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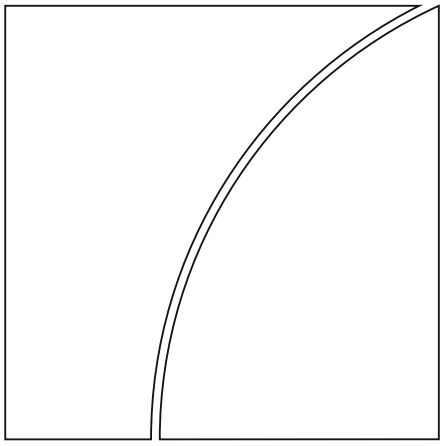

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by Stefan Avdjiev, Cathérine Koch, Patrick McGuire and Goetz von Peter

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Keywords: International banking, macroprudential measures, spillovers

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# International prudential policy spillovers: a global perspective

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## Abstract

We combine the BIS international banking statistics with the IBRN prudential instruments database in a global study analyzing the effect of prudential measures on international lending. Our bilateral setting, which features multiple home and destination countries, allows us to simultaneously estimate both the international transmission and the local effects of such measures. We find that changes in macroprudential policy via loan-to-value limits and local currency reserve requirements have a significant impact on international bank lending. Balance sheet characteristics play an important role in determining the strength of these effects, with better capitalized banking systems and those with more liquid assets and less core deposits reacting more. Overall, our results suggest that the tightening of these macroprudential measures can be associated with international spillovers.

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## Contents

# 1. Introduction

Increased recourse to prudential and, in particular, macroprudential policy measures in the wake of the financial crisis has fueled a debate about the transmission mechanisms and impact of these instruments. An elusive, but important, aspect of this debate is the extent to which prudential measures generate spillovers in international banking that affect credit conditions faced by borrowers abroad.

This paper provides a global perspective on the international transmission of prudential measures that complements the country-specific studies using bank-level data in the context of the International Banking Research Network (IBRN). The BIS international banking statistics are aggregated, but they are available for multiple national banking systems and destination markets.[2] By painting a comprehensive picture of the main banking systems' foreign positions, these statistics provide a perspective lacking in other banking datasets. We use these data in a bilateral panel regression, where indicators of prudential policy changes taken in home and destination countries enter jointly.

When a country enacts prudential policy, three types of effects may occur. The first, purely domestic, effect relates to domestically-owned banks altering their local positions vis-à-vis borrowers in the same country. The other two effects are international in nature, and are the focus of our study on spillovers. First, banks headquartered abroad may change their foreign lending to the country that enacted the policy; we use the term *local effect* to denote that it affects borrowers in the very country that changed the policy, the "destination" of credit flows. At the same time, banks headquartered in the country that enacted the measure may alter their foreign lending to the rest of the world; here, the term *international transmission* captures that the effect of "home country" regulation is felt by borrowers in other destinations (see IMF-FSB-BIS, 2016, for an overview).

To measure these effects, we use a panel of 16 banking systems and 53 counterparty countries, covering nearly 90% of global foreign claims from 2000 to 2014. Our focus is on two components of banks' consolidated foreign claims – (i) international claims, which consist of banks' cross-border claims and local claims in foreign currencies, and (ii) foreign affiliates' local claims denominated in local currency. Claims include both loans and banks' holdings of debt securities.

Amongst the policy measures contained in the IBRN database, loan-to-value (LTV) limits and local currency reserve requirements are the macroprudential instruments that have the most significant effects on international bank lending. In the majority of cases we consider, the estimated international effects of a macroprudential tightening turn out to be expansionary.

We find that a tightening of LTV limits in a *destination* country leads to an increase in international bank lending to the residents of that country (local effect). Banks' international claims also respond to LTV changes in their home country (international transmission), whereby their balance sheet characteristics modulate the strength of this effect. Better capitalized banking systems and those with more liquid assets and less core deposit funding tend to increase their international claims by

[2] In this paper, "national banking system" refers to the set of large internationally-active banks that are headquartered in each respective BIS reporting country, and "destination" to the country where these banks' counterparties (borrowers) reside.

more in the face of tighter LTV requirements at home. This is consistent with the idea that stronger bank balance sheets are generally associated with more lending (see Gambacorta and Shin, 2016) – in our case, international lending.

Similar effects are evident for a tightening of local currency reserve requirements. When implemented by a *destination* country, such a tightening is associated with an increase in international bank lending to borrowers in that country. When enacted by a *home* country, such a tightening is transmitted abroad by international banks in the form of higher growth in lending to borrowers in other destinations. Again, this effect is stronger for better-capitalized banking systems and those less reliant on deposit funding.

## 2. Data and stylized facts

This section describes the data used in our analysis, drawing on the BIS consolidated banking statistics (CBS),[3] Bankscope, the IBRN prudential instruments database, and various indicators of business and financial cycles. In contrast to the single-country studies in the IBRN research initiative, we examine the transmission of prudential measures via bilateral international lending between multiple home countries and destination markets, as elaborated in Section 3. In this setting, the country where banks are headquartered is the *home country*, which is synonymous with those banks' nationality, whereas the *destination country* is the location of the borrowers receiving credit.

### 2.1 International bank lending

We draw on the BIS CBS on an immediate counterparty basis to construct a quarterly panel of 16 bank nationalities (home countries) and 53 destination markets for the period Q1 2000 to Q4 2014.[4] These 16 nationalities include the major internationally active banks, and account for almost 90% of the aggregate stock of global foreign claims reported in the CBS at end-Q4 2014. Note that, while we use the term "lending" throughout the paper, reported claims include not only bank loans, but also holdings of securities on banks' balance sheets.

The first dependent variable we consider is *international claims* (IC), which is the sum of two components: *cross-border claims* (XBC), ie claims booked by banks headquartered in a given country ("home") vis-à-vis residents of another country ("destination"), and *local claims in foreign currencies* (LCFC) booked by those banks' affiliates in that destination country (IC=XBC + LCFC).[5] Our second dependent variable is *local claims in local currency* (LCLC), ie claims booked by banks' affiliates in

[3] For more detail on the BIS international banking statistics, see BIS (2015).

[4] The 16 creditor bank nationalities and 53 borrower (destination) countries are listed in Appendix C. The panel is unbalanced in that not all banking systems have outstanding claims on all 53 destination countries.

[5] The BIS CBS do not distinguish between the positions of branches and subsidiaries.

the destination country and denominated in that country's local currency.[6] Both dependent variables enter the specification in quarterly log changes (denoted as $\Delta Y_{i,j,t}$).

We adjust both dependent variables for exchange rate fluctuations and breaks in series. The currency of LCLC is known by construction, so adjusting for exchange rate movements is straightforward. By contrast, the currency composition of international claims is not reported in the CBS. We still adjust international claims for currency valuation effects using the methodology described in Appendix A.

