Discussion Paper

The international transmission of monetary policy

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Non-technical summary

Research question
Understanding the transmission of monetary policy shocks across borders is important from macroeconomic and microeconomic perspectives. From a macroeconomic perspective, the key question is whether changes in the stance of monetary policy and the use of new policy instruments transmit into the real economy through lending to the nonbank sector by commercial banks. In the international context, understanding the spillovers from monetary policy into bank lending activity across countries is important for the effectiveness of monetary policy and for financial stability. From a microeconomic perspective, how banks adjust to changes in the monetary policy stance depends on bank-specific characteristics and the frictions that banks face. Different frictions on the asset and on the liability side of banks' balance sheets bind under different circumstances, and may be particularly manifested in specific types of banks.

Contribution
This paper provides evidence on monetary policy transmission across borders and the sources of heterogeneity in this transmission. It presents the methodology and broad results from nineteen coordinated empirical analyses conducted by members of the International Banking Research Network (IBRN) that show how changes in monetary policies transmit internationally to the real economy through bank lending. Seventeen individual country analyses place special emphasis on heterogeneity across banks and across periods of conventional and unconventional policy. This meta-analysis paper draws out broad insights from across these country studies based on consistent empirical set-ups performed within countries. In addition, two cross-country studies examine a larger cross-section of countries, focusing on foreign currency exposures of banking systems and differences across euro area countries.

Results
The meta-analysis and the individual papers from the IBRN participants provide some important messages. First, international spillovers of monetary policy into lending of banks are pervasive. Second, while bank heterogeneity clearly matters for international transmission, the pattern of heterogeneity is not straight-forward and singular. Third, the contribution of heterogeneity toward explaining overall cross-bank and over time variation in loan growth to nonfinancial borrowers differs greatly across countries. These findings are consistent with a growing set of evidence that the global factor in international financial flows is more pronounced in asset prices and interbank lending than in other forms of bank and nonbank capital flows.

Nichttechnische Zusammenfassung

Fragestellung

Die internationale Transmission geldpolitischer Schocks hat – aus makroökonomischer Sicht – Einfluss darauf, wie geldpolitische Instrumente über die Kreditvergabe an nichtfinanzielle Unternehmen auf die Realwirtschaft wirken. Aus mikroökonomischer Sicht hängt die Reaktion einer Geschäftsbank auf eine geldpolitische Maßnahme von den Charakteristika einzelner Banken und den Friktionen ab, denen sie sich ausgesetzt sehen.

Forschungsbeitrag

Das Diskussionspapier fasst die Ergebnisse von empirischen Untersuchungen zur Transmission von Geldpolitik über Ländergrenzen hinweg in Form einer Metastudie zusammen. Das Papier stellt die Methodik und die Ergebnisse von 19 Länderstudien vor, die im Rahmen des International Banking Research Network (IBRN) durchgeführt wurden. Es wird untersucht, wie heimische Geldpolitik über die Kreditvergabe der Geschäftsbanken auf die Realwirtschaft anderer Länder wirkt. Ein Schwerpunkt das Analysen liegt auf der Rolle der Heterogenität zwischen Banken; es werden Phasen konventioneller und unkonventioneller Geldpolitiken unterschieden.

Ergebnisse

Die Studien liefern Hinweise darauf, dass geldpolitische Maßnahmen durch die grenzüberschreitende Tätigkeit von Banken auf die Kreditvergabe im Ausland übertragen werden. Einzelne Banken passen sich jedoch sehr unterschiedlich an Änderungen der geldpolitischen Rahmenbedingungen an. Zudem ist der Erklärungsgehalt der empirischen Modelle relativ gering.

The International Transmission of Monetary Policy[1]

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Abstract

This paper presents the novel results from an internationally coordinated project by the International Banking Research Network (IBRN) on the cross-border transmission of conventional and unconventional monetary policy through banks. Teams from seventeen countries use confidential micro-banking data for the years 2000 through 2015 to explore the international transmission of monetary policies of the U.S., euro area, Japan, and United Kingdom. Two other studies use international data with different degrees of granularity. International spillovers into lending to the private sector do occur, especially for U.S. policies, and bank-specific heterogeneity influences the magnitudes of transmission. The effects are supportive of the international bank lending channel and the portfolio channel of monetary policy transmission. They also show that the frictions that banks face matter; in particular, foreign currency funding and hedging considerations can be a key source of heterogeneity. The forms of bank balance sheet heterogeneity that differentiate spillovers across banks are not uniform across countries. International spillovers into lending can be large for some banks, even while the average international spillovers of policies into nonbank lending generally are not large.

I.   Motivation and main results

This paper provides evidence on monetary policy transmission across borders and the sources of heterogeneity in this transmission. [2] It presents the methodology and broad results from nineteen coordinated empirical analyses conducted by members of the International Banking Research Network (IBRN)[3] that show how changes in monetary policies transmit internationally to the real economy through bank lending. Seventeen individual country analyses place special emphasis on heterogeneity across banks and across periods of conventional and unconventional policy. As banks' decisions play a central role in the effects and the effectiveness of domestic monetary policy, understanding heterogeneity in banks' responses to monetary policy shocks is key as these capture the frictions faced by banks (Kashyap and Stein 1994, 2000). This meta-analysis paper draws out broad insights from across these country studies based on consistent empirical set-ups performed within countries. In addition, two cross-country studies examine a larger cross-section of countries, focusing on foreign currency exposures of banking systems and differences across euro area countries.

The meta-analysis and the individual papers from the IBRN participants provide some important messages. First, policies do spill over internationally through banks and to real lending activity. The incidence of the spillovers in terms of the type of transmission channel or form of friction differs across countries, though, thus showing the importance of a multi-country perspective. Evidence for some countries is more consistent with funding frictions and the international bank lending channel. For other countries, evidence points more to asset reallocation frictions and the portfolio channel. The bank-specific features that matter most tend to be their cross-border positions, their funding structures, and levels of capitalization.

Second, on average, incidence of cross-border transmission of monetary policy through bank lending is limited in economic terms. Outside of highly financially open economies and emerging markets, international spillovers to non-bank private sector lending are significant but are not economically large for the nonbank lending growth of the average bank. That

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[2] The IMF World Economic Outlook (2011) provides an overview of earlier literature on the role of financial linkages in the transmission of US monetary policy changes.

[3] For details on the International Banking Research Network, see https://www.newyorkfed.org/ibrn.

said, across countries the forms of heterogeneity that matter for inward transmission, such as cross-border liabilities and intragroup funding, can generate quantitatively large differences across banks in lending growth responses to foreign monetary policy.

The evidence from this novel international effort supports international policy spillovers through banks. These spillovers can differ considerably across institutions within a banking system, even when the average international spillovers of policies into nonbank lending generally are not large. Empirical tests used in prior studies of highly advanced economies are only a starting point for understanding the patterns of diverse transmission effects through banks around the world. The IBRN results underscore the importance of using disaggregated bank level data and identifying country-specific frictions, for example regarding the ability to access local versus foreign currency funding, for understanding monetary policy transmission across borders.

I.1 Literature on cross-border monetary transmission

Spillovers of monetary policy are at the core of international economics. The "impossible trinity" of a fixed foreign exchange rate, free capital movement, and an independent monetary policy arises from the responsiveness of international capital flows to monetary policy. Previous empirical work has studied different aspects of monetary spillovers, working through volumes of flows, prices, or institutions involved in international flows.

A first set of papers studies how the *volume* of capital flows responds to global factors such as advanced economy policy rates, global risk aversion, uncertainty, leverage of financial institutions, and global output growth (Cerutti, Claessens and Ratnovski 2017; Forbes and Warnock 2012; Miranda-Agrippino and Rey 2015; Rey 2013). Also, the structure of the financial system in destination countries influences the volatility of capital flows (Pagliari and Hannan 2017), as do the balance sheet characteristics of the banks in source countries (Avdjiev, Gambacorta, Goldberg and Schiaffi 2017). Even if the global factor explains a minority of the variation in country aggregate data for international capital flows (Cerutti, Claessens, and Rose 2017), it may be statistically and economically important in specific episodes. Our findings support the view that global factors such as monetary policy do indeed have a diverse impact across banks and countries.

Another strand of research looks at the impact on asset prices or interest rates, finding that asset *prices* and costs of capital more generally move closely across borders (Chari, Stedman

and Lundblad 2017). Co-movements of short term interest rates also depend on the exchange rate regimes in place, with stronger co-movements observed for countries that have tighter currency pegs and relations with base currencies (Obstfeld, Shambaugh and Taylor 2010; Shambaugh 2004), with roles for both capital flow management instruments (Klein and Shambaugh 2015) and global bank penetration (Goldberg 2013). This literature complements our work at it focuses on transmission through asset prices and interest rates rather than quantities such as bank lending.

A third and closely related line of research highlights the importance of capital flows specifically channeled through internationally active banks. Within advanced economies, frictions across banks in access to external capital markets drive the differential transmission into bank-specific lending. Access to external capital markets is joined by access to internal capital markets in differentiating the effects of monetary policy when banks are global (Cetorelli and Goldberg 2012a,b). Leverage of global banks could matter for their roles as conduits (Bruno and Shin 2015), and costly access to foreign exchange hedging could diminish the returns on lending in foreign markets (Brauning and Ivashina 2017). An open question is how much of the transmission through global banks and into domestic banks is channeled into local credit. While this effect is sometimes viewed as large for emerging markets, some recent evidence suggests that the cost of capital might change more than borrowing constraints and volumes of local credit (Baskaya, di Giovanni, Kalemli-Ozcam, and Ulu 2018). As the channels for policy transmission into the real economy may change during periods of unconventional monetary policy (Engen, Laubach, and Reifschneider 2015), the channels for international transmission of policies might also differ (Neely 2015).[4]

The empirical literature on international spillovers through banks mostly takes the perspective of advanced economies. The bulk of this literature aims at identifying the bank lending, portfolio rebalancing, and risk-taking channels of monetary policy. The structure of banks' international operations as well as funding patterns and capitalization affect policy transmission. Generally, during a US monetary tightening, US banks significantly reduce their

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[4] A separate literature attempts to identify the response of international bond prices or exchange rates to monetary policy, which requires high frequency data and the identification of monetary shocks. Lee, Liu, and Stebunovs (2017) examine responses of credit spreads in the global market for syndicated loans with regard to US monetary policy shocks, providing evidence of higher risk-taking from expansionary policy.

holdings of cross-border claims on foreign residents consistent with funding frictions and an international bank lending channel (Correa and Murry 2009). Home lending is more insulated from changes in domestic monetary policy by banks that activate internal capital markets to adjust net available funding (Cetorelli and Goldberg 2012a), and policy propagates through international lending to a greater degree for foreign countries that are more peripheral to the core business of each bank (Cetorelli and Goldberg 2012b). Differentiating further the types of foreign lending by US-resident banks, cross-border claims are more impacted than claims by affiliates abroad (Temesvary, Ongena and Owen 2017).

Banks rebalance international portfolios, as demonstrated using BIS bilateral cross-border claims (Correa, Paligorova, Sapriza, and Zlate 2015). The changes in riskiness of bank positions depend on their leverage (Bruno and Shin 2015; Shin 2016). Using Mexican loan-level data, Morais, Peydro, and Ruiz (2015) find that inward monetary spillovers through banks have an important impact on domestic lending: looser foreign monetary policy increases the supply of credit of hosted foreign banks to Mexican firms, with UK, US and euro area policy working through their respective banks. The extent to which non-US banks change the lending to their counterparties can depend on the currency choices used in funding and lending, with disproportionate responses to the lending that has a currency mismatch with the funding shock (Ivashina, Scharfstein and Stein 2015).

