Supply- and demand-side factors in global bank credit

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Abstract: International banking flows follow a boom and bust pattern. Identifying the demand-side and supply side drivers of these cycles is essential for sound macroeconomic policy analysis. This paper applies a new empirical methodology pioneered by Amiti and Weinstein (2015) to identify supply-side, demand-side and common shocks in bilateral international banking flows since 2000. The methodology allows us to overcome two hurdles that hamper analysis of bilateral capital flows data: (a) the severe heteroscedasticity in bilateral positions which yield parameter estimates that explain little of the aggregate flows; and (b) the bias induced in the parameter estimates caused by the formation of new bilateral links. Applied to global banking data (BIS *Consolidated Banking Statistics*), the methodology yields supply-side shocks for those national banking systems known to have faced difficulties in particular periods (eg Japanese banks in 2001-02, and selected banking systems during the financial crisis). It also generates plausible demand-side shocks for particular countries known to have experienced downturns independent from the global economy (eg the European periphery in 2010-13).

Keywords: International banking, global financial crisis, supply vs demand shocks, BIS consolidated banking statistics

JEL classification: *F34*, *G01*, *G21*

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1. Introduction

International banking flows can be characterised by periods of rapid growth in cross-border credit followed by sudden reversals caused by adverse shocks to either the creditor banking system or the borrower country. This boom-bust cycle has had particularly devastating consequences for those countries highly dependent on cross-border sources of capital. The Latin American debt crisis and the subsequent retrenchment of global banks in the 1980s and the Asian financial crisis in the late 1990s are two examples where emerging economies suffered massive withdrawals of bank capital. More broadly, the Global Financial Crisis that erupted in 2007 led to one of the largest contractions in international banking on record, affecting borrowers in advanced and emerging economies alike. This was followed by the euro area sovereign debt crisis, which induced further contractions in international bank credit globally, and in the euro area in particular.

Policy makers have a keen interest in better understanding these boom-bust cycles in international credit flows. To assist them, researchers have developed numerous empirical methodologies that attempt to isolate the so-called "supply-side" and "demand-side" drivers of international credit flows generally, and banking flows in particular.[2] Identifying these drivers, and tracking them as they evolve, is not only of empirical interest; it is relevant to macroprudential authorities in those countries that are re-evaluating the usefulness of capital controls that fell out of favour following the Global Financial Crisis. Determining whether such controls might be appropriate and how they should be implemented requires first understanding whether or not the observed capital flows are in some sense excessive and whether or not they are sensitive to an economic downturn either at home or abroad.

Empirically, however, credibly separating supply- and demand-side factors in capital flow data has proven to be difficult. Many attempts that have focused on international banking flows involve some sort of panel regression with creditor-side and borrower-side health measures, and often fixed effects to identify demand and supply shocks. And most of these attempts do indeed succeed in identifying statistically significant drivers. But, at the same time, they typically fall short in explaining the aggregate growth patterns observed in the data, as evidenced by low *R*-squared values. It is often the aggregate growth patterns that are of interest to policy makers. For example, how much weight should policy makers place on a finding that, say, interest rate differentials across countries are correlated with capital flows when the empirical model used to achieve this result is able to explain only a single digit share of the aggregate movements in these flows? Such problems become even more severe in periods of stress, when statistical relationships that seem strong in normal times break down.

[2] Depending on the study, "demand" and "supply" drivers are sometimes referred to as "push" and "pull" factors. These latter terms seem to be used more often when the focus is on pure residence – based capital flow data for a country (eg balance of payments data, IIP data and the BIS locational banking statistics). By contrast, the data used here (BIS consolidated banking statistics) capture reporting banks' globally consolidated balance sheets, as described in Section 3. That is, the perimeter of the reporting entities is not based on the (country) location of creditor banks but rather follows the perimeter of their global operations (eg claims of "UK banks" rather than of "banks located in the United Kingdom"). We thus retain the use of "supply" and "demand" shocks in favour of "push" and "pull" factors since the former are more applicable to cases where the decision making units on both sides of the transaction can be cleanly separated. See Koepke (2015) for a review of the literature on "push" and "pull" factors in capital flows to emerging economies.

In this paper, we rely on a new empirical methodology pioneered in Amiti and Weinstein (2015) that helps in separately identifying supply- and demand-side shocks in international banking flows. The methodology generalizes the benchmark estimation framework used in Khwaja and Mian (2008), and later in Cetorelli and Goldberg (2011), but it includes features that allow for more efficient estimation of these shocks. We apply this methodology to the BIS *Consolidated Banking Statistics* (CBS), which track the consolidated foreign claims (ie loans and other financial claims) of banks headquartered in 30 reporting countries on counterparties in more than 200 countries (Section 2). The methodology is "inward-looking" in the sense that no measures of creditor bank- or counterparty country-health are used in the estimation. As a result, many empirical complications, for example the endogeneity of the explanatory variables, do not arise. But, post estimation, we correlate the estimated supply- and demand-side shocks with independent measures of bank-health to establish the credibility of these estimates.

It is important to state clearly what this methodology can and cannot do, and what we mean by "supply-side" and "demand-side" shocks. The methodology yields measures of how far out of the norm the growth in claims of a particular banking system is relative to that of all other banking systems, which we call supply shocks, as well as measures of how far out of the norm the growth in credit to a particular country is relative to that to all other countries, which we call demand shocks.

Importantly, the methodology, described in Section 2, makes maximum use of the information in the bilateral data, and thus provides a useful monitoring tool to identify both banking systems and borrower countries where credit growth is out of the ordinary. By construction, summing the estimated supply- and demand-side shocks, plus a "common shock" that characterises the common element in the growth of all banking systems to all countries, yields (a) the observed growth rate for all bilateral positions, (b) the observed growth rate for any one banking systems' claims on all countries, and (c) the observed growth rate for all banking systems' claims on any one country.[3]

The methodology is particularly well-suited to the characteristics observed in the international banking data. As discussed in Section 3, global bank claim stocks are highly concentrated in only a handful of banking systems and a somewhat larger set of counterparty countries. In other words, the vast majority of the bilateral observations are small claims amounts (less than $1 billion). Given the somewhat discrete nature credit, growth rates derived from small outstanding claim stocks tend to exhibit wild swings. To be precise, banks can easily triple in a quarter their outstanding claims of $1 billion (ie a 300% quarterly growth rate), and when this position matures, the bilateral link could easily disappear (ie a -100% quarterly growth rate). But a quarterly growth rate of only 5% on a bilateral stock of $400 billion, which

[3] Note, however, that the terms "supply" and "demand" in reference to the estimated shocks are not as precise as we would like them to be. We cannot, for example, say in relation to an estimated negative demand shock that the borrowers that had previously demanded credit suddenly no longer wanted it; one or more key creditor banking systems that decided to pull out, either because of an increase in the perceived riskiness of that borrower country or because they decided to channel funds previously given to that country elsewhere, would also register a negative "demand shock". As a concrete example, Fernandez-Arias (1996) argued that the low policy rates in advanced economies in the 1990s had the effect of improving the creditworthiness of some emerging market borrowers, which in turn led to greater capital flows to these countries. All else equal, this would show up as a positive "demand-side" shock in our methodology, at least to the extent that the growth in credit to these countries was higher than elsewhere, even though it could be argued that it was a change in the external environment that induced the flow.

is roughly the size of UK headquartered banks' claims on Hong Kong, would be enormous. In short, the concentration of global claims in a handful of bilateral pairs induces extreme heteroscedasticity in the growth rates of bilateral claims in the global sample of all bilateral pairs. Less-efficient empirical methodologies that do not take this into account, ie those that place equal weight on all observations regardless of their underlying properties, generally fail to explain much of the variation in the data.

Equally important in generating plausible estimates of the demand and supply shocks is the calculation of the bilateral growth rates used as inputs. Banks' bilateral positions are typically denominated in many currencies but are expressed in US dollars when reported to the BIS. Exchange rate movements change the relative value of the underlying currencies and thus induce changes in outstanding stocks that do not actually signify the extension or withdrawal of credit. As described in Section 3, failure to adjust the data for these factors yields wildly inaccurate growth rates, both at the bilateral level and in the aggregate. Similarly, breaks in series – for example bank mergers or changes in reporting methodology – induce jumps in claim stocks that are generally orders of magnitude larger than those that occur in the absence of such events. Yet, many empirical studies that rely on the BIS consolidated banking statistics do not take these factors into account.[4]

The results of our analysis are detailed in Section 4. To assess whether the estimated supply and demand shocks are meaningful in an economic sense, we compare them to measures of banking system and country health during periods of known stress. In some cases, these comparisons are little more than a check against widely-known events, for example the near bankruptcy and subsequent restructuring of the major Japanese banks in 2001-02, Russia's sovereign default in 1998 and Argentina's sovereign default in 2001. In other cases, we correlate the estimated shocks with outside measures of bank health and balance sheet structure, for example their reliance on core funding (ie deposits) prior to the 2007-09 financial crisis and their total losses incurred during the crisis. In virtually every case, the estimated shocks jibe with these outside measures.

There are four main takeaways from Section 4. First, the growth in bilateral bank claims has been much more heterogeneous across banking systems and borrower countries in the post crisis period than in the pre-crisis period. Pre-crisis, the estimated common shocks were by far the largest contributing factor to aggregate claim growth. Post crisis, however, the common element all but disappeared, reflecting the various states of bank health and changes in their organisational structure induced by the crisis and the subsequent regulatory scrutiny.

Second, during the crisis itself, supply shocks contributed significantly to the contraction in credit to most all counterparty countries, but most importantly to emerging economies. This is consistent with earlier studies (eg Cetorelli and Goldberg (2011)) that linked the shock to banks' balance sheets from losses on structured finance products and the turbulence in US dollar funding markets to a diversion of credit. Importantly, the estimates of the supply shocks presented here imply a much larger contribution in the overall growth dynamics than those estimated elsewhere.

Third, negative supply shocks seem to have contributed little to the euro area sovereign crisis which started in mid-2010 and continued in fits and starts through 2015. The severe downturn in global banks' foreign claims on the key countries involved in the crisis – Greece, Italy, Ireland, Portugal and Spain – were unique to

[4] Exceptions are Cerrutti (2015) and McGuire and von Peter (2016), which do make these adjustments.

these countries, and hence are registered as negative demand-side shocks. That said, negative supply shocks did play some role in that banks headquartered in these countries saw large contractions in their foreign credit, some of which had been directed to other countries in crisis.

Finally, and perhaps most important from the perspective of policy makers today, the estimates offer an up-to-date view of the recent peak in the credit cycle in emerging economies. While growth in claims globally has slowed, the contraction in credit to emerging Asia and emerging Europe – to China and Russia in particular – has been severe. Negative supply shocks, which in part reflect the ongoing contraction in European banks' global balance sheets, contributed somewhat. But the estimates presented here suggest that these countries are unique, with large negative demand shocks accounting for virtually all of the decline in the growth in bank credit.

2. Empirical framework

Much of the existing work based on the CBS relies on panel regressions of the growth in cross-border claims on a host of creditor-banking system and borrower-country control variables, and fixed effects for both, to tease out the supply- and demand-side drivers. Of particular interest has been the role of these drivers in bank claims on emerging economies, many of which suffered significant contractions in cross-border claims during the key quarters of the 2007-09 global financial crisis.

The number of such studies that have emerged since the crisis is too numerous to review here, but a few examples will help set the stage for how the empirical methodology described below contributes to this literature. Using data through end-Q2 2007 (ie before credit markets deteriorated in July 2007 and the collapse of Lehman Brothers in September 2008), McGuire and Tarashev (2008) used panel OLS regressions to investigate how the deterioration in banks' balance sheet health contributed to the subsequent slowdown in claim growth in the initial phases of the crisis. Using a similar framework, Cerutti (2015) examined cross-border banking exposures throughout the crisis, after making adjustments for the role of subsidiaries in the banks' global operations. Takáts (2010) and Avdjiev et al (2012) used regression analysis to decompose cross-border bank flows to emerging economies and found that home-country (ie supply) factors generally contribute to cross-border credit growth, but their importance increased sharply during the 2008-09 financial crisis and again during the euro area sovereign crisis.[5]

In an oft-cited study, Cetorelli and Goldberg (2011) examined how shocks to banks' US dollar funding during the crisis contributed to the contraction in claims on emerging economies. Their empirical methodology is a variant of that in the seminal paper by Khwaja and Mian (2008), who developed a structural model to derive an estimating equation where time-varying fixed effects for both individual banks and individual borrowers capture the desired supply- and demand-side shocks. (As discussed below, this model is the departure point for the methodology used here.)

[5] Note that these studies do not estimate bilateral panel data; the dependent variable in these studies is BIS reporting banks' *combined* cross-border bank flows to individual countries from the BIS *Locational Banking Statistics*. Thus, rather than estimate banking-system supply shocks directly, Avdjiev et al (2012) identify "home country" effects by constructing indices of credit bank health for each counterparty country as weighted averages of various bank health measures where the weights are creditor banks' consolidated foreign claims on each country.

Looking beyond just the crisis period, Bruno and Shin (2014) develop a model of how leverage in internationally-active banks interacts with local banks in the transmission of financial conditions across borders, and then use panel regression analysis on the BIS *Locational Banking Statistics* to test the predictions of their model. Similar in spirit, Cerutti et al. (2014a) use the same data to examine the determinants of global liquidity in a panel regression framework, and find that investor uncertainty, US monetary policy and bank conditions in large countries all contribute to cross-border banking flows. Finally, Avdjiev and Takáts (2014) followed with an analysis of the slowdown in cross-border claims on emerging economies during the so-called "taper tantrum" in May 2013, when the Federal Reserve hinted that it might end its quantitative easing, and highlighted the central role of the US dollar in bank credit to many economies.

Each of the studies mentioned above were successful in identifying particular drivers that can credibly be attributed to supply- or demand-side shocks. But, they were less successful in generating model estimates that can explain the observed behaviour in aggregate claim growth, as evidenced by R-squared values often in single digits. In some cases, the failure to adjust the data for exchange rate movements and breaks in series, as discussed in Section 3 below, was a contributing factor. But, arguably the main reason why existing models have fared poorly in this regard is that they do not take into account the extreme heteroscedasticity in the bilateral growth rates in their samples (also discussed in Section 3 below).

This problem is particularly acute when changes in the aggregate level of the dependent variable (ie summed across all banking systems and counterparty countries) are driven by changes in only a few underlying observations, ie those where the *bilateral* levels are large. For example, a 2% increase in a $500 billion bilateral claim position contributes much more to the change in global claims than does a 300% increase in a $0.5 billion position. Yet, in a typical panel regression where growth rates are used as the dependent variable, both observations are given equal weight in the determination of the regression coefficients. And as a result, the estimated coefficients reflect the "average effect" across all observations, without taking into account each observation's unique contribution to the growth in aggregate claims.

An estimation technique introduced in Amiti and Weinstein (2015) can address this problem. We briefly review the methodology here, but interested readers are encouraged to consult the original paper for a full derivation of the estimating equation. We begin with equations (1) and (1′), two alternative specifications which relate the bilateral growth in claims reported by banking system *b* on counterparty country *c* to time-varying "supply" shocks that affect creditor banks ($\alpha_{b,t}$) and time-varying "demand" shocks that affect counterparty countries ($\beta_{c,t}$).[6]

$$\frac{L_{b,c,t} - L_{b,c,t-1}}{L_{b,c,t-1}} = \alpha_{b,t} + \beta_{c,t} + \varepsilon_{b,c,t} \quad (1)$$

$$\Delta ln L_{b,c,t} = \alpha_{b,t} + \beta_{c,t} + \varepsilon_{b,c,t} \quad (1')$$

One strategy is to estimate equations (1) or (1′) in a simple OLS regression of the bilateral growth rate in claims on a full set of time-varying banking system and country fixed effects. This approach, however, suffers from two problems. First, OLS will produce estimates that cannot be aggregated to yield banking systems',

[6] Khwaja and Mian (2008) derive a version of this equation from a structural model in which banks face positive marginal financing costs and decreasing returns to capital as aggregate borrowing increases.

counterparty countries', or total claim growth rates even if all bilateral relationships are maintained in periods *t* and *t-1*. Second, OLS can yield biased estimates of the supply and demand shocks in any data sample where new bilateral links form (eg when a banking system starts or resumes lending to a particular country) since, for such observations, $L_{b,c,t-1}$ is zero and $\Delta lnL_{b,c,t}$ is undefined. Hence the bilateral growth rate for the period is undefined.[7] We address these two problems sequentially.

The basic intuition for the problem is that OLS estimation of equation (1) weights all of the observations equally and would be appropriate if one wanted to obtain an estimate of the *unweighted* arithmetic averages of loan growth rates. Similarly, estimation of equation (1') is appropriate if one wanted to estimate *unweighted* geometric average of loans in period *t* divided by the geometric average of loans in period *t-1*. Neither method, however, yields parameter estimates that can be aggregated to yield the growth in aggregate claims, or even the growth in claims of a particular banking system or on a particular country.

Amiti and Weinstein (2015) prove that when thinking of the growth rate of pre-existing claims (ie claims for which $L_{b,c,t-1} > 0$), one can solve these problems by weighting the data by the lagged claim level. We can obtain some intuition for why this works by considering the adding-up requirements. Let $\emptyset_{b,c,t-1}$ be the share of banking system *b*'s claims on country *c* in period *t-1* (equation (2)).

$$\emptyset_{b,c,t-1} \equiv \frac{L_{b,c,t-1}}{\sum_c L_{b,c,t-1}} \tag{2}$$

Multiplying both sides of equation (1) by equation (2) and summing across counterparty countries yields equation (3), where we have chosen an arbitrary normalization such that the "common shock", γ_t, equals the median claim shock and variables with tildes are deviations from the median. In other words, $\tilde{\alpha}_{b,t}$ is the "idiosyncratic" counterparty country shock and $\tilde{\beta}_{c,t}$ is the idiosyncratic creditor banking system shock. The left side of equation (3) is the sum of the growth in banking system *b*'s bilateral claims on each country weighted by the size of those claims in that banking system's total portfolio of claims (note that *new* claims in period *t* (i.e., where $L_{b,c,t-1} = 0$ are excluded; we return to this point below).

$$\sum_{c:L_{b,c,t-1}>0} \left(\frac{L_{b,c,t-1}}{\sum_c L_{b,c,t-1}} \left(\frac{L_{b,c,t} - L_{b,c,t-1}}{L_{b,c,t-1}} \right) \right) = \sum_c \left(\frac{L_{b,c,t-1}}{\sum_c L_{b,c,t-1}} \left(\gamma_t + \tilde{\alpha}_{b,t} + \tilde{\beta}_{c,t} + \varepsilon_{b,c,t} \right) \right). \tag{3}$$

The left side of equation (3) reduces to the growth in banking system *b*'s *aggregate* claims on all countries, in equation (4). Similarly, the right side of equation (3) simplifies to the banking system-specific shock ($\tilde{\alpha}_{b,t}$) plus the weighted average of all the country-specific shocks ($\tilde{\beta}_{c,t}$).

$$\frac{\sum_{c:L_{b,c,t-1}>0} L_{b,c,t} - \sum_c L_{b,c,t-1}}{\sum_c L_{b,c,t-1}} = \gamma_t + \tilde{\alpha}_{b,t} + \sum_c \left(\emptyset_{b,c,t-1} \tilde{\beta}_{c,t} \right) + \sum_c \left(\emptyset_{b,c,t-1} \varepsilon_{b,c,t} \right) \tag{4}$$

[7] Coefficients estimated with OLS are unbiased for the subset of *existing* bilateral claims, but often what is of interest is the behaviour of aggregate credit growth. Thus, in data samples where bilateral links regularly disappear and reappear, simple OLS is of little use.

