# How does the interaction of macroprudential and monetary policies affect cross-border bank lending?[1]

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**Abstract**: We study the interaction between monetary policy and macroprudential policy in international bank lending. We combine the new BIS Stage 1 enhanced banking statistics on bilateral cross-border lending flows with the IBRN's macroprudential database. We find an economically and statistically significant positive interaction between the monetary policy of major international currency issuers (USD, EUR and JPY) and macroprudential policies enacted in source (home) lending banking systems. That is, tighter macroprudential policies in the jurisdiction of the source banks mitigate the negative impact of tighter monetary policy of the currency issuer. The interaction is economically significant. The results suggest potentially material externalities between monetary and macroprudential policies.

*Keywords:* Monetary policy; macroprudential policy; cross-border claims; diff-in-diff analysis

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## 1. Introduction

Central banks and financial regulators use monetary and macroprudential policies simultaneously to influence economic conditions. Furthermore, such policies are (1) designed to generally respond to similar variables, such as credit growth, and (2) often operate through similar channels, such as the cost of credit of bank lending. This raises the question on how these polices might interact.

Understanding potential interactions is relevant within the same jurisdiction where different agencies are responsible for monetary and macroprudential policies. Furthermore, gauging such interactions is even more policy relevant in an international setting when policies in one country can spill over to other countries. Yet, we do not fully understand how monetary and macroprudential policies interact. This is in part due to the fact that macroprudential policies are relatively new, at least in major advanced economies. Advanced economies have just started to use macroprudential tools on a larger scale only after the Global Financial Crisis (IMF-FSB-BIS, 2016). However, this lack of understanding also reflects an inherently difficult identification problem: macroprudential tools and monetary policy are highly endogenous, especially within the same country. Precisely identifying interactions between simultaneously enacted policies, which aim at similar variables and operate through similar channels, is daunting.

We apply a novel identification strategy using international data to shed light on the interaction between macroprudential tools and monetary policy. To uncover such interactions, we jointly examine (i) the currency-specific monetary transmission in international bank lending ("currency dimension of the bank lending channel" as detailed in Takats and Temesvary (2017)) and (ii) source lending banking system-specific macroprudential policies. As an example, we investigate how US monetary policy interacts with UK macroprudential tools in affecting cross-border bank lending denominated in USD from UK headquartered banks. In our benchmark specification, we apply a Khwaja and Mian (2008)-type identification method, including country-time fixed effects to control for demand conditions (in borrowers' countries) and supply effects (in lending banking systems) – thereby clearly identifying policy interactions.

To undertake this analysis, we combine two main datasets. First, we use the "Stage 1 Enhancements" to the Bank for International Settlements' (BIS) International Banking Statistics. This dataset uniquely allows us to identify the currency dimension of the (international) bank lending channel, that is, monetary policy transmission through the currency denomination of cross-border bank lending (Takats and Temesvary (2017)). In this context, we examine cross-border bank lending denominated in the three major internationally used currencies: the USD, the EUR and the JPY.

Second, we use the International Banking Research Network's (IBRN) prudential regulatory database to obtain country-specific measures of macroprudential policy stringency. In addition, we use shadow interest rates from Krippner (2013, 2015 and 2016) to capture monetary policy stance in the (post-crisis) years of unconventional policy.

Detailing a bit further our example on USD-denominated cross-border bank lending from the UK, might clarify how this identification works. The currency dimension of the international bank lending channel posits that US monetary policy affects cross-border bank lending denominated in USD, even if the US is neither the source bank lending system nor the host borrowers' country. That is to say, the monetary policy of the Federal Reserve Board can affect UK banks' USD-denominated lending to Malaysia through this channel. Our unique dataset allows us to see how this international dimension of the bank lending channel interacts with macroprudential tools. An example would be if UK macroprudential tools interact with US monetary policy in USD-denominated cross-border bank lending. US monetary policy is (almost fully) exogenous to UK macroprudential policy, which helps us to achieve an identification that would be impossible in a single-country setup.

In our analysis, we find consistent evidence that macroprudential measures enacted in source (lending) banking systems significantly interact with changes in monetary policy associated with the currency of lending. Referring back to our earlier example, our findings imply that macroprudential tightening in the UK can mitigate the negative impact of US monetary tightening on USD denominated cross-border bank lending from the UK. For the sake of completeness, we also repeat the analysis for host (borrowers') country macroprudential tools (while controlling for supply factors), but in this case we do not find consistently significant results. The interaction is not only statistically, but also economically significant. The differential effect on cross-border flows of a 100 basis point monetary tightening is around 8 percentage points, when we compare source bank lending systems at the $90^{th}$ vs $10^{th}$ percentile of macroprudential tool tightening.