I.2 Introducing the IBRN's project: Spillovers and bank-level frictions

This IBRN initiative mainly focuses on monetary policy spillovers from the euro area, Japan, the United Kingdom (UK), and the United States (US). Comparable micro-level datasets and empirical approaches are used across countries and are a key comparative advantage of the IBRN analysis. The country studies are based on confidential bank-level data. Every country team ran an identical set of core regressions that are included in this meta-analysis.

The seventeen country teams are from diverse regions, characterized by different financial systems, but use a common methodology applied to each country's bank-level datasets.[5] Some countries study inward transmission, where the focus is on how monetary policy in key

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[5] The bank-level data used by the different country teams are confidential and can be used only under strict country-specific rules preserving this confidentiality.

foreign partner countries affects lending by domestic resident banks or hosted foreign branches. Other countries take an outward perspective, exploring how domestic banks adjust their foreign lending to changes in domestic monetary policy, including via their affiliates located in other countries. Identification additionally comes through the distinction between periods of conventional and unconventional monetary policies. As the analyses are part of a broad coordinated initiative, even statistically insignificant findings are emphasized as informative and the conclusions are not subject to publication bias.

Research conducted in this project starts from the channels of monetary transmission stressed in the literature – the bank lending channel, the portfolio channel, and (relatedly) the risk-taking channel. While country studies do find evidence for these channels, they also show that transmission channels are much richer and differ in scale and nature depending, for example, on the country from which monetary shocks originate, or whether inward or outward transmission channels are studied. Perhaps most importantly, there is no single balance sheet item or bank characteristic that determines how banks respond to shocks.

Therefore, we emphasize the importance of bank-level characteristics and the "frictions" that banks face when we discuss monetary policy transmission. Frictions are reflected in the capital and liquidity position of individual banks, access to different types of funding such as through the wholesale market, availability of collateral, or access to an internationally active banking network. These frictions influence how monetary policy impacts bank lending (domestic or cross-border). In an international context, the costs of external funding in local versus foreign currency and the ability to manage foreign exchange risk through financial instruments as opposed to exclusively through balance sheet composition also can matter. Exchange rate risks might vary in accordance to base currencies in foreign exchange regimes or with restrictions on international capital flows.

This focus on "frictions" captures the fact that there is substantial heterogeneity in balance sheets and business models across banks. Hence, there are varying marginal costs and benefits to changing balance sheet positions, some of which are binding at certain points in time and thus become effective constraints to the adjustment of banks. For example, even if banks would adjust certain positions in an unconstrained optimum, they cannot do so because, for example, they cannot raise new capital on short notice (i.e. the Modigliani-Miller theorem does not hold). In this sense, the adjustment of banks runs through the "channels" that previous literature has focused upon (bank lending channel, bank funding channels, portfolio channel) but how the banks adjust depends on the frictions that they are facing.

This implies that bank capital could potentially be an important determinant of the strength of *both*, the bank lending and the portfolio channel, instead of being a feature that allows distinguishing across channels. Moreover, in periods of conventional monetary policy, the liquidity structure of banks' balance sheets may be relatively more important while, during periods of unconventional monetary policy, bank capital might become the relevant friction.

Accordingly, our approach looks for heterogeneous effects on bank-level lending in association with specific bank-level characteristics, and examines how the roles of these characteristics change across periods of conventional and unconventional monetary policy. Country-specific studies add substantial value by providing insights into idiosyncratic frictions that might be missed in a literature on monetary policy effects on bank lending that heavily draws on the experiences of the most financially developed economies.

We consider how the empirical findings map into different financial frictions, often in an overlapping way, without committing to conducting a horse race between the strengths of the particular transmission channels. Financial frictions have a complex relationship with the channels of policy transmission. There are other channels of monetary policy that can create international spillovers into bank lending that we do not aim to capture – for example, demand shifts through the exchange rate channel – which to some extent may interact with bank lending. Relatedly, we focus primarily on lending to the real economy, to the extent that this is the route through which monetary policy is intended to operate. But there can also be indirect effects of monetary policy running, for instance, through interbank lending, also known as the most volatile component of bank lending internationally. Focusing on the response of private sector lending on changes in monetary policy may thus bias our results against finding econometrically significant effects while focusing attention on a key indicator that is relevant for real economic activity.

Our initiative explicitly recognizes that spillovers of policy may differ between periods of conventional monetary policy compared with quantitative easing or unconventional periods. Accordingly, this paper discusses the challenges in measuring policy stance during these latter periods, and alternative approaches are used in the broader econometric analyses for robustness purposes. All results are replicated using standard measures of monetary policy and using shadow policy rates, with tests for differences in international spillovers across conventional and unconventional monetary policy regimes.

I.3 Previewing the main conclusions

This meta-analysis of evidence from the seventeen countries responds to a number of high-level questions in order to move forward our collective understanding of international monetary policy transmission. The main results can be summarized as follows:

1. *How pervasive are international spillovers of monetary policy into private-sector lending of banks?* The studies look at the spillover of monetary policy in major "source" economies – the euro area, Japan, UK, US – into lending in countries *outside* these regions. Every country team studying *inward* transmission of foreign monetary policy to domestic lending of resident banks found statistically significant policy transmission. However, the sign of transmission was in some cases positive and in some cases negative. *Outward* transmission occurs via global banks, both through local lending by hosted foreign branches and through cross-border lending.

2. *Does the proxy used for representing monetary policy matter for detecting international spillovers?* Evidence for significant international spillovers is based on two alternative proxies for monetary policy, and it matters which proxy is chosen. The first approach uses the short term policy rate in combination with a measure of quantitative easing, i.e. the size of central banks' balance sheets. The second approach uses a shadow policy rate and allows effects to differ across periods of conventional versus unconventional policy. During periods of conventional monetary policy, both approaches generate similar results with regard to the incidence of significant international spillovers of monetary policy. In the unconventional policy periods, the shadow rate measures generate more evidence of international spillovers. Our interpretation is that the size of the central bank's balance sheet as a proxy for unconventional policy misses some consequences of forward-guidance and balance compositional effects that work along the yield curve and are relevant for lending to nonfinancial firms.

3. *How do international spillovers of monetary policy differ across countries?* Generally, the degree of monetary policy spillovers into lending activity differs substantially across source countries. Transmission of US policy rates is statistically significant for nearly all countries. Some countries also find that policy rates from other foreign central banks transmit into domestic lending. But transmission of monetary policy from source countries other than the US is considered to be less relevant for most markets.

4. *Which types of bank-level heterogeneity and thus frictions matter most for international transmission?* The most prevalent forms of bank heterogeneity that matter for differential lending responses by banks are cross-border asset and liability positions of banks. Banks with international activities can isolate lending in the home economy by shifting assets across countries or by drawing on alternative sources of funding. Banks that operate in only a few jurisdictions or only on the domestic market would be expected to face more binding frictions, in contrast. Beyond international exposures, balance sheet ratios such as net intragroup funding and Tier 1 capital ratios affect how monetary policy shocks transmit into lending, but no single balance sheet feature clearly dominates across the exercises.

5. *Do the relevant frictions vary during conventional versus unconventional monetary policy periods?* During conventional monetary policy periods, specifications using the actual short policy rate or the shadow policy rate yield similar results. However, during periods of unconventional policy, the specifications using the shadow policy rates pick up more evidence of policy spillovers compared with the central bank balance sheet measure of quantitative easing (QE). Our interpretation is that the QE measures reflect the expansion of central bank balance sheets but do not reflect other important elements of monetary policy that affect the yield curve. In addition, the frictions that matter for international transmission vary by currency of transmission, by monetary policy regime (conventional versus unconventional), and by country characteristics.

6. *Is the international transmission of monetary policy through bank lending important?* The contribution of the balance sheet characteristics to the overall explanatory power of our regression specifications varies substantially across countries and specifications. It is low in many cases but materially larger for emerging markets. There are also notable differences in the explanatory power of the specifications across advanced economies. For example, explanatory power is relatively high for inward transmission into the domestic private lending of Swiss banks and Irish banks. International spillovers into lending can be large for banks with high levels of specific characteristics, even while the international spillovers of policies into nonbank lending generally are not large for the average bank.

These results from using micro-banking data across seventeen countries are important for interpreting international spillovers of monetary policy. Despite significant and heterogeneous spillovers, the results could suggest greater insulation of *real domestic lending*

activity by banks than might be inferred from a literature that has focused on finding a strong global (monetary policy) factor in *international financial flows or asset prices*. Global factors do not dominate the variation in lending to the real economy across banks and over time for most countries participating in this IBRN initiative. This is in line with recent research on spillovers to credit supply in Turkey (Baskaya, di Giovanni, Kalemli-Ozcan and Ulu 2017), and differentiation across types of counterparties in global liquidity flows (Avdjiev, Gambacorta, Goldberg and Schiaffi 2017).

Accordingly, these results from the meta-analysis of common specifications across countries are complemented by in depth explorations of specific themes within the papers written as part of this IBRN initiative. [6] These separate papers respectively focus on experiences of small open economies in proximity to large economies (Austria, Canada and Switzerland), countries that experienced banking crises (Ireland and Portugal), countries hosting financial centers (Hong Kong and United Kingdom), emerging markets (Chile, Korea, Poland, and Russia), countries hosting global financial institutions (Netherlands, Spain, and United States), or large countries within currency unions (France, Germany, and Italy). Disrupted access to world markets could also impact international transmission of monetary policy (Russia), as can differences in country size and financial linkages (e.g. Austria and Germany), or currency and counterparty specifics (e.g. France and Italy). A global perspective using BIS data across banks aggregated at the country level explores the fundamental question of which countries' monetary policy matters most for international transmission, emphasizing in particular the role of the US dollar as a global funding currency. A cross country perspective for the euro area banks emphasizes the responses to non-standard ECB monetary policy accommodation.

The paper proceeds as follows. In Section II, we look in more detail at identification challenges. Section III describes the data used, alongside some basic descriptive statistics. Section IV introduces the empirical strategy. Section V presents a meta-analysis of the results from the seventeen country studies and interprets key findings. Section VI concludes.

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[6] See Argimon, Bonner, Correa, Duijm, Frost, de Haan, de Haan, and Stebunovs (2017); Auer, Friedrich, Ganarin, Peligrova and Towbin (2017); Avdjiev, Koch, McGuire, and von Peter (2017); Barbosa, Bonfim, Costa and Everett (2017); Gajewski, Jara, Kang, Mok, Moreno, and Serwa (2017); Gräb and Zochowski (2017); Hills, Ho, Reinhardt, Sowerbutts, Wong and Wu (2017); Kruglova and Styrin (2017); Loeffler, Segalla, Valitova and Vogel (2017); and Schmidt, Caccavaio, Carpinelli and Marinelli (2017).

II.   Hypotheses and identification

Three important and related identification challenges arise around estimating monetary policy spillovers on bank lending. The first identification issue that arises is how to relate the data to the theoretical foundation of policy transmission and the relevant frictions affecting international spillovers (Section II.1). The second identification challenge is to identify credit demand and supply (Section II.2). The third challenge is to distinguish the effects of foreign monetary policy from those of domestic monetary policy (Section II.3). Throughout, the premise is that monetary policy in key foreign countries is exogenous from the vantage point of individual banks in the recipient countries, which are the unit of analysis here.[7] In addition, we explicitly address challenges in capturing monetary policy in conventional versus unconventional monetary policy periods, discussing alternative proxies in Section III.

