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Abstract

This paper examines whether cross-border spillovers of macroprudential regulation depend on the organisational structure of banks' foreign affiliates. Our analysis compares the response of foreign banks' branches versus subsidiaries in the United Kingdom to changes in macroprudential regulations in foreign banks' home countries. By focusing on branches and subsidiaries of the same banking group, we are able to control for all the factors affecting parent banks' decisions regarding the lending of their foreign affiliates. We document that there are important differences between the type of regulation and the type of lending. Following a tightening of capital regulation, branches of multinational banks reduce interbank lending growth by 6 percentage points more relative to subsidiaries of the same banking group. Lending to non-banks does not exhibit such differences. A tightening in lending standards or reserve requirements at home does not have differential effects on both interbank and non-bank lending in the United Kingdom.

Key words: Macroprudential regulation, cross-border lending, credit supply, foreign banks organisational structure.

JEL classification: G21, G28, E51, E58.

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Summary

Do multinational banks' branches reduce their lending in foreign markets more than subsidiaries in response to changes in the regulatory environment in their domestic markets? And if so, how strong is this effect and how long does it last? To answer these questions, we use a novel dataset on changes in the intensity of macroprudential regulation in approximately 70 countries. Our analysis focuses on the effect of tightening of capital requirements, lending standards and reserve requirements on foreign banks' lending to bank and non-bank borrowers in the United Kingdom.

This work relates to a number of strands in existing research: how multinational banks transmit financial shocks to their balance sheets across country borders; how differences between banks – such as being geographically distant, poorly capitalised, or a branch versus a subsidiary – affects how these spillovers occur; and also the cross-border spillovers of regulatory changes via multinational banks' operations.

This paper's main contribution is that we explore how the change in lending by foreign banks in the United Kingdom in response to regulatory changes in their home countries depends on whether the lending is done via a branch or a subsidiary. Why would the change in lending differ depending on the organisational form of foreign banks? We argue that it does so because of the legal distinction between branches and subsidiaries. Under the branch structure foreign affiliates constitute an inseparable part of the parent organisation. This structure allows for cheaper and more flexible transfer of funds between the parent and its foreign entity. Subsidiaries on the contrary are considered as stand-alone institutions, with their own board of directors that are separately capitalised and are subject to the host country regulations.

More importantly, the organisational form of foreign affiliate also determines the degree of control which the parent organisation has over its foreign affiliate. Branches form an integral part of the parent bank, but in contrast subsidiaries' business decisions need to be verified and approved by their own board of directors. As a result it should be easier for the parent to control a branch than a subsidiary. It therefore seems reasonable to expect that in the case of a capital requirement tightening, the parent bank might find it easier and swifter to reduce lending provided by its foreign branches than lending provided by subsidiaries.

Providing compelling evidence that the magnitude of the cross-border regulatory spillovers varies with the organisational structure of foreign banks' affiliates requires addressing several challenges. One needs to control for all factors that might affect parent banks' lending decisions. But this is made difficult by the fact that many of these aspects, such as the strength of home bias, are difficult to observe and quantify. We overcome this problem by using an identification strategy that focuses on UK lending provided by branches and subsidiaries which belong to the *same* banking group. In other words, we limit our sample to foreign affiliates of multinational banks that operate at least one branch and one subsidiary in the United Kingdom.

The United Kingdom is an ideal country to examine our hypothesis as there are more than 150 branches and approximately 100 subsidiaries of multinational banks operating in the country and, in addition, there a number of banking groups operating under both organisational structures.

Using this strategy we find that an increase in capital requirements at home causes foreign branches to reduce their lending growth to other banks operating in the United Kingdom by 6.3 percentage points more than foreign subsidiaries. However, a tightening in lending standards and reserve requirements does *not* affect lending of branches and subsidiaries differently. Additionally, we find that none of the macroprudential regulations in our sample causes differences in the provision of lending to non-bank borrowers

1. Introduction

Do multinational banks' branches reduce their lending in foreign markets (host country) more than subsidiaries in response to changes in the regulatory environment in their domestic markets (home country)? And if so, how strong is this effect and how long does it prevail? To answer these questions, we exploit a novel dataset on changes in the intensity of macroprudential regulation in approximately 70 countries. Our analysis focuses on the effect of tightening of capital requirements, lending standards and reserve requirements on foreign banks' lending to bank and non-bank borrowers in the UK.

Our work is motivated by three strands of the empirical literature. First, studies that document how multinational banks transmit financial shocks to their balance sheets across country borders. Cetorelli and Goldberg (2012) find that during the recent financial crisis banks from advanced economies restricted their credit supply in developing markets. Schnabl (2012) and Chava and Purnanandam (2011) show that international banks' liquidity shocks triggered by the 1998 Russian default crisis were transmitted via interbank lending to Peru and the US, respectively. Aiyar (2012) documents how foreign banks contributed to the lending contraction in the UK during the crisis by withdrawing funding from UK-resident affiliates. Giannetti and Laeven (2012) show that crisis periods increase home bias among multinational banks, which shift from foreign to domestic lending.

A second strand of literature examines heterogeneities in these bank balance sheet spillovers. De Haas and Van Horen (2013) use the collapse of Lehman Brothers as an exogenous shock to internationally operating banks and find that foreign-owned banks significantly contract their lending in host markets. However, the key finding for this paper is the substantial heterogeneity in the extent to which different banks retrenched from the same country. Banks reduced credit supply mainly in countries geographically distant from their home country, countries where foreign banks were less experienced, where they operated under a branch structure, and where they were disintegrated from the network of domestic co-lenders. Popov and Udell (2012) study whether contraction of lending provided by foreign banks may be sensitive to parent banks' balance sheet conditions. They find that firms in emerging market countries experienced more difficulty obtaining credit from foreign banks whose parent banks suffered from negative shocks to their financial conditions. Firms in their sample were particularly constrained in localities served by banks with lower Tier 1 capital ratios. In addition to these studies Hoggarth, Hooley, and Korniyenko (2013) show that lending provided by foreign branches in the UK was more volatile during the recent financial crisis compared to lending provided by foreign banks' subsidiaries.[1]

[1] Goulding and Nolle (2012) also show that foreign branches lending was much more volatile compared to lending provided by subsidiaries in the US, whereas Albetrazzi and Bottero (2014) find that foreign owned branches operating in Italy shrunk their lending in response to the collapse of the Lehman Brothers much more than subsidiaries of multinational banks.

Finally, a literature related to our work focuses on cross-border spillovers of regulatory changes via multinational banks' operations. Peek and Rosengren (1997, 2000) evaluate the effect of the Japanese market collapse which coincided with the introduction of the Basel Accord in Japan in the early 1990s. They find that multinational Japanese banks whose capital ratios fell below the required level due to rapid declines of the stock market retrenched their commercial and industrial, and real estate lending in the US, to comply with the new, tighter capital regulation. More recently, Aiyar, Calomiris, Hooley, Korniyenko, and Wieladek (2014a) examine the effect of bank specific capital requirements on foreign banks' credit supply. They find that banks subject to stringent capital regulation in their domestic markets (home country) reduce lending in the foreign markets (host country) by 5.5 percentage points following a 100 basis points increase in required capital adequacy. Using the same dataset on bank specific capital requirements, Aiyar, Calomiris and Wieladek (2014b) also find a negative correlation between the intensity of regulation and lending provided by affected banks in their domestic market. Cross-border spillovers of financial regulation were also found to affect banks' lending standards. Ongena, Popov, and Udell (2013) find that banks respond to tighter lending standards in the home country by taking more risk in foreign markets proxied by more lending to ex ante risky firms.