Table 1 (Panel A) provides summary statistics for our bilateral dependent variables for the full sample and for the main subsamples that we examine in the empirical part.

## 2.2 Changes in prudential instruments

Our data on the use of prudential instruments are taken from the IBRN prudential instrument database, which is described in Cerutti et al (2016). After tailoring these data to our global setting, Table 2 summarizes the policy changes in each prudential instrument from the perspectives of home countries (Panel A) and destination markets (Panel B). With an eye on the variation needed for identification, we consider two levels of aggregation. Column (1) shows the total number of measures taken, while Columns (2) and (3) distinguish between tightening and loosening of measures at the country-time level.

Our estimation is performed at the level of home-destination pairs observed at the quarterly frequency. Columns (4) to (6) provide the number of changes in prudential measures from this perspective. For each type of instrument, a typical tightening episode is coded as "+1", and a loosening as "-1" in the quarter the prudential measure takes effect, and "0" otherwise (Cerutti et al, 2016, and Buch and Goldberg, 2016). In most of the analysis below, we ignore sector-specific capital buffers, interbank exposure limits and concentration ratios, as these measures exhibit too little variation for obtaining robust results. We ultimately steer our main focus to macroprudential policies implemented via LTV limits and local currency reserve requirements, since these measures have the largest estimated impact on international bank lending.

## 2.3 Balance sheet characteristics and cycle variables

Balance sheet characteristics for the 16 bank nationalities are constructed using Bankscope data and the BIS international banking statistics. Using Bankscope, we compute the log of total assets, the total customer deposit ratio, the capital ratio and a measure of illiquidity for the set of internationally-active banks headquartered in each CBS-reporting jurisdiction. These data are adjusted for mergers and acquisitions (see Brei et al, 2013) to eliminate jumps in balance sheet positions that are unrelated to lending. Since international banking activity is highly concentrated, we select a set

[6] Cross-border claims account for the bulk of international claims for most lender-borrower (nationality-destination) pairs in our sample. As of end-2014, global cross-border claims totaled $19.2 trillion, or 86% of global international claims. At the same time, most local claims tend to be denominated in local currency. At the end of 2014, 71% of all local currency claims were denominated in local currency.

of internationally active banks in each jurisdiction that also contributes to the BIS CBS. To aggregate bank-level characteristics to system-wide variables, we use weighted averages across the individual banks of a given nationality.

We construct the net intragroup funding ratio and the measure of international activity for each banking system from various parts of the BIS international banking statistics. The variable definitions are provided in Appendix A, in line with the common approach laid out by Buch and Goldberg (2016). Table 1 (Panel B) presents summary statistics for the balance sheet characteristics used in the empirical analysis.

Finally, in our regression analysis we also control for business and financial cycles[7] using the output gap estimates in BIS (2014) and the financial cycle indicator based on the methodology in Drehmann et al (2011). While the credit-to-GDP gap is not the only relevant financial cycle indicator, it has been demonstrated to be the single most reliable measure of countries' position in the financial cycle. As such, it has been proposed by the Basel Committee on Banking Supervision as an internationally consistent guide for taking decisions on the countercyclical capital buffer (BCBS, 2010). An additional advantage of the credit-to-GDP gap is that it is available for a broader set of countries and time periods than the main alternatives. Table 1 (Panel C) provides some descriptive statistics for the financial and business cycle variables of home and destination countries as used in our regressions.

# 3. Empirical methodology

The BIS international banking statistics lack the bank-level data available to the IBRN country teams. But they open an additional dimension by combining data from many reporting countries. To complement the country-level analyses, we use the aggregate BIS CBS in a global specification to investigate the effects of prudential measures on international banking activity. This specification amounts to a bilateral panel regression in which such measures in both home and destination countries enter jointly. In this setting, inward and outward transmission are two sides of the same coin, and the effect of prudential policy changes on international credit can be estimated separately from their effect on local credit.

## 3.1 The global specification

An empirical specification appropriate for the bilateral nature of the BIS international banking statistics must include multiple home countries and destination markets simultaneously. Appendix B shows that our global specification can be derived from the inward as well as from the outward transmission channels presented in Figure 1 of Buch and Goldberg (2016). The index $i$ denotes a bank's home country (ie its nationality), $j$ represents the destination market, and bold font is short-hand for vectors consisting of the contemporaneous and lagged values of the respective

[7] The financial cycle is defined as the self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms followed by busts (Borio, 2014).

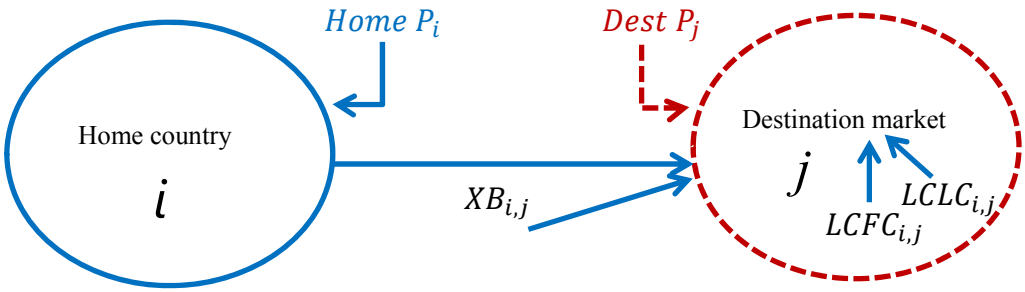
variables.[8] Our specification relates the log change in international claims of banks headquartered in country *i* on residents of destination country *j* at time *t*, in response to prudential measures in home and destination countries (while controlling for the variables described above),

$$\Delta Y_{i,j,t} = \alpha_0 + \boldsymbol{\gamma' HomeP_{i,t}} + \boldsymbol{\alpha' DestP_{j,t}} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{i,t} + \alpha_6 Z_{j,t} + f_i + f_j + f_t + \varepsilon_{i,j,t}. \quad (1)$$

The global specification based on bilateral country-level data brings two advantages. First, it provides a single baseline for both inward and outward transmission. The coefficients on $HomeP_{i,t}$ and its lags measure the *international transmission* of prudential measures from *i* to the rest of the world, whereby the flow of credit "outward from *i*" and "inward to *j*" are two sides of the same coin. Meanwhile, $DestP_{j,t}$ captures the *local effect* of prudential measures taken by the destination country *j* on its own borrowers, via international banks from other home countries. Hence, the second advantage of the global specification is that it contains multiple home countries *and* destination markets, so the additional dimension helps to identify the local effect separately from the international transmission channel. In principle, our estimates of $\boldsymbol{\alpha}$ and $\boldsymbol{\gamma}$ should be weighted averages of those found in single-country studies. Figure 1 helps to illustrate the logic of our bilateral setting.