We distinguish two directions – inward and outward – of cross-border transmission mechanism of monetary policy. Chart 1 illustrates this visually. Under inward transmission, the dependent variable is lending to the non-financial private sector by foreign-owned banks. Transmission of monetary policy is then through cross-border flows via banks, which allows for the identification of bank-specific responses to monetary policy shocks. Alternatively, for the case of outward transmission, cross-border flows and local lending by affiliated banks represent the dependent variables, and balance sheet frictions of commercial banks are used to identify transmission.

<div align="center">--- Include Chart 1 here. ---</div>

II.1 Frictions affecting monetary transmission

In the literature on monetary policy transmission, studies tend to broadly distinguish between two main channels through which banks respond to changes in the monetary policy stance: the bank lending and portfolio channels. These channels, in turn, reflect frictions (or constraints) that banks are facing. Given the substantial degree of bank-level heterogeneity that we observe in the data, banks use different channels of adjustment to monetary policy

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[7] Drechsler, Savov, and Schnabl (2017) show that expected changes of monetary policy affect banks' balance sheets. A similar logic applies here where bank lending adjusts only after the monetary policy change has been implemented – independently of whether it was expected or not.

shocks. Hence, in reality, the channels through which monetary policy operates are even richer than the traditional channels suggest.

Bank lending channel. In the classical formulation of the bank lending channel[8] (such as in Bernanke and Blinder 1988 or Kashyap and Stein 1994, and internationally in Cetorelli and Goldberg 2012a,b), monetary policy works by changing both the short-term funding costs paid by banks and the liquidity constraints that banks are facing. In the case of a monetary tightening, interest rates increase. If reserve requirements bind, banks shrink reservable deposits. Banks also increase the interest rate paid on non-deposit assets. As a result of the drop in deposit supply, banks might have to cut lending if they cannot access alternative sources of funding such as commercial paper or intragroup funding. Lending and aggregate demand drop – both domestically and internationally.

Disyatat (2011) reformulates the bank lending channel to stress the reverse causality. In this model, loans drive deposits, reserve requirements are not binding, and there is no exogenous constraint on the supply of credit except through regulatory capital requirements. In this framework, a monetary tightening increases the external finance premium that banks are required to pay, as determined by their perceived balance sheet strength, and it is this mechanism that leads them to cut their lending to the real economy.[9]

In either of these cases, the bank lending channel can be characterized as reflecting a friction in banks' ability to access alternative sources of funding. More specifically, the identification of monetary policy effects on banks' balance sheets comes from the heterogeneity across banks in their reliance on short-term (wholesale) funding, the share of (short-term) deposit funding, or the ratio of liquid to total assets. Financial linkages between affiliates or across countries play a key role: banks relying on (net) funding from a banking system that experienced a tightening in short-term funding rate should be more impacted than other banks. The level of capital is likely to affect the lending response as well: better capitalized

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[8] This channel is also labelled as the bank funding channel in the literature.

[9] Relatedly, a monetary policy tightening that limits banks' deposit funding can make banks less willing to lend, to the extent that these deposits offer a more expensive source of financing (Butt, Churm, McMahon, Morotz, and Schanz 2015). But if the variability of these deposits decreases at the same time, banks may actually be more likely to increase their lending at a given price, as this reduces the likelihood that today's funding may have to be replaced with more expensive funding tomorrow.

and/or rated banks may be better able to attract funding and more willing to lend to each other or to firms and households. Larger banks may be better able to attract low-cost funding, although it could work the opposite way if the bank's balance sheet expansion were thought to be driven by riskier assets.

Portfolio (or balance sheet) channel. Under the portfolio channel, monetary policy works by changing the risk structure of banks' assets. This change in risk can occur in different ways. First, the value of banks' assets can change. For example, when the monetary policy rate falls, the value of long-term assets such as treasuries held rises. Second, the returns that the bank receives on its short- and long-term investments change (Koetter, Podlich, and Wedow 2016). Tight monetary policy weakens the creditworthiness of firms and households, and banks reduce their lending to the real economy (Bernanke and Gertler 1995). Third, in an international context, tighter monetary policy in source countries leads to a decrease in the net worth and collateral values of domestic borrowers. This prompts banks to substitute away from domestic credit and toward foreign credit to safer locations and borrower types (Correa, Paligorova, Sapriza, and Zlate 2015).

This channel is underpinned by market frictions arising from imperfect substitutability between different asset classes, investors' preferences for particular asset classes, or limits to arbitrage (Haldane, Roberts-Sklar, Wieladek, and Young 2016). Given this, the bank-level characteristics that we might most closely want to examine relate to banks' existing asset holdings: the share of cross-border assets, the relative share of securities holdings and lending, and the relative share of lending to banks and real economy borrowers (Christensen and Krogstrup 2016). Typically, banks with riskier existing holdings are expected to exhibit stronger transmission. As in the bank lending channel, smaller banks' size and capital levels are likely to strengthen this form of transmission.

Other frictions. Generally, most of the identification within country analyses comes from bank-level heterogeneity. Bank-level characteristics are used to identify the most pertinent frictions that affect how bank lending reacts to changes in monetary policy. Yet, frictions are also likely to differ by country. Two examples of frictions not covered above include, first, the costs of transacting in or even accessing foreign exchange markets for liquidity or investments (for instance as reflected in currency swap spreads). Second, access of bank affiliates to internal capital markets often differs across branches and subsidiaries and depending on the location in major financial centers. More generally, regulations are important financial frictions, although they are in many cases incorporated into the other

frictions we study. For instance, the pre- and post-crisis periods differ with regard to the level and quality of regulatory capital requirements imposed on banks. While overall changes in regulations are captured by country and country-time fixed effects, we indirectly capture the bank-level impact of these regulations by including, for instance, bank capital as a regressor.

Frictions and the most appropriate monetary policy measure. When testing for the presence of funding frictions, the actual short-term policy rate is the most relevant monetary policy measure. Given that its path has a floor at the zero lower bound (ZLB), we include alternative proxies for periods of unconventional monetary policy. As banks rely on short-term funding, monetary policy actions that affect the long end of the yield curve may not be as relevant. At the same time, when considering market frictions such as those underpinning the portfolio balance channel, there are effects on the balance sheet from both short-run policy rate adjustments and from "unconventional" measures that target longer term returns. So, in this case, the actual short-term policy rate alone does not adequately capture the span of monetary policy instruments relevant for this channel, such as short-term rates or communications strategies (see Section III.1).

Obviously, it is difficult to map precisely between a given bank balance sheet variable and the two standard transmission channels – for example, the capitalization of banks affects both their funding (e.g. the bank lending channel) as well as their asset allocation strategies (e.g. the portfolio channel) – which explains our focus on frictions. Moreover, our ability to distinguish between different channels is limited by the availability of bank balance sheet variables across countries. For example, not all countries are able to provide information on the internal capital market channel. In a meta-analysis of results across countries, broader country-specific features can be used to sort results and shed more light on relevant frictions.

II.2 Distinguishing between loan demand and supply

Identifying demand and supply effects is important for the identification of transmission channels. Bank lending could change because demand for credit has changed or as a result of general macroeconomic conditions. Credit supply could change in response to a change in a bank's willingness or ability to lend following a monetary policy shock. The identification should exist in obtaining bank-specific responses by determining to what extent a bank can insulate its portfolio from monetary policy shocks by, for instance, accessing external funds.

The combination of data on bank-level characteristics and international lending patterns of individual banks contributes to the identification of demand versus supply effects: a bank resident in the foreign country where a contractionary monetary policy shock takes place experiences an increase in the interest rates by which it is funded. This can lead to a change in lending. If the frictions faced by this bank cannot be alleviated by tapping on alternative sources of funding, the bank will transmit the shock cross-border by reducing external loans to the non-bank sector as well as to the banking sector. The latter reflects a funding shock for banks at home. If these banks are not able to tap on other sources of funding, they will reduce their loan supply.

Comparable dynamics occur in the outward transmission of monetary policy originating in the home country through foreign affiliates. Affiliates can take the form of overseas bank branches or separately chartered subsidiaries (both inward and outward).

II.3 Identifying the effects of monetary policy

In identifying the effects of monetary policy for bank lending, this project uses two types of variations: (i) the distinction between periods of conventional monetary (C) and periods of unconventional monetary policy (U); and (ii) the distinction between the different forms of bank heterogeneity, and therefore, frictions through which monetary policy has an impact on bank lending.   The forms of heterogeneity enter specifications with different potential interpretations across conventional and unconventional periods.

For example, in periods of "normal" monetary policy conditions, *liquidity* may be the binding constraint on bank's lending growth. Hence, indicators of bank liquidity may have power in explaining heterogeneous responses of banks to changes in the monetary policy stance, with the actual short-term rate being the relevant monetary policy measure. Relatedly, banks relying on (net) funding from a banking system that experienced a tightening in short-term

funding rate should be impacted more than other banks. In periods of unconventional monetary policy, *bank capital* may become more of a binding constraint as shifts into riskier asset classes are possible only for banks with capital buffers in excess of the regulatory minimum. Hence, while bank capital may not be as relevant in normal periods, its impact should be *relatively* more important in periods of QE. For some countries, additional considerations include the costs of hedging foreign exchange risks, which may change over time.

Another key distinction is between domestic and foreign monetary policy. A foreign monetary policy "shock" should be exogenous to domestic economic conditions (and vice versa). If foreign policy would respond to domestic monetary policy, the recovered coefficients could capture the effect of domestic policy instead of that of foreign monetary policy. Throughout, the premise is that monetary policy in key foreign countries (United States, Japan, euro area, and United Kingdom) is exogenous from the vantage point of banks in the recipient countries.

III.   Data and descriptive statistics of IBRN country analyses

This section provides information on dependent variables, proxies for monetary policy, and bank-level and country-level control variables used in the respective country studies. Data used in the country studies usually cover the period 2000Q1-2015Q4.

III.1   Monetary policy measures

A measure that has commonly been used in the literature to accommodate periods of both conventional monetary policy and periods of quantitative easing is the *shadow policy rate*, which we use as our baseline specification in first differences.[10] Shadow interest rates have the advantage of translating quantitative easing into comparable nominal interest rates. Hence, they capture factors associated with general liquidity conditions and the fact that QE also impacts the long-end of the yield curve.

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[10] One caveat here is that the shadow rate itself may include some of the financial frictions that we are trying to study. As such, it may lead to bias, although it is not clear in which direction.

The alternative estimated shadow rate measures from previous studies are not perfect measures of the monetary policy stance as they are all sensitive to the assumptions used in their construction. However, as *changes* in shadow rates can be consistent and effective proxies for monetary policy changes and are highly correlated with each other in first differences across studies, the underlying analyses conducted are more insulated from such critiques. We select Krippner's (2016) measure for our analysis of possible transmission of monetary policy originating in multiple countries, with shadow rates readily available for the United States, the euro area, the United Kingdom and Japan (Chart 2).[11] For countries for which we cannot obtain shadow policy rates, actual interest rate data are used.

--- Insert Chart 2 here. ---

We also consider two commonly used alternative measures of the monetary policy stance. The first is the *actual short term policy rate*, defined in first-difference form in order to account for changes in the policy stance. For the US, the effective federal funds rate (FFR) is a typical measure. The rate used should represent an average funding cost for banks. The second measure is the degree of quantitative easing (QE) capturing the *volume of central bank liquidity provision* such as the change in the central bank's balance sheet relative to GDP.