Our findings are robust to a range of alternative specifications. The results are similar when we use our benchmark macroprudential index (that we create and that excludes prudential policy changes in bank capitalization) or when we use the IBRN pre-defined macroprudential index definition (which includes prudential capital rules). We further check robustness across geography (by excluding the euro area or emerging market borrowers) and across types of claims (by excluding interoffice claims, i.e. claims between parent banks and their subsidiaries) or all interbank lending among other checks.

The results are relevant for policymakers: The identified significant interactions matter for the supply of cross-border bank lending. This is not only crucial for the central banks of borrowing

countries (who consider the supply of cross-border bank loans to their economies), but also to the central banks associated with the major international currencies (who may need to consider potential spillback effects to their economies). The statistically and economically significant interaction effects we find also suggest that under some circumstances, international coordination of macroprudential and monetary policies might be useful.

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 concludes with policy implications.

## 2. Related literature

Our research focuses on the interaction between macroprudential policies and monetary policies in an international setup. 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.

There is also growing evidence that monetary policy spills over internationally through cross-border bank lending (Cetorelli and Goldberg (2012); Miranda-Agrippino and Rey (2012); Forbes and Warnock (2012)). Furthermore, there are several papers showing, in line with our identification approach, that the currency denomination of bank lending acts as a separate dimension for the international bank lending channel (see Alper et al (2016); Ongena et al (2015); Avdjiev and Takats (2016); Avdjiev, Subelyte and Takats (2016); Takats and Temesvary (2017)).

In addition, 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 argue that the lending bank's nationality tends to be more relevant than its residence in identifying the decision-making unit. 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 macroprudential measures*

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 A1 summarize and describe these indices. The index provide quarterly changes in macroprudential stance, across several categories on a quarterly frequency between Q1 2000 and Q4 2014.

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) reflects more (micro)prudential considerations, as we explain in more detail below. The nine indices are detailed in Table A1 in the Appendix.[4]

For our formal analysis, we create a new index of prudential tools (which we call *macroprudential*). This *macroprudential* index is analogous to the pre-defined PruC index of the IBRN database, but excludes changes in capital requirements. More precisely, our *macroprudential* variable is a country index by time *t* and country *c*, which equals 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 -1 if the sum of the instruments is less than or equal to -1, and is 0 otherwise. In other words, our *macroprudential* 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 twofold in this case. First, and more important, is our emphasis: we focus on the interaction with macroprudential tools, while capital requirements, particularly the adoptions of Basel III capital rules captured by cap_req, generally belong to the category of microprudential instruments. Second is the role of expectation: given the adoption of Basel III, measures similar to cap_req were not discretionary and were

[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 1 if the sum of nine distinct macroprudential instruments (shown in Table A1) is greater than or equal to 1, equals -1 if the sum of the instruments is less than or equal to -1, and is 0 otherwise. Second, 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 -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.

anticipated well in advance along country-specific timelines. Nonetheless, despite our concerns for including cap_req as a macroprudential measure, we also repeat our analysis for the pre-defined indices to check robustness of our findings.

*3.2 Data on bilateral cross-border lending flows*

We use 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). The data covers around 30 trillion U.S. dollars in total cross-border claims. It is available in quarterly frequency starting from 2012 Q2 onward both in stocks and in currency change-adjusted flows. The stocks and flows are also available across major international currencies, of which we focus on the USD, EUR and JPY-denominated stocks and flows. By definition, these flows are not affected by currency valuation changes.

The main advantage of using the Stage 1 enhancements is that this dataset uniquely allows us to use all three necessary dimensions of the underlying cross-border bank lending data: (1) currency denomination of the lending, along with (2) the identification of the lending banking systems and (3) borrowing countries. The currency denomination (i.e. dimension 1) allows us to directly investigate lending denominated in major currencies and thereby identify the currency dimension of the international bank lending channel. The identification of the lending banking system (i.e. dimension 2) allows us to focus on macroprudential tools applied in source bank lending systems and control for supply factors. The identification of the borrowing country (i.e. dimension 3) allows us to control for demand factors, and to extend the analysis to macroprudential tools applied in borrowing countries.

