In this paper, we address these questions, which were overlooked by the aforementioned studies that investigate the effect of the euro on financial integration.[4] Our main contribution is to identify the sources of the euro's impact on financial integration. We do so exploiting a unique (confidential) dataset from the Bank of International Settlements (BIS) that reports bilateral cross-border bank assets and liabilities for twenty advanced economies over the past thirty years. Although our focus is primarily in understanding the underlying mechanisms on euro's impact on financial integration, the rich panel structure allows us to perform a comprehensive before-after analysis of the impact of the single currency on cross-border integration accounting for time-invariant country-pair characteristics and global trends. This is important since due to data limitations most previous studies employed cross-sectional approaches.[5] A natural concern with the cross-sectional estimates in the literature is that they might reflect hard-to-account-for and unobserved country-pair factors that are both correlated with the euro and financial integration. Accounting for such factors is essential, as recent studies show that information asymmetries, distrust and cultural dissimilarities are significant determinants of cross-border investment (eg Portes and Rey (2005), Portes et al (2001), Aviat and Coeurdacier (2007), Guiso et al. (2009), Ekinci et al. (2008); Buch (2003); Gianneti and Yafeh (2008); Mian (2006); Buch, Driscoll, and Ostergaard (2009); Papaioannou (2009)).[6]

Thus before we analyze the sources of euro's impact, we start our analysis quantifying the total effect of the single currency on cross-border financial integration. We estimate difference-in-difference specifications that compare the \within" country-pair impact of the single currency among the twelve initial euro area member countries (the treatment group)

---

[3] Lane (2006a) and Coeurdacier and Martin (2008) estimate that the monetary union increased cross-border bond holdings among the euro area countries by 230% and 150% respectively. Similarly Lane and Milesi-Ferretti (2008), Coeurdacier and Martin (2009), and de Santis and Gerard (2007), among others, document that the euro has increased international equity investment among member states by as much as 150%. In the same vein, Spiegel (2009a, b) finds that cross-border bank lending increased three-fold in Portugal and Greece after the euro's introduction. Blank and Buch (2007) find a positive and significant increase in intra-euro area financial linkages following the introduction of the euro.

[4] In recent work Hale and Spiegel (2009) also investigate the sources of the euro effect using disaggregated firm-level data on bond issuance before and after the euro. They find that after the introduction of the single currency an increased number of mostly non-financial firms issued euro denominated securities.

[5] A notable exception is the study by Blank and Buch (2007), who also also report "within" estimates controlling for country-pair fixed-effects. However their study does not aim to identify the underlying channels of the euro's positive impact on cross-border investment, which is the main question we pursue in this paper.

[6] The parallel literature that assesses the impact of currency unions on trade shows that accounting for country-pair unobservables is fundamental. For example while cross-sectional ("between") studies document that the euro's impact on trade was as large as 200%, the average fixed-effect ("within") estimates falls to 8%–12%, see Rose (2009) and Baldwin (2006).

with the general evolution of banking activities across the control group of economies (that consists of other EU and non-EU industrial countries). Our results suggest that following the adoption of the euro bilateral bank holdings and transactions increased by roughly 40% among the euro area countries. We obtain similar, though somewhat smaller estimates in the range of 25%–30%, when we compare the increase in banking integration in the twelve countries that first adopted the euro with the three EU15 nations that have not joined the currency union. Both estimates, although highly significant, are much lower than the ones found in previous studies examining the impact of the single currency on various types of capital flows/holdings. This illustrates that failing to account for country-pair fixed-effects and global trends can lead to in inflated estimates, due to omitted-variable bias.

After quantifying the total effect of the euro we turn to the main focus of our analysis and investigate the roots of this impact. First, we explore the impact of reducing currency risk and eliminating exchange rate fluctuations among the euro area countries. Among policy circles this was always considered to be the main channel of the euro's impact on financial integration and trade. To isolate the effect of the nature of the currency regime from other policies and developments, we use the recent update of the Reinhart and Rogoff (2004) exchange rate regime classification (from Ilzetzki et al (2008)) and construct time-varying measures of the flexibility of bilateral exchange rates. This allows us to control for the fall in the exchange rate volatility among the EU currencies in the 1990s before the euro's adoption, when the EU countries joined the exchange rate mechanism (ERMII). Our panel specifications show that international banking activities increase significantly among pairs of countries that adopt hard pegs. Most importantly for our focus, once we control for the nature of the exchange rate regime, the indicator variable that switches to one after 1999 for the euro area countries drops significantly compared to the unconditional specifications; in addition, in most permutations it becomes statistically indistinguishable from zero. This illustrates that the euro's positive effect is mainly driven by elimination of the currency risk. This result is also interesting in the light of the so-called "fear of floating" literature, which argues that due to commitment issues, developing countries are unwilling to let their currencies float (eg Calvo and Reinhart (2002); Gelos and Wei (2005)). Our results contribute to this body of work by showing a similar pattern among industrial economies.

Second, we examine the impact of legislative harmonization policies in financial services. Acknowledging that legal, regulatory, and supervisory differences in financial markets are significant impediments to the full integration of capital markets, the EU countries implemented various reforms in banking, insurance, and equity markets over the past decade. Most of these measures were under the umbrella of the Financial Services Action Plan (FSAP), an ambitious initiative launched by the EU Commission and the EU Council in the late 1990s aiming to harmonize the functioning of financial intermediaries. The most important policies of the FSAP were detailed into a set of EU-level laws, the Directives and the Regulations. Among others, the FSAP included new legislation on cross-border M&A activity of financial institutions, money laundering, transparency in capital markets, investor protection, and supervision (see Table 1 and the Appendix).

Table 1

Legislative measures (Directives) of the Financial Services Action Plan (FSAP)

	Directive no	Directive title	Deadline
1	1998/26/EC	Implementation of the Settlement Finality Directive	
2	2000/46/EC	Directive on the taking up, pursuit and prudential supervision of the businesses of electronic money institutions	27/04/2002
3	2000/64/EC	Directive amending the insurance directives and the ISD to permit Information exchange with third countries	17/11/2002
4	2001/17/EC	Directive on the reorganisation and winding-up of Insurance undertakings	20/04/2003
5	2001/24/EC	Directive on the reorganisation and winding-up of banks	05/05/2004
6	2001/65/EC	Directive amending the 4th and 7th Company Law Directives to allow fair value accounting	09/10/2004
7	2001/86/EC	Directive supplementing the Statute for a European Company with regard to the envolvement of employees	10/10/2004
8	2001/97/EC	Directive amending the money laundering directive	15/06/2003
9	2001/107/EC	1st Directive on UCITS (Undertakings for Collective Investments in Transferable Securities)	13/08/2003
10	2001/108/EC	2nd Directive on UCITS (Undertakings for Collective Investments in Transferable Securities)	13/08/2003
11	2002/13/EC	Directive amending the solvency margin requirements in the insurance directives	20/09/2003
12	2002/47/EC	Directive on financial collateral arrangements	17/12/2003
13	2002/65/EC	Directive on the Distance marketing of Financial Services	01/01/2004
14	2002/87/EC	Directive on the supervision of credit institutions, insurance undertakings and investment firms in a financial conglomerate	11/08/2004
15	2002/83/EC	Solvency 1 Directive for life insurance	20/09/2003
16	2002/92/EC	Directive on insurance mediation	15/01/2005
17	2003/6/EC	Directive on insider dealing and market manipulation	12/10/2004
18	2003/41/EC	Directive on the prudential supervision of pension funds	23/09/2005
19	2003/48/EC	Directive on the taxation of savings income in the form of interest payments	01/01/2004
20	2003/51/EC	Directive modernising the accounting provisions of the 4th and 7th Company Law Directives	01/01/2005
21	2003/71/EC	Directive on prospectuses	07/01/2005
22	2004/25/EC	Directive on Take Over Bids	20/05/2006
23	2004/109/EC	Transparency Directive	20/01/2007
24	2004/39/EC	Directive on Markets in Financial Instruments (update of ISD) - MiFID	20/01/2007
25	2005/56/EC	10th Company law Directive on cross-border mergers	15/12/2007
26	2006/48/EC	Directive on the relating to the taking up and pursuit of the business of credit institutions	31/12/2006
27	2006/49/EC	Directive on the capital adequacy of investment firms and credit institutions	31/12/2006

The Table reports the timing of circulation by the EU Commission of the 27 Directives of legislative-regulatory harmonization in banking, insurance, and capital markets included in the Financial Services Action Plan (FSAP). Section 2.2 and the Supplementary Appendix give details for each of the FSAP Directives.

To assess the impact of financial reforms on banking integration, we use information from the EU Commission and each of the EU-15 countries and build a new dataset on the implementation of the 27 Directives of the FSAP across member states (see Table 2). In contrast to Regulations that become immediately enforceable across the EU, the Directives are legislative acts that require from member states to achieve some well-specified results, but without clearly dictating the means. Most importantly the EU countries have discretion in the timing of the transposition of the Directives into the domestic legal order. Governments usually delay the transposition of the Directives to national law for various reasons such as technical difficulties in transposing the directives into national law and protecting domestic interests. Hence, the transposition of the Directives takes in practice several years and differs considerably across the EU. As a result, we have significant variation in the adoption time of the 27 legislative acts incorporated in the FSAP.

After constructing this new dataset, we estimate the effects of legislative convergence in the regulation of banking (as well as insurance and capital markets) on financial integration. Our estimates indicate that cross-border banking activities increased significantly among European countries that quickly adopted the financial services Directives of the FSAP. This result contributes to the law and finance literature (La Porta et al (1997), (1998)), which emphasizes the importance of contracting institutions in shaping financial patterns. To our knowledge, this finding is the first result linking bilateral legislative harmonization to cross-border financial integration. However, although financial services legislative harmonization is a significant driver of banking integration, it cannot explain the total effect of the euro on its own.

Finally, we investigate whether the spur in cross-border banking integration is driven by an increased volume of transactions in international trade. As goods and asset trade move in tandem (eg Obstfeld and Rogoff (2000); Rose and Spiegel (2004); Rose (2005); Aviat and Coeurdacier (2007)) and currency unions raise bilateral trade (eg Rose (2000, 2009)), the positive impact of the single currency on financial integration may partly at least be coming from goods trade. Although there is a strong “within” correlation between banking activities and international trade, trade can not explain any part of the effect of the euro on financial integration.

Besides our contribution to the literature on the impact of the single European currency on financial integration and how this impact works, our work relates to the broader literature that examines the determinants of international capital flows. Empirical studies by Wei (2000), Alfaro et al (2008), Papaioannou (2008) and others show that institutions – broadly defined – are important determinants of all types of international capital flows. Our findings that legal and regulatory harmonization in financial services is strongly associated to international movements illustrates that differences in institutions (broadly defined) and the transparency in governance of financial intermediaries are important factors explaining capital flows and the lack of international diversification. Our results further show that, besides institutional frictions, a crucial factor explaining the lack of international diversification is currency risk (see also Wei and Gelos (2005)).

The paper is structured as follows. In the next section we discuss the empirical specification and explain in detail our data. Section 3 gives our estimates on the total effect of the euro, and presents our analysis on the impact of the three aforementioned channels for the impact of the euro on financial integration. Section 4 concludes.’

Table 2

Transposition date (year quarter) for the Directives of the Financial Services Action Plan (FSAP)

Directive	AT	BE	DE	DK	ES	FR	FI	GR	IE	IT	LU	NL	PT	SE	UK
1998/26/EC	1999 Q4	1999 Q2	1999 Q4	2000 Q2	1999 Q4	2001 Q2	1999 Q4	2000 Q1	1999 Q1	2001 Q2	2001 Q1	1999 Q1	2000 Q1	2000 Q1	1999 Q4
2000/46/EC	2002 Q2	2003 Q2	2002 Q3	2005 Q1	2002 Q4	2003 Q1	2003 Q1	2003 Q2	2002 Q2	2002 Q2	2002 Q2	2002 Q3	2002 Q1	2002 Q2	2002 Q2
2000/64/EC	2003 Q3	2004 Q1	2002 Q1	2004 Q1	2002 Q4	2006 Q1	2004 Q2	2004 Q4	Not Yet	Not Yet	2001 Q3	2003 Q1	2000 Q4	2000 Q3	2003 Q2
2001/17/EC	2003 Q3	2004 Q4	2003 Q4	2006 Q3	2003 Q4	2005 Q1	2004 Q2	Not Yet	2003 Q2	2003 Q2	2004 Q2	2004 Q2	2003 Q2	2006 Q2	2003 Q2
2001/24/EC	2003 Q3	2004 Q4	2004 Q1	2004 Q2	2005 Q2	2004 Q4	2004 Q2	2006 Q2	2004 Q2	2004 Q3	2004 Q2	2005 Q2	2006 Q4	2006 Q1	2004 Q2
2001/65/EC	2004 Q1	2005 Q1	2004 Q4	2002 Q1	2004 Q1	2004 Q4	2004 Q4	2006 Q2	2004 Q4	2005 Q1	2006 Q2	2005 Q3	2004 Q2	2004 Q1	2004 Q4
2001/86/EC	2004 Q4	2004 Q4	2004 Q4	2004 Q2	2006 Q3	2005 Q3	2004 Q4	2006 Q2	2006 Q4	2005 Q4	2006 Q3	2005 Q1	2005 Q4	2004 Q4	2004 Q4
2001/97/EC	2003 Q2	2004 Q1	2002 Q3	2005 Q1	2003 Q3	2004 Q1	2003 Q2	2005 Q4	2003 Q3	2004 Q1	2004 Q4	2001 Q4	2004 Q2	2005 Q1	2004 Q2
2001/107/EC	2003 Q3	2004 Q2	2004 Q1	2004 Q1	2004 Q1	2003 Q4	2004 Q3	2004 Q4	2003 Q4	2003 Q4	2003 Q1	2005 Q3	2004 Q1	2004 Q2	2004 Q1
2001/108/EC	2003 Q3	2004 Q2	2004 Q1	2005 Q3	2004 Q1	2003 Q4	2004 Q3	2004 Q4	2003 Q4	2003 Q4	2003 Q1	2005 Q3	2004 Q1	2004 Q2	2004 Q1
2002/13/EC	2003 Q3	2004 Q1	2004 Q1	2004 Q1	2004 Q1	2004 Q2	2004 Q2	2005 Q1	2005 Q1	2004 Q1	2004 Q2	2003 Q4	2003 Q4	2004 Q2	2004 Q1
2002/47/EC	2003 Q4	2005 Q1	2004 Q2	2004 Q4	2002 Q4	2005 Q1	2004 Q1	2004 Q4	2004 Q1	2004 Q3	2005 Q3	2004 Q2	2004 Q2	2005 Q2	2005 Q4
2002/65/EC	2004 Q4	2006 Q1	2004 Q4	2005 Q3	Not Yet	2005 Q2	2005 Q2	2005 Q2	2004 Q4	2005 Q4	Not Yet	2006 Q1	Not Yet	2004 Q2	2004 Q4
2002/87/EC	2005 Q1	2005 Q1	2005 Q1	2004 Q3	2005 Q2	2004 Q4	2004 Q3	2006 Q2	2005 Q1	2005 Q3	2006 Q4	2007 Q1	Not Yet	2006 Q3	2004 Q3
2002/83/EC	2003 Q3	2004 Q2	2004 Q1	2004 Q1	2004 Q1	2004 Q2	2004 Q2	2005 Q1	2005 Q1	2004 Q1	2004 Q2	2003 Q4	2003 Q4	2004 Q2	2005 Q1
2002/92/EC	2004 Q4	2005 Q1	Not Yet	2005 Q3	2006 Q3	2005 Q4	2005 Q3	2005 Q1	2005 Q1	2006 Q2	2005 Q4	2005 Q3	2006 Q4	2005 Q3	2005 Q1
2003/6/EC	2005 Q1	2005 Q3	2004 Q4	2005 Q2	2005 Q4	2005 Q3	2005 Q3	2005 Q3	2005 Q3	2005 Q2	2006 Q2	2005 Q4	2006 Q2	2005 Q3	2005 Q3
2003/41/EC	2005 Q3	2006 Q4	2005 Q3	2005 Q4	2005 Q1	2006 Q2	2006 Q2	2005 Q3	2005 Q3	Not Yet	2005 Q3	2006 Q1	2006 Q1	2006 Q1	2005 Q4
2003/48/EC	2004 Q1	2005 Q3	2005 Q1	2004 Q2	2004 Q1	2003 Q4	2004 Q1	2005 Q1	2003 Q4	2005 Q2	2005 Q2	2004 Q1	2005 Q3	2005 Q3	2005 Q1
2003/51/EC	2005 Q1	2006 Q1	2004 Q4	2002 Q1	2005 Q1	2004 Q4	2004 Q4	2006 Q3	2005 Q1	Not Yet	2006 Q2	2005 Q3	2005 Q1	2006 Q1	2005 Q1
2003/71/EC	2005 Q3	2006 Q3	2005 Q3	2005 Q2	2005 Q1	2005 Q3	2005 Q3	2005 Q4	2005 Q3	Not Yet	2005 Q3	2005 Q3	2005 Q2	2005 Q3	2005 Q3
2004/25/EC	2006 Q2	2007 Q3	2006 Q3	2005 Q2	2007 Q3	2006 Q2	2006 Q4	2006 Q2	2006 Q2	2007 Q4	2006 Q2	2007 Q4	2006 Q4	2006 Q3	2006 Q2
2004/109/EC	2007 Q4	2007 Q4	2007 Q4	2007 Q4	2007 Q4	2007 Q4	2007 Q4	2007 Q4	2007 Q4	2007 Q4	2007 Q4	Not Yet	2007 Q4	2007 Q4	2007 Q4
2004/39/EC	2007 Q2	2008 Q3	2007 Q1	2007 Q2	2007 Q3	2007 Q4	2007 Q1	2007 Q2	2007 Q2	2007 Q4	2008 Q3	2007 Q4	2007 Q4	2007 Q1	2007 Q1
2005/56/EC	2007 Q4	2008 Q3	2007 Q2	2007 Q2	Not Yet	2008 Q3	2007 Q4	Not Yet	2008 Q2	2008 Q3	2007 Q1	2008 Q3	Not Yet	2008 Q1	2007 Q4
2006/48/EC	2007 Q1	2007 Q4	2006 Q4	2007 Q1	2008 Q1	2007 Q2	2007 Q1	2007 Q3	2007 Q1	2007 Q1	2007 Q4	2007 Q1	2007 Q2	2007 Q1	2007 Q1
2006/49/EC	2007 Q4	2007 Q4	2006 Q4	2007 Q1	2008 Q1	2007 Q2	2007 Q1	2007 Q3	2007 Q1	2007 Q1	2007 Q4	2007 Q1	2007 Q2	2007 Q1	2007 Q1

The Table reports the year and quarter of the transposition of each of the 27 Directives of the Financial Services Action Plan (FSAP) by EU15 countries. See Section 2.2 on details of the FSAP. Table 1 reports a brief description of each Directive. The Supplementary Appendix gives more details. Data on the transposition of the legislative-harmonization Directives are retrieved from the EU Commission and each of the EU15 countries.

2. Empirical specification and data

2.1 Specification

Our baseline specification takes the following form:

$$BI_{i,j,t} = \alpha_{i,j} + \alpha_t + \psi_1 EU1_{i,j,t} + \psi_2 EU2_{i,j,t} + \psi_3 EZ1_{i,j,t} + \psi_4 EZ2_{i,j,t} + X'_{i,t,y}\gamma + v_{i,j,t} \quad (1)$$

The dependent variable (BI) is the average of the log of real bilateral assets and liabilities holdings (or gross flows) of countries i and j in year t, standardized by the sum of the two countries' population. We construct BI using data on cross-border banking activities from the confidential version of BIS's International Locational Banking Statistics Database that reports bilateral positions. We extract from this dataset bilateral stocks and flows covering twenty industrialized countries over the period 1977–2007.[7] Our data covers all the twelve initial euro area countries (Austria, Belgium, Germany, Greece, Luxemburg, France, Finland, Netherlands, Spain, Portugal, Ireland, and Italy), plus the three EU15 non-euro area countries (Denmark, Sweden and the United Kingdom), and Australia, Canada, Japan, Switzerland, and the United States.[8]

Our focus is on the coefficient of the $EZ2_{i,j,t}$ variable that takes on the value one if both countries are members of the eurozone in year t and zero otherwise. To isolate the effect of the single currency from an EU-wide effect, we include in the specification a dummy variable that equals one if the two countries are members of the EU in year t and zero otherwise ($EU2_{i,j,t}$). In all specifications we also control for the unilateral effects of the EU and the euro on banking integration, adding indicator variables that take on the value one when only one of the two countries is a member of the EU or the euro zone in a given year ($EU1_{i,j,t}$ and $EZ1_{i,j,t}$ respectively).

The three dimensional panel structure allows us to control for year fixed-effects (α_t) and (more importantly) country-pair fixed-effects ($\alpha_{i,j}$). Year fixed-effects account for global trends on banking integration (see Lane and Milesi-Ferretti (2008)), that might be reflected by the euro variable if not controlled. Country-pair fixed-effects control for all time-invariant bilateral characteristics, such as trust, culture, information asymmetries that affect financial patterns. Our empirical model constitutes a difference-in-difference specification, where the euro area member countries are the "treatment" group, while the three EU and the five non-EU countries serve as the "control" group(s). Since we include both time and country-pair fixed-effects the coefficients on the indicator variables measure the effect of the EU and the euro membership on banking integration of the participating countries compared to evolution of international banking integration in the other industrial economies.

Vector $X'_{i,j,t}$ includes other independent and control variables, such as trade, the flexibility of the exchange rate regime and legal-regulatory harmonization, which are explained in detail below.

---

[7] The Locational Banking Statistics nowadays covers data from roughly forty countries; yet half of these countries started reporting only recently (mostly after 2000) or are "off-shore" centers. Therefore, we only analyze the twenty industrialized countries that appear in the BIS dataset since 1970s.

[8] Thus the maximum number of observations are 5,700 ($20 \times 19 \times 30 / 2$). Usually bilateral asset and goods trade data contain many zeros that make the logarithmic transformation questionable. Our focus on industrial countries makes our analysis immune to this problem, because we miss just a few observations and only in the beginning of the sample. Our baseline models are estimated in a sample of 5,566 observations. Most gaps involve Greece and Portugal. We thus re-estimated all models dropping these two countries. The results are similar.

2.2. Data

Dependent variable

The BIS Locational Banking Statistics database covers all of banks' on-balance sheet exposure, as well as some "off-balance sheet" items. The dataset reports asset and liability holdings of banks located in the main industrial countries ("the *reporting area*") against more than 100 economies (the "*vis-à-vis area*") since the end of 1977. The data includes mainly cross-border bank-to-bank lending activities, such as foreign loans, deposits and long-term debt placed with non-resident banks, including bank's own related offices abroad and subsidiaries.[9] The data also covers trade-related credit, and holdings of debt securities issued mainly by other banks, and participations of equity and FDI. Yet, BIS documentations suggests that equity portfolio was, until recently, a small fraction of international banking activities (see BIS (2003a, b) and Wooldridge (2002)).[10]

Quite importantly domestic monetary authorities report to the BIS the currency exposure of local banking institutions. Using this information the BIS experts can estimate cross-border flows accounting for valuation effects that occur due to exchange rate swings. As the BIS (2003a) documents "flows are estimated by the BIS staff as the exchange rate adjusted changes in holdings." Although from an international diversification standpoint studying stocks is more appropriate, flows account for valuation effects are also important and thus we opt for using both measures.[11]

The data is originally expressed in current US dollars. After deflating the series with the US price index, we construct two measures of banking integration, one based on stocks and one based on gross flows. $BI1_{i,j,t}$ is the average of the log of real bilateral assets and liabilities holdings of countries i and j in each year, standardized by the sum of the two countries' population. $BI2_{i,j,t}$ is the average of the log of real bilateral assets and liabilities gross flows, standardized by the sum of the two countries' population in year t.[12]

Exchange rate regime

To investigate the impact of currency risk we augment our main specification with a bilateral time-varying measure that reflects the flexibility of the exchange rate regime ($ER_{i,j,t}$). We do so using the latest update of the Reinhart and Rogoff (2004) exchange rate regime classification (by Ilzetzki, Reinhart and Rogoff (2008)). Using data on official and dual (parallel and black) foreign exchange markets, Reinhart and Rogoff (2004) produce two (*de*

---

[9] This is the main difference with the similar BIS Consolidated Banking Statistics Database, used for example by Spiegel (2009a, b). However, Spiegel measures the impact of the euro only for Greece and Portugal.

[10] Unfortunately the database does not distinguish between FDI, portfolio and fixed-income investments, and standard bank-to-bank loans and credit lines.

[11] de Santis and Gerard (2006) and Buch, Driscoll, and Ostergaard (2009) take a more "structural" approach than we do and compare the actual investment holdings of foreign investors and banks respectively to what an international mean-variance model predicts. While this approach has the obvious benefit of imposing some structure in the empirical analysis it is far from clear than international banks follow simple mean-variance global strategies. For example the corporate finance literature shows that due to monitoring costs and asymmetric information banks tend to lend to proximate borrowers. Moreover since our data includes investment in both debt and equity instruments it is not clear how one could estimate expected international returns.

[12] We also experiment with other measures of banking integration. First, following Rose and Spiegel (2004) we didn't standardize the variables with population (and controlled for the product of log population). Second, following early works on trade we used the log of the average (and alternatively the sum) of bilateral holdings and gross flows (see Baldwin (2006) for a critique of this measure). The results are similar and hence not reported for brevity.

facto) classifications of the exchange rate regime at a monthly frequency from 1946 till the end of 2007.[13] The "coarse" index distinguishes between four regimes, fixed (score of 1), crawling pegs (score of 2), managed floating (score of 3), and free floating (score of 4).[14] The "fine" grid ranges from 1, indicating a fixed-exchange rate regime (such as the euro), till 13, suggesting a freely floating exchange rate.[15] For our benchmark estimates we prefer the "fine" classification, as it exhibits larger variation and is less correlated with the binary euro area measure ($EZ2$) that we also include in many specifications. We also show results with the "coarse" classification for robustness. For both classifications, we construct a bilateral measure of exchange rate flexibility by taking the sum of the log of the scores for each country in the beginning (as of January) of each year ($ER_{i,j,t}^{f,c} \equiv \ln(ER_{i,t}^{f,c}) + \ln(ER_{j,t}^{f,c})$) where superscript f and c indicate the fine and the coarse classification).

Legislative harmonization

The introduction of the euro was accompanied by legislative reforms in financial services. To isolate the impact of these policies we use information from the European Commission and the EU-15 Member States on the implementation of the Financial Services Action Plan (FSAP) and construct a new dataset that measures the degree of legislative harmonization in financial services across European countries.[16]

The FSAP was a major 5-year program launched by the European Union in the end of 1998 with the aim to establish: (1) a single EU wholesale market for financial services, (2) open and secure retail markets, and (3) state-of-the-art prudential and supervisory regulations. The project included 42 measures that aimed to create a harmonized EU market for banking, securities and insurance. The most important part of the project consisted of (27) EU-level legislative acts (the Directives) and (2) Regulations. The other measures were Communications and Recommendations of the Commission with the member states on technical issues.

Until its official completion at the end of 2003, the EU legislative bodies (the EU Council and the European Parliament with the assistance of the EU Commission) passed most of the initially planned measures. In particular, the EU bodies passed 21 Directives and 2 Regulations. The remaining 6 Directives were initiated with some delay, but their circulation

---

[13] It should be stressed that in our sample of developed economies there are no major black or parallel currency markets. Thus in our group of economies the index is to great extent de jure as it reflects the choice of monetary authorities to peg their currencies.

[14] There is also a fifth category, free falling, that includes hyperinflation currencies. Yet none of the 20 industrialized countries we consider is ever placed in this category.

[15] For example, for most years the U.S. dollar, the Japanese yen, and the Australian dollar get a score around 11–13. The Swiss franc ranges from 8 to 12, while the Canadian dollar fluctuates around 8. The variation in European countries is substantial. In general, European currencies appear in intermediate status for most of the 1980s (in the range of 4 to 8); in the early 1990s the majority of countries move to a fixed-regime range (score of 4), and to a fully-fixed regime (score of 1) for the ones that join the euro in 1999. The Deutsche mark is classified as a free floating currency (score of 13) till 1998.

[16] Besides legal harmonization in financial services the introduction of the single currency was accompanied by a series of technical/infrastructure reforms. For example with the introduction of TARGET (Trans-European Automated Real-time Gross settlement Express Transfer system) payments between credit institutions within the euro-area take place in real-time and at a harmonized transaction fee. At the same time the number of payment systems was reduced from seventeen to six in 1999. Other important infrastructure innovations included the introduction of the SEPA (Single Euro Payments Area) and the STEP (Short-Term European Paper) platforms that aimed to integrate payments in retail banking and bond markets (see Kalemli-Ozcan, Manganelli, Papaioannou, and Peydro (2009) for a more-in-depth discussion). Since these electronic payment and settlement systems were introduced at the same time in all EU countries, one cannot isolate their impact from that of the elimination of the exchange rate variability.

and adaptation for most member-states took place before the end of our sample period (end of 2007). Unlike Regulations that become enforceable immediately after their passage across all EU member states, Directives have to be transposed within a certain period in the legal order of the member states. Usually the transposition time takes a couple of years, as it entails various technical modifications and adaptations. European governments prefer Directives to Regulations, as they can delay the transposition either for technical reasons (some countries need to change internal laws or/and create new institutions to incorporate the directive into national law), or for domestic policy considerations, such as protecting local firms, shielding national industry interests, etc.[17] Therefore, there is significant heterogeneity on the adaptation timing across countries, which is quite useful for our purposes.

Table 1 gives the title, the date of circulation by the EU Commission, and the deadline for the respective transposition for each of the 27 Directives of the FSAP. Appendix Table 1 provides a brief summary of the context of each directive. Table 2 reports the date of the transposition for each Directive across all EU15 member states. There is sizable heterogeneity on the timing of the transposition across member states. Take for example the first Directive of the FSAP on Settlements that was circulated by the Commission in late 1998. Only half of the EU-15 countries transposed the Directive in the following year. France, Luxemburg, and Italy took three years to incorporate this Directive into national law. The transposition pace of the Directive on the Supervision of Credit Institutions, Insurance Undertakings and Investment Firms in a Financial Conglomerate was notoriously slow. Although the transposition mandate expired in late 2004 (following an adoption time framework of two years), it was incorporated in time only by four countries (namely Denmark, France, Finland and the UK). Most countries took five years to transpose this important financial legislation into national law.

To create the bilateral harmonization variable ($HARMON_{i,j,t}$) we first define twenty-seven indicator variables that equal one starting at the year of the transposition of each directive into national law in each country, and zero otherwise. Second, we construct a country-level time-varying legal transposition measure ranging from zero to twenty-seven by summing up the values of the indicator variables for each Directive ($LEX_{i,t}$). Third, we construct the bilateral harmonization index by taking the sum of the logs of one plus the legislation measure for each country (ie $HARMON_{i,j,t} \equiv \ln(1 + LEX_{i,t}) + \ln(1 + LEX_{j,t})$).[18] For robustness we also construct the LEX and $HARMON$ indicators using the initial twenty-one Directives that were passed by the Commission before the official completion of the FSAP.

[17] Numerous assessments conclude that this system of transposition was too slow, rigid, and failing to distinguish between essential framework principles and implementing rules (see the so-called Lamfalussy report). The Takeovers Directive, for example, had been discussed and negotiated at the EU level for 12 years. Likewise it took more than 30 years for EU governments to agree, vote, transpose and implement the European Company Statute Directive.

[18] For robustness we also used the product of the logs of the countries' scores in transposition. We also simply took the sum rather than the sum of the logs of the country measures of legislative harmonization, again finding almost identical results. We prefer the logarithmic transformation because the harmonization variable is skewed. In addition, since the dependent variable is also specified in logs this transformation makes the interpretation of the coefficients easier.

3. Results

3.1. Total effect

Table 3 reports our results on the total (aggregate) effect of the euro on banking integration.[19] Columns (1)–(2) of Panel A report unconditional estimates in the maximum sample of twenty countries and thirty years with the stock and the flow based measures of banking integration. The coefficient on EZ2 is positive and statistically significant at the 1% level in both permutations. This indicates that bilateral banking activities among the euro area countries increased significantly after the adoption of the single currency. In contrast, the EU2 indicator enters with an insignificant estimate. This suggests that it was the adoption of the single currency rather than being a member of the EU that has contributed to the increase in financial integration. The coefficient on EU1 that equals one when one of the two counterparts is a member of the EU is negative and in most models significant at standard confidence levels. This is due to the fact that cross-border banking activities among the control group of countries (USA, Japan, Switzerland, Australia, and Canada) is quite high, as many of these countries are important financial centers. The coefficient on EZ1 that equals one when one of the two counterparts has adopted the euro is insignificant, suggesting that the unilateral impact was much smaller than the bilateral effect.[20]

While in the specifications reported in columns (1)–(2) we do not condition for other covariates, the inclusion of country-pair fixed-effects accounts for most of the usual control variables of standard gravity equations of financial flows, such as distance, colonial ties, and land areas, all of which have been shown to affect integration. In addition, the country-pair fixed-effects account for other hard-to-measure time-invariant bilateral factors that affect financial linkages, such as trust, cultural similarities, and information asymmetries. Gravity equations typically include the product of bilateral GDPs in the set of explanatory variables. The main idea is that larger-richer economies are able to attract more foreign investment, by providing a larger set of diversification opportunities (eg Martin and Rey (2004)) and offering collateral (eg Gertler and Rogoff (1990)). In columns (3) and (4) we repeat estimation controlling for the log of the product of real per capita GDP of the two countries in each year (using data from World Bank's World Development Indicators database). GDP is a significant correlate of cross-border financial holdings and transactions, even after conditioning on country-pair unobservables and time trends. Yet the coefficient on the indicator that equals one when both counterparts are members of the euro area ($EZ2$) remains significant at the 1% level.

In columns (5)–(8) we repeat the estimation, dropping observations from the late 1970s and the 1980s. As cross-border banking activities increased drastically since the early 1990s, when the initial stages of the EMU were designed and implemented, it is important to explore the sensitivity of our estimates in this dimension. In addition, focusing in the 1990s and the 2000s allows us to examine the effects of the single currency with the same number of pre and post-1999 observations, something always useful in before-after event studies. The estimate on the indicator that switches to one when both countries join the euro area ($EZ2$) is stable and remains highly significant.

---

[19] To account for serial correlation and potentially for country-pair specific heteroskedasticity, standard errors are clustered at the country-pair level (Bertrand et al (2004)).

[20] We also specified the EU1 and EU2 indicator variables in an alternative way. Specifically we run models where the EU1 and the EU2 dummies do not include the euro area countries. In these specifications (reported in Appendix Table F) the coefficient on the EZ2 indicator is around 0:35–0:40. The coefficient on EU2 indicator is also positive (around 0:58–0:70), although the estimate is not always statistically significant. In contrast the EU1 and EZ1 variables enter both with insignificant point estimates.

Table 3

EU membership, euro area membership and banking integration

	Panel A: Panel fixed-effect estimates in the full sample of countries							
	Sample period: 1978–2007				**Sample period: 1990–2007**			
	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
euone (*EU*1)	–0.6286	–0.4410	–0.4730	–0.3297	–0.4963	–0.5421	–0.4317	–0.4991
t-stat	(4.01)	(3.45)	(3.27)	(2.76)	(2.76)	(3.91)	(2.62)	(3.90)
euboth (*EU*2)	–0.0454	0.1406	–0.0372	0.1453	–0.0958	–0.0308	–0.1360	–0.0575
t-stat	(0.30)	(1.25)	(0.28)	(1.42)	(0.62)	(0.26)	(1.05)	(0.57)
euroone (*EZ*1)	–0.0082	0.0357	–0.3080	–0.1719	–0.0655	–0.0138	–0.2365	–0.1280
t-stat	(0.05)	(0.24)	(2.00)	(1.20)	(0.47)	(0.11)	(1.88)	(1.04)
euroboth (*EZ*2)	0.6241	0.5350	0.3474	0.3431	0.5417	0.4692	0.3680	0.3539
t-stat	(3.53)	(4.13)	(2.56)	(3.24)	(4.41)	(5.16)	(3.68)	(4.48)
Real pc GDP (*GDP*)			3.0715	2.1272			3.1000	2.0623
t-stat			(8.08)	(7.69)			(8.47)	(7.58)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5566	5566	5566	5566	3385	3386	3385	3386
Within *R*-squared	0.500	0.566	0.596	0.613	0.321	0.378	0.440	0.427
Country-pairs	190	190	190	190	190	190	190	190
	Panel B: Panel fixed-effect estimates in the EU15 sample of countries							
	Sample period: 1978–2007				**Sample period: 1990–2007**			
	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
euroone (*EZ*1)	–0.1272	–0.0858	–0.2914	–0.1871	–0.1598	–0.823	–0.2451	–0.1341
t-stat	(0.51)	(0.48)	(1.24)	(1.07)	(0.77)	(0.47)	(1.16)	(0.75)
euroboth (*EZ*2)	0.4007	0.2593	0.2484	0.1654	0.2981	0.2527	0.276	0.2099
t-stat	(2.21)	(2.01)	(1.75)	(1.52)	(2.43)	(2.79)	(2.21)	(2.59)
Real pc GDP (*GDP*)			2.8298	1.7456			2.2911	1.3923
t-stat			(5.37)	(4.93)			(4.19)	(4.05)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2260	2259	2260	2259	1679	1678	1679	1678
Within *R*-squared	0.627	0.687	0.704	0.720	0.525	0.580	0.585	0.602
Country-pairs	105	105	105	105	105	105	105	105

The Table reports panel fixed-effect estimates. All specifications include year fixed-effects and country-pair fixed-effects. Panel A reports coefficients estimated in the full sample of countries, while Panel B reports coefficients of otherwise identical specifications estimated only in countries that are EU members. In both Panels, columns (1)–(4) give coefficients of specifications estimated in the period 1978–2007, while columns (5)–(8) report coefficients of specifications estimated in the period 1990-2007. In odd-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral assets and liabilities holdings of banks in countries *i* and *j* in year *t*, standardized by the sum of the two countries' population in each year (*BI*1). In even-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral gross flows in assets and liabilities of banks in countries *i* and *j* in year *t*, standardized by the sum of the two countries' population in each year (*BI*2). *EU*1 is an indicator (dummy) variable that takes on the value of one if only one counterpart in each pair of countries is member of the EU in year *t* and zero otherwise. *EU*2 is an indicator (dummy) variable that takes on the value one if both countries are members of the EU in year *t* and zero otherwise. *EZ*1 is an indicator (dummy) variable that takes on the value of one if only one counterpart in each pair of countries is member of the euro area in year *t* and zero otherwise. *EZ*2 is an indicator (dummy) variable that takes on the value one if both countries are members of the euro area in year *t* and zero otherwise. Real pc GDP is the log of the product of real per capita *GDP* of the two countries in year *t*. The Data Appendix gives detailed variable definitions and data sources. *t*-statistics based on country-pair specific (clustered) heteroskedasticity and autocorrelation are reported in parenthesis below the coefficient estimates. The Table also reports the number of country-pairs, the number of observations, and the within *R*-squared.

