International Banking and Liquidity Risk Transmission: Lessons from Across Countries*

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Abstract

Activities of international banks are at the core of discussions on the causes and effects of the global financial crisis. The International Banking Research Network (IBRN), established in 2012, brings together researchers from around the world with access to micro-data on individual banks to close this gap. This paper summarizes the common methodology and results of empirical studies conducted in 11 countries to analyze the impact of liquidity shocks on bank lending, both domestic and foreign. Four main insights are established. First, liquidity conditions affecting parent banks transmit into both the domestic and foreign lending of these banks. Second, the ex-ante balance sheet composition of banks and banks' business model influence their responses to liquidity risk. No single balance sheet characteristic consistently plays a role in liquidity risk transmission. Third, internal liquidity management within multinational banks can damp the domestic lending effects of liquidity risk. Fourth, the availability of official sector liquidity tends to reduce the adverse consequences for lending during stress periods and to weaken the impact of balance sheet constraints.

JEL-codes: G01, F34, G21

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1 Motivation

In the past decades, banking systems became much larger, the ratio of credit over GDP surged, and banks were more exposed to global shocks. Internationally active banks have thus been at the core of discussions on the causes and effects of the global financial crisis. Policymakers have stated their intention "to manage capital flows in order to deal with the risks and reap the benefits of cross-border capital flows", recognizing that "central banks play a major role in addressing global liquidity shocks".[1] Yet, relatively little is known about the actual transmission of liquidity shocks into lending to the real economy through banks, about which types of banks are affected most, and about the effectiveness of policy interventions by governments and central banks.

The papers compiled in this volume address four questions: How do liquidity conditions affecting parent banks transmit into domestic and foreign lending? How does the ex-ante balance sheet composition of banks and banks' business models influence their responses to liquidity risk? What role does internal liquidity management within multinational banks play in magnifying or damping lending effects of liquidity risk? Did the availability of official sector liquidity provision influence the response of banks to liquidity shocks?

These questions cannot be answered using data that are aggregated or semi-aggregated across banks at the country level. Careful analysis of the transmission of shocks through internationally active banks requires micro-data on individual banks that allow studying heterogeneity across banks. Yet, the required bank-level data are confidential and cannot be merged together across countries. In order to develop cross-country insights, the International Banking Research Network (IBRN) was established in 2012 by central bank researchers and academics from Austria, Germany, the United Kingdom, and the United States. In 2013, the IBRN expanded to include researchers from Australia, Canada, France, Hong Kong, Ireland, Italy, Poland, and Spain, joined by representatives of the BIS and the IMF.[2] The network brings together researchers with access to bank-level data on banks' cross-border activities. The participants analyze bank-level datasets country-by-country and share empirical results

[1] See Communiqué of the G20 Finance Ministers and Central Bank Governors, Paris, October 15, 2011. On the role of public sector liquidity provision during crises, see also Committee on the Global Financial System (2011).

[2] As of 2015, the list of central banks engaged in the IBRN has expanded to 24. For details, see http://www.newyorkfed.org/IBRN/index.html.

and insights, but not the underlying confidential data. The resulting research yields comparable cross-country evidence on policy-relevant issues and insights into the reasons for heterogeneity observed within and across countries.

The papers included in this volume focus on the *exposure of banks to liquidity shocks* and the *impact of liquidity shocks on bank lending*, both domestic and foreign. The symposium includes 11 country studies, covering Australia, Austria, Canada, France, Germany, Hong Kong, Ireland, Italy, Poland, the United Kingdom, and the United States. All papers use a common research methodology wherein changes in different types of lending are regressed on balance sheet characteristics, measures of liquidity risk, and information on availability of official liquidity or capital interventions, data availability permitting. Regarding the type of lending, studies subdivide loans by (i) the type of borrower (domestic or foreign), (ii) the location of the lender (domestic versus cross-border loans), (b) foreign office claims (local lending from the foreign office), (iii) the nationality of the lender (domestic versus foreign banks), and (iv) intra-bank loans. The studies use quarterly data spanning 2006 through 2012.

These questions are particularly important in light of the significant increase in bank credit, both domestic and foreign, over recent decades followed by the disruption to this expansion during the financial crisis, particularly affecting cross-border lending. Between 2000 and 2007, the ratio of domestic credit over GDP expanded from close to 100% to an average of 120% in the countries under study; at the end of 2012, it stood at an even higher 125% of GDP. Cross-border credit doubled from about 30% to 66% of GDP before the crisis and declined to 55% subsequently.[3] These patterns are consistent with the greater fall in global liquidity compared to domestic liquidity in the wake of the crisis (CGFS 2011). While bank-to-bank lending has remained subdued, lending to private non-bank customers rebounded more quickly (Figure 1). The patterns in the data look very similar for the aggregate of BIS reporting countries shown in this figure and for the IBRN countries represented in this volume.

As the country studies provide specific insights into the drivers of international and domestic bank assets, we set up a meta-analysis in order to summarize results across the

[3] Data on annual net domestic credit (IFS line 32) and GDP are taken from the IMF and The World Bank. To convert net domestic credit from local currency to US-Dollar, we construct the annual exchange rate as implied by the conversion of GDP in local currency to GDP in US-Dollar. Data on cross-border credit are taken from the BIS Locational Banking Statistics. The corresponding numbers using the Consolidated Banking Statistics increased from 30% to 61% of GDP before the crisis and declined subsequently to 56%.

studies. Meta-analyses ask which features of the regression sample affect an outcome or the explanatory power of a particular empirical model. By design, the empirical studies we summarize are very homogenous across countries because all teams used the same baseline regression model. Hence, the publication biases that can affect meta-analyses that draw on only published research are not an issue for us. The meta-analysis is used to answer two questions. First, we ask which features of the regression samples affect the significance of balance sheet channels of liquidity risk transmission through banks. Second, we consider which features of the regression samples influence the likelihood that the balance sheet channels of transmission are consistent with or depart from ex ante theoretical priors.

Four key results emerge. First, the liquidity conditions affecting parent banks transmit into domestic and foreign lending of these banks. Second, the ex-ante balance sheet composition of banks and the banks' business model influence their responses to liquidity risk. Having a high share of deposit funding helps banks protect their lending against (market) liquidity risk, particularly for smaller or domestically-oriented banks. However, no single balance sheet characteristic consistently plays a role across all country experiences and all bank types in driving the cross-sectional differences between banks in credit supply response to liquidity risk.

Third, compared with domestic banks, the cross-sectional differences in lending across global banks are less well-explained by balance sheet characteristics such as deposit funding. One possible explanation is that global banks can activate internal capital markets, and thus are less dependent on local balance sheet constraints at times of stress. This liquidity management within global banks and across affiliated branches and subsidiaries can damp the domestic lending effects of liquidity risk.

Fourth, how liquidity risk affects lending of banks depends on the time period. Responses in more "normal" periods, when banks are not accessing official liquidity facilities, differ from responses in those periods when banks access these facilities. Use of official liquidity facilities is associated with weaker linkages between ex ante bank-specific characteristics and patterns of lending response as market liquidity conditions change.

In Section 2 we summarize previous relevant literature. Section 3 lays out the common empirical methodology applied across the country studies. Section 4 briefly presents the results of the individual country studies, leaving the broader details and discussions of the

country results to the respective papers. Section 5 provides descriptive statistics across the studies and the results of the meta-analysis. Section 6 concludes.

2 Previous Literature

Until recently, research on international banking was a relatively underdeveloped field within the fields of international economics and international business. This reflected the lack of a consistent theoretical framework to analyze international banking activities. But it also reflected a lack of access to relevant bank-level data. In recent years, theoretical and empirical research on international banking has made significant progress. More extensive insights into the operations and consequences of global banks have been developing.

2.1 Theoretical Work

Two strands of theoretical literature are particularly relevant for the research on liquidity risk transmission conducted by the IBRN. The first deals with the transmission of liquidity shocks in integrated banking markets. Allen and Gale (2000) show that the link between market integration and the contagion of liquidity risk is highly non-linear: the risk of contagion is greatest in partially integrated banking markets with an incomplete network of interbank linkages. Subsequent research has enriched the baseline model by including asset price shocks, by analyzing the role of publicly provided liquidity, and by examining the impact of systemic shocks. This literature shows a high risk of contagion when banks' liquidity buffers are depleted and when common (liquidity) shocks are more pronounced. This literature typically takes the degree of integration of banking markets as given.

The second more recent literature focuses on the underlying differences between the banks that engage in purely domestic versus more international activities. The new research applies insights from international economics and finance to international banking (Goldberg 2007), including the decision of banks to lend across borders or to set up affiliates abroad. The internationalization choices of banks are driven by bank size and productivity. Only the large and productive banks can afford the fixed costs of entering foreign markets, and

otherwise will either remain domestic or access foreign markets through cross-border transactions.[4]

These latter studies suggest conditioning the lending response to liquidity shocks on bank-specific characteristics, as done in domestic banking research (Cornett et al. 2011). However, the global banks can engage in a range of business models, reaching customers and funding sources through cross-border activities, branches and subsidiaries established abroad, and sometimes reallocating liquidity across the organization. Accordingly, analyses of contagion and responsiveness to shocks need to take into account the differences in business models across banks and the additional channels for contagion and responsiveness to shocks.

2.2 Empirical Work

A growing empirical literature focuses on the transmission of shocks through internationally active banks.[5] The seminal work by Peek and Rosengren (1997, 2000) documents the transmission of asset price shocks originating in Japan to the United States, exploiting the fact that these shocks were exogenous to the banks affected and that the presence of Japanese banks varied across U.S. regions. Subsequent work on the response of banks to shocks can largely be grouped into studies that emphasize different issues in domestic versus international transmission, and that use different shocks to generate compelling evidence.

A first set of studies highlights the importance of the bank business model and bank balance sheet characteristics. Across banks, the basic insight remains that access to a stable funding base in the form of deposits and the strength of the capital buffer of the parent bank affect the stability of lending (Allen et al. 2011). However, empirical work shows that domestic and international banks behave differently. Purely domestic banks were more isolated from the crisis and showed more stable lending patterns than global banks (Claessens and van Horen 2014). Global banks actively use internal capital markets with international affiliates to manage liquidity, weakening the domestic transmission of liquidity shocks compared with domestic banks (Cetorelli and Goldberg 2012a). Foreign banks with a high

[4] See de Blas and Russ (2013) and Niepmann (2013) for theoretical analyses of banks' strategy towards internationalization. Buch et al. (2011) analyze this choice empirically for German banks. Buch and DeLong (2012) provide a comprehensive survey of literature on cross-border bank mergers. Size effects also feature prominently in applications of gravity models to international banking (Brüggemann et al. 2012, Niepmann 2013, Okawa and van Wincoop 2012).