We examine quarterly log changes in bilateral cross-border bank lending in all three main currencies (USD, EUR and JPY). Given the well-documented large relative variation in the smaller bilateral lending flows, we winsorise the observations at the $5^{th}$ and $95^{th}$ percentile as is common in the literature (see, for instance, Avdjiev and Takats (2017), Takats and Temesvary (2017), Takats and Temesvary (2018)). The reason is that it is not unprecedented to observe several hundred percentage point changes across some very small bilateral claims. In these claims even small idiosyncratic shocks, such as a new FDI project, can drive cross-border bank lending volumes significantly.

*3.3 Data on monetary policy stance*

The other main variable of interest is our measure of monetary policy stance affecting the three reserve currencies (USD, EUR and JPY) of lending. We use shadow interest rates to measure monetary

stance because of our sample coincides with unconventional policies. That is, our sample of the 2012–2014 period covers the period of "unconventional" expansionary monetary policy actions by the Federal Reserve, the European Central Bank and the Bank of Japan. As a result of these steps, the short-term policy target interest rates set by these three central banks hit the zero lower bound in early 2009, rendering further "conventional" monetary policy easing infeasible onward (Figure 1).

In order to get a measure of monetary policy stance and liquidity shocks in the post-2009 period, we use the currency-specific short-term shadow interest rates (as described in Krippner (2013, 2015 and 2016)) as our measures of monetary conditions for the United States, the euro-zone and Japan (Figure 2). By construction, these short-term shadow interest rates are not subject to the zero bound, and are therefore able to capture expansionary monetary policy actions by dipping into the negative range. Furthermore, the variation between the trends seen in the monetary policies pursued by the central banks of the three main reserve currencies is also conducive for identification. We define the change in the monetary policy stance as the quarterly change (from t–1 to t, in percentage points) in the short-term shadow interest rate that corresponds to the monetary conditions determined by the central bank that issues currency c.

### *3.4 Additional macro controls*

Whenever we do not rely on country*time fixed effects, we need to control for macroeconomic and financial effects on credit demand in host (borrowers') countries and credit supply in source bank lending systems. To do so, we add (real) GDP growth and inflation as controls in specifications where country*time fixed effects are not included.

## 4. Estimation methodology

We analyze a panel of bilateral quarterly cross-border lending flows between Q2 2012 and Q4 2014, i.e. when our macroprudential and cross-border bank lending database overlaps.

### *4.1 Identification*

The main identification issue we face is that the use of macroprudential tools is often endogenous to the use of monetary policy. In a domestic context, policy makers might observe overheating credit markets and react with either macroprudential or monetary tightening – or a combination of the two. In short, the use of the two policies are typically endogenous in a domestic context. Consequently, when we investigate policy interactions with source macroprudential tools, we need to focus on the

effects of a monetary policy that is not linked to the source bank lending system. Similarly, when we extend the analysis to policy interactions with host (borrowers') country macroprudential tools, then we need to examine a monetary policy that is unrelated to host country macroprudential tools.

We achieve identification by focusing on the currency dimension of the bank lending channel (see Takats and Temesvary, 2017). We rely on this channel's result that the monetary policy of a currency issuer affects bank lending denominated in that currency, irrespective of the source lending system or the borrower country. For instance, the monetary policy pursued by the Federal Reserve affects cross-border bank lending denominated in USD even from UK banks to Malaysia – although neither the UK nor Malaysia uses the dollar as its own currency. This constitutes a channel of monetary policy transmission that is typically exogenous to (most) source or host countries. Of course to achieve clear identification, an implication is that we need to exclude the US both as a source lending banking system and as a borrower country when we investigate USD-denominated lending. Similarly, we exclude euro-area countries and Japan when we analyze EUR and JPY-denominated lending flows, respectively.

Importantly, we do not formulate hypotheses around specific tools and their impact on cross-border bank lending. Investigating the international working of individual macroprudential tools is clearly a fruitful avenue for future research, but might be premature at this stage when we explore more fundamental properties of macroprudential policies. Having said that, we use our dataset to carry out some preliminary explorations of the effects of individual macroprudential tools.

### *4.2 Panel regression setup*

Our dependent variable, *Δflows* is the log quarterly change in bilateral flows between the source lending banking system *i* and host (borrowers') country *j*. Our two main explanatory variables are (1) our index of applied macroprudential measures (*macroprudential*) in source bank lending system *i* as defined in section 3.1 above, and (2) the change in monetary policy stance (*monetary*) associated with the major international currencies (USD, EUR, JPY) as measured by the Krippner (2012, 20015 and 2016) shadow rates.