The most conservative estimate of the coefficient on $EZ2$ (in the specifications where we also control for GDP per capita) implies that – compared to the general increase in banking integration in the group of industrial economies – cross-border banking activities between the euro area countries increased by 40%–45% after the adoption of the single currency (exp(0.35) = 1.41). While this effect is large, it is smaller in magnitude than the estimates of Lane and Milesi-Ferretti (2008), Lane (2006a), de Santis and Gerard (2006) and Coeurdacier and Martin (2009), who, using IMF survey data and cross-sectional approaches, estimate that the euro has increased bilateral equity and bond holdings by around 100%, if not more. Our more conservative estimates stems from the inclusion of country-pair fixed-effects that accounts for all time-invariant bilateral factors that affect financial linkages. When we do not include country-pair fixed-effects, we also find significantly larger coefficients. We similarly find larger coefficients when we simply control for country (rather than country-pair) fixed-effects or when we perform random effects estimation.

Yet, the interpretation of our within results is somewhat different than the cross-sectional estimates. The coefficient on $EZ2$ in Table 2 measures the average increase in bilateral banking activities in a pair of countries that has adopted the euro compared to the evolution of international banking activities in the control group of countries. The cross-sectional estimates in contrast measure how much larger are financial linkages of the euro area countries compared to that of other economies in the post-1999 period.

The average bilateral effect of the euro on cross-border banking activities reported in Panel A of Table 3 is also lower than the estimates of Spiegel (2009a, b), who, using BIS consolidated banking statistics for Portugal and Greece over the period 1985–2006, finds that the single currency increased banking activities three-fold. Besides the different sample period, the main reason for this difference is the extent of the data. Spiegel (2009a, b) focuses on two small euro area countries, while we investigate the impact of the single currency in all twelve initial members of the euro area.[21] We thus explored whether the impact of the single currency was larger for small euro area countries compared to large economies. The estimates (not reported for brevity) are similar for the two group of countries (small and large) and almost identical to the coefficient reported in Panel A of Table 3.[22] Our results on the bilateral euro effect is also in line (though a bit more conservative) with the estimates of Blank and Buch (2007), who find that the euro increased cross-border bank assets and liabilities by around 80% and 35% respectively. While these authors also estimate country-pair fixed-effect models using a similar dataset, their panel just covers five pre- and five post-1999 observations. Our much larger time-dimension allows us to better account for trends in both the control and the treatment group of countries.

Panel B of Table 3 reports results of otherwise similar to Panel A specifications, estimated only in the EU15 sub-sample. Although in Panel A we control for both unilateral and bilateral effects of EU membership, one may worry that there are different dynamics in the EU and the larger group of industrial countries. To account for this, we re-estimated the specifications in the EU15 sample. The coefficient on the indicator that switches to one for the twelve countries that adopted the single currency after 1999 remains statistically different than zero in all permutations. This reassures that (the more efficient) estimates in the full sample of countries do not reflect an EU-wide effect or different patterns in banking activities in the EU.

---

[21] While we include in the specification country-pair fixed-effects to account for all time-invariant country-pair factors, Spiegel (2009a, b) includes source-country and recipient-country fixed-effects and directly controls for bilateral gravity factors (such as distance and common language). When we replace the country-pair fixed-effects with country fixed-effects the coefficient on the indicator variable that takes on the value one when both countries are euro area members retains significance and becomes significantly larger, much closer to Spiegel's estimate.

[22] We thank Mark Spiegel for proposing this robustness check.

The coefficient drops somewhat, implying that banking activities among the euro area countries increased by 25% (exp(0.21 – 0.25) – 1 = 23% – 29%), compared to the evolution of banking integration in the three European countries that have opted out of the currency union.

3.2. Channels

We now investigate the role of the exchange rate regime, harmonization policies in financial services, and trade on financial integration. This allows us to understand the underlying reasons for the total effect of the euro documented in Table 3. We start examining the effect of each channel. We then simultaneously control for all of these factors. Finally we explore the sensitivity of our results.

Exchange rate risk

The most immediate effect of the euro was to eliminate currency risk among member countries. Even before 1999 exchange rate fluctuations among the legacy currencies were limited. One of the criteria of the Maastricht Treaty of 1992 that set the rules for monetary union was that member countries had to join the exchange-rate mechanism (ERM II) for two consecutive years without devaluating its currency during the period. Yet, although exchange rate variability was lower for European countries participating in the ERM in the nineties than in previous years, foreign investors still had to bear a risk of an abrupt misalignment or a currency attack (as for example in the UK in September of 1992, in France in early 1993, or in Spain in 1992 and 1993).

To investigate the effect of exchange rate variability risk, in columns (1)–(2) of Table 4 we augment the baseline specification with the bilateral exchange rate flexibility measure, $ER^{f}_{i,j,t}$, based on "fine" classification of Reinhart and Rogoff (2004).[23] The coefficient on the variable that reflects the bilateral flexibility of the exchange rate regime is negative and significant at the 1% confidence level.[24] This suggests that banking activities have increased significantly among pairs of countries that have adopted more rigid currency regimes. This finding fits with the evidence from the "fear" of floating" literature (eg Calvo and Reinhart (2002); Klein and Shambaugh (2008); Gelos and Wei (2005)). This research argues that in order to attract foreign capital, emerging economies are unwilling to let their currencies float; and even when monetary authorities in developing countries argue that they do not manage the currency in practice they do so (Reinhart and Rogoff (2004)). While this body of work focuses on developing economies, our panel evidence in Table 4 shows a similar pattern across developed countries.

In addition to its direct effect on integration, controlling for exchange rate flexibility also makes the coefficient on the indicator variable that equals one when the two countries are members of the euro area ($EZ2_{i,j,t}$) insignificant. While in some perturbations (reported below in Table 5) the estimate on the $EZ2$ retains significance, this is only at 10%–20%. In addition the estimate falls considerably even when it is significant. This suggests that the positive effect of the single currency mainly comes from the elimination of currency risk.

[23] Since the product of log GDP per capita enters always with a highly significant coefficient, we always include it in the specifications. The results are similar if we drop this control variable from the estimation.

[24] We also estimated models using the sum of the exchange rate grid of the two countries. The results are similar. We also used the product of the logs of the two countries' classification score. The bilateral exchange rate regime index enters always with a negative and significant estimate.

Table 4

Euro membership, exchange rate regime and banking integration

Panel fixed-effects estimates

	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
euone (*EU*1)	–0.4337	–0.3020	–0.4661	–0.3239	–0.6409	–0.4527
t-stat	(2.91)	(2.50)	(3.27)	(2.75)	(4.46)	(3.84)
euboth (*EU*2)	–0.0684	0.1242	–0.0882	0.1001	–0.0733	0.1249
t-stat	(0.53)	(1.23)	(0.70)	(1.02)	(0.57)	(1.23)
euroone (*EZ*1)	–0.8097	–0.5265	–0.4089	–0.2596	–0.2799	–0.1480
t-stat	(4.42)	(3.31)	(2.64)	(1.79)	(1.82)	(1.02)
euroboth (*EZ*2)	–0.1504	–0.0104	0.2426	0.2503	0.3256	0.3125
t-stat	(1.04)	(0.08)	(1.71)	(2.27)	(2.59)	(3.18)
Exchange Rate (*ER*)	–0.2828	–0.2007				
t-stat	(4.52)	(3.66)				
Financial Legislation (*HARMON*)			0.1075	0.0951		
t-stat			(2.90)	(2.95)		
Trade (*TRADE*)					0.2618	0.1878
t -stat					(3.75)	(3.09)
Real pc GDP	3.1393	2.1783	3.0307	2.0914	3.7237	2.6419
t-stat	(8.72)	(8.36)	(7.92)	(7.55)	(11.57)	(10.77)
Observations	5566	5566	5566	5566	4882	4882
Within *R*-squared	0.606	0.618	0.599	0.616	0.668	0.653
Country-pairs	190	190	190	190	190	190

The Table reports panel fixed-effect estimates. All specifications include year fixed-effects and country-pair fixed-effects. In odd-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral assets and liabilities holdings of banks in countries i and j in year t, standardized by the sum of the two countries' population in each year (*BI*1). In even-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral gross flows in assets and liabilities of banks in countries i and j in year t, standardized by the sum of the two countries' population in each year (*BI*2). *EU*1 is an indicator variable that takes on the value of one if only one counterpart in each pair of countries is member of the EU in year t and zero otherwise. *EU*2 is an indicator variable that takes on the value one if both countries are members of the EU in year t and zero otherwise. *EZ*1 is an indicator variable that takes on the value of one if only one counterpart in each pair of countries is member of the euro area in year t and zero otherwise. *EZ*2 is an indicator variable that takes on the value one if both countries are members of the euro area in year t and zero otherwise. Real pc GDP is the log of the product of real per capita *GDP* of the two countries in year t. Exchange Rate is a bilateral time-varying measure of the flexibility of the exchange rate regime (based on the "fine" classification of Reinhart and Rogoff (2004) and Ilzetzki, Reinhart and Rogoff (2008)). Financial Legislation is a bilateral time-varying measure of legislative and regulatory harmonization policies in financial services based on the transposition of the 27 Directives Financial Services Action Plan (FSAP). *TRADE* is the log of real imports and exports as a share of the two countries GDP. The Data Appendix gives detailed variable definitions and data sources. *t*-statistics based on country-pair specific (clustered) heteroskedasticity and autocorrelation are reported in parenthesis below the coefficient estimates. The Table also reports the number of country-pairs, the number of observations, and the within *R*-squared.

Table 5

Euro membership, exchange rate regime, financial legislation harmonization policies, trade and banking integration

	Coarse Classification & FSAP 21 Directives		Fine Classification & FSAP 21 Directives		Fine Classification & FSAP 27 Directives		Coarse Classification & FSAP 27 Directives	
	*BI*1- Stocks	*BI*2- Flows	*BI*1- Stocks	*BI*2- Flows	*BI*1- Stocks	*BI*2- Flows	*BI*1- Stocks	*BI*2- Flows
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
euone (*EU*1)	–0.6098	–0.4329	–0.6100	–0.4332	–0.6055	–0.4250	–0.6057	–0.4252
t-stat	(4.24)	(3.69)	(4.24)	(3.70)	(4.22)	(3.63)	(4.22)	(3.63)
euboth (*EU*2)	–0.1279	0.0799	–0.1285	0.0788	–0.1260	0.0800	–0.1266	0.0789
t-stat	(1.05)	(0.83)	(1.05)	(0.82)	(1.03)	(0.84)	(1.04)	(0.83)
euroone (*EZ*1)	–0.5811	–0.3512	–0.5815	–0.3521	–0.4326	–0.2735	–0.4333	–0.2749
t-stat	(3.55)	(2.35)	(3.55)	(2.36)	(2.81)	(1.90)	(2.82)	(1.91)
euroboth (*EZ*2)	0.0377	0.1153	0.0373	0.1143	0.1869	0.1964	0.1861	0.1949
t-stat	(0.27)	(0.97)	(0.26)	(0.97)	(1.51)	(2.06)	(1.51)	(2.04)
Exchange Rate (*ER*)	–0.1222	–0.0744	–0.1220	–0.0740	–0.1311	–0.1034	–0.1310	–0.1031
t-stat	(2.15)	(1.40)	(2.15)	(1.40)	(2.29)	(1.92)	(2.29)	(1.92)
Financial Legislation (*HARMON*)	0.0829	0.0743	0.0852	0.0775	0.0832	0.0728	0.0856	0.076
t-stat	(2.44)	(2.47)	(2.44)	(2.50)	(2.49)	(2.45)	(2.49)	(2.49)
Trade (*TRADE*)	0.2451	0.1736	0.245	0.1733	0.2441	0.1726	0.244	0.1723
t -stat	(3.48)	(2.84)	(3.48)	(2.84)	(3.48)	(2.83)	(3.47)	(2.82)
Real pc GDP	3.7212	2.637	3.7198	2.6354	3.7105	2.6317	3.7092	2.6303
t-stat	(11.67)	(10.98)	(11.67)	(10.98)	(11.61)	(10.98)	(11.61)	(10.98)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4882	4882	4882	4882	4882	4882	4882	4882
Within R-squared	0.672	0.656	0.672	0.656	0.672	0.657	0.672	0.657
Country-pairs	190	190	190	190	190	190	190	190

The Table reports panel fixed-effect estimates. All specifications include year fixed-effects and country-pair fixed-effects. In odd-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral assets and liabilities holdings of banks in countries *i* and *j* in year *t*, standardized by the sum of the two countries' population in each year (*BI*1). In even-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral gross flows in assets and liabilities of banks in countries *i* and *j* in year *t*, standardized by the sum of the two countries' population in each year (*BI*2). *EU*1 is an indicator variable that takes on the value of one if only one counterpart in each pair of countries is member of the EU in year *t* and zero otherwise. *EU*2 is an indicator variable that takes on the value one if both countries are members of the EU in year *t* and zero otherwise. *EZ*1 is an indicator variable that takes on the value of one if only one counterpart in each pair of countries is member of the euro area in year *t* and zero otherwise. *EZ*2 is an indicator variable that takes on the value one if both countries are members of the euro area in year *t* and zero otherwise. Real pc GDP is the log of the product of real per capita *GDP* of the two countries in year *t*. Exchange Rate is a bilateral time-varying measure of the flexibility of the exchange rate regime based on the "fine" (in columns (1)–(4)) or the coarse (in columns (5)–(8) classification of Reinhart and Rogoff (2004) and Ilzetzki, Reinhart and Rogoff (2008)). Financial Legislation is a bilateral time-varying measure of legislative and regulatory harmonization policies in financial services based on the transposition of the 27 Directives Financial Services Action Plan (in columns (1), (2), (5) and (6)) or the initial 21 Directives (in columns (3), (4), (6), and (7)). Trade denotes the log of real bilateral imports and exports as a share of the two countries' GDP. The Data Appendix gives detailed variable definitions and data sources. *t*-statistics based on country-pair specific (clustered) heteroskedasticity and autocorrelation are reported in parenthesis below the coefficient estimates. The Table also reports the number of country-pairs, the number of observations, and the within *R*-squared.

Legislative Harmonization

The euro was supported by various legislative and regulatory harmonization policies in financial services. Although some reforms occurred before 1999 (mainly with the adoption of the First and the Second Banking Directive), European banking markets remained fragmented till the eve of the monetary union (eg Hartmann et al (2003)). The main objective of the Financial Services Action Plan (FSAP) was to tackle this issue and with its various legislative acts to create a single liquid financial market.

In columns (3)–(4) of Table 4, we augment the baseline specification with our newly constructed harmonization index ($HARMON_{i,j,t}$) that sums the log number of the transposed Directives of the FSAP across the two countries (LEX) in each year. We remove (for the time) the exchange rate regime index from the set of explanatory variables, since we want to investigate the role of each channel one at a time. The coefficient on $HARMON$ is positive and significant at the 1% level. This implies that legislative and regulatory harmonization policies in financial services had a significant positive effect on cross-border banking integration. As we control for EU and euro area membership (with the four indicator variables), the significantly positive estimates on the bilateral harmonization index suggests that legislative harmonization in financial markets also had a first-order effect on cross-border banking integration that works on top of the general positive effect of the euro area membership.

Once we control for legislative-regulatory policies among the EU-members states, the coefficient on the indicator variable that equals one when both counterparts are members of the Eurozone, $EZ2$, drops compared to the unconditional estimates (in Table 3). It retains significance though (at the 10%). This suggests that while financial sector harmonization policies did boost cross-border banking activities, the effect of the euro on integration goes only partially through legislative harmonization in financial services.

The significant correlation between legislative harmonization and financial integration reveal that legal system differences may explain the lack of international diversification. The empirical literature on law and finance shows that country-level differences in investor protection can explain a sizable portion of the size of domestic financial markets (see La Porta et al (2008) for a review). Our results contribute to this body of work by showing that legal harmonization has also an effect on bilateral financial linkages and can thus explain the lack of cross-border investment (see Shleifer and Wolfenzon (2002) for a theoretical exposition). Most likely the effect of legislative harmonization policies in financial services is larger than our estimates suggest, since our index contains some measurement error. The transposition of the Directives into the domestic legal order differs to some extent across countries. Most importantly, actual enforcement of the EU legislation differs considerably across the EU (eg Djankov et al (2003, 2008)) and thus the de-facto impact of the transposition might also be different than the de-jure effect that our estimates reflect.

Trade

Are trade in goods and trade in assets complements or substitutes? While it is quite challenging to establish causation, ample studies show a strong correlation between trade and financial integration (see for example Aviat and Coeurdacier (2007)). A volumious literature also shows that the euro had a positive effect on goods trade.[25] Thus, another potential channel explaining the spur in financial integration among the euro area countries

[25] While initial (cross-sectional) studies document an (unrealistically) high effect (eg Rose (2000)), recent (panel) studies estimate that the single currency increased bilateral trade approximately by 8%–14% (eg Flam and Nordstrom (2008)).

compared to other developed economies could stem from increased trade in goods. To account for this channel, in columns (5) and (6) of Table 4, we augment the baseline specification with the average of the log of bilateral exports and imports as a share of the two countries' population ($TRADE_{i,j,t}$), using data from IMF's Direction of Trade Database.[26]

The coefficient on $TRADE_{i,j,t}$ is positive and significant, suggesting that trade in goods and bank claims go in tandem (eg Rose and Spiegel (2004) and Rose (2005)). Compared to the previous literature our results demonstrate that the strong trade-finance nexus is present even when we control for country-pair fixed-effects and global trends. Yet, trade linkages cannot explain the total impact of the euro on integration at all. The coefficient on the $EZ2$ indicator in columns (5)–(6) is quite similar to the analogous estimates in Table 3. In addition the estimate remains statistically significant at the 1% level. Thus while trade is a significant correlate of financial integration, it can not account for the large effect of monetary union documented in Table 3.

All channels

There is a possibility that each channel is proxying one another. Thus, in Table 5 we augment the specification with all three variables that capture the exchange rate channel, the legislative harmonization policies in financial markets, and trade. We also explore the sensitivity of our results by presenting results with the alternative exchange rate index (ER^C) based on the "coarse" regime classification (in columns (5)-(8)) and the harmonization index ($HARMON$) using only the initial 21 Directives of the FSAP (in columns (3), (4), (7), and (8)). As we lose 15% of our sample when we control for trade (due to some gaps on IMF's Direction of Trade Statistics), in Table 6 we report otherwise identical to Table 5 specifications, but without trade in the RHS.

The ER index that sums (the log) of the exchange rate regime index of the two countries enters with a negative coefficient in all permutations of Tables 5 and 6. The coefficient drops by 20%–50% compared to the estimates in columns (1)–(2) of Table 4, where we didn't control for legislative harmonization policies in financial services and trade. Yet the estimate is statistically significant in all but two of the sixteen specifications. Turning now to the effect of legislative harmonization policies in financial markets, the results in Tables 5 and 6 show that the FSAP had a significantly positive impact on spurring cross-border banking activities across Europe. In all specifications the harmonization index enters with a coefficient that is at least two standard errors above zero. The estimate (around 0.07–0.09) is also quite similar to the more parsimonious specifications in columns (3)–(4) of Table 4. As we control for exchange rate fluctuations, GDP differences, and trade, this result is encouraging for European policy makers, who are in the process of further promoting legislative and regulatory harmonization in financial markets. Trade continues to enter with a significantly positive elasticity. As long as the estimate is not driven exclusively by reverse causation, this suggests that besides more immediate effects, the euro could speed financial integration indirectly through goods market integration.

[26] This measure follows Calderon et al (2007). We also experiment with other measures of trade, such as the (log and the level) of average bilateral exports and imports as a share of GDP, finding similar results.

Table 6

Euro membership, exchange rate regime, financial legislation harmonization policies, and banking integration

	Coarse Classification & FSAP 21 Directives		Fine Classification & FSAP 21 Directives		Fine Classification & FSAP 27 Directives		Coarse Classification & FSAP 27 Directives	
	*BI*1-Stocks	*BI*2-Flows	*BI*1-Stocks	*BI*2-Flows	*BI*1-Stocks	*BI*2-Flows	*BI*1-Stocks	*BI*2-Flows
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
euone (*EU*1)	–0.4306	–0.2993	–0.4307	–0.2994	–0.4237	–0.2918	–0.4239	–0.2918
t-stat	(2.93)	(2.51)	(2.93)	(2.51)	(2.88)	(2.45)	(2.88)	(2.45)
euboth (*EU*2)	–0.1070	0.0882	–0.1073	0.0875	–0.1054	0.0879	–0.1057	0.0871
t-stat	(0.86)	(0.91)	(0.87)	(0.90)	(0.85)	(0.91)	(0.86)	(0.91)
euroone (*EZ*1)	–0.8603	–0.5716	–0.8606	–0.5725	–0.5384	–0.3579	–0.5388	–0.3592
t-stat	(4.71)	(3.57)	(4.71)	(3.58)	(3.36)	(2.43)	(3.36)	(2.44)
euroboth (*EZ*2)	–0.2043	–0.0599	–0.2046	–0.0609	0.1204	0.1571	0.1201	0.1558
t-stat	(1.40)	(0.47)	(1.40)	(0.48)	(0.95)	(1.55)	(0.95)	(1.54)
Exchange Rate (*ER*)	–0.2662	–0.1849	–0.2662	–0.1847	–0.2964	–0.2265	–0.2966	–0.2264
t-stat	(4.22)	(3.36)	(4.22)	(3.36)	(4.60)	(4.01)	(4.60)	(4.01)
Financial Legislation (*HARMON*)	0.0854	0.0792	0.087	0.0819	0.0847	0.0774	0.0865	0.0802
t-stat	(2.36)	(2.51)	(2.34)	(2.52)	(2.39)	(2.49)	(2.38)	(2.51)
Real pc GDP	3.1029	2.1445	3.1016	2.1428	3.0896	2.138	3.0883	2.1364
t-stat	(8.55)	(8.20)	(8.54)	(8.20)	(8.56)	(8.25)	(8.55)	(8.24)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5566	5566	5566	5566	5566	5566	5566	5566
Within *R*-squared	0.608	0.620	0.608	0.620	0.610	0.622	0.610	0.622
Country-pairs	190	190	190	190	190	190	190	190

The Table reports panel fixed-effect estimates. All specifications include year fixed-effects and country-pair fixed-effects. For details on the specification, see the notes of Table 5. Table 6 reports otherwise identical to Table 5 specifications but without trade in the set of explanatory variables. The Data Appendix gives detailed variable definitions and data sources. *t*-statistics based on country-pair specific (clustered) heteroskedasticity and autocorrelation are reported in parenthesis below the coefficient estimates.

To get an estimate of the relative importance of the three channels we also estimated standardized beta coefficients. The average value of the beta coefficient for the bilateral exchange rate index in Table 5 is –0.06. This implies that a one standard deviation fall in *ER* that makes the exchange rate regime more rigid is associated with a 0.06 increase in the dependent variable. The average value of the standardized coefficient for the bilateral harmonization index (*HARMON*) is somewhat larger, 0.075, while trade's beta coefficient is on average 0.14.

In almost all perturbations in Tables 5 and 6 the coefficient on EZ2 turns insignificant. Even in the specifications that the estimate retains significance, this is borderline and the coefficient drops considerably compared to the unconditional estimates in Table 3. Combined with the results in Table 4, the elimination of exchange rate risk seems to be the most important channel. Yet, legislative harmonization policies in financial services have also

crucially contributed to the spur of cross-border financial linkages across the EU in the past decade. In contrast goods trade, while a highly significant correlate of banking integration (with the largest "standardized" coefficient), is not behind the large unconditional effect of the single currency documented in Table 3.[27]

Sensitivity Analysis

We explored extensively the sensitivity of our results. As already shown in Table 3 we estimated the specifications only in the 1990s and the 2000s to account for potentially different dynamics in the two sub-periods. Moreover, as the results in Tables 5 and 6 show our results are not sensitive to different ways measuring the nature of the exchange rate regime or the legislative harmonization policies of the FSAP.

In Table 7 we check whether the results are driven by Luxemburg and Switzerland, the two countries with the largest share of foreign bank and liabilities in our sample.[28] Columns (1)–(4) report simple specifications (analogous to the models in Table 3) that estimate the total effect of the single currency on banking integration. The coefficient on the indicator variable that takes on the value one when both countries are members of the euro area retains its economic and statistical significance. The most conservative estimate in column (4) implies that following the adoption of the euro cross-border banking activities by approximately 50%, compared to the general increase in the other industrial economies (exp(0.402) = 1.49). Yet once we control for the nature of the exchange rate regime and legislative harmonization (in (5)–(6)) the estimate on $EZ2$ turns insignificant as in our previously reported results; and although trade in goods is correlated with banking activities (column (7)–(8)), this cannot account for the effect of single currency on financial integration.

In Table 8 we control for structural features of the domestic banking system in countries i and j. This is a necessary robustness check as there is concern that the implementation of the FSAP directives was driven by local conditions in the banking system.[29] We do so using three time-varying proxies of bank's health and profitability from the latest update of World Bank's Financial Structure Database (Beck, Demirgüç-Kunt, and Levine (2000)). In columns (1)–(2) we control for banks' overhead costs, while in (3)–(4) we control for banks' profitability using the average value of banks' net interest revenue as a share of total assets (the Data Appendix gives detailed variable definitions). Both measures of banking performance enter with insignificant estimates. In (5)–(6) we control for competition in the banking system with a concentration index that equals the share of the assets of three largest banks as a share of assets of all commercial banks. The coefficient is indistinguishable from zero. More importantly, controlling for structural features of the banking system has no effect on our main results. Cross-border banking activities increase significantly when countries adopt more rigid exchange rate arrangements (such as joining the euro). Moreover, international financial linkages are stronger among countries with more similar legal and regulatory rules in financial services.

---

[27] This is not to say that other policies and reforms did not have any effect. The EMU project included many policies that is hard-to-precisely pin down and measure. See Kalemli-Ozcan et al (2010) for a detailed summary of the technical and infrastructure steps that the EU bodies have taken to homogenize the various market segments for financial services.

[28] The results are similar if we exclude only Luxemburg or only Switzerland or if we also drop the United Kingdom.

[29] We thank an anonymous referee for pointing out this possibility.

Table 7

Euro membership, exchange rate regime, legislation harmonization policies in financial services, trade and banking integration

Excluding Luxemburg and Switzerland

	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
euone (*EU*1)	–0.6620	–0.4804	–0.5571	–0.4007	–0.5009	–0.3592	–0.5725	–0.4030
t-stat	(3.81)	(3.46)	(3.47)	(3.12)	(3.12)	(2.83)	(3.60)	(3.17)
euboth (*EU*2)	–0.0122	0.1535	0.0335	0.1841	–0.0542	0.1117	–0.1177	0.0704
t-stat	(0.08)	(1.32)	(0.28)	(1.95)	(0.49)	(1.29)	(0.96)	(0.72)
euroone (*EZ*1)	0.0458	0.1580	–0.2300	–0.0379	–0.7252	–0.3977	–0.5873	–0.2977
t-stat	(0.24)	(1.02)	(1.43)	(0.27)	(4.02)	(2.52)	(3.40)	(1.93)
euroboth (*EZ*2)	0.6737	0.5881	0.4113	0.4020	–0.0828	0.0378	0.0021	0.0665
t-stat	(3.41)	(4.19)	(3.24)	(4.06)	(0.59)	(0.33)	(0.01)	(0.57)
Exchange Rate (*ER*)					–0.2114	–0.1455	–0.1511	–0.1043
t-stat					(3.52)	(2.70)	(2.59)	(1.94)
Financial Legislation (*HARMON*)					0.1445	0.1261	0.1314	0.1135
t-stat					(3.77)	(3.72)	(3.46)	(3.39)
Trade (*TRADE*)							0.2657	0.2104
t -stat							(3.64)	(3.20)
Real pc GDP			4.3749	3.091	4.3889	3.103	4.0317	2.8181
t-stat			(13.06)	(12.43)	(13.72)	(13.32)	(12.11)	(11.26)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4482	4482	4482	4482	4482	4482	4159	4160
Within R-squared	0.515	0.588	0.665	0.666	0.677	0.673	0.688	0.673
Country-pairs	153	153	153	153	153	153	153	153

The Table reports panel fixed-effect estimates. All specifications include year fixed-effects and country-pair fixed-effects. In odd-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral assets and liabilities holdings of banks in countries *i* and *j* in year *t*, standardized by the sum of the two countries' population in each year (*BI*1). In even-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral gross flows in assets and liabilities of banks in countries *i* and *j* in year *t*, standardized by the sum of the two countries' population in each year (*BI*2). *EU*1 is an indicator variable that takes on the value of one if only one counterpart in each pair of countries is member of the EU in year *t* and zero otherwise. *EU*2 is an indicator variable that takes on the value one if both countries are members of the EU in year *t* and zero otherwise. *EZ*1 is an indicator variable that takes on the value of one if only one counterpart in each pair of countries is member of the euro area in year *t* and zero otherwise. *EZ*2 is an indicator variable that takes on the value one if both countries are members of the euro area in year *t* and zero otherwise. Real pc GDP is the log of the product of real per capita *GDP* of the two countries in year *t*. Exchange Rate is a bilateral time-varying measure of the flexibility of the exchange rate regime based on the "fine" classification of Reinhart and Rogoff (2004) and Ilzetzki, Reinhart and Rogoff (2008)). Financial Legislation is a bilateral time-varying measure of legislative and regulatory harmonization policies in financial services based on the transposition of the 27 Directives Financial Services Action Plan. Trade denotes the log of real bilateral imports and exports as a share of the two countries' GDP. The Data Appendix gives detailed variable definitions and data sources. *t*-statistics based on country-pair specific (clustered) heteroskedasticity and autocorrelation are reported in parenthesis below the coefficient estimates. The Table also reports the number of country-pairs, the number of observations, and the within *R*-squared.

Table 8

Euro membership, exchange rate regime, and banking integration controlling for structural characteristics of the banking system

Banking characteristics	Bank overhead costs		Bank interest margin		Bank concentration	
	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**	***BI*1-Stocks**	***BI*2-Flows**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
euone (*EU*1)	–0.4600	–0.4937	–0.4471	–0.4775	–0.4558	–0.4878
t-stat	(2.74)	(3.29)	(2.71)	(3.19)	(2.77)	(3.30)
euboth (*EU*2)	–0.1843	–0.0387	–0.1661	–0.0289	–0.1791	–0.0408
t-stat	(1.49)	(0.39)	(1.37)	(0.29)	(1.48)	(0.41)
euroone (*EZ*1)	–0.7188	–0.4360	–0.6746	–0.4172	–0.6869	–0.4225
t-stat	(4.55)	(3.17)	(4.32)	(3.02)	(4.36)	(3.05)
euroboth (*EZ*2)	–0.1193	0.0519	–0.0883	0.0626	–0.1045	0.0526
t-stat	(0.90)	(0.49)	(0.66)	(0.58)	(0.79)	(0.48)
Exchange Rate (*ER*)	–0.2781	–0.1659	–0.2592	–0.1581	–0.2626	–0.1602
t-stat	(4.63)	(2.97)	(4.35)	(2.81)	(4.43)	(2.88)
Financial Legislation (*HARMON*)	0.0657	0.0477	0.0677	0.0493	0.0781	0.0575
t-stat	(2.34)	(1.81)	(2.43)	(1.91)	(2.93)	(2.32)
Trade (*TRADE*)	0.043	0.0395	0.0335	0.034	0.0334	0.0338
t -stat	(0.75)	(0.79)	(0.59)	(0.68)	(0.58)	(0.68)
Real pc GDP	2.6301	1.8637	2.3856	1.6479	2.3608	1.6352
t-stat	(6.98)	(6.11)	(6.20)	(5.25)	(6.11)	(5.27)
Banking Characteristic Country *i*	–0.089	0.0778	0.9594	–0.289	4.6699	4.4691
t-stat	(0.59)	(0.51)	(1.02)	(0.25)	(1.24)	(1.19)
Banking Characteristic Country *j*	0.0775	0.0866	1.6263	0.5172	–0.4615	–1.5221
t-stat	(0.54)	(0.68)	(0.74)	(0.28)	(0.17)	(0.55)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2958	2959	2942	2943	2942	2943
Within *R*-squared	0.4592	0.4320	0.4359	0.4164	0.4364	0.4176
Country-pairs	190	190	190	190	190	190

The Table reports panel fixed-effect estimates. All specifications include year fixed-effects and country-pair fixed-effects. In odd-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral assets and liabilities holdings of banks in countries *i* and *j* in year *t*, standardized by the sum of the two countries' population in each year (*BI*1). In even-numbered columns, the dependent variable (banking integration) is the average of the log of real bilateral gross flows in assets and liabilities of banks in countries *i* and *j* in year *t*, standardized by the sum of the two countries' population in each year (*BI*2). *EU*1 is an indicator variable that takes on the value of one if only one counterpart in each pair of countries is member of the EU in year *t* and zero otherwise. *EU*2 is an indicator variable that takes on the value one if both countries are members of the EU in year *t* and zero otherwise. *EZ*1is an indicator variable that takes on the value of one if only one counterpart in each pair of countries is member of the euro area in year t and zero otherwise. *EZ*2 is an indicator variable that takes on the value one if both countries are members of the euro area in year *t* and zero otherwise. GDP is the log of the product of real per capita GDP of the two countries in year *t*. Exchange Rate is a bilateral time-varying measure of the flexibility of the exchange rate regime (based on the "fine" classification of Reinhart and Rogoff (2004) and Ilzetzki, Reinhart and Rogoff (2008)). Financial Legislation is a bilateral time-varying measure of legislative and regulatory harmonization policies in financial services based on the transposition of the 27 Directives Financial Services Action Plan (FSAP). Trade is the log of real imports and exports as a share of the two countries' GDP. The Data Appendix gives detailed variable definitions and data sources. *t*-statistics based on country-pair specific (clustered) heteroskedasticity and autocorrelation are reported in parenthesis below the coefficient estimates. The Table also reports the number of country-pairs, the number of observations, and the within *R*-squared. In all specifications we control for time-varying structural features of the banking system in country *i* and country *j*. In columns (1)–(2) we control for banks net interest margin. In columns (3)-(4) we control for banks' overhead costs, while in columns (5)–(6) we control for a measure of banks' competition. All variables come from World Bank's Financial Structure Database (Beck, Demirgüç-Kunt and Levine (2000)). As these variables become available after the late 1980s, all specifications in Table 8 are estimated in the period 1990-2007.

We have performed many other sensitivity checks: First, to partly account for reverse causation we have run regressions using lagged values of all explanatory variables (see Appendix Table A). We have also estimated 2SLS specifications using lagged trade as an instrument for contemporaneous trade (see Appendix Table B). The results are quite robust and the estimates unaffected. Second, we have also analyzed assets and liabilities separately, as there is always a possibility that the euro might have affected them differently. The regressions (reported on Appendix Table C) show similar patterns. Third, we also controlled for a bilateral measure of nominal exchange rate volatility (following Devereux and Lane (2003)). Again all our results are robust to the inclusion of this control, which (as in and Lane (2006a)) appears with an insignificant coefficient (Appendix Table D). The insignificant effect of nominal exchange rate volatility suggests that foreign banks were particularly concerned with currency risk rather than with (relatively small) swings in the exchange rate. Finally, although the universal banking structure in Europe (see Allen et al (2004)) implies that all the FSAP directives are relevant for banks, we also specified a banking legislative harmonization measure that only reflects the Directives that are relatively more relevant to banking (ie excluding those ones which are relatively more important for security and insurance markets) finding similar results (Appendix Table E).[30]

4. Conclusion

The introduction of the euro has been one of the most important policy experiments in international economics over the past decades. The initial focus of the literature was to investigate the effect of the euro on trade integration. Following the development of new datasets on cross-border investment, recent studies examine the euro's impact on financial integration, documenting a large effect. Yet, we still do not know the exact mechanism through which the euro affects financial integration. This is the main task we undertook in this paper.

We construct a new dataset of legislative-regulatory harmonization policies in financial intermediation across the European Union in the last decade and then merge it with the confidential version of BIS's Locational Banking Statistics that records bilateral financial linkages among twenty industrial countries in the past thirty years. The rich panel structure allows us to reassess the euro's impact on financial integration accounting for all time-invariant country-pair factors, such as trust, culture, and information frictions.

First, our "within" before-after analysis shows that while the total effect of the euro on financial integration is highly significant, it is quantitatively much smaller from what has been reported in the previous studies that relied on cross-sectional approaches and data covering the last decade.

Second, our "channels" analysis shows that the euro's impact is primarily driven by the elimination of currency risk across member countries. We also document that legislative-regulatory harmonization policies in financial markets have contributed significantly to the spur of cross-border lending and investment across Europe; these integration reforms therefore explain a sizable portion of the aggregate effect of the euro. In contrast, while goods trade is a significant correlate of cross-border lending, it can not explain the euro's large impact on financial integration.