Apart from the choice of the proxy for the monetary policy stance, the issue of identification of monetary policy shocks arises. Otherwise, the sensitivity of banking variables to the policy measure is polluted by the effects of the variables to which policy rates respond. Identification of monetary policy shocks has, arguably, been one of the most contentious issues in the macroeconomic literature,[12] and we cannot settle this debate here.

III.2   Dependent variables $\left(\Delta Y_{b,t}\right)$

The specifications in the meta-analysis use bank lending to nonfinancial borrowers as the dependent variable. Specifically, the dependent variable is the *growth* in lending, calculated as log changes in exchange-rate adjusted stocks (if exchange rate adjustments are feasible) of

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[11] See   http://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-of-international-monetary-policy-measures.

[12] See Ramey (2016) for a recent review of these issues.

banks indexed by *b*.[13] The inward transmission exercise concentrates on domestic loans to the private non-bank sector, which is lending by all resident entities (domestic banks and foreign affiliates) to domestic resident borrowers using locational data. The outward exercise concentrates on cross-border or local lending by affiliates to the non-bank private sector. The dependent variable in the outward transmission requires mainly consolidated data given that it includes the lending of affiliates abroad.

One further consideration in international transmission is that changes in monetary policy may induce exchange rate effects, with a monetary tightening at home leading to exchange rate appreciation. The stock of bank assets denominated in foreign currency is, therefore, automatically reduced (when converted back into the home currency) warranting a data adjustment in relation to bank balance sheet positions. While not all country teams have sufficient information on the currency denomination of assets to implement this adjustment, where feasible, exchange-rate adjusted bank asset positions are used in analyses.[14] Moreover, we cannot rule out a broader indirect effect of exchange rates on aggregate demand shifts, as in the issue of demand and supply shocks of section II.2, we implicitly treat these as effects as common demand shocks across banking firms by date.

III.3   Balance sheet characteristics $(X_{b,t-1})$

The empirical model accounts for a number of bank balance sheet characteristics. Interactions of these variables with the measures of monetary policy stance help to identify the effects and frictions through which monetary policy changes affect lending growth spillovers. Note that for the meta-analysis, these balance sheet interactions are introduced one per regression specification.[15]

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[13] To make sure that *large* observations are not driving the results, the data on lending growth are adjusted by cutting off the edges of the distribution of lending growth (-100/+100%). In robustness exercises, this dependent variable can be winsorized at the 2.5% level to strengthen robustness.

[14] In the case of the US, lending in foreign currency by local affiliates abroad could be assumed to be in USD, whereas local lending is in the currency of the host country. In other cases, lending by local affiliates could be potentially either in USD or another major currency (Ivashina, Scharfstein and Stein 2015).

[15] Country teams also have run specifications with different groupings of characteristics, including standard balance sheet measures, those reflecting cross border liabilities with and without net intragroup funding, and those reflecting cross-border assets with and without net intragroup assets.

Country analyses account for the bank's funding structure by introducing the proportion of net/gross liabilities that is accounted for by the country source of the monetary policy shock (US, UK, euro area, Japan), as well as the proportion of the funding that is intragroup implying that the bank can operate an internal cross-border (XB) capital market. These are accounted for in the controls indicated by *XB Liabilities/Total Assets, Net XB Liabilities/ Total Assets,* and *Net Intragroup Funding Ratio/Total Assets.*[16] Core deposit funding (*Core Deposits/Total Assets*) and *Short Term Funding Ratio* capture the extent to which banks access alternative sources of funding outside of deposit taking or in the short-run. The volume of liquid assets (*Liquid Assets/Total Assets*) controls for the ability to adjust the asset side (cash and securities).

The degree of capitalization of banks, *Tier 1 Ratio*[17], accounts for the fact that portfolio rebalancing and in particular shifts into riskier asset categories could be impaired by binding capital constraints. Country analyses also include a set of variables to account for the structure of bank's asset holdings. *C&I* (commercial and industrial) *Loans/Total Assets* and *Securities/Total Assets* cover the degree to which the bank focuses on lending to the real economy. *Total Claims on Foreign Borrowers/Total Assets* and *Loans/Total Assets* capture the extent to which the bank has cross-border asset holdings in the country that is the source of the monetary policy shock (US, UK, euro area, Japan), and divides this total between exposure to the banking sector and to non-banking sectors.

In addition, analyses include a number of bank characteristics as controls. Bank size (*Log Total Assets*) is typically included in empirical banking models. Bank size can capture many bank-specific features which may be relevant for policy transmission. We thus refrain from a specific interpretation of bank size in terms of frictions.

The common model used across countries does not include an explicit measure of the riskiness of banks. The reason is that it is difficult to find a proxy (for example, CDS spreads or non-performing loans) which can be consistently applied across banks and countries.

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[16] These are defined as cross-border liabilities from country – claims on banks from country; and liabilities from own offices in country – claims on own offices in country. Net intragroup funding is defined from a liability perspective, so the share of net borrowing from affiliates abroad. The latter term captures internal capital market flows within the banking organization and across borders.

[17] Tier 1 risk-based capital/Risk-weighted assets (net of allowances and other deductions).

However, the variables included proxy for bank-level risk by, most importantly, including a measure of capitalization (the inverse of leverage), the stability of funding patterns (the deposit share), and the liquidity of assets. Ceteris paribus, bank-level risk decreases in the degree of capitalization, the reliance on deposit funding, and the liquidity of assets.[18]

IV.   Empirical strategy of IBRN country analyses

Monetary policy shocks can be transmitted *inward* in the sense that foreign monetary policy shocks affect domestic banks' balance sheets, but the direction of transmission can also be *outward* in the sense that domestic monetary policy affects the lending of banks' foreign affiliates. Separate types of regressions capture the bank-specific frictions in international transmission.

IV.1 Effects of monetary policy abroad on domestic banks' lending: Inward transmission

To identify monetary policy spillovers from abroad (a foreign country) in the cross-section requires that at least two banks from the foreign country, or at least two banks with offices in that foreign country (in the case of domestic banks with foreign offices), are included in the specification. For example, to analyze monetary spillovers from the United States to France, one would need information on the operations of at least two French banks in the United States or of two US banks in France. Identification comes from the bank heterogeneity, in the differences in the reaction of these two banks to monetary policy changes in the United States depending on (for instance) their reliance on US funding.

An initial regression summarizes the overall effect of monetary policy:

$$\Delta Y_{b,t} = \alpha_0 + \sum_{ctry} \left(\sum_{k=0}^{K} \alpha_{1,k}^{ctry} \cdot \Delta MP_{t-k}^{ctry} + \alpha_2^{ctry} \cdot Z_{t-1}^{ctry} \right) + \alpha_3 X_{b,t-1} + \alpha_4^{domestic} \cdot Z_{t-1}^{domestic}$$
$$+ \alpha_5^{domestic} \cdot \Delta MP_{t-1}^{domestic} + \alpha_6 VIX_{t-1} + f_b + \epsilon_{b,t} \quad (1)$$

---

[18]   The analyses do not explicitly account for the micro- and macro-prudential policy changes introduced pre- and post-crisis, some of which were explicitly explored in the former IBRN initiative summarized in Buch and Goldberg (2017). However, we implicitly account for the effects of these policy actions by having the transmission work through observed balance sheet characteristics of banks.

where b = bank, and k = number of lags. $\Delta Y_{b,t}$ is the log change of lending to the private non-bank sector by bank b at time t. $X_{b,t-1}$ is a vector of time-varying *bank* control variables. Z_t controls for demand effects at home (credit and business cycle)[19]. ΔMP_{t-k}^{ctry} measures the *changes* in foreign monetary policy where the countries (*ctry*) specified depend on their core financial partners from the perspective of the domestic economy. The common specifications across countries introduce a subset of: the United States, the United Kingdom, the euro area and Japan. Multiple foreign policy rates are used in order to isolate the impact of decisions taken in each specific country, given that policy rates of major economies tend to be quite highly correlated. f_b are bank fixed effects. By default, standard errors $\epsilon_{b,t}$ are clustered at the bank level. This initial regression does not disentangle demand and supply effects, and it only shows average effects across banks regardless of size and economic importance.[20]

The main regression specifications take the form:

$$\Delta Y_{b,t} = \alpha_0 + \sum_{ctry} \left(\sum_{k=0}^{K} \left(\alpha_{1,k}^{ctry} \cdot \Delta MP_{t-k}^{ctry} \cdot Channel_{b,t-K-1}^{ctry} \right) + \alpha_2^{ctry} Channel_{b,t-K-1}^{ctry} \right) + \alpha_3 X_{b,t-1}$$

$$+ f_b + f_t + \epsilon_{b,t} \quad (2)$$

$Channel_{b,t-K-1}^{ctry}$ is a variable that explores the link between heterogeneity of transmission of foreign monetary policy and bank-level characteristics. It enters the regression at the lag t-K-1 to make sure that it is not affected by contemporaneous changes in monetary policy. Tests for significance of an interaction capture one year of monetary policy changes (contemporaneous plus three lags).[21] The regression includes time fixed effects f_t as it controls for other global and domestic factors (including the non-interacted monetary policy variable).

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[19] Output and credit gap data from the BIS are used to control for domestic economic and credit conditions.

[20] While all countries participating in the IBRN initiative have run this initial specification for the purpose of the meta-analysis, not all countries have reported or discussed this particular specification in their analytical papers. The country teams may have introduced different additional specifications in their papers to inform other forms of frictions outside of the common IBRN exercise.

[21] Robustness tests have measures calculated and averaged over four quarters up to and including t-K-1.

IV.2 Effects of domestic monetary policy on cross-border lending: Outward transmission

A complementary model to the inward transmission exercise asks whether domestic monetary policy affects foreign activities of domestic banks. The baseline specification in the outward transmission exercise focuses on the lending of domestic banks' foreign affiliates or in cross-border lending:

$$\Delta Y_{b,j,t} = \alpha_0 + \sum_{k=0}^{K} \alpha_{1,k} \Delta MP_{t-k}^{domestic} + \alpha_2 X_{b,t-1} + \alpha_3 Z_{t-1}^{domestic} + \alpha_4 Z_{j,t-1} + \alpha_5 \cdot \Delta MP_{j,t-1}$$
$$+ \alpha_6 VIX_{t-1} + f_j + f_b + \epsilon_{b,j,t} \quad (3)$$

where $Z_{j,t}$ includes the country j credit and output gaps. Equation (3) serves to establish the aggregate effect of changes in domestic monetary policy on the dependent variable. The main specification introducing bank-specific heterogeneity is:

$$\Delta Y_{b,j,t} = \alpha_0 + \sum_{k=0}^{K} \left(\alpha_{1,k} \Delta MP_{t-k}^{domestic} \cdot Channel_{b,j,t-K-1} \right) + \alpha_2\, Channel_{b,j,t-K-1} + \alpha_3 X_{b,t-1}$$
$$+ f_{j,t} + f_b + \epsilon_{b,j,t} \quad (4)$$

The dependent variable $\Delta Y_{b,j,t}$ would in this case be local lending by the affiliate of domestic bank b in country j at time t. The coefficients $\alpha_{1,k}$ and $\alpha_{2,k}$ are now an estimate of the average effect of monetary policy taking into account bank-specific bilateral funding linkages. In contrast, the inward specification estimates one α for each key partner country. $Channel_{b,j,t-K-1}$ is in this case bank-country-time specific. Thus, if the dependent variable is local lending by foreign affiliates of bank b in country j at time t, the characteristic variable measures the cross-border flows of bank b to that country j at t-K-1. In the case of the liquid asset ratio or the dependence on short-term funding of the domestic bank, $Channel$ would vary only by b,t. $\Delta MP_{t-k}^{domestic}$ are changes of monetary policy in the domestic country. It

varies only with time.[22] For all equations: K = 3. Country-time fixed effects $f_{j,t}$ control for all other confounding factors, such as demand effects or monetary policy changes in the destination country j. The identification of spillovers with inclusion of country-time fixed effects requires that multiple banks b have positions in each j at each time t. Standard errors $\epsilon_{b,j,t}$ are clustered at the bank-time level.