Our main contribution to this literature is that we explore how the change in lending by foreign banks to the UK in response to regulatory changes in their home countries depends on whether the lending is done via a branch or a subsidiary. However, an important question is why would the change in lending differ depending on the organisational form of foreign banks? We argue that it does do because of the legal distinction between branches and subsidiaries.[2] Under the branch structure foreign affiliates constitute an inseparable part of the parent organisation. This structure allows for cheaper and more flexible transfer of funds between the parent and its foreign entity. Subsidiaries on the contrary are considered as stand-alone institutions, with their own board of directors. Unlike branches, subsidiaries are separately capitalised and are subject to the host country regulations (Hoggarth, Hooley, and Korniyenko, 2013; Fiechter, Otker-Robe, Ilyna, Hsu, Santos, and Surti, 2011)[3].

[2] When deciding on the structural form of foreign operations multinational banks are considering a number of factors, among which regulatory and taxation arrangements in the host country play a major role (Fiechter et al. 2011). Another key factor determining such decisions is the business model of the banking group (Hoggarth, Hooley, and Korniyenko, 2013). Banks focusing mainly on the wholesale operations may prefer to operate in host country under the branch structure, whilst subsidiary structure may be benefit those banking groups which aim to serve retail customers and establish banking relationships in the host market. Dell'Arrica and Marquez (2010) also consider various host country risks as important determinants in this decision making process. The theoretical model developed by the authors suggests that subsidiary structure benefits the banking group by protecting it from economic risks due to limited parent-affiliate liability (such risks may result from changes in the macroeconomic conditions, which in turn may affect creditworthiness of borrowers and thus lead to higher default rates). Branch structure on the other hand is more beneficial in countries where expropriation risk is higher (example of expropriation risks include forcing banks to hold government debt or lending to favoured institutions). Cerutti, Dell'Ariccia and Martinez-Peria (2007) provide the empirical evidence supporting these findings.

[3] This does not imply that subsidiaries will not be affected by the home country macroprudential regulation. For instance banking groups calculating adequate level of capital use consolidated balance sheet information, which includes assets and

More importantly, the organizational form of foreign affiliate also determines the degree of control which the parent organization holds over its foreign affiliate. Given that branches form an integral part of the parent bank, but in contrast that subsidiaries business decisions need to be verified and approved by their own board of directors, it should be easier for the parent to control a branch relative to a subsidiary. Therefore, one could expect that in case of a capital requirement tightening, the parent bank might find it easier and swifter to reduce lending provided by its foreign branches (relative to its subsidiaries) in order to meet a given capital ratio.[4] This is the main focus of our paper.

Providing compelling evidence that the magnitude of the cross-border regulatory spillovers varies with the organizational structure of foreign banks affiliates requires addressing several challenges. First, decisions regarding lending retrenchment depend to a large extent on the decisions made at the parent bank level. These decisions can reflect strength of parents lending relationship both at home and abroad (Peek and Rosengren, 1997, 2000) or the "level" of the home bias (Giannetti and Laeven, 2012). Geographical distance between banks' home and host countries might also affect banking groups' strategies with respect to cross-border lending (Ayiar et al. 2014a, De Haas and Van Horen, 2013).

Second, changes in the intensity of macroprudential regulation can disproportionately affect banking groups due to their balance sheet characteristics. For instance, banks or banking group with low capital buffers prior to a tightening in capital regulation might respond differently to those holding a higher capital buffer (Popov and Udell, 2012). Similarly, Mora (2014) suggests that banks holding lower excess reserves are likely to reduce their lending more to absorb an increase in required reserves relative to banks holding higher excess reserves. Kashyap and Stein (2000) show the effect of monetary policy on banks' lending is significantly influenced by banks' balance sheet liquidity.

Third, country-time-varying factors might also influence banking groups' lending strategies in foreign markets. For example, increasing (decreasing) demand for parent banks' products in the home market might provide an impulse to lend less (more) in foreign markets.

Given this, in order to accurately establish the degree to which organisational form affects the cross-border transmission of changes in the intensity of regulation one needs to control for all factors which might affect parent banks' lending decisions. But this is made difficult by the fact that many of these aspects, such as the strength of home bias, are difficult to observe and quantify. We overcome this problem by using an identification strategy that focuses on UK lending provided by branches and subsidiaries which belong to the *same* banking group. In other words, we limit our sample to foreign affiliates of multinational banks which operate at least one branch and one subsidiary in the UK. This

capital of all their foreign affiliates, including subsidiaries. Therefore, in response to capital requirements tightening banking group might decide to reduce lending of their branches, subsidiaries, or both in order to keep the Tier 1 capital ratio constant.
[4] We elaborate on this more in the hypothesis section of this paper.

allows us to exploit heterogeneities in the response to macroprudential regulation using difference-in-difference estimations while including banking group-time fixed effects. Therefore, one could think of our analysis as one where we compare the difference in the lending behaviour of branches and subsidiaries before and after the regulatory intensity adjustment as if all foreign institutions belonged to the same banking group.

The UK is an ideal country to examine whether spillovers depend on the organisational form because there are more than 150 branches and approximately 100 subsidiaries of multinational banks operating in the country and, in addition, there are a number of banking groups operating under both organisational structures. Together, branches and subsidiaries account for a high share of lending in the UK. As illustrated in Figure 1, during the period 1997-2014 both branches (40pp) and subsidiaries (10%) provided approximately 50% of loans to the UK borrowers. Figure 1 also shows differences in the business models of both bank structures. Branches provide significantly more lending to other financial institutions operating in the UK, whilst subsidiaries mainly focus on lending provided to non-bank borrowers.

Using our identification strategy we show that regulatory tightening in the home country disproportionately affects different organisational types of foreign banks. We find that an increase in capital requirements at home causes foreign branches to reduce their lending growth to other banks operating in the UK by 6.3pp more than foreign subsidiaries. However, we also find heterogeneity in the statistical significance of our results with respect to the type of macroprudential regulation and type of lending. Importantly, a tightening in lending standards and reserve requirements does *not* affect lending of branches and subsidiaries differently. Additionally, we find that none of the macroprudential regulations in our sample causes disparities in the provision of lending to non-bank borrowers.

One has to be cautious with the interpretation of these results. Our estimates indicate that a lending standards or a reserve requirements tightening in the home market does not affect banks' lending in the host countries. It is still possible that changes in the intensity of regulation have an effect on lending by both branches and subsidiaries, however estimating these results is beyond the scope of this paper. In this paper we are explicitly interested in documenting whether the effects of macroprudential regulations on cross-border banks' lending vary with the institutional form of foreign activities.[5] In an additional set of tests we also find that the differential effect of a change in macroprudential regulation is only contemporaneous. We find that in the first, second and third quarter following tightening of regulation both branches and subsidiaries do not exhibit statistically significant differences in their lending behaviour. We strengthen our identification estimating placebo

[5] Similarly, tighter capital requirements might also affect lending provided by foreign branches and subsidiaries to private sector non-bank borrowers. Our estimates do not rule out such possibility. Instead we argue that the effect of capital requirements does not differ between branches and subsidiaries for this type of lending.

regressions, excluding control variables and providing results of regressions with alternative clustering of standard errors.