[30] In particular, in Appendix Table E we use the directives numbered 2, 5, 8, 14, 19, 26 and 27 of Table 1. This follows the recent Commission study on the evaluation of the FSAP by Malcolm, Tilden and Wilsdon (2009)). We are grateful to Ana Margarida Monteiro, and the other experts of the ECB Financial Law department for clarifying these issues.

Our results have some straightforward policy implications. The fact that legislative-regulatory harmonization policies have a direct effect on financial integration on top of all the other channels and country/time factors is quite encouraging for European policy makers, who are currently in the process of promoting further harmonization. Future research should investigate the effect of such reforms on other aspects of integration, such as cross-border M&A activity, vertical and horizontal FDI, outsourcing, return co-movement, and risk-taking by banks.

5. Data appendix

Banking Integration 1 [$BI1$]: Banking integration index based on bilateral cross-border holdings (stocks) of banks. Data on bank's cross-border bilateral stocks of assets and liabilities come from the confidential version of BIS's Locational Banking Statistics. For each country-pair and year there are up to four observations. i) asset holdings (stocks) of banks located in country i in all sectors of the economy in country j; ii) asset holdings (stocks) of banks located in country j in all sectors of the economy in country i; iii) liabilities (stocks) of banks located in country i to country j. iv) liabilities (stocks) of banks located in country i to country i. The data is originally expressed in current US dollars. First, we deflate the four series with the US deflator. Second, we standardize the series by dividing asset and liabilities with the sum of the two countries population in each year (using data from World Bank's World Development Indicators Database). Third, we take the average of the log value of real bilateral assets and liabilities in each year. *Source: Bank of International Settlements, Locational Banking Statistics (2008).*

Banking Integration 2 [$BI2$]: Banking integration index based on bilateral cross-border gross flows of banks. Data on bank's cross-border bilateral gross flows of assets and liabilities come from the BIS Locational Banking Statistics. For each country-pair and year there are up to four observations. i) asset flows of banks located in country i in all sectors of the economy in country j; ii) asset flows of banks located in country j in all sectors of the economy in country i; iii) liability flows of banks located in country i to country j. iv) liability flows of banks located in country j to country i. The data is originally expressed in current US dollars. First we deflate the four series with the US deflator. Second we take the absolute value of (net) flows. Third, we standardize the series, by dividing asset and liability flows with the sum of the two countries population in each year (using data from World Bank's World Development Indicators Database). Fourth, we take the average of the log value of real bilateral gross flows in assets and liabilities in each year. *Source: Bank of International Settlements, Locational Banking Statistics (2008)*.

Euro Area Both [$EZ2$]: Bilateral index of membership in the euro area. The measure is an indicator variable that takes on the value one if both countries are members of the euro-zone in year t and zero otherwise. *Source: European Central Bank*.

Euro Area One [$EZ1$]: Bilateral index of membership in the euro area. The measure is an indicator variable that takes on the value one if only one country is member of the euro-zone in year t and zero otherwise. *Source: European Central Bank*.

European Union Both [$EU2$]: Bilateral index of membership in the EU. The measure is an indicator variable that takes on the value one if both countries are members of the EU in year t and zero otherwise. *Source: EU Commission*.

European Union One [$EU1$]: Bilateral index of membership in the EU. The measure is an indicator variable that takes on the value one if only one country is member of the EU in year

t and zero otherwise. Source: EU Commission.

Exchange Rate Flexibility [ER]: Bilateral index of the flexibility of the exchange rate, based either on the "fine" or "coarse" regime classification of Reinhart and Rogoff (2004). In the "fine" classification the country-specific index ranges from 1 to 14 where lower values suggest a more rigid regime, whereas in the "coarse" classification the index ranges from 1 to 5. We construct the bilateral index by taking the sum of the log classification of countries i and j in the beginning (January) of each year t ($ER_{i,j,t} = \ln(ER_{i,t}) + \ln(ER_{j,t})$). *Source: Ilzetzki, Reinhart, and Rogoff (2008) and Reinhart and Rogoff (2004)*.

Nominal Exchange Rate Volatility [$ERVOL$]: Standard deviation of the log first difference of the monthly bilateral exchange rate for each year over the period 1978–2007. $VOLER_{i,j} = STDEV_t[\Delta\ln(e_{i,j,m})]$ where $e_{i,j,m}$ is the monthly nominal exchange rate between countries i and j. The index follows Devereux and Lane (2003). *Source: ECB*.

Legislative Harmonization in Financial Services [$HARMON$]: Index of regulatory-legislative harmonization in financial services based on the transposition of the Directives of the Financial Services Action Plan (FSAP). The FSAP was launched in 1998 and included 27 EU-wide legislative acts (the Directives) that require from member countries to transpose in due time to the domestic legal order. Until the official completion of the plan in the end of 2003, the EU legislative bodies (the Commission and the Council) had initiated 21 of these laws. The remaining 6 Directives were initiated before the end of our sample and thus we include them in our analysis. However, Directives do not become immediately enforceable across the EU. EU member states have considerable discretion in the transposition (adoption) of these acts. We construct the bilateral harmonization index in three steps. First, for each country we define 27/21 indicator variables that equal one starting at the year of the transposition of each Directive into national law and zero otherwise. Second, we create a country-time varying legislation measure ranging from 0 to 27/21 by summing the values of the 27/21 indicator variables for each country ($LEX_{i,t}$). Third, we take the sum of the log value of the legislation measure for each country in each year (ie $HARMON_{i,j,t} \equiv \ln(1 + LEX_{i,t}) + \ln(1 + LEX_{j,t})$). The data is retrieved from the EU Commission's league tables (http://ec.europa.eu/internal_market/finances/index_en.htm). The Commission also provides links to the national legislative acts of the EU15 member countries. We were thus able to track down the exact timing of national legislative acts that transposed the Directives. *Source: EU Commission League Tables*.

Banking Legislative Harmonization in Financial Services [$BANK\_HARMON$]: The index of legislative harmonization policies in banking is based on the Directives of the Financial Services Action Plan (FSAP). Using the classification of the Directives into banking, insurance, and capital markets (from Malcolm, Tilden, and Wilsdon (2009)) we construct this measure similar to the $HARMON$ index, but we use information only on the seven Directives that were more relevant for banking activities. These Directives are numbered 2, 5, 8, 14, 19, 26 and 27 in Tables 1 and 2. See also Appendix Table 1. *Source: EU Commission League Tables*.

Trade [$TRADE$]: Index of bilateral trade intensity/integration. The measure is the log of bilateral real (deflated with the US price deflator) exports and imports as a share of two country's GDP. This measure follows Calderon et al (2007). *Source: IMF's Direction of Trade Database (2008)*.

Real Per Capita GDP [GDP]: Index of the economic importance of the two countries. The measure is the log of the product of real per capita GDP of the two countries in each year. *Source: World Bank's World Development Indicators Database (2008)*.

Bank Net Interest Margin [$MARGIN$]: Accounting value of bank's net interest revenue as a share of its interest-bearing (total earning) assets. *Source: Financial Structure Database, Beck, Demirgüç-Kunt and Levine (2000). Original Source: Fitch's BankScope Database*.

Bank Overhead Costs [OVERHEAD]: Accounting value of a bank's overhead costs as a share of its total assets. *Source: Financial Structure Database, Beck, Demirgüç-Kunt and Levine (2000). Original Source: Fitch's BankScope Database*.

Bank Concentration Index [CONCENTRATION]: Assets of three largest banks as a share of assets of all commercial banks. *Source: Financial Structure Database, Beck, Demirgüç-Kunt and Levine (2000). Original Source: Fitch's BankScope Database*.

References

Alfaro, L, Kalemli-Ozcan, S and Volosovych, V (2008), "Why Doesn't Capital Flow from Rich to Poor Countries? An Empirical Investigation." Review of Economics and Statistics, 90(2): pp 347–368.

Allen, F, Chui, M and Maddaloni, A (2004), "Financial Systems in Europe, the USA and Asia," Oxford Review of Economic Policy, 20(4): pp 490–508.

Aviat, A and Coeurdacier, N (2007), "The Geography of Trade in Goods and Assets", Journal of International Economics, 71 (1): pp 22–51.

Baldwin, R A (2006), "The Euro's Trade Effects", ECB Working Paper Series No 594.

Bank of International Settlements, Monetary and Economic Department (2003a), "Guide to International Financial Statistics", BIS (Basel, Switzerland) Papers No 14, February.

——— (2003b), "Guide to International Banking Statistics", BIS Papers No 16, April.

Bertrand, M, Duflo, E and Mullainathan, S (2004), "How Much Should We Trust Difference in Differences Estimates?" Quarterly Journal of Economics, 119 (1): pp 249–275.

Blank, S and Buch, C (2007), "The Euro and Cross-Border Banking: Evidence from Bilateral Data" Comparative Economic Studies, 49 (2): pp 389–410.

Buch, C (2003), "Information or Regulation: What Drives the International Activities of Commercial Banks?" Journal of Money, Credit, and Banking, 35 (6): pp 851–869.

Buch, C, Driscoll, J and Ostergaard, C (2009), "Cross-Border Diversification in Bank Asset Portfolios." unpublished manuscript.

Calderon, C, Chong, A and Stein, E (2007), "Trade Intensity and Business Cycle Synchronization: Are Developing Countries Any Different?," Journal of International Economics, 71 (1): pp 2–21.

Calvo G and Reinhart, C (2002), "Fear of Floating", Quarterly Journal of Economics, 117 (2): pp 379–408.

Coeurdacier, N and Martin, P (2009), "The Geography of Asset Trade and the Euro: Insiders and Outsiders", Journal of the Japanese and International Economies, 23 (2): pp 90–113.

De Santis, R and Gerard, B (2006), "Financial Integration, International Portfolio Choice and the European Monetary Union", ECB Working Paper No 626.

Devereux, M and Lane, P (2003), "Understanding Bilateral Exchange Rate Volatility," Journal of International Economics 60(1): pp 109–132.

Djankov, S, La Porta, R, Lopez-de-Silanes, F and Shleifer, A (2003), "Courts," Quarterly Journal of Economics, 118(2): pp 453–517.

——— (2008), "The Law and Economics of Self-dealing," Journal of Financial Economics, 88 (3): pp 430–465.

Ekinci M, Kalemli-Ozcan, S and Srensen, B (2008), "Financial Integration within EU Countries: The Role of Institutions, Confidence and Trust", NBER Working Paper 13440.

Flam, H and Nordström, H (2006), "Euro Effects on the Intensive and Extensive Margins of Trade", IIES Seminar Paper No 750. revised version available at: http://www-2.iies.su.se/flamh/.

Forum on Cross-Border Financial Groups. (2009), "Cross-Border Banking in Europe: What Regulation and Supervision?" Unicredit Group Discussion Paper. available at: http://www.unicreditgroup.eu/.

Gelos, G R and Wei, S-J (2005), "Transparency and International Investor Behavior." Journal of Finance, 60 (6): pp 2987–3020.

Gertler, M and Rogoff, K (1990), "North-South Lending and Endogenous Capital Market Inefficiencies." Journal of Monetary Economics, 26 (2): pp 245–266.

Giannetti, M and Yafeh, Y (2008), "Do Cultural Differences Between Contracting Parties Matter? Evidence from Syndicated Bank Loans", ECGI Finance Working Paper No. 224/2008.

Guiso, L, Sapienza, P and Zingales, L (2009), "Cultural Biases in Economic Exchange?", Quarterly Journal of Economics, 124 (3): pp 1095–1131.

Hale, G and Spiegel, M (2009), "Who Drove the Boom in Euro Denominated Bond Issues?" Federal Reserve Bank of San Francisco Working Paper Working Paper 2008–20.

Hartmann, P, Maddaloni, A and Manganelli, S (2003), "The Euro-Area Financial System: Structure, Integration and Policy Initiatives", Oxford Review of Economic Policy, 19(1): pp 280–313.

Ilzetzki E, Reinhart, C M and Rogoff, K S (2008), "Exchange Rate Arrangements Entering the 21st Century: Which Anchor Will Hold?", Mimeo. data available at: http://www.economics.harvard.edu/faculty/rogoff/Recent_Papers_Rogoff.

Kalemli-Ozcan, S, Manganelli, S, Papaioannou, E and Peydró, J–L (2010), "Financial Integration and Risk Sharing: The Role of Monetary Union", Forthcoming 2010. The Euro at Ten: 5th European Central Banking Conference, Lucrezia Reichlin, Ed., ECB.

Klein, M and Shambaugh, J (2008), "The Dynamics of Exchange Rate Regimes: Fixes, Floats, and Flips", Journal of International Economics, 75 (1): pp 70–92.

La Porta, R, Lopez-de-Silanes, F, Shleifer, A and Vishny, R (1997), "Legal Determinants of External Finance", Journal of Finance, 52 (3): pp 1131–1150.

——— (1998), "Law and Finance", Journal of Political Economy, 106 (6): pp 1113–1155.

La Porta, R, Lopez-de-Silanes, F, and Shleifer, A (2008), "The Economic Consequences of Legal Origins", Journal of Economic Literature, 46 (2): pp 285–332.

Lane, P R (2006a), "Global Bond Portfolios and EMU", International Journal of Central Banking, 2 (1): 1-23.

——— (2006b), "The Real Effects of European Monetary Union", Journal of Economic Perspectives, 20 (1): pp 47–66.

——— (2009), "EMU and Financial Integration", Forthcoming 2010 in The Euro at Ten: 5th European Central Banking Conference, Lucrezia Reichlin, Ed., ECB.

Lane, P and Milesi-Ferretti, G M (2008), "International Investment Patterns," Review of Economics and Statistics, 90 (3): pp 538–549.

Malcolm, K, M Tilden and T Wilsdon. (2009), "Evaluation of the Economic Impacts of the Financial Services Action Plan," CRA International report prepared for the European Commission, Internal Market and Services DG.

Martin, P and Rey H (2004), "Financial Supermarkets: Size Matters for Asset Trade", Journal of International Economics, 64 (2): pp 335–361.

Mian, A (2006), “Distance Constraints: The Limits of Foreign Lending in Poor Economies”, Journal of Finance, 61 (6): pp 1465–1505.

Mundell, R (1961), “A Theory of Optimum Currency Areas”, American Economic Review, 51 (4): pp 509–517.

Obstfeld, M and Rogoff, K (2000), “The Six Major Puzzles in International Economics: Is there a Common Cause?”, in NBER Macroeconomics Annual 2000, University of Chicago Press, Chicago, ILL.

Papaioannou, E (2009), “What Drives International Financial Flows? Politics, Institutions and Other Determinants,” Journal of Development Economics, 88 (2): pp 269–281.

Papaioannou, E and Portes, R (2009), “Costs and Benefits of Running an International Currency”, European Commission, DG-EC/FIN, Special Report on the European Economy, forthcoming.

——— (2010), “The International Role of the Euro: A Status Report”, Forthcoming 2010 in EMU@10 (Eds. M Buti, S Deroose, and V Gaspar), European Commission, DG-EC/FIN, European Economy Economic Papers, 317.

Portes, R and Rey, H (2005), “The Determinants of Cross-Border Equity Flows”, Journal of International Economics, 65(2): pp 269–296.

Portes, R, Rey, H and Oh, Y (2001), “Information and Capital Flows: The Determinants of Transactions in Financial Assets”, European Economic Review (Papers and Proceedings), 45 (4-6): pp 783–796.

Reinhart, C and Rogoff, K (2004), “The Modern History of Exchange Rate Arrangements: A Reinterpretation”, Quarterly Journal of Economics, 119 (1): pp 1–48.

Rose, A (2000), “One Market, One Money: Estimating the Effect of Common Currencies on Trade”, Economic Policy, 30 (1): pp 7–45.

——— (2005), “One Reason Countries Pay their Debts: Renegotiation and International Trade,” Journal of Development Economics, 77 (1): pp 189–206.

——— (2009), “Is EMU Becoming an Optimum Currency Area? The Evidence on Trade and Business Cycle Synchronization,” Forthcoming 2010 in The Euro at Ten: 5th European Central Banking Conference, Lucrezia Reichlin, Ed., ECB.

Rose, A and Spiegel, M (2004), “A Gravity Model of Sovereign Lending: Trade, Default, and Credit”, IMF Staff Papers, 51 (1): pp 50–63.

Shleifer, A and Wolfenzon, D (2003), “Investor Protection and Equity Markets.” Journal of Financial Economics, 66 (1): pp 3–27.

Shleifer, A and Vishny, R (1997), “A Survey of Corporate Governance,” Journal of Finance, 52 (2): pp 737–783.

Spiegel, M (2009a), “Monetary and Financial Integration: Evidence from the EMU”, Journal of the Japanese and International Economies, 23 (2): pp 114–130.

——— (2009b), “Monetary and Financial Integration in the EMU: Push or Pull?,” Review of International Economics, 17 (4): pp 751–776.

Wei, S-J (2000), “How Taxing is Corruption on International Investors?”, Review of Economics and Statistics, February 82 (1): pp 1–11.

Wooldridge, P D (2002), “Uses of the BIS Statistics: An Introduction”, BIS (Basel, Switzerland), Quarterly Review, March.

The geographical composition of national external balance sheets: 1980–2005[1]

Chris Kubelec and Filipa Sá[2]

Abstract

This paper constructs a dataset on stocks of bilateral external assets and liabilities for a group of 18 countries, including developed and emerging economies. The data covers the years 1980 to 2005 and distinguishes between four asset classes: FDI, portfolio equity, debt, and foreign exchange reserves. A number of stylized facts emerge from the data. There has been a remarkable increase in interconnectivity over the past two decades. Financial links have become larger and more frequent and countries have become more open. The distribution of financial links is asymmetric and has a long-tail, with a small number of nodes having many and large links. In addition, the network exhibits 'small-world' properties, such as high clustering and low average path length. The combination of high interconnectivity, long-tails, and 'small-world' properties makes for a robust-yet-fragile system, in which disturbances to the key hubs would be rapidly and widely transmitted. The global financial network is centred around the United States and the United Kingdom, which have large links and are connected to most other countries. This contrasts with the global trade network, which is arranged in three clusters: an European cluster (centred on Germany), an Asian cluster (centred on China), and an American cluster (centred on the United States).

JEL Classification: F2, F3

Keywords: international investment, financial liberalization

1. Introduction

Financial globalization is one of the most striking phenomena happening in the world economy in the last two decades. Until recently, very little was known about the size and composition of countries' external financial assets and liabilities. This gap was partly narrowed by the work of Lane and Milesi-Ferretti (2001, 2007), which provides estimates of the total external financial assets and liabilities of 145 countries, from 1970 to 2004. This data shows that there has been a marked increase in the ratio of foreign assets and liabilities to GDP, particularly since the mid-1990s. This increase has been especially pronounced among industrial countries, where financial integration has exceeded trade integration. However, very little is known about the geographical composition of assets and liabilities. This paper contributes to a better understanding of the geographical composition of

---

[1] The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England. This draft is preliminary and incomplete. Please do not quote without the authors' permission. The authors wish to thank Philip Lane, Vasileios Madouros and Peter Sinclair for helpful discussions and Gian Maria Milesi-Ferretti and Andreas Baumann for help with data. Participants at the Bank of England joint FS-MA seminar and at the BIS CGFS workshop on the use of BIS international financial statistics also provided useful comments. Amy Varty and Richard Edghill provided excellent research assistance. This paper was finalised on 31 July 2009.

[2] Bank of England, International Finance Division. E-mail: Chris.Kubelec@bankofengland.co.uk; Bank of England, International Finance Division; IZA. Email: Filipa.Sa@bankofengland.co.uk.

countries' external positions by constructing a dataset of stocks of bilateral assets and liabilities for a group of 18 countries, covering the period from 1980 to 2005.

The data is constructed separately for four asset classes: FDI, portfolio equity, debt and foreign exchange reserves. The methodology used to construct the data is similar for the first three asset classes. For reserves we adopt a different procedure and start by constructing the currency composition, which is then translated into the geographical composition.

For FDI, equity and debt we collect data from a variety of sources. For bilateral FDI assets, we use data from the OECD International Direct Investment by Country database and from the United Nations Conference on Trade and Development (UNCTAD). Data on equity is from the IMF Coordinated Portfolio Investment Survey (CPIS). For debt, we use data from both the CPIS and the Locational Banking Statistics of the Bank for International Settlements (BIS). Data gaps are filled in using gravity models, which have been used extensively to explain bilateral trade and have more recently been applied to bilateral financial stocks and flows. Consistent with previous studies, we find these models to have very good explanatory power.

For reserves, we use the BIS Multilateral Surveillance Statistics, which contains data on the currency composition of reserves for countries in the G10. The remaining countries are covered by the IMF COFER (Currency Composition of Official Foreign Exchange Reserves) database.

This data is confidential but has been used by some authors in previous studies. For these countries we estimate the currency composition using the estimated coefficients reported in Eichengreen and Mathieson (2000), who had access to COFER.

After describing the data construction in detail, we apply a number of tools from network analysis to examine the key stylized facts that emerge from the data. The international financial system can be seen as a network, where nodes represent countries and links represent bilateral financial assets. By examining the evolution of the global financial network over time, we observe that there has been a remarkable increase in interconnectivity over the past two decades. Financial links have become larger and more frequent and countries have become more open. The distribution of financial links is highly asymmetric and has a long-tail, with a small number of nodes having many and large links. The network also exhibits some 'small-world' properties, with a small number of degrees of separation between nodes and a high clustering coefficient. The combination of high interconnectivity, long-tails, and `small-world' properties makes for a robust-yet-fragile system, where a disturbance to one of the central countries would be transmitted rapidly and widely. These features of the global financial network are discussed in Haldane (2009).

The global trade network has some of the same features as the financial network and also shows an increase in interconnectivity over time. However, there are some important differences between the trade and financial networks. While the financial network is centred around the United States and the United Kingdom, which have large links and are connected to most other countries, the trade network shows strong intra-continental links and is arranged in three clusters: a European cluster (centred on Germany), an Asian cluster (centred on China), and an American cluster (centred on the United States).

2. Data construction

2.1 Country selection and treatment of financial centres

The data is constructed at annual frequency and includes 18 countries, listed in Table 1. The sample was selected to include countries located in different continents and include both emerging markets and developed economies. To measure the proportion of total external assets in the world that is accounted for by our sample, we use the data by Lane and Milesi-

Ferretti and compute the share of total external assets in their sample of 145 countries that is accounted for by the 18 countries in our sample. Chart 1 shows how this share has changed over time for different asset classes. The 18 countries in our sample account for the majority of the world's total external assets. Until the late 1990s, the share of the world's total external assets accounted for by our sample was between 70% and 80%. This fraction dropped to around 60% in the 2000s. Looking at the disaggregation by asset class, coverage is largest for FDI, followed by equity and debt. It is lowest for foreign exchange reserves, with our sample capturing between 50% and 60% of the world's total reserves.

Table 1

Country Coverage

Developed countries	Emerging Markets
Australia	Argentina
Canada	Brazil
France	Mexico
Germany	China
Italy	Hong Kong SAR
Japan	India
Portugal	Korea
Spain	Singapore
United Kingdom	
United States	

Some of the countries in the sample – the United Kingdom, the United States, Singapore and Hong Kong – are important financial centres and are both final destinations and intermediaries of foreign investment. Balance of payments statistics are constructed on the basis of 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 United Kingdom, balance of payments data would register the transaction as an asset of Germany in the United Kingdom and an asset of the United Kingdom in China, even though the United Kingdom has only acted as an intermediary.

There can be significant differences between bilateral links built on the basis of the residence principle and ultimate exposures. Felettigh and Monti (2008) derive ultimate exposures from data based on the residence principle. They use data from the IMF Coordinated Portfolio Investment Survey (CPIS), which is constructed following the residence principle. They focus on equity and debt assets held by France, Germany, Italy and Spain in Luxembourg and Ireland. These two destination countries are chosen because they have a large mutual funds industry. To illustrate the methodology used by Felettigh and Monti, suppose that we are looking at assets held by Italy in Ireland. To derive ultimate exposures, the authors first separate the share of assets that Irish mutual funds reinvest at home and the share that they reinvest abroad. They use the share reinvested at home to determine how much Italian investment stays in Ireland. The part that does not stay in Ireland is allocated to ultimate destinations using the geographical composition of foreign assets held by Ireland. Comparing bilateral exposures after this reallocation with data from the CPIS suggests that there is little difference between the two for debt assets, but there are sizeable differences for equity assets. For example, the share of intra-Euro Area securities on total Italian equity assets falls by 33.5 percentage points after this correction. This exercise gives an indication of the large

differences that may exist between bilateral links measured in terms of residence and ultimate exposures.

Most available datasets on bilateral financial links follow the residence principle. A notable exception is the BIS consolidated banking statistics, which contain information on cross-border assets held by banks and are based on the nationality of the reporting bank, netting out intra-group positions. This data is described in detail in McGuire and Wooldridge (2005). The BIS also collects data based on residence (locational banking statistics). For a useful discussion of the differences between the two databases see McGuire and Tarashev (2008). Which data is preferable depends on the question being addressed. Data based on residence is useful to have an idea of broad trends in cross-border links and analyse the structure and size of global financial links from a geographical perspective. Data based on nationality 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 Abbey in the United Kingdom (part of Santander, a Spanish group) borrows from households in the United Kingdom to 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 implications of a shock in the United Kingdom for cross-border capital flows. For this question locational data would be preferable.

Since neither residence nor nationality-based data is clearly preferable in all circumstances and residence-based data is more widely available, we follow the balance of payments methodology and construct the dataset based on the residence principle.

2.2 General approach for FDI, equity, and debt

The data is disaggregated in four asset classes: FDI, equity, debt, and foreign exchange reserves. The methodology used to construct the data is somewhat different for each asset class. For the first three asset classes, missing data is estimated using gravity models, which have been used extensively in the trade literature. These models explain bilateral assets using a variety of variables, including standard gravity variables, such as distance, common language, common border, time difference, and colonial links; and additional regressors, such as bilateral trade, and exchange rate volatility. For foreign exchange reserves, we start by estimating their currency composition and then transform it into geographical composition. Because data on the currency composition of reserves is confidential, we base our estimations on the results reported in previous studies which had access to such data.

Because the construction of data for FDI, equity, and debt follows a similar approach, it is useful to describe the general approach before discussing the elements that are specific to each asset class. The construction of data for these three asset classes follows a six-step procedure:

- **Step 1**. Collect available data on bilateral assets from a variety of sources.
- **Step 2**. Compute geographical weights.

  By dividing assets of country i in country j (A_{ijt}) by total external assets of country i (A_{it}), we obtain the percentage of assets of country i which are held in country j (w_{ijt}):

  $$w_{ijt} = \frac{A_{ijt}}{A_{it}}.$$

  Weights do not necessarily add up to 100, since the 18 countries in the sample do not account for countries' total external assets.
- **Step 3**. Estimation of gravity models for geographical weights.

Missing data is estimated using gravity models, which are the workhorse models for trade in goods. They explain trade flows between countries i and j using a variety of variables, such as distance, common language, common border, colonial links, etc. More recently, they have been applied to explain asset flows and stocks, and have been found to 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 cross-border equity flows and conclude that it performs at least as well as when used to explain trade in goods. The idea that variables such as distance 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. Also, if investors wish to diversify their portfolios, they may choose to invest in more distant countries, where the business cycle has a low or negative correlation with their own country's business cycle. 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. Martin and Rey (2004) develop a theoretical framework that delivers an equilibrium relation between bilateral asset flows, the size of the home and host countries and transaction and information costs. Their model provides a theoretical foundation for gravity regressions. We use the following specification for the gravity models:

$$\log\left(\frac{w_{ijt}}{1-w_{ijt}}\right) = \phi_i + \phi_j + \phi_t + \alpha X_{ij} + \beta Z_{ijt} + \varepsilon_{ijt}\,. \qquad (1)$$

This is estimated separately for each asset class: FDI, equity, and debt. w_{ijt} is the proportion of assets of country i held in country j in year t. We choose to estimate the model on weights rather than stocks of foreign assets because stocks would be non-stationary, implying that the usual distributions for OLS estimates would be invalid. The dependent variable is the logit of weights. This is a standard transformation to deal with proportions data, transforming (1) into a linear model which can be estimated by OLS. The downside of this transformation is that taking logs eliminates observations for which the weights are zero. However, given the small proportion of zeros in the data (less than 10%), eliminating them should not have much influence on the results.[3]

ϕ_i and ϕ_j are dummy variables for each source and host country and ϕ_t are time dummies. The host country fixed effects control for characteristics that explain why some countries are more attractive to foreign investors than others. The source country fixed effects control for characteristics that explain why some countries invest larger shares abroad than others. In addition to these fixed effects, we include a set of bilateral variables, X_{ij}, which are standard in trade gravity models and measure the geographic and historical proximity between economies: common border, common language, colonial links, distance, and time difference. The colony dummy is asymmetric and is equal to 1 if country i is a former colonizer of country j. We construct this variable asymmetrically to reflect the fact that, while former colonizers may have preferential status when they invest in former colonies, former colonies may not have preferential status when investing in former colonizers. The time difference between countries i and j is included as a measure of information asymmetry and transaction

[3] Eliminating zeros may be less problematic than estimating a model that fits over both zero and non-zero observations. This is because the determinants of whether a country has *any* financial linkages with another country may be different from the determinants of the *size* of the exposures given that countries are linked.

costs. It has been found to be significant in previous studies (Daude and Stein (2007)). Z_{ijt} is a set of time varying regressors.

- **Step 4**. Combine `actual' with estimated weights.

  After estimating gravity models for geographical weights, we use the estimated coefficients to obtain out-of-sample predictions of weights for those years and country pairs for which data is missing. We then combine 'actual' weights with those predicted values to obtain a dataset on asset weights with no missing observations $(\widetilde{w}_{ijt})$.

- **Step 5**. Multiply geographical weights by total assets from the Lane and Milesi-Ferretti (2007) dataset to obtain stocks of foreign assets.

  To transform geographical *weights* into *stocks* of foreign assets, we multiply the weights obtained in step 4 by total external assets of country i reported in the Lane and Milesi-Ferretti (2007) dataset:

  $$\widetilde{A}_{ijt} = \widetilde{w}_{ijt} \times A_{it,LMF}\,.$$

  This step ensures that bilateral stocks of foreign assets incorporate some adjustment for valuation effects arising from exchange rate movements and changes in asset prices. Lane and Milesi-Ferretti introduce this adjustment in their data. By multiplying bilateral weights by total external assets from their data, this adjustment will be incorporated into bilateral stocks.[4] This is potentially important, since valuation effects have been shown to be sizeable (see Gourinchas and Rey (2007)).

- **Step 6**. (symmetry). Construct liabilities from assets.

  The data is constructed taking the assets perspective. The last step in the data construction explores the fact that assets and liabilities should be symmetric and constructs liabilities from assets:

  $$Liabilities_{ijt} = Assets_{ijt}$$

  Liabilities of country i with country j at year t equal assets of country j in country i at year t.

2.3 FDI

2.3.1 Data

The main source of data on FDI assets is the OECD International Direct Investment by Country database. This contains FDI data at book value reported by OECD members, starting in 1981. There are many missing values in the data. To the extent possible, missing observations are filled in with data from the United Nations Conference on Trade and Development (UNCTAD). The two datasets do not report exactly the same numbers when the data overlap, but the discrepancy is not large and they are broadly consistent. Even after combining the datasets, there are still gaps in the data. Table 2 lists the percentage of missing data for each source country. Coverage is better for developed economies, with no missing data for Germany and small percentages of missing data for Canada and the United States. On the other hand, there is a large fraction of missing data for Mexico, Argentina and

[4] A more accurate method to adjust for valuation effects would be to do it directly on bilateral stocks, taking into account changes in bilateral exchange rates and in stock market valuations in the host country. By taking the adjustment from Lane and Milesi-Ferretti we are applying the adjustment on total external assets to bilateral assets, rather than making it specific to each country pair.

India. Overall, approximately 44% of the data on bilateral FDI is missing and needs to be estimated.

Table 2

Proportion of missing data[1]

In per cent

Source country	FDI	Equity	Debt
Argentina	84	63	76
Australia	40	68	62
Brazil	67	68	78
Canada	3	63	0
China	76	89	94
France	19	63	0
Germany	0	67	0
Hong Kong SAR	77	72	79
India	84	84	76
Italy	26	63	0
Japan	15	63	0
Korea	15	68	78
Mexico	86	85	86
Portugal	52	65	62
Singapore	54	64	77
Spain	76	64	11
United Kingdom	16	64	0
United States	6	63	0
Full Sample	44	69	43

[1] Proportions are computed after filling in missing values using the index of stock market liberalization. For equity, the CPIS only reports data for 1997 and the period from 2001 to 2005. Data for all other years is missing. For debt, data for Argentina, China, Hong Kong SAR, Korea, and Singapore is from the IMF CPIS only. Therefore, data is missing for all years except 1997 and 2001 to 2005.

Because the OECD and UNCTAD report data on both assets and liabilities, it would, in principle, be possible to combine the two and reduce the percentage of data that needs to be estimated. We could use liabilities reported by country j in country i to be equal to assets of country i in country j. However, there is a large asymmetry between reported FDI assets and liabilities. For example, we would expect the value of FDI assets reported by China in Hong Kong to be equal to the value of FDI liabilities reported by Hong Kong in China. However, the two are remarkably different: China reports a value of FDI assets in Hong Kong at US $24,632 million in 2003, while Hong Kong reports FDI liabilities in China at US $99,197 million, a value more than four times larger.

This discrepancy is due to the way FDI liabilities are reported, following the Ultimate Beneficiary Owner (UBO) principle, according to which the source of inward FDI is allocated to the country of ultimate ownership. The equivalent principle on the assets side would be the

Country of Ultimate Destination (CUD) principle, according to which outward FDI would be allocated to the country of final destination. However, while the UBO principle is widely adopted in the production of FDI statistics, the CUD principle is not the norm, ie liabilities are reported following the ultimate ownership principle and assets are reported following the residence principle adopted in the balance of payments statistics.

This difference in reporting principles generates large discrepancies between assets and liabilities. For illustration suppose that, in the example above, China channels part of its investment in Hong Kong through Chinese Taipei. When reporting its FDI assets in Hong Kong, China includes only investment that goes directly to Hong Kong. Investment channelled through Chinese Taipei is reported as a Chinese asset in Chinese Taipei. Hong Kong, on the other hand, follows the UBO principle and reports its liabilities with China including investment that is channelled through Chinese Taipei. Thus, Hong Kong's reported liabilities are much larger than China's reported assets. This confirms the findings of Felettigh and Monti (2008) that there can be large discrepancies between data based on the residence principle and data based on final destinations. Because of this discrepancy, it is not possible to mix data on FDI assets and liabilities. Since we choose to follow the balance of payments methodology, we focus only on assets and make no use of data on liabilities.

2.3.2 Estimation

FDI asset weights are estimated using model (1). The gravity variables, X_{ij}, are obtained from the Distance Database complied by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). The set of time varying regressors, Z_{ijt} includes GDP per capita in countries i and j, and the degree of openness of country j to inward FDI. GDP per capita captures the degree of development and is obtained from the World Bank, World Development Indicators. It is measured at constant prices and is PPP-adjusted. The degree of openness of country j to inward FDI is measured as a time varying index. For most countries, it is constructed from the tables in Kaminsky and Schmukler (2003), which report the chronology of stock market liberalization and classify countries into three degrees of liberalization over time:

- **No liberalization**: foreign investors are not allowed to hold domestic equity and cannot repatriate capital, dividends, and interest before five years of the initial investment.
- **Partial liberalization**: the country is open to foreign investment, but with restriction
- **Full liberalization**: foreign investors are allowed to hold domestic equity and to repatriate capital, dividends and interest without restrictions.

We transform this classification into a numerical variable which takes the value 0 if country j is not liberalized in year t, 1 if it is partially liberalized, and 2 if it is fully liberalized.

Some of the countries in our sample are not studied by Kaminsky and Schmukler (2003). For those countries, we use information on the timing of stock market liberalization from other studies and code it according to the criteria used by Kaminsky and Schmukler (2003). For China, we use information in Bekaert, Harvey, and Lundbland (2007), Prasad and Wei (2005) and OECD (2000), and for India, we use Ahluwalia (2002) and Reserve Bank of India (2006). Table 3 reports the index on liberalization to FDI investment for those countries that were not fully liberalized throughout the whole period.

Table 3

Liberalization index on inward FDI[1]

	Argentina	Brazil	China	India	Japan	Korea	Mexico	Portugal
1980	1	1	0	0	1	0	0	1
1981	1	1	0	0	1	0	0	1
1982	0	1	0	0	1	0	0	1
1983	0	1	0	0	1	0	0	1
1984	0	1	0	0	1	0	0	1
1985	0	1	0	0	2	0	0	1
1986	0	1	0	0	2	0	0	2
1987	0	1	0	0	2	0	0	2
1988	0	1	0	0	2	0	0	2
1989	2	1	0	0	2	0	1	2
1990	2	1	0	0	2	0	1	2
1991	2	1	0	1	2	0	2	2
1992	2	2	1	1	2	0	2	2
1993	2	2	1	1	2	0	2	2
1994	2	2	1	1	2	0	2	2
1995	2	2	1	1	2	0	2	2
1996	2	2	1	1	2	0	2	2
1997	2	2	1	1	2	0	2	2
1998	2	2	1	1	2	2	2	2
1999	2	2	1	1	2	2	2	2
2000	2	2	1	1	2	2	2	2
2001	2	2	1	1	2	2	2	2
2002	2	2	1	1	2	2	2	2
2003	2	2	1	1	2	2	2	2
2004	2	2	1	1	2	2	2	2
2005	2	2	1	1	2	2	2	2

[1] 0 denoted no liberalization; 1 denoted partial liberalization; and 2 denoted full liberalization. Countries in our sample that are not shown in this table are fully liberalized through the period 1980–2005.

