Finance and Economics Discussion Series
Divisions of Research & Statistics and Monetary Affairs
Federal Reserve Board, Washington, D.C.

Can macroprudential measures make cross-border lending more resilient? Lessons from the taper tantrum

Előd Takáts and Judit Temesvary

2017-123

Please cite this paper as:
Takáts, Előd, and Judit Temesvary (2017). "Can macroprudential measures make cross-border lending more resilient? Lessons from the taper tantrum," Finance and Economics Discussion Series 2017-123. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.123.

Can macroprudential measures make cross-border lending more resilient?

Lessons from the taper tantrum[1]

Előd Takáts[2]

Bank for International Settlements

Judit Temesvary[3]

Federal Reserve Board

December 2017

Abstract: We study the effect of macroprudential measures on cross-border lending during the taper tantrum, which saw a strong slowdown of cross-border bank lending to some jurisdictions. We use a novel dataset combining the BIS Stage 1 enhanced banking statistics on bilateral cross-border lending flows with the IBRN's macroprudential database. Our results suggest that macroprudential measures implemented in borrowers' host countries prior to the taper tantrum significantly reduced the negative effect of the tantrum on cross-border lending growth. The shock-mitigating effect of host country macroprudential rules are present both in lending to banks and non-banks, and are strongest for lending flows to borrowers in advanced economies and to the non-bank sector in general. Source (lending) banking system measures do not affect bilateral lending flows, nor do they enhance the effect of host country macroprudential measures. Our results imply that policymakers may consider applying macroprudential tools to mitigate international shock transmission through cross-border bank lending.

Keywords: Taper tantrum; cross-border claims; macroprudential policy; diff-in-diff analysis
JEL codes: F34; F42; G21; G38

[1] We are thankful for comments from Ingo Fender, Gretchen Weinbach, participants at seminars at the Bank for International Settlements, the Federal Reserve Board, and the London School of Economics, and participants at the IFABS Summer 2017 Conference in Oxford, England. The views expressed in this paper are solely those of the authors, and do not necessarily reflect the views of the Bank for International Settlements or the Board of Governors of the Federal Reserve System.
[2] Bank for International Settlements, Centralbahnplatz 2, Basel, CH-4002 Switzerland. Elod.takats@bis.org
[3] Federal Reserve Board, 1801 K Street, Washington, DC 20006 USA. Judit.temesvary@frb.gov

1. Introduction

Since the financial crisis, many jurisdictions have used macroprudential policies, applying prudential tools in order to limit systemic risk (IMF-FSB-BIS, 2016). Yet, evidence on the effectiveness of such tools remains scarce – in part due to the relative absence of recent episodes of financial disruptions which would allow for an assessment of what remains a fairly new set of tools. A notable exception is the so-called "taper tantrum" – a large U.S. dollar funding shock in international financial markets, which developed after Fed Chairman Ben Bernanke's indication in mid-2013 that the Fed would start tapering off its quantitative easing program – which caused a broad-based, but heterogeneous reduction in cross-border financial flows. As such, this episode is an ideal testing ground for assessing the role of macroprudential tools in lending stabilization. The taper tantrum has raised a series of questions for policymakers and researchers alike: Did cross-border bank lending remain more stable in borrowers' host countries which had more actively applied macroprudential tools beforehand? Was lending from those source (lending) banking systems which had applied more macroprudential tools more resilient? Were source or host measures more effective? Were advanced or emerging markets impacted differently? Which macroprudential tools affected cross-border bank lending more? Did regulations stabilize interbank and non-bank lending alike? Did source lending system and host country measures interact?

In this paper, we answer these questions by using a novel dataset. We combine the "Stage 1 Enhancements" to the Bank for International Settlements' (BIS) International Banking Statistics with the International Banking Research Network's (IBRN) prudential regulatory database. As we

are interested in the workings of macroprudential tools, we focus on macroprudential elements in the IBRN database (and not on (micro)prudential measures such as capital requirements).

In terms of methodology, we employ a difference-in-difference analysis to compare the growth rate of cross-border bank lending right before and immediately after the taper tantrum shock. More precisely, we assess whether the slowdown in lending growth during the taper tantrum was mitigated by the cumulative macroprudential measures undertaken in the period leading up to the tantrum (that is, from the beginning of our sample in 2000 Q1 until 2013 Q1 – the quarter just prior to the beginning of the taper tantrum).

We find broad evidence that macroprudential measures applied beforehand stabilized cross-border lending flows during the taper tantrum. Most importantly, macroprudential tools applied in borrowers' host countries stabilized the growth of cross-border bank lending inflows significantly. The impact is stronger for lending to borrowers in advanced economies than for lending to borrowers in emerging markets – but is present for lending to both bank and non-bank borrowers. We do not find evidence that macroprudential policies applied in source (lending) banking systems affected the growth of cross-border bank lending outflows during the tantrum, or that source (lending banking system) and host country macroprudential measures would have significantly interacted.

The lending-stabilizing impact of macroprudential tools was not only statistically, but also economically significant. In the overall sample, an additional macroprudential tightening action over the 2000 Q1 - 2013 Q1 period attenuated the tantrum effect on cross-border bank lending by around one percentage point. This translates to a differential tantrum impact on cross-border flows of around 8 percentage points, when we compare host countries at the 90^{th} vs 10^{th}

percentile of macroprudential regulatory stringency. For advanced economies, the respective figures are around 2.5 percentage points and 13 percentage points. Our findings are robust to various changes in the econometric specifications, such as applying different policy indices. The results are also present in most subsets of macroprudential tools, though, as expected, are not significant for all components.

The results are relevant for policymakers: They suggest that macroprudential tools not only contribute to the stability of the domestic financial system, but also enhance cross-border bank financing inflows to the economy. Our result confirming the strong and significant effects of macroprudential tools applied in host countries suggests that, though international coordination can play a useful rule, it remains paramount that countries "keep their house in order". Importantly, while we do not find significant evidence that the stabilizing potential depends on the interaction between source and host macroprudential measures, this does not necessarily imply that externalities do not exist. For instance, more stable host country financial systems might make the source (lending) banking systems also more resilient, by providing stable bank financing demand.

The paper proceeds as follows. In Section 2 we link our work to the growing related literature. In Section 3 we describe our data in detail, and Section 4 presents the econometric methodology. Section 5 details the results. We discuss the robustness of our findings in Section 6. Section 7 discusses the main caveats and Section 8 concludes with policy implications.

2. Related literature

Our research focuses on the intersection of macroprudential policies and spillovers in international financial stability and regulation. The research on macroprudential policies dates back to Crockett (2000) and Borio (2003) and is reviewed in detail by Galati and Moessner (2011), among others. The policy discussion, as shown for instance in the recent IMF-FSB-BIS (2016) publication, suggests that macroprudential policies might have an international dimension.

In particular, several research pieces point in the direction that macroprudential policies could spill over across borders through the activities of internationally active banks. There is growing evidence that monetary policy spills over internationally through cross-border bank lending (Cetorelli and Goldberg (2012); Miranda-Agrippino and Rey (2015); Forbes and Warnock (2012)), potentially also through the currency denomination of cross-border bank loans (see Alper et al (2016); Ongena et al (2015); Avdjiev and Takats (2016); Avdjiev, Subelyte and Takats (2016); Takats and Temesvary (2017)). In a similar vein, Houston et al (2012), for instance, find that regulations can affect international banks' activities. Even closer to our focus, Berrospide et al (2017) and Temesvary (2017) find evidence of regulatory spillovers into bilateral bank flows to and from the U.S. In addition, Ocampo (2011) studies counter-cyclical regulations in developing countries, and Laeven et al (2014) examine the importance of bank rules which address systemic risk. One particular channel of regulatory spillovers, as Karolyi et al (2017) show, could work through financial stability. The presence of this latter channel raises the possibility that macroprudential policies, which aim to strengthen financial stability, might also spill over to other

countries via international bank lending. Buch and Goldberg (2016) summarize evidence from central bank experiences in the framework of the IBRN network.