[5] See also Acharya et al. (2013) or Dietrich and Vollmer (2010).

exposure to the subprime crisis transmitted stress into US markets by reducing net internal funds available for their US branches and then having these branches engage in less lending (Cetorelli and Goldberg 2012b). Later on, those branches also contracted lending more during the European sovereign debt crisis (Correa, Sapriza and Zlate 2012). For the United Kingdom, there is evidence for a stronger impact of the crisis on foreign branches than subsidiaries (Aiyar 2011, Hoggarth et al. 2013). De Haas and van Lelyveld (2014) found that multinational bank subsidiaries curtailed credit growth more aggressively than domestic banks, especially those subsidiaries that relied more on wholesale funding or whose parents depended on wholesale funding.

Geography and country type also matter. Foreign banks remained more committed to an affiliated subsidiary in those countries that are geographically close and that have developed relationships with local banks (De Haas and van Horen 2012, 2013). Information for 51 multinational banks and their subsidiaries in 99 countries show the importance of accounting for differences between emerging markets and developed countries in lending responses to liquidity risks (Allen et al. 2011).[6] The global banks also may distinguish the transmission of shocks across their affiliates according to whether they serve as core funding or investment locations for the parent. A funding location has the local foreign offices fund their operations largely through local borrowing, with this borrowing in excess of local lending; a core investment location for a bank is a location that represents a large share of its overall foreign investments (Cetorelli and Goldberg (2012c). Parents tend to shield their core investment locations from liquidity shocks, leaving more peripheral investment and core funding locations to adjust to a greater degree.

A second set of studies analyzes the specific balance sheet channels that influence domestic lending responses to liquidity shocks. Tests of the bank lending channel of monetary policy find that bank size matters as small U.S. banks have relatively strong domestic lending responses to liquidity risks compared with large banks (Kashyap and Stein 2000). These patterns continue within periods in which banks face liquidity risks due to financial stress, and also are exacerbated by specific balance sheet structures that enhance the exposure to such

[6] Jeon et al. (2013) use bank-level annual data for 360 subsidiaries of 69 multinational banks to study the international transmission of financial shocks. Navaretti et al. (2009) study the EU27 using pre-crisis data. Most previous work using data from several countries focuses on emerging markets or developing countries such as Cetorelli and Goldberg (2011), He and McCauley (2013), De Haas and van Horen (2012) and Popov and Udell (2012).

shocks (Cornett, McNutt, Strahan and Tehranian 2011: hereafter CMST). Khwaja and Mian (2008: hereafter KM) the impact of cross-sectional variation in exposure to liquidity shocks following unanticipated nuclear tests in Pakistan, finding that liquidity shocks are transmitted differently to large and small borrowers because large borrowers find it easier to obtain substitutes for bank funding. [7] Both CMST and KM are important for the studies of IBRN represented in this model, as the two-period model of bank lending by KM provides a theoretical underpinning of our research (See Section 3 for details) and the empirical methods of CMST are a starting point for our extensions that incorporate global banks and official sector liquidity provision.

A third set of studies explicitly accounts for the effects of government interventions on bank lending during the crisis. Rose and Wieladek (2013) find that increased government interventions during the financial crisis have been associated with a disproportionate retreat from lending internationally by global banks. De Haas et al. (2012) analyze the impact of the Vienna Initiative on foreign banks' activities in Central and Eastern Europe and find that it had the intended stabilizing effects. Given the importance of regulatory initiative aimed at increasing the resilience of banks, the impact of capital requirements has been the focus of several additional papers focusing on the U.K. experience which show that changes in capital requirements affect banks' domestic and foreign lending (Aiyar et al. *forthcoming*; Aiyar et al. 2012, 2013; Bridges et al. 2013).

3 Theoretical Background and Regression Model

The previous section has shown that shock transmission depends on the nature of the shock, the balance sheet structure and business model of a bank, the relationship between a banking affiliate and its parent, and the availability of public sector liquidity support. In exploring the effects of liquidity shocks through bank credit supply, the key empirical challenge is the identification of loan demand and supply effects. The papers in this volume use micro-data for banks in order to identify the relevant loan supply channels for liquidity risk transmission, employing the general approach of "identification through heterogeneity" (Gilchrist and Zakrajsek 1995). In this section, we model bank lending and show how specifications are impacted by public liquidity provision.

[7] See also Ivashina and Scharfstein (2010) and Karam et al. (2014).

3.1 Baseline Model

We begin with the simple banking model suggested by Khwaja and Mian (2008). In period *t*, a representative bank *i* and firm *j* negotiate a loan of size L_t^{ij}. The bank receives funding through deposits, D_t^{ij} which are costless (or priced at a low fixed rate) up to some given level. Thereafter, additional external financing B_t^i is available to bank *i* with the marginal cost of funds given by $\alpha_B B_t^i$ with $\alpha_B > 0$. Credit demand is such that marginal returns on loans are decreasing in loan size $\bar{r}_t^{\,j} - \alpha_L L_t^{ij}$. At the end of period *t*, two types of shocks hit the economy: banks are subject to an aggregate credit supply shock ($\bar{\delta}_t$) and a bank-specific or idiosyncratic shock δ_t^i. Credit demand shocks also can occur, and work through the marginal returns on loans which increases with aggregate ($\bar{\eta}_t$) and idiosyncratic (η_t^j) productivity shocks.

As derived by KM, equilibrium changes in bank lending can be represented in reduced form as a function of changes in the market price of liquidity risk Δr_t^c in the country *c*, the aggregate shocks, and idiosyncratic productivity:

$$\Delta L_{t+1,t}^{ij} = \frac{1}{(\alpha_L + \alpha_B)}\left(\alpha_B \cdot \bar{\delta}_{t+1} + \bar{\eta}_{t+1}\right) + \frac{\alpha_B}{(\alpha_L + \alpha_B)} \chi_t^i \cdot \Delta r_t^c + \frac{1}{(\alpha_L + \alpha_B)} \eta_{t+1}^j \qquad (1)$$

In this specification, the interactions $\chi_t^i \cdot \Delta r_t^c$ are intended to capture how the balance sheet characteristics of individual banks χ_t^i influence bank-level lending responses to the market price of liquidity risk.

This KM specification (1) holds in "normal" periods, and it can be viewed as a conceptual foundation similar to that used in CMST. However, this formulation may not adequately capture the relationship between balance sheet characteristics of banks and liquidity costs in periods when banks can obtain liquidity provided by central banks. The reason is that the availability of official liquidity at a price below r_t^c renders the market price as being less relevant to the banks. In the crisis, the U.S. Federal Reserve, for instance, provided lending under the Term Auction Facility (TAF) at favorable conditions compared to liquidity available on the private market. Similar programs were made available by other central banks.

We illustrate graphically how the availability of public sector liquidity can distort relationships in accordance with bank characteristics. Figure 2a, Panel I relates banks'

external cost of finance to bank characteristics χ_t^i shown across the horizontal axis, and shows these cost frontier curves at different points in time t_0, t_1, t_2. The curvature of a single cost frontier reflects our first testable hypothesis:

> HYPOTHESIS 1: *The response of bank lending to liquidity risk depends on bank characteristics. In normal times, the effects of market liquidity shifts are more pronounced for weaker or more constrained banks (lower χ_t^i) than for stronger or less constrained banks (lower χ_t^i).*

Our empirical model includes a number of bank characteristics. In terms of balance sheet composition, weaker banks are posited to be those with a greater exposure to liquidity risk. Per CMST, these are the banks with a higher share of illiquid assets, a lower share of deposit funding, and a lower capital ratio. Banks with higher unused commitments may sustain lending to existing customers contractually in the near term, but customers without these commitment lines will be more exposed to loan supply contraction. Purely domestic banks will also have a greater exposure to domestic liquidity shocks than global banks because they cannot use an internal capital market with foreign affiliates to smooth shocks. Likewise, per Kashyap and Stein (2000), smaller banks may have more constrained access to alternative sources of funds than larger banks, all else equal.

As the market price of liquidity risk can evolve over time, generating different pricing frontiers at different dates, banks $i = 1, 2, \ldots, k$ may be affected differently. The cost frontiers are drawn so that t_0, t_1, t_2 reflect steadily worsening market liquidity conditions. In this case, the resulting time series of liquidity costs for specific types of banks are re-mapped in the time domain in Figure 2a Panel II. This figure visualizes how different "treatments" in terms of liquidity regimes are captured in our regression model.

3.2 Public Liquidity Provision

Panel I of Figure 2b provides a visualization of the effects of publically-provided liquidity, comparing normal times when these liquidity facilities are seldom used to periods when more banks drawn on official liquidity support. The pricing of public liquidity and the perceived stigma effect associated with its use generally leaves the cost of official-sector funding above the market prices of external finance (Armantier et al. 2011). In this panel, t_0 has the interpretation of "normal" market conditions, and the price of publicly provided liquidity for

banks residing in country *c* is $r_0^{c,pub}$. Given an exogenous shift in private sector liquidity costs to a higher frontier at time t_1, as long as the price of public sector liquidity $r_{t=0}^{c,pub}$ is above the private market rate, the effective cost of liquidity to the bank still corresponds to the funding costs on the private market. At the initial pricing of public sector funds, large and potentially disruptive changes in the private cost of funding are mitigated only for the weakest banks when market conditions worsen to the frontier depicted at t_2. At these times, stronger banks still prefer to borrow from the private market.

Suppose that public sector funding becomes available at more preferable terms $r_1^{c,pub} < r_0^{c,pub}$. This will lead to a discontinuity in the effects of private market liquidity conditions on banks. Weaker banks will find it cost-effective to access public sector liquidity mechanisms, and not face additional marginal funding pressures when the private cost of funds increase further (or will only face those marginal funding pressures on the residual liquidity that is market funded). The effective price of liquidity for the weak banks has a kink its time series profile, as shown in Panel II of Figure 2b. Throughout, however, the stronger banks will continue to acquire funding in private markets and respond to changes in market conditions. Ignoring the kink in empirical applications will yield estimates of the (normal) effects of liquidity risk on lending that are downward biased for all banks with characteristics χ_t^i below some threshold value. The bank really responds only to changes in the market price of liquidity during periods when the public cost of liquidity is above the private market cost of liquidity. For these weaker banks and at these dates, the elasticity of balance sheet response to changes in liquidity provision needs to be measured relative to the public cost of funds, not relative to the private cost of funds.