Sources: Kaminsky and Schmukler (2003), Table 1, Appendix Table 1, and Annex Table 1. For China: Bekaert, Harvey, and Lundbland (2007), Prasad and Wei (2005) and OECD (2000). For India, Ahluwalia (2002) and Reserve Bank of India (2006).

As well as being used as a control in regression (1), this index is used to fill in some of the missing data prior to estimation. Table 4 illustrates how this is done, using as an example FDI assets of the United Kingdom in China. Using the liberalization index on inward FDI in China, we are able to fill in the missing values from 1980 to 1990. Because China was closed to inward FDI in those years, there would have been no inwards flows to China from the rest of the world. We know the stock of assets of the United Kingdom in China in 1991, while China was still closed. Because there would have been no inward flows to China during the

period 1980 to 1990, the stock of assets in that period should equal the stock in 1991 adjusted for valuation effects due to changes in exchange rates and asset prices. To adjust for valuation effects, we assume that the bilateral stocks of the United Kingdom in China in the period from 1980 to 1990 grow at the same rate as total Chinese FDI liabilities. Therefore, we take the value is 1991 as the starting point and build stocks backwards using the growth rate of total Chinese liabilities.

Table 4

Using the liberalization index on inward FDI to fill in missing data

	FDI assets of UK in China[1]	Liberalization index on inward FDI in China
1981	7.8	0
1982	9.7	0
1983	12.8	0
1984	19.4	0
1985	29.7	0
1986	43.8	0
1987	60.1	0
1988	76.8	0
1989	99.9	0
1990	124.4	0
1991	149.7	0
1992	157.2	1
1993	271.1	1
1994	184.4	1
1995	269.7	1
1996	777.7	1
1997	775.6	1
1998	565.6	1
1999	2,027.0	1
2000	2,245.8	1
2001	3,054.5	1
2002	5,177.1	1
2003	3,228.5	1
2004	3,644.6	1
2005	5,363.7	1

[1] In millions of US dollars, highlighted values are filled in using the liberalization index.

Sources: OECD and UNCTAD.

Turning to the estimation results, we might expect the host country fixed effects to account for most of the explanatory power in regression (1). To study this, we estimate a model where FDI asset weights are only explained by the host country fixed effects. The results are

reported in column (1) of Table 5. The predictive power is not negligible, with an R^2 of 41%. Column (2) adds source country fixed effects, with an improvement in the R^2 to 50%. This suggests that some source countries are more diversified than others, investing a smaller share in a larger number of countries. Including the standard gravity variables further increases the R^2 to 68%, which is remarkably high and is consistent with the results found in other empirical studies.

Table 5

Estimation results for FDI weights[1]

	(1)	(2)	(3)	(4)
	Host country FE	Host & source country FE	Gravity variables	Model for prediction
Border			0.394***	0.340***
			(0.119)	(0.113)
Language			1.585***	1.598***
			(0.095)	(0.094)
Colony			0.507***	0.481***
			(0.092)	(0.096)
Log(Distance)			–0.681***	–0.681***
			(0.043)	(0.040)
Time difference			–0.054***	–0.054***
			(0.010)	(0.009)
Log($GDPpc_{it}$)				0.750***
				(0.295)
Log($GDPpc_{jt}$)				1.817***
				(0.137)
Index Liberalization FDI_{jt}				0.379***
				(0.054)
N	3810	3810	3810	3810
R^2	0.41	0.50	0.68	0.71
Marginal R^2 of gravity variables			0.36	
Marginal R^2 of time-varying variables				0.04

[1] Robust standard errors in parentheses. * significant at the 10% level, ** at the 5% level, *** at the 1% level. Regression (4) includes time dummies. The marginal R^2 of the gravity variables indicates the percentage improvement in the R^2 from including these variables, over and above the model with only host and source country fixed effects. The marginal R^2 of time-varying variables indicates the percentage improvement in the R^2 from the time-varying variables (including time dummies) over and above the model with fixed effects and the gravity variables.

The standard gravity variables are significant and have the expected signs: FDI weights are larger for countries that share a common border or a common language and have colonial links. Distance and time difference have a significant negative effect on FDI weights. Time varying controls are included in column (4). Countries with larger GDP per capita receive larger shares of FDI investment. This illustrates the paradox discussed in Lucas (1990) that capital tends to flow to rich countries even though the marginal product of capital is larger in poor countries, and is consistent with the findings in Papaioannou (2009). Countries whose markets are more liberalized to FDI also receive larger investment shares. However the improvement in the R^2 from including these time varying controls is only marginal. Most of the

explanatory power comes from the source and host country fixed effects and standard gravity variables.

We also experimented with additional controls. One variable which has been found in previous studies to have a significant effect on bilateral asset holdings is bilateral trade. There are at least two reasons why this may be the case. First, bilateral trade may capture an additional familiarity effect, over and above the gravity variables. Second, countries may use financial investment to hedge against shocks in countries with which they trade. For example, if country A imports from country B, a potential hedge against output shocks in country B is to hold equity in that country: an increase in the domestic demand for imports from country B would be compensated by higher dividend yields from holding equity in country B. We extended the model to include trade weights, measured as the ratio of trade between countries i and j (exports plus imports), over total trade of country i, using data from the IMF Direction of Trade Statistics (DOTS). Trade weights were found to have a positive but insignificant effect in explaining FDI weights and were not included in the model used for prediction.[5]

Another variable we experimented with was the volatility in bilateral exchange rates, measured as the standard deviation in the rate of change of monthly bilateral exchange rates on a three-year rolling window. Exchange rates were obtained from the IMF International Financial Statistics (IFS). This is a common explanatory variable in gravity models for financial stocks and flows. The idea is that bilateral financial positions may be smaller when the bilateral exchange rate is more volatile, since there is more uncertainty about the returns. This variable turned out to have an insignificant effect on FDI asset weights and was excluded from the model used for prediction. The insignificant effect of bilateral exchange rates is consistent with the findings of previous studies. Portes and Rey (2005) use it to explain bilateral equity flows and find an insignificant effect. The same result arises in Lane and Milesi-Ferretti (2008) for equity stocks.

2.4 Equity

2.4.1 Data

Data on portfolio equity assets is collected from the IMF Coordinated Portfolio Investment Survey (CPIS), which covers all countries in our sample except China, who did not participate in the survey. The time coverage though is quite limited: a pilot survey was conducted in 1997 and a regular annual survey was introduced in 2001 for an extended group of participating countries. Table 2 lists the proportion of missing data by source country. Given limited time coverage of the CPIS, over 60% of data is missing for all countries and needs to be estimated. For China, this proportion is higher since it does not participate in the CPIS.

As for FDI, we only use data on assets and make no use of liabilities data. This is because, while countries who participate in the CPIS are required to report assets, liabilities are reported on a voluntary basis. The only countries in our sample that report liabilities are Australia, India, Japan, Portugal and Spain. For these countries, there is a big discrepancy between reported liabilities and liabilities derived from assets reported by creditor countries. Because of this discrepancy we decided to use only reported assets.

[5] Only variables with a p-value lower than \$0.25\$ were kept in the model used for prediction.

2.4.2 Estimation

Table 6 shows the results of estimating model (1) on equity weights. The host country fixed effects only explain 46% of the variation in equity weights. Introducing source country fixed effects increases the R^2 to 55%, indicating that some source countries are more diversified and invest smaller shares in a larger number of destinations. The standard gravity variables, X_{ij}, are the same as in the regression for FDI weights. The coefficients on these variables are significant and have the expected signs except for colonial links, which is negative. This suggests that investors may prefer to invest in countries with a similar degree of development as their home country, regardless of historical colonial links. The inclusion of these variables leads to a significant improvement in the R^2, which rises to 71%.

Table 6

Estimation results for Equity weights[1]

	(1)	(2)	(3)	(4)
	Host country FE	Host & source country FE	Gravity variables	Model for prediction
Border			0.820***	0.820***
			(0.185)	(0.187)
Language			1.729***	1.736***
			(0.143)	(0.141)
Colony			–0.792***	–0.805***
			(0.203)	(0.192)
Log(Distance)			–0.453***	–0.433***
			(0.074)	(0.072)
Time difference			–0.107***	–0.110***
			(0.017)	(0.017)
Log($GDPpc_{jt}$)				4.063***
				(0.769)
Exchange rate volatility				–0.003**
				(0.001)
Index Liberalization FDI_{jt}				2.452***
				(0.603)
N	1341	1341	1341	1341
R^2	0.46	0.55	0.71	0.72
Marginal R^2 of gravity variables			0.29	
Marginal R^2 of time-varying variables				0.01

[1] Robust standard errors in parentheses. * significant at the 10% level, ** at the 5% level, *** at the 1% level. Regression (4) includes time dummies. The marginal R^2 of the gravity variables indicates the percentage improvement in the R^2 from including these variables, over and above the model with only host and source country fixed effects. The marginal R^2 of time-varying variables indicates the percentage improvement in the R^2 from the time-varying variables (including time dummies) over and above the model with fixed effects and the gravity variables.

The set of time varying controls, Z_{ijt}, includes GDP per capita in country j, bilateral exchange rate volatility, and the degree of openness of country j to inward equity investment. The results suggest that investors invest more in countries that are more open to inward equity investment and have a larger GDP per capita. They also invest more when the volatility of the bilateral exchange rate is smaller. However, these time varying variables do not have a large explanatory power and lead to a very small improvement in the R^2.

The degree of openness of country j to inward equity investment was constructed in the same way as the one for FDI. In fact, FDI can be seen as a type of portfolio equity investment where the degree of ownership exceeds 10% of the firm's equity. However, countries may liberalize their stock markets to foreign portfolio equity investment and remain closed to FDI by introducing a ceiling on the percentage of total equity that can be owned by foreign residents. While this may be true for other countries, the only country in our sample where the index of liberalization to equity investment differs from the one for FDI is Korea, where foreign portfolio equity investment was partially liberalized in 1991, while foreign FDI investment remained restricted. Both types of investment were then fully liberalized in 1998. For all other countries, the liberalization index for equity coincides with the index for FDI reported in Table 3.

As for FDI, the liberalization index for equity is used to estimate missing data. However, while for FDI it was possible to take a data point when the host country was still closed as build the data backwards using the growth rate of its total liabilities – as illustrated in Table 4 – for equity the data starts when all countries were already open to inward equity investment. Since it is not possible to build the data backwards in the same way as for FDI, we simply impose zero bilateral weights for the period when the host country was closed to inward equity investment. The only exception to this rule is equity investment of Hong Kong in China. China was closed to inward equity investment until 1992. However, given the strong political and administrative links between the two countries, we do not impose zeros for Hong Kong's equity investment in China pre-1992.

We also experimented with other control variables. To capture stock market returns and correlations in returns, we included averages, standard deviations, and the correlation coefficient of daily stock market indices in the host and source countries. These variables were insignificant and therefore were not included in the final regression. GDP per capita in country i, stock market capitalization in country j, and trade weights were also insignificant.

2.5 Debt

2.5.1 Data

Data on portfolio debt assets is also collected from the IMF CPIS. In addition, we use data from the BIS Locational Banking Statistics, which reports debt assets and liabilities of banks for all countries in our sample, except Argentina, China, Hong Kong, Korea, and Singapore. The BIS data has the advantage of having a much longer time coverage, going back to 1977 for most advanced countries. However, it has the limitation of only reporting debt assets held by banks, while the CPIS has a broader coverage, including not only banks but also other financial institutions, monetary authorities, the government, non-financial corporations, and households. Another difference between the two datasets is that, while the CPIS only covers portfolio debt, the BIS also covers loans and deposits.

To test whether it is sensible to combine data from the BIS and the CPIS, we computed the correlation coefficient between the asset weights generated by the two data sources. The correlation coefficient is quite large (80%), suggesting that it is appropriate to combine the two data sources. By default, we use asset weights computed from the BIS data, and complete it with weights computed from the CPIS data whenever possible. After combining the two datasets, approximately 43% of the data is missing. Looking at the proportion of missing data by source country in Table 2, the gaps are especially pronounced for China, which is not covered by either dataset, and for countries not covered by the BIS Locational Banking Statistics, for which we only have data after the CPIS was introduced in 1997.

As for the other asset classes we make no use of data on liabilities. For CPIS data we face the same problems as with equity: very few countries report liabilities in the CPIS and, when they do, there is a large difference between those reported liabilities and assets reported by creditors. For BIS data there is also a problem in using liabilities to build assets by symmetry.

Because the BIS reports assets and liabilities held by banks against both banks and non-banks, the data is not symmetric: banks in country *i* report assets held against *banks and non-banks* in country *j*, while *banks* in country *j* report liabilities against both banks and non-banks in country *i*. Because of this lack of symmetry it is not possible to derive assets from liabilities.

2.5.2 Estimation

Table 7 reports the results of estimating model (1) on debt weights. The model with only host country fixed effects explains 49% of the variation in debt weights. Adding source country fixed effects increases the R^2 to 57% and adding standard gravity variables further improves the R^2 to 69%. Border was excluded from the set of gravity variables because it had no significant effect on debt weights. The colony dummy has a negative sign, as in the model for equity. This is an interesting finding and suggests that, for types of investment which imply a larger degree of commitment, such as FDI, former colonizers tend to invest in former colonies. However, for equity and debt investment, they seem to prefer countries with a similar degree of development, regardless of colonial links.

Table 7

Estimation results for Debt weights[1]

	(1)	(2)	(3)	(4)
	Host country FE	Host & source country FE	Gravity variables	Model for prediction
Language			1.081***	1.001***
			(0.077)	(0.081)
Colony			–0.261***	–0.170**
			(0.078)	(0.082)
Log(Distance)			–0.423***	–0.367***
			(0.042)	(0.044)
Time difference			–0.119***	–0.114***
			(0.010)	(0.010)
Log($GDPpc_{jt}$)				0.892***
				(0.120)
Trade weights$_{ijt}$				1.160**
				(0.449)
Exchange rate volatility				–0.003***
				(0.001)
N	4187	4187	4187	4187
R^2	0.49	0.57	0.69	0.70
Marginal R^2 of gravity variables			0.21	
Marginal R^2 of time-varying variables				0.01

[1] Robust standard errors in parentheses. * significant at the 10% level, ** at the 5% level, *** at the 1% level. Regression (4) includes time dummies. The marginal R^2 of the gravity variables indicates the percentage improvement in the R^2 from including these variables, over and above the model with only host and source country fixed effects. The marginal R^2 of time-varying variables indicates the percentage improvement in the R^2 from the time-varying variables (including time dummies) over and above the model with fixed effects and the gravity variables.

Unlike for FDI and equity, the set of time varying controls, Z_{ijt}, does not include the degree of liberalization of the host country to inward debt investment. This is because we were unable to construct an index which captures restrictions only to *inward* investment. The closest measure we were able to find was a time series index for capital account restrictions, based on the chronology in Kaminsky and Schmukler (2003). This index captures restrictions to borrowing abroad by banks and corporations (which could be interpreted as restrictions to debt capital *inflows*) as well as exchange rates and other restrictions to capital *outflows*. Because it confounds restrictions to inward and outward investment, we decided not to use it.

As for equity, the results suggest that investors tend to invest larger shares in more developed countries – the Lucas paradox – and in countries with lower exchange rate volatility with respect to the currency of the source country. In contrast with the result for FDI and equity, bilateral trade weights have a significant and positive effect on debt weights. This is consistent with the findings in Rose and Spiegel (2004). In their paper borrowers fear that defaulting on their debt may lead to a reduction in international trade. Therefore, creditors systematically lend more to countries with closer trade links to the source country.

We experimented with additional controls and estimated the model including bond market capitalization and measures of bond returns, using the JP Morgan EMBI and Global Bond Index (GBI). These variables turned out insignificant and were not included in the model used for prediction.

The model captures the geographical composition of debt and abstracts from its currency composition. For FDI and equity, it is reasonable to assume that assets are denominated in the currency of the host country. For debt, however, this equivalence between currency and geographical composition is not so simple, since countries may issue bonds denominated in foreign currencies. Therefore, investors make a simultaneous decision about the *geographical* as well as the *currency* composition of their debt investments. This introduces a further complication, since we should model these two choices simultaneously. Here we simplify and focus solely on the geographical composition.

2.6 Reserves

The construction of the reserves data follows a different approach from the one used for the other three asset classes. While for FDI, equity and debt investors choose *where* to invest, for reserves they choose *in which currency* to invest. We follow a two-step procedure to obtain the geographical composition of reserves. First, we obtain the currency composition. Then, we translate it into the geographical composition: if country i holds an amount X of reserves in US dollars, we take X as being the amount of reserve assets that country i holds in the United States. For simplification, we focus on the four main reserve currencies: the US dollar, the euro, the pound, and the yen. These should capture the bulk of countries' foreign exchange reserves. Also for simplification, we treat reserves of country i denominated in euros as being assets of country i in Germany. For the period before the introduction of the euro, we use the Deutsche mark.[6]

An important limitation in constructing data on the currency composition of reserves is that, given its confidentiality, data is not readily available. The BIS Multilateral Surveillance Statistics contain data on the currency composition of reserves for the countries in the G10 since 1994. This gives us data for six counties in our sample: France, Germany, Italy, Japan, the United Kingdom, and the United States. Given the remarkable stability of currency

[6] A more precise way of dealing with euro reserves would be to allocate them according to the relative GDP of each country in the euro area. Here we take a shortcut and allocate all euro reserves to Germany.

weights over time, we assume that weights stay constant from 1980 to 1994. For the remaining countries, the IMF collects data in the COFER (Currency Composition of Official Foreign Exchange Reserves) database.

Although the numbers are only released as aggregates across industrialized and developing countries, disaggregated data has been used in some previous studies. We follow the approach in Lane and Shambaugh (2007) and use the results reported in those studies to obtain estimates of the currency composition of reserves for the countries in our sample that are not members of the G10.

The studies we use are Eichengreen and Mathieson (2000) and Dooley et al (1989), who adopt the following specification to explain the currency composition of reserves:

$$share_{ict} = c + \alpha_1 dollar\_peg_{ict} + \alpha_2 other\_peg_{ict} + \beta share\_trade_{ijt} + \gamma share\_debt\_payments_{ict} + \varepsilon_{ict} \quad (2)$$

The dependent variable is the share of foreign exchange reserves held by country i in currency c at time t, obtained from COFER. The regression includes a constant term, dummy variables equal to 1 if country i pegs to the US dollar or to another currency, the share of trade between country i and country j at time t (where country j is the country that issues currency c), and the share of debt service payments of country i in currency c at time t. The share of trade is calculated as the sum of exports and imports between countries i and j divided by total exports plus imports plus debt service payments of country i. The share of debt payments in currency c is calculated as service payments of country i on debt denominated in currency c divided by total exports plus imports plus debt service payments of country i.

Eichengreen and Mathieson (2000) report the results of estimating this model for a sample of 84 emerging and transition economies for the period 1979–1996. We collect data for the right-hand-side variables and multiply by the estimated coefficients reported in their paper to obtain estimates of the currency composition of reserves.[7]

Data on exchange rate regimes is obtained from Levy-Yeyati and Sturzenegger (2005). They report an index which classifies exchange rate regimes in three categories: floating, intermediate, and fixed. We transform this index into a binary variable, which takes the value 0 if the country has a floating regime and 1 if the country has an intermediate regime or a peg. We construct one indicator for US dollar pegs and another for other currency pegs. Data on trade is collected from the IMF Direction of Trade Statistics. Debt service payments are obtained by multiplying the 6-month Euro currency deposit rates, obtained from Datastream, by the amount of debt outstanding, obtained from the World Bank, Global Development Finance.

This approach gives us estimates of the currency composition of reserves which seem sensible. While it is difficult to have a benchmark for comparison, countries occasionally report their reserve shares in announcements and media interviews. For example, China is reported to hold roughly 70% of its reserves in dollars, 20% in euros and 10% in other currencies. Our estimation gives 79% in dollars and 21% in euros.

[7] We use the coefficients reported in Table 3 of Eichengreen and Mathieson (2000).

3. A look at the data

The international financial system can be seen as a network, where nodes represent countries and links represent bilateral financial assets. Our dataset provides information on the links and allows us to study how the global financial network has changed over time. In this section, we use network methods to give a flavour of the dataset and show the key stylized facts that emerge from it. First, we look at the evolution of the financial network for all asset classes. We then look at the configuration of the network in 2005 for each asset class: FDI, equity, debt, and reserves. Finally, we compare the financial network with the trade network.

3.1 Financial network – undirected

Chart 2 looks at the evolution of the global financial network and Table 8 provides some summary statistics, in particular measures of skewness and 'peakedness' of the distribution of links, average path length and clustering. Links are given by the sum of bilateral assets and liabilities divided by the sum of the GDP of the source and host countries:

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

Since assets and liabilities are symmetrical, the network is undirected, ie the link from i to j is the same as the link from j to i. To simplify the diagrams, we impose a cutoff and represent only the strongest links (where the ratio defined above is higher than 0.3%). This cutoff is chosen in such a way that every node is linked to at least one other node. 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. More interconnected countries are placed more centrally in the network and pairs of countries with stronger links are placed closer to each other.

Table 8

Summary statistics on the international financial network

	1985	1995	2005
Skewness	7.62	7.96	3.25
Kurtosis	75.07	80.63	15.11
Average path length	1.55	1.44	1.37
Clustering coefficient	0.71	0.83	0.84

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**. Measures of skewness and kurtosis show the asymmetry compared to the normal distribution. In particular, 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.[8]
- **The network has become more clustered over time**. The clustering coefficient measures the probability that, given that node i is linked to j and k, nodes j and k are also linked to each other.[9] The increase in this coefficient is another symptom of the increase in interconnectivity.

Low average path length and a high clustering coefficient are properties of the so-called 'small-world' networks described, for example, in Watts and Strogatz (1998). From a stability perspective, these networks are robust-yet-fragile. Because they are highly interconnected and have long-tails, with some nodes having multiple and large links, they are susceptible to targeted attacks affecting the key financial hubs. Disturbances to those hubs spread rapidly throughout the network. These properties of the global financial network and its consequences for stability are discussed in Haldane (2009).

3.2 Financial network – directed

Chart 3 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, including all asset classes – FDI, equity, debt, and foreign exchange reserves:

$$link_{ijt} = \frac{Assets_{ijt}}{GDP_{it}}.$$

The network is now 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. As before, the smallest links (with a ratio of assets to GDP below 1.7%) were deleted.

The directed network exhibits the same properties as the undirected network. 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. In addition, it allows us to analyse which countries are the main sources and destinations of international investment. Table 9 shows a number of measures of network centrality for each of the nodes. Detailed definitions for these measures are in the appendix and follow the ones used in von Peter (2007) to identify international banking centres.

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

- **The United States, the United Kingdom 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 United Kingdom – 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.

---

[8] Average path length is the average of the length of the shortest paths between all pairs of nodes.

[9] Formally, the clustering coefficient is given by $CI = (\Sigma\, i, j \neq i, k \neq j, k \neq i\ I_{ij}\, I_{ik}\, I_{jk})/(\Sigma\, i, j \neq i, k \neq j, k \neq i\ I_{ij}\, I_{ik})$, where I_{ij} is equal to 1 if there is a link between nodes i and j and 0 otherwise.

Table 9

Measures of network centrality – finance, 2005[1]

	In-degree	Out-degree	Closeness	Betweenness	Intermediation	Prestige
United States	100.00 (1)	35.29 (7)	1.00 (1)	24.67 (1)	49.89 (1)	7.41 (1)
Germany	82.35 (2)	35.29 (8)	0.85 (2)	11.18 (4)	9.28 (3)	2.68 (3)
Hong Kong SAR	23.53 (9)	76.47 (1)	0.81 (3)	7.34 (6)	2.35 (7)	1.30 (11)
Singapore	23.53 (10)	76.47 (2)	0.81 (4)	6.70 (7)	1.16 (9)	1.22 (14)
United Kingdom	64.71 (3)	70.59 (3)	0.77 (5)	21.82 (2)	15.46 (2)	4.33 (2)
Spain	41.18 (6)	52.94 (5)	0.74 (6)	16.46 (3)	5.60 (4)	1.72 (6)
France	58.82 (4)	52.94 (4)	0.71 (7)	9.21 (5)	5.26 (5)	2.31 (4)
Italy	41.18 (7)	29.41 (10)	0.65 (8)	0.00	2.35 (8)	1.70 (7)
Japan	47.06 (5)	35.29 (9)	0.65 (9)	4.90 (8)	2.57 (6)	2.03 (5)
Canada	29.41 (8)	29.41 (11)	0.63 (10)	0.00 (13)	1.14 (11)	1.59 (8)
Portugal	17.65 (12)	41.18 (6)	0.63 (11)	1.18 (9)	0.68 (14)	1.17 (16)
Australia	23.53 (11)	23.53 (12)	0.61 (12)	0.00	1.15 (10)	1.42 (9)
Korea	17.65 (13)	17.65 (13)	0.61 (13)	0.90 (10)	0.61 (15)	1.22 (13)
China	17.65 (14)	17.65 (14)	0.59 (14)	0.79 (11)	0.89 (13)	1.32 (10)
Argentina	5.88 (17)	17.65 (15)	0.57 (15)	0.00	0.22 (16)	1.07 (17)
Brazil	17.65 (15)	5.88 (16)	0.57 (16)	0.00	1.10 (12)	1.23 (12)
India	11.76 (16)	5.88 (17)	0.55 (17)	0.00	0.11 (18)	1.07 (18)
Mexico	5.88 (18)	5.88 (18)	0.53 (18)	0.00	0.18 (17)	1.19 (15)

[1] Numbers in parenthesis indicate the ranking. In-degree, betweenness and intermediation are expressed in per cent.

- **The countries which are located closer to other nodes in the network are the United States, Germany, Hong Kong, Singapore, and the United Kingdom**. Closeness is the inverse of the average distance between countries, where distance is measured by the number of links on the shortest path. A country which is directly connected to all other countries, such as the United States, has a closeness score equal to 1.
- **The United States and the United Kingdom 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 United States and United Kingdom 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.

3.3 Financial network – asset composition

To analyse differences across asset classes, chart 4 represents the networks with links given by the ratio of assets to GDP of the source country for each asset class in 2005.[10] Tables 10 to 13, meanwhile, provide measures of network centrality for each of these networks. These results are broadly consistent with the findings for the average across asset classes. In particular, the United States and the United Kingdom emerge as the main recipients of foreign investment for FDI, equity and debt, as can be seen by their high score for in-degree centrality. Singapore and Hong Kong score low as recipients of foreign investment, but score high as originators.

Table 10

Measures of network centrality – FDI, 2005[1]

	In-degree	Out-degree	Closeness	Betweenness	Intermediation	Prestige
United States	82.35 (1)	64.71 (2)	0.89 (1)	22.74 (1)	40.99 (1)	6.36 (1)
United Kingdom	64.71 (2)	70.59 (1)	0.81 (2)	10.87 (2)	13.14 (2)	3.35 (2)
France	41.18 (6)	58.82 (4)	0.74 (3)	3.62 (5)	3.62 (8)	1.78 (8)
Germany	47.06 (4)	52.94 (6)	0.74 (4)	3.64 (4)	4.04 (7)	1.81 (7)
Singapore	23.53 (12)	64.71 (3)	0.74 (5)	1.58 (8)	1.99 (11)	1.35 (14)
Canada	41.18 (7)	47.06 (8)	0.71 (6)	2.76 (6)	1.67 (14)	1.87 (5)
Hong Kong SAR	29.41 (10)	58.82 (5)	0.71 (7)	2.69 (7)	5.77 (4)	2.62 (3)
Brazil	52.94 (3)	11.76 (14)	0.68 (8)	0.18 (11)	5.13 (5)	1.70 (10)
Spain	47.06 (5)	47.06 (7)	0.68 (9)	6.74 (3)	6.96 (3)	1.75 (9)
Japan	41.18 (8)	17.65 (12)	0.65 (10)	0.77 (9)	2.08 (10)	1.43 (11)
Australia	35.29 (9)	35.29 (9)	0.63 (11)	0.54 (10)	2.31 (9)	1.82 (6)
Italy	23.53 (13)	29.41 (10)	0.59 (12)	0.00	1.68 (13)	1.34 (15)
Korea	17.65 (14)	17.65 (13)	0.57 (13)	0.11 (12)	1.48 (15)	1.18 (17)
Portugal	11.76 (15)	23.53 (11)	0.57 (14)	0.00	1.05 (17)	1.20 (16)
China	29.41 (11)	0.00 (16)	0.52 (15)	0.00	4.49 (6)	2.57 (4)
India	0.00 (18)	5.88 (15)	0.49 (16)	0.00	0.37 (18)	1.08 (18)
Mexico	5.88 (17)	0.00	0.49 (17)	0.00	1.25 (16)	1.42 (12)
Argentina	11.76 (16)	0.00	0.47 (18)	0.00	1.99 (12)	1.38 (13)

[1] Numbers in parenthesis indicate the ranking. In-degree, betweenness and intermediation are expressed in per cent.

There are some interesting differences across asset classes. The equity network is less dense than for other asset classes, with some countries (China, Korea, and India) being unconnected. The United States scores high as originator of FDI and equity investment, but scores low as originator of debt investment. For reserves, the network is less dense because we only measure reserve holdings in four currencies: dollars, euros, pounds and yens. Among these currencies, the dollar is clearly dominant, with much higher values for in-degree centrality, closeness and prestige.

[10] The cutoff for deletion of the smallest links is 0.3% for FDI and equity and 1% for debt. No cutoff is imposed for reserves.

Table 11

Measures of network centrality – equity, 2005[1]

	In-degree	Out-degree	Closeness	Betweenness	Intermediation	Prestige
United States	82.35 (1)	58.82 (1)	0.83 (1)	20.36 (1)	47.59 (1)	6.96 (1)
Germany	58.82 (3)	35.29 (6)	0.69 (2)	0.81 (6)	3.90 (6)	2.13 (5)
United Kingdom	64.71 (2)	52.94 (2)	0.69 (3)	7.13 (2)	13.62 (2)	3.62 (2)
France	58.82 (4)	35.29 (7)	0.65 (4)	0.85 (5)	5.77 (4)	2.48 (4)
Canada	11.76 (10)	52.94 (4)	0.61 (5)	0.07 (10)	0.80 (15)	1.50 (9)
Hong Kong SAR	23.53 (9)	52.94 (3)	0.61 (6)	1.30 (3)	3.92 (5)	1.80 (6)
Italy	47.06 (6)	29.41 (9)	0.61 (7)	0.15 (8)	2.66 (9)	1.66 (7)
Japan	52.94 (5)	17.65 (12)	0.61 (8)	0.09 (9)	6.22 (3)	3.07 (3)
Singapore	11.76 (11)	47.06 (5)	0.58 (9)	0.37 (7)	1.71 (12)	1.24 (13)
Spain	41.18 (7)	29.41 (10)	0.58 (10)	0.86 (4)	3.67 (7)	1.60 (8)
Australia	29.41 (8)	23.53 (11)	0.56 (11)	0.00	0.87 (14)	1.39 (12)
Portugal	0.00	35.29 (8)	0.53 (12)	0.00	0.59 (16)	1.12 (17)
Argentina	0.00	11.76 (13)	0.45 (13)	0.00	0.15 (18)	1.03 (18)
Brazil	11.76 (12)	5.88 (14)	0.45 (14)	0.00	3.27 (8)	1.23 (14)
Mexico	0.00	5.88 (15)	0.43 (15)	0.00	0.17 (17)	1.14 (16)
China	0.00	0.00	0.00	0.00	1.85 (11)	1.42 (11)
India	0.00	0.00	0.00	0.00	1.33 (13)	1.21 (15)
Korea	0.00	0.00	0.00	0.00	1.91 (10)	1.42 (10)

[1] Numbers in parenthesis indicate the ranking. In-degree, betweenness and intermediation are expressed in per cent.

Table 12

Measures of network centrality – debt, 2005[1]

	In-degree	Out-degree	Closeness	Betweenness	Intermediation	Prestige
United States	88.24 (1)	23.53 (10)	0.89 (1)	24.20 (2)	36.02 (1)	6.15 (1)
Singapore	23.53 (8)	76.47 (1)	0.81 (2)	9.82 (4)	2.76 (9)	1.36 (10)
United Kingdom	64.71 (2)	70.59 (2)	0.77 (3)	27.44 (1)	23.51 (2)	5.54 (2)
Hong Kong SAR	17.65 (12)	64.71 (3)	0.74 (4)	4.20 (7)	3.32 (7)	1.35 (11)
France	52.94 (3)	52.94 (4)	0.71 (5)	10.39 (3)	7.85 (3)	2.64 (3)
Germany	47.06 (4)	41.18 (5)	0.68 (6)	1.18 (9)	7.55 (4)	2.53 (4)
Italy	41.18 (5)	29.41 (9)	0.65 (7)	0.15 (10)	2.81 (8)	1.86 (6)
Spain	35.29 (6)	41.18 (6)	0.65 (8)	5.40 (5)	4.54 (5)	1.83 (7)
Japan	35.29 (7)	41.18 (7)	0.63 (9)	5.15 (6)	4.29 (6)	2.02 (5)
Australia	23.53 (9)	11.76 (11)	0.59 (10)	0.00	1.83 (10)	1.39 (9)
Portugal	23.53 (10)	41.18 (8)	0.59 (11)	2.50 (8)	0.83 (14)	1.21 (12)
Canada	23.53 (11)	11.76 (12)	0.57 (12)	0.00	1.26 (11)	1.45 (8)
Korea	17.65 (13)	5.88 (14)	0.57 (13)	0.00	0.60 (15)	1.21 (13)
Brazil	17.65 (14)	5.88 (15)	0.55 (14)	0.00	1.08 (13)	1.14 (14)
Argentina	0.00 (18)	11.76 (13)	0.50 (15)	0.00	0.07 (18)	1.03 (18)
Mexico	5.88 (16)	5.88 (16)	0.50 (16)	0.00	0.21 (17)	1.11 (16)
China	11.76 (15)	0.00	0.49 (17)	0.00	1.24 (12)	1.13 (15)
India	5.88 (17)	0.00	0.46 (18)	0.00	0.23 (16)	1.05 (17)

[1] Numbers in parenthesis indicate the ranking. In-degree, betweenness and intermediation are expressed in per cent.

Table 13

Measures of network centrality – reserves, 2005[1]

	1985	1995	2005
United States	94.12 (1)	0.94 (1)	11.19 (1)
Germany	58.82 (2)	0.71 (2)	5.84 (2)
United Kingdom	52.94 (3)	0.71 (3)	1.40 (4)
Japan	35.29 (4)	0.61 (4)	3.57 (3)

[1] Numbers in parenthesis indicate the ranking. In-degree is expressed in per cent.

3.4 Comparison with the trade network

It is interesting to compare the financial network with the trade network. Table 14 looks at some the same summary statistics as Table 8 for the global trade network and chart 5 is similar to chart 1 and looks at 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:

$$link_{ijt} = \frac{Exports_{ijt} + Imports_{ijt}}{GDP_{it} + GDP_{jt}}.$$

Data on bilateral trade is from the IMF Direction of Trade Statistics (DOTS). As before, a cutoff is imposed so that only the largest links (for which the ratio above is higher than 0.21%) are shown. This cutoff is set so that every node is linked to at least one other node. 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. 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 14

Summary statistics on the international trade network

	1985	1995	2005
Skewness	3.44	5.91	3.78
Kurtosis	15.5	46.37	21.24
Average path length	1.7	1.59	1.44
Clustering coefficient	0.6	0.76	0.78

A few findings emerge:

- Just as for the global financial network, **interconnectivity of the global trade network increased over the last two decades**. This can be seen from the increase in the size of the nodes and the increase in the size and number of links.
- **The distribution of trade links also exhibits a long-tail**, with a small number of countries having large links.

- **The global trade network has 'small-world' properties**, with a short average path length and a high clustering coefficient, even though these are less strong than in the financial network.

These properties are similar to the ones found for the global financial network and suggest that trade links also contribute to a robust-yet-fragile configuration of the system.

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

$$link_{ijt} = \frac{Exports_{ijt}}{GDP_{it}}.$$

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. Links for which this ratio is below 1.3% are not shown in the chart. Measures of centrality associated with this network in 2005 are given in Table 15.

Table 15

Measures of network centrality – T, 2005[1]

	In-degree	Out-degree	Closeness	Betweenness	Intermediation	Prestige
United States	88.24 (1)	5.88 (15)	0.89 (1)	5.33 (5)	28.55 (1)	5.42 (1)
Singapore	5.88 (12)	64.71 (1)	0.74 (2)	6.74 (4)	2.60 (12)	1.42 (13)
Germany	52.94 (2)	29.41 (2)	0.71 (3)	10.99 (2)	10.03 (2)	2.64 (3)
China	35.29 (3)	29.41 (3)	0.65 (4)	11.64 (1)	9.93 (3)	2.67 (2)
France	35.29 (4)	29.41 (4)	0.63 (5)	1.50 (8)	6.73 (5)	2.25 (5)
Korea	17.65 (8)	29.41 (6)	0.63 (6)	2.08 (7)	3.00 (11)	1.59 (12)
United Kingdom	35.29 (5)	17.65 (10)	0.63 (7)	0.27 (9)	7.29 (4)	2.25 (4)
Hong Kong SAR	17.65 (9)	29.41 (7)	0.61 (8)	7.90 (3)	3.52 (9)	1.69 (11)
Japan	23.53 (6)	11.76 (13)	0.57 (9)	0.25 (10)	5.66 (7)	2.10 (7)
Portugal	5.88 (13)	29.41 (8)	0.57 (10)	0.15 (12)	0.91 (18)	1.23 (17)
Italy	17.65 (10)	23.53 (9)	0.55 (11)	0.15 (13)	4.36 (8)	1.82 (10)
Argentina	0.00 (18)	17.65 (12)	0.53 (12)	0.00	0.97 (17)	1.13 (18)
Mexico	5.88 (14)	11.76 (14)	0.53 (13)	0.18 (11)	1.50 (16)	1.85 (9)
India	5.88 (15)	5.88 (17)	0.52 (14)	0.00	1.58 (14)	1.25 (16)
Brazil	5.88 (16)	5.88 (18)	0.50 (15)	0.00	3.47 (10)	1.35 (14)
Canada	11.76 (11)	5.88 (16)	0.50 (16)	0.00	1.54 (15)	2.12 (6)
Australia	5.88 (17)	17.65 (11)	0.49 (17)	0.00	2.16 (13)	1.35 (15)
Spain	23.53 (7)	29.41 (5)	0.47 (18)	4.29 (6)	6.21 (6)	1.90 (8)

[1] Numbers in parenthesis indicate the ranking. In-degree, betweenness and intermediation are expressed in per cent.