In terms of data use, Avdjiev et al (2017), part of the IBRN research effort discussed in Buch and Goldberg (2016), is the closest to our work, as they also combine BIS data (though not the Stage 1 enhancements) and the IBRN prudential database. However, their focus is very different from ours. They investigate the continuous impact of prudential tools on cross-border bank lending (i.e. whether prudential tools enacted in one quarter affect cross-border bank lending in the following quarter) and not, as we do, whether the accumulation of prudential regulation increases resilience of cross-border bank lending – and how rules adopted in one country affect cross-border bank lending and potential spillovers in this regard.

In terms of theoretical work, Agenor et al (2017) provide a model for how macroprudential policies might spill over internationally. In broad terms, our work can be seen as testing such spillovers. However, there is some distance as we do not focus on the impact of normal financial flows, but rather stability of such flows during a period of financial stress.

Finally, our work also builds on research which argues that national borders and economically relevant decision-making units often diverge, as we also describe in Takats and Temesvary (2017). The discussion dates back to Fender and McGuire (2010) and Cecchetti et al (2010), who show that the lending bank's nationality tends to be more relevant than its residence in identifying the decision-making unit. This argument is further developed from a policy perspective in CGFS (2011). Building on these findings, Avdjiev et al (2015a) coin the term of the (absence of) triple coincidence in international finance. This term refers to the phenomenon that national borders, the conventional units of international economic analysis, often do not coincide

with the economically relevant decision-making unit. Following these lessons, we focus on "lending banking systems" as opposed to "lending countries", so that we can follow the decision-making unit as precisely as possible.

3. Data description

3.1 Data on prudential measures

Our database combines information on country-level macroprudential measures enacted during the period up to the taper tantrum, with detailed information on bilateral cross-border lending flows before and after the tantrum. Our data on country-level regulatory measures come from the macroprudential database employed by the 2016 IBRN project, also incorporating the 2013 Global Macro Prudential Instruments (GMPI) survey (Cerrutti et al, 2015; Correa et al, 2016; Avdjiev et al, 2017; Berrospide et al, 2017). Table 1 and Table A1 summarize and describe these indices.

The IBRN database contains a mix of macroprudential measures and also standard (micro)prudential minimum capital requirements. More precisely, while eight out of the nine IBRN categories (sscb_res, sscb_cons, sscb_oth, concrat, ibex, ltv_cap, rr_foreign, and rr_local) are clearly macroprudential, the ninth index on capital requirements (cap_req) is less clearly macroprudential, as we explain in more detail below. The precise description of the nine indices is detailed in Table A1 in the Appendix.[4]

[4] In addition, the IBRN database contains three pre-defined indices. First, PruC is a country index by time *t* and country c, which equals to 1 if the sum of nine distinct macroprudential instruments (shown in Table A1) is greater than or equal to 1, equals to -1 if the sum of the instruments is less than or equal to -1, and is 0 otherwise. Second,

For our formal analysis, we create a new index of macroprudential tools (which we denote by Pruc6). This Pruc6 index is analogous to the pre-defined PruC index of the IBRN database, but excludes changes in capital requirements. More precisely, Pruc6 is a country index by time *t* and country *c*, which equals to 1 if the sum of eight distinct macroprudential instruments (sscb_res, sscb_cons, sscb_oth, concrat, ibex, ltv_cap, rr_foreign, and rr_local) is greater than or equal to 1, equals to -1 if the sum of the instruments is less than or equal to -1, and is 0 otherwise. In other words, our Pruc6 index is fully analogous to the pre-defined Pruc index, only it excludes the impact of capital requirements (cap_req).

The rationale for excluding the cap_req (capital requirements) index is threefold. First is focus: we hone in on the efficiency of macroprudential instruments, while capital requirements generally belong to the category of microprudential instruments rather than macroprudential ones. Second is policy stance: changes in capital requirements mostly signal the adoption of the Basel III regime and thereby international harmonization. Hence, cumulative differences in country-specific capital indices are more likely to reflect differences in prudential regulation at the start rather than at the end of the observation period. Third is the role of expectations: given that the adoption of Basel III was anticipated along country-specific timelines, the problem of expectations is the strongest for capital requirements. Nonetheless, despite these issues, we repeat our analysis for the pre-defined indices to check robustness.

PruC2 denotes a country index by time *t* and country c, which is equal to 1 if the sum of the nine instruments is greater than or equal to 1, equals to -1 if the sum of the instruments is less than or equal to -1, and is 0 otherwise. In this case, all individual instruments are adjusted to have maximum and minimum changes of 1 and -1. Third, sscb is the sum of changes in sector-specific capital buffers across the residential, consumer, and other sectors.

While the IBRN database is the most comprehensive and thorough database of country-specific macroprudential instruments, there are several issues associated with using this data, which we address in our analysis. First, there is the possibility of a confounding effect in that stricter macroprudential policy settings may signal (unobserved) vulnerability. Second, a cross-sectional analytical concern is that the IBRN macroprudential database does not measure the absolute level of policy stance at any given time: it shows *cumulative* actions taken relative to the start of the panel. Third, a time-series limitation is that the confounding effect of expectations complicates the identification of the timing of the regulatory spillovers. Fourth, we must consider the issue of asymmetry in that not all macroprudential actions have the same strength and effects.

For our analysis, we use a cumulative index that encompasses the entire available data starting from 2000 Q1 up until the quarter prior to the beginning of the taper tantrum: 2013 Q1. Importantly, using these cumulative changes mitigates potential problems arising from the uncertainty of timing (i.e. whether or not the announcement was expected beforehand). In short, our cumulative measurement provides a gauge of how much macroprudential regulations had tightened since the end of the financial crisis up to the tantrum.

According to these measures, the post-crisis period saw a general *tightening* of macroprudential policies across the countries in our sample, as shown in the summary statistics of Table 1 (see also IMF-FSB-BIS, 2016). Not only did countries use macroprudential tools more often, but also, when they used them, they tended to tighten credit conditions. These averages, however, hide important cross-sectional differences – with some countries, for instance,

substantially tightening and others significantly easing their macroprudential policy stance during this period.

3.2 Data on bilateral cross-border lending flows

We collect data on bilateral cross-border bank lending flows from the Stage 1 Enhancements to the Bank for International Settlement's International Banking Statistics (BIS IBS) which is detailed, for instance, in Avdjiev et al (2015b). The data covers around 30 trillion U.S. dollars in total cross-border claims (Table A2). The main advantage of using the Stage 1 enhancements is that this dataset allows us to link lending banking systems with the host countries of borrowers, while retaining information on the currency composition of the lending flows. Importantly, this dataset uniquely allows us to correctly measure the change in bank claims between lending banking systems and host countries – without the confounding impact of currency valuation movements. We select those source (lending) banking system–host country pairs for which the IBRN dataset provides detailed prudential regulatory information for both the source banking system and the host country.

The bilateral cross-border lending dataset is also broken down by target (counterparty) sector, separately covering claims on host countries' banking and non-banking (including non-bank financials, such as insurance) sectors. As shown in the summary statistics of Table 1, across all source lending systems and host countries, bilateral cross-border lending flows increased a little *on average* during the tantrum – however, these averages hide large cross-sectional differences in the shock impact. For instance, bilateral interbank lending fell by 16 percentage

points or more for one-quarter of all source-host pairs in the sample during the tantrum – while lending to non-banks was generally less negatively affected.