The cost of official sector funds could be reduced in times of concerns about large potential contractions in L_t^{ij} that generate a credit crunch, a lack of capital in the system, or a downward spiral of asset prices across banks as interbank credit constricts. If this is done, for example, through emergency liquidity facilities that lower the cost of public funds to $\mathbf{r_{t=1}^{c,pub'} < r_{t=1}^{c,pub}}$, weak banks experience a discrete drop in the effective cost of liquidity and a larger group of banks (with characteristics between *i* = 1 and *i* = 2) are faced with a kinked effective cost of funds (Panel II of Figure 2c).

Overall, these considerations lead us to the following testable hypothesis:

HYPOTHESIS 2: *In crisis episodes, the bias in empirical specifications becomes pronounced in models which ignore the role of public sector liquidity and balance sheet support. Because the market price for liquidity becomes less relevant in*

these periods, the impact of banks' balance sheet conditions on loan supply weakens, particularly for weaker or more constrained banks.

The implication is that the impact of bank-level characteristics on banks' funding costs may change between normal and stress periods. In normal times, illiquid assets may not be a constraining factor on loan supply because other funds are available. The effect on lending response to general liquidity conditions would thus be small. As the cost of other funds increase in times of crises, illiquid assets may become a more binding production factor. The sensitivity of loans with respect to illiquid assets may thus increase. Therefore, we would expect that the first order effect of illiquid assets on loan supply is negative and that the interaction of deposits and market liquidity costs is negative and statistically significant. Similar arguments can be made for other balance sheet characteristics that measure the exposure of banks to liquidity risk.

3.3 Translation to an Empirical Specification

The framework described above maps into an empirical specification which has a methodological antecedent in CMST (2011), who examine the role of ex-ante bank balance sheet composition in explaining ex-post differences across large and small U.S. banks in terms of adjustment to liquidity risk. We extend their framework to consider the international business models of some banks and the provision of official liquidity support. Accordingly, the baseline regression specification used in the studies of this volume is:

$$\Delta Y_{it} = \gamma_i + \mu_t + \left(\beta^0 + \beta^1 LIB\_OIS_t\right)\chi_{i,t-1} + \left(\alpha^0 + \alpha^1 LIB\_OIS_t \cdot \chi_{i,t-1}\right)F_{it} + \varepsilon_{it} \qquad (2)$$

where the dependent variable Y_{it} captures different forms of lending such as total lending, domestic lending, cross-border claims, foreign claims, or intra-bank claims channeled through the internal capital market. The baseline regression model includes bank (γ_i) and time (μ_t) fixed effects so that β tests how cross-sectional differences in balance sheet composition affect the response of bank lending to liquidity risk.

$\chi_{i,t-1}$ is a vector of variables capturing the degree to which a bank is exposed to liquidity risk. Liquidity risk is defined as the ability of a bank to settle its obligations at a given point in time. It has two dimensions. On the asset side, it captures the share of assets that can be converted into cash quickly. On the liability side, it captures the share of short-term debt and thus rollover risk, i.e. the risk of not being able to refinance short-term debt as it

becomes due. Exposure to liquidity risk is measured through bank-specific data on the structure of assets (illiquid asset share, unused commitments) and on the structure of liabilities (share of deposits, bank capital).[8] Because some of the banks are linked by their foreign affiliates through an internal capital markets, some specifications include related net due to shares in funding. We lag these variables to address simultaneity concerns.

Our examination starts with a liquidity risk time series r_t^c that is common across all banks *i* within each country *c*. For this purpose, each country team includes a relevant measure of money market spreads like a LIBOR over OIS spread $\left(LIB\_OIS_t\right)$.[9] The associated data are provided in Figure 3. Note that liquidity risk is measured at an aggregate level while our unit of observation for the regression model is the individual bank. It may still be objected that liquidity risk is endogenous. Therefore, in robustness tests, country teams replace the LIBOR-OIS spread for each individual country with the corresponding spread for the U.S. As the spread for the US is sometimes used as a proxy for a global liquidity shock, finding differences between the country-specific spread and the spread for the US can be interpreted as a proxy for the relevance of local versus global funding shocks.

In specification (2), the interaction between bank characteristics and the LIBOR over OIS spread shows whether banks' credit extension changes with liquidity risks depend on ex-ante balance sheet features, as stated by HYPOTHESIS 1. The specifications are implemented for banks with different business models, in accordance with the types of banks present in the respective countries conducting the studies. The distribution of specifications run across the 11 country studies, as well as the prevalence of statistical significance and expected signs for particular balance sheet characteristics and types of banks, are presented in the meta-analysis of Section 5.

For testing HYPOTHESIS 2 some country teams have obtained data on the actual use of official liquidity facilities by individual banks. These teams introduce interaction terms between the $\chi_{i,t-1}$ variables and a measure of official sector interventions, for example by

[8] Ideally, one would use bank-level information to measure liquidity risk. Such bank-level information can be obtained from banks' balance sheets or from information on banks' bidding behavior in central bank auctions (Drehmann and Nikolaou 2013).

[9] Series include the 3-month LIBOR-OIS spreads of the European Euro (EUR), Pound Sterling (GBP), Hong Kong Dollar (HKD), Japanese Yen (JPY), Swiss Franc (CHF), the US Dollar (USD), Australian Dollar (AUD), and the Canadian Dollar (CAD). For Hong Kong, the interbank rate is the Hong Kong Interbank Offered Rate (HIBOR).

having an indicator variable equaling 1 if a bank accessed an official liquidity facility at time *t* (F_{it}). During periods with official support, the overall sensitivity of the balance sheet to liquidity risk in periods of availability of central bank facilities is captured by $\beta^1 + \alpha^1$. More specifically, results analyze whether the impact of balance sheet variables becomes weaker in times when official lending facilities are being offered. For example, if the estimated sign of β^1 is in the expected direction and statistically significant, we expect the *opposite* sign on α^1. Moreover, the sum of the two terms should be closer to zero for periods when the official liquidity facilities are utilized.

Finally, each country team has computed the quantitative importance of specific balance sheet channels for liquidity risk transmission into lending activity. All country studies computed the predicted effect of a 100 basis point increase in liquidity risk on lending growth through each balance sheet channel, and specifically compared the difference in the magnitude at the 75 percentile (p75) compared with at the 50th percentile (p50) of the balance sheet composition distribution by channel.

4 Narratives from Each Country

The country studies contain data for individual banks, with each country team choosing coverage of the types of banks active in their local market. Overall, the 11 studies analyze liquidity risk transmission through balance sheets across business models of banks and national banking system structures. Regression samples can contain banks that are foreign-owned or domestic owned, samples may be limited to banks that are over a particular asset size threshold, and can be domestic or global in focus. Most studies capture the effects on this transmission of availability of official liquidity or capital support during the financial crisis. The country studies contain very different counts of banks in the regressions, with some analyses conducted over very few banks (e.g. Canada) and others having much broader numbers of institutions included (e.g. United Kingdom). The dependent variables of the regression specifications cover domestic and foreign lending as well as internal capital market flows as captured by “net due to” flows of the head office to its foreign affiliates. The independent variables are mostly ex-ante bank balance sheet characteristics, where variables are defined similarly across studies, subject to nuances of reporting and accounting conventions.

Before delving into a systematic analysis of the results in the form of a meta-analysis, this section provides some of the key features of the country results. The respective country papers provide the detailed analytics and the richer narratives which are specific to national experiences. Countries differ with regard to their role as host markets of internationally active banks, their role as international financial centers, or the types of shocks to which their banks have been exposed.

The study for the United States by Correa, Goldberg, and Rice (2015) analyzes differences between large banks that service only the domestic market and large banks that are globally active. In virtually all other countries, the large banks are also the internationally active ones. Correa et al. show that large banks without foreign affiliates have loan growth rates that differ cross-sectionally in line with reliance on core deposits for funding, their regulatory Tier 1 capital, and their outstanding credit commitments. By contrast, large U.S. global banks have loan growth rates that differ mainly in relation to their use of liquidity management within their broader organization and internationally. For example, the difference in lending growth of a bank in the 75th percentile of the Net Due To distribution (a ratio of Net Due To over Total Liabilities of 6.6 percent) to a bank in the 50th percentile (a ratio of 3.6 percent) when there is a 100 basis point increase in the LIBOR over OIS spread represent about 11 percent and 87 percent of the lending done by the median bank. Also, the characteristics of banks that matter are different when banks access official liquidity facilities, as the ex-ante reliance of global banks on internal liquidity management became less important in these periods.

Patterns of liquidity transmission through banks in the United Kingdom are influenced by the role of London as an international financial center. Hills et al. (2015) show that, following a rise in liquidity risk, the UK-resident banks that grew their balance sheets quicker relative to their peers pre-crisis, later decreased their foreign lending by more and increased their domestic lending by less relative to other banks. UK-owned banks cut back on external lending, while foreign-owned banks expanded domestic lending. Banks with a high share of funding through retail deposits cut back external lending to a lesser degree. These balance sheet characteristics are associated with economically relevant differences across banks.

Ireland is the host to many foreign banks, while Irish banks were among the European banks hit hardest by the financial crisis. The case study by Everett, Kelly, and McCann (2015) show that, when faced with an adverse liquidity shock, Irish banks with a funding base of

retail deposits were better able to stabilize their provision of credit to domestic borrowers. The redistribution of liquidity within an Irish banking group through its internal capital market mitigated the effects of a funding shock on domestic lending by Irish-owned banks but not their foreign lending. An Irish-owned bank at the 75th percentile of the Net Due To relative to Liabilities distribution supports domestic lending by €5.3 billion more than a Irish-owned bank at the median of this distribution, and it supports foreign lending by €4.2 billion less than a Irish-owned bank at the median of the distribution. The ability of larger Irish-owned banks to access official sector liquidity at below market costs provided a buffer against the adverse liquidity shock in the interbank market for their domestic lending.

With Hong Kong, another example of a market heavily dominated by foreign banks, the study by Wong, Tsang, and Kong (2015) compares the activities of the Hong Kong branches of these banks. In response to liquidity risk, parent banks that rely more on stable funding (i.e. deposits and capital) tend to sustain higher growth in loans and credit of their foreign branches in Hong Kong. Foreign branches in Hong Kong that are stronger net users (suppliers) of internal funds maintain (cut) their loans and credit more in response to liquidity shocks. The statistical significances of these drivers do not carry over when the parent banks access official lending facilities, a result consistent with the US finding for their global banks. Foreign branches in Hong Kong are more sensitive to US-dollar liquidity shocks than their home-country liquidity shocks.