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 (United States, Canada and Mexico), an Asian cluster (Singapore, Hong Kong, China, Korea, and Japan), and an European cluster (United Kingdom, Germany, France, Spain, Italy, and Portugal). This pattern contrasts with the one found for financial links, where the United Kingdom and the United States 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 United States 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 United Kingdom occupies a much less central position in the trade network than in the financial network**. While for finance the United Kingdom had high scores for all centrality measures this is not the case for trade.

4. Conclusions

This paper contributes to the study of financial globalization by constructing a dataset on bilateral financial links for a group of 18 countries, from 1980 to 2005. Network tools are used to identify the key stylized facts that emerge from the data. We find a remarkable increase in interconnectivity over the past two decades, with an increase in the number and size of financial links. In addition, the distribution of financial links has a long-tail, with a small number of countries having large and numerous links. The network also exhibits some 'small-world' properties, with a very small number of degrees of separation between nodes and a high clustering coefficient. The combination of high interconnectivity, long-tails, and 'small-world' properties makes for a robust-yet-fragile system, where disturbances to one of the central hubs would be transmitted widely and rapidly. The main hubs in the global financial network are the United States and the United Kingdom.

The trade network also reveals an increase in interconnectivity over time. However, unlike the financial network, where the United States and the United Kingdom are at the centre and intra-continental links are not particularly strong, the trade network exhibits much stronger links within continents. In particular, there is an European cluster, centred around Germany; an Asian cluster, centred around China; and an American cluster, centred around the United States. The United Kingdom plays a much less central role in the trade network than in the financial network.

Apart from giving an idea of the structure and evolution of the global financial network over time, the dataset can be applied to many other questions. For example, it can be used to understand how financial links contribute to the transmission of shocks across countries. There are some studies looking at whether business cycle co-movement among developed countries has increased. The consensus is that co-movement among developed countries rose sharply after the collapse of Bretton Woods and remained high since then. However, while in the 1970s and early 1980s co-movement was mainly due to common shocks, the key drivers from the late 1980s onwards are likely to have been spillovers of country-specific shocks through trade and financial links. A robust finding in the empirical literature is that pairs of countries that trade more with each other exhibit a higher degree of output co-movement (eg Baxter and Kouparitsas (2005)). Our dataset allows this type of exercise to be done taking into account financial links.

There has also been an intense debate in recent years on whether co-movement between Emerging Market Economies (EMEs) and advanced economies has decreased – the decoupling hypothesis. Kose, Otrok, and Prasad (2008) look at this question by decomposing output, investment and consumption fluctuations for a group of 106 countries into four factors: a global factor, three group specific factors (for industrial countries, emerging markets, and developing countries), country factors, and idiosyncratic factors specific to each time series. They find that during the period of globalization (1985-2005)

there has been an increase in business cycle convergence *within* the group of industrial countries and *within* the group of EMEs, but there has been divergence (or decoupling) *between* them. However, in a short chapter on this subject, Claessens and Kose (2008) make an important qualification. They note that the existing evidence in favour of the decoupling hypothesis has mainly focused on real economic links, but has left out financial links. Therefore, the evidence does not speak to the possibility of financial decoupling (or lack thereof). Our dataset provides the necessary information to analyse this question looking at cross-country financial links.

Finally, the dataset can be applied to another heated policy debate – the reform of IMF surveillance. The IMF has been under a gradual reform process for several years. An important aspect of this process is the shift in the perspective of surveillance from the country level to a multilateral level, taking into account cross-border spillovers. Having a better understanding of which countries are more closely linked by spillovers is an important step in the development of a framework for multilateral surveillance. By understanding these links, the IMF could highlight how a particular country may be affected by developments in other countries and how its policies may generate spillovers to the rest of the world. Our dataset can be used to measure the impact of financial links on the magnitude of cross-country spillovers and form groups of countries closely linked by spillovers.

Appendix: Measures of network centrality

This appendix provides definitions of the centrality measures used in the paper. It follows closely the box in von Peter (2007) and focuses on the directed financial network. Similar definitions hold for the trade network.

The network can be expressed in matrix form, where the typical element A_{ij} records the value of financial assets held by country i in country j. The matrix has dimension equal to the number of countries, n, and can be read in two directions: rows of A represent assets of country i in country j and columns of A represent liabilities of j in i. All diagonal elements are zero. Off-diagonal elements are zero for country pairs that have no links or whose links are below the cutoff, defined in such a way that each country is linked to at least one other country (either as a creditor or as a debtor). The network is directed and weighted, hence A is not symmetric and its entries reflect the size of financial assets.

The centrality measures apply to each node and describe how that node relates to the network, taking different perspectives. Degree, closeness and betweenness are based on whether a link exists or not, regardless of the value of the link, ie they are based on the indicator $N_{ij} = 1$ if $B_{ij} > 0$, and 0 otherwise. Intermediation and prestige take into account the size of the links and rely on the portfolio shares $P_{ij} = B_{ij}/\Sigma_k B_{ij}$ for all i.

In-degree is the number of links that point to a node, ie it is given by the sum $\Sigma_j N_{ji}$ The measure of in-degree centrality reported in the tables scales this sum by the total possible number of links, $n - 1$. **Out-degree** is the number of links departing from a node, ie $\Sigma_j N_{ij}$. This is divided by $n - 1$ to obtain the numbers reported in the tables.

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 $\Sigma_j \delta_{ij} /(n - 1)$. 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 $g_{jk}(i)/g_{jk}$. Betweenness of node i is the sum of these probabilities over all nodes excluding \$i\$, divided by the maximum that the sum can attain: $(\Sigma_{j \neq i} \ \Sigma_{k \neq i} \ g_{jk}(i)/g_{jk})/(n-1)(n-2)$.

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 $\Sigma_k \ p_{ik} \ p_{kj}$. The probability that a dollar sent by i reaches j through k is given by $p_{ik} \ p_{kj} / \Sigma_k \ p_{ik} \ p_{kj}$. 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 $i(v_i)$ is obtained by taking the prestige of its creditors, weighted by their portfolio shares with i, ie $v_i = \Sigma_j P_{ji} \ v_i$. This defines a linear system $v = P'v$, where P is the matrix of portfolio shares. The solution to this system is the eigenvector associated with the unit eigenvalue. Following von Peter (2007), we solve the alternative system $v = \frac{1}{2} P'v + e \Rightarrow (I - \frac{1}{2} P')^{-1} e$, where e is the unit vector. This avoids countries with a zero score contributing nothing to the centrality of others.

References

Ahluwalia, M (2002): "Economic reforms in India since 1991: Has gradualism worked?", *Journal of Economic Perspectives*, vol. 16, no. 3, pp 67–88.

Baxter, M and M Kouparitsas (2005: "Determinants of business cycle comovement: a robust analysis", *Journal of Monetary Economics*, vol 52, pp 113–57.

Bekaert, G, C Harvey and C Lundblad (2007): "Financial openness and the Chinese growth experience", available at SSRN http://ssrn.com/abstract=991640.

Claessens, S and A Kose (2008): *Euromoney emerging markets handbook, foreword*.

Daude, C and E Stein (2007): "Longitude matters: Time zones and the location of foreign direct investment", *Journal of International Economics*, vol 71, pp 96–112.

Dooley, M, S Lizondo and D Mathieson (1989): "The currency composition of foreign exchange reserves", *IMF Staff Papers*, vol 36, pp 385–434.

Eichengreen, B and D Mathieson (2000): "The currency composition of foreign exchange reserves: retrospect and prospect', *IMF Working Paper no 00/131*.

Felettigh, A and P Monti (2008): "How to interpret the CPIS data on the distribution of foreign portfolio assets in the presence of sizeable cross–border positions in mutual funds. Evidence from Italy and the main Euro–Area countries", *Banca d'Italia Questioni di Economia e Finanza Occasional Paper no 16*, August 2008.

Gourinchas, P-O and H Rey (2007): "International financial adjustment", *Journal of Political Economy*, vol 115(4), pp 665–703.

Haldane, A (2009): "Rethinking the financial network", speech delivered at the Financial Student Association, Amsterdam.

Kaminsky, G and S Schmukler, S (2003): "Short-run pain, long-run gain: The effects of financial liberalization", *NBER Working Paper no 9787*.

Kose, A, C Otrok and E Prasad (2008): "Global business cycles: Convergence or decoupling?", *IZA Discussion Paper no 3442*.

Lane, P and G M Milesi–Ferretti (2001): “The external wealth of nations: Measures of foreign assets and liabilities for industrial and developing countries”, *Journal of International Economics*, vol 55, pp 263–94.

Lane, P 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*, November. Updated data provided by the authors.

Lane, P and G M Milesi–Ferretti (2008): “International investment patterns”, *Review of Economics and Statistics*, vol 90(3), pp 538–49.

Lane, P and J Shambaugh (2007): ‘Financial exchange rates and international currency exposures”, *NBER Working Paper no 13433*.

Lucas, R (1990): “Why doesn't capital flow from rich to poor countries?”, *American Economic Review*, *Papers and Proceedings*, vol 80, no 2, pp 92–96.

Levy–Yeyati, E and F Sturzenegger (2005): “Classifying exchange rate regimes: deeds versus words”, *European Economic Review*, vol 49, Issue 6, August 2005, pp 1603–35.

Martin, P and H Rey (2004): “Financial super-markets: Size matters for asset trade”, *Journal of International Economics*, vol 64, pp 335–61.

McGuire, P and N Tarashev (2008): “Global monitoring with the BIS international banking statistics”, *BIS Working Paper no. 244*.

McGuire, P and P Wooldridge (2005): “The BIS consolidated banking statistics: Structure, uses and recent enhancements”, *BIS Quarterly Review*, September 2005.

OECD (2000): “Main determinants and impacts of foreign direct investment on China's economy”, *OECD Directorate for Financial, Fiscal and Enterprise Affairs Working Papers on International Investment no 2000/4*.

Papaioannou, E (2009): “What drives international financial flows? Politics, institutions and other determinants”, *Journal of Development Economics*, vol 88, pp 269–81.

Portes, R and H Rey (2005): “The determinants of cross-border equity flows”, *Journal of International Economics*, vol 65, pp 269–96.

Prasad, E and S Wei (2005): “The Chinese approach to capital inflows: Patterns and possible explanations', *IMF Working Paper WP/05/79*.

Reserve Bank of India (2006): “Report of the Committee on Fuller Capital Account Convertibility”, Chapter 3, available at http://www.rbi.org.in/scripts/PublicationReportDetails.aspx?fromdate=09/1/06%\&SecId=21\&SubSecId=.

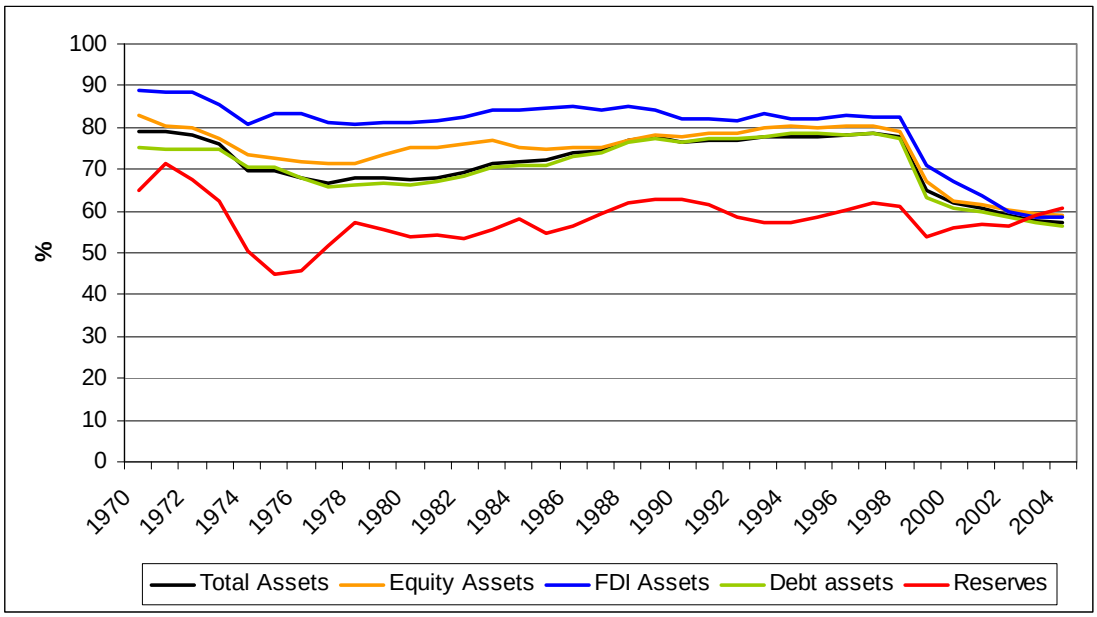
Rose, A and M Spiegel (2004): “A gravity model of sovereign lending: Trade, default, and credit”, *IMF Staff Papers,* vol 51 Special Issue, pp 64–74.

Von Peter, G (2007): “International banking centres: a network perspective”, *BIS Quarterly Review*, December 2007.

Watts, D and S Strogatz (1998): “Collective dynamics of ‘small-world’ networks”, *Nature*, pages 409-10.

Chart 1

Percentage of World's Total Assets accounted for by the 18 Countries in our Sample

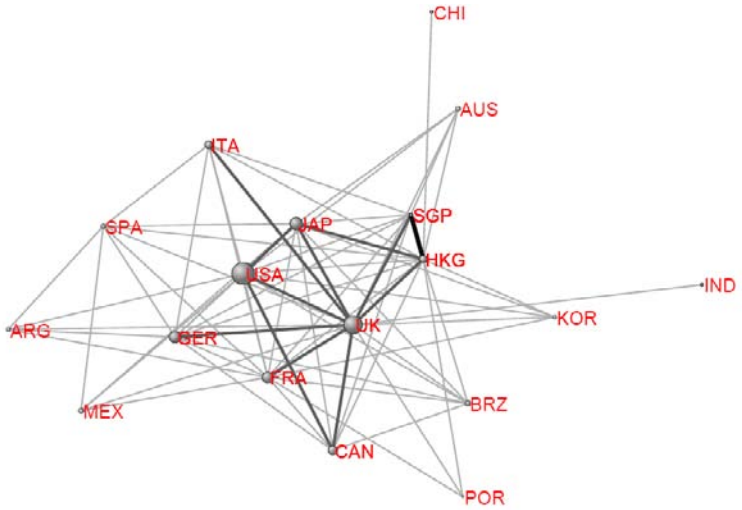


Source: Lane and Milesi-Ferretti (2001, 2007) dataset.

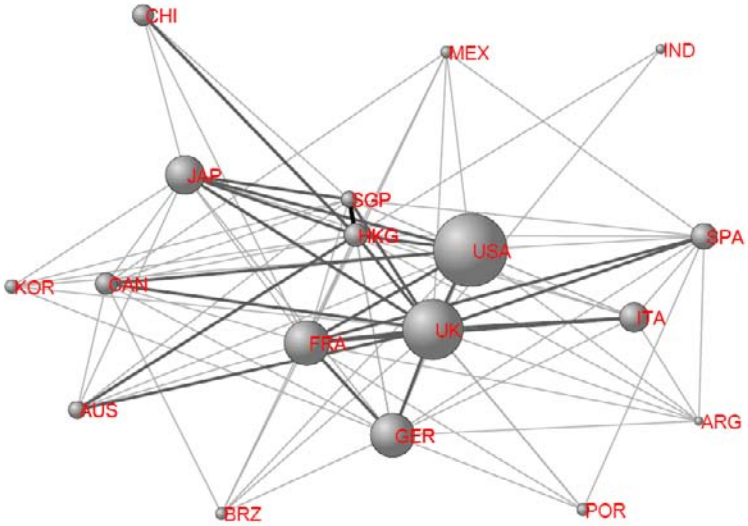
Chart 2

International Financial Network – Undirected

1985



1995



2005

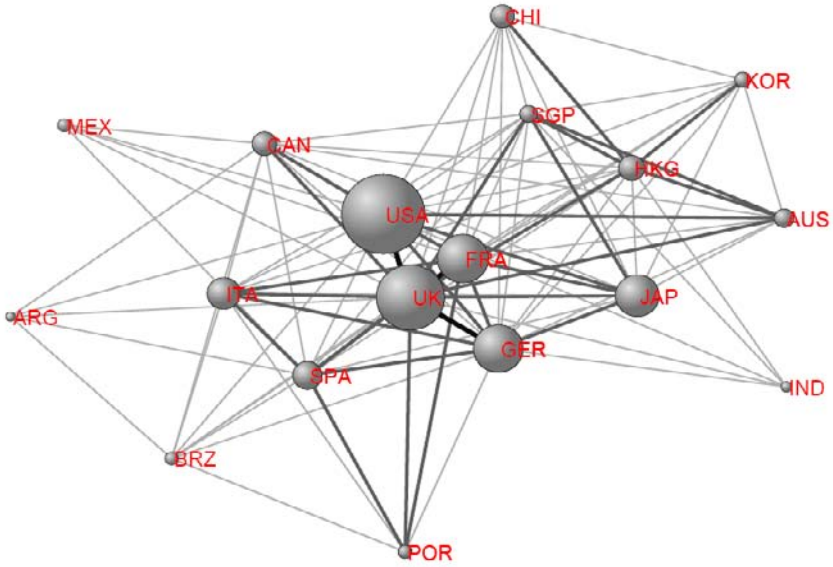
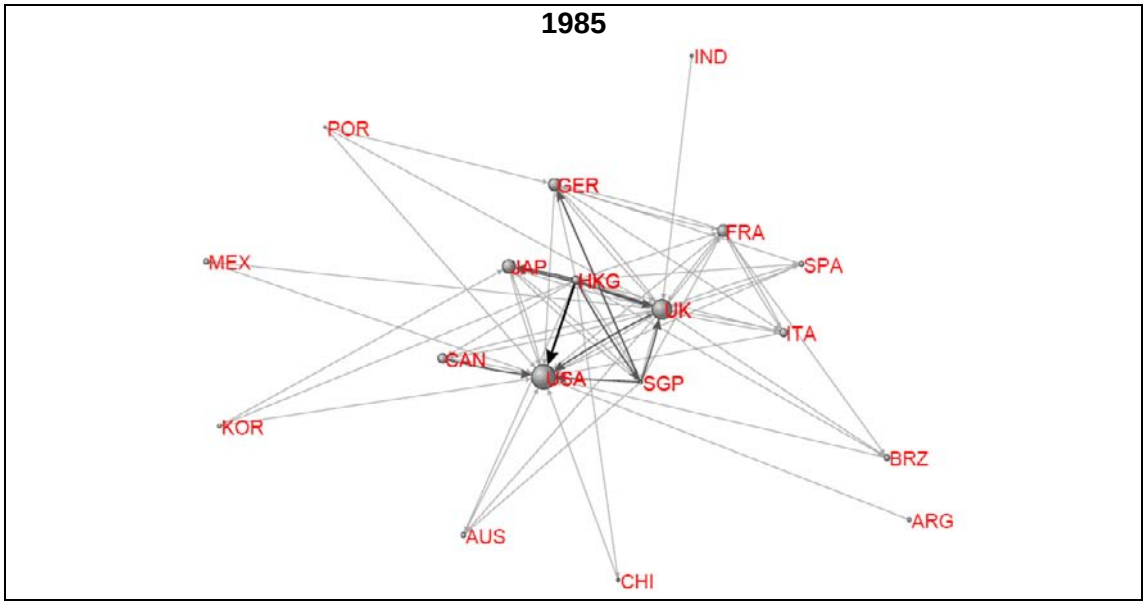


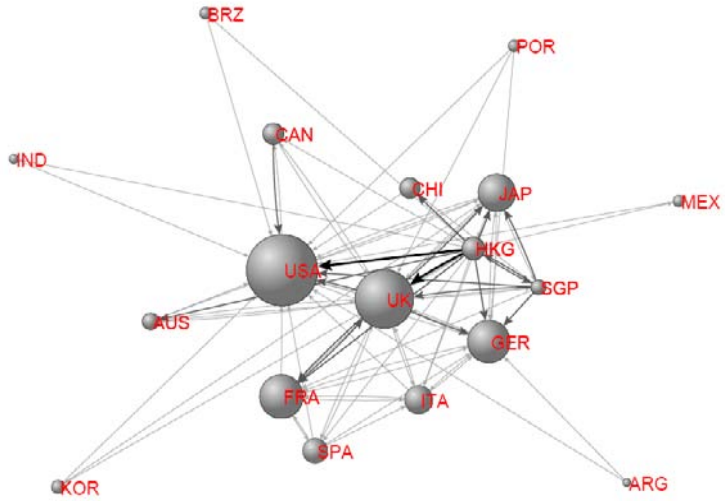
Chart 3

International Financial Network – Directed

1985



1995


BRZ
POR
CAN
IND
CHI
JAP
MEX
HKG
USA
SGP
UK
AUS
GER
FRA
ITA
SPA
KOR
ARG

2005

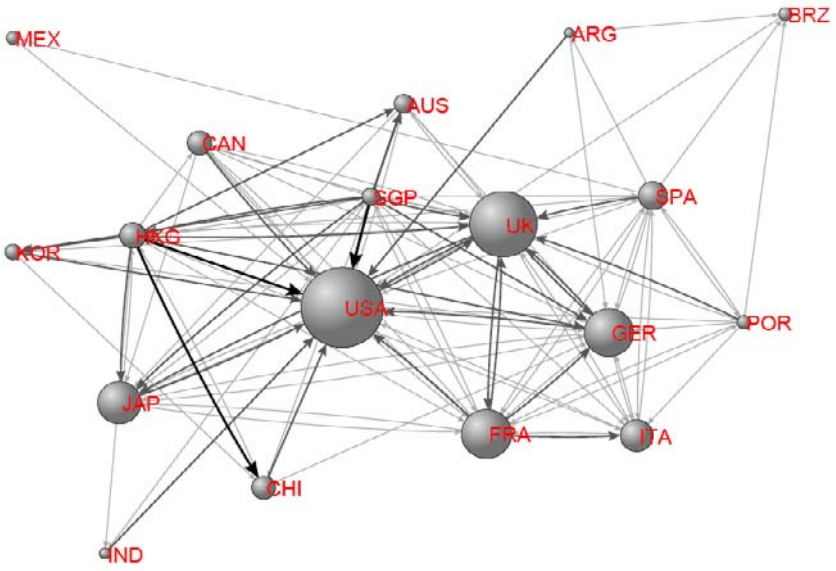
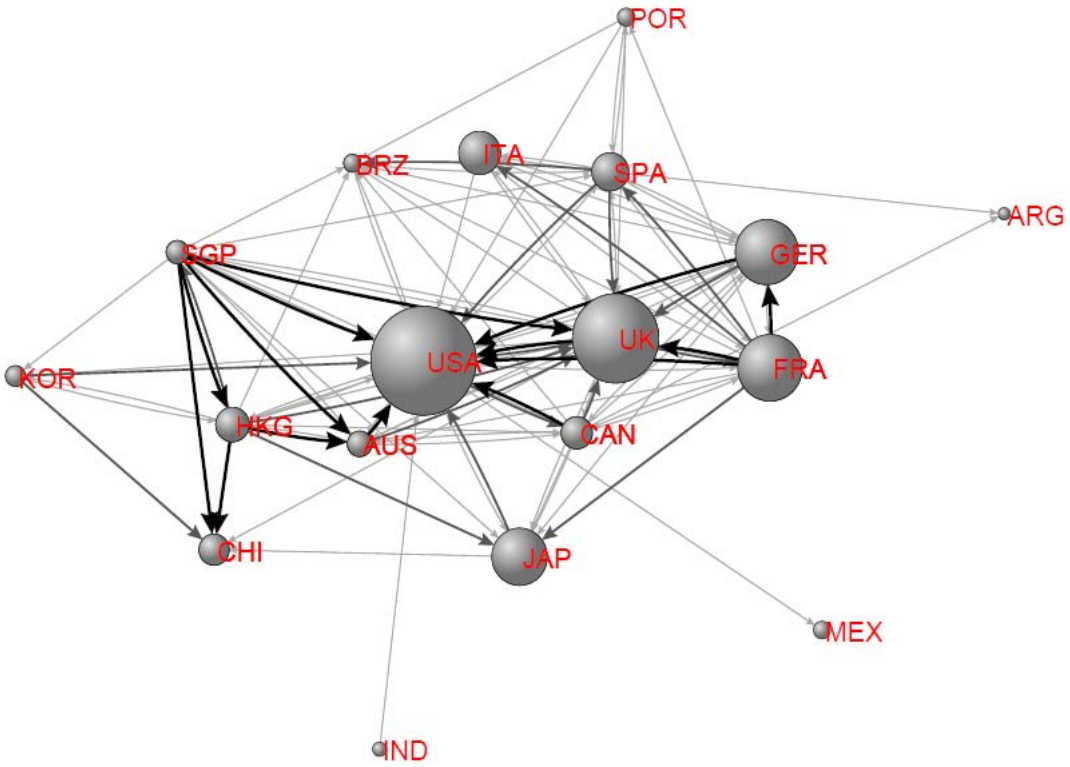

MEX
ARG
BRZ
AUS
CAN
SGP
SPA
UK
KOR
HKG
USA
GER
POR
JAP
FRA
ITA
CHI
IND

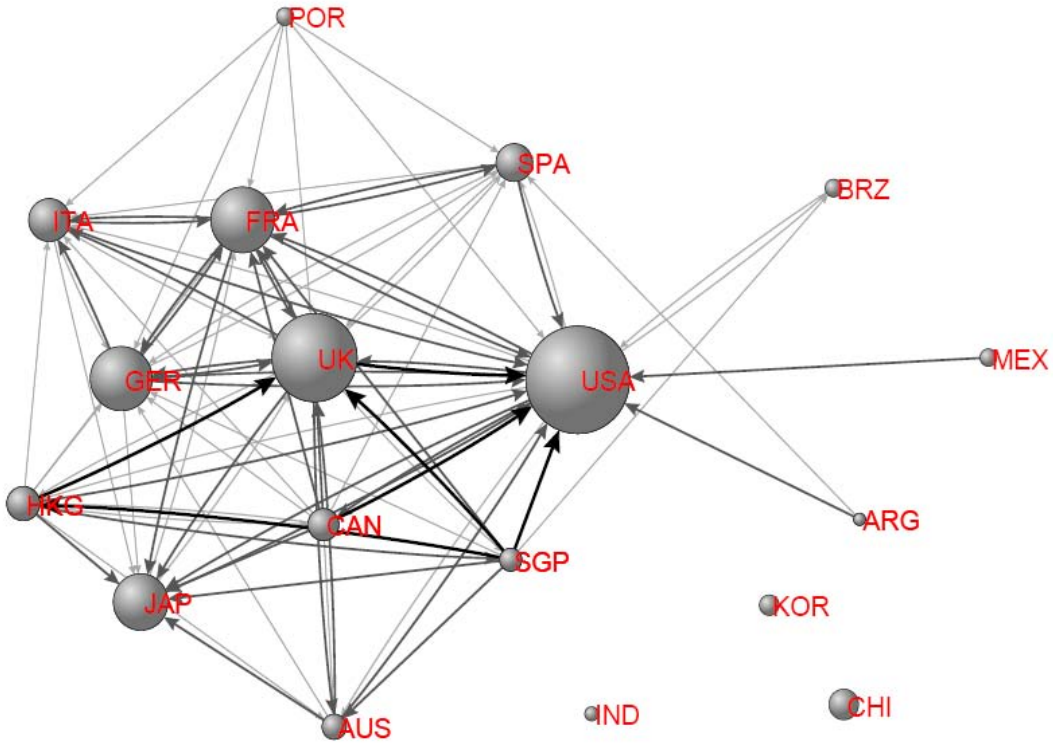
Chart 4

International Financial Network – Directed, by Asset Class, 2005

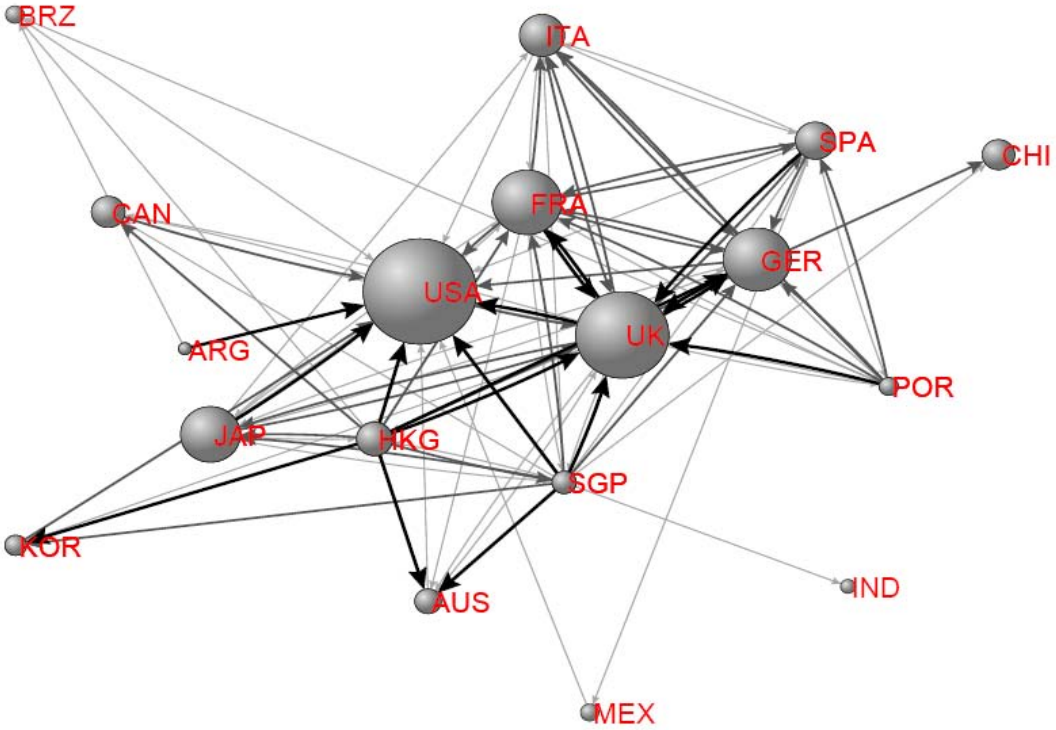
FDI



Equity



Debt



Reserves

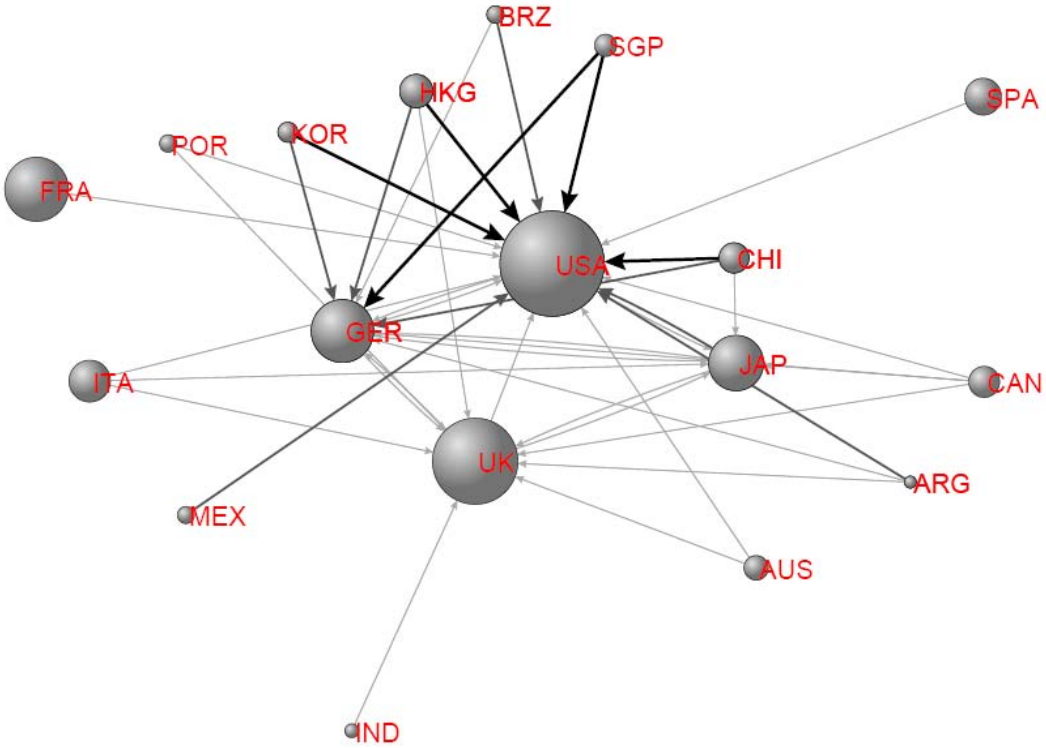
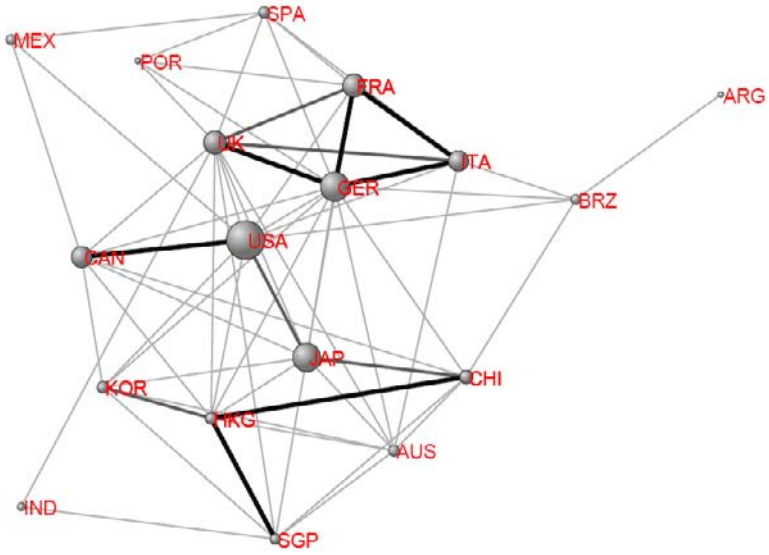


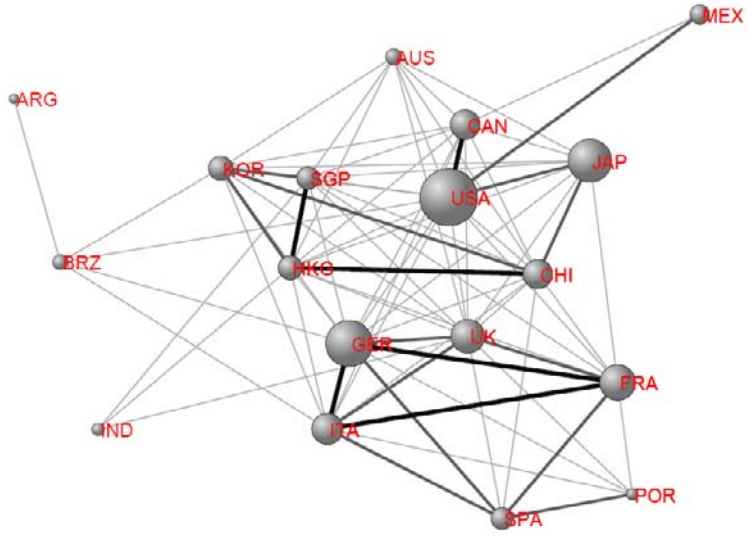
Chart 5

International Trade Network – Undirected

1985



1995



2005

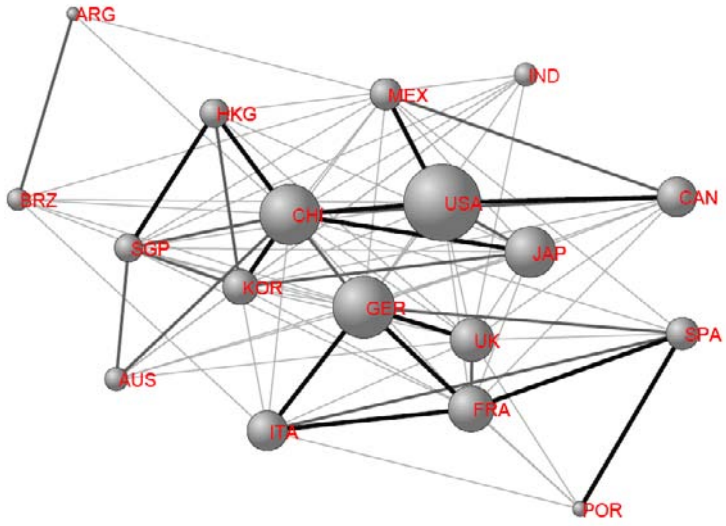
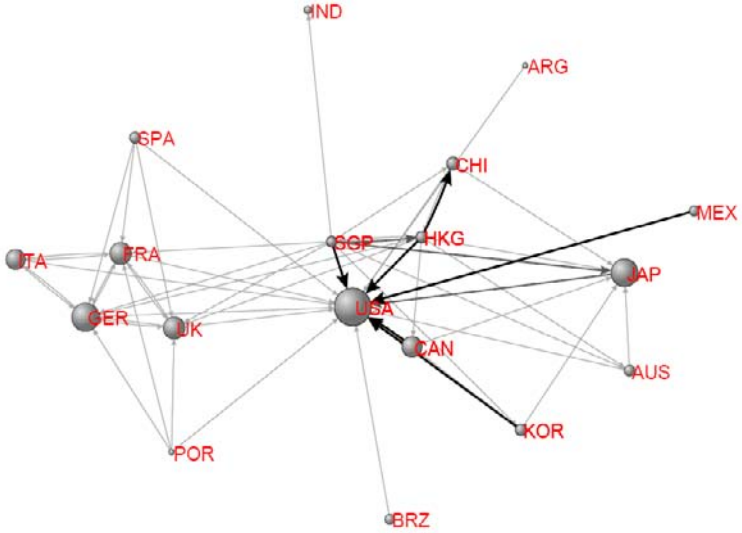


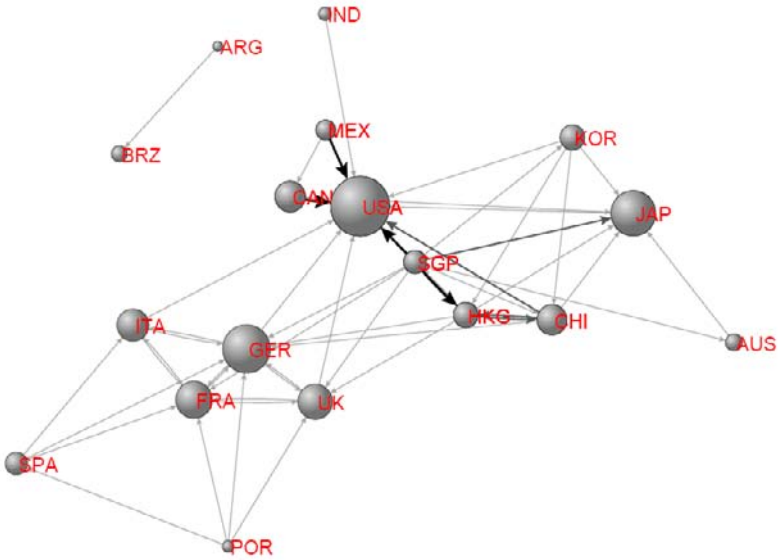
Chart 6

International Trade Network – Directed

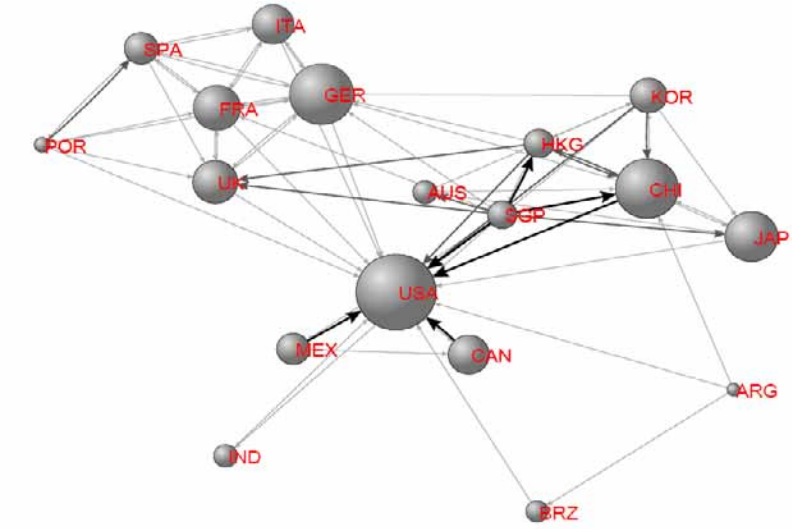
1985



1995



2005



Openness and geographic neutrality: How do they contribute to international banking integration?[1]

Iván Arribas, Francisco Pérez and Emili Tortosa-Ausina[2]

Abstract

The aim of this article is to develop new international financial integration indicators together with their determinants: financial openness and regularity (balance) of the bilateral financial flows. The study's contribution is based on the definition of the Standard of Perfect Financial Integration (SPFI). This standard characterizes the scenario attainable when financial flows are not geographically biased, and cross-border asset trade is not affected by home bias. We assess the gap between a hypothetical scenario of geographic neutrality and the current level of financial integration, along with both of its components. The empirical application to the banking systems of 18 countries – accounting for 83% of international banking markets – over the 1999–2006 period enables us to conclude that the level of financial integration has advanced rapidly over the last few years, and is close to 50% as of 2006, ie we are halfway to the SPFI. However, notable differences among countries are both persistent and growing, and the integration level achieved for each banking system differs when either assessed from the financial inflows or outflows perspective.