By analogy, we can derive a similar equation that relates the growth in *aggregate* claims of all banking systems on each country *c* to the country-specific shock ($\tilde{\beta}_{c,t}$) and a weighted average of the banking system-specific shocks ($\alpha_{b,t}$). Let $\theta_{b,c,t-1}$ be the share of total claims on country *c* that were booked by banking system *b* (equation (5)).

$$\theta_{b,c,t-1} \equiv \frac{L_{b,c,t-1}}{\sum_b L_{b,c,t-1}} \tag{5}$$

Multiplying both sides of equation (1) by $\theta_{b,c,t-1}$ and summing across banking systems yields equation (6), the analogue to equation (4) that relates the growth in aggregate claims on country *c* to supply and demand shocks can then be written as:

$$\frac{\sum_{b:L_{b,c,t-1}>0} L_{b,c,t} - \sum_b L_{b,c,t-1}}{\sum_b L_{b,c,t-1}} = \gamma_t + \sum_c \left(\theta_{b,c,t-1}\tilde{\alpha}_{b,t}\right) + \tilde{\beta}_{c,t} + \sum_c \left(\theta_{b,c,t-1}\varepsilon_{b,c,t}\right) \tag{6}$$

Equations (4) and (6) show that efficient estimates of the shocks should be consistent with the growth in aggregate claims of each banking system on all countries, and of all banking systems on each country. So chosen, the shock estimates will then be consistent with the growth in aggregate claims of all banking systems on all countries.

To operationalise equations (4) and (6), note first that the claims shares ($\emptyset_{b,c,t-1}$ and $\theta_{b,c,t-1}$) are predetermined in period t. Thus, we can make use of the fact that $E\left[\emptyset_{b,c,t-1}\varepsilon_{b,c,t}\right] = \emptyset_{b,c,t-1}E\left[\varepsilon_{b,c,t}\right] = 0$ and $E\left[\theta_{b,c,t-1}\varepsilon_{b,c,t}\right] = \theta_{b,c,t-1}E\left[\varepsilon_{b,c,t}\right] = 0$ to derive a set of moment conditions for equations (4) and (6) in which we impose on the data that the parameter estimates must exactly aggregate to the actual claim growth rates for banking systems and counterparty countries. We know that such a solution exists because equations (4) and (6) constitute a set of *C* + *B* linear equations of *C* + *B* unknowns. In other words, equations (4) and (6) show that efficient estimates of the shocks will equal the growth in aggregate claims of each banking system on all countries, and of all banking systems on each country. So chosen, the shock estimates will then be consistent with the growth in aggregate claims of all banking systems on all countries.

Amiti and Weinstein (2015) also contrast these moment conditions with those obtained by estimating equation (1) as in Khwaja and Mian (2008). Standard OLS estimation would produce the following moment conditions:

$$\frac{1}{N_{b,t}} \sum_{c:L_{b,c,t-1}>0} \frac{L_{b,c,t} - L_{b,c,t-1}}{L_{b,c,t-1}} = \gamma_t + \tilde{\alpha}_{b,t} + \sum_c \left(\frac{1}{N_{c,t}}\tilde{\beta}_{c,t}\right) + \sum_c \left(\frac{1}{N_{c,t}}\varepsilon_{b,c,t}\right) \tag{7}$$

and

$$\frac{1}{N_{c,t}} \sum_{b:L_{b,c,t-1}>0} \frac{L_{b,c,t} - L_{b,c,t-1}}{L_{b,c,t-1}} = \gamma_t + \tilde{\beta}_{c,t} + \sum_b \left(\frac{1}{N_{b,t}}\tilde{\alpha}_{b,t}\right) + \sum_b \left(\frac{1}{N_{b,t}}\varepsilon_{b,c,t}\right) \tag{8}$$

where $N_{c,t}$ and $N_{b,t}$ are the number of counterparty countries borrowing from banking system *c* and the number of countries on which banking system *b* has outstanding claims, respectively. These equations differ from equations (4) and (6) in two important ways. First the weights are no longer loan shares; and second the left-hand sides are not total loan growth but the average growth of each individual bilateral claim position. As long as $L_{b,c,t-1}$ is not constant across bilateral pairs, the two methodologies will yield different results, with OLS appropriate for estimating

average loan growth rates and the Amiti and Weinstein (2015) method appropriate for estimating country loan growth rates.

However, equations (4) and (6) are still not ideal for estimating actual claim growth rates because they are only appropriate for cases in which there are no new bilateral relationships. In order to deal with cases where a banking system starts (or resumes) a claim relationship with a counterparty country, we modify the equations slightly as follows:

$$\frac{\sum_c L_{b,c,t} - \sum_c L_{b,c,t-1}}{\sum_c L_{b,c,t-1}} = \gamma_t + \tilde{\alpha}_{b,t} + \sum_c \left(\emptyset_{b,c,t-1}\tilde{\beta}_{c,t}\right) + \sum_c \left(\emptyset_{b,c,t-1}\varepsilon_{b,c,t}\right) \quad (4')$$

$$\frac{\sum_b L_{b,c,t} - \sum_b L_{b,c,t-1}}{\sum_b L_{b,c,t-1}} = \gamma_t + \sum_c \left(\theta_{b,c,t-1}\tilde{\alpha}_{b,t}\right) + \tilde{\beta}_{c,t} + \sum_c \left(\theta_{b,c,t-1}\varepsilon_{b,c,t}\right) \quad (6')$$

By summing over all lending pairs instead of only those that existed in the previous period, we guarantee that the supply and demand shocks exactly match the *total* claim growth of each banking system and the *total* growth in claims on each counterparty country.

3. Data and summary statistics

One of the differences between this paper and prior research is the usage of a confidential version of the BIS *Consolidated Banking Statistics* (CBS) that enables us to eliminate the substantial measurement error that can arise from computing bilateral claim growth rates from the publicly available versions of these statistics. As is well known, the CBS are the most comprehensive data available that capture reporting banks' globally consolidated positions with information about the location and type of counterparties. However, the ability of researchers to use these data to understand actual bank credit behaviour has been limited by the violent jumps apparent in claims positions that arise from methodological changes (ie "breaks in series") and that occur solely because the exchange rates for the currencies in which the claims were denominated moved.

This section describes these statistics, with details about how we corrected their shortcomings and their appropriateness for interpreting the empirical results in Section 4. We review (a) the degree to which global bilateral banking positions are concentrated in a relatively small number of bilateral linkages, which reduces the power of standard panel estimation techniques; (b) the various adjustments applied to these data to produce the growth rates used as inputs to the empirical analysis; and (c) the different types of claims – cross-border vs locally booked claims – and how differences in the growth of these claim types are related to structure of the liabilities that fund them.

3.1 Overview of the BIS Consolidated Banking Statistics

The CBS track banks' outstanding claims (ie financial assets) on counterparties in particular countries and sectors. These quarterly data are not at the level of individual banks, but rather are aggregated at the level of *internationally-active* banks

headquartered in a particular country (eg "US banks", "French banks", etc).[8] But unlike other data sources that do provide bank-level detail (eg BankScope or SNL Financial), the CBS provide information about the location and sector of counterparties, which is essential for any analysis of how demand and supply factors affect the growth in international bank credit.

The basic unit in the CBS is "Foreign Claims" (FC). A reporting bank's FC on a particular country and sector include any loans extended to counterparties there, and any holdings of debt and equity securities issued by these counterparties.[9] Claims are reported on a *consolidated basis*.[10] That is, claims on counterparties in a particular country include all cross-border claims booked by a bank's home offices and its offices in other countries, plus claims extended locally by that bank's affiliates (subsidiaries and branches) located in the counterparty country.[11] In other words, the nationality of a reporting banking system in the CBS, eg "US banks", is not indicative of the location of these banks' offices, eg "banks in the United States".[12] To take an example, a cross-border loan extended by the subsidiary of a US bank located in London to a manufacturer in Germany would be included in US banks' consolidated foreign claims on Germany, as would a loan extended from the same US bank's home office in the United States to a household in Germany.

By contrast, on the counterparty country side, it is the location of the immediate counterparty that matters irrespective of the nationality of the borrower. For example, a cross-border loan extended by a branch of a French bank located in London to the subsidiary of a *German corporation* located in the United States would be included in French banks' worldwide consolidated *FC* on counterparties *in the United States*.

FC is broken down into two components: "International Claims" (INTLC) and "Local Claims in Local Currencies" (LCLC). INTLC on a particular counterparty country *c* is defined as (a) all cross-border claims in all currencies booked by the reporting banks' offices worldwide plus (b) any locally-extended claims (ie claims booked by the reporting banks' affiliates in country *c*) in non-local currencies. *LCLC* is defined as claims in the local currency booked by the reporting banks' affiliates located in country *c* vis-à-vis residents of the country, where "local currency" refers to the currency of country *c*.[13] So, for example, a euro-denominated loan booked by a

[8] We use CBS on an immediate counterparty basis (IC basis), which allocates claims to the country and sector where the contractual counterparty is located. These statistics are appropriate for analyzing the credit provided to particular countries. By contrast, the CBS on an ultimate risk basis (UR basis) allocates claims to the country and sector where the ultimate obligor resides, that is, after taking into account parent- and third-party guarantees, CDS protection bought, collateral and other credit hedges. In principle, the CBS (UR basis) are appropriate for analyzing banks' *exposures* to particular countries/sectors, but can provide a misleading picture of the actual credit extended. In practice, the differences across the two datasets in total foreign claims on most counterparty countries are small. As a result, in places we exploit the additional breakdowns available in the CBS (UR basis) in interpreting the CBS (IC basis).

[9] Claims do not include derivatives with a positive market value (from the reporting bank's perspective) with a contractual counterparty in the country. These are reported separately in the CBS (UR basis).

[10] Banks' claims on residents of their home country have been included in the CBS only since 2015 Q1, and are thus not considered in the analysis in this paper.

[11] See Cerutti (2015) for a separate consideration of the role of branches and subsidiaries in the CBS.

[12] See McCauley et al (2012), McGuire and von Peter (2012) and McGuire and Wooldridge (2005) for discussion of the CBS and the differences in reporting banking systems' organisational structure.

[13] That is, FC = INTL + LCLC where INTL = cross-border claims (XBC) plus locally extended claims in non-local (foreign) currencies (LCFC).

French bank's subsidiary in London to a borrower in Germany would be classified as an international claim on Germany, as would a US dollar loan booked by the same French bank's subsidiary in Germany to the same borrower. By contrast, a euro-denominated loan booked by this French bank's subsidiary in Germany to the same German borrower would be classified as a "Local Claim in Local Currency."

3.2 Concentration in bilateral bank claims

Idiosyncratic shocks to particular banking systems would not matter in a world with many lenders and borrowers each of whom had a trivial share of the total market. In this case, the law of large numbers would apply and idiosyncratic shocks would just cancel. However, the CBS data reveal that international bank positions are extremely concentrated in a handful of creditor banking systems and counterparty countries.

The CBS track the foreign claims positions of banks headquartered in 31 countries ("reporting countries") on more than 200 counterparty countries. As shown in Table 1, these claim positions are highly concentrated in a handful of creditor banking systems. And for each banking system, claims tend to be concentrated in only a handful of counterparty countries. On the creditor side, banks headquartered in Japan ("Japanese banks") reported the largest *FC* positions at end-Q4 2015 ($3.7 trillion) followed by UK banks" ($3 trillion), US banks ($2.8 trillion) and French banks ($2.5 trillion) (column 1). At the other end of the spectrum were Turkish banks ($23 billion), Panamanian bank ($21 billion) and Mexican banks ($6 billion).[14] Overall, the top ten banking systems – Canadian, Dutch, French, German, Italian, Japanese, Spanish, Swiss, UK and US banks – accounted for 83% of the total foreign claims of all 31 reporting banking systems at end-2015.

Most banking systems reported claims on well over 100 counterparty countries (Table 1, column 3), the bulk of which were emerging economies (column 5). That said, their claims were highly concentrated in a relatively small number of counterparty countries (columns 9 and 10). For example, amongst the top 10 banking systems listed above, claims on the top five countries accounted for more than 80% of Spanish banks' foreign claims, and more than 60% of Italian and Canadian banks' foreign claims. The shares for the remaining top ten banking systems all exceeded 50%, with the exception of Swiss and French banks, which were each 39%.

Graph 1 further illustrates just how concentrated bilateral foreign claims positions are. All banks combined reported a total of $24.8 trillion in foreign claims spread across counterparties in 225 countries at end-Q4 2015. The top 5 banking systems accounted for more than half of this total, and the top ten for more than 80% (top left-hand panel). Similarly on the counterparty side, banks' combined claims on a mere five countries made up almost half of the global total (top right-hand panel), with claims on the United States, United Kingdom and Germany accounting for more than one third. The top 35 countries shown in the panel accounted for 90% of this total implying that only 10% of global claims were on counterparties in the remaining 190 countries.

Concentration at the level of bilateral positions is even starker (Graph 1, lower panel). Overall, there were 3,957 positive bilateral links at end-Q4 2015. Dropping the

[14] In the analysis that follows, we exclude banks headquartered in Brazil, Greece, Ireland, Mexico and Norway due to data quality issues. We include banks headquartered in Luxembourg and Hong Kong, which are masked in Table 1 because their data is reported confidentially to the BIS.

BIS reporting banks' consolidated foreign and international claims

At end-Q4 2015 Table 1

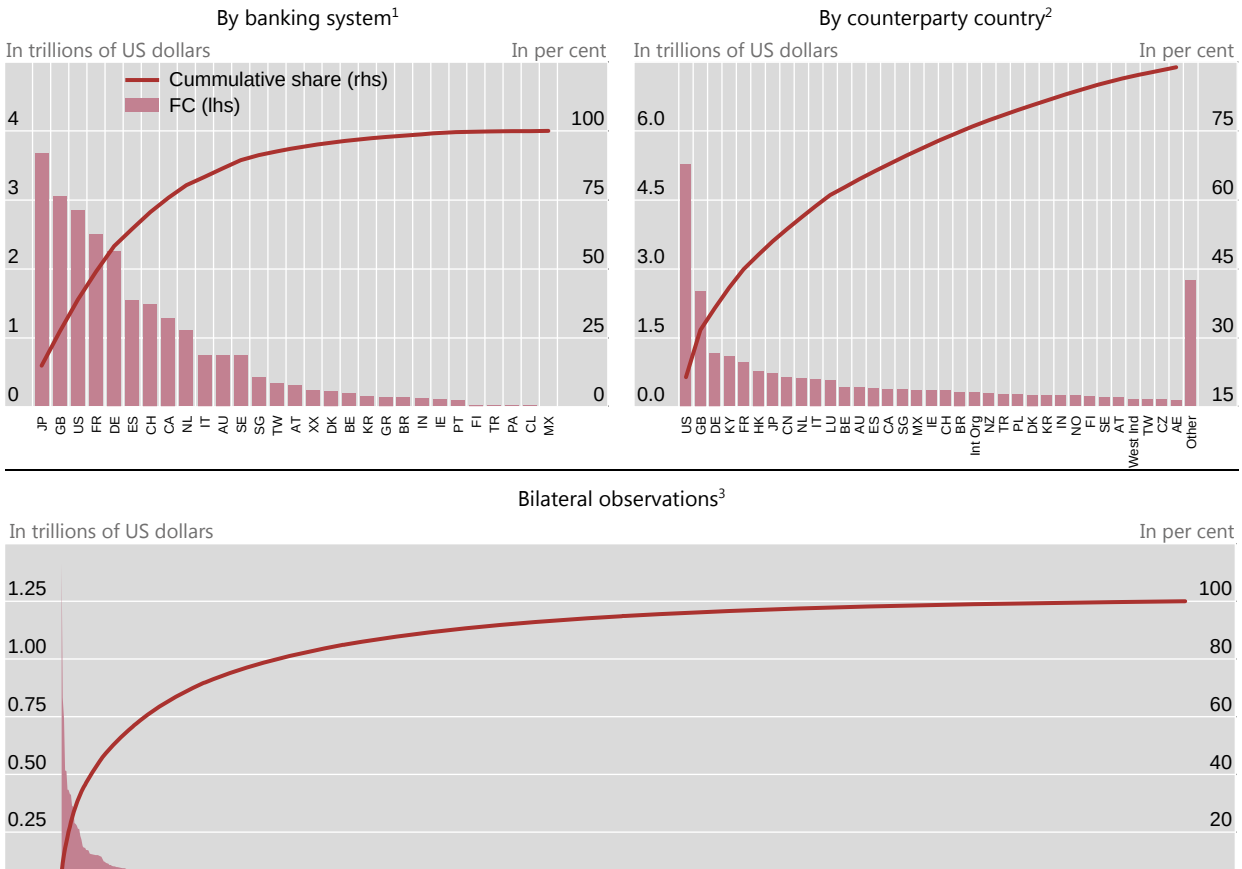
Banking system	Amounts (billions of USD)		Counterparty country count (number of countries)						Top 5 countries in FC (in per cent)	
	Foreign claims	Intl claims	By region				Exit since Q4 2000	Entry since Q4 2000	Full sample[1]	EMEs only[2]
			All	Advanced	EME	Other				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
AT	313	175	159	31	109	19	13	37	54	79
AU	751	280	173	31	119	23	0	114	76	72
BE	192	111	128	31	81	16	31	16	57	92
BR	135	112	101	26	57	18	4	68	63	88
CA	1,287	460	195	31	141	23	3	87	79	62
CH	1,492	949	206	33	150	23	4	49	63	39
CL	14	11	38	17	17	4	3	15	83	93
DE	2,260	1,785	175	33	121	21	18	15	54	50
DK	230	117	131	33	79	19	0	108	68	52
ES	1,549	397	195	33	141	21	6	67	67	83
FI	27	25	49	25	18	6	43	6	54	81
FR	2,500	1,301	195	35	139	21	12	21	51	39
GB	3,047	1,434	179	32	125	22	12	22	51	53
GR	144	106	81	26	40	15	18	21	74	88
IE	103	34	111	29	66	16	12	45	87	78
IN	118	90	133	29	87	17	12	36	57	84
IT	754	390	193	34	139	20	9	57	52	63
JP	3,679	2,872	115	27	75	13	5	20	65	53
KR	153	125	184	33	134	17	3	33	49	65
MX	6	6	37	15	15	7	2	29	88	93
NL	1,109	512	170	31	118	21	18	27	56	59
PA	21	21	64	21	32	11	2	23	57	59
PT	96	57	100	30	55	15	9	36	61	95
SE	747	283	182	33	129	20	5	83	72	67
SG	430	234	122	29	74	19	4	67	67	86
TR	23	20	92	25	58	9	5	47	66	70
TW	345	272	122	26	76	20	34	33	62	77
US	2,845	1,904	170	33	117	20	11	34	46	58
XX[3]	243	156	155	34	102	19	6	76	56	89
All	24,821	14,361	225	37	163	25	5	18	45	40

[1] Share of foreign claims on the top five counterparty countries in total foreign claims on all counterparty countries. [2] Share of foreign claims on the top five emerging economies in total foreign claims on all emerging economies. [3] Banks headquartered in Hong Kong, Luxembourg and Norway which are masked due to confidentiality restrictions.