Canadian banks provide another interesting case study in that there is a relatively concentrated banking system. As documented in Chapman and Damar (2015), while Canadian banks did not increase their exposure to foreign countries before the crisis, the big Canadian banks took advantage of their relatively healthy balance sheets to increase their market share and lending in several countries during the crisis period. Funds flowed via internal capital markets from subsidiaries to the home institution. Early in the crisis, when liquidity risk was high but banks did not access official sector liquidity, the big Canadian banks with a more mixed funding structure expanded as smaller domestic banks contracted.

Like Canadian banks, Australian banks did not build up foreign assets before the crisis and the banking system is quite concentrated, with four banks making up about 75 percent of the banking system. The country experienced significant inflows and outflows of bank assets during the crisis, and lending through banks declined to both domestic and foreign customers, (Guttmann and Rodgers 2015). No single balance sheet characteristic appeared as a robust

driver of cross-sectional differences in lending responses across banks in response to liquidity risk. No single bank received direct public intervention.

Across the rest of Europe, experiences differed for large euro area countries compared with the smaller ones. In Germany, the analysis focused on global banks, with differences in behavior observed between the larger and smaller banks, by their geographical focus, and in association with the use of government interventions (Kerl and Koch 2015). The study provides an interesting example of how bank business models influence their patterns of adjustment to stress. The smaller banks with higher core deposit ratios shielded *domestic* commercial and industrial (C&I) lending, reflecting their domestic business focus. By contrast, larger banks with higher illiquid asset ratios cut *foreign* C&I lending to a greater degree, but larger banks with higher credit commitments and core deposits do not withdraw more from the interbank market. When stress was high, the authors found that government interventions did not necessarily contain the real effects of liquidity shocks, and argue that the effects of scarce liquidity may have been exacerbated in some cases.

The findings for Germany contrast with those for France in which the commitment ratio and the core deposit ratio are key determinants of cross-sectional differences in bank lending during crisis times (Bussière, Camara, Castellani, Potier, Schmidt 2015). Foreign lending was affected to a larger degree than domestic lending due to the resilience of the domestic retail banking sector.

In Italy, banks had a weaker exposure to global banking markets at the onset of the crisis (Caccavaio, Carpinelli, Marinelli, and Sette 2015) and balance sheet characteristics were not very important for heterogeneous transmission of heightened liquidity risk. More significant effects were associated with sovereign risk spreads that were a country-specific shock on Italian banks funding conditions. In another example of the role of bank business models in outcomes, the Italian banks without foreign affiliates reduced lending by a greater degree than other banks when sovereign spreads widened. Among the banks with foreign affiliates, there is little evidence of heterogeneous transmission of shocks through the balance sheet characteristics.

The study for Austria supports that bank business models matter (Segalla 2015). Focusing only on the banks that are majority owned by Austrians and with assets over a certain size threshold, the cross-sectional variation of the response of smaller banks to liquidity risk is associated with balance sheet shares of core deposit funding and capital ratios.

For larger banks with foreign affiliates, no single balance sheet factor explains cross-sectional differences in lending patterns. For these banks with foreign affiliates, and which often have orientation toward Central and Eastern Europe, unused commitments mattered for the cross-sectional variation of cross-border lending, commitment ratios played a role during periods when banks accessed central bank liquidity. Those banks that received rescue packages and with higher unused commitments tended to cut lending to a greater degree.

Poland represents a market which is an important destination for foreign banks, and it provides an opportunity to contrast the responses of foreign-owned branches and subsidiaries with local banks. The business model of banks, and the ex-ante position of those foreign affiliates in each organization, matter for lending adjustment to liquidity risk within Poland (Pawłowska, Serwa, and Zajączkowski 2015). Banking affiliates with ex ante higher dependence on foreign (parent) funding lent relatively more when liquidity conditions worsened, and they continued to receive more funding than other banks during the period of global funding shocks. This result is in line with the hypothesis that intragroup links between banking institutions serve as a significant, and as shown in the study, stabilizing mechanism during the recent liquidity crises. While banks considerably reduced new mortgage lending in foreign currencies, the study attributes this change to forces other than liquidity risks.

Across these studies, we observe heterogeneity in which characteristics seem to matter for the lending effects of liquidity risk. However, there are three key messages. First, large and small banks differ in their response to liquidity shocks. For many countries, the large banks are the internationally active banks. Second, exposure to liquidity risk depends on the type of home market, in particular whether a country has been home or host to internationally active banks. Third, government support tends to weaken impact of bank-level characteristics. This could be a sign that government intervention mitigates frictions, but it could also be a sign of increased moral hazard in that balance sheet strength loses importance. It is important to note though that the type of government intervention matters. Fiscal support in the form of guarantees of banks' assets or capital injections may come with different conditionality and strings attached than access to central bank (emergency) liquidity facilities.

5 Meta-Analysis on the Patterns in Liquidity Risk Transmission

In this section, we provide a meta-analysis to characterize the full set of results from all of the main empirical specifications of the 11 studies. The focus is on the effects of liquidity risk through balance sheet channels on changes in total loans, domestic loans, foreign loans, cross-border loans, local claims, credit, and internal capital market positions.

5.1 Descriptive Statistics

The meta-analysis is performed using a total of 188 regression specifications. The coverage of these specifications is presented in Table 1, which details the number of countries providing regression specifications for each dependent variable. For example, 9 of the 11 countries have regression specifications for total loans, with 39 specifications spanning domestic-owned banks only (16 regressions), foreign-owned banks only (9 regressions), and a mixed sample of both types (14 regressions). A total of 9 countries have the data available to examine internal capital market flows between the head office and its foreign affiliates, with most of the 23 specifications for domestic-owned banks only (12) or foreign-owned banks only (9). The least populated type of specification is local claims (11 regressions), which are claims extended by the overseas branches or subsidiaries of either domestically-owned banks only (8) or a mix of domestic and foreign-owned banks (3). All specifications included contain bank and time fixed effects.

Table 2 provides the summary of statistical significance of balance sheet interactions with LIBOR-OIS terms. Most country studies have included in their specifications a basic vector of bank- and time-varying balance sheet characteristics. Shown in the leftmost column of the table are balance sheet characteristics describing the assets and liabilities of banks and thus their balance sheet strength. Each of the dependent variables in the regressions is introduced as a separate column, with the cells of the table depicting the number of estimated regression coefficients β^1 on the balance sheet characteristics that are statistically significant at a 10 percent level and positive in sign (in subcolumn a) or negative in sign (in subcolumn b), out of the total number of estimated coefficients (in subcolumn c) for this type of interaction and dependent variable. The statistical significance indicates whether the cross-bank variation in response of lending to a liquidity shock is significantly attributable to a particular balance sheet characteristic.

The upper panel of Table 2 considers these regression coefficients β^1 in periods when individual banks are *not* accessing public sector liquidity or receiving capital support. It is useful to recall the economic meaning behind these regressions. In the presence of elevated liquidity risks, loan growth is expected to be supported to a greater degree in those banks that have: higher ex ante deposit shares, as these banks are assumed to have a more stable funding base; more unused credit commitments, as customers might tap these lines when broader credit availability retracts, thereby reducing the ability of the bank to constrict loan supply; higher Tier1 capital, as the capital can be used to absorb adverse balance sheet shocks; and fewer illiquid assets, as these banks have more flexibility in adjusting the composition of the asset side of the balance sheets before restricting loan supply (Cornett et al. 2011). Loan growth is also supported to a greater degree for those banks that have access to external affiliates that serve as funding sources for the global bank (Cetorelli and Goldberg 2012c). Across banks, smaller banks are expected to have greater sensitivity to liquidity risk changes, all else equal, as they have weaker access to external capital markets, as are domestic banks compared to global ones (Cetorelli and Goldberg 2012a). Some forms of lending may be prioritized over others, as banks position their responses in accordance with their business models, protecting core activities.

The upper panel of Table 2 is related to our HYPOTHESIS 1 as it shows which balance sheet characteristics drive banks' adjustment to liquidity shocks. It shows that β^1 estimates for loan commitment ratios and deposit ratios are the most common drivers of significant cross-sectional variation in total loan growth when liquidity conditions change in a country. While these are generally of the expected positive sign, sometimes estimated β^1 are significant in an unexpected direction. Illiquid asset ratios and Tier1 capital less frequently enter as significant drivers, with a higher proportion of these estimates of an unexpected direction. Internal capital market activity appears to matter significantly in more than a quarter of the specifications in which these terms appear, with more evenly split directional effects. Given the large heterogeneity in the sample with regard to the banks, countries, and lending items considered, there is obviously not one single explanation for these unexpected effects. Rather, we leave it to the country studies to explore and explain the effects of bank-level covariates.

The lower panel of Table 2 is related to our HYPOTHESIS 2 as it details the total statistical significance of balance sheet characteristics in periods when official sector support

is available, as captured by the $\beta^1 + \alpha^1$ of equation (1).[10] One noteworthy finding is that the balance sheet characteristics that support loan growth in more normal times are much *less* likely to be significant in periods when the banks official facilities are available. The availability of facilities weakens the role of balance sheet condition in distinctions among firms in loan growth during stress periods, which is in line with our priors. Indeed, not only do balance sheet characteristics lose significance during these periods, the estimated coefficients often appear to be of opposite sign compared to those observed in normal periods.

5.2 Meta-Analysis Regression Results

Going beyond the descriptive statistics reported so far, meta-analysis allow analyzing the regression results more systemically and accounting for differences across countries and regression specifications. We follow many previous applications such as in labor economics (Boockmann 2010, Card and Krueger 1995, Doucouliagos and Stanley 2009). Using the full universe of regressions estimated for the country studies (as detailed in Table 1), the meta-analysis first characterizes which regression features are more likely to deliver statistically significant loan supply effects through particular balance sheet channels. The meta-analysis then focuses exclusively on the significant effects and assesses which regression characteristics and balance sheet channels are more likely to have sign patterns as predicted by theoretical arguments. Table 3 focuses on a test of Hypothesis 1 and thus the β^1 estimates and Table 4 focuses on the α^1 estimates and thus tests Hypothesis 2.

The first set of specifications of the meta analysis explores the likelihood of significance of balance sheet characteristics in liquidity risk transmission into bank lending in its different forms (Table 3a). These are Probit regressions with errors clustered at the specification level such as, for instance, local claims of domestic banks. The dependent variable takes the value of 1 if a particular balance sheet characteristic interacted with a LIBOR-OIS spread is statistically significant in a particular regression specification.