JEL Classification: F15, F21, F36, Z13

Keywords: Banking Integration, Financial Globalization, Geographic Neutrality, Network Analysis

1. Introduction

It is generally agreed that international integration is rapidly advancing in many economic activities, in particular finance. Capital markets are notable examples of the growing global interdependency, also evident in banking systems. At a regional level, it is also clear that monetary and financial integration acts as a starting point in the advance of economic and social integration processes. In the case of Europe, the monetary union and the plans to encourage the integration of financial services (Financial Services Action Plan, FSAP) are considered important leverages for construction of the European Union (European Central Bank, 2007).

---

[1] This paper is a result of the BBVA Foundation-Ivie Research Program. We thank Gordon Roberts, Nicole Allenspach, Rainer Haselmann, Stefanie Kleimeier, Lieven Baele, Gian Maria Milesi-Ferretti and Michele Manna for helpful comments. All three authors acknowledge the financial support of the Ministerio de Ciencia e Innovación (SEJ2007-66581, ECO2008-03813/ECON and ECO2008-05908-C02-01/ECON). Francisco Pérez and Emili Tortosa-Ausina also acknowledge the support of Generalitat Valenciana (PROMETEO/2009/066). Emili Tortosa-Ausina also acknowledges the financial support by Fundació Caixa Castelló-BANCAIXA (P1.1B2008-46). The authors are also grateful for the helpful comments by the editor, Bruce Mizrach, and a referee, as well as for excellent research assistance by Rodrigo Aragón and Juan Fernández de Guevara.

[2] Universitat de València; Universitat de València and Ivie; Universitat Jaume I and Ivie. Corresponding author: Emili Tortosa-Ausina, Departament d'Economia, Universitat Jaume I, Campus del Riu Sec, 12071 Castelló de la Plana, Spain. Tel.: +34 964387168, fax: +34 964728591, e-mail: tortosa@uji.es.

The advantages of an integrated financial market are associated with the hypothesis that participants follow a single set of rules, have identical access, and are treated equally (Beale et al, 2004; European Central Bank, 2007; García-Herrero and Wooldridge, 2007). Expected results of integration would be price convergence between different geographic markets and increasing cross-border allocation of investment. Cross-border integration can proceed gradually, either globally or regionally, because geographical proximity is still an important determinant of trade and financial flows (Berger et al, 2000; Portes et al, 2001; Portes and Rey, 2005). However, the development of remote access technologies in financial activities has taken off and, in cooperation with integration policies, makes it possible to bypass the traditional requirement of geographical proximity between suppliers of services and their customers.

Under these circumstances, the evaluation of financial and banking integration has received a great deal of attention.[3] Most of the results indicate that the convergence of interest rates and the increase in the proportion of cross-border activities confirm the advance of financial integration. However, it is necessary to evaluate the integration level achieved, as well as its trend. Regarding this, the current scenario is ambiguous, as the results hinge crucially on the indicators used. The results are often carried out without using precise criteria on the maximum value attainable by integration, and are therefore unsatisfactory.

With the aim of improving the available indicators of financial integration, this study develops three new indices, focusing on quantities. Following a suggestion by Frankel (2000), we shall call the central reference the Standard of Perfect Financial Integration (SPFI). This standard corresponds to the state achieved when financial cross-border assets and liabilities show no geographical bias, and are not influenced by distance or barriers between countries but only by the size of the financial systems.[4] The SPFI does not have a normative value. That is, it solely represents a benchmark – which perhaps is currently unavailable – that not only requires countries to be more financially open, but also to obtain a full and geographically unbiased development of the network of connections linking economies. Thus, the most important contributions of the study are that, developing the SPFI, we can measure the gap between the current level of international financial integration and the scenario of complete financial globalization, so as to evaluate the evolution of the level of international financial integration, as a starting point to analyse their determinants.

Previous initiatives to measure financial integration based on prices are preferred by many scholars when considering an axiomatic criterion – the compliance with the law of one price (LOOP) – in different geographical markets. The literature on financial integration based on the LOOP has grown rapidly over the last few years, owing to the existing data on prices.[5] However, the key problem of this approach is the lack of a benchmark to measure integration in the absence of perfect competition conditions, which is the most common situation in the case of banking markets. A unique price would only exist for homogeneous financial products, and not for others that can be differentiated. In this sense, convergence of interest rates is to be expected in markets, such as interbank and government bonds. However, this

[3] See the reviews by Cabral et al (2002). Lane and Milesi-Ferretti (2003), Baele et al (2004), Dermine (2006) among others. On the premise that integration is advancing, the literature has focused especially on the study of: a) the determinants of the degree of financial integration (Vo and Daly, 2007; Papaioannou, 2009); b) the consequences of integration, in particular on growth (Guiso et al, 2004); and c) the relationship between financial and commercial integration (Portes et al, 2001).

[4] Frankel (2000) indicates the need to define a Standard of Perfect International Integration, describing the conditions under which world trade web would operate as a global village.

[5] See Cabral et al (2002), Baele et al (2004), Flood and Rose (2005), Kleimeier and Sander (2006) or Vajanne (2006), among others.

is not the case in retail banking markets, which offer differentiated products for different investments and clients, in particular loans, credits and deposits.

In addition, this literature considers that the existence of a unique price suffices for economic or financial integration. However, even if trade, capital and monetary barriers are lifted and price differentials vanish, economic integration may not arise naturally as we must also take into account other factors such as the incentives of economic agents to go abroad, the institutional conditions of both the source and destination countries – especially in terms of property rights and law enforcement – and the influence of regulation, which is crucial for banks (Pérez et al, 2005).

The measures based on volume data are generally considered less satisfactory. As indicated by Manna (2004), this area of research has flourished comparatively less than the more established literature on prices/interest rates (see Dermine, 2002). Nevertheless, when thoroughly examined, quantity-based measures could contribute significantly to achieving a precise picture of integration. According to a recent state-of-the-art survey on economic globalization indicators (OECD, 2005), the current indicators are inordinately based on the old concept of market openness, which valuates the weight of external demand (export, import) in relation to national production (GDP). The objective of this is to understand whether a country and the rest of the world are given adequate attention in proportion to the importance of their economies. However, this approach has two important shortcomings.

The first one is that if the GDP is the denominator of the indicator for measuring the degree of financial openness, its meaning might be misleading because two separate processes are being convoluted: openness, and intensification of financial activities. Banking openness to the exterior could be measured as the weight of external assets when considering the balance sheet, AF/A, while financial intensity measures the proportion between the volume of financial activities and the real activity (A/GDP). Given that $AF/GDP = (AF/A)(A/GDP)$, and that the second term on the right-hand side has grown remarkably over the last decade in many countries, the GDP-based indicators of financial openness might have actually grown strongly even if the weight of the foreign assets did not increase remarkably in the balance sheet (AF/A). Therefore, although some available measures (see Pérez et al, 2005) consider GDP-based indicators as valid, we will not consider them because of the variety of meanings they may actually convey.

A further constraint when measuring the advance of international integration using the degree of openness, is that international integration is not only a question of increasing the openness of countries but also of developing a **network** of direct and indirect relations between economies. From the globalization perspective, the limitation of the degree of openness is that it completely disregards the architecture of financial trade connections that each country has with the rest of the world. In our objective to develop indexes of financial integration which take into account this complexity, two issues emerge as most relevant in the wide range of literature, and both are related to the geographic orientation of flows. First, the rationale for the biases observed in flows, at home or bilateral level; second, the analysis of the network of connections between countries.

At the beginning of the 21st century, several studies considered that, despite the forces that represent drastic reduction in global barriers to competition in the financial services industry (abolition of barriers, deregulation, improvements in information processing and telecommunications) the financial services industry, and retail banking in particular, currently remain far from globalized. The evidence suggests that borders continue to play an important role in the geographic orientation of financial flows, and that home bias is very relevant in the allocation of resources, as suggested by the equity home bias literature (see, for instance, Levy and Sarnat (1970). In particular, many banking services remain local, probably as a consequence of competitive advantages that the superior information of banks about local and non financial suppliers and customers represents (Berger et al, 2000, 2003; Berger, 2003). As found by Manna (2004), the share of cross-border banking activity is remarkably

lower for the four largest euro-area countries (Germany, France, Italy and Spain) than for the other countries. This factor indicates that geographical proximity and common language are still providing rationale for a home bias in banking retail products, whereas the effect is less pronounced in the wholesale segments, especially interbank markets.

The literature on gravity equations represents the most widely used empirical approach to explain the rationale for geographic biases in trade flows. The gravity equation relates international flows to different types of distance, and to the economic dimension (GDP's) of the source and destination countries. The success of the gravity model explaining data, increases interest by giving the gravity equation a structural interpretation in different ways. Adopting the gravity equation framework to describe the international asset flows is much more recent. The seminal paper by Portes and Rey (2005) merges elements of financial literature on portfolio composition, and international economics and asset trade literature. In their analysis, cross-border asset flows depend on market size in both source and destination country, as well as on trading costs, in which both information and transaction technology play a role. From this perspective, distance may also be important in the financial cross-border activities because it may be regarded as a proxy for information costs, and should enable the modest decline observed in home or regional biases of flows to be explained. Thus, the geography of information emerges as a main determinant of the pattern of international financial transactions.[6]

However, when geographic barriers disappear – because the importance of frontiers diminishes, and the cost of transport or information falls – , the effect of relative distance slowdowns and the shares of different countries in the financial inflows/outflows of a country ought to be closer to the GDP's shares. In an extreme scenario of eradication of every possibility of remoteness (Scholte, 2002), only the economic dimension of partners will matter.

The literature analyzing regionalism (and its effects on the intensity of intra-regional and extra-regional trade) also considers the problem of prioritizing some connections over others versus no-country, or no-regional, preference situation. The concept of geographic neutrality (Summers, 1991; Krugman, 1991, 1996) may be defined as the absence of preferential directions in flows. That is, the geographic distribution of a country's trade is said to be neutral if the weight of every partner in the country's trade is equal to its weight in the world trade.[7] Following a similar approximation in the financial area, Manna (2004) develops eight statistical indicators of the integration of the euro area banking system, two of which estimate home bias and the distance of the actual distribution of cross-border positions from the distribution prevailing under the assumption of no-country preference.

The situations of no-geographic preferences in flows will be an important reference to our analysis of the level of financial integration. They can be considered equivalent to the so-called “zero gravity” scenario (see, for instance, Eaton and Kortum, 2002), because distance does not matter and/or remoteness does not exit. In these scenarios, economies would be perfectly integrated through a complex network of connections, in which financial flows would be the vectors of a graph in which the nodes represent the countries, so it would be possible to analyze the degree of connectedness in the network. Although these techniques are

[6] Some recent studies have used gravity equations to describe financial flows; see, for instance, Buch and Lipponer (2007), Lane and Milesi-ferretti (2003), Papaioannou (2009) or Buch (2005).

[7] See also the cited literature in Gaulier et al (2004) for a discussion on the measures of regional trade intensity and their limitations.

somewhat underused by economists in comparison with other social sciences, this approach is not new in international economics,[8] and has attracted recent interest.[9]

Our analysis of financial integration shares two characteristics with the network analysis approach. First it pays attention to the number of connections and the way they are distributed. Second, we judge as important not only first-order relationships (direct links) but also higher order relationships (indirect links), since assets might cross several economies before reaching their final destination. Our integration index considers these aspects to define the SPFI, and to measure how far/close financial systems, or the global financial system as a whole, are to this scenario.

On the basis of these premises, the rest of the study develops indicators of financial integration which take into account the degree of financial openness, as well as

the regularity of the connections between countries' financial systems. The paper is structured as follows. In Section 2, we define the Standard of Perfect Financial Integration (SPFI), and characterize the indicators of the degree of financial openness, the degree of financial regularity, and the degree of financial integration for each country and for the global financial markets as a whole. In Section 3, we present the data used to apply our methodology to the case of banking systems, using available data on bilateral exchange of assets between a set of 18 countries, which represents 83% of the world financial assets in 2006. Sections 4 and 5 analyze the empirical evidence obtained on the integration of the banking systems, and Section 6 concludes.

2. Integration indicators: definitions and properties

The integration of international financial markets starts with the cross-border financial flows (foreign assets and liabilities). However, its effects and scope also depend on the structure of current relations between financial markets.[10] Relevant aspects of this structure include the number of countries each country is in contact with, and whether the relationships are direct or indirect (ie whether cross-border financial flows cross third economies). In addition, the volume of cross-border financial activity between them is also important, as well as the proportionality of this activity to the size of the financial markets.

If we consider financial globalization as synonymous of the highest possible level of financial integration, the flow from one country to another would only depend on their relative size because barriers to financial trade are lifted and there is no home bias effect. As suggested by the literature on home equity bias, investors should be able to exploit the benefits of international asset diversification, and not concentrate their investments in the assets of their home country (see, for instance Strong and Xu, 2003). Considering this global scenario, we will define the Standard Perfect Financial Integration (SPFI) as an extension of the concept of geographic neutrality (Krugman, 1996; Summers, 1991), and as a hypothetical benchmark that will not necessarily be reached if distance and other factors matter. Cross-country

---

[8] Several studies highlight the importance of information flowing through cultural, political or economic ties (Rauch, 2001; Rauch and Casella, 2003; Pandey and Whalley, 2004; Combes et al, 2005). For recent banking applications, see Mcguire and Tarashev (2006) or Von Peter (2007).

[9] Other studies suggest applying complex network analysis concepts, topological properties and instruments from different sciences developed to study the structure and dynamics of international trade, using instruments such as centrality, network density, clustering, assortative mixing or maximum flow. See, for instance Kali and Reyes (2009).

[10] Although we perform an application to cross-border banking activity, we will refer to financial/banking assets and liabilities interchangeably, in order to ease the readability and understandability of this section.

financial integration does not necessarily imply financial globalization according to the geographic neutrality criterion. A country whose cross-border financial flows are lower than those corresponding to the size of its total financial assets is as far from being integrated as another country whose financial flows are above that proportion. Both countries show an unbalanced situation, given that home (internal) financial flows and cross-border financial flows are not in accordance with the geographic neutrality criterion. Therefore, geographic neutrality implies that the proportion of home and foreign assets held by domestic investors should be proportional to the relative sizes of each financial system. The absence of geographic neutrality would be equivalent to the equity home bias effect (Lewis, 1999), where individuals hold too little of their wealth in foreign assets. However, the geographic neutrality concept is far more general, since deviations from equilibrium are explained away only by differences in the relative size of the financial systems.

Under the neutrality assumption, a balanced value for the cross-country financial activity exists, and the following property must be verified:

Home neutrality (P1): A country whose home financial assets are proportional to its share of the world financial market will have a higher level of financial integration.

Not only the total cross-border financial activity a country has is important, but also its distribution. In a global financial village, when there are no transaction (informational) costs or regional preferences, the distribution of the financial activity of a country between the destination countries should be characterized by their relative size. Under geographic neutrality, a country has no preferences of any kind (social, political, geographical, etc) for the direction of its financial cross-border flows, and they are only determined by the size of the recipient financial systems, as stated by the following property (P2),

Direct international neutrality (P2): a country that balances its direct financial relationships with other individual countries, in proportion to the size of their financial systems, will have a higher level of financial integration.

Financial flows between countries reflect only first-order relationships. However, higher-orders may also be relevant. The set of relationships established between countries operates like roads between cities. First, they allow countries to be connected even when there is no direct relationship between them. Second, there are different ways in which flows can reach their final destination, depending on the intermediating countries they cross. Goods, services, and capital may move from one country to another several times before arriving at its final destination. This possibility enables the interconnectivity of the world to increase, and therefore its integration,

Indirect international neutrality (P3): a country that reinforces its financial links with other countries through balanced indirect relationships which cross intermediating countries will have a higher level of financial integration.

A country can deviate from perfect financial integration due to some of the factors mentioned above. The impact of this deviation on financial globalization will depend on the size of every financial system. When a large economy departs from perfect integration, it reduces financial globalization to a larger extent than a small economy. For example, the influence of Germany on financial globalization is necessarily higher than, for instance, the influence of Greece. Thus, the integration index should also be weighted by the size of the financial systems.

Size (P4): the larger the financial market of a country, the more relevant its integration will be to the globalization of the world financial market system (global level of financial integration).

We say that the world achieves the SPFI if properties P1 to P4 are verified at the highest level, making this scenario an extension of the concept of geographic neutrality. Given its wider coverage, we name it geographic *superneutrality*.

In order to answer the question of how much countries meet the four properties above, we must define an integration index and assess the distance that sets the current level of

integration apart from the SPFI. We will proceed in four stages, each one defining different indicators, which correspond to the next four subsections. Furthermore, the analysis of the four indicators is conducted on two levels. The individual level focuses on each country, and the global level corresponds to the analysis of all economies. On the second level, the weight of each financial system enters the aggregation analysis and allows us to define our *Integration Index*.

Let us start with some definitions. Let $N = \{1, \ldots, g\}$ be the set of countries and let i and j be typical members of this set. Let g be the number of countries in N, ie the number of economies in the analysis. Given a measurable relationship between economies, we define the flow X_{ij} as the intensity of this relationship from economy i to economy j. In each year and for each balance-sheet indicator, we avail of a $g \times g$ matrix of data. To keep the presentation simple we omit the time index, unless this might generate confusion. The financial market activity between countries can be evaluated through either the cross-country flows of assets or liabilities. Moreover, in general the flow will be asymmetric, so that X_{ij} will not necessarily be equal to X_{ij}, for all $i, j \in N$; and also assume that X_{ii} measures the home assets or liabilities for all countries $i \in N$.

Let $X_i = \Sigma_{j \in N} X_{ij}$ be the size of the financial system of country $i \in N$. We define a_i as the country i's relative weight with respect to the world economy, ie $a_i = X_i / \Sigma_{j \in N} X_j$.

2.1 Degree of financial openness

In the first stage we characterize the *degree of financial openness*. We start with the usual definition but corrected for home bias to take into account the differing sizes of the financial systems of the countries being compared. Thus, we are taking into account that domestic investors hold a proportion of home assets, and that its volume will vary depending on the size of each particular financial system.[11] In order to control for home bias, we define $\hat{X}_i$ as the foreign claims of country i (ie assets held abroad by banks of country i, in case we considered data on bank flows) taking into account the weight in the world financial system of the country under analysis, namely, $\hat{X}_i = X_i - a_i X_i$. We then define the relative flow (cross-border banking assets or liabilities) or **degree of financial openness** between countries i and j as $DFO_{ij} = X_{ij} / \hat{X}_i$.

Definition 1: *Given a country $i \in N$, we define its **degree of financial openness***, DFO_i, as

$$DFO_i = \sum_{j \in N \setminus i} DFO_{ij} = \frac{\sum_{j \in N \setminus i} X_{ij}}{\hat{X}_i}. \qquad (1)$$

By definition the degree of financial openness takes the value of 1 if and only if home neutrality is verified (P1). The degree of financial openness yields nonnegative results, where a value lower than 1 indicates that its cross-border bank flows are lower than the corresponding ones, given the country's share of the world banking assets. In the unlikely instances of values higher than 1, it would indicate that country i's cross-border bank flows are higher than those it should have given the country's share of the world banking assets.

[11] As documented by the literature on home equity bias, the proportion of domestic assets held by domestic investors is too big relative to the predictions of the standard portfolio theory (see Lewis, 1999). We consider that it should be proportional to the size of the home financial system.

Differences in DFO among countries can be attributed to different barriers to financial integration (lack of information, regulations, political or cultural factors, economic riskiness, etc). However, differences in the measure of financial openness cannot be caused by the bias due to country size, since we have corrected for home bias.[12]

2.2 Degree of regularity of direct financial connections

In this second stage we analyze whether the connection of one country with others is proportional to the differing financial systems' sizes, or whether this connection does not show geographical neutrality. The latter instance would contribute to widen the gap between the current level of financial integration and the scenario corresponding to a financially globalized world according to the direct international neutrality property (P2). Thus, we define the *degree of regularity of direct financial connections* to measure the discrepancy between the cross-border financial flows in the real world and those corresponding to the SPFI.

In the financial network, the relative flow from country i to country j in terms of the total financial flows of country i, α_{ij}, is given by

$$\alpha_{ij} = \frac{X_{ij}}{\sum_{j \in N \setminus i} X_{ij}}, \tag{2}$$

where $i \neq j$ and $\alpha_{ii} = 0$ (recall that $X_{ii} \neq 0$). Let $A = (\alpha_{ij})$ be the square matrix of relative flows: the component ij of matrix A is α_{ij}.

We consider that the global financial system is perfectly connected if the financial flows between two countries are proportional to the relative size of their financial systems. A country that is part of a perfectly connected world financial system will hold assets in other countries in proportion to the size of the destination countries.

On the other hand, if the world economy is perfectly connected, then the flow from country i to country j should be equal to $\beta_{ij} = \widehat{X}_i$, where

$$\beta_{ij} = \frac{X_j}{\sum_{k \in N \setminus i} X_k}, \tag{3}$$

is the relative weight of country j in a world where country i is not considered.

Note that $\sum_{j \in N \setminus i} \beta_{ij} = 1$ and that β_{ij} is the degree of financial openness between countries i and j in the perfectly connected world, with $\beta_{ii} = 0$. Let $B = (\beta_{ij})$ be the square matrix of degrees of openness in the perfectly balanced connected world.

Starting from the previously defined matrices, we can define an indicator that measures the distance between the real distribution of financial flows and that corresponding to a perfectly balanced connected world. We consider the cosine of the angle of the vector of relative flows with the vector of the flows in a perfectly connected world.

Definition 2: *Given an economy $i \in N$, we define its* ***degree of regularity of direct financial connections*** of i, $DRDFC_i$, as

[12] We write DFO instead of DFO_i when general statements on the degree of financial openness are being made, or references to the variable itself, which do not hang on any specific country. The same rule will be applied to the other indicators.

$$DRDFC_i = \frac{\sum_{j \in N} \alpha_{ij} \beta_{ij}}{\sqrt{\sum_{j \in N} (\alpha_{ij})^2} \sqrt{\sum_{j \in N} (\beta_{ij})^2}} \quad (4)$$

Although the cosine of two vectors ranges between –1 and 1, the degree of direct financial connections always takes nonnegative values given that both vectors have only nonnegative components. $DRDFC$ measures whether financial systems meet P2, providing a single value that equals 1 if and only if a country meets the property of direct international neutrality, and approaches zero for a country whose cross-border financial flows are directed towards the smallest financial systems.

2.3 Degree of regularity of total financial connections

In the third stage, we consider the indirect relationships between countries along with their importance. In order to extend the analysis of financial market integration in this direction, we define the *degree of regularity of total financial connections*, which evaluates the importance of all direct and indirect relationships that countries establish with each other.

Both the real world matrix A and the perfectly connected world matrix B consider *direct* relative flows between countries. However, part of the flow from country i to country j may cross third countries, and those *indirect* flows also contribute to integration. This problem may be especially severe if we take into account the existence of asset trades which are conducted through intermediaries in third countries such as the financial centres of the UK and the Caribbean. As indicated by Warnock and Cleaver (2003), cross-border transactions with foreign counterparties are often intermediaries, and therefore the majority of flows are attributed to financial centres.

Let $A^n = A \cdot \overset{n}{\cdots\cdots} A$ be the n-times product matrix of matrix A and let α_{ij}^n be the element ij of A^n. It is not difficult to show that α_{ij}^n is the relative flow that goes from i to j crossing $n-1$ intermediate countries. Moreover, it is verified that $0 \leq \alpha_{ij}^n \leq 1$ for $n > 1$. In the same way we define B^n, the elements of which evaluate the flow passing through all countries in a perfectly connected world.

Let $\gamma_i \in (0,1)$ be the proportion of flow that country i receives from another country and remains invested in the first one, while $1 - \gamma_i$ is the proportion of received flow that a country redirects to another country. For estimating γ_i, an additional assumption is needed. Let us assume that this proportion is equal to the proportion of financial flows of country i that remain as home financial investment. If country i verifies this assumption, then the following equality holds,

$$X_i^F = (1-\gamma_i) L_i^H + (1-\gamma_i) L_i^F = (1-\gamma_i) L_i ,$$

where X_i^F is the country i assets issued from other countries and L_i^H are the home liabilities. Given that $L_i = X_i$ it implies that $1-\gamma_i = \sum_{j \in N \setminus i} X_{ij} / X_i$ or equivalently

$$\gamma_i = X_{ii} / X_i , \quad (5)$$

Therefore, under our assumption γ_i is the proportion of financial flows that are internally invested in country i. Of course, the procedure to estimate γ_i will hinge on the flow considered – either inflow or outflow.

Let Γ be the square diagonal matrix of direct flow proportions, so that the element ii of Γ is γ_i and the element ij for $i \neq j$ is zero. The matrix of total flows from one country to another is the sum of the direct and indirect flows and can be estimated as

$$A^{\Gamma} = \sum_{n=1}^{\infty} \Gamma(I - \Gamma)^{n-1} A^n \,, \tag{6}$$

$$B^{\Gamma} = \sum_{n=1}^{\infty} \Gamma(I - \Gamma)^{n-1} B^n \,, \tag{7}$$

where I is the identity matrix of order g. Both expressions depend on matrix Γ.

Let α_{ij}^{Γ} be the element ij of the matrix A^{Γ} and β_{ij}^{Γ} be the element ij of the matrix B^{Γ}. Each element of these matrices is the weighted sum of the direct and indirect flows through any possible number of intermediate economies. we can verify that the above two series are convergent.

Definition 3: *Given an economy $i \in N$, we define its* ***degree of regularity of total financial connections*** of i, $DRTFC_i^{\Gamma}$ as

$$DRTFC_i^{\Gamma} = \frac{\sum_{j \in N} \alpha_{ij}^{\Gamma} \beta_{ij}^{\Gamma}}{\sqrt{\sum_{j \in N} (\alpha_{ij}^{\Gamma})^2} \sqrt{\sum_{j \in N} (\beta_{ij}^{\Gamma})^2}} \,. \tag{8}$$

The degree of financial regularity of total connections ranges in the $(0, 1)$ interval. It measures the distance of the direct and indirect financial flows of a country from what its financial flows would be in a perfectly connected world financial system. Similarly to the degree of financial regularity of direct connections, it should equal 1 when the financial flows of a country are proportional to the size of the recipient countries (indirect international neutrality). It should be close to zero if the largest countries do not receive any financial inflows and the smallest receive all of them.

We should bear in mind that if there are no indirect flows, ie $\gamma_i = 1$ for all countries, then expressions (6) and (7) yield $A^{\Gamma} = A$ and $B^{\Gamma} = B$. Thus, the degrees of regularity of total connections and regularity of direct connections coincide. The limit case $\gamma_i = 0$ (financial products and services go through an infinite number of transformations before reaching their final destinations) cannot be derived directly from the above expressions. The basic limit theorem of Markov chains is needed to show that when $\gamma = 0$ the proportion of flow a country j receives from a country i is independent of i, ie all countries send the same proportion of flow to economy j.[13]

2.4 Degree of financial integration

From the concepts above we define the *degree of financial integration*, which combines degrees of financial openness and financial regularity of total connection, provided that both set limits to the financial integration level achieved.

[13] By definition we verify that $\Sigma_{j \in N}\, \alpha_{ij} = \Sigma_{j \in N}\, \beta_{ij} = 1$, thus both matrices A and B define Markov chains and it can be proved that they are recurrent irreducible aperiodic Markov chains.

Definition 4: *Given an economy $i \in N$, we define its* ***degree of financial integration***, DFI_i^{Γ} as

$$DFI_i^{\Gamma} = \sqrt{\min\{1/DFO_i, DFO_i\} \cdot DRTFC_i^{\Gamma}} \,. \tag{9}$$

The degree of financial integration of a given country is the geometric average of its deviation from the balanced degree of financial openness and financial regularity of total connections. Therefore, DFI depends on both the openness of the banking system and the balance in its direct and indirect flows with other financial systems. Moreover, if and only if the financial system verifies properties P1 to P4, then DFI will be equal 1.

If $DFI_i^{\Gamma} = \sqrt{\min\{1/DFO_i, DFO_i\} \cdot DRTFC_i^{\Gamma}}$, then

$$1 = \sqrt{\frac{\min\{1/DFO_i, DFO_i\} \cdot DRTFC_i^{\Gamma}}{DFI_i^{\Gamma}}} \sqrt{\frac{DRTFC_i^{\Gamma}}{DFI_i^{\Gamma}}} \,, \tag{10}$$

and we can interpret each of these two factors as the weight that the degrees of openness and regularity of total connections have over the degree of integration. In a given economy, this can be useful to analyze changes over time in the weight of the factors.

2.5 Other global indicators

In the previous subsections we have defined several indicators that characterize the integration of each individual country and that, as the degree of financial integration, can also be summarized for the whole economy:

Degree of global financial openness:

$$DGFO = \sum_{i \in N} a_i DFO_i \,. \tag{11}$$

Degree of regularity of global direct financial connections:

$$DRGDFC = \sum_{i \in N} a_i DRDFC_i \,. \tag{12}$$

Degree of regularity of global total financial connections:

$$DRGTFC^{\Gamma} = \sum_{i \in N} a_i DRTFC_i^{\Gamma} \,. \tag{13}$$

To characterize the integration of the whole economy, we should consider the share of each economy in the world (property 4) to define the global indicator as follows (recall that $a_i = X_i / \Sigma_{j \in N} X_j$),

Definition 5: *We define the* ***degree of financial integration (globalisation) of the whole economy*** as

$$DGFI^{\Gamma} = \sum_{i \in N} a_i DFI_i^{\Gamma} \,. \tag{14}$$

The $DGFI$ indicator is the most general quantitative approximation to the international financial market integration of countries, as it considers not only the degree of financial openness, but also the distribution of the direct and indirect flows between countries, and the size of a country's financial system. In light of the different concepts included in this definition, the indicator will be considered as a Globalization Index for the world financial system, according to properties P1 to P4. The first three properties are an increasing function

of $DGFI$ for any country. Property P4 is verified because $DGFI$ is a weighted average of the countries' degree of integration, where the weight of each country depends directly on its size. The degree of financial integration measures how close the world is to the SPFI, which should be equal to 1 when all countries are perfectly integrated and achieve their theoretical potential of integration in a world without any remoteness.

2.6 Bipartite decomposition of the factors affecting financial integration

Our decomposition of the factors affecting international financial integration is presented in Equation (9). The identity holds if we consider the different indicators at different points in time, ie:

$$\frac{DFI_{i,c}}{DFI_{i,b}} = \left(\frac{DFO_{i,c}}{DFO_{i,b}}\right)^{1/2} \times \left(\frac{DRTFC_{i,c}}{DRTFC_{i,b}}\right)^{1/2}, \tag{15}$$

where b indicates a base period and c indicates a current period – or simply a more recent period than b.

For simplicity, we may denote by lower-case letters the square roots of the ratios of current period divided by base period indicators, for both DFO and $DRTFC$, ie:

$$dfo = \left(\frac{DFO_{i,c}}{DFO_{i,b}}\right)^{1/2}, \tag{16}$$

and

$$drtfc = \left(\frac{DRTFC_{i,c}}{DRTFC_{i,b}}\right)^{1/2}. \tag{17}$$

Therefore, expression (15) becomes:

$$DFI_{i,c} = dfo \times drtfc \times DFI_{i,b}. \tag{18}$$

Thus, the distribution of the degree of financial integration in the current period (DFI_c) can be constructed by successively multiplying the degree of financial integration in the base period (DFI_b) by each of the two factors, ie degree of financial openness and degree of regularity of total financial connections. This in turn allows us to construct counterfactual distributions by sequential introduction of each of these factors.

Specifically, the counterfactual c period degree of financial integration distribution of the variable

$$DFI^{DFO} = dfo \times DFI_b, \tag{19}$$

isolates the effect on the distribution of changes in the degree of financial openness only, assuming that the degree of total connection is irrelevant.

Therefore, the shift from DFI_b to DFI_c would be induced by changes in the degree of financial openness only.

On the other hand, the counterfactual c period degree of financial integration distribution of the variable

$$DFI^{DRTFC} = drtfc \times DFI_b, \tag{20}$$

then isolates the effect of the degree of total connection, as if the degree of openness were irrelevant. Therefore, the shift from DFI_b to DFI_c would be induced by changes in the degree of regularity of total financial connections only.

3. Data

Our data set contains information on both total assets of the different banking industries under analysis, and bank foreign claims for both financial outflows and inflows. That is, assets held abroad by banks of a given country (outflows), and bank assets of a given country owned by foreign banks (inflows). The data on bilateral banking financial assets are provided by the Bank of International Settlements (BIS),[14] which issues quarterly the international claims of its reporting banks on individual countries, geographically broken down by nationality of the reporting banks. Our data contains information on the largest world economies, and also on some specific countries with large banking systems such as Switzerland, to the total of 18 countries. The data on total assets are provided by the European Central Bank for European Union countries, and by the central bank of each country, with some exceptions.

Our dataset is also crucially determined by the available information, which was incomplete in terms of countries and sample years. Finally, only eighteen countries and eight years (1999–2006) were selected to perform the analysis. Stretching the sample period in both dimensions, ie countries selected and length of the period, led inevitably to incomplete data sets and difficulties for drawing conclusions on the dynamics of financial globalization. Furthermore, even if some additional countries for which information was available for some years were included in the sample,[15] the gains in terms of total bank assets were not substantial, as the constrained sample accounted for more than 90% of the enlarged sample.

Our data also refers to flows from consolidated banks, constituting a clear advantage to avoid double counting compared to using unconsolidated balance sheet data, which is the usual approach followed by many other studies on banking integration. Table 1 provides information on these matters. As shown by columns five and six, it is quite apparent that the US financial system is far less “bancarized” than large European countries such as Germany, Italy, France, or Spain. As of 2006, the share of the US banking system was quite small (14.84%), especially taking into account the size of the US economy. As also indicated in Table 1, the total assets of the US banking system in terms of GDP are well below those of the other countries in the sample.