Illustration of the global specification

Figure 1




Foreign claims of banks headquartered in a given country *i* ("home") on residents in another country *j* ("destination") can take several forms. One is cross-border claims, which can be booked either in the home country or in a third country, both are denoted here by $XB_{i,j}$. Another is local claims which booked in the destination market *j*, and can be denominated in foreign currencies ( $LCFC_{i,j}$) or in the local currency of the destination ( $LCLC_{i,j}$). The sum of cross-border claims and local claims in foreign currencies is international claims, and the growth rate of this variable between all *ij*-pairs (home countries and destination markets) is one of the two dependent variables, $\Delta Y_{i,j}$, that we examine. The other dependent variable that we consider is based on the growth rate of local claims in local currency.

The extent to which these aggregates react to prudential measures in the home country, $Home\ P_i$, while controlling for other factors, measures the *international transmission* of prudential actions via banks from *i* (solid lines). Any concurrent prudential action in the destination, $Dest\ P_j$, represents a *local effect* of prudential action that is felt by borrowers in the country that enacts the measure (dashed lines).

[8] The empirical exercise in this paper is set up to examine the short-term impact of prudential measures on international bank lending. As a consequence, it has a different focus from the literature which studies the long-term relationship between bank capital and loan volume (eg Buch and Prieto, 2014; Gambacorta and Shin, 2016).

## 3.2 Controlling for balance sheet characteristics

The strength of transmission of prudential measures may well depend on the state of banks' balance sheets. Hence, in our second empirical specification, we extend (1) by interacting balance sheet characteristics with *home*-country prudential action,

$$\Delta Y_{i,j,t} = \alpha_0 + \boldsymbol{\gamma'} \boldsymbol{HomeP_{i,t}} + \boldsymbol{\alpha'} \boldsymbol{DestP_{j,t}} + \boldsymbol{\beta'} \boldsymbol{HomeP_{i,t}} X_{i,t-1}$$
$$+\alpha_4 X_{i,t-1} + \alpha_5 Z_{i,t} + \alpha_6 Z_{j,t} + f_i + f_j + f_t + \varepsilon_{i,j,t} \quad (2)$$

The effects of prudential measures are evaluated by joint F-tests. The estimate of $\boldsymbol{\alpha}$ captures the local effect of a measure, ie the sensitivity of foreign bank claims on borrowers in the same destination country that takes the measure. By contrast, significant estimates of $\boldsymbol{\gamma}$ and $\boldsymbol{\beta}$ are evidence of international transmission of prudential measures, where $\boldsymbol{\gamma}$ measures the baseline effect, and $\boldsymbol{\beta}$ indicates how the balance sheet composition of banks from the regulating country shapes the strength of the response. It is plausible that geographical focus, internal capital markets, or different business models and the associated funding structures, make a difference in this regard. International transmission overall is thus the sum of the estimated effects, $\sum_n \gamma_n{}' + \sum_n \beta_n{}' X_i$, or the partial derivative of (2) with respect to a unit impulse $HomeP_i$, evaluated at the median $X_i$.

In order to examine the robustness of our benchmark results and to investigate their main drivers, we estimate several alternative regression specifications for three subsamples: (i) lending by advanced economy (AE) banking systems to AE borrowers; (ii) lending by all banking systems to emerging market economy (EME) borrowers; and (iii) lending by EU banking systems to EU borrowers. All regressions use robust standard errors to accommodate heteroscedasticity of any type.[9] Further estimation details are provided in the table notes.[10]

# 4. Main results

Our empirical analysis draws on the regression specifications in equations (1) and (2). We estimate these specifications for each of the prudential instruments listed in Section 2.2, as well as for a composite prudential policy index which aggregates all prudential instruments into a single variable (Buch and Goldberg, 2016). As discussed above, we examine two types of bank claims for our dependent variable – international claims and (foreign affiliates') local claims denominated in local currency. The results we obtain for international claims are much more significant (from an econometric point of view) and more interesting (from an economic point of view) than the respective results for local claims. Thus, in the rest of this section we focus exclusively on our results for international claims.[11]

The estimated coefficients on the composite prudential policy index are statistically significant (for the home country, the destination country or both) in

[9] When clustering by nationality and destination (our cross-sectional dimension) standard errors exhibit only minor changes without affecting overall significance.

[10] We do not report additional results from the specifications with cumulative effects of prudential measures and their interactions with the business and financial cycle variables, as these yield no substantive additional insights.

[11] Due to space constraints, we only report the results for the prudential measures and specifications that have the most significant impact on international bank lending. All other results are available upon request.

several of the empirical specifications that we examine. This suggests that both home and destination country prudential actions have a significant impact on international bank lending. Nevertheless, since the composite prudential policy index aggregates information over a very diverse set of prudential tools, its estimated coefficients are difficult to interpret. The remainder of this section thus focuses on the results from the individual prudential instrument specifications.

Examining these results reveals that the prudential policy measures that tend to have the most significant impact on international bank lending are: (i) limits on loan-to-value ratios and (ii) local currency reserve requirements. This is in line with the findings of the majority of the national studies in the IBRN research initiative (Buch and Goldberg, 2016). In the remainder of this section, we discuss the estimated impact of each of the two macroprudential measures above in more detail and provide economic intuition for the main results.

## 4.1 Limits on loan-to-value ratios

From the perspective of a country as a ***destination*** of credit flows, we find that a tightening of its LTV limits leads to a statistically significant increase in international bank lending to the residents of that country (Table 3, Panel A). Intuitively, since LTV limits are usually tightened during upswings in the credit cycle, banks located abroad have an incentive to lend into the booming destination market. While internationally-active banks are not typically engaged in direct cross-border mortgage lending, it is quite likely that they extend cross-border loans to other borrowers in the destination country that benefit from the real estate boom (eg construction companies, real estate developers, etc.).

Our subsample estimates reveal that this relationship is statistically significant for all lender-borrower regional combinations that we examine (Table 3, Panel A, Columns 2-4). That said, the estimated impact is largest for the intra-EU sub-sample. This could be due to the higher degree of harmonization in legal frameworks within the EU, which tends to lower the costs associated with intra-EU international lending.

In terms of economic magnitude, our results suggest that a one-time tightening of LTV limits in the ***destination*** country is associated with a 4.4 percentage points (three-quarter) cumulative increase in the growth rate of international claims. As with any global regression, the above estimated impact should be interpreted with caution: since the estimated coefficients are obtained from a regression that contains multiple home countries *and* destination markets, they represent merely weighted averages across lenders and borrowers. The respective impacts for individual banking systems and destinations markets may vary considerably.

Next, we turn to the international transmission of LTV requirements from a ***home*** country to the rest of the world. LTV limits usually apply to local mortgage lending in order to curtail excessive credit growth and counteract a potential real estate bubble (Bruno et al, 2015). Such limits narrow the pool of eligible borrowers for all banks that engage in mortgage lending in a given country.[12] As a consequence, a tightening of LTV ratios in the home jurisdiction should limit domestic lending opportunities in the

[12] There is empirical evidence that the effectiveness of measures such as LTV caps is considerably enhanced if they are implemented in tandem with monetary policy moves in the same direction (Bruno et al, 2015).

affected sector, inducing banks to direct more lending to other sectors (including abroad).