The explanatory variables capture the following specifications of the initial underlying regressions:

[10] The type of official facility used by banks differs across the respective countries. For example, distressed banks in Germany benefited from guarantees and capital injections (Kerl and Koch 2015), while banks in the United States drew on the discount window and the term auction facility (Correa et al. 2015). Appendix Table 1 provides an overview of the *Facility* variable used in each country study.

- Bank size: Initial regressions may have included small banks or large banks only (indicated by a 0-1 variable). The floor for the definition of a large bank in a country is included as a specification characteristic for our meta-analysis (large bank cutoff, in units of $100 billion USD).
- Bank ownership: The specification may cover foreign-owned banks only, or have been inclusive of both domestic- and foreign-owned banks, or comprised of a subset of banks described as global banks. In the meta-analysis, "global bank" equals 1 if the banks included in the initial specification contain a global component, such as having foreign branches or subsidiaries, or having a foreign parent. The omitted category is domestically-owned only banks that do not have foreign branches or subsidiaries.
- Type of loan: The regression dependent variable from the country specifications are domestic loans, foreign loans, total loans, cross-border loans, local claims, credit, or Net Due To of the head office. The omitted category is domestic lending.
- Balance sheet characteristics: The balance sheet characteristic of the regression specifications include deposit funding share, or alternatively the illiquid asset ratio, commitment ratio, Tier1 capital ratio, or net due to of the head office.

"Ln Banks" indicates the log number of banks in a country's specification. Finally, initial specifications differ according to whether the interactions of balance sheet variables are run using country-specific LIBOR-OIS spreads, or the USD spread.

The meta-analysis presented in Table 3a examines which of these country regression characteristics contribute to the probability of statistical significance of particular balance sheet characteristics interacted with the LIBOR-OIS spread, all compared to a benchmark for significance. In all of the meta-analysis, the benchmark used is the significance of the omitted variable within the category considered for effects on statistical significance. The results show whether the probability of significance of the coefficients differs for other categories of lending relative to what is observed for domestic lending.

The table has a waterfall structure, showing the contribution of respective groups of characteristics to probability of significance of coefficients (columns 1-6). The results in Table 3b consider what country regression characteristics contributed to the probability of observing the expected sign on a balance sheet characteristic, conditional on that coefficient appearing significant (as summarized in Table 2).

One key result of our analysis is that international banks and international activities differ from domestic ones. Compared with domestic banks or a mix of domestic and foreign banks, global banks are less likely to have balance sheet characteristics that drive the cross-sectional variation in observed response to liquidity risk (Table 3a). Moreover, across all bank types, foreign lending is significantly less likely to respond to bank balance sheet characteristics systematically across banks when liquidity risks change. Distinguishing national from global liquidity shocks is not that crucial, in contrast, as regressions including domestic LIBOR-OIS spreads do not generate very different results from regressions using USD spreads.

In terms of balance sheet characteristics that matter, deposit shares are the most consistently observed drivers of banks' response to liquidity risk. When statistically significant, the sign on the interaction term between deposits and liquidity risk tends to be positive, i.e. banks with a stronger deposit base contract lending by less. This is in line with priors that access to deposits makes banks more resilient to (market) liquidity shocks. Bank capital, in contrast, does not seem to be an important insurance mechanisms against liquidity shocks as Tier 1 capital ratios are significantly less likely to be statistically important than deposit share as drivers of cross-sectional responses to liquidity risk.

When country regression coefficients on balance sheet items are significant, these are significantly more likely to be of the expected sign for the samples that exclusively are comprised of large or global banks (Table 3b). Compared with domestic loans as a dependent variable, foreign loans, credit and internal capital market flows are significantly less likely to appear with the expected sign. The gap between domestic and foreign loans response is particularly interesting, as it may be that domestic lending activity is supported at the expense of lending to foreign residents.

The internal capital market effect also is interesting, as the use of internal capital markets and the global banking model, as opposed purely to the direction of this use, may be the relevant consideration for supporting domestic lending in times of elevated liquidity risk. Additionally, compared with the estimated coefficient on the deposit share, statistical significance in the expected direction is less likely for the illiquid asset ratio and for Tier 1 capital.

The presentation of Probit results within Table 4 is similarly structured to Table 3, but the focus is instead on α^1, the marginal change in balance sheet characteristics in liquidity risk transmission into lending in the periods when banks access official sector liquidity or capital support. The only incremental variable in Table 4 specifications is an indicator variable capturing whether each regression specification had the balance sheet interaction with LIBOR-OIS (β^1) significant and of the expected sign during periods when the bank was not accessing official sector support.

The probability of a balance sheet characteristic being significant in times of official facilities being available is much higher if that balance sheet characteristic was statistically important for lending in normal times (Table 4a). The pattern of significance of α^1 is weaker for cross-border lending relative to the benchmark of domestic lending.

In terms of direction of the effect, we expect that those balance sheet characteristics that are important in explaining cross-sectional differences in loan growth across banks in "normal" times will be less important during times when official sector support is being utilized. This would be manifested as a coefficient on the marginal interaction (balance sheet item with LIBOR-OIS spread and with Facility) being opposite in sign to what was expected for Table 3b. The most important predictors of differences with the baseline are whether the normal period estimate was significant and of the expected sign, which raises the likelihood of the expected sign on the facility interaction (Table 4b). The likelihood of the expected sign on the facility interaction is also more likely for local claims, compared with the benchmark of domestic lending.

6 Conclusions

The papers included in this symposium issue contain the results of an international collaborative research effort conducted by the International Banking Research Network. The papers analyze how globally active banks respond to liquidity shocks. Given the large degree of heterogeneity of case studies, the papers generate lessons based on bank- and country-specific experiences. The standards used for generating identification of balance sheet channels that contribute to liquidity risk transmission are quite challenging. The studies explain *changes* in bank lending to exposure to liquidity risk during more normal times as well as in the financial crisis and in very different policy environments. Even with these high

bars for identifying effects, across country experiences we observe interesting patterns in the heterogeneity in bank lending response to liquidity risk that inform the four main questions initially posed.

First, how do liquidity conditions affecting parent banks transmit into domestic and foreign lending? Liquidity conditions affecting parent banks transmit into both the domestic and foreign lending of these banks. Large and small banks differ in their response to liquidity shocks. For many countries, the large banks are the internationally active banks. But exposure to liquidity risk depends on the type of home market, in particular whether a country has been home or host to internationally active banks.

Second, how does the ex-ante balance sheet composition of banks and thus banks' business model influence their responses to liquidity risk? The ex-ante balance sheet composition of banks and thus banks' business model does influence their responses to liquidity risk. However, there is no single balance sheet characteristic that consistently plays a role across all country experiences. Deposit shares can play a role, particularly for smaller and domestically oriented banks.

Third, what role does internal liquidity management within multinational banks play in magnifying or damping lending effects of liquidity risk? Internationally active banks have access to and have used internal capital markets as an additional channel of adjustment to liquidity risk, both during normal times and during the crisis. Banks increased net borrowing from affiliates as liquidity risk rose in order to support domestic and cross-border lending.

Fourth, did the availability of official sector liquidity provision influence the response of banks to liquidity shocks? The availability of official sector liquidity tended to reduce the adverse consequences for lending during stress periods and weaken the impact of balance sheet constraints. Caution is warranted in interpreting these findings. On the one hand, government intervention might mitigate frictions. But, on the other hand, interventions could also be a sign of increased moral hazard in that balance sheet strength loses importance. The type of interventions differs across countries, and these differences may affect the response. Fiscal support in the form of guarantees of banks' assets or capital injections, for example, may come with different conditionality and strings attached than access to central bank (emergency) liquidity facilities.

The large degree of heterogeneity across banks and across countries which the studies in this volume have revealed may suggest that there is no one-size-fits-all approach to regulation that aims at mitigating banks' exposure to liquidity risk. The high degree of heterogeneity may, at the same time, reflect differences in bank business models and thus contribute to an enhanced resilience of the system. Hence, regulators must account for general rules and standards that apply to all internationally active banks while retaining national responsibility for the stability of national financial systems through regulations that go beyond international standards.

Overall, the formation of the IBRN and the studies of this volume represent the first systemic cross-country work using individual bank micro-data and a common methodology across countries. This work provides an example of the benefits of international collaboration and communication between researchers in academia and central banks. Such collaboration helps support the common goals of macroeconomic and financial stability. These efforts also provide lessons that inform appropriate regulatory responses to liquidity risks and other shocks by providing comparable cross country evidence.

One big advantage of the IBRN network is the ability to access similar and very detailed datasets across countries, even when the underlying data cannot be shared by the researchers. At the same time, such analysis is constrained by gaps in the collection and availability of data within and across countries, both with regards to data on banks and on policy interventions. The successful and ongoing cross-country research efforts in this volume highlight the benefits of continuing efforts to collaborate across countries and to improve the availability, coverage, and granularity of micro-banking data for academic research and policy analysis.

7 References

Acharya, V., Afonso, G., Kovner, A. 2013. How do Global Banks Scramble for Liquidity? Evidence from the Asset-Backed Commercial Paper Freeze of 2007. Stern NYU Working Paper. New York.

Aiyar, S. 2011. How did the crisis in international funding markets affect bank lending? Balance sheet evidence from the UK. Bank of England Working Paper 424. London.

Aiyar, S., Calomiris, C., Hooley, J., Korniyenko, Y., Wieladek, T. The international transmission of capital requirements: Evidence from the UK. *Journal of Financial Economics*, forthcoming.

Aiyar, S., Calomiris, C., Wieladek, T. 2012. Does Macro-Pru Leak? Evidence from a UK Policy experiment. NBER Working Papers, No. 17822.

Aiyar, S., Calomiris, C., Wieladek, T. 2013. Identifying Channels of Credit Substitution: When Bank Capital Requirements Are Varied. Economic Policy, forthcoming.

Allen, F., Gale, D. 2000. Financial Contagion. *Journal of Political Economy* 108(1): 1-33.

Allen, F., Hryckiewicz, A., Kowalewski, O., Tümer-Alkan, G. 2011. Transmission of Bank Liquidity Shocks in Loan and Deposit Markets: The Role of Interbank Borrowing and Market Monitoring. Wharton Financial Institutions Center Working Paper. Pennsylvania.

Armantier, O., Ghysels, E., Sarkar, A., Shrader, J. 2011. Stigma in Financial Markets: Evidence from Liquidity Auctions and Discount Window Borrowing during the Crisis. Federal Reserve Bank of New York Staff Reports 483. New York.

Boockmann, B. 2010. The Combined Employment Effects of Minimum Wages and Labor Market Regulation: A Meta-Analysis. *Applied Economics Quarterly* 56: 156-188.