Source: BIS consolidated banking statistics (IC basis); authors' calculations.

Concentration in foreign claims (FC)

At end-Q4 2015 Graph 1



[1] Bars show the total claims on all counterparty countries for the banking system listed on the x-axis. Banking system "XX" is a combination of banks headquartered in Hong Kong, Luxembourg and Norway which are masked due to confidentiality restrictions. The red line shows the cumulative share in all banking systems' claims on all counterparty countries. [2] Bars show all banking systems' combined claims on the counterparty country listed on the x-axis. The red line shows the cumulative share in all banking systems' claims on all counterparty countries. [2] Bars show bilateral claims (ie single banking system vis-à-vis a single counterparty country) ordered from largest to smallest, while the red line depicts the cumulative share in all banking systems' claims on all counterparty countries. The x-axis shows 964 observations (>1$ billion) out of 3,957 bilateral pairs with positive outstanding claims.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

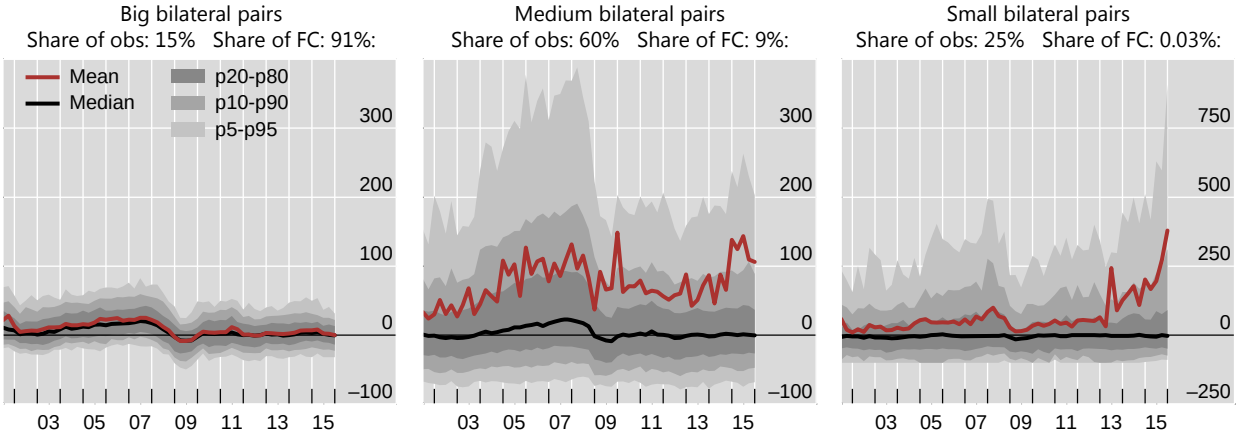
2,993 bilateral claims positions that were less $1 billion at end-Q4 2015 reduces the global total by a mere $363 billion (1.5%), leaving only the 964 bilateral links shown in the panel. The largest 47 bilateral links, or 1.2% of the total links, accounted for more than half of total foreign claims. For individual banking systems, concentration tends to be even more severe. For example, US banks' foreign claims excluding links less than $1 billion came to $2.829 trillion at end-Q4 2015. This was a mere 0.56% smaller than with these observations included, even though the number of bilateral links is 52% less (see Tables A.1 and A.2 in Appendix 1). Across all banking systems, the average percentage point decline in foreign claims after excluding bilateral links less than $1 billion was 9%, while that for the number of linkages was 79%.[15]

[15] For the top 10 banking systems, these shares were 1% and 64% respectively.

Dispersion in the year-over-year growth in bilateral foreign claims[1]

In per cent

Graph 2



[1] Panels show the mean, median and selected percentile values (grey shaded area) of the year-over-year growth in foreign claims (adjusted for breaks in series and exchange rate movements). All bilateral (reporting bank vis-à-vis counterparty country) observations are grouped based on the outstanding stock of foreign claims; "big" observations are those were the outstanding stock of foreign claims is greater than the 75th percentile value for the sample as a whole, "small" observations are those that are below the 45th percentile value, and "medium" observations are all others not classified as "big" or "small".

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

As discussed in Section 2, the concentration in bilateral positions in a relatively small number of banking systems and counterparty countries helps explain why unweighted fixed effects estimation is likely to have limited explanatory power. In order to understand what is driving the growth in claims of a banking system, we need know what is happening to its largest counterparty countries, not the typical counterparty, which is likely to involve a trivial outstanding claim position.

This problem is exacerbated by the fact that the smallest claims positions typically have growth rates with the greatest volatility, resulting in them mattering the most in an unweighted regression.[16] We can see this fact in Graph 2, which shows the dispersion in bilateral growth rates separately for "big", "medium" and "small" bilateral pairs.[17] The largest 15% of observations account for 91% of total outstanding foreign claims at end-Q4 2015. Moreover, the growth rates for big bilateral pairs tend to be much smaller and less volatile.

3.3 Adjustments to year-over-year growth rates

Ideally, the input to the empirical analysis in Section 4 would be the growth in *actual credit* provided by each reporting banking system to borrowers in each counterparty

[16] This reflects the fact that foreign claims, in particular the cross-border component of these claims, are not atomistic. For example, Cerutti et al (2014b) report that the average deal size for syndicated loans, which constitute a substantial portion of claims in the CBS, fluctuated around $400 million between 2000 and 2012 for borrowers in advanced economies; for those in emerging economies, average deal size rose from roughly $200 million in 2000 to $300 million in 2007. The discrete nature of claims means that the booking of a new loan, or the maturation of an old loan, generate significant jumps in total outstanding positions when claims stocks are small. By weighting observations, the empirical methodology outlined in Section 2 and applied in Section 4 tackles this problem head on.

[17] These growth rates have been adjusted for breaks in series and exchange rate movements as described in Section 3.3 below.

country. Such credit *flow* data would perfectly capture banks' choices about when and to whom to extend new credit, independent of redemptions or the maturation of existing positions.

However, such data is not available in the CBS. Instead, we rely on the year-over-year growth in the stock of outstanding foreign claims as a proxy for this ideal measure.[18] In its unadjusted form, this proxy captures any actual increases or decreases in credit *plus* additional sources of variation that are not directly related to actual credit flows. These include (a) valuation effects that arise as firms mark up or down their securities holdings that are subject to mark-to-market accounting (note that loans are typically held at book value); (b) valuation effects that arise from exchange rate movements; and (c) "breaks in series" in the underlying data.

We make two important adjustments to the raw bilateral claims stocks to generate a proxy that better approximates the growth in actual credit provided. The first is a correction for "breaks in series", which can arise for various reasons but typically when there are bank mergers across jurisdictions, or when a reporting country changes its reporting methodology or adds/removes banks from the population of internationally-active reporting banks. For example, in 2005, Unicredit, an Italian bank, bought HypoVereinsbank (HVB), a German bank. As a result, all foreign claims booked by the latter disappeared from German banks' consolidated foreign claims and appeared in Italian banks' claims. The growth in Italian banks' claims on most counterparty countries jumped, while the growth in German banks' claims fell, even though there was little actual change in overall claims on any counterparty country. A similar issue arose in 2009 Q1 when four US investment banks were converted to depository institutions and thus included for the first time in the population of US banks reporting in the CBS. While US banks' overall foreign claims on most counterparty countries jumped noticeably, it did not reflect the provision of new credit.

Fortunately, the distortions caused by many of the largest of these breaks in series can be corrected. Reporting countries often provide to the BIS, on a confidential basis, "pre-break" values of outstanding claims from which adjusted bilateral growth rates can be constructed. Where available, we have used these pre-break values in calculating the year-over-year changes in outstanding bilateral claims amounts. And, as discussed below, this adjustment is critical for generating accurate figures for the growth in bilateral claims, which are to be used as inputs in the empirical analysis in the next section.

When there is a known break-in-series but the pre-break data are not available (ie not provided by the reporting jurisdiction), we have two choices; either truncate the sample for the affected banking system, so that the series starts in the quarter after the break; or assume the pre-break growth rates are zero. *A priori*, it is not clear which procedure is better. Truncating the series has no effect on the estimated shocks in later periods. But the aggregate growth rates (and hence the estimated common and demand-side shocks) prior to the break date are necessarily affected since some observations have been excluded. By the same token, retaining the full series for these banking systems and simply assuming that the growth in claims in the quarter in which the break occurred is zero also introduces error into the estimated shocks. In practice, however, the difference between these approaches is small. In what is

[18] The underlying data are at a quarterly frequency. The empirical procedure is performed separately by quarter on the year-over-year growth in outstanding stocks.

presented below, we have truncated the series for certain banking systems where breaks occurred (as is evident in Graphs 7, 8 and A.1). For two observations, we manually adjusted the data.[19]

A second adjustment is a correction for valuation effects that arise from exchange rate movements. Bilateral claims positions tend to be denominated in *multiple currencies* but are reported to the BIS expressed in US dollars. Large movements in exchange rates, like those that occurred in the wake of the collapse of Lehman Brothers, induce correspondingly large changes in outstanding claims stocks that are not indicative of either new credit extended or credit withdrawn.[20] Unfortunately, the CBS provide only a partial breakdown by currency. Specifically, the currency of denomination for LCLC is known by construction. By contrast, that for INTLC is not known. To adjust INTLC for exchange rate movements, we use the information about the currency of denomination in the BIS *Locational Banking Statistics* (both *by residence* and *by nationality*), as described in Appendix 2.

The effects of both of these corrections – for breaks in series and exchange rate movements – are illustrated in Graph 3. The outstanding stock of all banking systems' combined FC (unadjusted) on various country groups is shown as the shaded area in each panel. The dotted black lines depict the year-over-year growth in these stocks, unadjusted for breaks in series and exchange rate movements. The dashed black lines show these growth rates after adjusting for breaks in series only, and the solid red lines shows the growth rates after an additional correction for exchange rate movements.

These adjustments make a noticeable difference even for the year-over-year growth in *aggregate* foreign claims on all countries (top left-hand panel). In particular, the unadjusted growth rate tended to be higher prior to the crisis, when many currencies were appreciating against the US dollar. By contrast, the adjusted growth rate shows a far less dramatic move into negative territory during the crisis. This difference between the unadjusted and the adjusted growth rates primarily reflects the massive appreciation of the US dollar in the months following the collapse of Lehman Brothers. The breaks-in-series adjustment (dashed black lines) appears to contribute less when viewed at the aggregate level (top left-hand panel), although it should be noted that, where breaks in series do occur, they tend to have a larger effect at the *bilateral* level than do exchange rate movements.[21]

Across counterparty regions, the effect of these adjustments differs depending on the relative shares of US dollar-denominated claims in total foreign claims. For

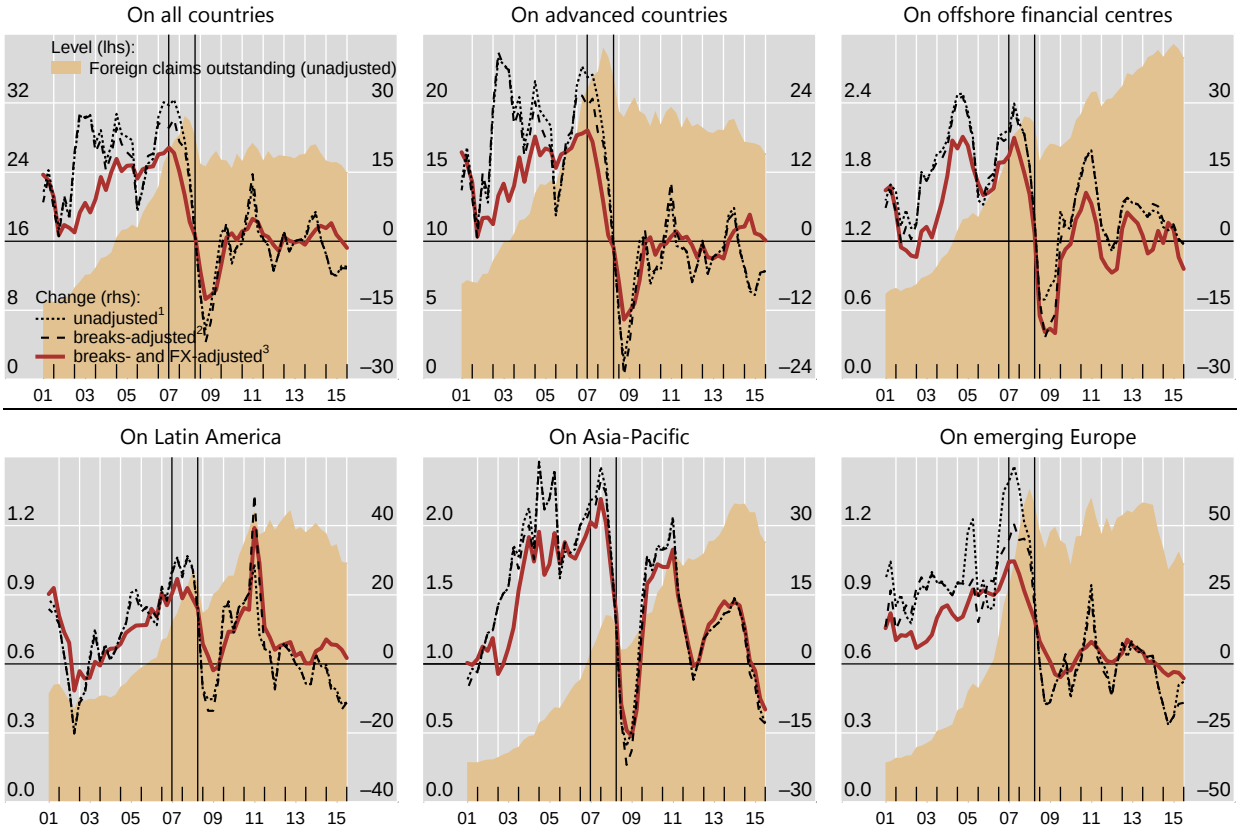
[19] First, in 2008 Q2 Australia masked the value of local claims in local currencies vis-à-vis two counterparty countries. But, because Australia reported the correct claims position on all counterparty countries, we can accurately approximate the missing values. Second, in 2015 Q3, BBVA completed its acquisition of Garanti, a Turkish bank, leading to a substantial jump in foreign claims on Turkey. Because Spain did not report a pre-break claim value, we assume that the pre-break value is the same as the lagged value of foreign claims on Turkey, which in effect implies a bilateral growth rate of zero for that quarter.

[20] For example, suppose German banks' claims on Hungary are primarily denominated in euros. If the euro depreciates against the US dollar during a quarter, the US dollar value of German banks' claims on Hungary will fall as well, even without an actual change in credit to Hungary. In the five months following the collapse of Lehman Brothers in September 2008, the US dollar appreciated by 25% against the euro and by even more against many emerging market currencies.

[21] Bilateral observations that illustrate this point are not shown due to the confidentiality of the breaks in series data.

Adjusted year-over-year growth in foreign claims, by counterparty region

Graph 3



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Growth in foreign claims without adjustments for breaks-in-series or exchange rate movements. [2] Growth in foreign claims after adjustments for breaks-in-series only. [3] Growth in foreign claims after adjustments for breaks-in-series and exchange rate movements.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

countries in Asia Pacific and those classified as offshore financial centres, where US dollar-denominated claims are dominant, the overall difference between the adjusted and unadjusted series is rather small. By contrast, the adjusted growth rates for claims on Latin America and emerging Europe were less than the corresponding unadjusted rates prior to the crisis, and much higher than the unadjusted rates during the crisis. That is, the unadjusted rates show much larger swings. For the full country sample (top left panel), a regression of the unadjusted rate (dotted black line) on the adjusted rate (red line) yields a statistically significant coefficient of 1.4, indicating that the bias in the unadjusted series is far from trivial.[22]

In short, breaks-in-series and exchange rate movements have a non-negligible effect on the year-on-year growth in claims. Failure to take these into account means that the dependent variable tends to overstate claim growth in the run up to the crisis, and massively overstates the contraction in claims during the crisis. The effect is large enough to overshadow the impact of the underlying drivers of foreign claims that econometric analysis tries to tease out.

[22] If there were no systematic measurement error in the unadjusted line, the coefficient should be one. The *R*-squared from this regression is 81%, and the coefficient on the adjusted series is statistically significant at the 99th percentile, with a *t*-statistics of 15.8.