We find that the stand-alone impact of a tightening of home country LTV requirements on international bank lending is not statistically significant (Table 3, Panel A). Nevertheless, the results from the regressions which include the interaction terms indicate that certain balance sheet characteristics significantly affect the response of national banking systems to changes in home country LTV limits (Table 3, Panel B).

Better capitalized banking systems tend to increase their international claims by more in the face of tighter LTV requirements in their home country. Accordingly, the sums of the estimated coefficients on the interaction terms between the capital ratio and the home LTV limits variable are positive and significant. One possible explanation is that, as intended in a macroprudential context, banks interpret a tightening of LTV ratios in their home country as a signal of elevated credit risk in a booming housing market. Well-capitalized banks are in a better position to expand internationally in spite of the state of the housing market at home. Our regional subsample results reveal that the estimates above are mainly driven by international claims on EME borrowers (Table 3, Column 3). Since EME claims tend to have higher risk weights, banking systems with thicker capital cushions would be more likely to rebalance their lending portfolios towards EMEs in response to a tightening of LTV requirements in their home jurisdiction.

Banks' liquidity and funding positions also modulate the strength of the international transmission. The estimated coefficients on the home country LTV interactions with the illiquid asset ratio and the core deposits ratio are both negative and statistically significant. Intuitively, the more illiquid a bank's assets are, the less flexibility that bank has to shift out of domestic into international lending. At the same time, higher shares of core deposits in the funding mix could be taken to mean that this banking system has a local business focus and mostly operates the traditional business model of collecting deposits and making mortgage loans. Such a banking system would not only be more exposed to the housing market in its home country, but would also find it more difficult to expand internationally in response to a tightening of home country LTV limits since it may lack the expertise and sophistication to do so.

Results on the size variable suggest that larger banking systems tend to increase their international claims by less than smaller banking systems in response to a tightening of home country LTV limits. Intuitively, larger banking systems tend to have bigger home markets. As a result, when faced with tighter LTV limits, they have more opportunities to switch out of domestic mortgage lending into other forms of domestic lending, which dampens their incentives to increase their international claims.

## 4.2 Local currency reserve requirements

Historically, reserve requirements have often been applied as monetary policy instruments. More recently, however, Ma et al (2013) and Cordella et al (2014) document that they are increasingly used as countercyclical macroprudential tools. The IBRN prudential instruments database includes only changes in reserve requirements, which the respondents to the IMF Global Macroprudential Policy

Instruments survey have explicitly identified as macroprudential tools (as opposed to monetary policy instruments) (Cerutti et al, 2016).

From the perspective of a country as a ***destination*** of credit flows, we find that a tightening of its local currency reserve requirements is associated with an increase in international bank lending to the country (Table 4, Panel A). The estimated coefficient is positive and statistically significant (at the 10% level). It implies that a one-time increase in local currency reserve requirements in the destination country is associated with a 1.1 percentage point (three-quarter) cumulative rise in the growth rate of international claims.[13] Intuitively, higher reserve requirements imply that banks located in the destination country need to hold a larger share of funding as reserves. This would typically lead to a reduction in local lending by local banks (Buch and Goldberg, 2016). The resulting market gap is likely to be filled by increased international lending from foreign banks.

Our results also indicate that a tightening of local currency reserve requirements in the ***home*** country is associated with a statistically significant increase in international bank lending to the rest of the world (Table 4, Panel A). The estimated coefficient suggests that, on average, a one-time increase in local currency reserve requirements in the home country is associated with a 3.1 percentage point (three-quarter) cumulative increase in the growth rate of international claims of banks headquartered there to the individual destination countries they are lending to.

Intuitively, higher reserve requirements imply that the return offered to depositors would have to be lower, which would most likely lead to a decline in local deposit funding (Buch and Goldberg, 2016). As a consequence, internationally active banks that are affected by the increase in local currency reserve requirements would be more likely to rebalance their funding mix away from deposit funding and towards wholesale funding. The former funding source is typically used to finance local lending, while the latter often funds international lending (McGuire and von Peter, 2016). Thus, the shift in banks' funding structure triggered by a tightening of local currency reserve requirements may ultimately result in a rebalancing away from domestic and towards international lending.

The subsample estimates reveal that the above result is mostly driven by international lending from AE banks to AE borrowers (Table 4, Panel B, Column 2). This is not surprising. AE banks which have just shifted their funding mix in response to a tightening of home reserve requirements would be more likely to re-allocate their lending to other AEs rather than to EMEs, since (foreign) AE borrowers would tend to have more similar characteristics to AE banks' domestic borrowers.

Furthermore, we find evidence that banks' business models affect the international transmission of changes in home country local currency reserve requirements (Table 4, Panel B). The estimated coefficients on the interaction terms between the capital ratio and the local currency reserve requirements are positive and strongly statistically significant (Table 4, Column 1). This implies that banking systems that are better capitalized tend to respond to a tightening of local currency reserve requirements in their home country with a greater expansion in their international claims than thinly capitalized banking systems. A possible explanation for this result is related to the fact that, all else equal, domestic assets are likely to carry lower risk

[13] The caveats about the interpretation of the estimated size of the cumulative impact discussed in the preceding sub-section apply here as well.

weights than foreign assets, especially if the latter are vis-à-vis borrowers in EMEs. Indeed, our regional results reveal that the relationship estimated above is strongest in the case of international claims on EME borrowers (Table 4, Column 3). Furthermore, although the estimated interaction coefficient for international claims on AE borrowers (Table 4, Column 2) is also statistically significant – albeit less so than its counterpart for EME borrowers – the respective coefficient for the intra-EU subsample (Table 4, Column 4) is insignificant. This combination of results could be a manifestation of the fact that the risk-weight differential between domestic and foreign assets tends to be smaller for intra-EU (lender-borrower) pairs than for other AE-to-AE (lender-borrower) pairs.

Our results also suggest that banking systems which are more reliant on core deposits tend to increase their lending by less in response to a tightening of home country reserve requirements (Table 4, Column 1). As discussed in the previous subsection, banking systems with higher shares of core deposits tend to be locally-oriented and focus on the traditional business model of collecting deposits and making mortgage loans. The ability of such banking systems to expand internationally in response to a tightening of (home country) local currency reserve requirements would normally be limited by a lack of expertise and sophistication. This potential explanation is supported by the results from our regional estimates, which reveal that the statistical significance of the estimated coefficients is highest for the subsample of EME borrowers (Table 4, Column 3). Intuitively, banks with more traditional business models would be less likely to venture into lending to EMEs as a response to a tightening of local reserve requirements due to the greater credit risk and the higher monitoring costs associated with such lending.