Bridges, J., Gregory, D., Nielsen, M., Pezzini, S., Radia, A., Spaltro, M. 2013. The Impact of Capital Requirements on Bank Lending. Bank of England Working Paper, forthcoming.

Brüggemann, B., Kleinert, J., Prieto, E. 2012. A Gravity Equation for Bank Loans. Universities of Graz and Tuebingen. Mimeo.

Buch, C.M., Koch, C.T., Koetter, M. 2011. Size, Productivity, and International Banking. *Journal of International Economics* 85(2): 329-334.

Buch, C.M., DeLong, G.L. 2012. Banking Globalization: International Consolidation and Mergers in Banking. *The Oxford Handbook of Banking*.

Card, D., Krueger, A. 1995. Time-Series Minimum-Wage Studies: A Meta-Analysis. *American Economic Review* 85(2): 238-43.

Cetorelli, N., Goldberg, L. 2011. Global Banks and International Shock Transmission: Evidence from the Crisis. *IMF Economic Review* 59(1): 41-76.

Cetorelli, N., Goldberg, L. 2012a. Banking Globalization and Monetary Transmission. *Journal of Finance* 67(5): 1811-1843.

Cetorelli, N., Goldberg, L. 2012b. Follow the Money: Quantifying Domestic Effects of Foreign Bank Shocks in the Great Recession. *American Economic Review* 102(3): 213-18.

Cetorelli, N., Goldberg, L. 2012c. Liquidity management of U.S. Global Banks: Internal Capital Markets in the Great Recession. *Journal of International Economics* 88(2): 299-311.

Claessens, S., van Horen, N. 2014. Foreign Banks: Trends and Impact. *Journal of Money, Credit and Banking* 46(1): 295-326.

Committee on the Global Financial System. 2011. Global liquidity – concept, measurement and policy implications. CGFS Papers 45. Report submitted by an Ad-hoc Group established by the Committee on the Global Financial System. November. Basel.

Communiqué of the G20 Finance Ministers and Central Bank Governors, Paris, October 15, 2011.

Cornett, M., McNutt, J., Strahan, P, Tehranian, H. 2011. Liquidity Risk Management and Credit Supply in the Financial Crisis. *Journal of Financial Economics* 101(2): 297-312.

Correa, Ricardo, Horacio Sapriza, and Andrei Zlate (2012). "Liquidity Shocks, Dollar Funding Costs, and the Bank Lending Channel during the European Sovereign Crisis," International Finance Discussion Papers 1059. Board of Governors of the Federal Reserve System (U.S.).

de Blas, B., Russ, K. 2013. All Banks Great, Small, and Global: Loan Pricing and Foreign Competition. *International Review of Economics & Finance* 26(C): 4-24.

De Haas, R., Van Horen, N. 2012. International Shock Transmission after the Lehman Brothers Collapse: Evidence from Syndicated Lending. *American Economic Review: Papers & Proceedings*, 102(3): 231-237.

De Haas, R., Van Horen, N. 2013. Running for the Exit? International Bank Lending During a Financial Crisis. *Review of Financial Studies* 26: 244-285.

De Haas, R., Korniyenko, Y., Loukoianova, E., Pivovarsky A. 2012. Foreign banks and the Vienna initiative: Turning sinners into saints. EBRD Working Paper 143. London.

De Haas, R., Van Lelyveld, I. 2014. Multinational Banks and the Global Financial Crisis: Weathering the Perfect Storm? *Journal of Money, Credit and Banking* 46(1): 333-364.

Dietrich, D., Vollmer, U. 2010. International Banking and Liquidity Allocation. *Financial Services Research* 37: 45-69.

Doucouliagos, H., Stanley, T.D. 2009. Publication Selection Bias in Minimum-Wage Research? A Meta-Regression Analysis. *British Journal of Industrial Relations* 47(2): 406-428.

Drehmann, M., Nikolaou, K. 2013. Funding Liquidity Risk: Definition and Measurement. *Journal of Banking & Finance* 37(7): 2173-2182.

Gilchrist, S., Zakrajsek, E. 1995. The Importance of Credit for Macroeconomic Activity: Identification through Heterogeneity. In: *Is Bank Lending Important for Transmission of Monetary Policy? Federal Reserve Bank of Boston*, 39: 129-173.

Goldberg, L. 2007. Financial Sector FDI and Host Countries: New and Old Lessons. Federal Reserve Bank of New York *Economic Policy Review*: 1-17.

He, D., McCauley, R.N. 2013. Transmitting Global Liquidity to East Asia: Policy Rates, Bond Yields, Currencies and Dollar Credit. BIS Working Paper 431. Basel.

Hoggarth, G., Hooley, J., Korniyenko, Y. 2013. Which way do foreign branches sway? Evidence from the recent UK domestic credit cycle. Bank of England Financial Stability Paper 22. London.

Ivashina, V., Scharfstein, D. 2010. Bank Lending During the Financial Crisis of 2008. *Journal of Financial Economics*, 97(3): 319-338.

Jeon, B. N., Olivero, M. P., Wu, J. 2013. Multinational banking and the international transmission of financial shocks: Evidence from foreign bank subsidiaries. *Journal of Banking and Finance* 37: 952-972.

Karam, P., Merrouche, O., Souissi, M.,Turk, R. 2014. The Transmission of Liquidity Shocks: The Role of Internal Capital Markets and Bank Funding Strategies. IMF working paper WP/14/207. International Monetary Fund. Washington.

Kashyap, A.K., Stein, J.C. 2000. What Do a Million Observations on Banks Say about the Transmission of Monetary Policy? *American Economic Review*, 90(3): 407-428.

Khwaja, A., Mian, A. 2008. Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market. *American Economic Review* 98(4): 1413-42.

Navaretti, G., Calzolari, G., Pozzolo, A., Levi, M. 2009. Multinational banking in Europe: financial stability and regulatory implications – lessons from the financial crisis. Economic Policy 25, 703-753. National Bank of Poland. Financial Stability Report. Warsaw.

Niepmann, F. 2013. Banking across Borders. Federal Reserve Bank of New York Staff Reports 609. New York.

Okawa, Y., van Wincoop, E. 2012. Gravity in International Finance. *Journal of International Economics* 87 205-215.

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

Peek, J., Rosengren, E. 2000. Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States. *The American Economic Review* 90(1): 30-45.

Popov, A., Udell, G. F. 2012. Cross-border banking, credit access, and the financial crisis. *Journal of International Economics* 87: 147–161.

Rose, A.K., Wieladek, T. 2013. Financial Protectionism? First tests. *Journal of Finance*, forthcoming.

Individual paper contributions in the International Banking Research Network

Bussière, Matthieu, Boubacar Camara, Francois-Daniel Castellani,Vincent Potier, and Julia Schmidt. 2015. "Shock Transmission through International Banks – Evidence from France." Banque de France.

Caccavaio, Marianna, Luisa Carpinelli, Giuseppe Marinelli, and Enrico Sette. 2015. "Shock Transmission through International Banks: the Italian Case." Banco d'Italia.

Chapman, James and H. Evren Damar. 2015. "Shock Transmission through International Banks: Canada." Bank of Canada.

Correa, Ricardo, Linda Goldberg, and Tara Rice. 2015. "International Banking and Liquidity Risk Transmission: Lessons from the United States." Manuscript Federal Reserve Bank of New York and Board of Governors of the Federal Reserve System.

Everett, Mary, Jane Kelly and Fergal McCann. 2015. "International Banking and Liquidity Risk Transmission: Lessons from Ireland." Central Bank of Ireland.

Guttmann, Rochelle and David Rodgers. 2015. "International Banking and Liquidity Risk Transmission: Lessons from Australia." Reserve Bank of Australia.

Hills, Robert, John Hooley, Yevgeniya Korniyenko, and Tomasz Wieladek. 2015. "International Banking and Liquidity Risk Transmission: Lessons from the United Kingdom." Bank of England.

Kerl, Cornelia and Catherine Koch. 2015 "International Banking and Liquidity Risk Transmission: Lessons from Germany." Deutsche Bundesbank.

Pawłowska, Małgorzata, Dobromił Serwa, and Sławomir Zajączkowski. 2015. "International Banking and Liquidity Risk Transmission: Lessons from Poland." Central Bank of Poland.

Segalla, Esther. 2015. "Shock Transmission through International Banks: Austria." Oesterreichische Nationalbank.

Wong, Eric, Andrew Tsang, and Steven Kong. 2015. "International Banking and Liquidity Risk Transmission: Lessons from Foreign Bank Branches in Hong Kong" Hong Kong Monetary Authority.

Table 1: Counts of Regressions Included in the Meta-Analysis

This Table summarizes the number of countries reporting regression specification (spec.) results for each combination of dependent variable (rows) and bank sample characteristics (columns), followed by the number of regressions reported in total by all countries. Countries included are Australia, Austria, Canada, France, Germany, Hong Kong, Ireland, Italy, Poland, the United Kingdom, and the United States.

Regression Sample / Dependent Variable	Total number		Domestic-owned banks only		Foreign-owned banks only		Foreign- and domestic-owned banks	
	# Countries	# Spec.	# Countries	# Spec.	# Countries	# Spec.	# Countries	# Spec.
Δ Loans/Assets	9	39	6	16	4	9	4	14
Δ Domestic Loans/Assets	10	39	7	19	4	8	5	12
Δ Foreign Loans/Assets	8	27	5	14	2	5	3	8
Δ Cross-border Loans/Assets	8	24	6	12	3	4	5	8
Δ Local Claims/Assets	6	11	4	8		0	2	3
Δ Credit/(Assets+Commitments)	8	25	5	12	3	7	3	6
Δ Net Due To (of Head Office)/Assets	9	23	6	12	4	9	2	2

Table 2: Impact of Liquidity Risk in Periods With and Without Official Support

This Table shows the significance of the interaction terms with LIBOR-OIS. It gives the number of specifications with positive significant coefficients and negative significant coefficients, both at the 10%-level, and the number of total specifications. The following countries have specifications with Net Due To (LHS) (with Bank FEs): Australia, Austria, Canada, France, Germany, Hong Kong, Ireland, Poland, US. The following countries have information on official support: Austria, Canada, France, Germany, Hong Kong, Ireland, Italy, Poland, UK, US. The upper panel shows the effect without official support and the lower panel shows the effect with official support. The rows denote the right-hand side interaction term associated with each estimated coefficient. The columns denote the dependent variable.