The rest of the paper proceeds as follows. The next section explains our data. In Section 3 we discuss our identification strategy. We present our results in Section 4, and finally we conclude in Section 5.

2. Hypotheses and Data

2.1 Hypotheses

2.1.1 Capital requirements

Ayiar et al. (2014a) test hypotheses predicting the relationship between the intensity of capital requirements and banks' cross-border lending. Banks which are required to increase their capital ratios can do it either by increasing their capital (capital issue, retained earnings), reducing their capital buffer or by reducing their risk weighted assets. Since raising capital is expensive, and the empirical evidence suggests that banks prefer to keep a constant capital buffer, banks may prefer to reduce risk weighted assets. Multinational banks, which calculate their capital ratio based on consolidated accounts, including assets of their cross-border branches and subsidiaries have a choice of either reducing lending in the home market or in the foreign markets. Since bank operations in their home markets could be more important to preserve, banks are likely to prefer to contract lending provided by their foreign affiliates in their host markets.

Our study expands this hypothesis by studying whether cross-border banks' response to macroprudential regulation varies with their organizational form of their foreign affiliates. In other words, we want to find out if branches of multinational banks restrict their lending to a greater extent than multinational banks' subsidiaries. The main factor which makes us believe that such heterogeneity exists is the degree of control which parent banks hold over their foreign affiliates. A foreign entity operating under the branch structure constitutes an integral part of the parent bank. Its assets and liabilities constitute a fraction of the parent organization. Subsidiaries, on the contrary, under most circumstances are treated as separate institutions. They have their own board of directors making decisions regarding the functioning of the subsidiary.[6] They are separately capitalized and regulated by the host country (Hoggarth et al., 2013). Further, in case of distress parent banks are not always required to provide financial assistance to their subsidiaries, in contrast to branches. Given

[6] Even if the board of directors is appointed by the parent bank decisions such as whether to reduce lending have to be approved by subsidiaries board, which makes this process longer than in case of branches.

these differences we hypothesise that the cross-border effect of capital requirements to be more pronounced for branches rather than subsidiaries.[7]

2.1.2 Lending standards

To construct the hypotheses related to lending standards regulation we follow the reasoning in Ongena, Popov and Udell (2013), who consider a number of mechanisms which can explain potential effects of home country lending standards on banks cross-border activities. First, in response to tighter lending standards and tougher regulation banks may adopt more conservative lending approaches at home, which they then pass on to their foreign affiliates. Foreign banks' branches and subsidiaries may also adopt less risky lending strategy for reputational reasons; the perception of bad risk management at an affiliate may have a negative impact on the reputation of the parent bank. Conversely, multinational banks subject to tighter lending standards might try to employ more risky lending strategies in foreign markets to compensate for inability to extract higher returns from more risky borrowers at home.

Ongena et al. find support in their data for the third of these hypotheses: multinational banks subject to tighter regulation at home engage in more risky lending in the foreign markets. This finding does not mean that foreign banks increase the quantity of lending in the host countries following tightening of regulation at home. Banks adopting a more risky lending approach could substitute lending to more risky borrowers for less risky borrowers. In such a case, we would not expect any changes in aggregate (ie risky and non-risky) lending growth provided by branches and/or subsidiaries of multinational banks operating in the UK following a tightening of lending standards in their home markets.

Lending standards regulation only affects lending in the country in which it is applied – in other words the home market. In contrast to capital regulation, lending standards regulation does not affect the balance sheet of the consolidated group. This suggests that lending standards regulation is less likely to have an international spillover effect than capital regulation and is importantly also less likely to have a differentiated effect between branches and subsidiaries.

2.1.3 Reserve requirements

Finally, our paper evaluates the effect of reserve requirements on multinational banks cross-border lending. According to the "bank lending view" of monetary transmission increasing reserves should result in credit supply contraction (Kashyap and Stein, 2000).[8] An increase in the reserve

[7] Multinational banks calculate their capital ratios based on consolidated accounts, which include assets of their cross-border branches and subsidiaries, and therefore although subsidiaries are subject to host country regulation they will also be subject to macroprudential regulation in their home markets.

[8] In a more recent paper Kashyap and Stein (2012) develop theoretical model which shows that the central bank can control credit supply increasing or decreasing quantity of reserves in conjunction with adjusting interest rate on reserves.

requirements acts as an implicit tax because the interest rates central banks pay on reserves held by banks are often below market rates. As a result of a tightening of reserve requirement it is likely that we would observe an increase in the loan-deposit rate spread, and consequently a fall in aggregate lending. Additionally, higher reserves mean banks have fewer funds available to lend, which can directly affect banks' lending provision.[9] Mora (2014) provides an empirical evidence for the effect of reserve requirements on banks' lending.[10]

Considering that the liabilities of foreign branches are directly on the balance sheet of the parent bank it is likely that branches of foreign banks operating in the UK will also increase their loan-deposit rate spreads in response to higher reserve requirements in their home countries. Higher cost of credit for UK borrowers should therefore result in a reduction of lending provided by branches, relative to subsidiaries of foreign banks. Alternatively, parent banks might attempt to absorb the effect of higher reserve requirements by relying on their internal capital markets (Mora, 2014).[11] Providing funds to parent banks might have an adverse effect on the ability of foreign affiliates to sustain lending in the host country at the same level. Since capital flows between parent bank and its affiliated branches are subject to lower constraints compared to subsidiaries, we would expect foreign branches to be more active in smoothing reserve requirements shocks to their parent institutions, and therefore we expect them to cut down their lending to the UK borrowers more relative to subsidiaries.

However, in normal times, parent banks are likely to be able to access wholesale markets to substitute the lost liquidity, which may make detecting such a (differential) effect on foreign affiliate lending difficult. And potentially more difficult than for capital requirements because raising equity to meet higher requirements is more costly and takes more time than raising short-term liquidity.

2.2 Data

We use data from a number of sources to test these hypotheses. The data on macroprudential policy actions has been constructed from a number of sources. Lim *et al*. (2011), Borio and Shim (2007) and Kuttner and Shim (2013) have been the main sources. Data from these sources have been supplemented with hand-collected data from searches of regulators' websites and financial stability reports, and from communication with relevant authorities. This allowed us to build a dataset containing information on macroprudential policy actions in 70 countries over the period 1990 to

[9] Reserve requirements are often employed by the regulators in the emerging markets as a macroprudential tool. Reinhart and Reinhart 1999, Montoro and Moreno 2011, Terrier et al. 2011 suggest that regulators prefer to vary reserves requirements to tap credit supply rather than increase the interest rates as the later might attract capital inflows and lead to depreciation of the domestic currency.

[10] Mora (2014) exploits an increase in reserve requirements in Lebanon which disproportionally affected deposits denominated in different currencies'. Deposits denominated in foreign currency were subject to higher reserve requirements, relative to domestic currency deposits. Results show that this increase in required reserves had more adverse effects of lending provided by banks relying on funds denominated in foreign currency.

[11] This reasoning is in line with the results provided by Cetorelli and Goldberg (2012) which show that multinational banks are able to mitigate domestic liquidity shocks via cross-border flow of funds within the organization.