Given the substantial heterogeneity in the bilateral banking data, we winsorise the observations at the 5th and 95th percentile as is common in the related literature (for instance, Avdjiev and Takats, 2017; Takats and Temesvary, 2017). The reason is that the growth rate of smaller volume bilateral lending pairs is very volatile, sometimes amounting to several hundred percentage points changes. For instance, small idiosyncratic shocks, such as a new FDI project, can substantially affect these smaller-scale relationships.

3.3 Additional macro controls

Whenever we are not able to rely on time fixed effects, we need to control for macroeconomic effects on credit demand in host countries. To do so, we add several macroeconomic controls in specifications where country fixed effects are not included. Specifically, we include (real) GDP growth and inflation as our main macro controls. In additional specifications, we also add the credit-to-GDP gap as a control for the financial cycle.

4. Estimation methodology

We employ a difference-in-difference methodology to compare the cross-section of bilateral cross-border lending flows before the taper tantrum with the cross-section immediately following the tantrum, as a function of ex-ante macroprudential measures taken in source

banking systems and host countries. In other words, we investigate the second derivatives of bank claims: their acceleration or slowdown.

Our main hypothesis is straightforward: macroprudential tools in place, irrespective of the specific tool, increase the resilience of the banking system. Hence, macroprudential tools applied in source (lending) banking systems strengthen lending banks by making their operations more prudent, thereby stabilizing the supply of cross-border lending during times of stress. Similarly, macroprudential tools applied in host countries make the local banking system more resilient. They do so by directly stabilizing banks' loan demand (i.e. interbank lending) as banks become more robust to shocks, and indirectly stabilizing the demand from non-banks (as the non-bank private sector also becomes more stable by curbing excessive borrowing).

Importantly, we do not formulate hypotheses around specific tools and their impact on cross-border bank lending. That is, we are not only interested in direct effects, such as a tool specifically targeting lending denominated in a foreign currency, that could improve international lending during stress. Rather, we are also interested in indirect effects. For instance, sector-specific capital buffers in real estate lending, a tool that is applied purely for domestic reasons, may also improve the resilience of the banking system in such a way that it is able to lend more to cross-border borrowers as well.

Our main explanatory variable is our index of applied macroprudential measures (Pruc6). As described above, we use the cumulative changes from the beginning of the sample (2000 Q1) up until the quarter immediately preceding the tantrum (2013 Q1) to proxy for ex-ante bank macroprudential regulatory stringency at the country level.

In all specifications, *Δflows* is the log change in bilateral flows (i.e. the growth rate of claims) between the source and host country before the tantrum (measured as the change in claims from 2012 Q4 to 2013 Q1) compared to the change in claims after (from 2013 Q2 to 2013 Q3) the tantrum. In our benchmark regressions, we weigh the observations by the size of pre-tantrum (2013 Q1) bilateral exposures. In specifications without fixed effects, we also add macroeconomic controls for both source and host jurisdictions.

The shock-mitigating effects of macroprudential tools are two-sided: measures taken by both source banking systems and host countries can affect bank flows' resilience. The basic difference-in-difference regressions take the form:

1. $$\Delta flows_{ij} = \beta_0 + \beta_1 source\_reg\_ind_j + \beta_2 dem\_host_i + \varepsilon_{ij}$$

2. $$\Delta flows_{ij} = \gamma_0 + \gamma_1 host\_reg\_ind_i + \gamma_2 dem\_source_j + \upsilon_{ij}$$

In Equation (1), we examine the shock-mitigating effect of source (lending) banking system macroprudential measures, while controlling for changes in the demand for credit at the host country level through the use of fixed effects. Similarly, in Equation (2) we focus on the role of host country macroprudential stringency in mitigating the tantrum shock on bilateral cross-border bank inflows, while controlling for shocks to the supply-side of credit through source fixed effects.

In Equations (1) and (2) we include fixed effects on the lending or borrowing side, in order to control for unobserved country-level characteristics. We drop these fixed effects in Equation (3) to be able to investigate regulatory effects on both sides simultaneously:

3. $$\Delta flows_{ij} = \delta_0 + \delta_1 host\_reg\_ind_i + \delta_2 source\_reg\_ind_j + \upsilon_{ij}$$

In Equation (3), we aim to assess the impact of both source and host country-specific macroprudential tools simultaneously. In these specifications, we are no longer able to include country fixed effects, so we apply macroeconomic controls. Yet, the use of macro controls raises a valid concern that the macroeconomic controls we add as alternatives, are not able to fully capture all the unobserved credit demand and supply-side traits which could play a role in lending flows.

Next, we also investigate the interaction between source and host macroprudential measures. Formally, in Equation (4) we include a policy interaction term, and also apply source and host country fixed effects:

4. $$\Delta flows_{ij} = \theta_0 + \theta_1 dem_{host_i} + \theta_2 dem_{source_j} + \\ + \theta_3 host\_reg\_ind_i * source\_reg\_ind_i + \upsilon_{ij}$$

Similar to Khwaja and Mian (2008), this identification approach controls for any potential credit supply (source banking system-specific) or demand (host country-specific) effects simultaneously

(Avdjiev and Takats, 2016). While this formulation identifies the policy interaction precisely, it also precludes us from being able to observe the impact of source and host measures in *levels*. In all estimations we cluster the standard errors across the source (lending) banking systems. For robustness, later we also cluster the standard errors along host countries.

5. Estimation results

5.1. Prudential measures index: source banking systems vs host countries

We find broad evidence that macroprudential measures taken before the taper tantrum, as captured by our Pruc6 index, are indeed associated with more stable cross-border bank lending in the full sample of borrowers (Table 2). Model 1 estimates Equation (1). It investigates the impact of macroprudential measures taken in the source (lending) jurisdiction and uses fixed effects to control for potential credit demand shocks at the host country level. Model 1 suggests no statistically significant impact.

In contrast, Model 2 estimates Equation (2) and finds significant effects. Recall, that Equation (2) investigates the impact of macroprudential measures taken in the host jurisdiction and uses fixed effects to control for potential credit supply impacts at the source level. The positive coefficient implies that lending flows to those host countries which had applied more macroprudential tools before the taper tantrum slowed less (or accelerated more) than lending to borrowers in those host countries which had applied less macroprudential stringency.

In Model 3 we simultaneously estimate the impact of both source and host macroprudential tools through Equation (3). Based on these estimates we confirm the significant shock mitigating effect of host country macroprudential rules.

The estimates are not only statistically but also economically significant. From the perspective of a given source banking system, lending flows to a host country with an additional pre-crisis prudential measure declined by around one percentage points less. In other words, cross-border bank lending to host countries at the 90th percentile of the macroprudential regulation index received around 8 percentage point more cross-border lending inflows than those at the 10th percentile.

Next, we disaggregate the data by two sectors: lending to banks (Models 4-6) and to non-banks (Models 7-9). The results show roughly the same picture as the aggregated analysis: macroprudential measures applied in host countries have a significant stabilizing effect in both sectors, irrespective of whether we control for credit supply-side effects (Models 5 and 8) or include source rules as well (Models 6 and 9). The host regulatory effects on non-bank lending are somewhat stronger.

5.2. Macroprudential vs prudential indices

As a first check on robustness, we repeat the previous analysis now using the pre-defined overall PruC index (Table 3). The pre-defined PruC index also includes capital requirements besides macroprudential tools. The coefficient estimates show the same qualitative picture: the tantrum shock-mitigating effect of host country macroprudential rules is significant in these estimations

as well. This is not surprising given the extent of the overlap between our index excluding prudential capital regulation (Pruc6) and the predefined index (PruC).