Independent Variable / Libor Interaction Terms	Δ Loans/Assets			Δ Domestic Loans/Assets			Δ Foreign Loans/Assets			Δ Cross-border Loans/Assets			Δ Local Claims/Assets			Δ Credit/ (Assets+ Commitments)			Δ Net Due To (of Head Office)/Assets		
a = positive significant at the 10%-level, b = negative significant at the 10% level, c = total specifications																					
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Effect without official support																					
Illiquid Asset Ratio	5	2	39	5	2	39	4	2	27	3	4	21	0	1	11	3	1	25	1	0	23
Commitment Ratio	9	2	27	5	1	27	2	1	23	3	0	14	2	0	7	5	4	25	1	1	17
Log Assets	3	4	36	7	3	34	3	3	27	6	4	22	0	2	9	1	4	24	1	3	21
Deposit Ratio	11	0	39	11	3	38	4	3	27	2	0	22	2	0	10	5	2	25	1	0	23
Tier 1 Ratio	1	1	34	7	2	34	1	2	27	1	4	19	0	0	11	2	1	25	3	0	21
Net Due To of Head Office / Liabilities	4	3	17	3	2	19	1	2	15	2	1	14	0	0	9	1	3	15	5	1	21
Effect with official support																					
Illiquid Asset Ratio	0	2	25	1	4	26	2	3	25	0	0	13	2	0	9	3	8	22	4	2	19
Commitment Ratio	4	1	21	1	8	22	0	4	21	2	1	11	0	3	7	2	3	22	0	1	17
Log Assets	1	2	25	3	6	26	2	1	25	1	1	13	0	2	9	2	0	22	1	8	19
Deposit Ratio	2	2	25	5	3	26	0	0	25	0	0	13	1	5	9	2	1	22	4	1	19
Tier 1 Ratio	1	0	25	2	1	26	1	1	25	1	0	13	2	1	9	2	0	22	2	2	19
Net Due To of Head Office / Liabilities	3	3	12	0	5	15	2	3	15	0	1	10	0	2	7	0	3	15	7	5	17

Table 3: Statistical Significance of Balance Sheet Characteristic in Liquidity Risk Transmission in Periods without Bank Use of Official Support

This table provides probit specifications with errors clustered at the regression specification level. The dependent variable equals 1 if the coefficient on the interaction between balance sheet characteristic and LIBOR-OIS is statistically significant. The benchmark for each specification is the omitted category. Results indicate differential probability of significance from the benchmark in accordance with the indicated specification characteristic. In Table 3a, the beta coefficients assessed are during periods without official facility support available. In Table 3b, the meta-analysis assesses the probability that statistically significant estimated coefficients are of the expected sign. To save space, t-values are not shown. ***, **, * = significant at the 1%, 5%, 10%-level.

(a) Coefficients during periods without bank use of official facilities

	(1)	(2)	(3)	(4)	(5)	(6)
Ln Banks	0.10**					
Large Banks		0.09				
Large Bank Cutoff:$ 100bil		-0.24*				
Global Bank			-0.66***			
Foreign-owned Bank			0.30**			
DepVar total loans				-0.05		
DepVar foreign loans				-0.26		
DepVar cross-border loans				-0.12		
DepVar local claims				-0.62*		
DepVar credit				-0.08		
DepVar net due				-0.52**		
Illiquid Assets Ratio					-0.21	
Commitment Ratio					0.06	
Tier 1 Capital					-0.34**	
Net Due To					0.05	
US Dollar LIBOR-OIS						-0.05
Constant	-1.12***	-0.79***	-0.27*	-0.64***	-0.71***	-0.79***
Observations	790	790	790	790	790	790
Pseudo R^2	0.01	0.01	0.02	0.02	0.01	0.00

(b) Meta-analysis for the expected sign of the coefficient

	(1)	(2)	(3)	(4)	(5)	(6)
Ln Banks	0.01					
Large Banks		0.33*				
Large Bank Cutoff:$ 100bil		0.07				
Global Bank			0.79***			
Foreign-owned Bank			-0.22			
DepVar total loans				-0.02		
DepVar foreign loans				-0.69**		
DepVar cross-border loans				-0.32		
DepVar credit				-0.53**		
DepVar net due				-1.31***		
Illiquid Assets Ratio					-1.09***	
Commitment Ratio					-0.15	
Tier 1 Capital					-0.88***	
Net Due To					-1.01***	
US Dollar LIBOR-OIS						-0.03
Constant	0.21	0.10	-0.39	0.58***	0.83***	0.25**
Observations	166	166	166	166	166	166
Pseudo R^2	0.00	0.01	0.03	0.07	0.10	0.00

Table 4: Statistical Significance of Marginal Changes in the Balance Sheet Characteristics for Liquidity Risk Transmission in Periods with Bank Use of Official Support

This table provides probit specifications with errors clustered at the specification level. The dependent variable equals 1 if the coefficient on interaction between balance sheet characteristic, LIBOR-OIS, and official facility is statistically significant. The benchmark for each specification is the omitted category. Results indicate differential probability of significance from the benchmark in accordance with the indicated specification characteristic. The beta coefficients assessed for significance are during periods with official facility support for individual banks. In Table 4b, the meta-analysis assesses the probability that statistically significant estimated coefficients are of the expected sign. To save space, t-values are not shown. ***, **, * = significant at the 1%, 5%, 10%-level.

(a) Coefficients for marginal effects during periods with bank use of official facilities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln Banks	0.12*						
Large Banks		0.11					
Large Bank Cutoff:$ 100bil		0.24					
Foreign-owned Bank			-0.14				
DepVar total loans				-0.33			
DepVar foreign loans				-0.39*			
DepVar cross-border loans				-1.26***			
DepVar local claims				0.18			
DepVar credit				0.01			
DepVar net due				-0.50*			
Illiquid Assets Ratio					0.08		
Commitment Ratio					0.42***		
Tier 1 Capital					-0.31**		
Net Due To					0.15		
US Dollar LIBOR-OIS						-0.22	
Significant & Expected LIBOR-OIS Interaction							0.79***
Constant	-1.19***	-0.94***	-0.78***	-0.56***	-0.88***	-0.74***	-0.92***
Observations	626	626	626	626	626	626	626
Pseudo R^2	0.01	0.01	0.00	0.05	0.03	0.00	0.04

(b) Meta-analysis for the Expected Sign of the Coefficient

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln Banks	-0.18						
Large Banks		0.57***					
Large Bank Cutoff:$ 100bil		0.08					
Foreign-owned Bank			-0.50**				
DepVar total loans				-0.05			
DepVar foreign loans				0.16			
DepVar local claims				0.89**			
DepVar credit				-0.26			
DepVar net due				-0.08			
Illiquid Assets Ratio					-0.51		
Commitment Ratio					0.28		
Tier 1 Capital					-0.61		
Net Due To					0.14		
US Dollar LIBOR-OIS						0.41*	
Significant & Expected LIBOR-OIS Interaction							1.41***
Constant	0.78*	-0.11	0.30**	0.18	0.29	0.10	-0.08
Observations	131	131	131	131	131	131	131
Pseudo R^2	0.01	0.04	0.02	0.04	0.06	0.01	0.13

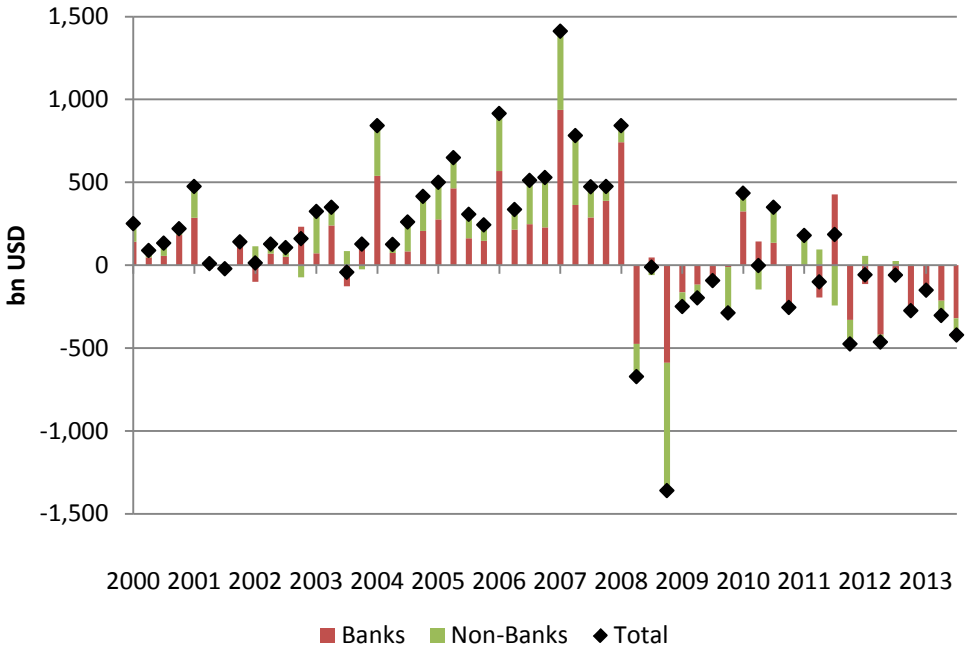
Appendix Table 1. Description of Liquidity and Capital Facilities

	Description of "Facility" in each study, by country	Liqui-dity support	Capital support	Bank-time specific
Australia	No facility used.	no	no	no
Austria	The Austrian government allowed for a total banking package consisting of several rescue measures in November 2008. An independent clearing house, supported through state liabilities, was incorporated in the second quarter of 2009 until the first quarter of 2011. The clearing bank AG acted like an auction platform to help liquidity enhancing transactions between banks. Furthermore the program allowed banks access to state liabilities and recapitalization depending on its size of the balance sheet and solvability. The last measure was a core deposit insurance that guaranteed up to 100,000 Euros for private households until 2009, afterwards without volume limits. Banks without foreign affiliates never received direct support from the banking package.	yes	yes	yes
Canada	Term Purchase and Resale Agreement (Term PRA) facility. Designed to provide short-term (not overnight) collateralized funds via repo auctions, in order to relieve pressure short-term bank funding markets in Canada. The main participants in these auctions were the "primary dealers" (which includes all major Canadian banks). The facility ran from 2007Q4 to 2010Q3.	yes	no	
France	French banks made use of the refinancing operations provided by the ECB. We define a dummy indicator which equals one whenever a bank's liabilities vis-à-vis the central bank is larger than a certain percentage of its core deposits. We chose as a threshold the ECB's minimum reserve requirements which are 2% of core deposits until 2011 and 1% from 2012 onward.	yes	no	yes
Germany	Government support during the financial crisis mostly in the form of guarantees and capital injections. We study the effect of these rescue measures instead of the commonly suggested access to official sector liquidity provision, as these support measures were the critical ones for German banks.	yes	yes	yes
US (Hong Kong)	Facility use for a bank (at the group level) is captured by whether it has a positive balance in Federal Reserve's Discount Window and Term Auction Facility within a particular quarter.	yes	no	yes
Ireland	Bank-level data on amount of official central bank liquidity. Official liquidity includes borrowings from the European Central Bank (ECB), the Central Bank of Ireland or the other national central banks (NCBs) of the monetary union area and from other official monetary authorities. Official liquidity comprises borrowing via the ECB's marginal lending facility, sale and repurchase agreements, other secured advances and any other remaining funds. The measure therefore combines standard and unconventional Eurosystem monetary policy operations including Exceptional Liquidity Assistance.	yes	no	yes
Italy	Dummy variable equal to one if the bank takes refinancing from the central bank, and equal to zero otherwise	yes	no	yes
Poland	The liquidity funding in the form of repo transactions was provided to banks by the National Bank of Poland. The binary variable F_(i,t) takes on value 1 for those banks whose liabilities from the National Bank of Poland were unusually high (more than 2% of bank's total liabilities) at time t and it equals zero otherwise.	yes	no	yes