To strengthen identification, we restrict all our estimations to exclude both same country lending and own currency lending (in the terminology of Takats and Temesvary (2017)). These two sets of lender-borrower pairs could potentially confuse identification. First, same country lending (e.g. US-owned bank subsidiaries lending back to US-based borrowers) suffer from a more severe endogeneity of monetary and macroprudential policies. Second, own currency lending (e.g. German bank lending in EUR or US banks' lending in USD) might confound the country and currency-specific

impact of monetary policy. We address these potential concerns by excluding both same country and own currency lending from our analysis.

The first regression explains changes in lending flows as a function of macroprudential policies in source bank lending system *i* ($\Delta macroprudential_{it}$), monetary policy by currency issuer country *c* ($\Delta monetary_{ct}$) and our main interest: their interaction ($\Delta macroprudential_{it} * \Delta monetary_{ct}$). In addition, we control for macroeconomic variables such as inflation and the output gap, both in source bank lending system *i* ($\Delta macro_{it}$) and host borrowers' country *j* ($\Delta macro_{jt}$). Furthermore we apply fixed effects for each source bank lending system ($FE_i$), host (borrowers') country ($FE_j$) and currency ($FE_c$) to capture any time-invariant level differences. Finally, we apply time fixed effects for each quarter ($FE_t$) to control for unobserved global factors. Taken all the above together, Equation (1) is formally written as:

$$\begin{aligned}\Delta flows_{ijct} = {} & \beta_1 \Delta macroprudential_{it} + \beta_2 \Delta monetary_{ct} + \\ & + \boldsymbol{\beta_3 \Delta macroprudential_{it} * \Delta monetary_{ct}} + \beta_4 \Delta macro_{it} + \\ & + \beta_5 \Delta macro_{jt} + FE_j + FE_i + FE_c + FE_t + \varepsilon_{ijct} \end{aligned} \quad (1)$$

The main issue for identification in Equation (1) is that the macro controls might not fully capture non-policy related changes in credit demand from the host (borrowers') countries and credit supply from the source bank lending systems. This might result in omitted variable bias, which in turn might affect our interaction estimates. To address this potential omitted variable bias, we expand the logic outlined in Khwaja and Mian (2008) to a broader context by adding country*time (and currency*time) fixed effects for (1) source bank lending system *i*, (2) host borrowers' country *j* and (3) currency *c*. These fixed effects allow us to control for any potential direct time-varying (1) source banking system-specific credit supply shock, (2) host borrowers' country-specific credit demand shock and (3) currency-specific credit supply effects simultaneously. Given that the large number of time-fixed effects capture any potential level effects, we drop the stand-alone terms for lending system *i* ($\Delta macroprudential_{it}$), the monetary policy by currency issuer *c* ($\Delta monetary_{ct}$) and all the time invariant fixed effects ($FE_j$, $FE_i$, $FE_c$ and $FE_t$). The resulting benchmark Equation (2) is written as:

$$\begin{aligned}\Delta flows_{ijct} = {} & \boldsymbol{\beta_1 \Delta macroprudential_{it} * \Delta monetary_{ct}} + \\ & + FE_{i*t} + FE_{j*t} + FE_{c*t} + \varepsilon_{ijct} \end{aligned} \quad (2)$$

Importantly, while this formulation identifies the policy interaction precisely, it also precludes us from being able to observe the impact of source and host policy measures in *levels*. While Equation (1)

provides some estimates for such level effects, these results should be treated cautiously due to the identification challenge mentioned above. In all estimations we apply two-way clustering of the standard errors across the source (lending) banking system and borrower country dimensions.

## 5. Results

Our results show conclusive evidence that the monetary policy of major currency issuers and the macroprudential policies in source bank lending systems interact in a statistically and economically significant way.

### *5.1 Main results*

In our estimations, we start from relatively simple models and gradually develop more sophisticated identification strategies following the estimation logic outlined in Section 4.2. Our first model applies a simplified version of Equation (1), where only source bank lending system macroprudential policy is included – with currency-specific monetary policy and its interaction omitted (Table 1, Model 1). We capture macroprudential policy change by considering the changes over the last four quarters. The coefficient estimate has a positive sign, and it is significant at the 5 percent level. The positive sign means that stricter macroprudential policy in source lending banking systems is associated with higher cross-border bank lending flows abroad.[5] This is consistent with a substitution effect from more regulated domestic lending to more (relatively less regulated) cross-border bank lending. This positive association remains remarkably stable in the increasingly complete Models 2-4 and 6 as well.

It is important to note that even in this relatively simple setup, we control for source bank lending system and host borrowers' country macroeconomic variables. Furthermore, we apply fixed effects to capture level effects specific to (1) source bank lending systems, (2) to host borrowers' countries, and (3) to the individual currencies. Finally, we use time fixed effects to capture any global factors.