## 4.3 Robustness checks

In addition to our benchmark regressions, we estimate weighted regressions in which we give larger bilateral positions more weight in the estimation (in proportion to the lagged *level* of the dependent variable). The weighted regression forces the estimation to align with the response of the larger banking systems that account for the bulk of global bank credit (Amiti et al, 2016), and thereby serves as a robustness check for our benchmark results.[14] The main results from the weighted regressions are very close to their counterparts from the benchmark regressions discussed in the previous two sub-sections.

In our benchmark specifications, we evaluate the impact of each prudential policy measure on international bank lending without controlling for other types of prudential policy actions. For example, when examining the impact of changes in LTV caps, we do not control for changes in local currency reserve requirements and vice versa. In order to test the robustness of our results, we re-estimate our benchmark specifications (equations (1) and (2)), while simultaneously including the two most relevant prudential policy variables (LTV caps and local currency reserve requirements). The estimates of the main coefficients from the simultaneous

[14] For example, a 2% growth in claims in a large bilateral link (eg UK banks' claims on the United States) contributes far more to the aggregate growth in claims worldwide than a 90% growth in numerous small bilateral positions (eg Austrian banks' claims on Chile).

regressions are similar to those obtained in the benchmark regressions, indicating that our results are robust along that dimension as well.[15]

## 5. Concluding remarks

In this paper, we provide a global perspective on the international effects of prudential and, in particular, macroprudential policy measures; one that complements the bank-level analyses in the various jurisdiction-specific IBRN companion papers. We investigate the effects of prudential actions on international banking activity in a global specification, using the BIS international banking statistics, which lack the bank-level detail available to individual jurisdictions, but which offer an additional dimension by combining data from many reporting countries. Our benchmark specification amounts to a bilateral panel regression in which prudential actions in home and destination countries enter jointly. In this setting, the international transmission can be estimated separately from the local effects of a given change in prudential policy.

Our results from a panel of 16 banking systems and 53 counterparty countries suggest that changes to macroprudential policy via loan-to-value limits and local currency reserve requirements are the measures from the IBRN database that are most likely to have a significant impact on banks' international lending.

Specifically, tighter loan-to-value limits in the ***destination*** country have a positive impact on international claims extended to that country. Banks' international claims also respond to LTV changes in their ***home*** country, with balance sheet characteristics affecting the strength of the international transmission. In particular, better capitalized banking systems and those with more liquid assets and less core deposits tend to increase their international claims by more in the face of tighter LTV requirements in their home country.

A tightening of local currency reserve requirements in either the home or the destination country is also associated with an increase in international bank lending. The latter effect is stronger for banking systems that are better capitalized and those that are less reliant on deposit funding.

Overall, the results suggest that the tightening of macroprudential policy measures, often intended to constrain domestic credit, can give rise to potentially sizeable expansionary international spillovers

[15] Space constraints prevent us from publishing the tables associated with the above robustness checks. All sets of results are available upon request.

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## Summary statistics

Table 1

| | N=all; D=all | | | N=advanced, D=advanced | | | N=all; D=emerging | | | N=EU; D=EU | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Obs: | 26,326 | | Obs: | 15,431 | | Obs: | 10,691 | | Obs: | 10,201 |
| | Mean | Median | SD | Mean | Median | SD | Mean | Median | SD | Mean | Median | SD |
| ***Panel A: Dependent Variables*** | | | | | | | | | | | | |
| Δ International Claims | 1.08 | 0.81 | 18.09 | 0.57 | 0.57 | 18.52 | 1.80 | 1.10 | 17.46 | 0.66 | 0.48 | 17.21 |
| Δ Local Claims in Local Currency | 1.54 | 0.00 | 18.97 | 0.73 | 0.00 | 19.04 | 1.54 | 0.00 | 18.97 | 1.11 | 0.00 | 17.45 |
| ***Panel B: Balance Sheet Composition of Home country banking systems*** | | | | | | | | | | | | |
| Log Total Assets | 8.02 | 8.08 | 0.87 | 7.93 | 8.00 | 0.87 | 8.19 | 8.23 | 0.81 | 7.83 | 7.91 | 0.92 |
| Tier 1 Ratio (%) | 3.80 | 4.01 | 1.65 | 3.82 | 4.04 | 1.59 | 3.72 | 3.92 | 1.71 | 3.43 | 3.52 | 1.52 |
| Illiquid Asset Ratio (%) | 53.14 | 52.48 | 13.46 | 54.32 | 54.12 | 13.45 | 50.79 | 50.09 | 12.46 | 54.32 | 57.34 | 14.88 |
| International Activity (%) | 39.22 | 35.15 | 16.76 | 39.44 | 34.84 | 16.45 | 39.51 | 36.03 | 16.77 | 42.15 | 39.70 | 17.12 |
| Net Intragroup Liabilities (%) | –0.78 | –0.43 | 2.40 | –0.93 | –0.50 | 2.45 | –0.57 | –0.27 | 2.34 | –1.35 | –0.86 | 2.39 |
| Deposits Ratio (%) | 42.52 | 39.81 | 12.35 | 41.99 | 39.67 | 12.04 | 42.69 | 39.84 | 12.13 | 36.79 | 37.34 | 9.10 |
| ***Panel C: BIS Cycle Variables*** | | | | | | | | | | | | |
| BIS financial cycle (Destination) | 1.77 | 3.70 | 13.18 | 2.52 | 3.88 | 13.69 | 0.63 | 3.37 | 12.43 | 4.05 | 4.27 | 12.99 |
| BIS financial cycle (Home) | 3.23 | 3.36 | 16.32 | 4.54 | 4.52 | 18.38 | 1.44 | 1.77 | 12.64 | 5.32 | 4.41 | 18.55 |
| BIS business cycle (Destination) | –0.01 | –0.09 | 1.46 | 0.00 | –0.09 | 1.46 | –0.01 | –0.07 | 1.44 | 0.01 | –0.13 | 1.51 |
| BIS business cycle (Home) | 0.00 | –0.05 | 2.04 | –0.02 | –0.12 | 1.85 | 0.04 | 0.06 | 2.29 | –0.03 | –0.21 | 2.06 |

This table provides summary statistics for our bilateral dependent variable on lending, balance sheet characteristics of our included home country banking systems and the included BIS cycle variables for home and destination countries. Data are observed quarterly from 2000Q1 to 2014Q4. International claims and local claims in local currency are from the BIS CBS on an immediate borrower basis (Panel A). For Panel B, banking systems' balance sheet characteristics on total assets, Tier 1 capital, illiquid assets, and core deposits are from Bankscope. Banking system data on international activity draw on foreign claims from the BIS CBS, while the net intragroup liabilities are based on the BIS locational banking statistics. The net intragroup liabilities are measured from the perspective of a bank's head office total net internal borrowing vis-à-vis all its related international offices. As for Panel C, the BIS business cycle indicator draws on the output gap estimates presented in BIS (2014), and the financial cycle indicator is based on estimates of credit-to-GDP gaps using the methodology of Drehmann et al (2011).