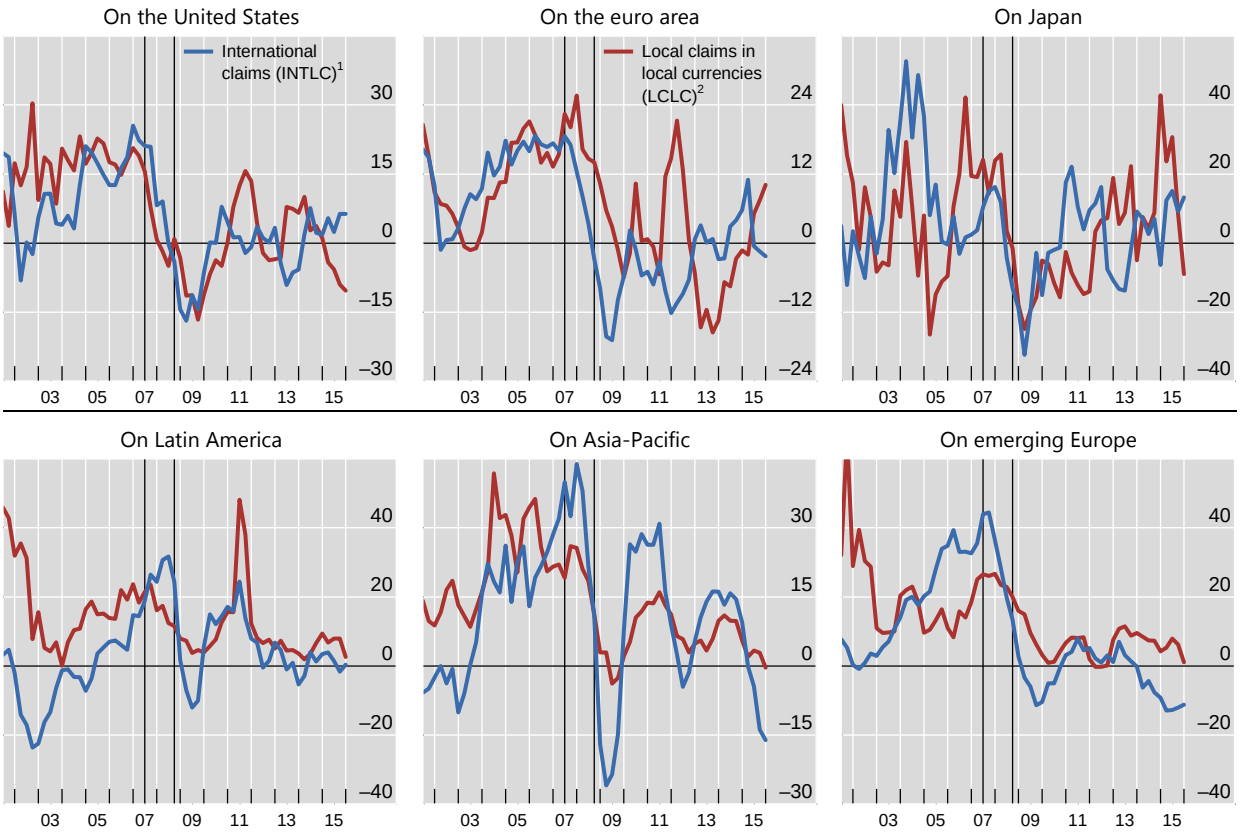
3.4 The stability of local vs. international lending

The stability of claim stocks during the crisis depended also on the *type* of claim, with banks' local claims, in particular their local claims in local currencies (LCLC), being more stable in aggregate than their cross-border claims (McCauley et al (2012), McGuire and von Peter (2016)). Cross-border claims, which account for the bulk of international claims (INTLC), are often backed by short-term wholesale funding, which experienced significant disruptions during the crisis (Baba et al (2009), McGuire and von peter (2012, 2016)). Local claims, by contrast, are more often funded with local liabilities (often in the same currency), and were relatively unaffected by the disruptions in global wholesale funding markets.

That said, this finding for the aggregate masks considerable heterogeneity across borrower regions, primarily reflecting differences in the types of funding that support these claims stocks (Graph 4). For example, vis-à-vis obligors in the United States, non-US banks' locally-booked US dollar claims contracted at roughly the same rate as their international claims (top left panel). The simultaneous contraction in these non-US banks' local US dollar *liabilities* (not shown) suggests that these local assets were funded by short-term wholesale liabilities rather than by stable retail deposits, which are not directly observable in the CBS data. Similarly, banks' international claims

Growth in foreign claims, by claim type and counterparty region

In per cent — Graph 4



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Year-over-year growth in international claims, after adjustments for breaks-in-series and exchange rate movements. [2] Year-over-year growth in local claims in local currencies, after adjustments for breaks-in-series and exchange rate movements.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

on borrowers in the euro area and Japan (top centre and right panels) decelerated and started to shrink somewhat earlier than their local claims, but the growth rates for both types of claims turned negative during and following the crisis.

Vis-à-vis obligors in emerging economies, however, banks' local currency claims proved to be far more stable than their international claims (Graph 4, lower panels). Unlike in the advanced economies, banks' local operations in emerging economies tend to be retail and corporate lending on the assets side, funded by local *deposits* on the liabilities side. The year-on-year growth in international claims, which are more likely to be funded by less stable short-term wholesale liabilities, plunged from near 30% in each region prior to the crisis to –10% or lower in the wake of the collapse of Lehman Brothers. In contrast, the growth in these banks' local currency claims slowed much less and actually remained positive up to end-2011 in Latin America and emerging Europe.

The mix of claim types thus has bearing on the stability of the growth rate of *overall foreign claims* on these regions during the crisis. International claims accounted for an estimated 61% of banks' total foreign claims on Asia-Pacific in mid-2008, and 56% of their claims on emerging Europe. By contrast, banks' foreign claims on Latin America were primarily in the form of local claims in local currencies (64%) reflecting operational requirements imposed by both host supervisory authorities (eg Brazil, Chile and Mexico) and home supervisory authorities (in Spain).[23]

This is clearly reflected in the patterns of growth in total foreign claims on each region in Graph 3. That is, foreign claims on Asia Pacific, where international (mainly cross-border) claims were dominant, experienced the largest contraction during the crisis. By contrast, the growth in foreign claims on Latin America, which tended to be locally booked and funded, never moved into negative territory. We return to this point in Section 4, where we relate the size of the estimated shocks to overall foreign claims during the 2007-09 financial crisis to the underlying structure of these claims.

4. Estimating supply, demand and common shocks

We now turn estimating the shocks using the methodology described in Section 2 on the sample of adjusted year-over-year growth in bilateral foreign claims described in Section 3. We first show how the aggregate growth in all banking systems' foreign claims on all borrower countries can be decomposed into supply-side, demand-side and common shocks, and then compare how these estimates fare against standard panel regression estimates in their ability to explain aggregate growth dynamics. From there, we decompose the growth in individual banking systems' foreign claims (on all counterparty countries) before turning to an examination of individual counterparty countries.

[23] In the CBS (IC basis) used throughout this paper, foreign claims are split into international claims and local claims in local currencies (ie FC = INTLC + LCLC, where INTLC = XBC + LCFC). From a financial stability perspective, local claims in foreign currencies (LCFC) are often funded with a cross-border liability thus making them similar to pure cross-border credit. However, an estimate of the share of pure cross-border claims in total claims can be had from CBS (UR basis), where foreign claims are split into cross-border claims and local claims in *all* currencies (ie FC = XBC + LCAC). Using these statistics, the share of pure cross-border claims in total foreign claims on Asia-Pacific in mid-2008 came to 52%, and those for emerging Europe and Latin America were 43% and 30%, respectively.

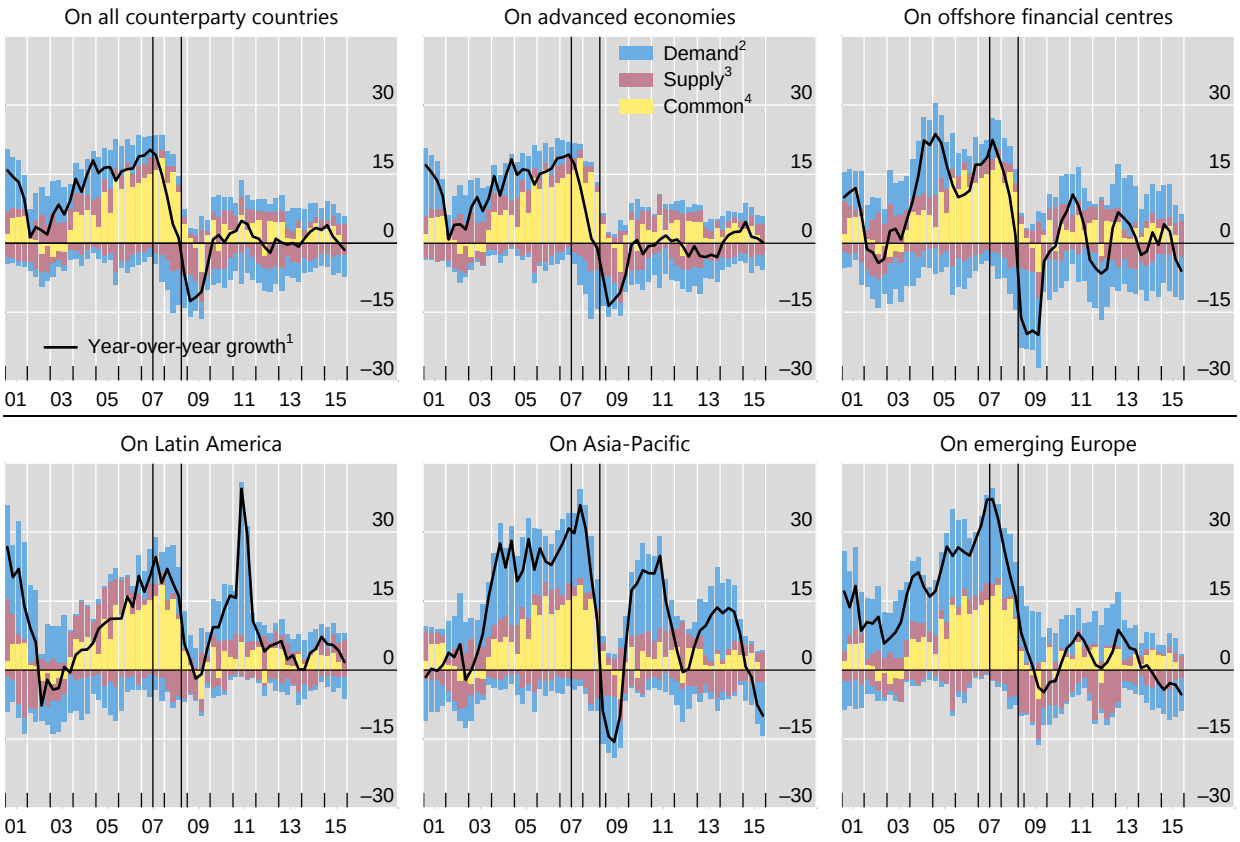
4.1 The importance of adding up constraints

Graph 5 shows the decomposition of the year-over-year growth in all banking systems' combined foreign claims. Red bars indicate supply shocks, or shocks to individual banking systems' claims on all counterparty countries. Blue bars indicate demand shocks, or those attributable to that country only. Both the supply and demand shocks are separated into "positive" and "negative" shocks, and hence there are two sets of bars for each. Yellow bars depict the common shocks, or the portion of the aggregate growth rates than cannot be separately identified as a pure supply or demand shock.

Common shocks (yellow bars) loom large in periods when all banking systems' claims on all countries grow at similar rates. This was clearly the case during the run up to the global financial crisis. Between 2003 and 2008, virtually all large banking systems (Table 1) expanded credit at similar rates to borrowers in all major counterparty countries (Table A.2 in Appendix 2). Vis-à-vis those in advanced economies, offshore financial centres and Latin America, the common component

Shocks to banks' aggregate foreign claims, by counterparty region

In per cent — Graph 5



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Year on year growth in BIS reporting banks' combined foreign claims on the country group indicated in the panel title, adjusted for breaks in series and exchange rate movements. [2] Estimated demand shocks unique to each counterparty country in the country group in the panel title. Positive and negative demand plotted separately. [3] Estimated supply shocks to the constellation of banking systems that report claims on the country group in the panel title. Positive and negative shocks plotted separately. [4] Estimated shocks that are common to all counterparty countries and banking systems.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

accounted for bulk of the aggregate claim growth during this period. Similarly, it accounted for roughly half of the growth rate in aggregate claims on Asia-Pacific and emerging Europe.

The crisis, however, affected banking systems and borrower countries differently, and at different times. It introduced more variability in the observed bilateral growth rates, and thus our estimation procedure yields a cleaner separation of supply and demand shocks once the crisis was underway. The common component virtually disappeared by late-2008, and turned slightly negative in 2009, indicating that the contraction in claims globally was uneven across banking systems and counterparty countries. By contrast, starting in 2007, negative supply shocks (red bars) contributed increasingly more to aggregate claims growth. Below we examine which banking systems experienced the largest supply shocks and correlate our estimates with outside measures of their health during the crisis.

Negative demand shocks (blue bars) during the crisis further lowered the growth in aggregate claims, particularly on advanced economies and offshore financial centres. (The overall direction of the demand shocks is the net of the positive and negative blue bars). This is consistent with two key macro-economic trends that were, for the most part, unique to these country groups. First, the crisis was precipitated by a severe downturn in housing prices in advanced economies that, once underway, devastated household balance sheets. Second, the structured finance products that turned toxic during the crisis were overwhelmingly backed by mortgages and other securities issued by obligors located in the advanced economies (in particular in the United States), and these products sat primarily in the portfolios of banks, pension funds and other asset managers from these advanced economies. Often, these structured products were issued by financial vehicles located in offshore financial centres (eg Cayman Islands). In short, the crisis had a direct effect on *many* sectors in advanced economies – most notably households, construction and the broader (non-bank) financial sector. This both lowered demand for credit and at the same time worsened the creditworthiness of these borrowers, making global banks less willing to lend to them. The out-sized net negative demand shocks for these countries groups also reflected in part the losses banks suffered as they marked down the values of the mortgage securities.

By contrast, the meltdown in structured products that originated in the advanced economies had little *direct* impact on emerging economies. That is, very few of the packaged products contained securities or mortgages tied to obligors in emerging economies, and very few of these products where held in the portfolios of emerging market investors. As a result, the net demand-side shocks remained positive for many emerging economies throughout the crisis and after, albeit with much smaller positive contributions to growth during the most severe quarters. Asia-Pacific, mainly driven by claims on China, is the exception in this regard, where large negative demand shocks were also evident. As discussed below, this is in part a function of the mix of claim types on Asia-Pacific, where international claims were the most common.

By construction, the three shock components add up to the observed aggregate growth rate for global foreign claims. That is, the empirical methodology yields estimates of the supply-side, demand-side and common shocks that exactly yield the growth rate in foreign claims for any bilateral banking system-counterparty country pair, and for all pairs combined. As argued in Section 2, standard panel regression techniques typically fall short in this regard.

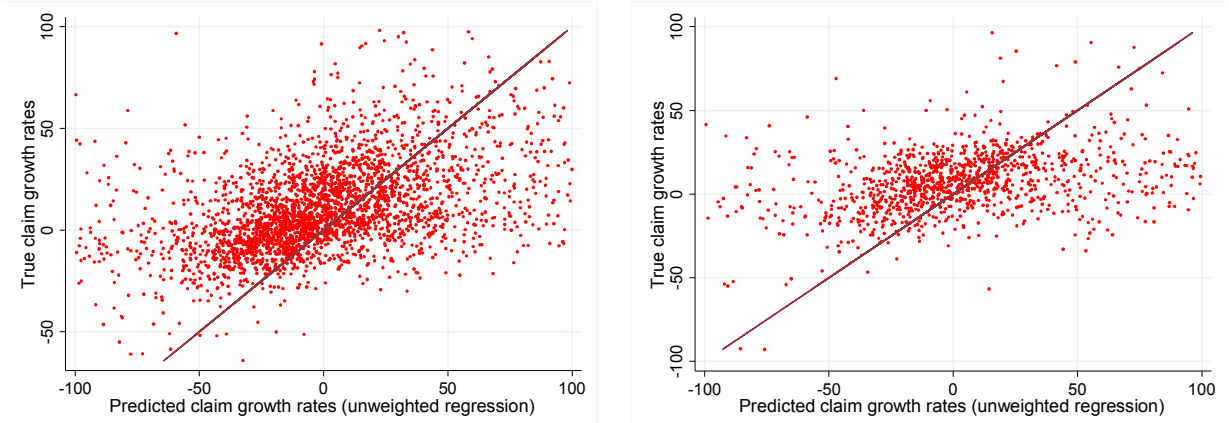
Graph 6 illustrates the problem that arises with these data when used in a standard fixed-effects estimation. A state-of-the-art technique, introduced by Khwaja

The predictive power of fixed effects regressions[1]

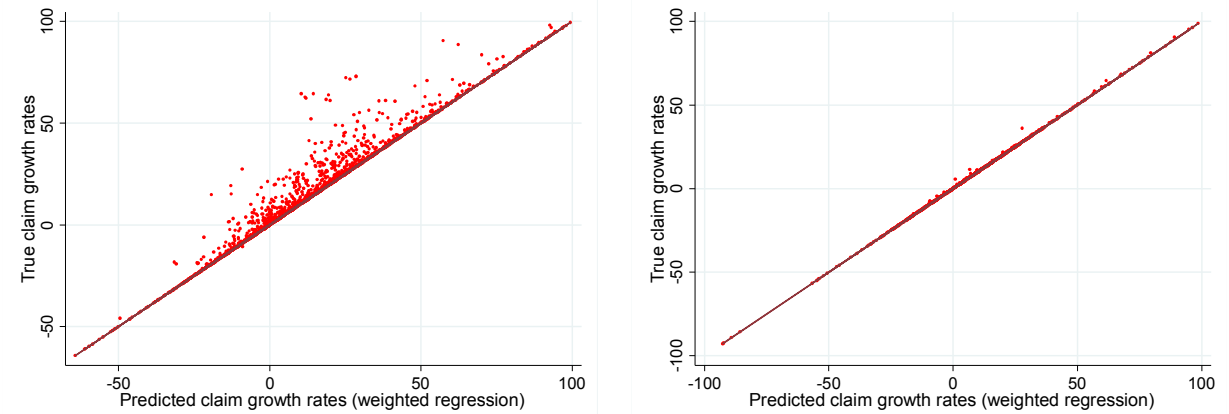
In per cent — Graph 6

Aggregate claims on individual countries[2] | Aggregate claims of individual banking sytems[3]

Unweighted observations



Observations weighted by lagged outstanding claims[4]



[1] Scatter plots of the actual year-over-year growth (y axis) in foreign claims (adjusted for breaks in series and exchange rate movements) against the predicted growth (x axis) from a regression with time-varying banking-system and counterparty-country fixed effects. Outlier values have been dropped in each panel. [2] Growth in all reporting banks' combined claims on individual counterparty countries. [3] Growth in individual banking systems aggregate foreign claims on all counterparty countries. [4] Fixed effects regression where observations are first weighted by the lagged value of outstanding claim amounts.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

and Mian (2008), is a regression of the growth in bilateral claims on a constant term and fixed effects for both creditors and borrowers. Importantly, both sets of fixed effects are time varying (ie crossed with time fixed effects) so that supply shocks and demand shocks in particular periods can be estimated. Identification is possible in this panel setting since each creditor banking systems has outstanding claims with multiple countries, and each country received credit from multiple banking systems.