Next, we add the shadow interest rates to our setup, but still without the interaction term (Model 2). Changes in the shadow interest rates, again taken over four quarters, load with negative (though statistically insignificant) coefficient estimates. This association is consistent with the

[5] We are very clear about mentioning association, i.e. correlation, instead of causation here, because these macroprudential policies might correlate with other economic factors that might eventually drive cross-border bank lending.

operation of the currency dimension of the international bank lending as identified in Takats and Temesvary (2017).

We then turn to estimate the full Equation (1) which contains our main focus: the interaction of the shadow interest rate and macroprudential policy (Model 3). The interaction term is positive and significant at the 10 percent level. The positive term implies that macroprudential tightening in a source bank lending system mitigates the negative impact of a monetary tightening of the currency issuer on cross-border bank lending (in that currency). As an example, if the UK tightens macroprudential policy while the Federal Reserve tightens its monetary policy, then the reduction in USD-denominated lending flowing out of the UK lending banking system becomes weaker due to the interaction of these policies. In other words, the decline is less pronounced, than what one would expect based on the standalone coefficient estimates on *macroprudential* and *monetary*. The interaction term remains significant as we introduce host country*time fixed effects (Model 4). Furthermore, the magnitude of the coefficient estimate remains materially unchanged. In fact, the statistical significance increases.

The estimated interaction coefficient remains robustly in the same ballpark and its statistical significance increases further, up to 1 percent, when we estimate the full Equation (2) specification, i.e. our benchmark model (Model 5). Thus, adding increasingly sophisticated fixed effect controls reinforces our initial results on positive interactions. The stability of the size of the interaction coefficient estimates is also remarkable.

Finally, as a robustness check, we add source*host fixed effects to our estimation (Model 6). That is, we add a time-invariant fixed effect for each pair of source bank lending system *i* and host borrowers' country *j* in our specification. Given that our identification depends on cross-sectional variation due to the relatively short time series, the source*host fixed effect is indeed a very demanding control.[6] The significance and size of the interaction term coefficient estimate remain in line with our earlier results.

### *5.2 Economic significance*

The coefficient estimate on the interaction term does not allow for straightforward translation to economic significance, because both macroprudential and monetary policy stance matters for characterizing the interaction effect. In addition, while we have an intuitive understanding of how significant a given monetary tightening is, it is less clear how to assess the magnitude of change in

[6] It also precludes using source-time and host-time fixed effects simultaneously.

macroprudential policies. To characterize the magnitude of the effects of macroprudential measures, we use percentile ranks: we compare the interaction effect for 25 and 100 basis points of tightening in shadow interest rates, and for the 90$^{th}$ vs 10$^{st}$ and 99$^{th}$ vs 1$^{st}$ percentile of macroprudential policy tightening over a year (Table 2).

The results suggest that the interaction effect is economically significant. For instance, the interaction of a 25 basis point monetary tightening reduces cross-border lending outflows 10 percentage points more for a source lending banking system which substantially tightens macroprudential rules (at the 99$^{th}$ percentile of such tightening in the cross-section of the sample) than for a source lending system with macroprudential easing (at the 1$^{st}$ percentile). The differential effect is about 2 percentage points when we compare source lending systems at the 90$^{th}$ vs. 10$^{th}$ percentile of macroprudential tightening.

*5.3 Host borrowers' country macroprudential tools*

Next, we turn to macroprudential tools applied in host (borrowers') countries (Table 4). The results in some cases suggest significantly positive policy interactions, but not consistently and even less so in the models using more sophisticated controls. This suggests that either the host-monetary interaction is weaker than the source-monetary interaction, or, at the very least, that we need to accumulate more observations to precisely identify such effects at the host level.

## 6. Alternative specifications

We explore two alternative specifications in detail. First, we hone in on a specific macroprudential tool, concentration limits, that is more likely to affect the whole bank conglomerate when applied in the headquarter's jurisdiction. We replicate the models shown on Table 1 focusing on this measure, and find that the concentration limit alone remains a significant driver of monetary-macroprudential policy interactions (Columns 1-3 in Table 3). The significant interaction term estimates are roughly similar in magnitude as the benchmark results of Table 1 – although less consistent across specifications. This suggests that macroprudential tools might have to be evaluated jointly as a system, rather than to look at the impact of individual tools.