V.   Meta-analysis across country analyses of international transmission

This section explores the evidence derived across the seventeen country studies that are based on confidential bank-level data. Importantly, every country team ran an identical set of core regressions that are included in this meta-analysis. This section proceeds by first documenting the coverage of the exercise and specifications included in the meta-analysis (Section V.1). We then show how patterns of monetary policy spillovers observed across these countries differ across banks and monetary policy regimes (Section V.2).

The results distinguish between evidence for conventional and unconventional monetary policy periods, between inward transmission through resident banks and foreign-owned resident branches, and outward transmission through global banks via cross-border lending and by local lending. We show which balance sheet characteristics of banks are associated with significant and heterogeneous spillovers of monetary policy into bank lending to nonbanks. The inward analyses address whether *any* advanced economy (external) monetary policies spill over into domestic lending growth, and it presents the evidence of differential spillovers of monetary policies of the US, UK, Japan, or ECB. Our criterion for the statistical *significance* of a "spillover" is the summed effect on bank lending over four quarters from the change in the monetary policy variable, at the 10 percent level of significance.

Finally, country teams sometimes highlight in their respective papers alternative specifications that they judged as appropriate to capture relevant frictions by their banks. While the results presented in this meta-analysis are not always identical to those presented in the country papers, there is an underlying consistency in methodology and data.

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[22] Through their robustness checks, teams can also control for monetary policy in the foreign country, either by including the terms $\Delta MP_{t-k}^{foreign}$ non-interacted in specification (3) or interacted in specification (4).

V.1 Overview of exercises performed by country teams

Each of the seventeen country teams selected the type of transmission viewed as the most relevant and for which requisite data are available (Table 1). Inward transmission to bank lending growth of resident banks is explored by thirteen countries, spanning both advanced and emerging market economies. Two countries separately explored inward transmission through foreign-owned resident branches. Outward transmission through resident banks is explored by five countries, spanning cross-border and local lending. The meta-analysis includes two types of monetary policy proxies within specifications: (i) a short rate plus a central bank balance sheet measure (QE) and (ii) the Krippner (2016) shadow monetary policy rate with tests that allow for different coefficients on balance sheet characteristics associated with transmission across conventional and unconventional periods with interest rates at the zero lower bound.

--- Include Table 1 here. ---

The samples of banks used for the analyses differ in size and features across the countries studying international spillovers (Table 2). The countries engaged in inward transmission exercises have samples of banks that range from mean size of $1.03 billion (Russia) up to $535.3 billion (Canada), with some large variance across banks in total asset size. Funding shares are described using the share of core deposits in total assets and range from a mean size of 0.14 (France) to 0.66 (Hong Kong). Lending focus, as represented by the share of commercial and industrial loans in total assets, varies from 0.12 for the United Kingdom to 0.65 for Spain.

--- Include Table 2 here. ---

The regression specifications introduce different forms of bank-level heterogeneity (Table 3). For inward transmission, most teams tested for heterogeneous effects through bank balance sheet structure via direct funding exposures as reflected in cross-border liabilities shares or net cross-border liability shares. Also, Tier 1 capital ratio and cross-border asset shares are used. For outward transmission, country teams examined heterogeneity in spillovers in accordance with bank liquid asset share, short term funding ratio, bank size, Tier 1 capital ratio, and commercial and industrial (C&I) loan share in assets. Intragroup funding differences are introduced in some specifications, but not for all countries, due to lack of data availability. As each form of bank heterogeneity is introduced in a separate empirical specification, the meta-analysis covers a total of 253 specifications spanning thirteen countries on inward

transmission of foreign monetary policy, and 154 regression specifications spanning five countries on outward transmission through global banks.

--- Include Table 3 here. ---

V.2 Incidence of international monetary spillovers by country and policy rate

The analytical results show statistically significant spillovers of monetary policy rates in the US, the euro area, Japan, and UK. Table 4a considers whether any of these rates spill over, and whether these spillovers differ for conventional and unconventional policy periods, and in accordance with the monetary policy instruments examined. As multiple policy rates are considered in the inward transmission exercises, the incidence of significant spillovers by monetary policy source country are further detailed in Table 4b. In both tables, incidence of spillovers during conventional monetary policy periods is shown under columns headed by "C", while columns headed by "U" refer to periods of unconventional policy. The rows of each table reflect the types of proxies used to capture monetary policy changes, either the actual short rate and QE measure, or the shadow policy rate. Each heading for periods C or U is further divided to reflect when a country did *not* observe any statistically significant spillovers (sub-columns a) versus when some significant spillovers *are* identified (sub-columns b). Within each cell, countries are indicated by standard two-letter initials.

Table 4a covers results for the inward transmission exercise, with differentiation by samples of banks considered, and covers results for outward transmission whether through local lending growth or cross-border lending. Table 4b further expands on the inward transmission exercise columns in Table 4a by considering each source of monetary policy and contains a row indicating when a specific monetary policy is *not* tested for spillovers by a particular country. This choice is generally based on the country team's priors that exposures to the particular policy measure were small or that effects are unimportant. Data limitations were also an issue in some cases.

--- Include Table 4 here. ---

Each country experienced some form of transmission of foreign monetary policy through domestic lending activity from the perspective of inward transmission. During conventional monetary policy periods, this incidence of spillovers is similar across the specifications using

the actual short policy rate or the shadow policy rate specifications. However, during unconventional periods, the specifications using the shadow policy rates picked up more evidence of policy spillovers compared with the central bank balance sheet measure of quantitative easing. This is perhaps intuitive: the QE measures reflect balance sheet expansion, but miss communications, forward guidance, and compositional changes in central bank assets that all influence the shape of the yield curve.

For inward transmission, evidence for spillovers of US monetary policy is stronger than spillovers of other countries' policy rates. In the unconventional policy period, spillovers are picked up particularly when using the shadow rate measures. All other policy rates (euro area, Japan, UK) are examined for transmission by fewer countries, reflecting mainly the *ex ante* views of countries that the impact would likely be small. Across countries, the evidence of spillovers of the euro area, Japanese, and UK rates is mixed, and the "advantage" of using the shadow rate is weaker.

V.3 Incidence of international monetary spillovers by type of bank heterogeneity

Next, we consider the forms of bank-specific heterogeneity that differentiate the lending growth responses across banks. Tables 5 and 6 consider only specifications using the shadow policy rate as the monetary policy proxy. Also, these tables consider only the spillover of US monetary policy, as this was shown to generate the most pervasive evidence (supplementary results are provided as appendix tables).

What evidence is there that transmission is shaped by banks' characteristics? Table 5 provides, in each cell, the results of regression specifications on inward transmission that include one bank-specific characteristic at a time, or that exclude the bank-specific heterogeneity altogether to yield only an average effect of policy across banks. This "without interactions" effect does not come from the same regression as the later interactions, because of time fixed effects in the regression with interactions. Of course, caveats about lack of identification of supply and demand effects in these specifications apply.

The top panel refers to the conventional monetary policy period and the bottom panel refers to the unconventional period. An "O" denotes a result of significance of the shadow rate *outside* the ZLB period in the panel for the periods of conventional monetary policy (top) or of the shadow rate *during* the ZLB period for the unconventional periods (bottom). A green symbol means that a statistically significant positive coefficient is observed on this interaction

term: when monetary policy is tightened, lending growth is higher for banks with a larger value of the characteristic. Red means that lending growth effects are significantly lower for banks with a larger value of this characteristic. It is important to interpret these results relative to average effects of policy changes on bank lending growth. If policy tightens and the average effect across banks is an associated contraction of lending growth, then the green circles indicate an offset to the otherwise negative effect – and therefore a weaker response to policy changes – while the red circles indicate a reinforcement of the negative effect.

--- Include Table 5 here. ---

During the conventional period, specifications excluding balance sheet characteristics either show that international spillovers are not significant on average or are consistent with US monetary policy tightening leading to an *increase* in bank lending growth. Although that would be consistent with the portfolio rebalancing effect, it is perhaps surprising that it dominates the results to such a degree. Recall that the policy debate on spillovers from US monetary policy tends to be based on the assumption that a *loosening* of policy leads to an increase in capital inflows to other countries – whereas these findings suggest the opposite.

During the unconventional period, the incidence of significance is similar to the conventional period, although with mixed evidence on the direction. Cells in rows at the bottom of the table show the marginal impact of each bank balance sheet characteristic. For instance, a red "O" for the share of cross-border liabilities to the US means that the average effect masks compositional differences across banks. Compared to an average bank in that country, a bank with a larger share of cross-border liabilities vis-à-vis the US will increase its domestic lending growth by less when US monetary policy is tightened.

It is difficult to draw firm conclusions from these results on the role of specific forms of bank heterogeneity – and thus also with regard to the bank lending or portfolio channels discussed in the literature. For instance, during the conventional period, there is ample evidence that a high share of funding from the US dampens banks' lending growth, particularly in the euro area. This is quite intuitive and in line with the predictions of the bank lending channel. That evidence is somewhat less pronounced during the unconventional period, which is consistent with the idea that balance sheet frictions matter less when official liquidity is abundant. Elsewhere, though, there are few clear patterns of bank heterogeneity effects, during both periods – not even, at least not across the board, that balance sheet frictions matter less during unconventional periods.

It is notable how difficult it is to tell a story using these results that corresponds neatly to the conventional portfolio rebalancing and bank lending channels, common in the (largely US-based and domestic-focused) literature. That could suggest that cross-border transmission channels work very differently from domestic channels, and/or that the transmission mechanism differs materially country-by-country. It is striking how different the results are, even for countries with apparent similarities – global financial centers, emerging markets, even countries with a common (euro-area) domestic monetary policy.

Indeed, there are large differences across exercises in the contribution to regression explanatory power by allowing effects of monetary policy on lending to differ across banks with different characteristics and thus banks facing different frictions. The bank-specific heterogeneity adds substantial explanatory power only for a few countries (Austria, Chile, Ireland, Switzerland) and otherwise is not large.

On the outward transmission side, during conventional policy periods, heterogeneity across the parent bank balance sheets tended to be more important for cross-border lending than for local lending growth (Table 6). Once again, no single characteristic dominates the results. Fewer types of heterogeneity matter across banks and across countries in the unconventional policy period, despite evidence of spillovers playing a significant role.

--- Include Table 6 here. ---

The magnitude of empirical consequences of bank heterogeneity on international policy transmission can be illustrated by a couple of examples. The two forms of heterogeneity that matter most often in differentiating inward transmission are cross-border liabilities (gross and net) and intragroup funding (only in conventional monetary policy periods). Ten of thirteen countries found significant differences across banks in transmission of US monetary policy and in relation to net or gross cross-border liabilities. Three of four countries testing for heterogeneity using intragroup funding data found that this characteristic matters. Since the average bank's net cross border liabilities is small in some countries (notably Austria and Switzerland), the spillover effect on loan growth for the average bank would be small. By contrast, where the means are larger (Ireland, Hong Kong), the quantitative impact for the average bank is also be economically relevant. The direction of effect can differ too, as the average Hong Kong bank has a net cross-border asset position during the conventional policy period. For example, a one standard deviation change in the cross-border funding share can generate a tenfold difference in the effect on quarterly log lending growth relative to the

sample average loan growth rate across all Hong Kong banks. While examined for a much smaller group of countries, the results also show that net intragroup funding can be similarly quantitatively important, if not more so given the diversity of reliance on this type of funding. During the unconventional policy period, bank-specific heterogeneity through cross-border funding is less likely to matter for heterogeneity in spillovers, or tends to have a smaller effect; intragroup funding differences were no longer statistically significant for any of the countries.