The top panels of Graph 6 show the results of the applying this technique to the CBS data used here. The left column shows predicted values of the growth in all banking systems' combined claims each country compared to the actual growth in claims on these countries, and the right column shows the predicted values of the growth in each banking system's claims on all countries (combined) compared to the actual growth in each banking system's claims. Ideally, in both cases, the predicted values should equal (or be close to) the actual values, and thus lie on forty-five degree

lines. The closer they are to a forty-five degree line at this disaggregated level, the more of the aggregate growth in total claims that can be explained by the time-varying fixed effects. However, as noted above, such techniques rarely perform close to the ideal when the levels are highly concentrated in only a few bilateral pairs, since the estimated "average" effects captured in the coefficients on the fixed effects place too little weight on the sub-set of observations that contribute most to the growth in the aggregate claims. In this case, the predicted values in the top panels of Graph 6, where observations are unweighted (ie standard OLS) are nowhere close to a forty-five degree line.

The predictive power of such regressions improves considerably if more weight is given to those observations that contribute most to aggregate growth. The bottom panels of Graph 6 show the corresponding predicted values of the same regression discussed above, but where the observations are weighted by the lagged value of the level of bilateral claims. Here, the predicted aggregate growth rates are, overall, much better aligned with the actual rates. Note, however, observations where the lagged bilateral claim value was zero – eg where a banking system forms a new link with a country – do not lie on the forty-five degree line. Such new bilateral links do contribute to the total growth in claims on a country, and in the growth of the creditor banking system's claims on all countries (y axes). But these observations are dropped in the fixed-effects regressions, and thus the predicted values of the total growth rates understate the true values (ie lie above the forty-five degree line). Note from Section 2 that the methodology used in this paper modifies the moment conditions to include these observations, and thus is able to exactly reproduce these aggregate growth rates.[24]

4.2 From the perspective of creditor banking systems

Do the estimated supply shocks for individual banking systems make sense? Graph 7 shows how supply and demand shocks contributed to the growth in total foreign claims reported by selected banking systems that were hit particularly hard during the crisis. Graph 8, in turn, shows the corresponding figures for banking systems that emerged from the crisis relatively unscathed. (Additional banking systems are presented in Graph A.1 in Appendix 1.) In any given quarter, each banking system has outstanding claims on many countries, some of which experience a negative demand shock and some of which experience a positive demand shock. In these graphs, these negative and positive demand-side shocks (blue bars) are plotted separately; the net value of the blue bars is the overall demand shock for that banking system.

Between 2000 and 2004, well before the financial crisis, the estimated supply shocks (red bars) reveal which banking systems systematically expanded or contracted their global footprint. For example, Japanese banks (Graph 8) registered a series of large supply shocks in the early 2000s. At the time, many of the large Japanese banks were on the verge of collapse and under intense regulatory scrutiny by the Japanese Financial Services Agency.[25] Other banking systems did not exhibit such severe supply side shocks during this period. That said, many other banking systems registered only modest growth in foreign claims between 2000 and 2004. Canadian and Spanish banks' foreign claims were virtually flat, at around $370 billion

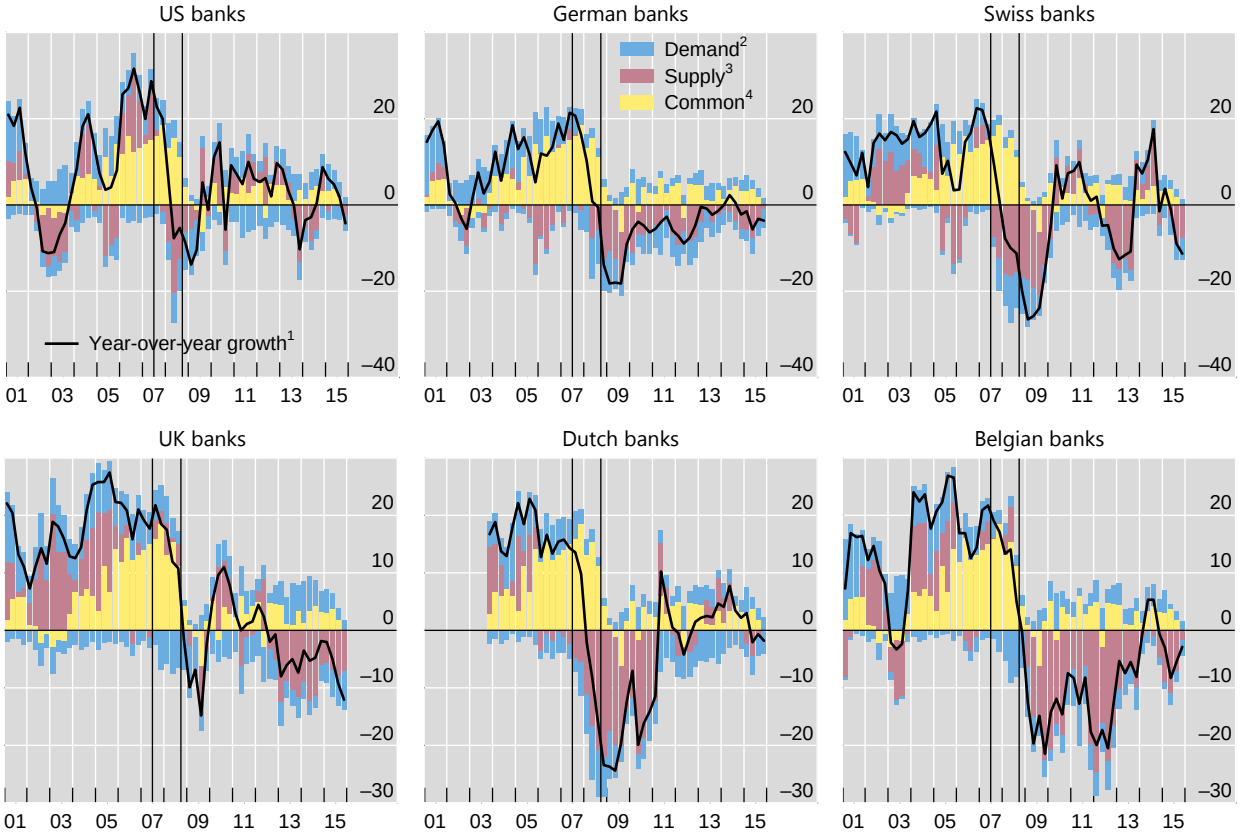
[24] In bilateral panels where "entry" does not occur, the two methodologies yield identical estimates.

[25] A subsequent wave of mergers in 2002 and 2003 produced the three Japanese "mega banks" that today are classified as Globally Systemically Important Banks (G-SIBs) by the Financial Stability Board (FSB). See McGuire (2009) for a mapping of this merger process.

Shocks to banking systems *most affected* during the global financial crisis

In per cent

Graph 7



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Year-on-year growth in foreign claims of internationally active banks of the nationality indicated in the panel title, adjusted for breaks in series and exchange rate movements. [2] Estimated demand shocks to the counterparty countries on which the banking system in the panel title has outstanding foreign claims. Positive and negative demand shocks plotted separately. [3] Estimated supply shocks that are unique to banking system in the panel title. [4] Estimated shocks that are common to all banking systems and counterparty countries.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

and $400 billion, respectively, while US banks' claims fluctuated between $750 billion and $1 trillion. Their main counterparty countries at the time for the most part registered positive demand shocks (blue bars), and the sustained global expansion in claims that led to the crisis was just getting started (positive common shocks). As a result, the relatively lacklustre growth in these banks' foreign claims during this period is picked up as negative supply shocks (red bars).

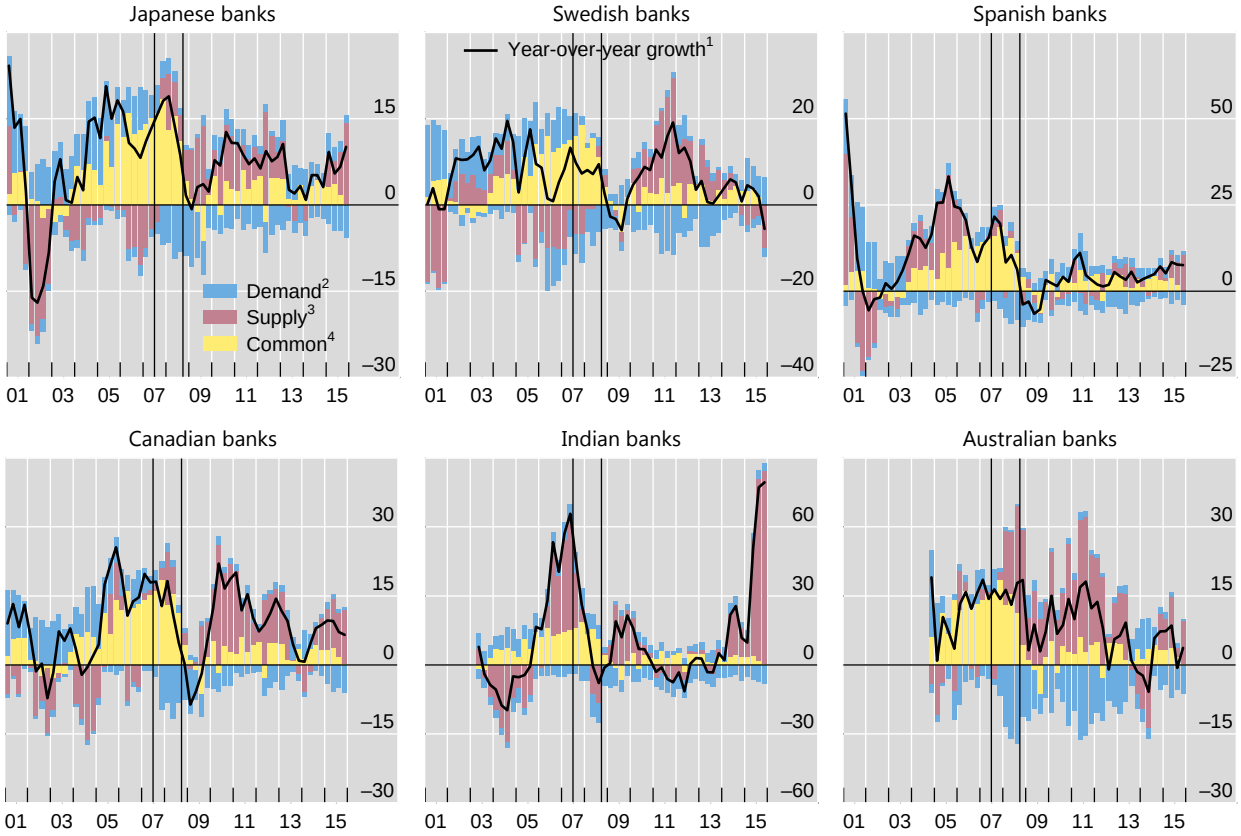
By contrast, several European banking systems, in particular Belgian, Dutch, German, Swiss and UK banks – amongst the largest at the time – reported robust growth in foreign claims even in the earlier years of the decade. As pointed out in McGuire and von Peter (2012), US dollar and other non-euro-denominated positions accounted for more than half of the overall increase in these European banks' foreign claims in the run-up to the crisis. For several of these banking systems, positive supply shocks (red bars) *added to* the positive common shocks in these years.

As noted above, all major banking systems saw rapid expansions in their global balance sheets as the decade wore on, with greater credit flowing to virtually all of the major advanced and emerging economies. This is reflected in the rising positive common shock (yellow bars), which peaked in 2007.

Shocks to banking systems *less affected* during the global financial crisis

In per cent

Graph 8



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

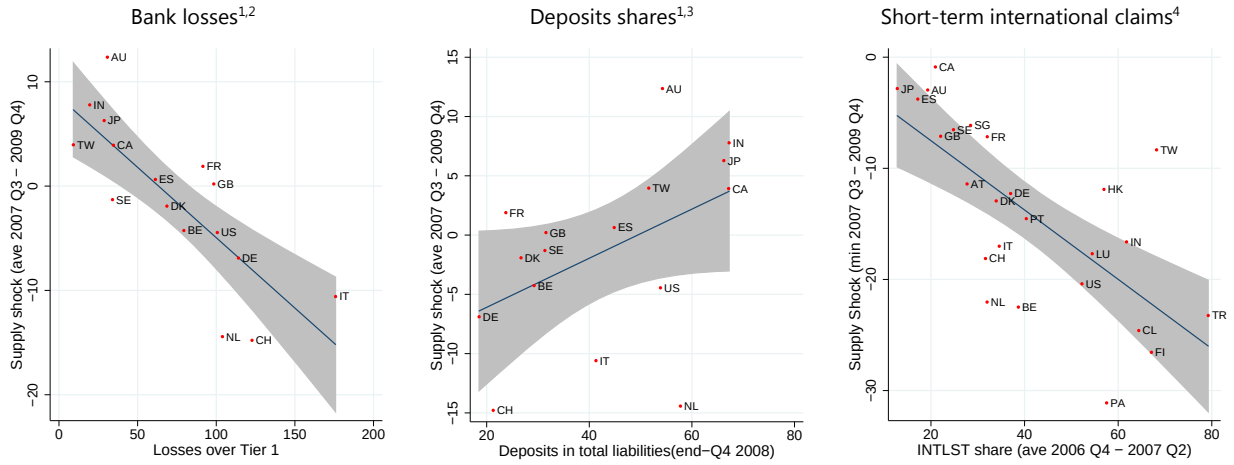
[1] Year-on-year growth in foreign claims of internationally active banks of the nationality indicated in the panel title, adjusted for breaks in series and exchange rate movements. [2] Estimated demand shocks to the counterparty countries on which the banking system in the panel title has outstanding foreign claims. Positive and negative demand shocks plotted separately. [3] Estimated supply shocks that are unique to banking system in the panel title. [4] Estimated shocks that are common to all banking systems and counterparty countries.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

Once the crisis struck, however, it affected banking systems differently. Japanese banks, for example, held relatively small amounts of toxic assets (Graph 8). That is, they did not face a direct negative supply shock and, despite facing funding difficulties during the most intense quarters of the crisis, their overall growth in foreign claims recovered relatively quickly. Australian, Canadian, Swedish and several smaller Asian banking systems were similar in this regard. Even the internationally-active Spanish banks, whose home country was particularly hard hit when the unsustainable housing boom came to an end, emerged from the crisis in relatively good shape. This reflected Spanish banks' overwhelming reliance and local lending funded by local liabilities in their many host countries across Latin America, which had the effect of insulating them from the disruptions in funding market in their home country and elsewhere (McGuire and von Peter (2016)).

By contrast, Belgian, Dutch, French, German, Swiss, US and UK banks, all of which had invested heavily in structured products in the run up to the crisis, saw much steeper and more sustained contractions in the growth of their foreign claims. These appear as negative supply shocks in Graph 7. The collapse of ABN Amro, a Dutch bank, and Fortis, a Belgian bank, drove the particularly sharp contractions in foreign

Supply shocks during the financial crisis (Q3 2007 – Q4 2009) Graph 9



[1] The y axis depicts the average value of the supply shock between Q3 2007 and Q4 2009 for the banking system listed in the panels. Grey shaded areas show the error bands for the linear regression line. [2] The x axis plots each banking system's total credit losses reported between 2008 and 2010 as a share of the same banks' combined Tier 1 capital as of end-2008. For each individual bank entering these banking system aggregates, total credit losses are taken to be the larger value from two different sources: the maximum of non-performing loans reported in 2008–10 (SNL Financial), and reported credit losses on loans and securities (Bloomberg). [2] Total deposits as a percentage of total debt liabilities (including domestic banking liabilities) as of end-2008, weighted average across the major banks headquartered in the countries shown. [4] The y axis depicts the *minimum* value of the supply shock between Q3 2007 to Q4 2009 for the banking system listed in the panels. The x axis shows the share of each banking system's short-term international claims (INTLST) in total foreign claims on all counterparty countries; average over the 2006 Q4 – 2007 Q2 window. Short-term international claims are those with a remaining maturity of one year or less. Note that there is no maturity breakdown for local claims in local currencies (LCLC).

Source: Bloomberg, SNL Financial; BIS consolidated banking statistics (IC basis); BIS locational banking statistics; authors' calculations.

claims booked by all internationally-active banks headquartered in these countries, and hence the severe negative supply shocks. Similarly, Swiss banks, whose appetite for structured products in the first half of the decade swelled their global balance sheets to an estimated eight times Swiss GDP on the eve of the crisis, were particularly hard hit, prompting UBS to drastically scale back its investment banking operations.

While US and UK banks also suffered losses during the crisis, the estimated supply shocks appear relatively smaller for these banking systems than for others. For both banking systems, this in part reflects the fact that much of their losses were sustained vis-à-vis counterparties in their home countries. Moreover, at least two of the largest UK global lenders (Standard Chartered and HSBC) have large operations in emerging economies, and much of their business is conducted in offices in Hong Kong, in part insulating these banks from the turmoil in advanced economies.