Second, we use the locational dataset (instead of the Stage 1 enhancements) from the BIS International Banking Statistics as a robustness check. The locational dataset allows us only to identify the country of the lending bank not the lending banking system. For example, if a German bank lends to its UK subsidiary which lends further to Malaysia, then the locational data would capture two cross-

border bank lending pairs, one between Germany and the UK, and one between the UK and Malaysia. However, it would not register the link between Germany and Malaysia. Not surprisingly given this noise, the locational dataset provides a less consistent picture on interactions. Even though the locational data is available on a longer time horizon allowing us to start our panel regression from 2000 Q1, the results are inconclusive. While some less sophisticated models show statistically significant positive interactions, the significance is not present in our benchmark specification (Columns 4-6 in Table 3). This suggests to serve as indirect evidence for paying close attention to the "triple coincidence" literature and identify lending banking systems as the decision making units.

## 7. Conclusion

In this paper, we study the interaction between monetary policy and macroprudential policy in international bank lending. We combine the new BIS Stage 1 enhanced banking statistics on bilateral cross-border lending flows with the IBRN's macroprudential database. We find an economically and statistically significant positive interaction between the monetary policy of major international currency issuers (USD, EUR and JPY) and macroprudential policies enacted in source (home) lending banking systems. That is, tighter macroprudential policies in the jurisdiction of the source banks mitigate the negative impact of tighter monetary policy of the currency issuer. The interaction is economically significant. The results suggest potentially material externalities between monetary and macroprudential policies.

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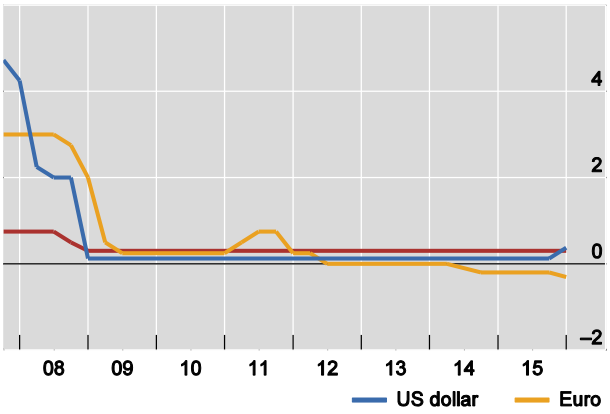
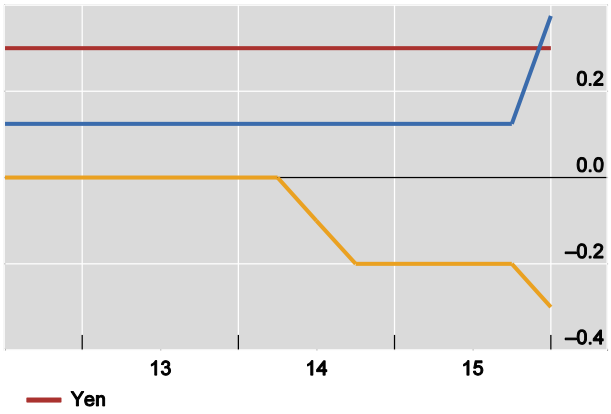
## Short-term target interest rates

In per cent — Figure 1

2007Q3—2015Q4




2012Q2—2015Q4




US dollar — Euro — Yen

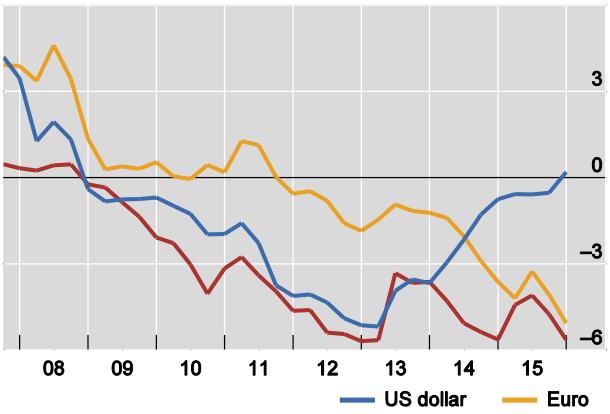
These graphs present the paths of the short-term policy target interest rates set by the Federal Reserve (blue), the European Central Bank (yellow) and the Bank of Japan (red).

Source: Central bank websites.