2014. Although the early time period mainly covers actions taken in emerging economies, advanced economies have been more proactive in taking macroprudential actions since the global financial crisis. The dataset covers a wide range of macroprudential actions. We cover any action which is 'macroprudential'-like, rather than focusing on actions which have been specifically taken for macroprudential purposes. In our analysis we exploit information on adjustments to capital requirements, reserve requirements and lending standards.[12] Information on capital requirements includes changes in the level of both overall capital requirements and sector specific capital requirements such as changes in risk weights. Lending standards encompass changes to loan-to-value ratios, debt-to-income ratios, and underwriting standards. We are also able to observe changes in reserve requirements which traditionally are not considered as a macroprudential tool but are often used for financial stability purposes and therefore are likely to have macroprudential consequences.

To estimate the effect of these regulatory changes on the scale of banks' business activities via their multinational operations, we use quarterly banks' balance sheet information provided by the Bank of England. This dataset contains financial information for all banks operating in the UK between 1997q4 and 2014q1. We use data on lending provided by foreign banks branches and subsidiaries and we are able to distinguish between the lending provided to other banks (Interbank lending) and non-banks (Non-bank lending).

Financial data provide us with 15,148 observations for 497 foreign banks (both branches and subsidiaries) operating during our sample period. We map regulatory data into this dataset which allows us to observe 191 changes to macroprudential regulation. Next, we restrict our sample to institutions which belong to the banking group operating at least one branch and subsidiary over the sample period. This is crucial for our identification strategy as it allows us to control for banking group-time-varying factors affecting lending by branches and subsidiaries of these groups in the UK. However, it also restricts our sample size to 4,107 observations. The number of banks in our final sample is reduced to 103 banks (51 branches and 52 subsidiaries). These banks, however, account for approximately 75% of total foreign banks' assets in the UK. We also observe 40% of all of the macroprudential regulatory changes in our original dataset. Our sample includes 19 cases of capital requirements tightening, 23 lending standards tightening and 35 reserve requirements tightening. Table 1 provides summary statistics for our dependent and explanatory variables as well as timing of regulatory changes.

[12] Other types of macroprudential regulation do not vary sufficiently over time during our sample period and therefore are excluded from the analysis.

3. Identification strategy

3.1 Baseline model

We exploit cross-country cross-time variation in the tightening of macroprudential regulation and rely on difference-in-differences estimations as our identification strategy. Specifically, we compare changes in the evolution of lending prior to and following the introduction of the change to macroprudential regulation between treatment and control group. Our treatment group consist of foreign branches affected by the change in macroprudential regulation. Control group consist of foreign subsidiaries and branches which home country regulators did not introduce changes to macroprudential regulation. We estimate the following baseline model:

$$\Delta y_{ijkt} = \alpha_i + \beta\left(Regulation_{kt} * Type_{ijk}\right) + Type_i + BC_{ijkt} + \delta_{jkt} + \varepsilon_{ijkt} \quad (1),$$

where Δy_{ijkt} denotes percentage point change in lending of bank *i*, part of banking group *j*, from country *k*, in quarter *t*. Our main explanatory variable is an interaction term between the dummy variable *Regulation* and dummy variable *Type*. *Regulation* takes a value of 1 for quarters and countries when a tightening of macroprudential regulation has taken place, and 0 otherwise.[13] Variable *Type* takes the value of 1 for foreign banks' branches, and 0 for banks operating in the UK as subsidiaries. The coefficient β provides information on the difference in the response of branches and subsidiaries to changes in macroprudential regulation.

Our regressions include a number of bank-time varying control variables denoted by BC_{it}. Specifically, we control for the size of the branch using log of total assets (*Bank size (ln)*), and differences in the bank type business models including the share of interbank lending (*Wholesale*).

The volume of credit provided by foreign affiliates of multinational banks will depend on the decisions, and strategy of their parent banks. Therefore, to identify heterogeneous effects of regulatory changes on lending provided by branches and subsidiaries we need to control for all the factors affecting parent banks (i.e. demand for parent bank products or conditions in the home market). Focusing our analysis on branches and subsidiaries belonging to the same banking groups allows us to introduce banking group-time-varying fixed effects, δ_{jkt}. Including these fixed effects allows us to compare subsidiaries and branches as if they belonged to the same banking group. Therefore, our estimates are unlikely to be affected by parent bank specific factors affecting their decisions regarding cross-border lending of their foreign affiliates.

3.2 Difference-in-difference assumptions

[13] In unreported tests we use alternative Regulation variable, taking values of -1 if regulation is loosened in country k at time t, and 0 otherwise. This specification yields exactly the same results, which are available upon request.

The difference-in-difference estimates are valid under two assumptions. The first is that the treatment event, a change in macroprudential regulation policy is exogenous. In other words, changes in macroprudential regulation in the home country should not depend on the lending provided by foreign branches and subsidiaries in the UK. The second, (the parallel trends assumption) is that the evolution of lending growth in treatment and control groups is similar prior to the change in the macroprudential regulation. This assumption allows us to believe that absent changes in macroprudential regulation both branches and subsidiaries' lending would continue to evolve at a similar pace and any divergences in lending are due to changes in regulation. In this section we discuss results of tests providing support for the validity of both assumptions.

3.2.1 Exogenous treatment event assumption

To test formally whether macroprudential policies at home are not driven by lending growth abroad, we use three alternative models. We examine whether lending provided by foreign banks' branches and subsidiaries in the UK increases or decreases the probability of observing changes in the stringency of macroprudential regulation in the country of origin of their parent bank. In order to perform this analysis we collapse our data at the country-level and model the likelihood of the home country of the parent bank tightening its regulation as a function of mean lending growth of foreign branches and subsidiaries abroad. If our assumption is valid, we expect lending growth by foreign branches to *not* impact the probability of the home country tightening its prudential policies.

Table 3 presents the results. Panel A shows results obtained using complementary log-log regressions. In Panel B, we show results obtained from logit regressions. Finally, in Panel C we present results obtained using a linear probability model. Across all specifications, the coefficient on the main variables of interest (mean lending growth) remains statistically indistinguishable from zero, suggesting that the volume of banks' cross-border lending plays no significant role in the bank regulators decision to change macroprudential regulation.

3.2.2 Parallel trends assumption

To test this assumption, we begin with a graphical illustration presented in Figure 2. In each of the graphs we plot the development in the mean lending growth for both types of institutions over the three quarters preceding each change in macroprudential regulation. Foreign banks branches lending growth is denoted by a blue solid line and triangles, whereas the trend in the lending growth of foreign banks' subsidiaries is denoted by red dashed line. Panel A illustrates the movement in lending to non-bank borrowers (Non-bank lending) and Panel B illustrates the movement in the interbank lending. In most cases growth of lending provided by branches and subsidiaries exhibits a very similar pattern, suggesting that our data meet this assumption.

As an additional check, we follow Lemmon and Roberts (2010) and conduct t-tests for the differences in the changes of quarterly growth rates of interbank and non-bank lending provided by branches and subsidiaries of foreign banks in the UK. Lack of statistically significant differences in the evolution of lending growth rates between subsidiaries and branches prior to regulatory changes would strengthen our inferences from the visual inspection in Figure 2. Note that this assumption does not require identical levels of lending growth between treatment and control groups as they are differenced out. In other words, this assumption requires a similar trend in the growth rates of our dependent variables; however it does not require growth rates to be at the same level (Lemmon and Roberts (2010)).