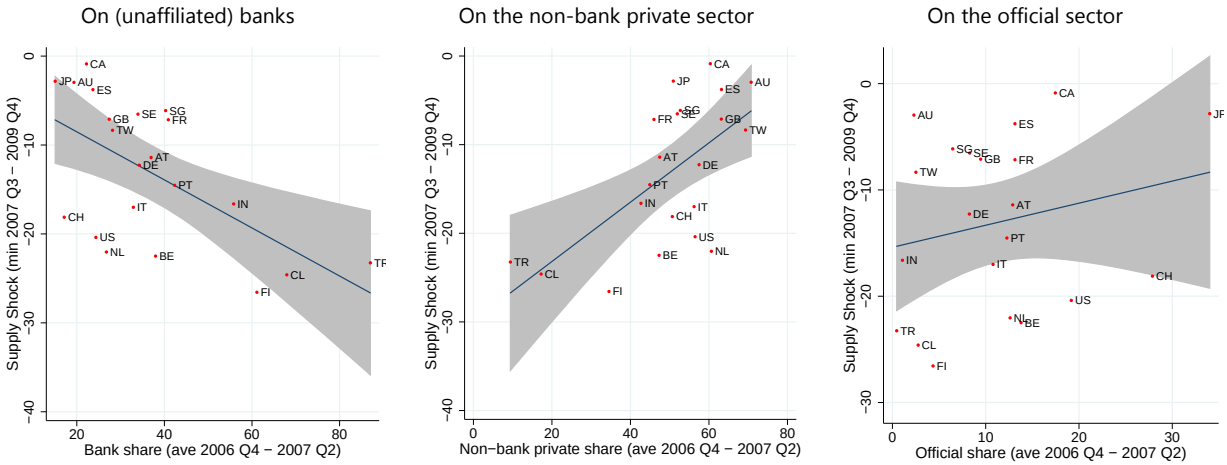
To evaluate the plausibility of the estimated supply shocks across banking systems, we correlate them with outside measures of the size of the shocks banks suffered during the crisis. From Bloomberg and SNL Financial, we assemble data on the losses incurred by individual banks between 2008 and 2010, aggregate these to the level of national banking systems and scale the totals by the Tier 1 capital of the same set of banks.[26] As shown in the left panel of Graph 9, the scaled losses incurred by banking systems are negatively correlated with the average size of their estimated supply shocks during the crisis, implying that those systems that incurred larger losses

[26] Loss data are available for only those banking systems shown in the left panel of Graph 9. For each reporting banking system, we assemble the data for the top internationally-active banks headquartered in each country and match these with the list of reporting banks for those countries provided to the BIS by each reporting jurisdiction.

Estimated shocks and claims on counterparty sectors (Q3 2007-Q4 2009)[1]

In per cent

Graph 10



[1] The y-axes show the minimum value of the estimated supply shock experienced by each country in the 2007 Q3 – 2009 Q4 crisis window. The x-axes show the share of each banking system's total foreign claims on other (unaffiliated) banks (left panel), the non-bank private sector (centre panel) and the official sector (right panel); average over the 2006 Q4 – 2007 Q2 window. These counterparty sector shares are constructed using the CBS (Ultimate Risk basis), since the sectoral breakdown in these statistics applies to total foreign claims.

Source: BIS consolidated banking statistics (IC basis and UR basis); BIS locational banking statistics; authors' calculations.

recorded slower claims growth on *all* counterparty countries. The relationship is highly statistically significant, with an *R*-squared of 64%, and provides some verification that our estimated supply shocks capture banks' actual experiences during the crisis.

A second key transmission channel during the crisis was the dislocations in banks' funding markets. Those banks that relied more on wholesale funding and cross-currency swaps found themselves unable to roll over their positions during the most severe quarters of the crisis. Consistent with this, the estimated supply shocks during the crisis are positively correlated with banks' funding profile in place on the eve of the crisis (Graph 9, centre panel). The regression line has a positive slope (significant at the 90% level), and an *R*-squared of 21%. That is, those banking systems with a higher share of relatively-stable deposit funding in 2008 experienced, on average, either positive supply shocks or smaller negative shocks.

Perhaps not surprisingly, banks cut their short-term claims the most during the crisis, primarily on other (unaffiliated banks). In the right-panel of Graph 9, we relate the size of bank supply shocks to a lower-bound estimate of the share of foreign claims that had a remaining maturity of one year or less.[27] Because the effects of the crisis hit different banking systems in different quarters, their supply shocks arise at different times, and are not always consistently negative throughout the 2007 Q3 – 2009 Q4 window used above. But, if we consider the *most severe* negative supply shock during that window, we find it highly correlated with the share of each banking

[27] International claims (INTLC) are broken down into three maturity buckets (remaining maturity of less than one year, less than two years but more than one year, and over two years). No maturity breakdown is available for local claims in local currencies, and thus not for total foreign claims (FC). As a result, the ratio used in the right panel of Graph 9 is a lower bound estimate each banking system's share of foreign claims that are short term. The relationship holds if international claims rather than foreign claims is used in the denominator of this ratio.

systems total foreign claims with a short-term maturity. The regression line has a negative slope (significant at the 95% level), and an *R*-squared of 32%. Similarly, as shown in Graph 10 (left panel), the share of banks' claims on other (unaffiliated) banks, which tend to have shorter-term maturities, was negatively correlated with the size of the most severe negative supply shocks in the crisis window.[28] By contrast, the share of claims on counterparties in the non-bank private sector, which have longer-term maturities, was positively related.

4.3 From the perspective of counterparty countries

In this section, we evaluate the growth in foreign claims on individual counterparty countries. Here, the growth rates of all banking systems' combined foreign claims on selected countries are disaggregated into the common, supply-side and demand-side shocks. Demand-side shocks are unique to each counterparty country while negative and positive supply-side shocks are plotted separately.

4.3.1 Claims on advanced economies

Turning first to advanced economies, Graphs 11 and 12 show that the growth in aggregate claims on several large countries in the run up to the financial crisis was driven primarily by common shocks (yellow bars). Specifically, the common component matches well the actual growth in foreign claims on the United States, the United Kingdom, Australia and Switzerland during this period. By contrast, foreign claims on Germany grew at a much slower rate in the pre-crisis period, and hence the country registered relatively large negative demand shocks. This is consistent with the relatively lack-lustre economic growth in Germany pre-crisis and the fact that it is one of the few large advanced countries that did not experience a housing price boom during that period (Tsatsaronis and Zhu (2004)).

During and following the crisis, however, the common element becomes much less important as the growth in claims across banking systems and counterparty countries diverged. The contraction in non-UK banks' claims on the United Kingdom was amongst the most severe (-24%), reflecting the fact that London is a financial Hub for both banks and non-bank financial institutions, with many hedge funds and asset managers located there. All were hit hard by the crisis. Cross-border interbank lending to banks in the UK in particular dropped sharply and has yet to recover.

The growth in non-US banks' claims on the United States returned to positive territory in 2010 and remained there through 2012. However, much of this reflected the extraordinary growth in these banks' holdings of reserves at the Federal Reserve.[29] Excluding these claims on the US official sector (which includes claims on the Federal Reserve System), non-US banks claims on (unaffiliated) banks and the non-bank private sector in the United States actually declined for most of this period.

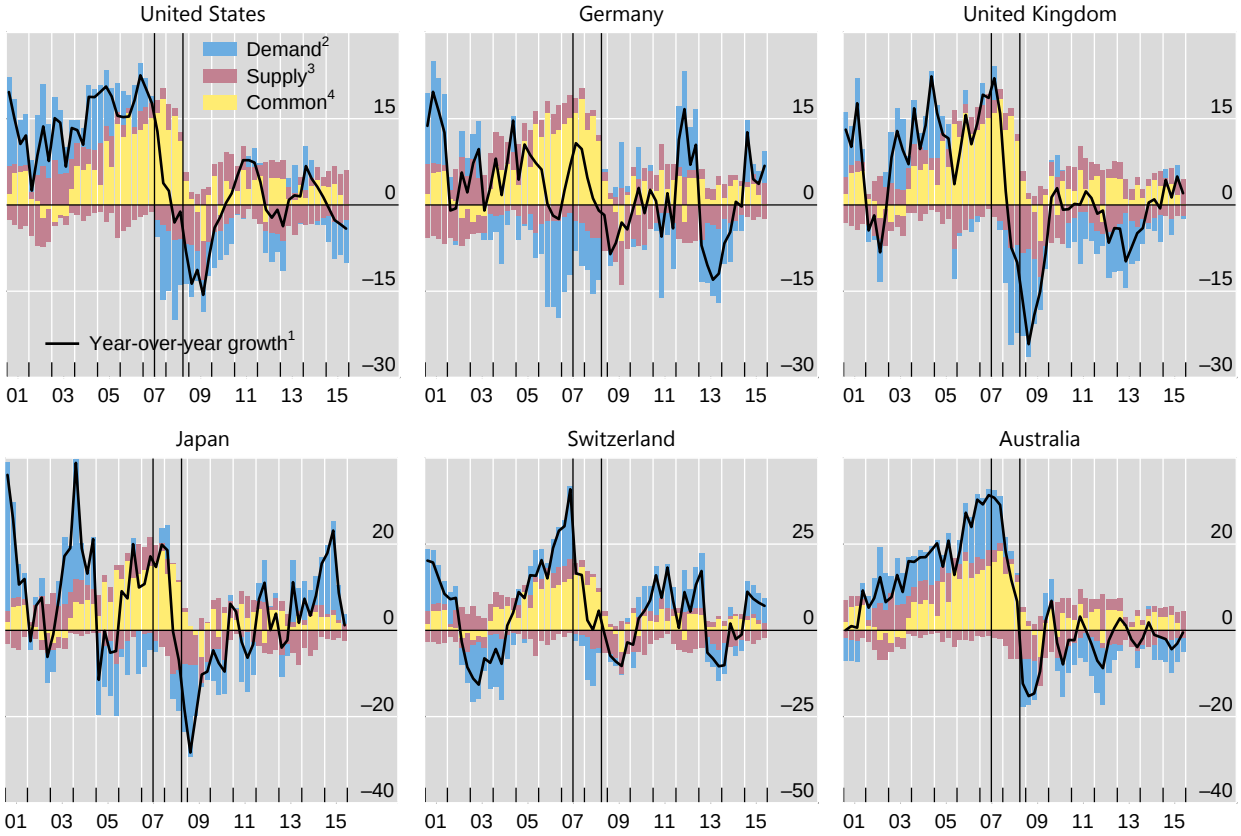
[28] In Graph 10, we use the CBS (UR basis) to construct the counterparty sector shares since the sector breakdown is available for total foreign claims. By contrast, the counterparty breakdown in the CBS (IC basis) is available for international claims only; no sector breakdown is available for local claims in local currencies in these statistics.

[29] Kreicher et al (2014) and McCauley and McGuire (2014) show the Federal Reserve's balance sheet expansion and quantitative easing operations, coupled with the FDIC's change in April 2011 in the assessment base for fees levied on US chartered banks, prompted non-US banks' to increase their holdings of reserves at the Federal Reserve by roughly $1 trillion between mid-2008 and mid-2013 These reserves holdings are included in these banks' foreign claims on the United States (as claims on the official sector). If these positions are excluded, non-US banks' claims on the United States actually decreased over this period.

Shocks to foreign claims on selected advanced economies

In per cent

Graph 11



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Year-on-year growth in foreign claims of all reporting internationally active banks on the country listed in the panel title, adjusted for breaks in series and exchange rate movements. [2] Estimated demand shocks to unique to the counterparty country listed in the panel title. [3] Estimated supply shocks to the constellation of banking systems that have outstanding foreign claims on the counterparty country listed in the panel title. Positive and negative supply shocks plotted separately. [4] Estimated shocks that are common to all banking systems and counterparty countries.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

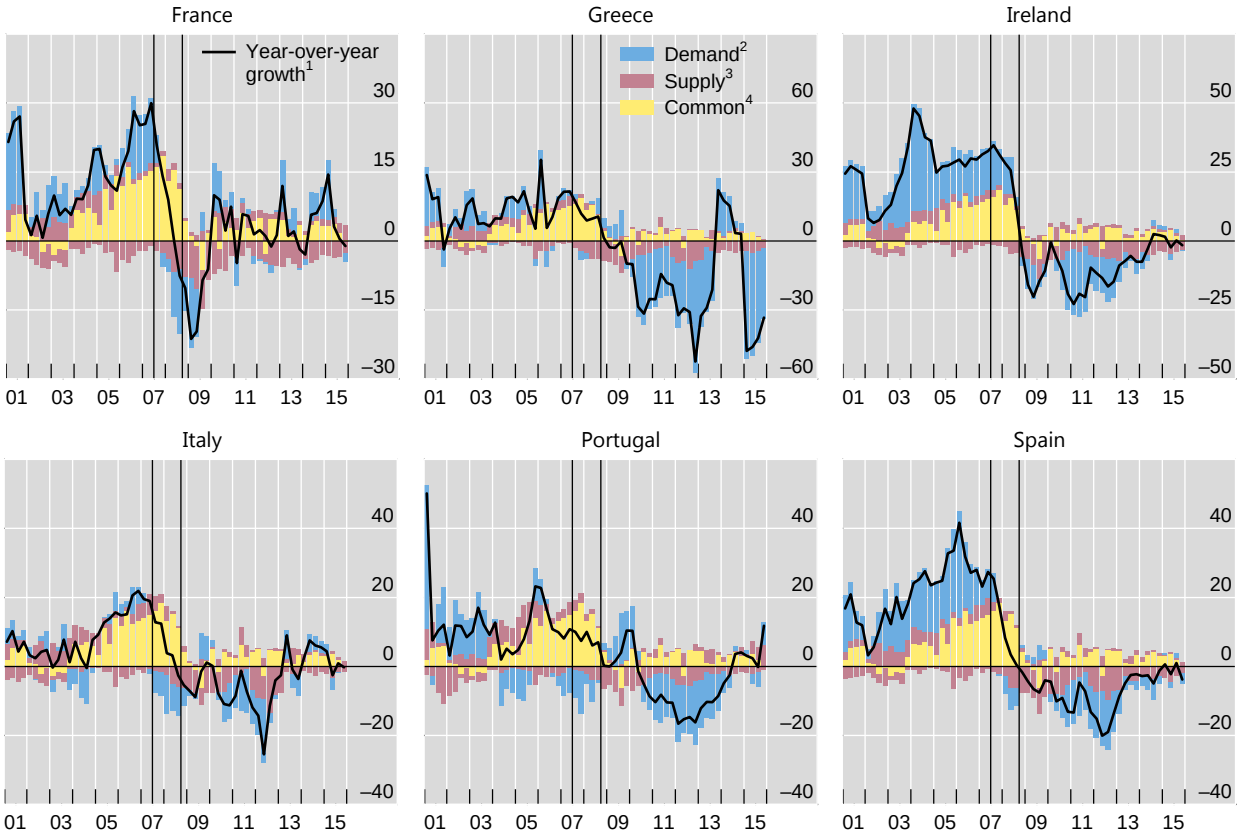
Graph 12 shows the decomposition for selected euro area countries, many of which came under severe strain in 2010 and later as the European sovereign debt crisis unfolded. Again, the patterns are largely consistent with what might be expected prior to the financial crisis in 2008: common shocks boosted the growth in foreign claims on these countries, just as they did for other advanced economies.

Post-crisis, however, Greece, Ireland, Italy, Portugal and Spain all registered large negative demand-side shocks (blue bars), consistent with the heightened market scrutiny of their sovereign debt levels. In other words, banks' claims on these countries contracted more rapidly than did these same banks' claims on other countries. That said, several of creditor banks to these countries were themselves headquartered in countries that also were under strain. French, Italian, Spanish and Portuguese banks, for example, accounted for 11% of the total foreign claims on Greece, and almost 60% of foreign claims on Portugal, at end-2010. Similarly, they accounted for roughly half of the foreign claims on Italy. The supply-side shocks to these banks that were themselves headquartered in a crisis country contributed to the downturn in the growth in foreign claims on the European periphery, evidenced by the negative supply shocks (red bars) starting in 2010.

Shocks to foreign claims on selected euro area countries

In per cent

Graph 12



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Year-on-year growth in foreign claims of all reporting internationally active banks on the country listed in the panel title, adjusted for breaks in series and exchange rate movements. [2] Estimated demand shocks to unique to the counterparty country listed in the panel title. [3] Estimated supply shocks to the constellation of banking systems that have outstanding foreign claims on the counterparty country listed in the panel title. Positive and negative supply shocks plotted separately. [4] Estimated shocks that are common to all banking systems and counterparty countries.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

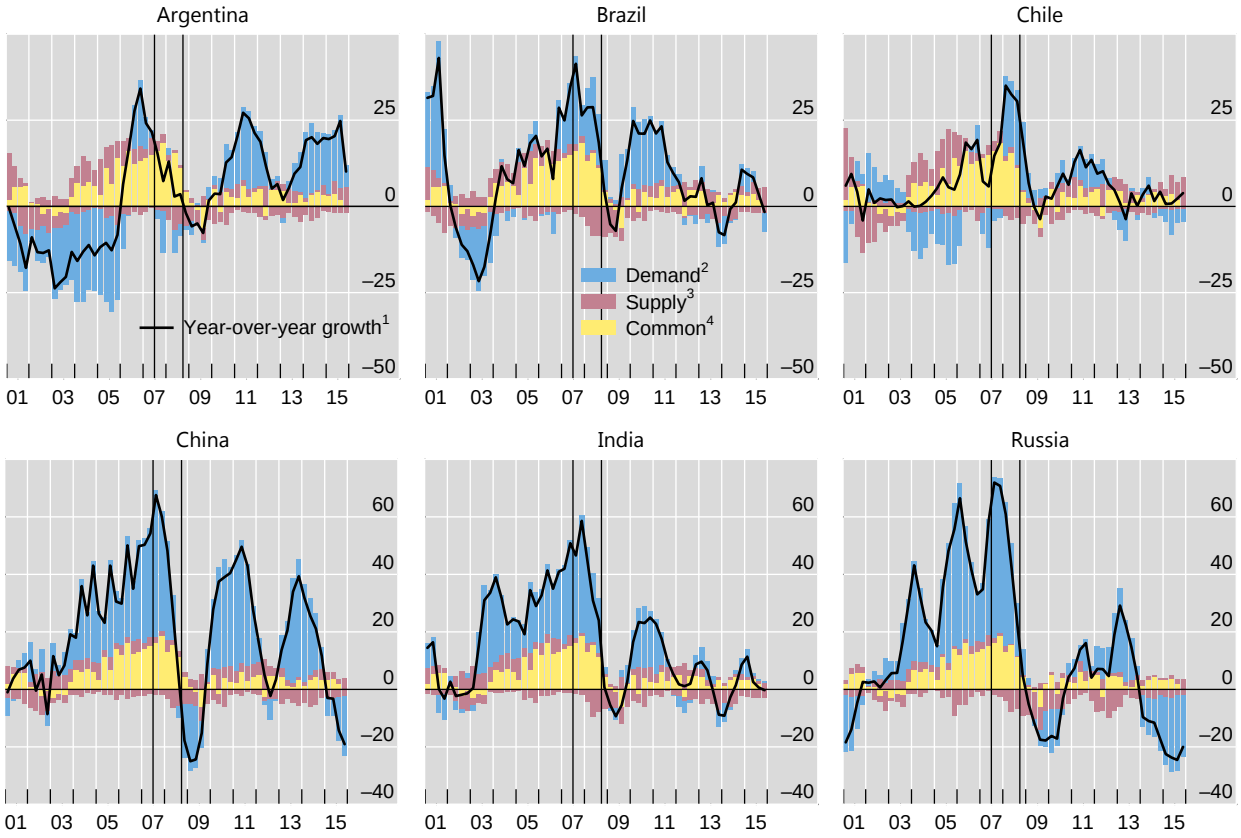
4.3.2 Claims on emerging market economies

The decomposition of the growth in claims on emerging economies shows that demand shocks played an even larger role for these economies both before and after the financial crisis (Graphs 13 and 14). Between 2000 and 2005, large negative demand shocks are clearly apparent for Argentina and Brazil (Graph 13). Argentina's default in late 2001 pushed the country's unemployment rate up to 22% and prompted an 11% contraction in GDP in 2002. Creditor banks accelerated their withdrawal of credit, and marked down their positions, as reflected in negative demand shocks that reached -40% in 2005. For its part, several years of drought conditions in Brazil, which is heavily reliant on hydroelectric power, precipitated one of the most severe energy crises in that country's history in 2001-02. This, along with the spill-over effects of the Argentine default and a crisis of confidence surrounding the election of President Lula de Silva in 2002 was behind short but significant depreciation of the real, a pickup in inflation and a slowdown in economic activity (Afonso and Araujo (2014)).