	Description of "Facility" in each study, by country	Liqui-dity support	Capital support	Bank-time specific
United Kingdom	The liquidity dummy variable takes the value of 1 if a bank participated in a liquidity insurance scheme, such as the one implemented by HM Treasury in late 2008. Importantly, it does not contain information on individual banks' access to either the Special Liquidity Scheme (SLS) or Emergency Liquidity Assistance (ELA) at the Bank of England, since this information was confidential at the time of the construction of the dummy variable.	yes	yes	yes
United States	Discount Window Facility and Term Auction Facility (TAF): Facilities established by the Federal Reserve to provide funds to depository institutions. The TAF was established during the financial crisis to provide credit to depository institutions through an auction mechanism. All lending through these facilities must be fully collateralized with an appropriate haircut applied to the collateral.	yes	no	yes

Figure 1: Changes in Cross-Border Claims of BIS Reporting Banks (2000-2013)

This graph shows the changes in cross-border claims on banks and non-banks during the period from the first quarter of 2000 through the third quarter of 2013. The sample covers the IBRN Australia, Austria, Canada, France, Germany, Ireland, Italy, the United Kingdom, and the United States. The data are taken from the BIS locational banking statistics.



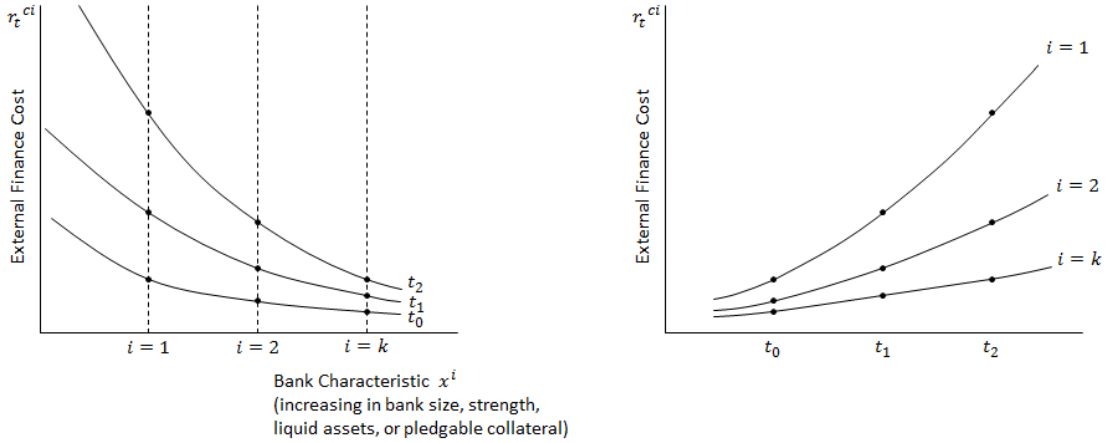
Source: BIS Locational Banking Statistics

Figure 2: Liquidity Risk Pricing and Bank Characteristics

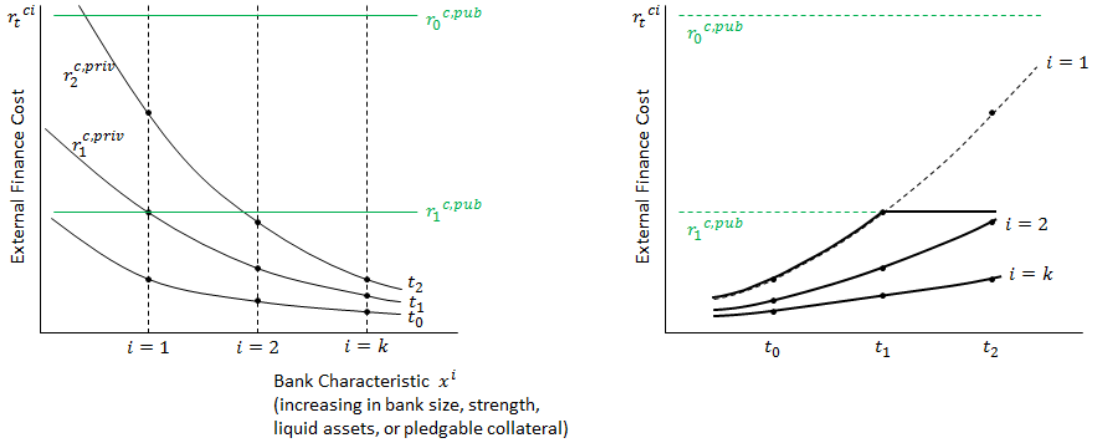
Row (a) shows how the external funding costs evolve for banks with different balance sheet strength (Panel I). In Panel II, the evolution of funding costs is plotted over time. Row (b) shows the same information but accounting for public liquidity provision in normal times, Row (c) additionally introduces emergency lending.

Panel I **Panel II**

(a) Baseline scenario



(b) With public liquidity provision



(c) With emergency lending

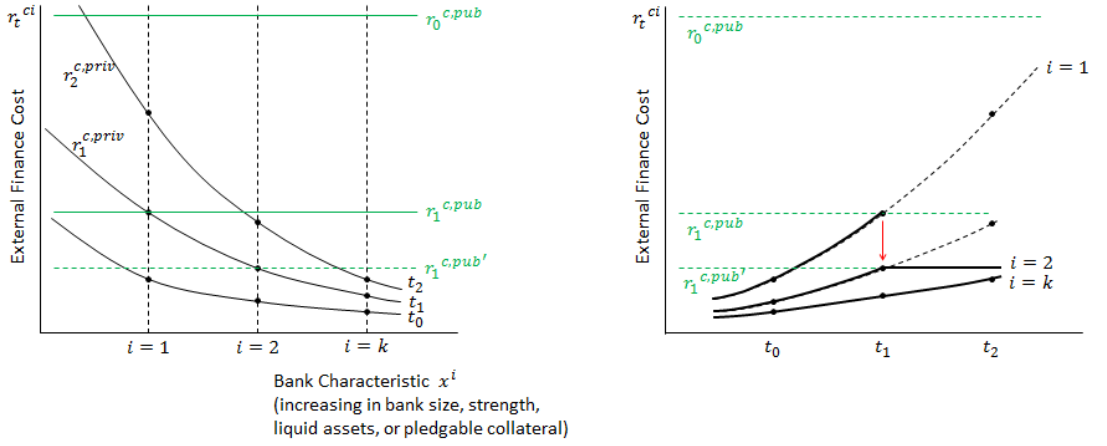
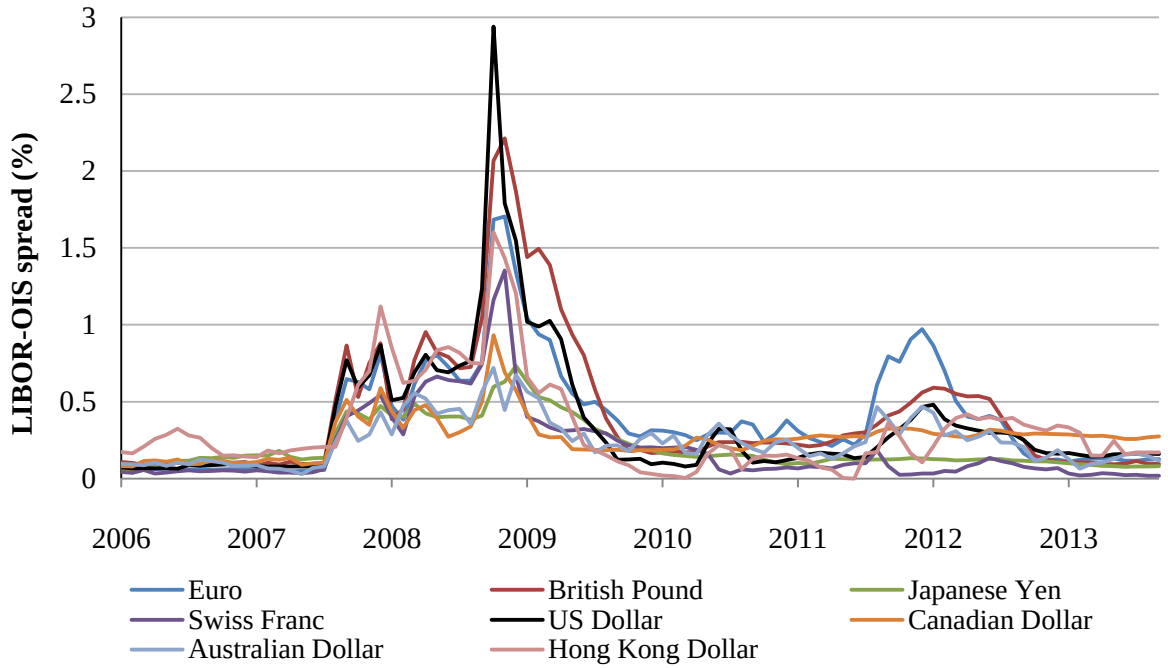


Figure 3: LIBOR-OIS Spread

This graph shows the 3-month LIBOR-OIS spreads of the Euro (EUR), Pound Sterling (GBP), Hong Kong Dollar (HKD), Japanese Yen (JPY), Swiss Franc (CHF), the US Dollar (USD), Australian Dollar (AUD), Canadian Dollar (CAD). For Hong Kong, the interbank rate is Hong Kong Interbank Offered Rate (HIBOR).



Source: Data from January 2006 through September 2013 provided by country teams.