However, the coefficient estimates (and the implied economic impact) are much smaller when we use the overall PruC index. This result further justifies our earlier reasoning to exclude capital requirements from the main analysis. Furthermore, these findings are also consistent with the argument that during this period, i.e. the Basel III adoption phase, differences in capital requirement measures probably reflected more variation in the initial capital requirements than differences in the end-period capital requirements.

5.3. Advanced economies and emerging markets

Next, we divide our sample across the host countries of borrowers, and re-estimate the first regression for lending to borrowers in advanced economies (Table 4) and emerging markets (Table 5). The separate estimations reveal two main findings. First, the main pattern we detected in Tables 2 and 3, namely the significant role of host country macroprudential measures in stabilizing cross-border flows, is mostly driven by cross-border bank lending into advanced economies. In general, the coefficient estimates on host macroprudential rules are larger and more statistically significant for borrowers in advanced economies than in the aggregated sample. As before, macroprudential tools applied in source (lending) banking systems are insignificant for lending flows into both advanced and emerging host countries.

In more detail, when we examine lending flows into advanced economies in Table 4, the coefficient estimates on the shock-mitigating role of host country macroprudential tools are larger than in the aggregated sample. We find that an additional macroprudential measure

applied at the host country level mitigated the tantrum shock on lending inflows by around 2.6 percentage points (Table 4). The magnitudes are similar for lending to all sectors (Models 1-3), lending to banks (Models 4-6) and lending to non-banks (Models 7-9). However, standard errors increase, especially in the case of interbank lending, so the interbank lending coefficients lose their statistical significance.

Corresponding to the larger coefficient estimates, the economic effects are also much larger for lending to borrowers in advanced economies. In the subsample where we look at lending to borrowers in advanced economies, the difference in lending flows are around 13 percentage points between host countries at the 90^{th} vs at the 10^{th} percentile of macroprudential regulatory stringency.

Examining the macroprudential effects on lending inflows into emerging markets in Table 5, we find that the impacts are smaller and less statistically significant. The coefficient estimates hover in the 0.5-0.8 percentage point range, and are only consistently significant for lending to non-banks (Models 8 and 9).

Though smaller, the mitigating effects of host country rules are economically significant for lending to borrowers in emerging markets as well. The impact amounts to a lending flow difference of around 8 percentage points when we compare cross-border inflows into emerging market hosts at the 90^{th} vs the 10^{th} percentile of regulatory stringency.

It is worthwhile to note that the reason we might observe weaker significance in the case of lending to borrowers in emerging markets may be that their share of cross-border bank lending is much smaller than that of borrowers in advanced economies, which affects our weighted regressions.

In additional estimations, we also repeat the analysis for advanced and emerging markets separately using the pre-defined PruC index (Tables A3 and A4). While the advanced economy results remain statistically significant (with the exception of interbank lending), the tantrum effect-mitigating role of macroprudential regulation in emerging host markets loses significance. These additional regressions suggest that we can observe a similar, but weaker, relationship between the general pre-defined PruC index and lending stability than the one with the more focused Pruc6 macroprudential index.

5.4. Individual macroprudential measure categories

We also check how individual macroprudential tool categories affected cross-border lending during the taper tantrum (Table 6). Earlier we found evidence for the impact of macroprudential tools enacted in host countries. Hence, now we focus on the results for individual macroprudential tool categories enacted in host countries. In order to gain a more representative picture, we do not confine the analysis to lending to borrowers in advanced economy hosts (where the results were stronger). Similarly, we consider total lending rather than breaking results into lending to bank and non-bank borrowers. Models 1-9 show the impact of individual macroprudential tool categories one by one.

Three main findings stand out. First, some macroprudential tool groups seem to be significant even individually: (1) change in concentration limits (Model 5, concrat), (2) change in loan-to-value ratio caps (Model 7, ltv_cap) and (3) change in local currency reserve requirements (Model 9, rr_local).

Second, most other macroprudential tools do not appear to be significant individually. Macroprudential tools aim to increase the resilience of the financial system or to contain the build-up of vulnerabilities. This finding thus likely reflects that it is the compounded effects of various tools that matters, rather than the application of one "key" tool.

Third, the capital requirement prudential tool (Model 4, cap_req) is also insignificant. This further confirms our reasoning in subsection 5.2, namely that excluding capital requirements from the main analysis is reasonable not only based on the definition of macroprudential tools, but also from an empirical perspective.

In terms of interpreting these results, we should be cautious not to see our analysis as "evaluating" individual macroprudential measures. These tools might work together to increase the resilience of the financial system, even if appearing individually as insignificant.

5.5. Interaction of source and host regulations

The question which naturally arises is: how do macroprudential policies interact? In order to more closely investigate the interaction of source and host macroprudential policies, in estimating Equation (4) we apply fixed effects both across source (lending) banking systems and host countries in Models 3, 6 and 9 of Table 7. By doing so, we isolate the interaction of source and host measures from any unobservable host country-specific credit demand or source (lending) banking system-specific credit supply shocks.

The application of fixed effects follows and extends the Khwaja and Mian (2008) type of identification applied on both sides in bilateral lending relationships, as in Avdjiev and Takats (2016). Importantly, our interactive formulation does not identify the *level* effects of any

measures (as these are subsumed by the fixed effects) – only the interactions between them. Therefore, we also add specifications in which we include the levels of host (Models 1, 4 and 7) and source (Models 2, 5 and 8) regulations together with their interaction. In doing so, we include one-sided fixed effects (as in our earlier estimates).

Our estimations, including the interaction of source and host regulatory stringency with fixed effects on both the source and host sides, reveal no statistically significant results. Estimating Equation (4) for all countries (Model 3), for borrowers in advanced economy hosts (Model 6) and in emerging market hosts (Model 9) all yield statistically insignificant coefficients. The results remain insignificant when we delineate the sample by target sector (bank and non-bank lending, results available upon request). This suggests that macroprudential tools applied in source (lending) banking systems and in host countries did not significantly strengthen or weaken each other's lending shock-mitigating impact during the taper tantrum.

However, the results for the regressions which include the levels of regulatory stringency together with the interaction term confirm our earlier results. The significant shock-mitigating impact of host country macroprudential regulations is evident even after the inclusion of the interaction term, while the role of source regulations remains insignificant (see Models 1, 2, 4, 5, 7, 8). In other words, our main results are robust to controlling for potential source-host regulatory interactions.

Of course, this is not the final word on possible interactions associated with the application of macroprudential tools. Hence, we should perhaps be cautious before dismissing a potential cross-border interaction of macroprudential tools for three main reasons. First, our methodology of two dimensional fixed effects in a single cross-section is very demanding.

Second, we focus on the taper tantrum episode alone — such regulatory interaction effects might be observed during other stress episodes. Third, our regressions measure direct interactions, and macroprudential policies could affect banks' lending behavior more indirectly.

6. Robustness checks

We undertake a number of robustness tests to ensure that our results hold under various specifications. In all of the below scenarios we repeat the main analysis (Table 2); and the breakdown between advanced economy and emerging market hosts (Tables 4 and 5).

The results remain robust to the following changes (detailed results are available upon request):

- clustering standard errors along host countries,
- no clustering of standard errors,
- using pre-defined index Pruc2 for the macroprudential variable,
- creating a new index (Pruc5) similar to our PruC6 with the same eight subindices but without constraining the quarterly index value on the {-1,0,1} spectrum,
- dropping source (lending) banking systems one by one from the sample (to ensure outliers do not drive the results),
- dropping the hosts countries of borrowers one by one from the sample (for the same reason as above),
- adding macroeconomic controls to source and host countries.