Shocks to foreign claims on selected emerging economies

In per cent

Graph 13



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Year-on-year growth in foreign claims of all reporting internationally active banks on the country listed in the panel title, adjusted for breaks in series and exchange rate movements. [2] Estimated demand shocks to unique to the counterparty country listed in the panel title. [3] Estimated supply shocks to the constellation of banking systems that have outstanding foreign claims on the counterparty country listed in the panel title. Positive and negative supply shocks plotted separately. [4] Estimated shocks that are common to all banking systems and counterparty countries.

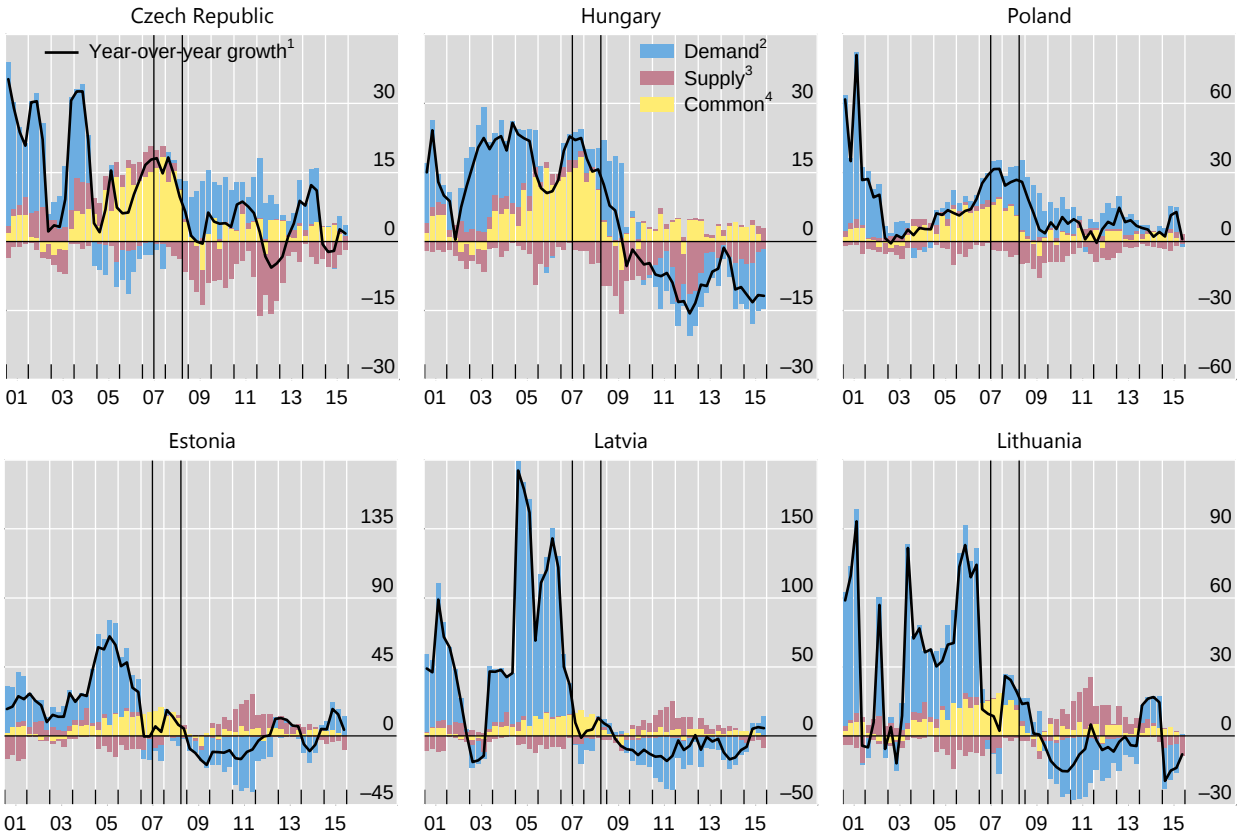
Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

By the same token, claims on Russia and on many countries in Asia-Pacific, in particular China and India, grew much more rapidly than claims on most other emerging economies in both the pre- and post-crisis periods. This rapid growth is reflected in the large *positive* demand-side shocks. Capital flows to China in particular surged post crisis. The global retrenchment by several European banking systems drove the negative supply shocks for China (negative red bars), but Japanese and UK banks stepped in to pick up much of the slack (positive red bars).

During the 2007-2009 financial crisis, negative supply shocks contributed significantly to the downturn in the growth in claims on many emerging economies. This was clearly evident in the Czech Republic, Hungary and Poland (Graph 14, top panels). By contrast, Estonia, Latvia and Lithuania (lower panels), three of the hardest

Shocks to foreign claims on selected emerging European economies

In per cent — Graph 14



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Year-on-year growth in foreign claims of all reporting internationally active banks on the country listed in the panel title, adjusted for breaks in series and exchange rate movements. [2] Estimated demand shocks to unique to the counterparty country listed in the panel title. [3] Estimated supply shocks to the constellation of banking systems that have outstanding foreign claims on the counterparty country listed in the panel title. Positive and negative supply shocks plotted separately. [4] Estimated shocks that are common to all banking systems and counterparty countries.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

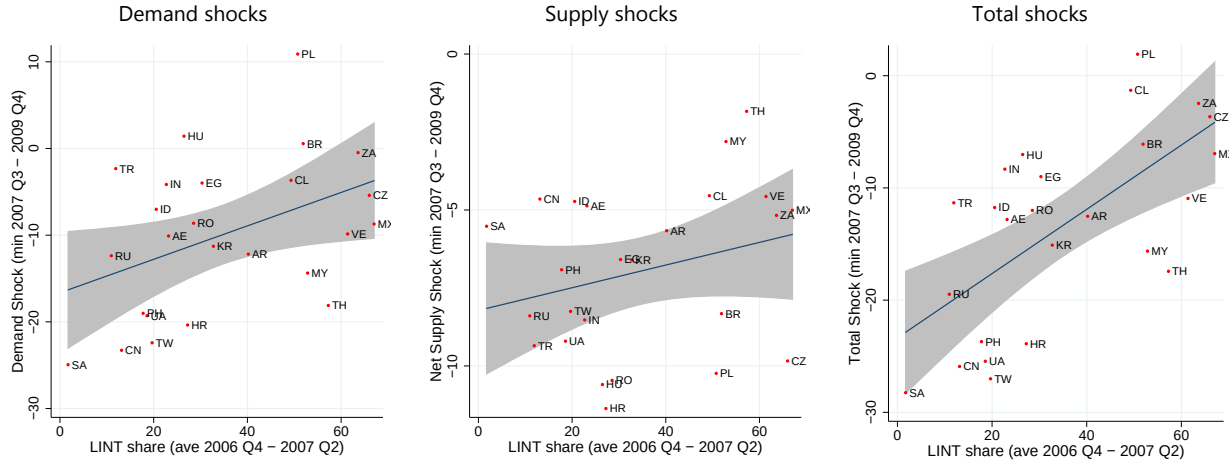
hit countries in the world during the 2008 crisis, all registered large negative demand shocks in the following years (bottom panels).[30] The key to understanding these different patterns is the mix of banking systems that have claims on these countries. The largest creditor banking systems to the Czech Republic in mid-2008 were Austrian ($60 billion), Belgian ($57 billion) and French ($38 billion) banks, each of which sustained large negative supply shocks in the wake of the crisis and smaller once since (Graph 7). Similarly for Hungary, where Austrian, German and Italian banks were the largest creditors, and Poland, where Italian, German and Dutch banks were the largest. All these banks were hit hard during the crisis.

By contrast, Swedish banks were by far the dominant creditor banking system to the Baltic countries (Graph 14, lower panels). They extended $30 billion to these countries (combined) in mid-2008, compared to the next largest creditor banking system, German banks, at $500 million. Swedish banks actually emerged from the

[30] The Baltic countries of Estonia, Latvia and Lithuania were amongst the hardest hit in the world during the crisis, with output contractions of 20-25% in 2008 and 2009 (Purfield and Rosenberg (2010)).

Estimated shocks and local intermediation in emerging economies (Q3 2007-Q4 2009)[1]

In per cent — Graph 15



[1] The y-axes show the minimum value of the estimated demand shock (left panel), net supply shock (centre panel) and total shock (ie demand plus net supply shocks, right panel) experienced by each country in the 2007 Q3 – 2009 Q4 crisis window. For each counterparty country, the local intermediation share (LINT) is defined as the sum (across creditor banking systems) of the minimum of each banking system's local claims and local currencies and local liabilities (ie min(LCLC, LLLC) as a share of all creditor banking systems' total foreign claims the country; average value in 2006 Q4 – 2007 Q2. See footnote 31 in main text.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

crisis relatively unscathed, and the growth in their foreign claims globally returned to pre-crisis levels relatively quickly (Graph 8). As a result, Swedish banks' overall contraction in claims on the Baltic countries registers primarily as demand shocks, since they did not simultaneously reduce claims on other countries.

As noted in Section 3, local claims on emerging economies proved to be more stable during and following the 2007 – 2009 crisis (Graph 4). In part, this reflects the fact that, in many countries, these local positions were corporate and retail lending backed by local deposits. These pieces of banks' balance sheets were relatively insulated from the rest of their global operations, in particular from the meltdown in structured finance products held in banks' offices in home countries and major financial centres. It stands to reason, then, that those counterparty countries where these local positions were particularly important experienced less severe negative shocks during the crisis period.

To examine this, Graph 15 zeros in on the top 25 emerging economies, ranked by total foreign claims, which together accounted for almost 90% of all banks' total foreign claims on all emerging economies in mid-2007. The panels relate the *most adverse* shocks experienced by each counterparty country in the 2007 Q3 – 2009 Q4 crisis window (y-axes) to the local intermediation share (LINT) measured on the eve of the crisis (x-axes).[31] LINT is a proxy that captures the portion of claims on a country whose funding is insulated from the rest of creditor banks' global operations, and is

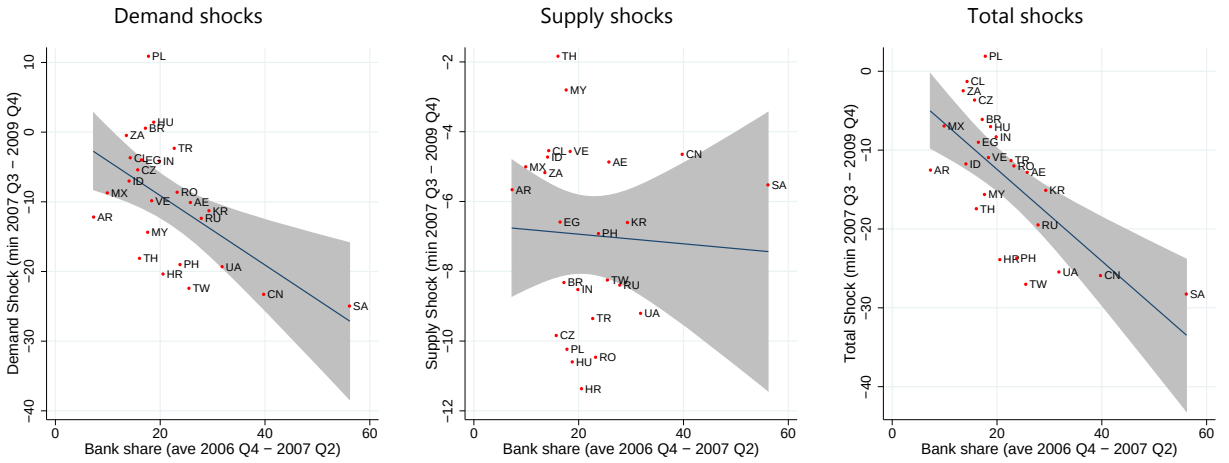
[31] The y-axes in Graphs 15 and 16 show the minimum value of the shock measures (ie the smallest positive or the largest negative values) during the crisis window.

defined as the share of total foreign claims on a country that are both extended locally in the local currency *and* funded locally in the local currency.[32]

The most severe negative demand shocks (left panel) experienced by each country in the crisis window were smaller for countries with high LINT values. The relationship is statistically significant (at the 95% level), and the slope of the regression line indicates that a ten percentage point higher local intermediation share on the eve of the crisis is associated with a maximum negative demand shock that was 1.9 percentage points smaller (ie less severe) during the crisis window. For their part, the regression based on the supply shocks (centre panel) falls just short of statistical significance.[33] However, when LINT values are compared to the maximum negative *overall* shock (ie the demand plus the net supply shock, the relationship is particularly robust with an R-squared of 43% (right panel). Here, the slope coefficient is significant at the 99% level, and implies that a 10 percentage point higher local intermediation share on the eve of the crisis was associated with maximum negative overall shock that was 2.8 percentage points smaller.

Estimated shocks and claims on banks in emerging economies (Q3 2007-Q4 2009)[1]

In per cent — Graph 16



[1] The y-axes show the minimum value of the estimated demand shock (left panel), net supply shock (centre panel) and total shock (ie demand plus net supply shocks, right panel) experienced by each country in the 2007 Q3 – 2009 Q4 crisis window. For each counterparty country, the bank share (x-axes) is the share of foreign claims on banks in the country in total foreign claims on all sectors. This share is constructed using the CBS (Ultimate Risk basis), since the sectoral breakdown in these statistics applies to total foreign claims.

Source: BIS consolidated banking statistics (IC basis and UR basis); BIS locational banking statistics; authors' calculations.

[32] In many countries, a portion of banks' local claims in local currencies are funded by cross-border inter-office positions, or by non-local currencies raised either locally or offshore. By focusing on the local intermediation share, which captures only those local claims that have local currency funding, we arguably better capture the most insulated portions of creditor banks' balance sheets. See McCauley et al (2012) for more discussion. Formally, LINT is defined as the ratio of the minimum of local claims in local currencies and local liabilities in local currencies summed across creditor banking systems *b* to total foreign claims on the country, or:

$$LINT_{c,t} = \frac{\sum_b min\left(LCLC_{b,c,t}, LLLC_{b,c,t}\right)}{\sum_b FC_{b,c,t}}.$$

[33] Note, however, that the *average value* during the crisis window of the net supply shocks for each counterparty country (as opposed to the minimum value) is positively correlated with LINT and highly statistically significant.

Graph 16 relates the size of the estimated shocks to the share of reporting banks' total foreign claims on banks in each of the top 25 emerging economies. Consistent with the results above for banking systems, a higher share of claims on other (unaffiliated) banks is highly correlated with more severe negative shocks during the crisis window. This share was particularly highly correlated with demand shocks (left panel), but even more so with the combination of both the demand and net supply shocks (right panel). Here, the slope coefficient was statistically significant at the 99% level, and implied that a 10 percentage point higher share of claims on banks in a country on the eve of the crisis was associated with a 5.8 percentage point more severe maximum overall shock during the crisis window. This share of claims on banks explained a full 47% of the variation across countries in the size of these maximum negative overall shocks.

After several post-crisis years of rapid economic growth and surging capital flows, emerging economies came under investor scrutiny in 2014 and 2015 prompting massive capital outflows from many countries. Both Russia and China stand out in this regard, as evidenced by the large negative demand shocks in these years (Graph 13). The economic sanctions on Russia introduced in early 2014 following its annexation of the Crimea and the subsequent collapse in oil prices in mid-2014 put significant strain on Russia's fiscal position, prompting creditor banks to significantly reduce their exposures to the country. The growth in foreign claims on Russia, which had reached almost 30% year-over-year in late 2012, subsequently fell to -20 by end-2015. For its part, uncertainty about the breadth of the slowdown in China's economy sparked dislocations in Chinese equity markets and large capital outflows in 2015. Year-on-year claims growth fell from a high of roughly 40% in 2013 to -18% by end-2015.

Elsewhere, supply shocks have in recent quarters contributed positively to the growth in claims on Latin American countries (Graph 13, top panels), reflecting the expansion in some of their main creditors' global balance sheets (Spanish, Japanese and Canadian banks). In the case of Argentina, demand side factors further boosted claims growth. But for Brazil and Chile, banks' foreign claims on these countries have not kept pace with their overall expansion, as evidenced by the offsetting demand shocks. In contrast to Latin America, the global retrenchment of several large European banking systems contributed negatively (supply shocks) to the growth in claims on key emerging European countries (Graph 14, top panels).

6. Conclusion

Understanding the drivers of the global credit cycle is critical for macroprudential policy makers interested in monitoring cross-border capital flows. But credibly estimating supply- and demand-side drivers of these flows has proven to be difficult. Previous studies that rely on panel regression models with fixed effects generally find statistically significant coefficients on a host of plausible drivers. But the models tend to fall short in explaining the aggregate dynamics in the data, as evidenced by single-digit *R*-squared values and predicted dependent variables that bear little resemblance to the actual data.