Table 3 shows results of these tests for three quarters prior to changes to capital requirements (Panel A), lending standards (Panel B) and reserve requirements (Panel C). In each panel we compare growth rates of both lending categories. In all but one case these differences cannot be statistically distinguished from zero. This suggests that prior to regulatory changes the evolution in foreign banks' lending does not vary with the organisational form of the institution. Therefore, as discussed, we could expect that the potential differences are the result of changes in the macroprudential regulation rather than pre-treatment trends in the evolution of lending steaming from individual characteristics of branches and subsidiaries (e.g. different business models).

4. Results

4.1 Main results

Table 4 presents our main results. All our regressions include banking group-specific time-varying fixed effect, and bank type fixed effects. Each regression controls for the size of the institution measured as a logarithm of total assets (Bank size (ln)), and share of interbank loans to total loans (Wholesale), a proxy for the differences in institutions' business models. We remove years 2008 and 2009 to avoid our estimates being driven by an extraordinary high frequency of regulatory changes during the crisis period.[14] In all specifications we cluster standard errors at the institutions' home country level to account for serial correlation within each panel (Bertrand, Mullainathan, and Duflo (2004)). The figures in brackets report t-statistics.

Columns 1 to 4 show the effect of changes in foreign banks' home country macroprudential regulation on lending provided by foreign branches and subsidiaries to the non-bank sector in the UK. Column 1 reports regression results of the model which includes interactions between the *Type* and all the regulatory dummies. The coefficients show that following tightening of capital requirements branches

[14] We also performed our tests including the crisis period and the results were almost identical to those presented in Table 4. Additionally, we perform robustness tests where we remove banks from countries where changes to macroprudential regulation occur at a very high frequency (see Panel D of Table 1) to avoid our results being driven by factors specific to those countries. Results of these tests again are almost identical to those presented in Table 4.

reduce their lending growth by -5.9 percentage points more relative to subsidiaries. However, t-statistics of -0.62 suggest that this effect is not statistically significant at any conventional level. Similarly, the t-statistic for the coefficients on the interactions between the *Type* and the lending standards and reserve requirements shows that the effect of these regulations cannot be distinguished from zero. The results in Column 1 are reinforced by the results in Columns 2-4 where we include interaction terms for each regulation individually in each regression. Again, none of the interaction terms exhibit statistically significant effects on non-bank lending growth.

This is consistent with other findings in the literature such as Aiyar et al (2014a) who find a significant reduction in lending for banks but not to non-banks following an increase in capital requirements. We conjecture that this is because non-bank lending relationships are more likely to be relationship-based and therefore more profitable and so will not be cut in response to a change in regulation. In contrast, banks are generally able to substitute funding in the interbank market easily; this means that any attempt to pass on increased capital costs by an affected branch will be swiftly met by a bank finding an alternative lender, while a subsidiary will be less affected by the increased cost and so banks are less likely to find an alternative source of borrowing.

Columns 5 to 8 show the results for the effect of macroprudential regulation on interbank lending provided by foreign banks in the UK. Again, we first report the estimates for the tests where the interactions between *Type* and all three regulations are included at once. We find heterogeneity in lending provided by branches and subsidiaries in response to changes in capital requirements. We find that foreign banks' branches reduce lending to other banks operating in the UK by 6.3 pp (coefficient -0.063) more than subsidiaries following a tightening of capital requirements. This effect is statistically significant at the 1% level (t-statistic of -3.13). The economic magnitude of this effect is also significant. The mean interbank lending growth in our sample is 5pp. For a mean bank the coefficient of -0.063 (or -6.3pp) translates into a reduction of interbank lending growth rate from 5pp to -1.3pp.

The remaining coefficients on reserve requirements and lending standards again lack statistical significance with t-statistics of 0.54 and 1.07, correspondingly. In columns 6 to 8 we report the estimates of regressions where the effect of each regulatory change is evaluated individually. Estimates of these tests support the results in Column 5. The coefficient on capital requirements is again negative and statistically significant, whilst the coefficients for our two additional regulation variables remain indistinguishable from zero.

Among the control variables, we find that the size of the foreign affiliate does not influence lending, whereas the share of the interbank loans significantly correlates only with non-bank private sector loans. The negative sign of the coefficient suggests that a greater focus on wholesale lending provision decreases the reduction in the growth rate of loans to the non-bank sector.

Our baseline results suggest that tighter capital regulation in the home country has a stronger effect on lending provided by multinational banks' branches compared to subsidiaries. These results are in line with our predictions. A greater degree of control of the parent bank over its affiliates operating in form of a branch makes it is easier to reduce the banking group's risk-weighted assets through contraction of branch lending. But we only find heterogeneity in the provision of lending to banks.

4.2 Robustness tests

We run a number of robustness tests. First, we examine if our results are driven or biased by events coinciding with the changes in macroprudential regulation. Such events could bias the results the extent to which they affect UK branches and subsidiaries of foreign banks differently. One type of event is a change in microprudential, bank-specific, capital requirements, of the sort examined in Aiyar et al. (2014a, 2014b). Banks subject to these requirements include UK-owned banks and foreign subsidiaries of foreign banks, but not branches of foreign banks. Imagine a tightening of capital requirements in a given home country of a foreign bank overlaps with a loosening of capital requirements of its UK subsidiaries. In that case it is possible that the bank's branches will reduce their lending in response to the capital requirements in their home country, whilst subsidiaries faced with lower capital requirements in the UK will increase their lending. Such situation is likely to render an upward bias on our treatment effect, since the differences in branches and subsidiaries' lending growth around the change in macroprudential regulation will increase. To test if our main results can be biased by such events we exclude from our sample all subsidiaries which were subject to changes in bank-specific capital requirements. Table 5 presents the resulting regressions, which are very close to those presented in Table 4. Most importantly the effect of capital requirements on interbank lending is still statistically significant.

Secondly, we revisit the validity of the assumption that the changes in macroprudential regulation are exogenous. Whited and Roberts (2012) argue that if the treatment effect is randomly assigned then the magnitude of this effect should not depend on the inclusion of control variables in the model. Otherwise, random assignment for the treatment variable should be called into question. Table 6 presents results of tests in which we omit bank-specific time-varying control variables from the baseline specification. The magnitudes of the coefficients for the main explanatory variable are very similar to the ones reported in Table 4. Most importantly the magnitude for the effect of capital requirement changes on interbank lending is almost exactly the same for both models. These results suggest that the treatment effect is exogenous with respect to characteristics of individual branches and subsidiaries.

Our third robustness test reconsiders the parallel trends assumption. We replicate our main results forwarding our treatment variable by one, two and three quarters. This test allows us to establish whether the treatment effect we observe in Table 4 is a result of some general trends in lending

behaviour of branches and subsidiaries or truly due to changes in the macroprudential regulation. The intuition is that if the latter is true we should not observe statistically significant differences in lending of branches and subsidiaries prior to the real occurrence of the regulatory change. We plot the coefficients and the 95% confidence intervals estimated using these tests in Figure 3. In all cases forwarded treatment variable shows no statistical significance, which further strengthens the argument that the disparities between the lending provided by foreign banks branches and subsidiaries are due to changes in the intensity of macroprudential regulation in their home country.