Furthermore, the main thrust of the results remain robust under even more substantial changes. Even when specifying a longer crisis window – comparing changes in lending flows from two

quarters before with two quarters after the tantrum (rather than the one quarter pre- and post-tantrum specification we used in our main analysis), we see a significant stabilizing impact for lending to non-banks – though not for interbank lending anymore. The impact estimate is also similar in magnitude to our benchmark results. In addition, the results remain significant in aggregate when looking at cumulative changes in macroprudential tools after the financial crisis (i.e. after 2010 Q3). Though the estimated magnitudes remain similar, the significance is lost when we disaggregate these results to lending to banks and lending to non-banks.

Lastly, we investigate how the impact of macroprudential policies worked in a currency area in order to tightly control for the potentially confounding effects of monetary policy. More specifically, we run estimations in which we constrain our sample to intra-euro area lending, i.e. including only country pairs where both source (lending) banking systems and host countries of borrowers are located in the euro area. These intra-euro area results confirm our earlier findings. They also show that host country macroprudential tools were effective in stabilizing cross-border bank lending (Table A5). Though the coefficients remain significant in the overall sample, statistical significance declines throughout the various delineations, perhaps reflecting the smaller number of observations and less cross-country variation in macroprudential rules.[5]

7. Caveats

There are some caveats which deserve consideration in interpreting our results. First, we must consider the possibility that changes in macroprudential tools are endogenous, i.e. they also

[5] The results also remain significant in the ex-euro area sample.

signal macroeconomic or financial vulnerabilities of either the source (lending) banking system or the host country of borrowers. This would imply that one could observe a negative association between the application of macroprudential tools and the resilience of cross-border bank lending. However, this vulnerability signaling effect, to the degree it exists in the data, would work against the significance of our results, as it would imply weaker or outright negative coefficient estimates. Furthermore, the potential existence of such a signaling effect suggests that our results should be seen as a lower bound on the effect of macroprudential tools.

Second, the IBRN macroprudential database does not contain information on the strength of the individual macroprudential measures, and there is also no information on the stance of these policy tools which would allow cross-sectional comparison at a given point in time. Furthermore, we have no objective measure on how large a financial shock the taper tantrum constituted. Combined, these factors make it more difficult to precisely interpret the economic impact we show. While it is clear that we identify an economically significant lending-stabilization in the context of the taper tantrum shock, it is less clear how much stabilization a marginal macroprudential policy action would yield during other economic shocks.

Third, there are potentially relevant non-linearities in the relationship between macroprudential stringency and cross-border lending stabilization. As we examine the circumstances of a particular identified shock – the taper tantrum – our results do not make precise predictions about the potential lending effects of other, different global funding shocks. Therefore, our estimates should be read as suggesting that macroprudential tools can have a sizeable stabilizing impact during a stress scenario – not as a precise calibration.

Fourth, a potential complication is that the timing of the effective implementation of tighter macroprudential measures is unknown, and thereby the effects can be confounded by expectations. Regulatory actions are often expected beforehand, and the same is true for macroprudential measures. Our methodology, choosing a long window prior to the tantrum episode, largely addresses this concern. While our results hold for shorter windows as well, the potential role of these expectations implies that applying even shorter time windows biases the analysis against finding significant results, because macroprudential actions in any given short window might have been expected beforehand.

Finally, our results show substantial heterogeneity in the lending stabilization impact of macroprudential tools – both across host countries (borrowers in advanced economies vs. in emerging markets), counterparties (bank vs non-bank borrowers), and macroprudential tools. Hence, our results should be read at most as providing broad support for the potential role macroprudential tools in stabilizing cross-border bank lending as opposed to a detailed assessment of specific tools or their impact on specific countries or sectors.

8. Conclusion

We show that macroprudential tools applied prior to the U.S. taper tantrum episode helped to stabilize lending during the tantrum. Most importantly, macroprudential tools enacted in the host countries of borrowers stabilized cross-border bank lending significantly. The impacts are stronger for borrowers in advanced economies than for borrowers in emerging markets – and

are present in lending to both bank and non-bank borrowers. The impacts are also economically significant.

The results are relevant for policymakers: they demonstrate that macroprudential tools not only stabilize the domestic financial system directly, but also make cross-border bank lending inflows into host economies more stable. The result which shows strong and significant effects for macroprudential tools applied in borrowers' host countries suggests that, though international coordination can play a useful role, it is paramount that countries "keep their house in order". In particular, while we do not find significant evidence for direct policy interaction, this does not necessarily imply that externalities do not exists. More financial stability in one country could indirectly enhance financial stability elsewhere.

Finally, we hope that our results will pave the way for future research on the role of macroprudential policies in detail, and ultimately contribute to a better understanding of the international ramifications of macroprudential policy.

References:

Agenor, Pierre-Richard, Enisse Kharroubi, Leonardo Gambacorta, Giovanni Lombardo and Luiz a Pereira da Silva (2017). "The international dimensions of macro-prudential policies," Working paper, BIS.

Alper, Koray, Fatih Altunok, Tanju Capacioglu and Steven Ongena (2016). "The effect of US unconventional monetary policy on cross-border bank loans: Evidence from an emerging market," Working Paper.

Avdjiev, Stefan, Robert N McCauley and Hyun Song Shin. (2015a). "Breaking free of the triple coincidence in international finance," BIS Working Paper 524.

Avdjiev, S, P McGuire and P Wooldridge (2015b): "Enhancements to the BIS international banking statistics", IFC Bulletin, no 39.

Avdjiev, Stefan and Elod Takats (2014). "Cross-border bank lending during the taper tantrum: the role of emerging market fundamentals," *BIS Quarterly Review* (September).

Avdjiev, Stefan and Elod Takats (2016). "Monetary policy spillovers and currency networks in cross-border bank lending," *BIS Working Paper* (March), forthcoming in the *Review of Finance*

Avdjiev, Stefan, Agne Subelyte and Elod Takats (2016). "The ECB's QE and euro cross-border bank lending," *BIS Working Paper* 549

Avdjiev, Stefan, Catherine Koch, Patrick McGuire and Goetz von Peter (2017). "International prudential policy spillovers: A global perspective," *International Journal of Central Banking* 13(s1), 5-33.

Borio, Claudio (2003), "Towards a macroprudential framework for financial supervision and regulation?" BIS Working Paper 128, February.

Berrospide, Jose, Ricardo Correa, Linda Goldberg and Friederike Niepmann (2017). "International banks and cross-border effects of regulation: Lessons from the United States," International Journal of Central Banking 13(s1), 435-476.

Buch, Claudia and Linda Goldberg (2016) "Cross-Border Prudential Policy Spillovers: How Much? How Important? Evidence from the International Banking Research Network", Federal Reserve Bank of New York Staff Reports, No 801, November

Cetorelli, Nicola and Linda S. Goldberg (2012). "Banking globalization and monetary transmission," The Journal of Finance 67(5), pp. 1811–1843.

Cecchetti, Stephen, Ingo Fender and Patrick McGuire (2010): "Towards a global risk map", BIS Working Paper 309.

Committee on the Global Financial System – CGFS (2011). "Global liquidity – concept, measurement and policy implications," CGFS Papers 45.

Crockett, Andrew (2000), "Marrying the micro- and macroprudential dimensions of financial stability", BIS Speeches, 21 September.

Fender, Ingo and Patrick McGuire (2010). "Bank structure, funding risk and the transmission of shocks across countries: concepts and measurement", BIS Quarterly Review, September 2010, pp. 63–79.

Forbes, Kristin J. and Francis E. Warnock (2012). "Debt and equity-led capital flow episodes," NBER Working Paper Series 18329.