Cross-border claims have also been increasing sharply for all countries and, as documented by some authors, today they are over 30 times larger in absolute terms than thirty years ago (Mcguire and Tarashev, 2006). This information is reported in columns seven through twelve. For all countries there has been a sharp increase in foreign claims from 1999 to 2006, not only in absolute terms (columns 11–12) but also as a % or GDP (columns 7–8) or as a % of total assets (columns 9–10). Finally, columns 13–16 report information on the representativeness of our sample, which varies depending on the country but is generally quite high.

[14] See http://www.bis.org/statistics/histstats10.htm.

[15] Australia, Brazil, Canada, Chile, Mexico, Panama and Chinese Taipei.

Table 1

Data by country: 1999 and 2006

Country	Total bank assets[1]		Shares of international markets		Total assets as % of GDP		Total consolidated foreign claims as % of national GDP		Total consolidated foreign claims as % of total assets[1]		Total consolidated foreign claims		Total consolidated foreign claims of the sample countries as % of their total foreign claims		Total consolidated foreign claims of the sample countries as % of total assets	
	1999	2006	1999	2006	1999	2006	1999	2006	1999	2006	1999	2006	1999	2006	1999	2006
Austria	489	1,040	1.4	1.6	229.4	322.6	47.6	126.0	20.8	39.1	67	166	66.3	40.9	13.8	16.0
Belgium	719	1,481	2.0	2.3	283.2	377.8	151.7	283.5	53.6	75.0	319	944	82.8	85.0	44.4	63.8
Canada	1,120	2,285	3.2	3.5	172.0	182.6	44.9	50.2	26.1	27.5	251	528	85.9	84.1	22.4	23.1
Denmark	356	827	1.0	1.3	204.9	300.5	28.8	82.8	14.0	27.6	32	181	64.5	79.2	9.1	21.8
Finland	120	357	0.3	0.5	93.3	170.7	24.3	47.0	26.0	27.5	25	71	79.5	72.2	20.7	19.9
France	3,644	8,127	10.3	12.4	250.3	364.3	57.7	117.2	23.0	32.2	662	2,145	78.9	82.1	18.2	26.4
Germany	5,705	9,422	16.1	14.3	266.1	324.2	80.6	121.9	30.3	37.6	1,334	2,816	77.2	79.5	23.4	29.9
Greece	182	423	0.5	0.6	148.3	172.6	NA	25.4	NA	14.7	NA	17	NA	27.4	NA	4.0
Ireland	304	1,915	0.9	2.9	315.1	860.2	78.0	281.0	24.7	32.7	69	545	92.3	87.1	22.8	28.4
Italy	1,649	3,780	4.7	5.8	137.4	204.9	21.5	22.9	15.7	11.2	198	272	76.7	64.5	12.0	7.2
Japan	7,517	6,300	21.3	9.6	172.9	145.2	23.6	42.7	13.7	29.4	763	1,339	74.3	72.2	10.1	21.3
Netherlands	988	2,467	2.8	3.8	237.8	375.1	97.3	317.1	40.9	84.5	312	1,873	77.2	89.8	31.6	75.9
Portugal	251	524	0.7	0.8	205.9	272.1	37.1	64.1	18.0	23.6	30	89	66.6	72.1	12.0	17.0
Spain	1,049	3,313	3.0	5.0	169.7	270.7	41.3	80.7	24.3	29.8	195	899	76.4	90.9	18.6	27.1
Sweden	478	1,103	1.4	1.7	188.4	286.7	35.7	157.7	19.0	55.0	70	430	76.8	70.8	14.6	38.9
Switzerland	1,403	2,618	4.0	4.0	529.6	689.3	363.8	648.4	68.7	94.1	887	2,115	92.0	85.9	63.2	80.8
United Kingdom	3,802	9,993	10.8	15.2	259.6	426.1	59.1	132.0	22.8	31.0	565	2,253	65.3	72.8	14.9	22.6
United States	5,597	9,751	15.8	14.8	60.7	73.9	7.4	10.1	12.1	13.7	468	921	69.0	69.1	8.4	9.5

[1] In billions of current US$.

The analysis performed in the ensuing sections will focus on both directions of foreign claims. That is, not only on bank assets held abroad by banks of a given country (cross-border bank outflows) but also on bank assets of each country owned by foreign banks (cross-border bank inflows). We will refer to each direction using the *out* and *in* superscripts, in order to refer to outflows and inflows, respectively. Table 1 contains information on outflows only, so as to save space and also because the information on total consolidated foreign claims of the sample countries either as a percentage of their total foreign claims or their total assets (ie the information reported by columns 13–16) is not available for inflows.

4. Empirical evidence: the integration of the international banking systems

4.1 Degree of financial openness

Table 2 shows the results of the degree of financial openness for years 1999 and 2006 – ie the initial and final sample years. The first two columns refer to assets held abroad by banks of each country listed, whereas columns three and four refer to bank assets of a given country owned by foreign banks. Results vary a great deal in several dimensions. Looking at country differences, we notice that the most open financial systems in terms of assets held abroad as of 2006 are those of Switzerland, the Netherlands, and Belgium, indicating that the assets held abroad by banks from these countries represent the 85.2%, 75.8%, and 66.0% of their total assets. These are important international financial centres, and therefore have large external portfolios (Lane and Milesi-ferretti, 2008). Although these are small countries, we must take into account that when dividing by total assets we control for home bias. That is, the fact that the share of cross-border activity is markedly lower for the largest country (Manna, 2004), and therefore countries with the largest banking markets could have also high degrees of financial openness. In contrast, the Greek, Italian and US banking markets are far less internationalized, as shown by degrees of financial openness of 4.0%, 8.0%, and 10.5% by 2006. Even if we control for home bias, the assets held abroad by banks in these countries are extremely low.

These results vary, not only across countries but also over time. Indeed, many countries show cross-border bank flows which have increased sharply. In some cases such as Denmark, the Netherlands, or Sweden they have more than doubled, while in others they have also been substantial but more moderate. Of special note is the case of some large European countries whose degrees of openness have increased a great deal. However, this is not entirely attributable to the effect of the euro, since some of the largest increases have taken place in countries which have not yet adopted the single currency (basically Denmark and the UK).

These patterns vary when considering the international bank flows in the opposite direction, ie the bank assets of each country in the table owned by foreign banks. Results differ greatly, especially for the most extreme cases. Indeed, the correlation coefficient is –38.2% for year 2006, and this highly negative sign holds for all sample years. Some countries whose DFO^{out} was quite high, such as Switzerland, have now become much more closed. On the other hand, the US is quite open in terms of bank assets in the US held by foreign banks. Disparity in the results is the general tendency. Apart from the US some countries have now become much more open – such as Finland, Greece, Italy, Portugal, or the UK In contrast, others become less financially open – Belgium, Canada, France, Germany, Japan, the Netherlands, Sweden, and Switzerland.

Table 2

Degree of financial openness (DFO)

In per cent

Country	DFO_i^{out}		DFO_i^{in}	
	1999	2006	1999	2006
Austria	13.77	16.17	16.90	18.22
Belgium	45.47	66.02	25.38	28.56
Canada	22.66	24.10	11.48	12.79
Denmark	9.24	22.39	15.02	30.60
Finland	20.42	20.02	30.29	44.88
France	21.62	33.34	11.83	15.95
Germany	32.03	39.75	11.45	16.05
Greece	NA	3.96	24.33	44.62
Ireland	23.10	30.17	35.15	34.11
Italy	12.20	7.99	24.98	28.93
Japan	15.29	24.53	8.20	11.01
Netherlands	29.05	75.80	28.36	32.83
Portugal	11.54	16.23	20.38	34.36
Spain	14.00	22.99	15.07	25.12
Sweden	14.76	39.79	16.60	18.72
Switzerland	66.86	85.16	7.98	9.00
United Kingdom	17.01	28.64	37.06	42.99
United States	9.23	10.49	47.10	80.17
Unweighted mean	21.01	31.53	21.53	29.38
Standard deviation	0.15	0.23	0.11	0.17
Coefficient of variation	0.73	0.72	0.51	0.58

These tendencies are summarized in Figure 1, which contains information on different aspects of the distribution of the degrees of financial openness. The upper panels show the evolution of relevant summary statistics such as the mean – both weighted and unweighted. Both statistics show a tight upward trend, for both DFO^{out} and DFO^{in}, which has increased by roughly 50%. It is also worth noting the similarities between the patterns found for both weighting schemes, suggesting that the enhanced internationalization has occurred regardless of the size of the banking markets in each country.

The lower panels in Figure 1 provide information on the *entire* distributions of the variable under analysis via violin plots.[16] Accordingly, each figure contains both the box plot and the density trace, which is plotted symmetrically to the left and right of the vertical box plot. In our case, we provide information for both initial and final years, and both DFO^{out} and DFO^{in}. Both cases show a tendency in the distribution to become more spread, although

[16] As indicated by Hintze and Nelson (1998), violin plots combine the box plot and the density trace into a single display that reveals structure found within the data. Therefore, it contains both the information provided by box plots (such as centre, spread, asymmetry, and outliers), but also the distributional characteristics of data contained in nonparametric density estimation (Silverman, 1986).

asymmetrically. That is, *some* (very few) countries are becoming more open in both directions, but most of them remain in the lower tails of the distribution. However, violin plots do not offer information on the *relative* positions, or intra-distribution mobility over time. We do not know – unless we examine data individually – whether some countries are moving upwards in their financial openness rankings over time, leaving us with an apparently stable distribution.

4.2 Degree of regularity of financial connections

As indicated in Section 2, the $DRTFC$ indicates whether cross-border bank flows are balanced in terms of the banking systems size of both the sending and recipient countries. According to the geographic neutrality idea, cross-border asset holdings of each country's banks should be directed preferably towards France, Germany, Japan, UK, or the US, whereas Denmark, Finland, Greece or Portugal should attract less cross-border flows (in absolute terms).

Table 3 reports information on individual degrees of regularity of financial connections ($DRTFC$), following the geographic neutrality idea. The information is split into eight columns following three criteria, namely, the direction of the flows ($DRTFC^{out}$ and $DRTFC^{in}$), the relevance of indirect connections ($\gamma = 1$ and country-specific γ_i), and also the initial and final years. As suggested by the first two columns in Table 3, some of the countries with lower levels of $DRTFC^{out}$, especially in 2006, are the Nordic countries in our sample – Denmark, Finland and Sweden. These are countries with strong economic and financial ties, suggesting that the incentives of economic agents to go abroad might be geographically biased by these already established links. The apparently low values of $DRTFC$ for these countries arise because they are small in terms of total assets. The only non-Nordic country with $DRTFC^{out}$ < 60% as of 2006 is Canada, which shares a common characteristic with these three countries, namely, the existence of strong links with the neighbours (the US, in spite of the border effect; see McCallum, 1995). In this case, although the size of the US banking markets is big, it might be attracting too much of Canada's cross-border bank asset holdings – ie the cross-border flows are not *balanced*.

Should we control for the likely existence of indirect financial links – ie the instance in which the bank flows from country i to country j cross a third country k –, considering a country-specific γ_i parameter, results change variedly. In general, we can observe that indirect connection play a role, increasing the level of connection between financial systems. Since the parameter controlling for this effect is country-specific, the gap between $DRTFC^{\gamma=1}$ and $DRTFC^{\gamma=\gamma i}$ also varies across countries to a great extent, and it is wider for those countries with lower γ_i values (see Table 4, which contain data on the specific values of γ_i) such as Belgium, the Netherlands or Switzerland (year 2006).

There are also some countries whose $DRTFC$ does not overhang for being either too high or too low, which is the case of Ireland. However, Ireland's $DRTFC$ exhibits the highest growth between 1999 and 2006, regardless of the γ considered. This increase reflects the fact that their cross-border financial flows have become more balanced, in terms of number and size of Ireland's financial partners: whereas by 1999 the UK and the US accounted for more than 85% of Ireland's foreign claims (54.9% and 31.5%, respectively), by 2006 some of its largest European partners account for higher shares of its foreign assets. Specifically, the UK and the US have fallen in their relative importance (now representing only the 42.2% and 10.3% of Irish foreign claims), whereas Germany, Italy, Spain and France account for 15.6%, 9.6%, 5.3% and 4.9%, respectively. This implies that, as suggested by the definition of the degree of regularity of the financial connections, now Ireland's cross-border flows are more *balanced* – both in terms of countries and volumes. Explanations for this pattern may be manifold,

such as the adoption of the euro, which might have constituted an incentive for Irish financial agents to go abroad and trade more intensely with countries sharing the same currency.

Table 3

Degree of regularity of total financial connections (*DRTFC*)

In per cent

	Outflows				Inflows			
	$\gamma = 1$		$\gamma = \gamma_i$		$\gamma = 1$		$\gamma = \gamma_i$	
	1999	2006	1999	2006	1999	2006	1999	2006
Austria	80.98	84.71	82.53	88.29	66.93	66.64	71.36	71.68
Belgium	67.07	80.92	80.54	89.79	74.76	75.34	79.50	80.90
Canada	55.92	54.87	62.10	61.78	93.36	87.78	94.18	89.68
Denmark	58.67	59.64	62.20	67.86	74.78	42.92	78.16	55.56
Finland	53.89	32.65	62.40	42.33	60.17	26.03	71.40	49.12
France	90.50	86.72	90.59	88.77	82.69	85.45	83.35	85.99
Germany	86.86	90.19	86.95	90.31	85.57	83.67	86.07	84.80
Greece	NA	80.77	NA	81.41	83.07	67.18	86.23	79.51
Ireland	55.01	77.80	61.94	84.16	76.05	83.66	83.01	87.26
Italy	78.05	88.78	79.63	89.64	75.15	76.07	79.16	81.00
Japan	73.82	71.56	75.69	76.44	87.65	80.37	87.97	81.93
Netherlands	84.46	86.30	86.04	88.83	68.20	75.77	75.62	82.04
Portugal	70.09	72.47	73.47	78.90	64.03	61.25	70.68	74.19
Spain	76.41	70.79	78.85	76.29	77.73	81.58	79.99	84.20
Sweden	61.33	56.16	65.51	72.05	76.69	61.40	79.89	67.75
Switzerland	72.04	66.49	81.57	85.09	79.06	86.51	80.14	87.15
United Kingdom	75.16	70.83	76.86	74.37	77.74	85.82	82.45	87.73
United States	83.33	87.98	83.69	88.24	90.01	84.86	92.57	91.43
Unweighted mean	71.98	73.31	75.92	79.14	77.42	72.91	81.21	79.00
Standard deviation	0.12	0.15	0.10	0.12	0.09	0.17	0.07	0.12
Coefficient of variation	0.16	0.21	0.13	0.16	0.11	0.23	0.08	0.15

Results also vary if we reverse the direction of the flows and examine the assets of each country owned by foreign banks ($DRTFC^{in}$). This information is contained in the last four columns of Table 3, for both γ schemes, and for both initial and final sample years. Results for $\gamma = 1$ suggest the Nordic countries are still at the bottom, ie they show geographic bias, regardless of the directions of their financial flows. However, Canada moves upwards in this ranking reaching the top, suggesting its financial links with the US are asymmetric. In this case, both $DRTFC^{\gamma=1}$ and $DRTFC^{\gamma=\gamma i}$ are high for Canada because of Canada's bank assets owned by foreign banks (mostly US banks). That is, the cross-border bank flows between Canada and its financial partners, are *balanced*: large countries own larger shares of Canadian bank assets.

Table 4

Country-specific γ values

In per cent

Country	γ_i^{out}		γ_i^{in}	
	1999	2006	1999	2006
Austria	86.61	84.33	83.56	82.35
Belgium	56.36	36.92	75.64	72.72
Canada	78.75	77.55	89.23	88.09
Denmark	90.95	78.17	85.28	70.17
Finland	79.72	80.20	69.91	55.60
France	82.60	74.40	90.48	87.75
Germany	77.47	70.83	91.95	88.22
Greece	NA	96.09	75.92	55.95
Ireland	77.29	71.57	65.45	67.85
Italy	88.91	92.90	77.30	74.31
Japan	90.52	79.95	94.92	91.00
Netherlands	72.55	29.79	73.20	69.58
Portugal	88.63	84.03	79.91	66.19
Spain	86.82	79.27	85.81	77.35
Sweden	85.63	61.54	83.85	81.91
Switzerland	38.33	21.48	92.64	91.70
United Kingdom	86.45	79.41	70.48	69.09
United States	93.46	92.39	66.62	41.85
Unweighted mean	80.06	71.71	80.68	73.98
Standard deviation	0.14	0.21	0.09	0.14
Coefficient of variation	0.17	0.30	0.12	0.19

Figures 2 and 3 are graphical counterparts to the results reported in Table 3, displaying analogous information like that reported in Figure 1 in the case of the degree of financial openness. In contrast to the DFO case, the degrees of regularity of financial connections show a higher level yet rather fuzzy pattern – although it is difficult to uncover with only eight years. Figure 2 suggests the pattern is slightly increasing for the total connections (country-specific γ), although it is rather unstable for the direct connections, with all three statistics in the upper panels sharing this pattern. However, in both cases the values are much higher than those corresponding to the degree of financial openness, emerging as the main contributor to financial integration. The lower panels display 1999 and 2006 violin plots for the variables under analysis. We corroborate that the values for most countries are high – at least higher than the DFO – , and that we cannot conclude any clear tendency exists as to the central values of the distribution, but that the variety of behaviours is increasing, as shown by probability mass becoming more spread. However, the direction of the spread is not `positive'. In other words, it is not that the distribution is shifting rightwards (or upwards, if looking at the violin plot) but it is shifting towards lower values of regularity, and this finding is common to both γ schemes. Therefore, although the contribution of this indicator to the world

financial integration is high, some countries – those shifting the distribution leftwards – are jeopardizing the advance of international financial integration.

Although this is a hypothesis that requires further testing, both distance and regional trade agreements might be playing a role. This finding has already been documented by Portes and Rey (2005) who found that distance, which proxies for information asymmetries, is a very large barrier to cross-border asset trade. The latter, as we do, use data on cross-border bank asset holdings and find that a 10% increase in bilateral trade raises bilateral asset holdings by 6% or 7%. Therefore, an increasing role of distance (cross-border financial activity is higher with neighbours, or between regional trade agreements' members) implies a decreasing role of geographic neutrality (only the size of the trading countries matters) and, ultimately, a declining contribution to international economic integration.

4.3 Degree of financial integration

The degree of financial integration results from combining financial openness and regularity of financial connections, following Equation (9). Results are reported analogously to the DFO and $DRTFC$ cases. Table 5 provides results arrayed in eight columns which split the information according to three criteria, namely, the direction of the flows, the existence of indirect connections, and the initial and final years. The first four columns provide results for the assets held abroad by banks of each listed country. Since DFI^{out} combines DFO^{out} and $DRTFC$, its tendencies can be explained via the evolution of its components. Disparities among countries were more pronounced in the case of the degree of financial openness, whereas the $DRTFC$ values were more homogeneous. Thus, differences among countries are mainly determined by the degree of financial openness and, as such, those countries more financially integrated are Belgium, the Netherlands, or Switzerland. Of special note is the case of Sweden, whose $DRTFC$ ranges amongst the lowest, whereas its high degree of financial openness pushes it upwards in the ranking ranging among the few countries with financial integration degrees above 50% as of 2006.

However, although the more financially integrated countries in the world are small, large countries have also participated in this process: both Germany and France have DFI^{out} > 50% by 2006, and Japan, the UK or Spain also go beyond the 40% line. Although some large countries still remain below these levels, if we extend the analysis to the cross-border bank flows flowing in the opposite direction, both Italy and particularly the US become much more integrated. In contrast, some small countries such as Switzerland show a reversed pattern, as to be expected.

Figures 4 and 5 provide graphical counterparts to Table 5. In both cases (for DFI^{out} and DFI^{in}) the pattern is increasing, especially under DFI^{out}. The violin plots contained in the lower panels also show relevant patterns, suggesting disparity is increasing, especially for DFI^{out}. Therefore, although the world is more financially integrated today than eight years ago, the involvement of the different countries is unequal, and these inequalities are becoming more apparent over time.

Therefore, the picture emerging is of a multiplicity of ways through which countries attain their levels of international financial integration. Both openness and balance in the volume and direction of cross-border flows are relevant, and their relevance has different angles. Whereas openness generates marked differences between countries, the degree of regularity of the total financial flows is more homogeneous, and higher. However, this indicator also shows differences across countries and over time, suggesting a geographical bias exists for the bilateral asset trading, as documented by previous literature. In addition, both home and foreign banks contribute differently to the integration level of each country, the extreme and opposite cases being represented by Switzerland and the US.

Table 5

Degree of integration (*DFI*)

In per cent

	Outflows				Inflows			
	$\gamma = 1$		$\gamma = \gamma_i$		$\gamma = 1$		$\gamma = \gamma_i$	
	1999	2006	1999	2006	1999	2006	1999	2006
Austria	33.39	37.02	33.71	37.79	33.63	34.84	34.73	36.14
Belgium	55.22	73.09	60.52	76.99	43.56	46.38	44.92	48.07
Canada	35.60	36.36	37.51	38.59	32.74	33.50	32.89	33.86
Denmark	23.28	36.54	23.97	38.98	33.52	36.24	34.27	41.23
Finland	33.17	25.57	35.69	29.11	42.69	34.18	46.51	46.95
France	44.24	53.77	44.26	54.40	31.28	36.92	31.40	37.04
Germany	52.75	59.87	52.77	59.91	31.30	36.65	31.39	36.89
Greece	NA	17.89	NA	17.96	44.96	54.75	45.81	59.56
Ireland	35.65	48.45	37.83	50.39	51.70	53.42	54.02	54.56
Italy	30.86	26.63	31.18	26.76	43.33	46.91	44.47	48.40
Japan	33.60	41.90	34.02	43.30	26.80	29.74	26.85	30.03
Netherlands	49.53	80.88	49.99	82.05	43.98	49.88	46.31	51.90
Portugal	28.44	34.29	29.12	35.78	36.12	45.87	37.95	50.49
Spain	32.70	40.34	33.22	41.88	34.23	45.27	34.72	45.99
Sweden	30.09	47.27	31.10	53.54	35.68	33.90	36.42	35.61
Switzerland	69.41	75.25	73.85	85.13	25.11	27.91	25.28	28.01
United Kingdom	35.75	45.04	36.16	46.15	53.67	60.75	55.28	61.42
United States	27.74	30.38	27.80	30.42	65.11	82.48	66.03	85.61
Unweighted mean	38.32	45.03	39.57	47.17	39.41	43.87	40.51	46.21
Standard deviation	0.12	0.18	0.13	0.19	0.10	0.13	0.11	0.14
Coefficient of variation	0.31	0.39	0.33	0.40	0.26	0.30	0.26	0.30

4.4 Global indicators

The previous sections have focused mainly on the individual analysis of the three indicators, as well as providing some summary statistics. One of the summary statistics provided was the weighted mean, which was computed for all three indicators, considering the role of indirect links, and also taking into account the direction of the cross-border flows. This result is relevant, since it indicates the gap between the current level of international financial integration and its theoretical full potential, the latter defined by the SPFI.

Given this importance, which is one of the most important goals of the study, we report this information explicitly in Table 6, where we provide information on all global indicators and consider the weight of the total bank assets in each country. These indicators have been computed following expressions (14), (11) and (12) for the degree of global financial integration, the degree of global financial openness, and the degree of regularity of the total financial connections. Results indicate that, regardless of the direction of the asset flows, the level of global integration attained as of 2006 is quite similar in terms of outflows or inflows. Figures range between 46.9% and 49.5%, depending on whether indirect links are

considered, or the direction of the flows. Therefore, although the pace is rapid (by 1999, the *DGFI* was mostly below 40%), we are still not halfway to the theoretical full potential of international financial integration – ie to the Standard of Perfect Financial Integration. The increase in *DGI* has been mostly driven by the increase in the degree of global financial openness, whose advance has been proportionally higher. In contrast, the contribution of the *DRTFC* has even been small for $DRTFC^{out}$ and negative for $DRTFC^{in}$, although this finding was partly to be expected because the values of *DRTFC* were already high by 1999.

Table 6

Global degrees (*DGO, DGDC, DGTC, DGI*)

1999–2006; in per cent

Year	Outflows					Inflows				
	DGO	*DGTC*		*DGI*		*DGO*	*DGTC*		*DGI*	
		$\gamma = 1$	$\gamma = \gamma_i$	$\gamma = 1$	$\gamma = \gamma_i$		$\gamma = 1$	$\gamma = \gamma_i$	$\gamma = 1$	$\gamma = \gamma_i$
1999	20.85	78.23	80.15	38.95	39.55	21.13	83.32	85.38	39.58	40.19
2000	23.22	80.44	82.67	41.69	42.41	23.84	85.63	88.04	42.57	43.31
2001	24.84	81.50	84.16	42.86	43.76	25.79	84.34	87.15	43.88	44.80
2002	25.18	81.03	84.20	42.72	43.80	26.41	81.42	84.30	43.87	44.81
2003	24.99	80.17	83.22	42.43	43.47	25.81	81.45	84.27	43.36	44.29
2004	27.71	78.41	81.91	44.37	45.62	28.65	80.40	83.78	45.41	46.62
2005	28.78	79.88	83.33	45.41	46.67	30.48	80.25	83.52	46.64	47.83
2006	30.61	79.20	82.84	46.89	48.21	32.15	81.55	84.82	48.35	49.53

5. On the relative positions between bank flows' directions

In the previous Section it has become apparent that the direction of cross-border financial flows is crucial in assessing each country's degree of financial integration. The extreme cases are represented by Switzerland and the US, whose *DFO* shows opposite patterns when evaluating them through either inflows or outflows.

The aim of this Section is to show visually this type of evidence for all countries in the sample. The information provided is decomposed into two figures. First, Figure 6 provides information on the relative positions for each country, for *DFO* (first row in the Figure), *DDC* (second row), and *DFI* (bottom row), and also for 1999 (first column), 2006 (second column) and all sample years (pooled, third column). Second, Figure 7 displays how countries have transited from their positions in 1999 to those as of 2006.

As shown by the first row sub-figures in Figure 6, some countries show opposite behaviours which, in addition, are getting more extreme over time. Those countries above the 45-degree diagonal are more open regarding their inflows, whereas those below that diagonal are more financially open on the outflows side. The general tendency is to deepen, or at least to remain, in their preferred orientation. Those countries below the 45-degree diagonal tend to shift rightwards when comparing 1999 and 2006 (ie their DFO_i^{out} increases), whereas those above the main diagonal tend to shift upwards (ie their DFO_i^{in} increases). Therefore, it seems there is a tendency towards "specialization within increased financial integration".

Table 7

Distribution hypothesis tests

1999 versus 2006 (Li, 1996)

	Null hypothesis (H_0)	T-test statistics	Significance level		
			10% (critical value: 1.28)	5% (critical value: 1.64)	1% (critical value: 2.33)
$\gamma = 1$	$f(DFI_{2006}) = g(DFI_{1999})$	3.231	H_0 rejected	H_0 rejected	H_0 rejected
	$f(DFI_{2006}) = g^{DFO}(dfo \times DFI_{1999}) = g(DFI^{DFO})$	–0.059	H_0 not rejected	H_0 not rejected	H_0 not rejected
	$f(DFI_{2006}) = g^{DFTC}(dftc \times DFI_{1999}) = g(DFI^{DFTC})$	2.275	H_0 rejected	H_0 rejected	H_0 not rejected
Country-specific γ	$f(DFI_{2006}) = g(DFI_{1999})$	2.864	H_0 rejected	H_0 rejected	H_0 rejected
	$f(DFI_{2006}) = g^{DFO}(dfo \times DFI_{1999}) = g(DFI^{DFO})$	–0.061	H_0 not rejected	H_0 not rejected	H_0 not rejected
	$f(DFI_{2006}) = g^{DFTC}(dftc \times DFI_{1999}) = g(DFI^{DFTC})$	1.979	H_0 rejected	H_0 rejected	H_0 not rejected

Notes: The functions $f(\cdot)$ and $g(\cdot)$ are (kernel) distribution functions for the actual degree of integration in 2006 and 1999, respectively; $g^{DFO}(\cdot)$ and $g^{DFTC}(\cdot)$ are counterfactual distributions obtained by adjusting the 1999 distribution of DFI for the effects of advances in the degree of financial openness (DFO) and advances in the degree of total financial connection ($DFTC$), respectively. Results are provided for both $\gamma = 1$ and country-specific γ.

That is, although countries become, in general, more financially open, the enhanced openness does not generally occur both via inflows and outflows simultaneously but rather countries focus increasingly on their relative specializations. When evaluating the sample years altogether, these tendencies become even more apparent, since observations tend to scatter in both two directions.

The second row in Figure 6 presents analogous information for the $DRDFC$.[17] In this case, the tendency for most countries is to shift in both possible directions – ie both cross-border inflows and outflows are much more balanced by 2006 that they were by 1999. However, some notable exceptions exist such as Denmark and Sweden – two of the non euro-area European countries in our sample – together with one of their most important economic and financial partner – ie Finland. These three countries show an opposite behaviour with respect to that by countries which have joined the euro. While the flows of euro-area countries are now slightly more balanced, the Nordic countries in our sample perform more poorly in this respect. This behaviour could not only be related to their traditionally strong links, but also to the openness of some Eastern European countries such as the Baltic republics or Russia, which are not included in our sample.

Figure 7 provides information as to how countries' have evolved in the indicators under analysis – ie it is the graphic counterpart to Tables 2, 3 and 5. The general tendency has been to move upwards, for both flows' directions, and for the degree of financial openness and the degree of financial integration. However, as mentioned in the previous paragraph, not only has the $DRDFC$ remained rather stagnant but it has decreased for some specific

[17] We do not provide information on indirect cross-border flows, in order to save space. These results are available from the authors upon request.

countries, as shown by several countries below the 45-degree line – especially for cross-border inflows. As a final result, although financial integration is affecting most countries worldwide, some of them have participated less intensively in this process (when comparing 1999 versus 2006), namely, Italy (outflows), Sweden (inflows) and Finland (inflows and outflows).

6. Concluding remarks

The aim of the article has been to develop new indicators of the degree of international financial integration along with its determinants, taking into account not only financial openness but also the regularity in the network of bilateral cross-border flows. The contribution of the study consists of defining a Standard of Perfect Financial Integration (SPFI) for characterizing the scenario in which the links between financial systems were established as if they made up a "global financial village". In such a case, cross-border financial flows would not show geographical bias, and home bias should also vanish for international financial flows. They should only hinge on the relative size of the financial system, as would be the case for a gravity model in which distance were irrelevant.

After revising the related literature, Section 2 established the properties for characterizing the concept of geographic neutrality, and defined the indicators of degree of financial openness, degree of regularity of direct financial connections (both direct and indirect), and degree of financial integration, for each country and for the world economy. For all of them we set precise intervals, ranging between $[0, 1]$. Compared with the corresponding benchmark to a scenario of geographic neutrality, it is possible to assess the degree of financial integration achieved, and assess the relative contributions of each of its determinants.

In comparison with previous measures proposed by the literature, our indicators have some interesting features. First, we consider a network approach in which not only financial openness is relevant but also where we can describe the direction and intensity of financial connections. This distinction is relevant, since the distinguishing between financial openness and financial integration has been an issue not sufficiently stressed by the literature. Second, although our measures are quantity-based, they have an interesting feature which so far has been virtually confined to price-based indicators, namely, we set a benchmark – the Standard of Perfect Financial Integration (SPFI) – describing the theoretical full potential of economies in terms of financial integration. Accordingly, we can measure the gap between the current level of integration and that level achievable should perfect financial integration exist. As we may easily infer, the SPFI constitutes the quantity-based counterpart to the LOOP, according to which the prices for the products in question would be the same irrespective of the geographical domicile of the seller or the buyer of the product. As suggested by some authors (Cabral et al, 2002), this law is especially difficult to hold in the banking field due to the lack of data.

The empirical application performed in the second half of the study analyzes the banking integration for 18 countries, accounting for the 83% of international banking markets over the 1999–2006 period. According to the results obtained, the degree of financial integration advances rapidly, and has increased from 40% to 50% over the eight years analyzed. However, we are barely halfway to the theoretical full potential of complete international financial integration. The level of financial globalization achieved is the result of a moderate openness (around 30%) yet strongly increasing (it has increased by 50% in eight years time), and a network of bilateral bank flows which attains a high level of regularity (close to 80%, on average), which is slightly reinforced by factoring indirect connections, but is quite stable over time.

Therefore, we might conclude that the highest barrier for financial integration is that separating each specific banking system from the exterior (ie the border effect), setting limits

for the degrees of financial openness. However, this barrier, along with the home bias (which is still high), is losing relevance slowly. Once financial flows have crossed borders, they follow a variety of different directions with no special preferences – ie geographical bias is not too high *on average*. Nevertheless, we must bear in mind that although our sample is highly representative in terms of total foreign claims of the world banking system, it is only made up of matrices of bilateral financial flows for a limited number of countries which, because of their level of financial development may contribute to geographic neutrality.

However, results vary markedly from country to country, and differences tend to increase over time, as shown by the violin plots corresponding to all three indicators. In addition, the levels corresponding to each banking system indicators tend to differ strongly when assessed from either the perspective of foreign assets or liabilities. Ideally, the study should be extended to developing countries in order to corroborate the findings by some authors such as Lane and Milesi-ferretti (2008), according to whom financial integration advances rapidly among advanced economies, whereas trade integration advances more rapidly among emerging economies. Unfortunately, the available data (which requires data on both foreign assets and liabilities for each trading country pair) sets a limit difficult to cross.

In contrast to what one might sometimes find in the literature, higher (lower) sizes do not explain lower (higher) degrees of financial openness. In the case of bank foreign assets, we may find a myriad of examples including small countries which are either very open (Belgium, the Netherlands, Switzerland) or very closed (Greece, Austria, Portugal). In addition, some countries' behaviour reverses when reversing the direction of the financial flow. This is the case of the U.S. (Switzerland), which is very closed (open) when considering bank foreign assets, but very open (closed) when considering liabilities.

Regarding the regularity of connections, some countries excel because of the higher geographical bias of their cross-border bank flows. This is the case of Canada and the Nordic countries in the sample – for both bank foreign assets and liabilities. In the Canadian case, a likely explanation could be derived from the strong ties with the US (despite the relevance of the border effect; see McCallum, 1995), whereas the geographical bias affecting Nordic countries might be explained by the intensity of the flows between them. While one must look directly at the data to corroborate these facts, the degree of regularity provides us with an index containing this type of information. Another interesting case is represented by Ireland, whose degree of regularity has increased sharply from 1999 to 2006 because both the UK and the US now account for lower volumes of foreign claims, whereas euro-area countries (Germany, Italy, Spain and France) have gained importance. In other words, Ireland's cross-border flows are now more *balanced*, contributing positively to its international financial integration.

The interpretation of the determinants of the differences between countries in their degrees of openness and regularity calls for a deeper analysis following the research lines suggested here, in order to delve into the likely causes of the failure to meet the geographic neutrality criterion. One of the hypothesis to be tested relates to distance (either geographical, cultural, political, or informational), which still matters as suggested by gravity models recently developed to interpret cross-border asset flows. However, the asymmetries detected for the degrees of openness and regularity when shifting the perspective from bank foreign assets to liabilities indicate that integration levels vary a great deal depending on the adopted perspective. This event might suggest that the distances between banking systems do not offer satisfactory explanations for the different integration levels achieved, given that the causes would be the same while the effects would vary depending on the perspective adopted. In relation to this, the network analysis literature distinguishes between symmetric and asymmetric networks. Financial connections would fall into the latter category, because the direction of flows matters when assessing financial integration, as indicated by Rodrik (1999) when referring to the relevance of looking not only at exports but also at imports when analyzing international trade integration.

References

Baele, L, A Ferrando, P Hördahl, P, E Krylova and C Monnet (2004): “Measuring European financial integration”, *Oxford Review of Economic Policy*, vol 20(4), pp 509–530.

Berger, A, S Ongena, D Smith and Q Dai (2003): “To what extent will the banking industry be globalized? A study of bank nationality and reach in 20 European nations”, *Journal of Banking and Finance*, vol 27(3), pp 383–415.

Berger, A N, R DeYoung, H Genay and G F Udell (2000): “Globalization of financial institutions: Evidence from cross-border banking performance”, Finance and Economics Discussion Series 2000–04, Board of Governors of the Federal Reserve System.

Berger, A N and D C Smith (2003): “Global integration in the banking industry”, *Federal Reserve Bulletin*, 89(11), pp 451–460.

Buch, C M (2005): ”Distance and international banking”, *Review of International Economics*, vol 13(4), pp 787–804.

Buch, C M and A Lipponer (2007): “FDI versus exports: Evidence from German banks”, Journal of Banking and Finance, vol 31(3), pp 805–826.

Cabral, I, F Dierick and J Vesala (2002): “Banking integration in the euro area”. *ECB Occasional Paper Series 6*, European Central Bank, Frankfurt.

Combes, P-P, M Lafourcade and T Mayer (2005): “The trade-creating effects of business and social networks: evidence from France”, *Journal of International Economics*, vol 66, pp 1–29.

Dermine, J (2002): “European banking, past, present and future”, *Working paper, INSEAD, Fontainebleau*, France.

Dermine, J (2006): “European banking integration: Don't put the cart before the horse”, *Financial Markets, Institutions and Instruments*, vol 15(2), pp 57–106.

Eaton, J and S Kortum (2002): “Technology, geography, and trade”, *Econometrica*, vol 70(5), pp 1741–1779.

European Central Bank (2007): *Financial integration in Europe. Technical report*, ECB, Frankfurt.

Flood, R P and A K Rose (2005): “Financial integration: A new methodology and an illustration”, *Journal of the European Economic Association*, vol 3(6), pp 1349–1359.

Frankel, J A (2000): “Globalization of the economy”, *NBER Working Paper 7858,* Cambridge, Massachusetts.