Summary statistics on changes in prudential instruments

Table 2

| | # of Country-Time Changes | | | # of Destination-Nationality-Time Changes | | | |
|---|---|---|---|---|---|---|---|
| | all | of which *tightenings* | of which *loosenings* | all | of which *tightenings* | of which *loosenings* | as % share of observations |
| ***Panel A: Changes in the home country of nationality (HomeP)*** | | | | | | | |
| Prudential index | 94 | 70 | 24 | 4888 | 3640 | 1248 | 19.69% |
| General capital requirements | 31 | 31 | 0 | 1612 | 1612 | 0 | 6.49% |
| Sector specific capital buffer | 13 | 10 | 3 | 676 | 520 | 156 | 2.72% |
| Loan-to-value ratio limits | 19 | 13 | 6 | 988 | 676 | 312 | 3.98% |
| Reserve requirements: Local | 37 | 13 | 24 | 1924 | 676 | 1248 | 7.75% |
| Interbank exposure limit | 10 | 10 | 0 | 520 | 520 | 0 | 2.10% |
| Concentration ratio | 8 | 8 | 0 | 416 | 416 | 0 | 1.68% |
| ***Panel B: Changes in the destination country (DestP)*** | | | | | | | |
| Prudential index | 486 | 325 | 161 | 7158 | 4928 | 2230 | 28.84% |
| General capital requirements | 94 | 94 | 0 | 1473 | 1473 | 0 | 5.93% |
| Sector specific capital buffer | 65 | 48 | 17 | 989 | 734 | 255 | 3.98% |
| Loan-to-value ratio limits | 89 | 65 | 24 | 1346 | 991 | 355 | 5.42% |
| Reserve requirements: Local | 241 | 99 | 142 | 3410 | 1474 | 1936 | 13.74% |
| Interbank exposure limit | 24 | 23 | 1 | 347 | 331 | 16 | 1.40% |
| Concentration ratio | 31 | 29 | 2 | 449 | 420 | 29 | 1.81% |

This table shows summary statistics on changes in prudential instruments over the period 2000Q1-2014Q4. The reported data are based on the regression sample.

Impact of changes in *loan-to-value limits* on international claims Table 3

| | N=all D=all | N=advanced D=advanced | N=all D=emerging | N=EU D=EU |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| ***Panel A: Prudential measures, equation (1)*** | | | | |
| DestP | 4.39*** | 3.30* | 3.35*** | 4.15** |
| | (0.00) | (0.06) | (0.01) | (0.05) |
| HomeP | –0.45 | 2.58 | –4.58** | –0.90 |
| | (0.78) | (0.24) | (0.05) | (0.76) |
| Observations | 26,326 | 15,431 | 10,691 | 10,201 |
| R-squared | 0.05 | 0.05 | 0.06 | 0.07 |
| Adjusted R-squared | 0.04 | 0.04 | 0.05 | 0.06 |
| Number of destination countries | 53 | 28 | 25 | 27 |
| Number of home countries | 16 | 15 | 16 | 11 |
| ***Panel B: Prudential measures and their interactions with balance sheet characteristics, equation (2)*** | | | | |
| DestP | 4.38*** | 3.27* | 3.35*** | 4.17** |
| | (0.00) | (0.06) | (0.01) | (0.04) |
| HomeP | 143.10*** | 151.30* | –27.97 | 651.60*** |
| | (0.01) | (0.07) | (0.76) | (0.00) |
| Log Total Assets*HomeP | –15.56*** | –15.43* | –5.40 | –58.00*** |
| | (0.01) | (0.06) | (0.56) | (0.01) |
| Capital Ratio*HomeP | 7.20*** | 3.55 | 11.91*** | 1.88 |
| | (0.00) | (0.22) | (0.00) | (0.75) |
| Illiquid Assets Ratio*HomeP | –0.67*** | –0.55 | –0.50* | –2.47*** |
| | (0.00) | (0.28) | (0.07) | (0.01) |
| International Activity*HomeP | 0.07 | –0.02 | 0.79** | –1.38 |
| | (0.77) | (0.96) | (0.03) | (0.37) |
| Net Intragroup Liabilities*HomeP | –1.06 | –1.34 | –0.64 | 1.74 |
| | (0.41) | (0.49) | (0.75) | (0.80) |
| Core Deposits Ratio*HomeP | –0.37* | –0.30 | 0.31 | 0.12 |
| | (0.06) | (0.61) | (0.41) | (0.97) |
| Observations | 26,326 | 15,431 | 10,691 | 10,201 |
| R-squared | 0.05 | 0.05 | 0.07 | 0.08 |
| Adjusted R-squared | 0.04 | 0.04 | 0.06 | 0.06 |
| Number of destination countries | 53 | 28 | 25 | 27 |
| Number of home countries | 16 | 15 | 16 | 11 |

This table estimates equations (1) and (2) and reports the effects of changes in destination (*DestP*) and home (*HomeP)* country prudential policy measures on log changes in international claims. The quarterly data for home-destination country pairs range from 2000Q1 to 2014Q4. All regressions control for home country bank balance sheet characteristics (lagged by one quarter) as well as business and financial cycles, as described in Section 3 and Appendix A. Panel A shows the sum of coefficient estimates (including the contemporaneous effect and two lags) of *DestP* (vector $\alpha$) and of *HomeP* (vector $\gamma$) with p-values of F-tests in parentheses. Panel B adds the sums of interaction effects (contemporaneous effects and two lags) of *HomeP* with individual lagged home bank characteristics (vector $\beta$). For details on the variables, see Appendix A. Column (1) features all countries, column (2) only advanced economies, column (3) emerging market economies as destinations, and column (4) focuses on EU member countries. Appendix C lists the countries used as home (N) and destination (D). All specifications include N, D and T fixed effects. Standard errors are robust. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Impact of changes in *local reserve requirements* on international claims Table 4