Galati, Gabriele and Richhild Moessner (2011) “Macroprudential policy – a literature review”, BIS Working Paper 337, February

Houston J., C. Lin, Y. Ma (2012) “Regulatory arbitrage and international bank flows” Journal of Finance, 67 (2012), pp. 1845-1895

IMF-FSB-BIS (2016) “Elements of Effective Macroprudential Policies - Lessons from International Experience”, 2016

Karolyi, G. A., Sedunov, J. and Taboada. A. G. (2016) “Cross-border bank flows and systemic risk” Working Paper.

Laeven, Luc, Lev Ratnovski and Hui Tong (2014). “Bank size and systemic risk,” *IMF Staff Discussion Note* 14/04.

Miranda-Agrippino, Silvia, and Hélène Rey (2012). “World asset markets and the global financial cycle,” National Bureau of Economic Research Working Paper 21722.

Ocampo, Jose Antonio (2011). “Reforming the international monetary system,” *United Nations University: WIDER Annual Lecture* 14.

Takats, Elod and Judit Temesvary (2017). “The currency dimension of the bank lending channel in international monetary transmission,” *Finance and Economics Discussion Series Divisions of Research & Statistics and Monetary Affairs Federal Reserve Board* 2017-001.

Temesvary, Judit (2017). “The role of regulatory arbitrage in U.S. banks’ international flows: Bank-level evidence,” Working paper.

Tables

Table 1: Variable definitions and summary statistics

Variables	Unit	Definition	(1) mean	(2) sd	(3) min	(4) p25	(5) p50	(6) p75	(7) max	(8) N
Dependent Variables										
Change in bilateral lending flows - Total	%	Change in total bilateral bank lending flows for each source-host pair, from before to after the taper tantrum; BIS Banking Statistics	5.231	48.03	-218.3	-9.343	3.728	21.5	195.2	1,875
Change in bilateral lending flows - Banks	%	Defined as above - for claims on banks	2.309	81.53	-334.8	-16.95	3.312	30.86	267.7	1,599
Change in bilateral lending flows - Non-banks	%	Defined as above, for claims on non-banks	5.19	42.6	-150.6	-12.43	2.792	25.34	124.8	1,743
Regulatory indexes										
Cumulative source Pruc6 index	Integers	Country index by time t and country c, which equals to 1 if the sum of eight macroprudential instruments (sscb_res, sscb_cons, sscb_oth, concrat, ibex, ltv_cap, rr_foreign, and rr_local, as defined in Table A1) is greater than or equal to 1, equals to -1 if the sum of the instruments is less than or equal to -1, and is 0 otherwise	0.998	2.022	-3	0	1	2	8	1,875
Cumulative host Pruc6 index	Integers	Defined as source Pruc6 index, for host regulations	1.445	3.527	-5	0	1	3	16	1,875
Cumulative source PruC index	Integers	Defined as Pruc6 index, also including cap_req, as defined in Table A1	2.002	2.349	-2	1	2	3	13	1,723
Cumulative host PruC index	Integers	Defined as source PruC index, for host regulations	2.591	4.535	-6	0	2	4	22	1,723
Cumulative source sscb index	Integers	Sum of sscb_res, sscb_cons and sscb_oth (as defined in Table A1) in the country which the source banking system is located	0.191	0.882	-2	0	0	0	5	1,723
Cumulative host sscb index	Integers	Same as source sscb, for host country	0.375	1.188	-3	0	0	0	5	1,723
Additional variables										
Bilateral lending flows - Total	%	Change in the natural logarithm of total bilateral bank lending claims for each source-host pair, from before to after the taper tantrum; BIS Banking Statistics	1.087	21.44	-83	-5.637	-0.823	4.712	190.8	1,875
Bilateral lending flows - Banks	%	Defined as above - for claims on banks	1.238	30.06	-83	-8.347	-1.743	6.673	190.8	1,628
Bilateral lending flows - Non-banks	%	Defined as above, for claims on non-banks	1.8	19.18	-60.4	-5.958	-0.177	7.062	90.16	1,784
Weights in estimations										
Share of a source-host pair in aggregate bilateral total claims	Ratio	Bilateral cross-border claims from banking system i to host country j at time t, divided by aggregate cross-border claims at time t (summed across all source-host pairs)	0.0476	0.0448	6.64E-06	0.0141	0.0316	0.0672	0.214	1,875
Share of a source-host pair in aggregate bilateral claims on banks	Ratio	Defined as share of total claims, for claims on banks	0.0468	0.0457	8.66E-06	0.0125	0.0299	0.0685	0.201	1,663
Share of a source-host pair in aggregate bilateral claims on non-banks	Ratio	Defined as share of total claims, for claims on non-banks	0.0454	0.0473	0	0.0133	0.0297	0.0636	0.295	1,779

Table 2: The impact of macroprudential regulations index (Pruc6) on changes in lending flows from before to after the taper tantrum

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by borrower sector:	Total	Total	Total	Banks	Banks	Banks	Non-banks	Non-banks	Non-banks
Variables									
Cumulative source Pruc6 index	0.147		0.111	0.291		0.175	-0.420		-0.471
	(0.790)		(0.749)	(1.392)		(1.282)	(1.310)		(1.332)
Cumulative host Pruc6 index		1.040***	1.035***		0.885**	1.029**		1.263***	1.079***
		(0.300)	(0.263)		(0.434)	(0.381)		(0.332)	(0.338)
Constant	-21.85	-0.559**	3.626**	39.14	-3.567***	1.479	-31.56*	0.750***	4.520**
	(15.99)	(0.219)	(1.429)	(30.99)	(0.404)	(2.121)	(17.41)	(0.181)	(1.972)
Observations	1,875	1,875	1,875	1,591	1,591	1,591	1,734	1,734	1,734
R-squared	0.06	0.06	0.01	0.06	0.05	0.002	0.07	0.10	0.01
Source Fixed Effects	No	Yes	No	No	Yes	No	No	Yes	No
Host Fixed Effects	Yes	No	No	Yes	No	No	Yes	No	No
Difference in the tantrum effect on bilateral lending outflows from banks in *source* banking systems at the 90th vs 10th percentile of Pruc6 regulations index									
	0.88		0.664	1.75		1.047	-2.1		-2.35
Difference in the tantrum effect on bilateral lending inflows to borrowers in *host* countries at the 90th vs 10th percentile of Pruc6 regulations index									
		8.31	8.28		7.08	8.23		10.1	8.63

Note: Table 2 shows the percentage point *change* in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum) in response to a one unit change in the cumulative Pruc6 index. Summary statistics and variable definitions are shown in Table 1. Robust standard errors are shown in parentheses below the coefficient estimates; *** p<0.01, ** p<0.05, * p<0.1

Table 3: The impact of the pre-defined prudential regulations index (PruC) on changes in lending flows from before to after the taper tantrum

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by borrower sector:	Total	Total	Total	Banks	Banks	Banks	Non-banks	Non-banks	Non-banks
Variables									
Cumulative source PruC index	0.009		-0.032	0.129		0.007	-0.551		-0.545
	(0.593)		(0.566)	(1.128)		(1.104)	(1.344)		(1.352)
Cumulative host PruC index		0.581**	0.570***		0.480	0.585*		0.693***	0.571**
		(0.230)	(0.197)		(0.371)	(0.315)		(0.238)	(0.236)
Constant	-21.70	-0.691*	3.576**	39.20	-3.592***	1.340	-30.75*	0.540*	5.065*
	(16.04)	(0.352)	(1.675)	(31.30)	(0.657)	(2.405)	(17.30)	(0.308)	(2.780)
Observations	1,723	1,723	1,723	1,488	1,488	1,488	1,617	1,617	1,617
R-squared	0.06	0.06	0.003	0.06	0.05	0.001	0.07	0.09	0.004
Source Fixed Effects	No	Yes	No	No	Yes	No	No	Yes	No
Host Fixed Effects	Yes	No	No	Yes	No	No	Yes	No	No
Difference in the tantrum effect on bilateral lending outflows from banks in *source* countries at the 90th vs 10th percentile of PruC regulations index									
	0.54		-0.19	0.78		0.045	-2.75		-2.725
Difference in the tantrum effect on bilateral lending inflows to borrowers in *host* countries at the 90th vs 10th percentile of PruC regulations index									
		5.81	5.7		4.32	5.26		6.23	5.14