V.4 Lessons from country and cross-country studies

The evidence reviewed so far shows statistically significant spillovers of monetary policy internationally. The adjustment patterns found in the data are broadly consistent with the traditional bank lending channel for countries including Canada, Chile, Germany, Hong Kong, Italy, Korea, Portugal, and the UK. Evidence for the portfolio channel is found for Canada, France, Hong Kong, Ireland, Korea, Portugal, Switzerland, and the UK. At the same time, no country team finds evidence in favor of those traditional channels across all specifications.

Instead, additional frictions and constraints influence international shock transmission through banks and into lending to nonfinancial borrowers, and these may differ across countries. It also matters whether the analytical focus is on inward or outward transmission, whether evidence is based on experiences before or after the financial crisis, whether lending is to banks or non-banks, and which currencies are considered.

Idiosyncratic country-level features help explain the incidence or lack thereof of effects on private lending growth rates, as illustrated below using examples based on analyses by country teams.

In both Switzerland and the UK, banks with a higher share of cross-border liabilities to the US increase lending by more (or decrease lending by less) when US monetary policy is tightened, at least during the conventional monetary policy period. The standard bank lending channel would predict the opposite sign (i.e. that there would be an increase in those banks' funding costs, so they would lend less), and indeed several euro-area countries found significant effects in that direction.

In this context, the role of Switzerland and the UK as international financial centers is important (Auer et al. 2017). A substantial share of international liabilities of Swiss domestic banks is liabilities to foreign banks, and indeed different effects arise when splitting cross-border liabilities into bank and non-bank liabilities. These results are consistent with other recent research showing that the traditional bank lending channel is not necessarily valid for wholesale interbank deposits, and indeed that, in response to a monetary policy tightening, funding tends to shift away from retail deposits to wholesale deposits, such that the effects on wholesale deposits are opposite to those predicted on retail deposits (Drechsler, Savov, and Schnabl 2017). Moreover, the IBRN analysis for the UK and Switzerland (Auer et al. 2017) argues that UK banks tend to have access to multiple sources of funding, and so can usually easily replace a source that has become more difficult to access. The international spillover effects are stronger for interbank lending, particularly when split by currency: a tightening in US monetary policy leads to a large negative change in USD-denominated lending to the financial sector by banks dependent on the US for net funding. The results for the US policy transmission are distinct because most of the funding from the US is denominated in US dollars, whereas only around half of the funding from the euro area is denominated in euros. The UK analysis suggests that the most likely friction is the cost of foreign currency hedging, as in Brauning and Ivashina (2017).

For Germany, the average impact of a tightening in US monetary policy during the unconventional monetary policy period is found to be negative with regard to lending, consistent with a standard bank lending channel (Loeffler, Segalla, Valitova, and Vogel 2017). But banks with higher net cross-border liabilities to the US decrease lending by less, which is the opposite direction to that predicted by the standard bank lending channel. This result might reflect the fact that only around one-third of German banks' funding in US dollars actually comes from the US, while a large share comes from offshore countries or global financial centers. Bank funding from these sources might be considered less likely to be driven by US monetary policy. The analysis finds that inward international spillovers are statistically significant for bank lending, but not robust to changes in regression specifications, and are overall weak. Outward transmission of euro area monetary policy through German banks' international lending activity is also viewed as providing only weak support to arguments based on funding frictions.

In Hong Kong and Korea, banks with a higher Tier 1 capital ratio increase lending by less when US monetary policy is tightened during the conventional monetary policy period

(Gajewski, Jara, Kang, Mok, Moreno, and Serwa 2017; Hills, Ho, Reinhardt, Sowerbutts, Wong, and Wu 2017), and the same is true for Irish banks in the unconventional period (Barbosa, Bonfirm, Costa, and Everett 2017). The standard portfolio channel would suggest that because better capitalized banks are more able to insulate themselves from adverse shocks, one would expect to see the opposite relationship. This remains something of a puzzle; indeed, for Irish banks this relationship is not robust to different measures of monetary policy. The importance of public guarantees in Ireland is one possible explanation provided. In 2010, the expiration of a guarantee granted by Irish government during the financial crisis approached. Subsequently, Irish banks were required to increase their regulatory capital given greater than anticipated loan losses, which at least would tend to muddy the relationship between capital and lending during this period.

Cross-country analyses using more aggregated BIS data suggest that significant monetary policy spillovers are tied to currencies used, not just to countries as partners in financial transactions (Avdjiev, Koch, McGuire, and von Peter 2017). A monetary easing in the US fuels cross-border lending in US dollars, while a tightening in other currencies reinforces dollar lending. Global banks turn to the dollar when the domestic currency becomes more expensive, and borrowers do so when their local funding conditions tighten. These results are not limited to the US dollar, which is the dominant global reserve currency, but are also obtained for euro-denominated lending, strengthening the view that monetary policies spill over across countries and also currencies.

The reliance on foreign-currency denominated loans is particularly strong in, but not limited to, emerging market economies (Gajewski, Jara, Kang, Mok, Moreno, and Serwa 2017). In Chile, a substantial fraction of loans are denominated in US dollars. Not surprisingly, lending in Chile falls significantly after a monetary tightening in the US. This reduction in lending is, however, less severe if banks in Chile rely more on internal capital markets, i.e. net intra-group funding, and are thus less financially constrained after facing a tightening in US monetary policy. Even in France, a large developed economy within a currency union, banks reduce their credit supply at home when US monetary policy tightens (Schmidt, Caccavaio, Carpinelli, and Marinelli 2017). French banks may rely to a large extent on US dollar funding, mostly via their affiliate network in the US, which channels US dollar funds to the headquarters in France. These banks adjust their domestic and foreign currency lending differently, suggesting that funding sources in different currencies are not perfect substitutes, consistent with earlier insights by Ivashina, Scharfstein and Stein (2015).

The role of internal capital markets in the international transmission of monetary policies is also emphasized in Gräb and Zochowski (2017). While euro area banks significantly increase their lending to the private non-financial sector in response to a balance sheet expansion of both the ECB and the Federal Reserve, these spillovers are substantially stronger for banks that are liquidity constrained and those that rely on net intra-group funding.

All of these idiosyncratic findings provide a rich and complex window into the international transmission of monetary policy through banks. All countries studying inward transmission find significant foreign policy into nonbank lending growth of domestic banks. In general, the explanatory power of this transmission relative to overall lending growth varies across banks and on average is small. Yet, spillovers of monetary policy into bank lending do nonetheless occur, may be more substantial for the activities of global banks, and may be concentrated in banks with specific characteristics.

VI.   Conclusion

Understanding the transmission of monetary policy shocks across borders is important from macroeconomic and microeconomic perspectives. From a macroeconomic perspective, the key question is whether changes in the stance of monetary policy and the use of new policy instruments transmit into the real economy through lending to the nonbank sector by commercial banks. In the international context, understanding the spillovers from monetary policy into bank lending activity across countries is important for the effectiveness of monetary policy and for financial stability. From a microeconomic perspective, how banks adjust to changes in the monetary policy stance depends on bank-specific characteristics and the frictions that banks face. Different frictions on the asset and on the liability side of banks' balance sheets bind under different circumstances, and may be particularly manifested in specific types of banks.

In this initiative of the International Banking Research Network, we have combined the macro- and the micro-perspectives. How monetary policy affects bank lending in the international context is distinguished across conventional and unconventional monetary policies, across banks which differ with regard to frictions on the asset and liability sides of their balance sheets, and across seventeen different countries.

The research has three key findings.

First, international spillovers of monetary policy into lending of banks are pervasive. Every country team studying inward transmission of foreign policy to domestic nonfinancial lending of resident banks found statistical significance. Outward transmission by banks through their local claims and cross-border loans is also evident. International transmission was especially prevalent for US monetary policy, with some teams also finding effects of monetary policy from other regions (euro area, Japan, UK). Transmission occurs both in periods of conventional and unconventional policy. During unconventional policy periods, specifications using the shadow policy rates were more likely to identify significant international policy transmission.

Second, while bank heterogeneity clearly matters for international transmission, the pattern of heterogeneity is not straight-forward and singular. Bank characteristics that reflect the frictions that banks face, such as liquidity positions and capitalization, can clearly matter. Country-specific idiosyncratic factors also influence patterns of international spillovers into bank lending. Cross-border assets and liabilities exposures of banks are most important for capturing heterogeneous transmission across banks into private sector lending growth rates. Some lending spillovers may be moderated by banks that rely more on internal capital markets, and in banking systems that have better and cheaper access to foreign currency risk hedging.

Third, the contribution of heterogeneity toward explaining overall cross-bank and over time variation in loan growth to nonfinancial borrowers differs greatly across countries. In general, this contribution is larger for emerging market economies and for some financial centers. The two forms of heterogeneity that matter most for inward transmission, including gross or net cross-border liabilities and intragroup funding (in conventional periods), can be associated with large differences across banks in the magnitude of international policy spillovers into credit extended to nonfinancial borrowers.

These findings are consistent with a growing set of evidence that the global factor in international financial flows is more pronounced in asset prices and interbank lending than in other forms of bank and nonbank capital flows. The findings also show that finding the global factor during unconventional policy periods may be aided by the use of shadow measures of monetary policy, even more so than by the size of central bank balance sheets.

Overall, studying the heterogeneities across banks provides complementary insights to studies using more aggregate data and focusing on average effects. International spillovers into

lending can be large for some banks, even when the average international spillovers of policies into nonbank lending generally are not large.

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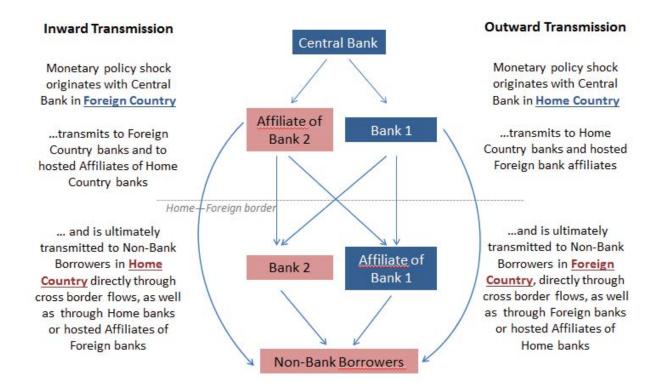
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Chart 1: Stylized inward and outward transmission of monetary policy

Inward Transmission

Monetary policy shock originates with Central Bank in **Foreign Country**

...transmits to Foreign Country banks and to hosted Affiliates of Home Country banks

... and is ultimately transmitted to Non-Bank Borrowers in **Home Country** directly through cross border flows, as well as through Home banks or hosted Affiliates of Foreign banks

Outward Transmission

Monetary policy shock originates with Central Bank in **Home Country**

...transmits to Home Country banks and hosted Foreign bank affiliates

...and is ultimately transmitted to Non-Bank Borrowers in **Foreign Country**, directly through cross border flows, as well as through Foreign banks or hosted Affiliates of Home banks

Central Bank

Affiliate of Bank 2

Bank 1

Home—Foreign border
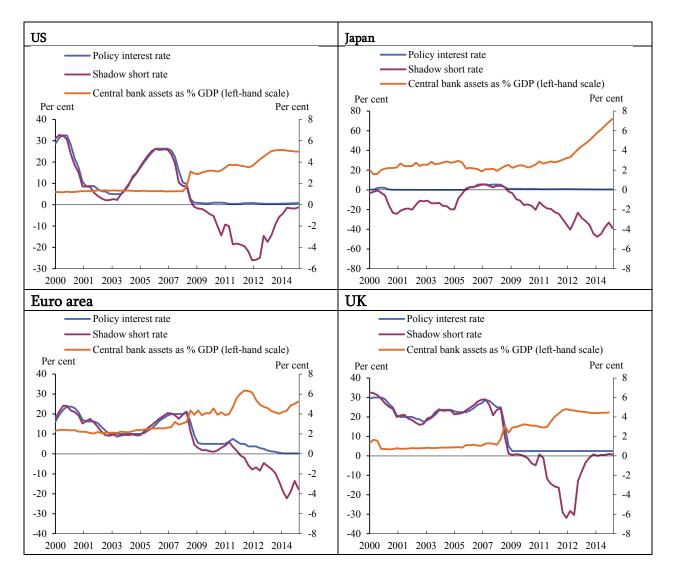
Bank 2

Affiliate of Bank 1

Non-Bank Borrowers

Chart 2: Measures of monetary policy for US, euro area, UK and Japan, 2000-2015

(a) Policy interest rate. Source: Datastream.