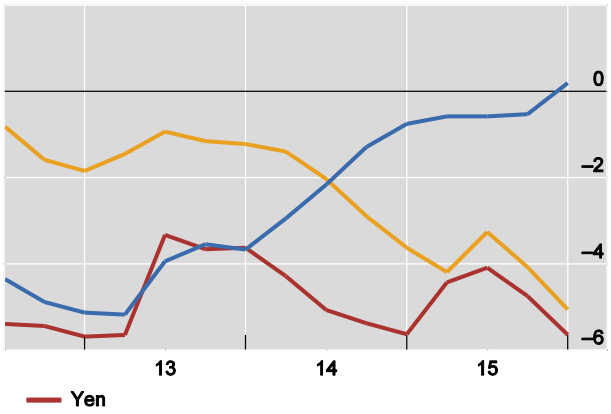
## Short-term shadow interest rates

In per cent — Figure 2

2007Q3—2015Q4




2012Q2—2015Q4




US dollar — Euro — Yen

These graphs present the paths of the short-term shadow interest rates for the US dollar (blue), the euro (yellow) and the yen (red).

Source: Krippner (2016)

Table 1: Main specifications: Source Macroprudential Stringency

| Model | [1] | [2] | [3] | [4] | [5] | [6] |
|---|---|---|---|---|---|---|
| ΣΔ Source Macropru Stringency {t-1 to t-4} | 9.939 | 10.08 | 6.44 | 5.313 | | 5.842 |
| | [4.951]** | [5.118]** | [4.909] | [5.322] | | [6.728] |
| ΣΔ Shadow Interest Rate {t-1 to t-4} | | -3.319 | -3.746 | | | |
| | | [2.672] | [2.708] | | | |
| ΣΔ Source Macropru Stringency * ΣΔ Shadow Interest Rate {t-1 to t-4} | | | 9.871 | 11.14 | 7.929 | 11.8 |
| | | | [5.643]* | [5.447]** | [2.106]*** | [5.844]** |
| ΣΔ Host Macropru Stringency {t-1 to t-4} | | | | | | -1.317 |
| | | | | | | [5.69] |
| ΣΔ Shadow Interest Rate* ΣΔ Source Macropru Stringency {t-1 to t-4}* ΣΔ Host Macropru Stringency {t-1 to t-4} | | | | | | 10.86 |
| | | | | | | [17.05] |
| Constant | 2.854 | 1.792 | 2.884 | 1.867 | 2.839 | 0.0471 |
| | [2.558] | [2.28] | [2.855] | [2.992] | [0.781]*** | [1.482] |
| Source Macro Controls | Yes | Yes | Yes | Yes | n/p | Yes |
| Host Macro Controls | Yes | Yes | Yes | n/p | n/p | Yes |
| Source Fixed Effects | Yes | Yes | Yes | Yes | -- | -- |
| Time Fixed Effects | Yes | Yes | Yes | -- | -- | -- |
| Host Fixed Effects | Yes | Yes | Yes | -- | -- | -- |
| Currency Fixed Effects | Yes | Yes | Yes | -- | -- | -- |
| Source * Host Fixed Effects | No | No | No | No | No | Yes |
| Host * Time Fixed Effects | No | No | No | Yes | Yes | No |
| Source * Time Fixed Effects | No | No | No | No | Yes | No |
| Currency * Time Fixed Effects | No | No | No | Yes | Yes | Yes |
| R - squared | 0.07 | 0.07 | 0.06 | 0.06 | 0.17 | 0.13 |
| Number of Observations | 8,155 | 8,155 | 9,054 | 10,508 | 5,707 | 9,153 |

Two-way clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 2: Economic significance

*Economic significance of interaction effects: Marginal effect of a tightening in the monetary policy of the currency of lending, in source banking systems with macroprudential strengthening (over the preceeding four quarters) vs in source banking systems with macroprudential easing*

| *Dataset* | *Stage 1 Enhanced - full controls* | | | *Locational data - full controls* | | |
|---|---|---|---|---|---|---|
| | | *Magnitude of monetary tightening* | | | *Magnitude of monetary tightening* | |
| | | *100 bps* | *25 bps* | | *100 bps* | *25 bps* |
| *Percentile range used for macroprudential tightening vs easing comparison* | *99 -- 1* | 39.64 | 9.91 | *99 -- 1* | 15.07 | 3.7675 |
| | *90 -- 10* | 7.93 | 1.9825 | *90 -- 10* | 2.52 | 0.63 |