Note: Table 3 shows the percentage point change in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum), in response to a one unit change in the cumulative PruC index. Summary statistics and variable definitions are shown in Table 1. Robust standard errors are shown in parentheses below the coefficient estimates; *** p<0.01, ** p<0.05, * p<0.1

Table 4: Borrowers in advanced economies: The impact of macroprudential regulations index (Pruc6) on changes in lending flows from before to after the taper tantrum

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by borrower sector:	Total	Total	Total	Banks	Banks	Banks	Non-banks	Non-banks	Non-banks
Variables									
Cumulative source Pruc6 Index	0.282		0.221	0.355		-0.004	0.0153		0.123
	(0.997)		(0.938)	(1.699)		(1.559)	(1.135)		(1.117)
Cumulative host Pruc6 index		2.613***	2.590***		3.033	2.895		2.608***	2.608***
		(0.821)	(0.899)		(2.004)	(1.980)		(0.921)	(0.882)
Constant	16.73	-4.935***	2.659	25.08	-12.83***	-0.101	9.008	1.267***	3.850*
	(12.50)	(0.0522)	(1.752)	(18.43)	(0.764)	(2.683)	(7.592)	(0.124)	(2.212)
Observations	747	747	747	688	688	688	708	708	708
R-squared	0.05	0.11	0.01	0.06	0.08	0.01	0.05	0.13	0.02
Source Fixed Effects	No	Yes	No	No	Yes	No	No	Yes	No
Host Fixed Effects	Yes	No	No	Yes	No	No	Yes	No	No
Difference in the tantrum effect on bilateral lending outflows from banks in *source* banking systems at the 90th vs 10th percentile of Pruc6 regulations index									
	1.41		1.107	2.13		-0.022	0.77		0.616
Difference in the tantrum effect on bilateral lending inflows to borrowers in advanced *host* economies at the 90th vs 10th percentile of Pruc6 regulations index									
		13.06	12.95		15.17	14.47		13.06	13.04

Note: Table 4 shows the percentage point change in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum) to borrowers in advanced economies, in response to a one unit change in the cumulative Pruc6 index. Summary statistics and variable definitions are in Table 1. Robust standard errors are below the coefficients; *** p<0.01, ** p<0.05, * p<0.1

Table 5: Borrowers in emerging markets: The impact of macroprudential regulations (PruC6) on changes in lending flows from before to after the taper tantrum

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by borrower sector:	Total	Total	Total	Banks	Banks	Banks	Non-banks	Non-banks	Non-banks
Variables									
Cumulative source Pruc6 Index	-0.414		-0.349	-0.297		0.0299	-1.255		-1.453
	(1.230)		(1.106)	(2.353)		(2.303)	(2.048)		(2.021)
Cumulative host Pruc6 Index		0.656	0.549*		0.389	0.288		0.785**	0.715*
		(0.394)	(0.318)		(0.654)	(0.538)		(0.381)	(0.392)
Constant	-21.20	5.335***	6.112**	39.99	6.980***	5.909	-30.64*	0.992*	6.465**
	(16.05)	(0.614)	(2.257)	(31.31)	(1.027)	(4.344)	(17.07)	(0.570)	(2.391)
Observations	976	976	976	800	800	800	909	909	909
R-squared	0.07	0.06	0.003	0.06	0.08	0.001	0.09	0.1	0.01
Source Fixed Effects	No	Yes	No	No	Yes	No	No	Yes	No
Host Fixed Effects	Yes	No	No	Yes	No	No	Yes	No	No
Difference in the tantrum effect on bilateral lending outflows from banks in *source* banking systems at the 90th vs 10th percentile of Pruc6 regulations	-2.49		-2.097	-1.78		0.179	-7.53		-8.718
Difference in the tantrum effect on bilateral lending inflows to borrowers in emerging *host* markets at the 90th vs 10th percentile of Pruc6 regulations		6.56	5.49		3.89	2.88		7.85	7.15

Note: Table 5 shows the percentage point change in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum) to borrowers in emerging markets, in response to a one unit change in the cumulative Pruc6 index. Summary statistics and variable definitions are in Table 1. Robust standard errors are below the coefficients; *** p<0.01, ** p<0.05, * p<0.1

Table 6: The impact of individual macroprudential regulation in host countries on changes in lending flows from before to after the taper tantrum

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by borrower sector:	Total	Total	Total	Total	Total	Total	Total	Total	Total
Variables									
Cumulative host sscb index on residential lending	1.878								
	(1.885)								
Cumulative host sscb index on consumer lending		0.984							
		(3.027)							
Cumulative host sscb index on other lending			0.395						
			(3.976)						
Cumulative host cap_req				5.318					
				(4.615)					
Cumulative host concrat index					2.195*				
					(1.206)				
Cumulative host ibex index						0.996			
						(2.137)			
Cumulative host ltv_cap							1.666**		
							(0.789)		
Cumulative host rr_foreign								-0.343	
								(0.558)	
Cumulative host rr_local									0.779*
									(0.405)
Constant	-0.273	0.133	0.115	-4.410	-0.826	-2.456	-4.587***	0.341	1.532**
	(0.475)	(0.208)	(0.868)	(3.865)	(0.927)	(2.658)	(0.743)	(0.228)	(0.693)
Observations	1,723	1,723	1,723	1,564	1,007	603	890	1,723	1,723
R-squared	0.056	0.056	0.056	0.062	0.072	0.184	0.090	0.056	0.057
Source Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Host Fixed Effects	No	No	No	No	No	No	No	No	No

Note: Table 6 shows the percentage point change in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum), in response to a one unit change in the regulatory sub-index as shown. Summary statistics and variable definitions are in Table 1. Robust standard errors are below the coefficients; *** p<0.01, ** p<0.05, * p<0.1

Table 7: Interaction of source and host regulations: The impact of interaction between source and host country macroprudential regulations on changes in lending flows from before to after the taper tantrum

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by host country:		Full sample			Advanced economies			Emerging markets	
Lending flows by borrower sector:	Total	Total	Total	Total	Total	Total	Total	Total	Total
Variables									
Cumulative source Pruc6 index		0.240			0.345			-0.382	
		(0.922)			(0.978)			(1.745)	
Source Pruc6 Index*Host Pruc6 Index	-0.0852	-0.0527	-0.0443	-0.290	-0.218	-0.291	0.126	-0.00772	0.143
	(0.189)	(0.137)	(0.196)	(0.351)	(0.369)	(0.355)	(0.286)	(0.188)	(0.316)
Cumulative host Pruc6 index	1.142***			2.855***			0.511		
	(0.279)			(0.819)			(0.341)		
Constant	-0.758*	-22.27	-26.90	-4.988***	17.19	11.90	5.954***	-21.28	-22.67
	(0.392)	(16.12)	(16.82)	(0.0754)	(12.36)	(12.60)	(1.165)	(16.42)	(18.95)
Observations	1,875	1,875	1,875	747	747	747	976	976	976
R-squared	0.063	0.056	0.115	0.110	0.048	0.150	0.062	0.072	0.133
Source Fixed Effects	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Host Fixed Effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Difference in the tantrum effect on bilateral lending outflows from banks in *source* banking systems at the 90th vs 10th percentile of Pruc6 regulations									
	8.45	-0.42	-0.35	12.96	-0.98	-1.31	6.53	-0.09	1.61
Difference in the tantrum effect on bilateral lending inflows to borrowers in *host* countries at the 90th vs 10th percentile of Pruc6 regulations									
	-0.738	0.985	-0.384	-0.44	1.397	-0.441	2.853	-2.466	3.243