(b) Shadow short rate. Source: Krippner (2016).

(c) Central bank assets as % GDP. Source: Datastream.

Table 1: Specifications Implemented by Country and Transmission Direction

This table provides counts of the number of regression specifications run by country, type of bank, form of lending, and direction of transmission. Regression specifications include interactions between monetary policy metrics and bank characteristics.

Country	Inward transmission		Outward transmission	
	All resident banks	Foreign-owned resident branches	Local lending	Cross-border lending
Austria	22			
Canada			9	9
Chile	18			
France	20			
Germany	22		18	18
Hong Kong	22	16		
Ireland	18			
Italy	10			
Netherlands			16	16
Poland	12			
Portugal	18			
Russia	6			
South Korea	20			
Spain			16	16
Switzerland	16			
United Kingdom	21	12		
United States			18	18
Total	**225**	**28**	**77**	**77**

Table 2: Country Banking Sector Characteristics

This table provides the mean and standard deviation (SD) of various banking industry characteristics for each country. Foreign Exposure Share is defined as the negative value of the total net cross-border liabilities/total assets for the countries completing the inward (IN) analysis (Austria, Chile, France, Germany, Hong Kong, Ireland, Italy, Portugal, South Korea, Switzerland, and United Kingdom) and as the total claims to foreign borrowers/total assets for the countries completing the outward (OUT) analysis (Canada, Netherlands, Spain, and United States).

* Portugal uses Leverage Ratio instead of Tier 1 Ratio and uses the ratio of loans of non-financial corporate & public sector loans to total loans as a proxy for C&I Loan Share. Switzerland uses Total Capital/Total Assets instead of Tier 1 Ratio.

Country	Bank Assets (USD mn)		Number of Banks	C&I Loan Share		Core Deposits Ratio		Tier 1 Ratio		Foreign Exposure Share	
	Mean	SD		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Austria (IN)	19361	37503	38	0.17	0.11	0.38	0.23	0.09	0.04	-0.06	0.23
Canada (OUT)	535298	198255	4	0.23	0.03	0.53	0.13	0.05	0.04	0.17	0.03
Chile (IN)	13468	13880	12	0.38	0.12	0.17	0.09	0.10	0.02	0.01	0.04
France (IN)	33899	144265	170	0.26	0.23	0.14	0.16	0.12	0.14	0.08	0.31
Germany (IN)	94059	254393	78	0.15	0.14	0.25	0.25	0.05	0.03	-0.01	0.05
Germany (OUT)	85172	291876	123	0.35	0.29	0.17	0.21	0.06	0.08	0.58	0.28
Hong Kong (IN)	19675	42033	86	0.51	0.14	0.66	0.21	0.10	0.03	-0.10	0.21
Ireland (IN)	37385	39910	9	0.20	0.15	0.30	0.13	0.11	0.03	0.07	0.09
Italy (IN)	49459	164081	99			0.42	0.19	0.12	0.11		
Netherlands (OUT)	113535	275198	7	0.48	0.29	0.51	0.24	0.07	0.06	0.43	0.33
Poland (IN)	10020	14713	28	0.26	0.17	0.21	0.15	0.15	0.07		
Portugal* (IN)	10448	26366	67	0.30	0.26	0.15	0.19	0.08	0.10	0.12	0.36
Russia (IN)	1027	11878	1065	0.38	0.20	0.30	0.21	0.13	0.18		
South Korea (IN)	74185	68875	14	0.33	0.12	0.24	0.07	0.12	0.03	0.03	0.06
Spain (OUT)	107548	248777	97	0.65	0.17	0.54	0.12	0.06	0.02	0.09	0.14
Switzerland* (IN)	107548	248777	18			0.57	0.13	0.08	0.02	0.00	0.01
United Kingdom(IN)	26838	117000	297	0.12	0.17	0.21	0.28	0.15	0.22	0.11	0.30
United States (OUT)	253121	497591	36	0.13	0.09	0.44	0.23	0.12	0.04	0.11	0.13

Table 3: Counts of Countries and Models in Meta-Analysis, by Transmission and Channel

This table provides counts the number of unique countries and the number of regression specifications (models) collected by type of transmission and form of bank heterogeneity.

Channel	Inward transmission				Outward transmission			
	All resident banks		Foreign-owned resident branches		Local lending		Cross-border Lending	
	# Countries	# Models	# Countries	# Models	# Countries	# Models	# Countries	# Models
Without Bank Heterogeneity Interaction	13	26	2	4	5	9	5	9
XB Liabilities/Total Assets	13	26						
Net XB Liabilities/Total Assets	10	20						
Core Deposits/Total Assets			2	4				
Short Term Funding Ratio					5	9	5	9
XB Assets/Total Assets	11	22						
XB Assets to Bank/Total Assets	9	18						
XB Assets to Nonbank/Total Assets	8	16						
Liquid Assets/Total Assets	13	26	2	4	5	9	5	9
Securities/Total Assets	9	18	2	4	5	9	5	9
C&I Loans/Total Assets	10	20			5	9	5	9
Total Claims on Foreign Borrowers/Total Assets					5	9	5	9
Loans/Total Assets			2	4				
Net Intragroup Funding Ratio/Total Assets	5	9	2	4	3	5	3	5
Tier 1 Ratio	12	24	1	2	5	9	5	9
Log Total Assets					5	9	5	9
Impaired Loan Ratio			1	2				

Table 4: Countries Finding Significant Monetary Policy Spillovers, by Types of Transmission

*For panels (a) and (b), "**C**" columns report the significance of spillovers from conventional monetary policy by country while "**U**" columns report the significance of spillovers from unconventional monetary policy by country. In the Short rate and QE rows, C and U indicate the significance of the short rate and QE coefficients, respectively; in the Shadow rate with ZLB rows, the C columns report the significant spillovers of shadow policy rates *outside* of the ZLB period and the U columns report significance *during* the ZLB period. *Significance in the Inward Transmission of All Resident Banks indicates that monetary spillover for at least one of up to four currency rates was found to be significant. For additional detail by reference country and sign, see Table 4b. Country names: AT- Austria, CA- Canada, CH- Switzerland, CL- Chile, DE- Germany, ES- Spain, FR- France, GB- United Kingdom, HK- Hong Kong, IE- Ireland, IT- Italy, KR- Republic of Korea, NL- Netherlands, PL- Poland, PT- Portugal, RU- Russian Federation, US- United States.

(a) Countries With Significant Monetary Policy Spillovers, by Transmission, Monetary Policy Instrument, and Conventional/Unconventional Policy

This table reports the countries which recorded any or no significance of overall monetary policy spillovers (at the 10% level), broken down by type of transmission, transmission subcategory, and monetary policy instrument.

Monetary Policy Instrument	Inward transmission of								Outward transmission of							
	All resident banks*				Foreign-owned resident branches				Local Lending				Cross-Border Lending			
	At the 10% level, Countries with: a=no significant results, b=significant results															
	C		U		C		U		C		U		C		U	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Short rate and QE	IT	AT, CH, CL, DE, FR, GB, HK, IE, KR, PL, PT, RU	PL, RU	AT, CH, CL, DE, FR, GB, HK, IE, IT, KR, PT	GB, HK		GB	HK		CA, DE, ES, NL, US	DE, ES	NL, US	DE	CA, ES, NL, US	DE	ES, NL, US
Shadow rate with ZLB	PL	AT, CH, CL, DE, FR, GB, HK, IE, IT, KR, PT, RU	IT	AT, CH, CL, DE, FR, GB, HK, IE, KR, PL, PT, RU	GB, HK			GB, HK		DE, ES, NL, US		DE, NL, US		DE, ES, NL, US		DE, NL, US

(b) Countries With Significant Results, by Currency of Inward Transmission, Monetary Policy Instrument, and Conventional/ Unconventional Monetary Policy

This table reports the countries which recorded any or no significance of overall monetary policy spillovers (at the 10% level) for inward transmission, broken down by currency dimension and monetary policy instruments. The bottom row reports countries that completed the inward transmission analysis, but excluded particular foreign policy rates from their analysis.

	Inward transmission of all resident banks															
	U.S. monetary policy				Euro area monetary policy				Japan monetary policy				U.K. monetary policy			
	At the 10% level, Countries with: a=no significant results, b=significant results															
	C		U		C		U		C		U		C		U	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Short rate and QE	IT	AT, CH, CL, DE, FR, GB, HK, IE, KR, PL, PT, RU	CH, FR, IE, PL, RU	AT, CL, DE, GB, HK, IT, KR, PT	CH, RU	GB, HK, KR, PL	PL, RU	CH, GB, HK, KR	HK, IT	AT, DE, FR, GB, KR	HK	AT, DE, FR, GB, IT, KR	CH, IT	AT, DE, FR, HK, IE, KR, PT	DE, FR	AT, CH, HK, IE, IT, KR, PT
Shadow rate with ZLB	IT, PL	AT, CH, CL, DE, FR, GB, HK, IE, KR, PT, RU	FR, IT, KR	AT, CH, CL, DE, GB, HK, IE, PL, PT, RU	HK, PL, RU	CH, GB, KR	CH, PL, RU	GB, HK, KR	AT, HK, IT, KR	DE, FR, GB	IT	AT, DE, FR, HK, KR	FR	AT, CH, DE, HK, IE, IT, KR, PT	DE, FR	AT, CH, HK, IE, KR, PT
Does not report this policy rate spillover					AT, CL, DE, FR, IE, IT, PT				CH, CL, IE, PL, PT, RU. GB does not report for Shadow rate unconventional period.				CL, GB, PL, RU. IT does not report for Shadow rate unconventional period.			