Next we perform three falsification tests to check whether differences between the growth of lending provided by branches and subsidiaries presented in Table 4 can be attributed to changes in macroprudential regulation or are driven by other factors, or chance. We run two Monte Carlo simulations with 1,000 replications where first we randomly assign placebo treatment to branches affected by changes in regulation in their home markets but we pretend that these changes occurred in periods preceding their actual occurrence. In the second falsification test we pretend that the change in macroprudential regulation affected branches from countries which never altered their macroprudential regulation. We estimate the following regression

$$\Delta y_{ijkt} = \alpha_i + \beta Placebo_{ijkt} + Type_i + \delta_{jkt} + \varepsilon_{ijkt} \qquad (2),$$

where *Placebo* is a binary variable randomly set to 1 for banks in the treatment group (affected foreign banks' branches) in periods preceding actual change to macroprudential regulation, and later equal to 1 for banks in countries where no changes to macroprudential regulation occurred during our sample period. We repeat this process 1,000 times saving the *p-value* on the coefficient β from each regression and compute the rejection rates of the null hypothesis β=0 at the 1%, 5%, and 10% levels. Because we know that placebo treatments should have had no effect in both tests, we know that the null of zero effect is true. We should therefore only reject the null by making Type I errors. The results of this exercise are shown in Panel A and Panel B of Table 7. The rejection rates for all dependent variables are in line with those that would occur through Type I errors. This analysis further strengthens our main results.

In our third falsification test, we want to observe if UK banks alter their lending during quarters in which changes to macroprudential regulation where taking place in other countries. Results of these tests are important for two reasons. Finding significant effects would suggests that UK-owned banks' lending is also affected by changes to macroprudential regulation via reduced availability of interbank funds, which we document in Table 4. However, given that banks can substitute interbank funds from affected institutions with funds from non-affected banks or with other type of funding significant results may also suggest that some other UK-specific factors may be coinciding with changes in

macroprudential regulation in foreign markets. To this end we restrict our sample only to UK banks and estimate the following model

$$\Delta y_{it} = \alpha_i + \beta Placebo_{it} + BC_{it} + \delta_i + \gamma_t + \varepsilon_{ijkt}, \qquad (3),$$

where $Placebo$ takes a value of one for periods in which variable $Regulation_{kt}$ in specification 1 is equal to 1, and 0 otherwise. We generate placebo treatment variable for each type of macroprudential regulation. Results of this test are presented in Panel C of Table 7. Coefficient on all of our placebo treatment variables remains indistinguishable from zero providing support for our baseline results.

In our final robustness test we examine sensitivity of our estimates to alternative standard errors clustering. Our main results are estimated using specification in which we cluster heteroskedasticity-adjusted standard errors at the country level. Table 8 presents the results for tests where errors are clustered at the banking group level. Our findings remain very similar. Standard errors are slightly higher compared to those in our baseline model; however the effect of capital requirements on foreign banks' interbank lending is still significant at 5% level.[15]

4.3 Long-run effects

Our baseline results explore heterogeneity in the effect of regulatory changes on contemporaneous lending provided by foreign banks in the UK. But it is also important to investigate the duration of these effects. To consider this we modify regression specification 1 in Table 4 by replacing the interaction term with its first, second and third lag. Significant coefficients of the lags of the interactions will inform us about the duration of the effects found in Table 4.

Table 9 present the results of this analysis. In all of the regressions the lagged interactions between the Type and Regulation variables are statistically insignificant. This suggests that the differences in the effect of changes in macroprudential regulation on lending provided by foreign banks' branches and subsidiaries are only contemporaneous and disappear after the quarter in which changes occurred. These results are not surprising: in the case of capital requirements a tightening requires an immediate response from the banking group. Since the higher degree of control over the branch allows the parent bank to immediately adjust its affiliate branch lending we would expect that the adjustment would be most significant around the announcement of the new capital adequacy regime. In the later quarters, we would not observe the significant differences in lending growth between branches and subsidiaries due to lack of further adjustments or due to the fact that lending adjustments in case of subsidiary require more time. Once they are in place the differences between lending growth provided by both types of institutions diminishes.

[15] Additionally we perform tests with standard errors clustered at the individual bank level. Results are similar to those in Table 4 and are also available upon request.

5. Conclusion

Studies show that multinational banks transmit negative shocks to their parent banks' balance sheets – including changes in regulation – across national borders. In this paper we examine if the magnitude of the spillover effects depends on the organisation structure of banks' foreign affiliates. We exploit cross-country cross-time variation in the implementation of macroprudential regulation to test if lending in the UK of foreign banks' branches and subsidiaries respond differently to a tightening of capital requirements, lending standards or reserve requirements in foreign banks' home countries. Focusing on differences in lending responses of branches and subsidiaries which belong to the banking group allows us to control for all factors which might affect parent banks' decisions regarding their foreign affiliates' lending.

Our results show that whether foreign branches or subsidiaries react differently to changes in regulation in their home countries depends on the type of regulation and the type of lending. Multinational banks' branches respond to tighter *capital requirements* in their home countries by contracting their lending more than subsidiaries. On average, branch interbank lending growth in the UK grows by 6.3 percentage point slower relative to subsidiaries following a tightening of capital requirements in the bank's home country. This is in line with our hypothesis which predicts that branch lending will be affected due to higher degree of control which parent banks have over its foreign branches. But this heterogeneity in response to capital requirements is only observed in case of lending to other banks. We find that the response of lending to non-bank borrowers to a tightening in capital requirements does not depend on the organisational forms of foreign banks' UK affiliates. Turning to the impact of a tightening in *lending standards* or *reserve requirements*, we find that there are no differential effects on interbank and non-bank lending.

Additional analysis suggests that the stronger contraction in the provision of interbank loans exhibited by branches is only contemporaneous – ie the differential effect fades out after one quarter. Our research provides some evidence that a branch structure is more likely than a subsidiary structure to transmit a tightening in capital requirements affecting the parent institution in the home country. However, the effects we find are short-lived which means that the potential negative effects associated with a higher number of foreign branches we find in this study may not necessarily outweigh any benefits.

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Table 1
Sample representativeness and summary statistics

Panel A: Bank characteristics

	All banks		Banks in the sample	
	Observations	*Mean*	*Observations*	*Mean*
Non-bank lending growth	15,148	0.023	4,107	0.035
Interbank lending growth	15,148	0.044	4,107	0.050
Bank size (ln total assets)	15,148	14.084	4,107	15.216
Interbank share	15,148	0.729	4,107	0.672

Panel B: Regulatory changes and number of banks

	Total	*Included in the sample*
Capital requirements tightening	43	19
Lending standards tightening	75	23
Reserve requirements tightening	73	35
All foreign banks	497	103
Foreign banks branches	321	51
Foreign banks subsidiaries	176	52

Panel C: Summary statistics

Variable	***N***	***Mean***	***SD***	***Min***	***Max***	***Source***
Dependent variables						
Non-bank lending growth	4,107	0.035	0.243	-0.42	0.62	Bank of England
Interbank lending growth	4,107	0.050	0.306	-0.51	0.89	Bank of England
Regulatory dummies						
Capital requirements tightening	4,107	0.006	0.078	0	1	IMF/BIS
Lending standards tightening	4,107	0.015	0.124	0	1	IMF/BIS
Reserve requirements tightening	4,107	0.009	0.097	0	1	IMF/BIS
Control variables						
Bank size (ln total assets)	4,107	15.216	2.250	6.03	20.21	Bank of England
Interbank share	4,107	0.672	0.320	0.02	0.97	Bank of England