Table 3: Alternative specifications: Source Macroprudential Stringency

| Model | [1] | [2] | [3] | [4] | [5] | [6] |
|---|---|---|---|---|---|---|
| Data type | *Stage 1 Enhanced* | *Stage 1 Enhanced* | *Stage 1 Enhanced* | *Locational* | *Locational* | *Locational* |
| Macropru tool: | *Concentration limits* | *Concentration limits* | *Concentration limits* | *PruC6 Index* | *PruC6 Index* | *PruC6 Index* |
| VARIABLES | | | | | | |
| ΣΔ Source Macropru Stringency {t-1 to t-4} | 16.250 | 17.420 | | 0.259 | -0.382 | |
| | [4.549]*** | [5.846]*** | | [1.975] | [2.059] | |
| ΣΔ Shadow Interest Rate {t-1 to t-4} | -5.462 | | | -1.882 | | |
| | [2.204]** | | | [0.957]** | | |
| ΣΔ Source Macropru Stringency * ΣΔ Shadow Interest Rate {t-1 to t-4} | 11.400 | 3.108 | 16.730 | 5.203 | 2.516 | 0.790 |
| | [3.535]*** | [2.655] | [5.504]*** | [1.642]*** | [2.981] | [5.766] |
| Constant | 0.970 | -1.197 | 3.599 | 9.463 | 5.441 | 9.258 |
| | [3.370] | [1.335] | [1.126]*** | [3.017]*** | [0.89]*** | [0.473]*** |
| Source Macro Controls | Yes | Yes | n/p | Yes | Yes | n/p |
| Host Macro Controls | Yes | n/p | n/p | Yes | n/p | n/p |
| Source Fixed Effects | Yes | Yes | -- | Yes | Yes | -- |
| Time Fixed Effects | Yes | -- | -- | Yes | -- | -- |
| Host Fixed Effects | Yes | -- | -- | Yes | -- | -- |
| Currency Fixed Effects | Yes | -- | -- | Yes | -- | -- |
| Source * Host Fixed Effects | No | No | No | No | No | No |
| Host * Time Fixed Effects | No | Yes | Yes | No | Yes | Yes |
| Source * Time Fixed Effects | No | No | Yes | No | No | Yes |
| Currency * Time Fixed Effects | No | Yes | Yes | No | Yes | Yes |
| R-squared | 0.06 | 0.08 | 0.19 | 0.06 | 0.10 | 0.17 |
| Number of Observations | 6,089 | 7,029 | 3,856 | 34,180 | 34,584 | 29,511 |

Two-way clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4: Main specifications: Host Macroprudential Stringency

| Model<br>VARIABLES | [1] | [2] | [3] | [4] | [5] | [6] |
|---|---|---|---|---|---|---|
| ΣΔ Host Macropru Stringency {t-1 to t-4} | -7.746 | -8.032 | -0.445 | -8.708 | | -1.587 |
| | [4.072]* | [4.164]* | [2.933] | [3.445]** | | [5.821] |
| ΣΔ Shadow Interest Rate {t-1 to t-4} | | -3.036 | -3.075 | | | |
| | | [2.746] | [2.711] | | | |
| ΣΔ Host Macropru Stringency * ΣΔ Shadow Interest Rate {t-1 to t-4} | | | 7.963 | 12.990 | -0.525 | 7.792 |
| | | | [4.509]* | [5.923]** | [8.303] | [6.073] |
| ΣΔ Source Macropru Stringency {t-1 to t-4} | | | | | | 5.428 |
| | | | | | | [6.116] |
| ΣΔ Shadow Interest Rate* ΣΔ Host Macropru Stringency {t-1 to t-4}* ΣΔ Source Macropru Stringency {t-1 to t-4} | | | | | | 0.976 |
| | | | | | | [13.95] |
| Constant | 1.299 | 0.248 | 1.317 | 0.728 | 3.115 | 1.160 |
| | [2.808] | [2.587] | [2.526] | [1.773] | [0.799]*** | [2.684] |
| Source Macro Controls | Yes | Yes | Yes | n/p | n/p | Yes |
| Host Macro Controls | Yes | Yes | Yes | Yes | n/p | Yes |
| Source Fixed Effects | Yes | Yes | Yes | Yes | -- | -- |
| Time Fixed Effects | Yes | Yes | Yes | -- | -- | -- |
| Host Fixed Effects | Yes | Yes | Yes | -- | -- | -- |
| Currency Fixed Effects | Yes | Yes | Yes | -- | -- | -- |
| Source * Host Fixed Effects | No | No | No | No | No | Yes |
| Source * Time Fixed Effects | No | No | No | Yes | Yes | No |
| Host * Time Fixed Effects | No | No | No | No | Yes | No |
| Currency * Time Fixed Effects | No | No | No | Yes | Yes | Yes |
| R - squared | 0.07 | 0.07 | 0.06 | 0.13 | 0.18 | 0.07 |
| Number of Observations | 8,155 | 8,155 | 9,054 | 7,944 | 5,707 | 9,173 |

Two-way clustered standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

**Appendix Tables**

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** |