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Table 5: Patterns of Heterogeneity in Inward Transmission of US Monetary Policy

This table reports the significance of inward transmission of US monetary policy by country and form of heterogeneity at the 10% level. An empty cell indicates no significant results, and a grey cell indicates that the given country-heterogeneity specification was not examined. For the "Conventional Monetary Policy" panel, the coefficient of interest is the shadow rate interacted with bank balance sheet characteristic. A green (red) symbol in the first row, "Without bank heterogeneity interaction" indicates that lending growth is higher when monetary policy is tightened. A green (red) symbol in the following bank heterogeneity rows indicates that this effect is amplified (dampened) for banks with higher values of that type of heterogeneity. For the bottom "Unconventional Monetary Policy" panel, the coefficient of interest is the sum of shadow rate interacted with channel and shadow rate interacted with channel and an indicator for ZLB period. The rightmost column reports the number of countries that found significant spillovers for that channel and the total number of countries reporting that specification. The last column indicates numbers of countries with statistical significance compared with total countries. Country names: AT- Austria, CH- Switzerland, CL- Chile, DE- Germany, FR- France, GB- United Kingdom, HK- Hong Kong, IE- Ireland, IT- Italy, KR- Republic of Korea, PL- Poland, PT- Portugal, RU- Russian Federation.

Bank Balance Sheet Characteristics	CH	GB	Euro Area Countries AT	DE	FR	IE	IT	PT	Emerging Markets CL	HK	KR	PL	RU	# Sig/Total
Conventional Monetary Policy														
Without Bank Heterogeneity Interaction		O				O		O					O	**4/13**
XB Liabilities/Total Assets	O	O	O		O			O						5/13
Net XB Liabilities/Total Assets	O		O			O		O		O				5/10
XB Assets/Total Assets					O									1/11
XB Assets to Bank/Total Assets					O			O						2/9
XB Assets to Nonbank/Total Assets	O			O										2/8
Liquid Assets/Total Assets										O				1/13
Securities/Total Assets								O						1/9
C&I Loans/Total Assets					O					O				2/10
Net Intragroup Funding Ratio/Total Assets			O						O	O				3/4
Tier 1 Ratio								O		O	O			3/12

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Table 5, continued.

Bank Balance Sheet Characteristics	CH	GB	AT	DE	FR	IE	IT	PT	CL	HK	KR	iv.iv	RU	# Sig/Total
			Euro Area Countries						Emerging Markets					
Unconventional Monetary Policy														
Without Bank Heterogeneity Interaction				O		O		O		O				**4/13**
XB Liabilities/Total Assets			O					O	O				O	4/13
Net XB Liabilities/Total Assets			O	O				O	O					4/10
XB Assets/Total Assets				O										1/11
XB Assets to Bank/Total Assets								O						1/9
XB Assets to Nonbank/Total Assets														0/8
Liquid Assets/Total Assets		O										O		2/13
Securities/Total Assets			O					O						2/9
C&I Loans/Total Assets		O										O		2/10
Net Intragroup Funding Ratio/Total Assets														0/4
Tier 1 Ratio	O					O		O						3/12

Note: The effect described in the "without bank heterogeneity interaction" row does not come from the same regression as those with interactions, because of time fixed effects in the regression with interactions.

Table 6: Patterns of Heterogeneity in Outward Transmission

This table reports the significance of outward transmission of own country monetary policy into local lending and into cross-border lending, and form of heterogeneity at the 10% level. An empty cell indicates no significant results, and a grey cell indicates that the given country-heterogeneity specification was not run. For the top "Conventional" panel, the coefficient of interest is the shadow rate interacted with bank balance sheet channel. A green (red) symbol in the first row, "Without bank heterogeneity interaction" indicates that external lending growth is higher when monetary policy is tightened. A green (red) symbol in the following bank heterogeneity rows indicates that this effect is amplified (dampened) for banks with higher values of that type of heterogeneity. For the bottom "Unconventional" panel, the coefficient of interest is the sum of shadow rate interacted with channel and shadow rate interacted with channel and an indicator for ZLB period. The rightmost column reports the number of countries that found significant spillovers for that channel and the total number of countries reporting that specification. * Canada uses the short rate instead of the shadow rate, since they never entered the ZLB period or used QE.
Country names: CA- Canada, DE- Germany, ES- Spain, NL- Netherlands, US- United States.

Bank Balance Sheet Characteristics	Local Lending Euro Area Countries DE	ES	NL	CA*	US	Cross-Border Lending Euro Area Countries DE	ES	NL	CA*	US	Local #Sig/Total	Cross-Border #Sig/Total
Conventional												
Without Bank Heterogeneity Interaction	O	O	O		O	O			O	O	**4/5**	**3/5**
Short Term Funding Ratio				O				O		O	1/5	2/5
Liquid Assets/Total Assets				O			O			O	1/5	2/5
Securities/Total Assets											0/5	0/5
C&I Loans/Total Assets					O				O	O	1/5	2/5
Total Claims on Foreign Borrowers/Total Assets							O				0/5	1/5
Net Intragroup Funding Ratio/Total Assets		▨	▨				▨	▨			0/3	0/3
Tier 1 Ratio				O							1/5	0/5
Log Total Assets							O		O	O	0/5	3/5

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Bank Balance Sheet Characteristics	Local Lending					Cross-Border Lending					Local #Sig/Total	Cross-Border #Sig/Total
	Euro Area Countries					Euro Area Countries						
	DE	ES	NL	CA*	US	DE	ES	NL	CA*	US		
Unconventional												
Without Bank Heterogeneity Interaction	O		O	▓		O			▓	O	**2/5**	**2/5**
Short Term Funding Ratio				▓		O		O	▓		0/5	2/5
Liquid Assets/Total Assets				▓	O				▓		1/5	0/5
Securities/Total Assets			O	▓					▓		1/5	0/5
C&I Loans/Total Assets				▓					▓		0/5	0/5
Total Claims on Foreign Borrowers/Total Assets	O		O	▓					▓		2/5	0/5
Net Intragroup Funding Ratio/Total Assets		▓	▓	▓			▓	▓	▓		0/3	0/3
Tier 1 Ratio				▓	O			O	▓		1/5	1/5
Log Total Assets				▓				O	▓	O	0/5	2/5

Note: The effect described in the "without bank heterogeneity interaction" row does not come from the same regression as those with interactions, because of time fixed effects in the regression with interactions.

Appendix Table A1: Patterns of Heterogeneity in Inward Transmission

Appendix Tables A1a, A1b, and A1c record countries which found Euro Area, Japanese, and UK monetary policy spillovers positively or negatively significant at the 10% level for the inward transmission by country, monetary policy instrument, conventional/ unconventional monetary policy, and channel. The coefficients of interest for the "Conventional" and "Unconventional" panels, and the interpretation of symbols are the same as for Table 5. The rightmost column reports the number of countries that found significant spillovers for that channel and the total number of countries reporting that specification. Country names: AT- Austria, CH- Switzerland, CL- Chile, DE- Germany, FR- France, GB- United Kingdom, HK- Hong Kong, IE- Ireland, IT- Italy, KR- Republic of Korea, PL- Poland, PT- Portugal, RU- Russian Federation. Note: The effect described in the "without bank heterogeneity interaction" row does not come from the same regression as those with interactions, because of time fixed effects in the regression with interactions.

(A1a) Patterns of Heterogeneity in Inward Transmission of Euro Area Monetary Policy

Bank Balance Sheet Characteristics	CH	GB	Emerging Markets				#Sig/Total
			HK	KR	PL	RU	
Conventional							
Without Bank Heterogeneity Interaction				O			**1/6**
XB Liabilities/Total Assets				O			1/6
Net XB Liabilities/Total Assets							0/4
XB Assets/Total Assets							0/4
XB Assets to Bank/Total Assets							0/4
XB Assets to Nonbank/Total Assets		O		O			2/4
Liquid Assets/Total Assets	O	O					2/6
Securities/Total Assets				O			1/4
C&I Loans/Total Assets				O			1/4
Net Intragroup Funding Ratio/Total Assets							0/1
Tier 1 Ratio	O						1/5

Appendix Table A1a, continued.

Bank Balance Sheet Characteristics	CH	GB	Emerging Markets				#Sig/Total
			HK	KR	PL	RU	
Unconventional							
Without Bank Heterogeneity Interaction		O					**1/6**
XB Liabilities/Total Assets							0/6
Net XB Liabilities/Total Assets							0/4
XB Assets/Total Assets			O				1/4
XB Assets to Bank/Total Assets			O				1/4
XB Assets to Nonbank/Total Assets							0/4
Liquid Assets/Total Assets							0/6
Securities/Total Assets							0/4
C&I Loans/Total Assets		O					1/4
Net Intragroup Funding Ratio/Total Assets							0/1
Tier 1 Ratio				O			1/5

Table A1b: Patterns of Heterogeneity in Inward Transmission of Japanese Monetary Policy

Bank Balance Sheet Characteristics	GB	Euro Area Countries				Emerging Markets		#Sig/Total
		AT	DE	FR	IT	HK	KR	
Conventional								
Without Bank Heterogeneity Interaction			O					**1/7**
XB Liabilities/Total Assets							`	0/7
Net XB Liabilities/Total Assets								0/6
XB Assets/Total Assets	O		O					2/7
XB Assets to Bank/Total Assets								0/6
XB Assets to Nonbank/Total Assets								0/6
Liquid Assets/Total Assets								0/7
Securities/Total Assets								0/6
C&I Loans/Total Assets								0/6
Net Intragroup Funding Ratio/Total Assets								0/2
Tier 1 Ratio				O				1/7
Unconventional								
Without Bank Heterogeneity Interaction								**0/6**
XB Liabilities/Total Assets		O	O			O		3/6
Net XB Liabilities/Total Assets			O					1/5
XB Assets/Total Assets				O				1/6
XB Assets to Bank/Total Assets			O					1/5
XB Assets to Nonbank/Total Assets				O				1/5
Liquid Assets/Total Assets							O	1/6
Securities/Total Assets								0/5
C&I Loans/Total Assets							O	1/5
Net Intragroup Funding Ratio/Total Assets								0/2
Tier 1 Ratio							O	1/6

Table A1c: Patterns of Heterogeneity in Inward Transmission of UK Monetary Policy

Bank Balance Sheet Characteristics	CH	AT	DE	FR	IE	IT	PT	HK	KR	#Sig/Total
			Euro Area Countries					Emerging Markets		
Conventional										
Without Bank Heterogeneity Interaction										**0/9**
XB Liabilities/Total Assets					O		O	O	O	4/9
Net XB Liabilities/Total Assets		O				▓	O			2/8
XB Assets/Total Assets					O			O	O	3/9
XB Assets to Bank/Total Assets					O	▓		O		2/8
XB Assets to Nonbank/Total Assets						▓	▓		O	1/7
Liquid Assets/Total Assets							O		O	2/9
Securities/Total Assets	▓		O			▓	O			2/6
C&I Loans/Total Assets							O		O	2/7
Net Intragroup Funding Ratio/Total Assets	▓		O	▓	▓	▓	▓		▓	1/3
Tier 1 Ratio	O		O			O	O	O		5/9

Table A1c, continued.

Bank Balance Sheet Characteristics	CH	AT	DE	FR	IE	IT	PT	HK	KR	#Sig/Total
			Euro Area Countries					Emerging Markets		
Unconventional										
Without Bank Heterogeneity Interaction					O			O	O	**3/8**
XB Liabilities/Total Assets		O			O		O			3/8
Net XB Liabilities/Total Assets					O		O			2/8
XB Assets/Total Assets					O					1/8
XB Assets to Bank/Total Assets	O				O					2/8
XB Assets to Nonbank/Total Assets										0/7
Liquid Assets/Total Assets		O					O			2/8
Securities/Total Assets		O					O			2/6
C&I Loans/Total Assets							O			1/7
Net Intragroup Funding Ratio/Total Assets		O								1/3
Tier 1 Ratio	O				O		O			3/8