| | N=all D=all | N=advanced D=advanced | N=all D=emerging | N=EU D=EU |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| ***Panel A: Prudential measures, equation (1)*** | | | | |
| DestP | 1.13* | 1.86 | 0.36 | –0.14 |
| | (0.07) | (0.45) | (0.59) | (0.93) |
| HomeP | 3.10** | 9.84*** | –1.43 | 4.07 |
| | (0.03) | (0.01) | (0.53) | (0.49) |
| Observations | 26,326 | 15,431 | 10,691 | 10,201 |
| R-squared | 0.05 | 0.05 | 0.06 | 0.07 |
| Adjusted R-squared | 0.04 | 0.04 | 0.05 | 0.06 |
| Number of destination countries | 53 | 28 | 25 | 27 |
| Number of home countries | 16 | 15 | 16 | 11 |
| ***Panel B: Prudential measures and their interactions with balance sheet characteristics, equation (2)*** | | | | |
| DestP | 1.10* | 1.72 | 0.35 | –0.04 |
| | (0.08) | (0.48) | (0.60) | (0.98) |
| HomeP | 24.17 | 73.86 | –50.56 | 22.69 |
| | (0.58) | (0.38) | (0.37) | (0.79) |
| Log Total Assets*HomeP | –0.91 | –3.36 | 3.72 | –0.17 |
| | (0.78) | (0.60) | (0.37) | (0.98) |
| Capital Ratio*HomeP | 3.56*** | 3.93* | 4.15*** | 3.61 |
| | (0.00) | (0.07) | (0.00) | (0.11) |
| Illiquid Assets Ratio*HomeP | 0.00 | 0.18 | 0.50 | 0.19 |
| | (1.00) | (0.83) | (0.16) | (0.81) |
| International Activity*HomeP | –0.03 | 0.15 | 0.16 | 0.09 |
| | (0.81) | (0.64) | (0.31) | (0.77) |
| Net Intragroup Liabilities*HomeP | 1.45 | 2.04 | 0.91 | –0.57 |
| | (0.34) | (0.43) | (0.64) | (0.82) |
| Core Deposits Ratio*HomeP | –0.52** | –1.82* | –0.62** | –1.24 |
| | (0.03) | (0.07) | (0.05) | (0.21) |
| Observations | 26,326 | 15,431 | 10,691 | 10,201 |
| R-squared | 0.05 | 0.05 | 0.06 | 0.07 |
| Adjusted R-squared | 0.04 | 0.04 | 0.05 | 0.06 |
| Number of destination countries | 53 | 28 | 25 | 27 |
| Number of home countries | 16 | 15 | 16 | 11 |

This table estimates equations (1) and (2) and reports the effects of changes in destination (*DestP*) and home (*HomeP)* country prudential policy measures on log changes in international claims. The quarterly data for home-destination country pairs range from 2000Q1 to 2014Q4. All regressions control for home country bank balance sheet characteristics (lagged by one quarter) as well as business and financial cycles, as described in Section 3 and Appendix A. Panel A shows the sum of coefficient estimates (including the contemporaneous effect and two lags) of *DestP* (vector $\alpha$) and of *HomeP* (vector $\gamma$) with p-values of F-tests in parentheses. Panel B adds the sums of interaction effects (contemporaneous effects and two lags) of *HomeP* with individual lagged home bank characteristics (vector $\beta$). For details on the variables, see Appendix A. Column (1) features all countries, column (2) only advanced economies, column (3) emerging market economies as destinations, and column (4) focuses on EU member countries. Appendix C lists the countries used as home (N) and destination (D). All specifications include N, D and T fixed effects. Standard errors are robust. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

# Appendix A: Data descriptions and definitions

**Selection of banking systems.** The BIS consolidated banking statistics contain data covering the foreign positions of banks from (headquartered in) more than 30 home reporting countries. Some banking systems were excluded because (a) there were large jumps due to breaks in series for which no pre-break data are available; (b) the underlying breakdowns by claim type (local vs international) or by sector (bank, non-bank financial and official sector) were incomplete or missing; or (c) consolidated foreign claims outstanding were always less than $100 billion. The sample of 16 national banking systems used in this paper (see Appendix C) account for almost 90% of the reported global total at end-2014.

**Selection of bilateral nationality-destination pairs.** International claims are highly concentrated between major pair of bank nationalities and counterparty countries, leaving many other bilateral pairs with small reported positions. To ensure that growth rates (our dependent variables) are economically meaningful, we restrict the sample of nationality-destination pairs to those that exceed $1 billion. Individual international loans tend to be large, often exceeding $100 million on any one counterparty. As a result, a single claim on a counterparty located in a country attracting a small stock of claims otherwise can induce excessive swings in the growth rates.

**Adjustments for exchange rate movements.** International claims on a particular counterparty country tend to be denominated in a mixture of currencies. Changes in the relative value of these currencies induce changes in the outstanding stock of claims when expressed in any single currency, here in US dollars. Our interest in this paper is to understand how changes in policy measures affect the growth in credit, net of any valuation changes induced by exchange rate movements.

To adjust the quarterly growth rate of international claims, we use the BIS locational banking statistics (LBS) to derive estimates of the currency composition of the bilateral positions. We first split international claims into cross border claims in all currencies (XBC) and local claims in foreign currencies (LCFC) (ie INTL = XBC + LCFC). For LCFC, a partial currency breakdown (USD, EUR, JPY, Other) is available in the BIS LBS by Nationality, at least for the key banking systems' bilateral claims on countries that themselves report in the LBS.

For these and any other banking systems' LCFC on countries that do not report the LBS, and for all banking systems' XBC on all countries, we base estimates of the currency shares (USD, EUR, JPY, CHF, GBP, Other) on the LBS by Residency. Here, we assume that the currency distribution of international claims on a particular counterparty country is identical across banking systems. That is, that the currency shares of US banks' cross-border claims on Hungary are assumed to be the same as the shares of German, Swiss and other banks' claims on Hungary. For those counterparty countries that themselves report the LBS to the BIS, we make an additional correction to exclude interoffice positions from each currency total.

With the currency shares for the two components – LCFC and XBC – in hand, we are able to estimate the overall currency shares for each consolidated banking system's total international claims on each counterparty country. The second step in our adjustment is to feed these series, along with exchange rates, into a calculation of the quarterly growth rate in international claims that excludes the effect of exchange rate movements in the key currencies.

Construction of variables used in the empirical analysis

| Variable Name | Description | Data Source |
|---|---|---|
| **Dependent Variable** | | |
| International claims① | Cross-border claims + local claims in foreign currencies (growth rate) | BIS international banking statistics② |
| Local claims① in local currency | Claims booked by banks' affiliates in the destination country and denominated in that country's local currency (growth rate) | BIS international banking statistics② |
| **Independent Variables** | | |
| Illiquid asset ratio | (Loans and advances to banks + loans and advances to non-banks, including received bills)/Assets (in %) | Bankscope③ |
| Log Assets | Log (balance sheet total) | Bankscope③ |
| Core deposits ratio | Savings deposits/Assets (in %) | Bankscope③ |
| Capital ratio | CET1/Total Assets | Bankscope③ |
| Net intragroup funding/ liabilities | (Liabilities minus claims of the parent bank vis-à-vis foreign affiliates / Total Liabilities (in %) | BIS locational banking statistics②, Bankscope③ |
| International activity | Ratio of foreign claims to total assets (in %) | BIS consolidated banking statistics②, Bankscope③ |

① Claims include both reporting banks' loans and holdings of debt securities. ② Certain portions of the data are publicly available; others are marked as confidential by the respective reporting national authorities. The publicly available parts of the data can be accessed at: http://www.bis.org/statistics/consstats.htm?m=6%7C31%7C70. ③ Commercial dataset.