Panel D: Timing of changes to macroprudential regulation

Capital requirements		**Lending standards**		**Reserve requirements**			
Country	*Quarter*	*Country*	*Quarter*	*Country*	*Quarter*	*Country*	*Quarter*
Australia	1998q3	Portugal	1998q4	Philippines	1998q2	China	2007q4[b]
South Africa	1998q4	Portugal	1999q1	France	1998q4	Indonesia	2007q4
Philippines	1998q4	China	2001q1	Philippines	1998q4	China	2008q1[a,b]
China	2002q1	Ireland	2001q4	Germany	1999q1	China	2008q2[a,b]
Australia	2004q4	China	2003q2	Portugal	1999q1	Indonesia	2009q4[a,b]
Indonesia	2004q4[b]	Italy	2004q1	France	1999q1	Indonesia	2010q1
Indonesia	2005q1[b]	China	2004q3	Spain	1999q1	China	2010q1[b]
Indonesia	2005q3[b]	China	2005q1	Greece	1999q3	Indonesia	2010q2
Indonesia	2005q4[b]	Greece	2005q4	Italy	2000q1	China	2010q2[b]
Ireland	2006q1	China	2006q1	France	2000q1	China	2010q4[b]
Ireland	2006q2	China	2006q2	Ireland	2000q1	China	2011q1[b]
Indonesia	2006q2[b]	France	2007q1	Germany	2000q1	China	2011q2[b]
Indonesia	2006q3[b]	Canada	2008q4[a,b]	Greece	2000q2	China	2011q3[b]
Indonesia	2006q4[b]	China	2009q4[a,b]	Indonesia	2000q3		
Indonesia	2007q1[b]	Indonesia	2010q1	Greece	2001q1		
Italy	2007q1	China	2010q1	China	2003q3[b]		
Spain	2008q1[a]	Canada	2010q2[b]	China	2004q2[b]		
Spain	2008q2[a]	Canada	2011q1[b]	Indonesia	2004q3		
Indonesia	2008q2[a,b]	Canada	2011q2[b]	Switzerland	2005q1		
Switzerland	2009q1[a]	Canada	2011q4[b]	China	2006q3[b]		
Indonesia	2009q4[a,b]	Indonesia	2011q4	China	2006q4[b]		
Indonesia	2010q3[b]	Canada	2012q3[b]	China	2007q1[b]		
Indonesia	2010q4[b]	Canada	2013q1[b]	Indonesia	2007q1		
Switzerland	2012q2	China	2013q1	China	2007q2[b]		
		USA	2014q1	China	2007q3[b]		

Note. Table 1 presents summary statistics for our sample and information on the timing of changes to macroprudential regulation. [a)] Excluded from the main analysis due to occurrence during the crisis period; [b)] Excluded in the robustness test to tests if our results are driven by factors specific to countries where regulatory changes occur at high frequency.

Table 2
Exogeneity tests

Panel A: Complementary log-log model									
	Capital requirements tightening			*Lending standards tightening*			*Reserve requirements tightening*		
Non-bank lending	-0.074	-0.092		0.085	0.079		0.009	0.010	
	(-1.30)	(-1.56)		(1.11)	(0.85)		(0.08)	(0.08)	
Interbank lending	-0.141		-0.151	-0.032		-0.008	0.006		0.007
	(-1.35)		(-1.42)	(-0.35)		(-0.08)	(0.09)		(0.10)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	413	413	413	462	462	462	618	618	618
Panel B: Logit model									
	Capital requirements tightening			*Lending standards tightening*			*Reserve requirements tightening*		
Non-bank lending	-0.130	-0.144		0.082	0.086		0.184	0.188	
	(-0.53)	(-0.58)		(0.65)	(0.68)		(1.29)	(1.31)	
Interbank lending	-0.142		-0.154	-0.026		-0.037	0.180		0.175
	(-0.62)		(-0.67)	(-0.20)		(-0.29)	(1.30)		(1.32)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	541	541	541	614	614	614	677	677	677
Panel C: Linear probability model									
	Capital requirements tightening			*Lending standards tightening*			*Reserve requirements tightening*		
Non-bank lending	0.000	-0.000		0.002	0.002		0.002	0.002	
	(0.02)	(-0.03)		(0.97)	(0.94)		(0.66)	(0.68)	
Interbank lending	-0.001		-0.001	-0.000		-0.000	0.002		0.002
	(-1.07)		(-1.06)	(-0.04)		(-0.01)	(0.87)		(0.88)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	1,241	1,241	1,241	1,241	1,241	1,241	1,241	1,241	1,241

Notes. This table presents results obtained using Complementary log-log regressions (Panel A), logistic regressions (Panel B) and linear probability model (Panel C) which verify that changes in the macroprudential regulation in banks' home countries are exogenous with respect to banks' lending to the UK borrowers. Our dependent variables are binary variables equal to 1 for countries and quarters where tightening of capital requirements, lending standards or reserve requirements occur, and 0 otherwise. Our explanatory variables are lending growth rates to non-bank borrowers and other banks (Interbank lending). Lending growth is calculated as a mean of all banks headquartered in a given country. *** p<0.01, ** p<0.05, * p<0.1.

Table 3
Parallel trends assumption

Panel A: Capital requirements									
	Period t-3			**Period t-2**			**Period t-1**		
	Difference	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*
Non-bank lending growth	-0.011	-0.92	0.36	0.005	0.29	0.77	-0.008	-0.29	0.82
Interbank lending growth	-0.021	-1.80	0.03*	-0.002	-0.15	0.98	-0.027	-0.87	0.39
Panel B: Lending standards									
	Period t-3			**Period t-2**			**Period t-1**		
	Difference	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*
Non-bank lending growth	-0.015	-0.86	0.18	-0.005	-0.57	0.56	-0.021	-1.66	0.11
Interbank lending growth	-0.012	-1.18	0.14	-0.004	-0.25	0.31	-0.008	-0.69	0.67
Panel C: Reserve requirements									
	Period t-3			**Period t-2**			**Period t-1**		
	Difference	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*	*Difference*	*t-statistic*	*Wilcoxon (p-value)*
Non-bank lending growth	-0.037	-1.75	0.19	0.007	0.47	0.55	-0.024	-1.55	0.15
Interbank lending growth	-0.006	-0.42	0.62	-0.021	-1.25	0.16	-0.022	-1.41	0.17

Notes: Table 3 presents the results of t-tests examining parallel trends assumption. We test for the differences in mean lending growth rates (both interbank and non-bank lending) in three quarters preceding tightening of capital requirements (Panel A), lending standards (Panel B) and reserve requirements (Panel C). ** p<0.01, * p<0.05.