Using a recently-developed empirical methodology that greatly increases estimation efficiency, this paper decomposes the growth in internationally-active banks' consolidated foreign claim positions. It takes as inputs the BIS *Consolidated Banking Statistics*, the most comprehensive dataset available on national banking systems' country exposures. Importantly, the CBS, unlike balance of payments data

and other residence-based statistics, respect the perimeter of banks' *consolidated* balance sheets, which means that supply shocks that affect these national banking groups can be credibly estimated.

The methodology used here allows for an exact decomposition of claim growth into supply, demand and common factors. Banks' foreign claims are highly concentrated in a handful of large banking systems and counterparty countries. Small percentage point changes in the big bilateral positions contribute far more to the aggregate dynamics in global claim growth than do the far more numerous small bilateral positions, which tend to have highly volatile growth rates. Standard panel estimation techniques that give equal weight to all observations generally capture the "average" effect of the right hand side variables, even though this average affect is largely based on the small bilateral observations. The methodology used here addresses this problem by explicitly taking into account the aggregate adding-up constraints. As a result, it yields estimated supply, demand and common shocks that, when summed, match perfectly the growth in claims for any banking system-country pair. In addition, they perfectly match the growth in each banking system's claims on all countries, and all banking systems' claims on any one country.

The shock estimates afforded by this methodology are only as good as the inputs. Along the way, the paper demonstrates the importance of two adjustments to the raw CBS data: for breaks in series and for exchange rate movements. Absent these adjustments, the raw data present a very misleading picture of the trajectory of international claims growth.

The estimated supply and demand shocks appear plausible across a number of dimensions. Negative supply shocks, for example, are clearly evident for Japanese banks in the early 2000's, when their poor balance sheet health invited intense regulatory scrutiny that ultimately led to a wave of mergers. Similarly, the size and direction of the supply shocks across all banking systems during the 2007-09 financial crisis are very highly correlated with the losses suffered by these banks during that period. On the demand side, negative shocks are clearly evident for those European economies that came under strain during the sovereign debt crisis that started in 2010. And they correlated well with idiosyncratic macro-economic shocks (eg sovereign defaults) and recessions in emerging economies. Importantly, those emerging economies where the bulk of creditor banks' claims were both extended *and* funded locally seemed to suffer from less sever supply and demand shocks during the 2007-09 financial crisis.

The methodology used in the paper provides policy makers with a convenient tool for monitoring global banking activity. By decomposing bilateral growth rates into supply, demand and common shocks, policy makers can quickly ascertain whether rapid increases or decreases in credit to a particular country are driven by *systematic* changes in the balance sheets of that country's key creditor banking systems (ie supply shocks), or whether the changes are unique to that country (ie demand shocks). It is well known, for example, that China's economy slowed in 2014 and 2015, and that capital has exited the country at an alarming rate. What has been less well understood until now is the role of foreign banks, and whether their pullback from China has been part of a broader global retrenchment, or whether the withdrawal from China has been uniquely severe. The estimates here show clearly that demand shocks – a more rapid contraction in claims on China than on other countries – rather than creditor banks' systematic retrenchment has been the driving force.

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A.1. Summary statistics for reporting banks' claims positions

Size and concentration of BIS reporting banks' claims

At end-Q4 2015 Table A.1

Banking system	All bilateral links[1]			Links > $1bn[2]			Links > $1bn (always)[3]		
	count	FC	INTL	count	FC	INTL	Count	FC	INTL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AT	159	313	175	31	300	163	13	169	100
AU	173	751	280	32	735	266	10	616	167
BE	128	192	111	21	182	101	13	163	91
BR	101	135	112	15	122	100	3	57	52
CA	195	1,287	460	45	1,273	450	21	1,181	389
CH	206	1,492	949	59	1,468	924	36	1,359	833
CL	38	14	11	3	10	7	0	0	0
DE	175	2,260	1,785	74	2,240	1,766	56	2,197	1,725
DK	131	230	117	19	220	109	6	136	57
ES	195	1,549	397	41	1,536	385	20	1,346	286
FI	49	27	25	9	22	21	0	0	0
FR	195	2,500	1,301	86	2,476	1,280	53	2,344	1,202
GB	179	3,047	1,434	80	3,033	1,423	54	2,948	1,365
GR	81	144	106	13	135	97	5	46	29
IE	111	103	34	8	94	26	3	85	17
IN	133	118	90	17	105	78	2	30	24
IT	193	754	390	46	739	375	21	633	320
JP	115	3,679	2,872	58	3,667	2,860	42	3,578	2,774
KR	184	153	125	25	133	106	16	120	93
MX	37	6	6	2	4	4	0	0	0
NL	170	1,109	512	53	1,089	493	36	1,032	449
PA	64	21	21	4	11	11	1	7	7
PT	100	96	57	16	90	52	5	27	16
SE	182	747	283	35	734	271	11	645	196
SG	122	430	234	24	421	225	10	355	178
TR	92	23	20	6	17	14	2	10	8
TW	122	345	272	29	331	259	10	220	169
US	170	2,845	1,904	82	2,829	1,892	52	2,725	1,802
XX[4]	155	243	156	31	230	145	12	184	107
Big banks[5]	224	22,641	12,942	151	22,622	12,927	107	22,470	12,813
BIS banks[6]	225	24,821	14,361	155	24,801	14,344	111	24,651	14,238

Note: Count = number of counterparty countries; FC = Foreign claims and INTL = International claims, in billions of US dollars

[1] Sample of all counterparty countries (+200) in the BIS *Consolidated Banking Statistics*. [2] Set of counterparty countries where outstanding foreign claims at end-Q4 2015 exceeded $1 billion. [3] Set of counterparty countries where outstanding foreign claims exceeded $1 billion in every quarter between end-Q4 2000 and end-Q4 2015. [4] Banks headquartered in Hong Kong, Luxembourg and Norway, which are masked due to confidentiality restrictions. [5] Restricted sample of the largest banking systems (AT, AU, BE, CA, CH, DE, ES, FR, GB, IN, IT, JP, NL, SE and US banks). [6] All BIS reporting banking systems in the table.

Source: BIS consolidated banking statistics (IC basis); authors' calculations.

Consolidated foreign and international claims, by counterparty country

At end-Q4 2015 Table A.2

Counter party country	All bilateral links[1]			Links > $1bn[2]			Links > $1bn (always)[3]		
	count	FC	INTL	count	FC	INTL	count	FC	INTL
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
US	30	5,286	2,186	28	5,285	2,185	25	5,271	2,175
GB	30	2,518	1,289	28	2,517	1,288	23	2,486	1,265
DE	30	1,178	680	25	1,176	678	17	1,153	655
KY	30	1,097	1,096	21	1,095	1,093	13	1,054	1,053
FR	30	971	836	22	968	832	16	942	808
HK	30	781	328	16	778	325	12	760	310
JP	30	724	369	15	721	366	12	710	355
CN	31	654	407	19	652	406	8	482	293
NL	30	624	527	24	622	526	14	589	493
IT	30	610	313	14	605	308	11	595	298
LU	29	581	476	22	578	473	15	558	454
BE	30	425	171	15	419	165	9	406	152
AU	30	423	233	18	420	231	11	401	214
ES	30	409	317	17	405	313	10	388	296
CA	30	379	255	19	375	250	8	342	224
SG	29	376	242	16	372	239	11	352	221
MX	27	359	123	12	355	119	9	351	116
IE	28	356	289	15	350	282	11	335	271
CH	30	353	254	19	350	251	10	319	221
BR	28	326	159	14	322	155	9	313	148
Int Org	25	310	309	19	308	307	8	221	220
NZ	29	296	32	7	294	30	5	282	26
TR	28	274	165	14	270	161	8	153	112
PL	27	263	103	13	261	100	6	170	58
DK	29	260	146	13	257	142	8	235	121
KR	27	255	131	12	252	128	11	237	127
IN	28	248	152	14	247	151	7	210	120
NO	29	246	119	14	243	116	9	220	99
FI	28	226	103	16	224	101	7	174	79
SE	30	209	159	14	205	155	9	181	141
AT	28	208	141	13	204	137	8	195	130
West Ind	27	167	165	13	161	159	6	109	109
TW	25	166	79	11	165	78	7	130	62
CZ	28	161	34	8	158	31	5	104	21
AE	30	146	115	12	141	110	2	74	47
MY	28	141	57	10	138	54	6	130	47
ID	25	136	101	11	133	98	9	123	91
PT	28	128	45	7	124	41	7	124	41
TH	26	128	40	9	125	38	5	118	33
CL	25	123	46	10	120	44	7	97	30
RU	30	121	89	13	119	86	8	91	61
ZA	29	102	31	7	98	28	6	96	27
PA	28	79	79	11	75	75	7	65	65
BM	26	79	77	14	76	74	6	59	57

Note: Count = number of banking systems; FC = Foreign claims and INTL = International claims, in billions of US dollars.

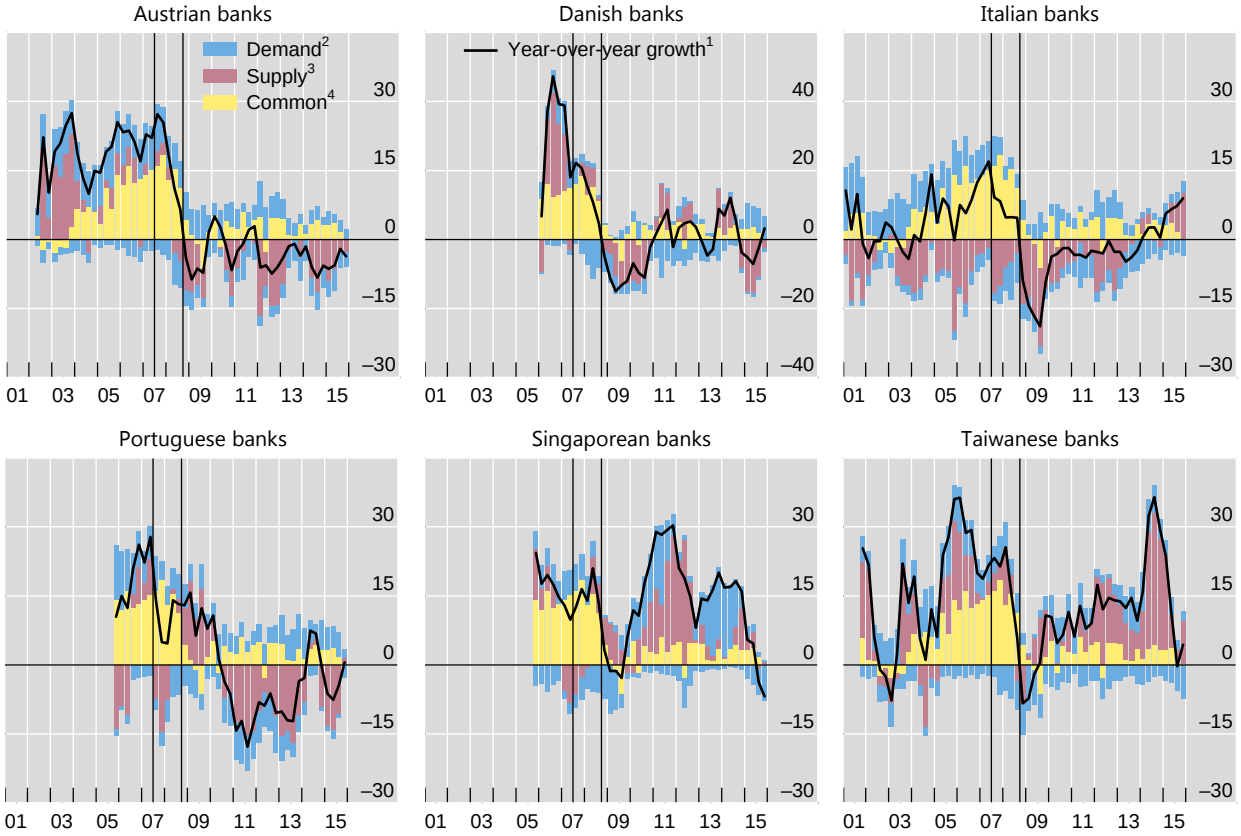
[1] All bilateral observations. [2] Observations where bilateral foreign claims exceeded $1 billion at end-Q4 2015. [4] Observations where bilateral foreign claims exceeded $1 billion in every quarter between end-Q4 2000 and end-Q4 2015.

Source: BIS consolidated banking statistics (IC basis); authors' calculations.

Shocks to selected banking systems

In per cent

Graph A.1



Note: Vertical black lines indicate end-Q2 2007 and end-Q3-2008.

[1] Year-on-year growth in foreign claims of internationally active banks of the nationality indicated in the panel title, adjusted for breaks in series and exchange rate movements. [2] Estimated demand shocks to the counterparty countries on which the banking system in the panel title has outstanding foreign claims. Positive and negative demand shocks plotted separately. [3] Estimated supply shocks that are unique to banking system in the panel title. [4] Estimated shocks that are common to all banking systems and counterparty countries.

Source: BIS consolidated banking statistics (IC basis); BIS locational banking statistics; national data; authors' calculations.

A.2. Adjustments to foreign claims for exchange rate movements

Foreign claims on a particular counterparty country tend to be denominated in a mixture of currencies. Changes in the relative value of these currencies induce changes in the outstanding stock of claims when expressed in any single currency, here in US dollars. Changes in exchange rates may have economic meaning from the perspective of a reporting banking system, for example in analyses of how currency mismatches across the balance sheet affect bank profitability. However, they are not indicative of the provision or retraction of actual credit, which is the metric needed for the empirical analysis in this paper. In most quarters, exchange rate movements contribute little to the growth in aggregate foreign claims. But, as shown in the main text, extreme exchange rate movements, like those that occurred in the months following the collapse of Lehman Brothers, significantly distort measures of the growth in foreign claims.

The first step in the adjustment is to obtain measures of the share of each currency in foreign claims. Foreign claims can be broken into three pieces: (a) cross-border claims (XBC), (b) local claims in foreign (ie non-local) currencies (LCFC) and (c) local claims in local currencies (LCLC). That is, FC = XBC + LCFC + LCLC. In the CBS, XBC and LCFC are reported together as international claims (INTLC = XBC + LCFC), although these claims can be separated (albeit imperfectly) using the BIS locational banking statistics, which has a currency breakdown. We obtain the currency shares for each of these three components separately, and then use them to obtain the shares of each currency in total foreign claims.

The currency shares for these three pieces are obtained as follows:

(a) LCLC: The currency of denomination of LCLC is known by construction. It is simply the currency in use in the counterparty country.

(b) LCFC: For many banking-system counterparty pairs, the currency shares for LCFC are also known, from the BIS *Locational Banking Statistics by Nationality* (LBSN). Unlike the CBS, the LBSN track the cross-border claims and local claims in non-local currencies (LCFC) of banks located in a particular location, broken down by the nationality of the banking system.[34] Thus, for any country that reports the LBSN to the BIS, we know the currency breakdown (USD, EUR, JPY and Other foreign currencies) for each national banking systems' LCFC on the residents of that reporting country.

Currently, more than 40 countries report the LBSN to the BIS, covering more than 95% of each consolidated national banking systems' global foreign claims. But there are only a few emerging economies that report the LBSN (Argentina, Brazil, Chile Mexico, South Africa, Chinese Taipei, India, Indonesia, Malaysia and South Korea), and several of them only started reporting after 2000. We do not have actual data about the currency composition of each banking systems' LCFC vis-à-vis those countries that do not report in the LBSN (eg China, Czech Republic, Hungary, Poland). For these countries, we

[34] For example, in the LBSN, the reporting country United Kingdom reports LCFC with a currency breakdown separately for the German banks, Swiss banks, French banks, etc that are located there.

assume that the composition of each banking systems' LCFC is the same as that for all cross-border claims on that country, as described in (c) below.[35]

(c) XBC: Obtaining the currency shares for a consolidated national banking system's cross-border claims on a particular country is the most problematic. The LBSN provide information about the currency composition of banks' cross-border claims booked by their offices in each reporting location. But, critically, they do not reveal the location of the counterparty country.[36] The BIS *Locational Statistics by Residency* (LBSR), by contrast, track the cross-border claims booked by banks offices in each reporting country on individual counterparty countries, broken down by currency. But, the LBSR, unlike the LBSN, do not reveal the nationality of the banking system located in each reporting country. In addition, cross-border claims in the LBSR *include* banks' interoffice positions, which are not included in the CBS and thus not in foreign claims. Cross-border claims in the LBSR are broken down into positions denominated in USD, EUR, JPY, GBP, CHF, the domestic currency of the counterparty country, and "Other" foreign currencies.

To obtain the currency shares of each national banking system's worldwide consolidated cross-border claims on a particular country, we take the shares reported in the LBSR for banks of all nationalities and apply these to banks of each nationality. That is, the currency shares of US banks' cross-border claims on Hungary are assumed to be the same as the shares of German, Swiss and other banks' claims on Hungary. For those counterparty countries that themselves report the LBSN to the BIS, we make an additional correction to exclude interoffice positions in each currency. Specifically, for these countries, we obtain the currency distribution by taking cross-border claims of all banks in all other BIS reporting countries on all sectors in the counterparty country and subtract from this the total cross-border interoffice *liabilities* reported by banks (of all nationalities) located in the counterparty country.

For those counterparty countries that do not report the LBSN, we assume that the currency composition of the total international claims in the CBS (INTLC = XBC + LCFC) is simply equal to the currency composition of total cross-border claims (including interoffice) from the LBSR.

With the currency shares for the three components of foreign claims in hand, we are able to estimate the overall currency shares for each consolidated banking system's total foreign claims on each counterparty country. The second step in our adjustment is to feed these data series, along with exchange rates, into a chain-linked adjustment that yields the year-over-year growth in foreign claims excluding the effect of exchange rate movements.

[35] By definition, LCFC does not include positions denominated in the domestic currency of the counterparty country. Thus, in applying the currency distribution taken from cross-border claims on that country as described (c), the domestic currency of that country is excluded.

[36] That is, they reveal, for example, the currency composition of the cross-border claims of German banks in the United Kingdom, and that of cross-border claims of German banks in every other reporting location. These can be aggregated to reveal the currency composition of German banks' total cross-border claims booked in all locations. But the information about the counterparty country was introduced in the LBSN only in 2013. Thus, they do not reveal the currency distribution of German banks' worldwide consolidated claims on counterparties in any one particular country.