# Appendix B: Derivation of the global specification

This appendix derives a global specification, appropriate for the structure of the BIS CBS, building on Buch and Goldberg's (2016) regression devised for individual IBRN country teams. We show that this extension gives rise to a single bilateral panel regression in which prudential actions in both home and destination countries enter jointly, regardless of whether we start from the inward or outward specification.

Consider inward transmission with respect to the domestic market of a given country. Throughout, we use *i* to denote a bank's home country (ie nationality) and *j* for the destination country (ie counterparty). In Buch and Goldberg (2016), the destination index is omitted since the regression relates to a single destination market. Reproducing the baseline inward specification with lags and interaction terms omitted for simplicity,

$$\Delta Y_{b,i,t} = \alpha_0 + \alpha_1 HomeP_{i,t} + \alpha_4 X_{b,i,t-1} + \alpha_5 Z_{i,t} + f_b + f_t + \varepsilon_{b,j,t} \quad \text{(A1)}$$

where $\Delta Y_{b,t}$ is the log change in lending of bank *b* from country *i* to the domestic market, $X_{b,i,t-1}$ is a vector of control variables of foreign bank balance sheets, and $Z_{i,t}$ represents the cycle variables for country *i*. Specifically, individual banks *b* from different foreign countries *i* operate in a given domestic market. Credit thus flows via foreign banks to the domestic market, possibly affected by prudential policies in their respective home countries, captured by $HomeP_{i,t}$. The fixed effect $f_t$ controls for any concurrent prudential action in the domestic market. The term *inward transmission* thus consistently refers to the direction of credit flows, as well as to the effects of policy abroad, imported to the domestic market.

The global version is a straightforward extension, based on the fact that the BIS CBS contain not one, but many, domestic markets: there are now multiple destinations *j*,[16]

$$\Delta Y_{i,j,t} = \alpha_0 + \alpha_1 HomeP_{i,t} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{i,t} + f_i + f_t + \beta_1 DestP_{j,t} + f_j + \alpha_6 Z_{j,t} + \varepsilon_{i,j,t} \quad \text{(A1')}$$

The estimate of $\alpha_1$ measures inward transmission, while $\beta_1 DestP_{j,t}$ measures the effect of concurrent prudential actions in the various destination markets *j*.

Extending the IBRN equation for outward transmission demonstrates the virtue of the symmetry afforded by our global setting. Specification 3 in Buch and Goldberg (2016), simplified, becomes

$$\Delta Y_{b,j,t} = \alpha_0 + \alpha_1 DestP_{j,t} + \alpha_4 X_{b,t-1} + \alpha_5 Z_{j,t} + f_j + f_t + f_b + \varepsilon_{b,j,t}. \quad \text{(A2)}$$

In that setting, the banks observed in a given country lend to various foreign destinations *j*, through cross-border claims and local claims booked abroad. These banks are all from the same home country (not indexed), with any prudential action at home subsumed in $f_t$. A limitation of that setting is that *outward transmission*

[16] Aggregate characteristics of banking system *i* replace bank-specific features $X_{b,i,t}$ in (A1), and variables distinguishing the different destinations *j* now enter symmetrically with those for different home countries *i*.

refers to the flow of credit, not to the transmission of prudential actions to foreign markets.[17]

Expanding the baseline to a global specification leads to a more natural measure of outward transmission, since the equation will contain prudential actions in various *home* countries too. Expanding equation (2) for multiple home countries $i$ allows to see the variation in prudential action across home countries, $HomeP_{i,t}$,

$$\Delta Y_{i,j,t} = \alpha_0 + \alpha_1 DestP_{j,t} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{j,t} + f_j + f_t + f_i + \beta_1 HomeP_{i,t} + \alpha_6 Z_{i,t} + \varepsilon_{i,j,t} \quad \text{(A2')}$$

Importantly, outward transmission of prudential actions from home to destination countries is measured by $\beta_1$, in analogy to the way that $\alpha_1$ captured inward transmission from abroad in (A1'). Indeed, the global specifications (A1') and (A2') are symmetric, up to the coefficient labels. The directions of credit flows and policy transmission are now aligned. This symmetry is natural, since one bank's home is another's destination market.

It follows that the global specification provides a single baseline for both inward and outward transmission which, including two lags in vector form (bold), reads

$$\Delta Y_{i,j,t} = \alpha_0 + \boldsymbol{\gamma' HomeP_{i,t}} + \boldsymbol{\alpha' DestP_{j,t}} + \alpha_4 X_{i,t-1} + \alpha_5 Z_{i,t} + \alpha_6 Z_{j,t} + f_i + f_j + f_t + \varepsilon_{i,j,t} \quad \text{(A3)}$$

This is equation (1) in the main text. The coefficients on $HomeP_{i,t}$ and its lags measure the international transmission of policy, whereas those on $DestP_{j,t}$ capture the local effect of prudential policy changes.

[17] Prudential actions at home most likely affect all home banks. It thus takes meaningful variation in actions taken abroad (in destinations *j*) to identify any effect of such actions. Hence outward transmission no longer refers to the direction of regulatory transmission as before (as equation (A2) associates prudential action with *destination* countries). Instead, "outward" refers to the flow of lending, which runs "outward" from the home country to destinations *j*.

# Appendix C: Sets of home and destination countries

## Home countries (bank nationalities)

### All (N=16)

Austria, Australia, Belgium, Canada, Germany, Denmark, France, India, Italy, Japan, Netherlands, Portugal, Spain, Sweden, United Kingdom, United States.

### Advanced (N=15)

Austria, Australia, Belgium, Canada, Germany, Denmark, France, Italy, Japan, Netherlands, Portugal, Spain, Sweden, United Kingdom, United States.

### EU member countries (N=11)

Austria, Belgium, Germany, Denmark, France, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom.

## Destination countries

### All (D=53)

Argentina, Austria, Australia, Belgium, Brazil, Bulgaria, Canada, Chile, China, Croatia, Czech Republic, Germany, Denmark, Estonia, Finland, France, Greece, Hong Kong, Hungary, Iceland, Indonesia, India, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Malaysia, Mexico, Netherlands, Norway, New Zealand, Peru, Poland, Portugal, Romania, Russia, Singapore, Slovenia, Slovakia, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Kingdom, United States, South Africa.

### Advanced (D=28)

Austria, Australia, Belgium, Canada, Germany, Denmark, Estonia, Finland, France, Greece, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, New Zealand, Portugal, Slovenia, Slovakia, Spain, Sweden, Switzerland, United Kingdom, United States.

### Emerging (D=25)

Argentina, Brazil, Bulgaria, Chile, China, Croatia, Czech Republic, Hong Kong, Hungary, Iceland, Indonesia, India, Israel, Korea, Malaysia, Mexico, Peru, Poland, Romania, Russia, Singapore, Thailand, Turkey, Ukraine, South Africa.

### EU member countries (D=27)

Austria, Belgium, Bulgaria, Croatia, Czech Republic, Germany, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Sweden, United Kingdom.

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