Note: Table 7 shows the percentage point change in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum), in response to a one unit change in the cumulative Pruc6 index. Summary statistics and variable definitions are in Table 1. Robust standard errors are below the coefficients; *** p<0.01, ** p<0.05, * p<0.1

Appendix

Table A1: Types of prudential indices

Nine categories	
sscb_res	Change in sector specific capital buffer: Real estate credit. Requires banks to finance a larger fraction of these exposures with capital.
sscb_cons	Change in sector specific capital buffer: Consumer credit Requires banks to finance a larger fraction of these exposures with capital.
sscb_oth	Change in sector specific capital buffer: Other sectors. Requires banks to finance a larger fraction of these exposures with capital.
cap_req	Change in capital requirements. Implementation of Basel capital agreements.
Concrat	Change in concentration limit. Limits banks' exposures to specific borrowers or sectors.
Ibex	Change in interbank exposure limit. Limits banks exposures to other banks.
ltv_cap	Change in the loan-to-value ratio cap. Limits on loans to residential borrowers.
rr_foreign	Change in reserve requirements on foreign currency-denominated accounts.
rr_local	Change in reserve requirements on local currency-denominated accounts.

Table A2: Characterization of the BIS IBS Stage 1 Enhanced data

	Currency composition (A)	Residence of borrower (B)	Nationality of lending bank (C)
Consolidated Data	No	Yes	No
Locational Data			
by Residence	Yes	Yes	No
by Nationality	Yes	No	Yes
Stage 1 data	**Yes**	**Yes**	**Yes**

Table A3: Borrowers in advanced economies: The impact of prudential regulation (PruC) interaction on changes in lending flows from before to after the taper tantrum

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by borrower sector:	Total	Total	Total	Banks	Banks	Banks	Non-banks	Non-banks	Non-banks
Variables:									
Cumulative source PruC index	0.0207		-0.0281	-0.197		-0.511	-0.0139		0.109
	(0.756)		(0.728)	(1.380)		(1.296)	(1.100)		(1.087)
Cumulative host PruC index		2.367**	2.409**		2.939	2.821		2.302**	2.350***
		(1.099)	(1.129)		(2.380)	(2.351)		(0.863)	(0.824)
Constant	17.04	-7.311***	0.811	25.99	-15.89***	-1.590	9.050	-1.040	1.721
	(12.52)	(1.180)	(2.208)	(18.70)	(3.416)	(3.781)	(7.434)	(0.733)	(3.005)
Observations	747	747	747	688	688	688	708	708	708
R-squared	0.05	0.11	0.01	0.06	0.08	0.01	0.05	0.13	0.01
Source Fixed Effects	No	Yes	No	No	Yes	No	No	Yes	No
Host Fixed Effects	Yes	No	No	Yes	No	No	Yes	No	No
Difference in the tantrum effect on bilateral lending outflows from banks in *source* banking systems at the 90th vs 10th percentile of PruC regulations index	0.1		-0.140	-0.98		-2.55	-0.07		0.543
Difference in the tantrum effect on bilateral lending inflows to borrowers in advanced *host* economies at the 90th vs 10th percentile of PruC regulations index		11.83	12.05		14.69	14.1		11.51	11.75

Note: Table A3 shows the percentage point change in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum) to borrowers in advanced economies, in response to a one unit change in the cumulative PruC index. Summary statistics and variable definitions are in Table 1. Robust standard errors are below the coefficients; *** p<0.01, ** p<0.05, * p<0.1

Table A4: Borrowers in emerging markets: The impact of prudential regulation (PruC) on changes in lending flows from before to after the taper

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by borrower sector:	Total	Total	Total	Banks	Banks	Banks	Non-banks	Non-banks	Non-banks
Variables									
Cumulative source PruC index	-0.00813		-0.0606	0.633		0.745	-1.317		-1.421
	(0.959)		(0.853)	(1.865)		(1.879)	(1.878)		(1.847)
Cumulative host PruC index		0.216	0.164		0.0370	0.00500		0.267	0.248
		(0.294)	(0.236)		(0.521)	(0.415)		(0.238)	(0.248)
Constant	-21.66	5.901***	7.022***	37.79	7.512***	5.481	-28.98*	1.655***	9.082***
	(16.40)	(0.620)	(2.559)	(32.24)	(1.125)	(4.323)	(16.79)	(0.457)	(3.127)
Observations	976	976	976	800	800	800	909	909	909
R-squared	0.07	0.06	0.001	0.06	0.08	0.001	0.1	0.09	0.01
Source Fixed Effects	No	Yes	No	No	Yes	No	No	Yes	No
Host Fixed Effects	Yes	No	No	Yes	No	No	Yes	No	No
Difference in the tantrum effect on bilateral lending outflows from banks in *source* banking systems at the 90th vs 10th percentile of PruC regulations index	-0.05		-0.36	3.7953		4.47	-7.9		-8.52
Difference in the tantrum effect on bilateral lending inflows to borrowers in emerging *host* markets at the 90th vs 10th percentile of PruC regulations index		3.03	2.3		0.517	0.07		3.74	3.47

Note: Table A4 shows the percentage point change in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum) to borrowers in emerging markets, in response to a one unit change in the cumulative PruC index. Summary statistics and variable definitions are in Table 1. Robust standard errors are below the coefficients; *** p<0.01, ** p<0.05, * p<0.1

Table A5: Intra euro area lending: The impact of macroprudential regulation (Pruc6) on changes in lending flows from before to after the taper tantrum

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lending flows by borrower sector:	Total	Total	Total	Banks	Banks	Banks	Non-banks	Non-banks	Non-banks
Variables									
Cumulative source Pruc6 index	-0.209		-0.149	-0.711		-0.939	0.946		0.971
	(1.211)		(1.163)	(2.260)		(2.109)	(2.128)		(1.995)
Cumulative source Pruc6 index		2.179**	2.103**		3.440	3.075		1.877	1.980*
		(0.980)	(0.880)		(2.196)	(2.049)		(1.072)	(1.027)
Constant	-14.34	1.364	2.734	-18.52	-1.103	2.491	-7.311	0.816	2.436
	(8.365)	(0.803)	(3.072)	(11.50)	(1.442)	(4.571)	(7.223)	(0.905)	(3.632)
Observations	211	211	211	191	191	191	211	211	211
R-squared	0.09	0.11	0.02	0.13	0.10	0.01	0.09	0.15	0.03
Source Fixed Effects	No	Yes	No	No	Yes	No	No	Yes	No
Host Fixed Effects	Yes	No	No	Yes	No	No	Yes	No	No
Difference in the tantrum effect on bilateral lending outflows from banks in *source* banking systems at the 90th vs 10th percentile of PruC regulations index	-0.836		-0.596	-2.84		-3.76	4.73		4.85
Difference in the tantrum effect on bilateral lending inflows to borrowers in *host* countries at the 90th vs 10th percentile of PruC regulations index		10.89	10.52		17.2	15.37		9.39	9.90

Note: Table A5 shows the percentage point change in the taper tantrum effect on bilateral lending flows (measured as the change in outstanding bilateral bank claims from before to after the taper tantrum) within the euro area, in response to a one unit change in the cumulative Pruc6 index. Summary statistics and variable definitions are in Table 1. Robust standard errors are below the coefficients; *** p<0.01, ** p<0.05, * p<0.1