García-Herrero, A and P Wooldridge (2007): Global and regional financial integration: progress in emerging markets”, *BIS Quarterly Review*, pp 57–70. September.

Gaulier, G, S Jean and D Ünal Kesenci (2004): “Regionalism and the regionalisation of international trade”, *Centre d'tudes Prospectives et d'Informations Internationales (CEPII) Working Paper 16*, Paris.

Guiso, L, T Jappelli, M Padula and M Pagano (2004): “Financial market integration and economic growth in the EU”, *Economic Policy*, vol 19(40), pp 523–577.

Hintze, J L and R D Nelson (1998): “Violin plots: a box plot-density trace synergism”, *The American Statistician*, vol 52(2), pp 181–184.

Kali, R and J Reyes (2009): “Financial contagion on the international trade network”, *Economic Inquiry*, forthcoming.

Kleimeier, S and H Sander (2006): "Regional versus global integration of Euro-zone retail banking markets: Understanding the recent evidence from price-based integration measures", *Quarterly Review of Economics and Finance*, vol 46(3), pp 353–368.

Krugman, P R (1991): "The move to free trade zones", in Federal Reserve Bank of Kansas City (ed), *Policy implications of trade and currency zones*, pp 7–41, Federal Reserve Bank of Kansas City, Kansas City, MO.

Krugman, P R (1996): "Regionalism versus multilateralism: analytical notes", in J de Melo and A Panagariya (eds), *New Dimensions in Regional Integration*, CEPR, Chapter 3, pages 58–89. Cambridge University Press, Cambridge.

Lane, P R and G M Milesi-Ferretti (2003): "International financial integration", *IMF Staff Papers 50*, IMF, Washington.

Lane, P R and G M Milesi-Ferretti (2008): "The drivers of financial globalization", *American Economic Review Papers and Proceedings*, vol 98(2), pp 327–332.

Levy, H and M Sarnat (1970): "International diversification of investment portfolios", *American Economic Review*, vol 60(4), pp 668–675.

Lewis, K (1999): "Trying to explain home bias in equities and consumption", *Journal of Economic Literature*, vol 37(2), pp 571–608.

Li, Q (1996): "Nonparametric testing of closeness between two unknown distribution functions", *Econometric Reviews*, vol 15, pp 261–274.

Manna, M (2004): "Developing statistical indicators of the integration of the euro area banking system", *European Central Bank Working Paper Series 300*, Frankfurt am Main.

McCallum, J (1995): "National borders matter: Canada-US regional trade patterns", *American Economic Review*, vol 85(3), pp 615–623.

McGuire, P and N Tarashev (2006): "Tracking international bank flows", *BIS Quarterly Review*, pp 27–28.

OECD (2005): *Measuring globalisation,* OECD handbook on economic globalisation indicators, OECD Publishing, Paris.

Pandey, M and J Whalley (2004): "Social networks and trade liberalization", *NBER Working Paper 10769*, Cambridge, MA.

Papaioannou, E (2009): "What drives international financial flows? Politics, institutions and other determinants", *Journal of Development Economics*, 88(2), 269–281.

Pérez, D, V Salas-Fumás and J Saurina (2005): "Banking integration in Europe", *Moneda y Crédito*, 220, pp 105–144.

Portes, R and H Rey (2005): "The determinants of cross-border equity flows", *Journal of International Economics*, vol 65(2), pp 269–296.

Portes, R, H Rey and Y Oh (2001): "Information and capital flows: The determinants of transactions in financial assets", *European Economic Review*, vol 45(4-6), pp 783–796.

Rauch, J E (2001): "Business and social networks in international trade", *Journal of Economic Literature*, vol 39, pp 1177–1203.

Rauch, J E and A Casella (2003): "Overcoming informational barriers to international resource allocation: prices and ties", *Economic Journal*, vol 113, pp 21–42.

Rodrik, D (1999): "The new global economy and developing countries: Making openness work", *Overseas Development Council Policy Essays Number 24*, Washington, DC.

Scholte, J A (2002): “What is globalization? The definitional issue – again”, *Centre for the Study of Globalisation and Regionalisation (CSGR) Working Paper 109*, University of Warwick, Coventry.

Strong, N and X Xu (2003): “Understanding the equity home bias: Evidence from survey data”, *Review of Economics and Statistics*, vol 85(2), pp 307–312.

Summers, L (1991): “Regionalism and the world trading system”, in Federal Reserve Bank of Kansas City, (ed), *Policy implications of trade and currency zones*, pp 295–301, Federal Reserve Bank of Kansas City, Kansas City, MO.

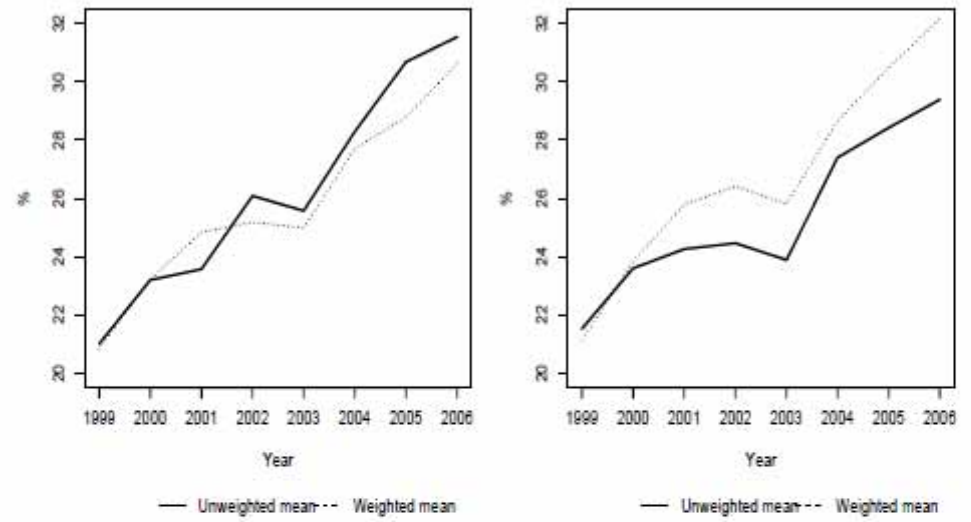
Vajanne, L (2006): “Integration in euro area retail banking markets convergence of credit interest rates”, *Bank of Finland Working paper 8*.

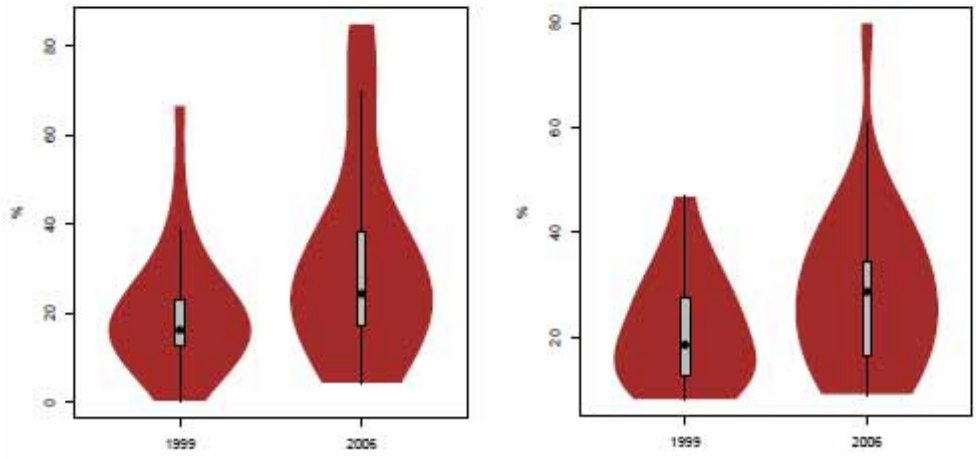
Vo, X and K Daly (2007): “The determinants of international financial integration”, *Global Finance Journal*, vol 18(2), pp 228–250.

von Peter, G (2007): “International banking centres: a network perspective”, *BIS Quarterly Review*, pp 33–45, December.

Warnock, F and C Cleaver (2003): “Financial centres and the geography of capital flows”, *International Finance*, vol 6(1), pp 27–59.

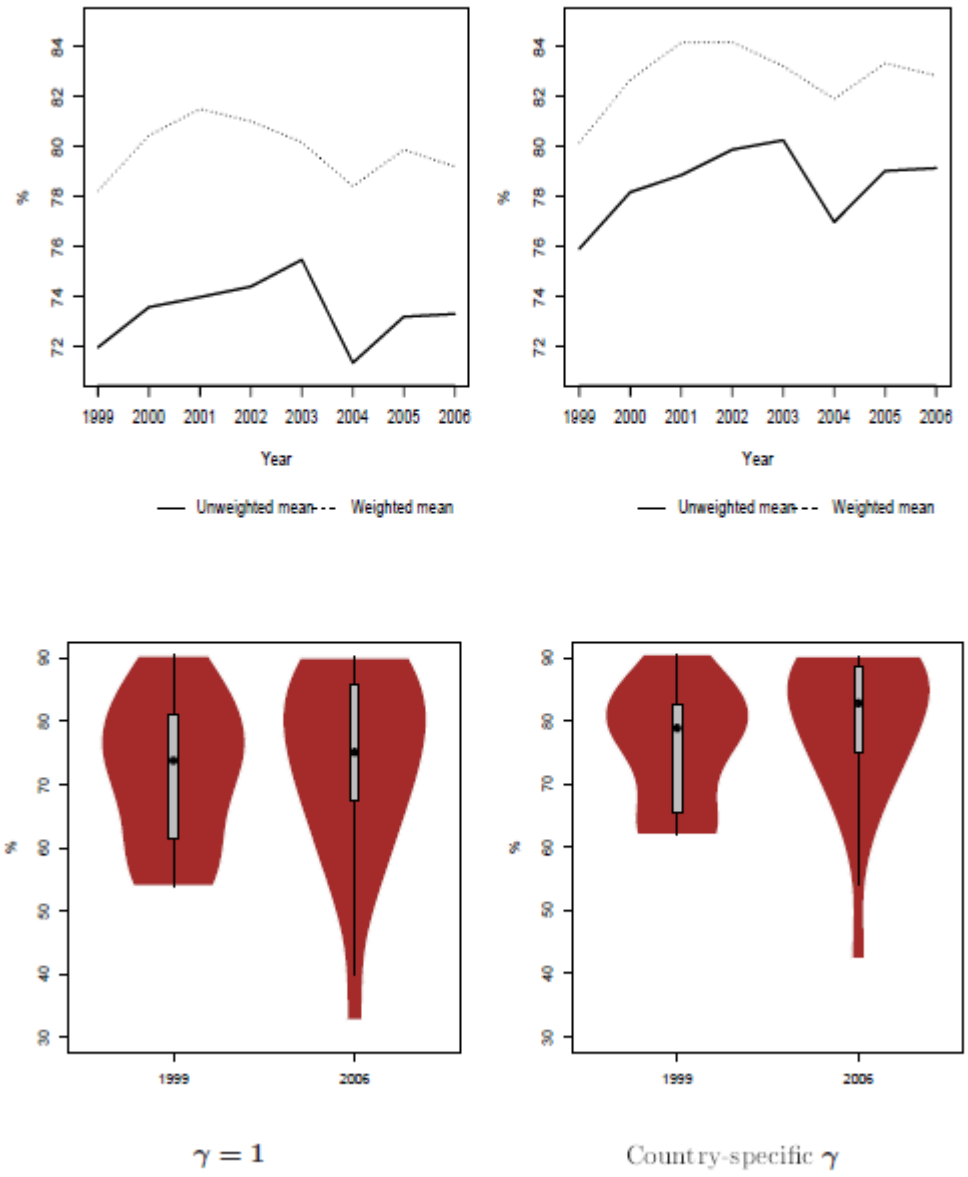
Figure 1: Degree of financial openness (DFO), 1999–2006





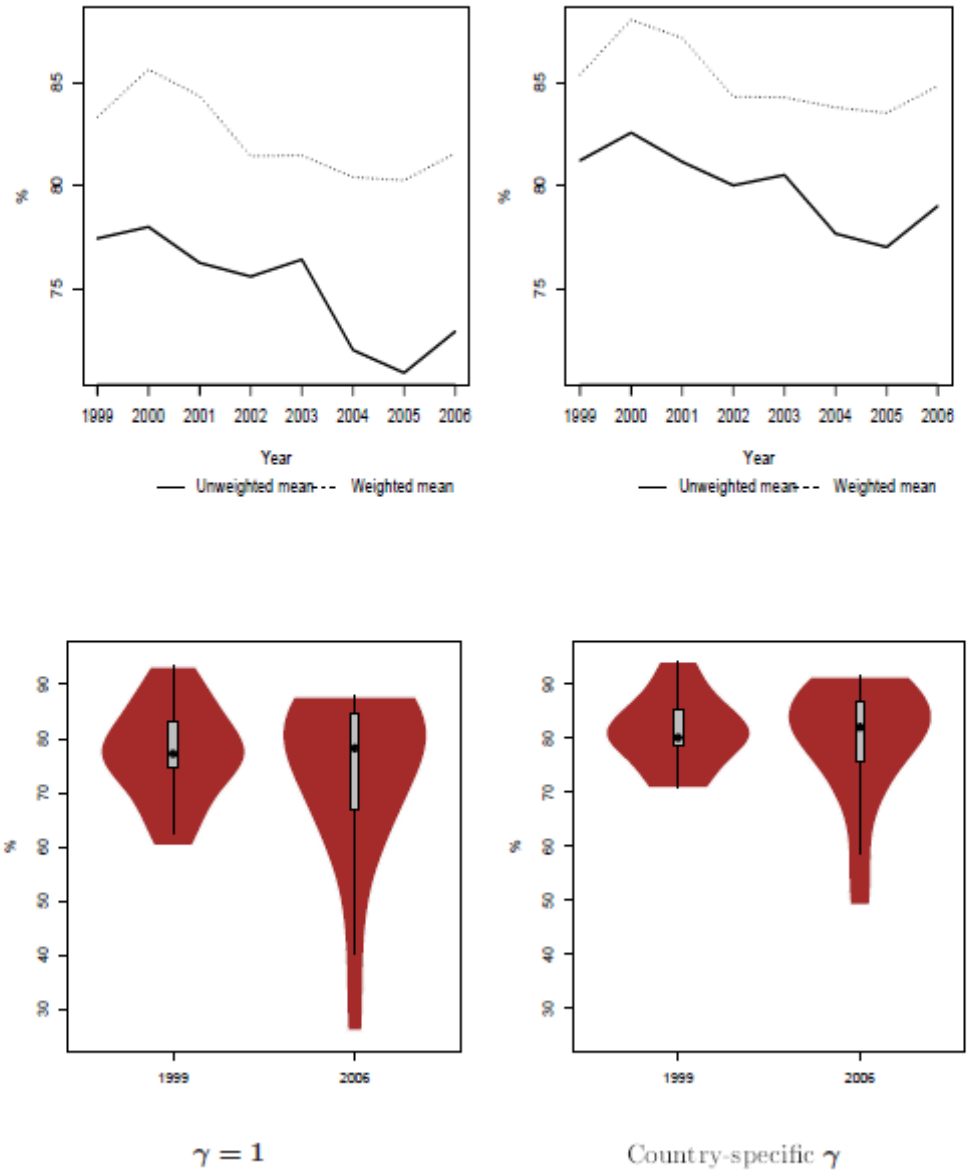
DFO^{out} DFO^{in}

Figure 2: Degree of regularity of total financial connections ($DRTFC$), outflows, 1999–2006



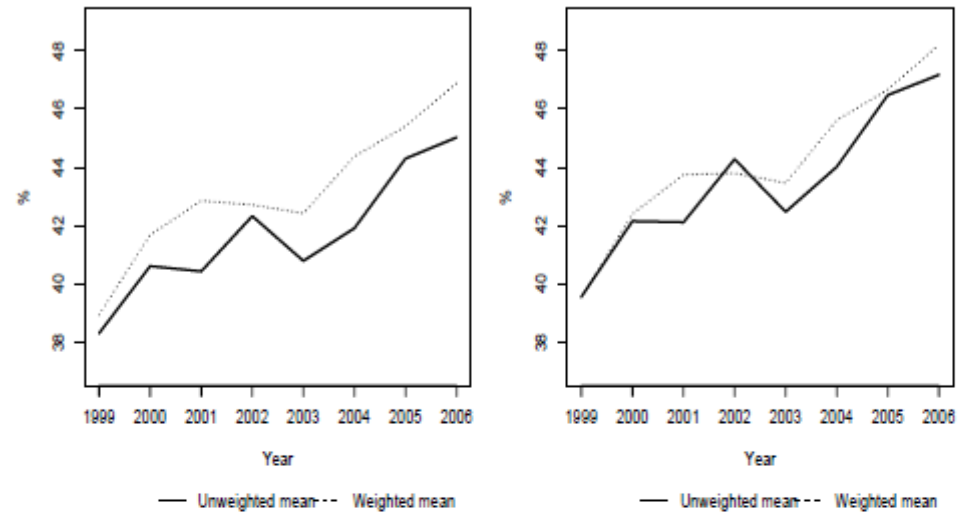
$\gamma = 1$ Country-specific γ

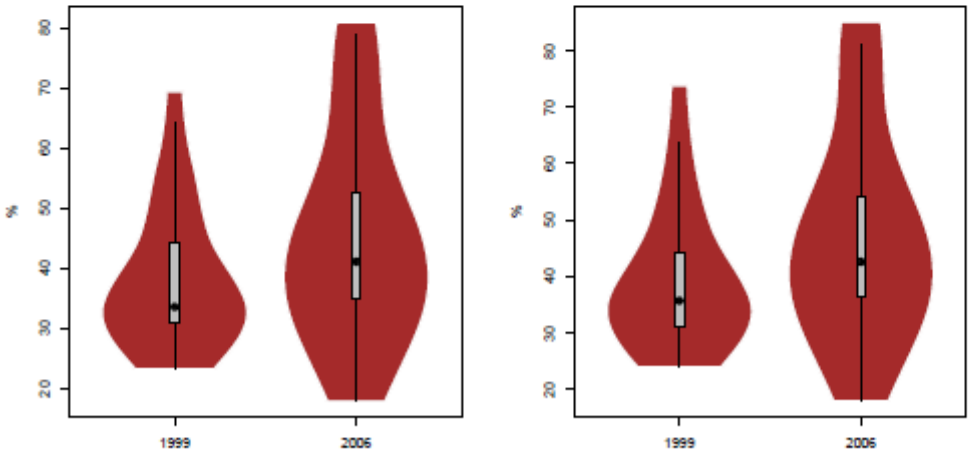
Figure 3: Degree of regularity of total financial connections ($DRTFC$), inflows, 1999–2006



$\gamma = 1$ Country-specific γ

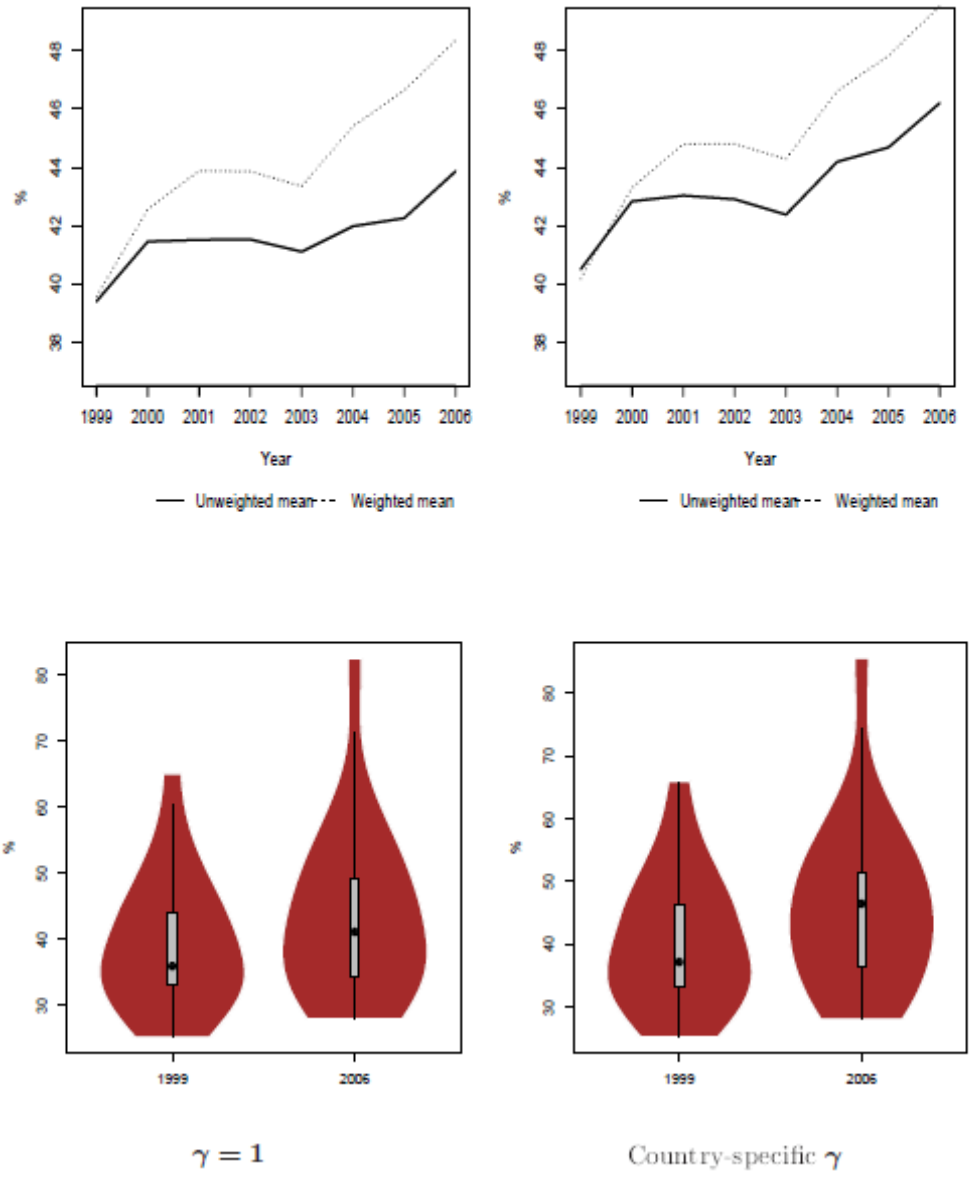
Figure 4: Degree of financial integration (DFI), outflows, 1999–2006





$\gamma = 1$ Country-specific γ

Figure 5: Degree of financial integration (DFI), inflows, 1999–2006



$\gamma = 1$ Country-specific γ

Figure 6: Relative positions between inflows and outflows, *DFO*, *DRDFC* and *DFI*

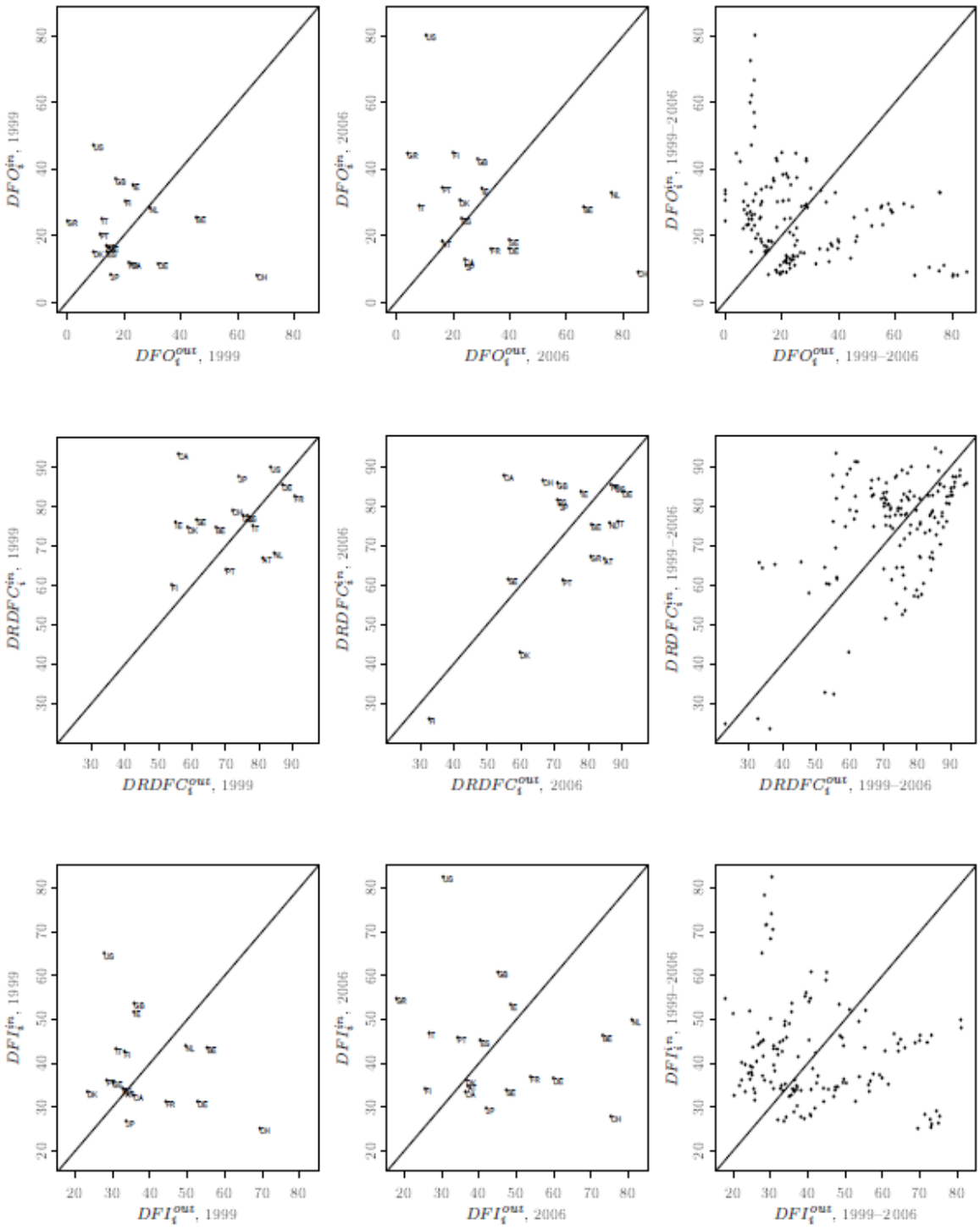


Figure 7: Relative positions between 1999 and 2006, *DFO*, *DRDFC* and *DFI*

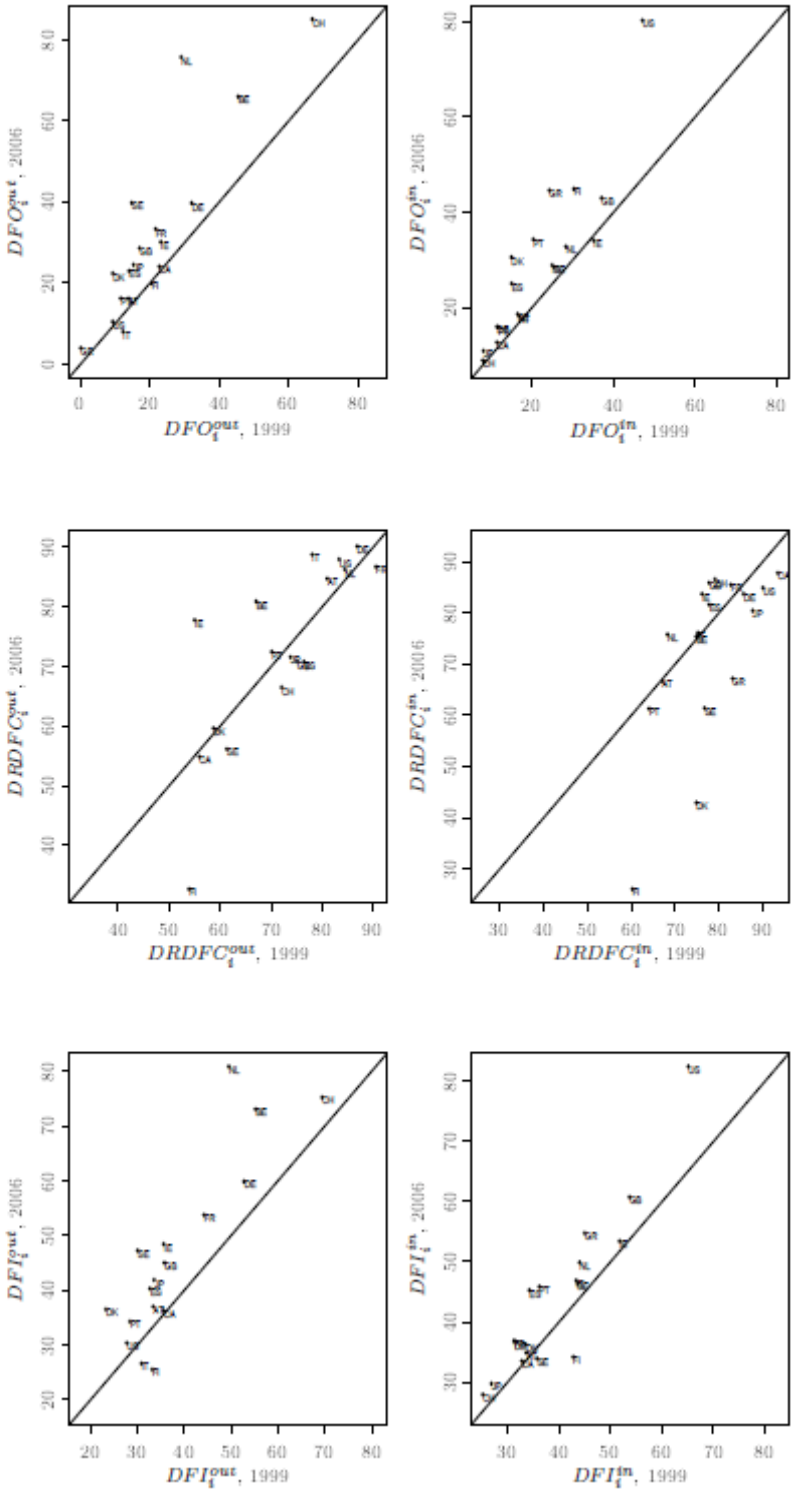


Figure 8: Bipartite decomposition of the degree of financial integration, outflows ($DFI^{\gamma=1}$), 1999–2006

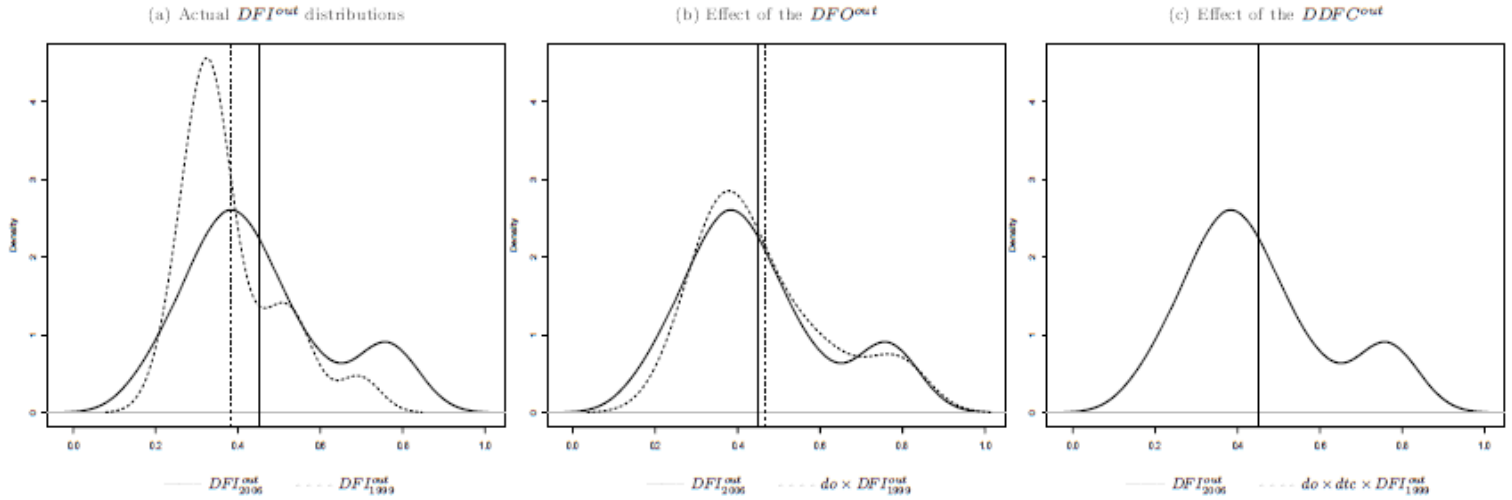


Figure 9: Bipartite decomposition of the degree of financial integration, outflows ($DFI^{\gamma=1}$), 1999–2006

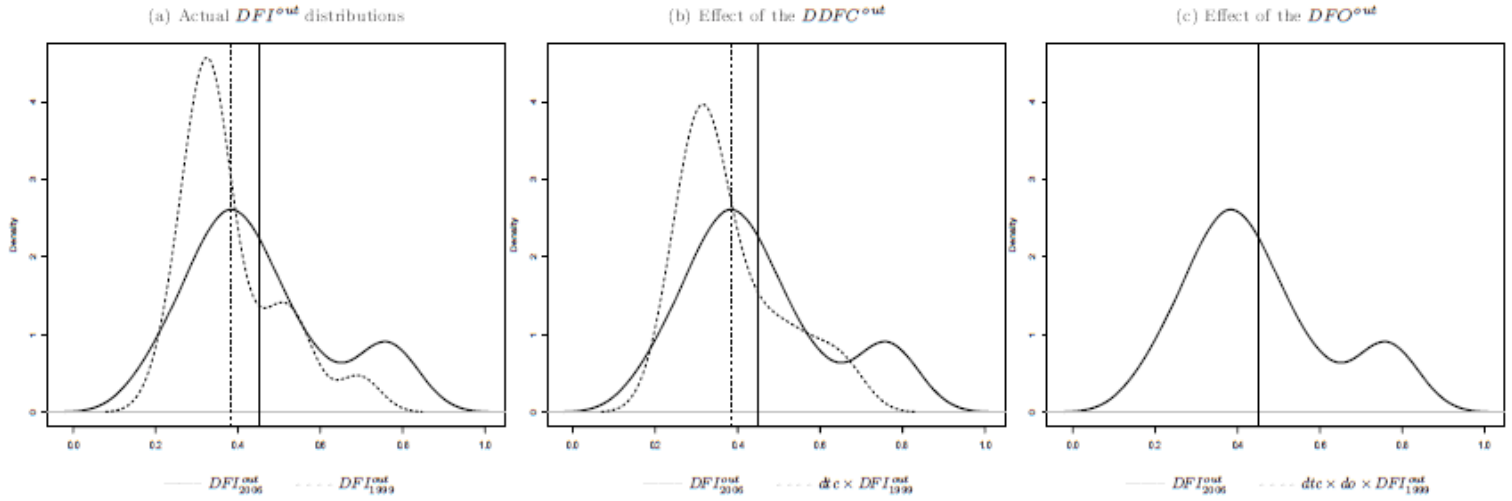


Figure 10: Bipartite decomposition of the degree of financial integration, inflows ($DFI^{\gamma=1}$), 1999–2006

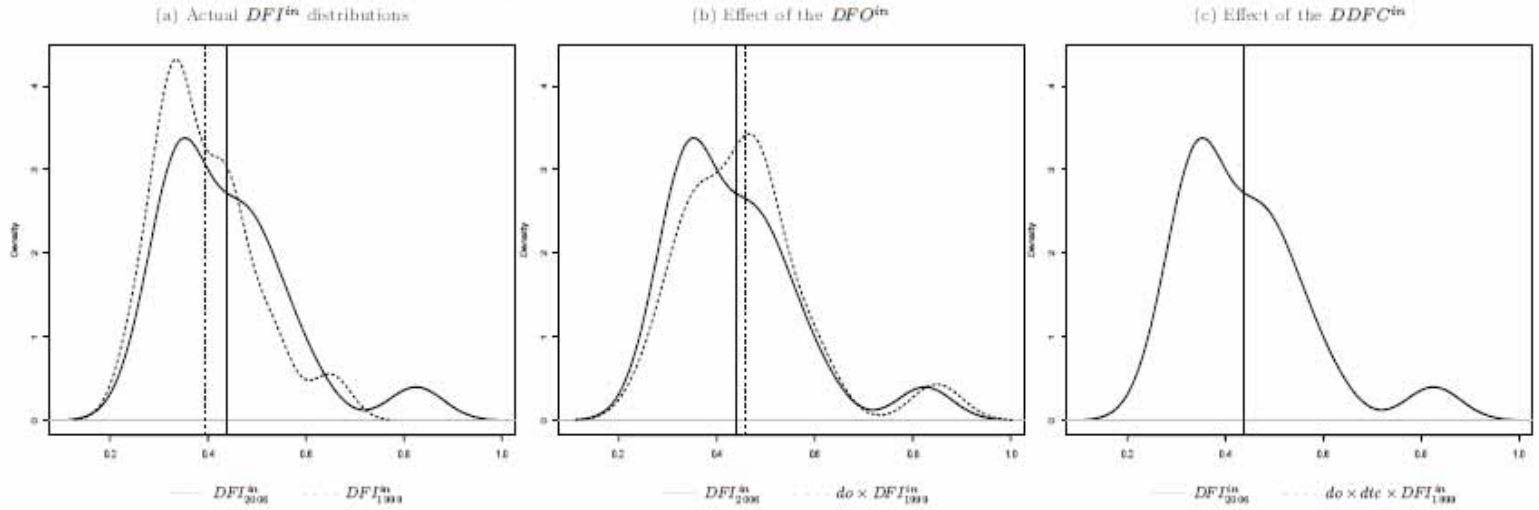


Figure 11: Bipartite decomposition of the degree of financial integration, inflows ($DFI^{\gamma=1}$), 1999–2006