Table 4
Macroprudential regulation and cross-border lending

	Non-bank lending				Interbank lending			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Capital regulation*Type	-0.059	-0.065			-0.063***	-0.068***		
	(-0.62)	(-0.66)			(-3.13)	(-4.13)		
Lending standards*Type	0.034		0.037		0.020		0.024	
	(0.36)		(0.40)		(0.54)		(0.60)	
Reserve requirements*Type	0.025			0.026	0.084			0.085
	(0.27)			(0.28)	(1.07)			(1.08)
Type	0.030*	0.031*	0.030*	0.030	-0.042**	-0.041**	-0.041**	-0.042**
	(1.86)	(1.76)	(1.89)	(1.70)	(-2.38)	(-2.30)	(-2.31)	(-2.40)
Bank size (ln)	0.001	0.001	0.001	0.001	0.005	0.005	0.005	0.005
	(0.18)	(0.20)	(0.19)	(0.19)	(1.56)	(1.58)	(1.59)	(1.57)
Wholesale	-0.101**	-0.101**	-0.101**	-0.101**	0.039	0.039	0.038	0.039
	(-2.18)	(-2.24)	(-2.19)	(-2.25)	(1.03)	(1.02)	(1.01)	(1.03)
Observations	4,107	4,107	4,107	4,107	4,107	4,107	4,107	4,107
R-squared	0.529	0.529	0.529	0.529	0.515	0.514	0.514	0.514
Bank Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country

Notes. Table 4 presents results of difference-in-difference regressions examining the effect of macroprudential regulatory changes on lending of foreign banks in the UK. We estimate the following model: $\Delta y_{ijkt} = \alpha_i + \beta\left(Regulation_{kt} * Type_{ijk}\right) + Type_i + BC_{ijkt} + \delta_{jkt} + \varepsilon_{ijkt}$. Our dependent variables include foreign banks' lending to the UK non-bank sector and foreign banks' interbank lending in the UK. All dependent variables are in percentage point growth rates. The main explanatory variable is an interaction term between *Regulation* and *Type*. *Regulation* is a dummy for regulatory change, equal to 1 if regulation is tightened in country *i* at quarter *t*, and 0 for all other periods. *Type* is a dummy variable equal to 1 if foreign bank operates in the UK as a branch, and 0 if it operates as a subsidiary. The coefficient β provides information about the effect of macroprudential regulation tightening. The set of bank-time varying control variables BC include the logarithm of banks' total assets (Bank size (ln)), and the share of interbank lending (Wholesale). Additionally, regressions include banking group-quarter-fixed effects. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5
Robustness test: Subsidiaries subject to bank specific capital requirements removed

	Non-bank lending		Interbank lending	
	(1)	*(2)*	*(3)*	*(4)*
Capital regulation*Type	-0.070	-0.050	-0.050***	-0.055**
	(-0.56)	(-0.41)	(-2.94)	(-2.76)
Type	0.006	0.027	-0.034**	-0.046**
	(0.45)	(1.34)	(-2.48)	(-2.32)
Bank size (ln)		0.001		0.005
		(0.33)		(1.37)
Wholesale		-0.095**		0.037
		(-2.13)		(0.87)
Observations	3,882	3,882	3,882	3,882
R-squared	0.529	0.542	0.528	0.533
Bank Group*Quarter FE	YES	YES	YES	YES
Cluster	Country	Country	Country	Country

Notes. Table 5 presents results of difference-in-difference regressions examining the effect of macroprudential regulatory changes on lending of foreign banks in the UK. We estimate the following model: $\Delta y_{ijkt} = \alpha_i + \beta\left(Regulation_{kt} * Type_{ijk}\right) + Type_i + BC_{ijkt} + \delta_{jkt} + \varepsilon_{ijkt}$. Our dependent variables include foreign banks' lending to the UK non-bank sector and foreign banks' interbank lending in the UK. All dependent variables are in percentage point growth rates. The main explanatory variable is an interaction term between *Regulation* and *Type*. *Regulation* is a dummy for regulatory change, equal to 1 if regulation is tightened in country *i* at quarter *t*, and 0 for all other periods. *Type* is a dummy variable equal to 1 if foreign bank operates in the UK as a branch, and 0 if it operates as a subsidiary. The coefficient β provides information about the effect of macroprudential regulation tightening. The set of bank-time varying control variables BC include the logarithm of banks' total assets (Bank size (ln)), and the share of interbank lending (Wholesale). Additionally, regressions include banking group-quarter-fixed effects. We remove subsidiaries which experienced change in bank specific capital requirements imposed by the Financial Services Authority. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6
Macroprudential regulation and cross-border lending: *Control variables excluded*

	Non-bank lending				Interbank lending			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Capital regulation*Type	-0.078	-0.083			-0.056***	-0.062***		
	(-0.78)	(-0.80)			(-3.03)	(-4.72)		
Lending standards*Type	0.028		0.032		0.027		0.030	
	(0.31)		(0.36)		(0.69)		(0.73)	
Reserve requirements*Type	0.035			0.036	0.088			0.089
	(0.34)			(0.35)	(1.12)			(1.13)
Type	0.006	0.007	0.006	0.006	-0.030**	-0.028**	-0.029**	-0.030**
	(0.45)	(0.59)	(0.46)	(0.51)	(-2.60)	(-2.45)	(-2.48)	(-2.67)
Observations	4,107	4,107	4,107	4,107	4,107	4,107	4,107	4,107
R-squared	0.516	0.516	0.516	0.516	0.509	0.509	0.509	0.509
Bank Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country	Country	Country

Notes. Table 6 presents results of difference-in-difference regressions examining the effect of macroprudential regulatory changes on lending of foreign banks in the UK. We estimate the following model: $\Delta y_{ijkt} = \alpha_i + \beta\left(Regulation_{kt} * Type_{ijk}\right) + Type_i + \delta_{jkt} + \varepsilon_{ijkt}$. Our dependent variables include foreign banks' lending to the UK non-bank sector and foreign banks' interbank lending in the UK. All dependent variables are in percentage point growth rates. The main explanatory variable is an interaction term between *Regulation* and *Type*. *Regulation* is a dummy for regulatory change, equal to 1 if regulation is tightened in country *i* at quarter *t*, and 0 for all other periods. *Type* is a dummy variable equal to 1 if foreign bank operates in the UK as a branch, and 0 if it operates as a subsidiary. The coefficient β provides information about the effect of macroprudential regulation tightening. Additionally, regressions include banking group-quarter-fixed effects and institution type-fixed effects. We exclude the set of bank-time varying control variables BC. Standard errors are clustered at the banks' home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7
Falsification tests

Panel A: Falsification test 1		**Panel B: Falsification test 2**	
Number of replications: 1000		Number of replications: 1000	
Interbank lending	*Non-bank lending*	*Interbank lending*	*Non-bank lending*
Rejection rates at 1% level (2-tailed test):		Rejection rates at 1% level (2-tailed test):	
1.00%	1.30%	0.70%	1.20%
Rejection rates at 5% level (2-tailed test):		Rejection rates at 5% level (2-tailed test):	
3.00%	5.50%	3.40%	4.30%
Rejection rates at 10% level (2-tailed test):		Rejection rates at 10% level (2-tailed test):	
6.30%	9.60%	6.70%	8.70%

Panel C: Falsification test 3		
Variable	*Interbank lending*	*Non-bank lending*
Placebo *Capital requirements*	0.0301	-0.0192
	(0.35)	(0.56)
Placebo *Lending standards*	0.0395	-0.0111
	(1.15)	(0.96)
Placebo *Reserve requirements*	-0.047	0.0252
	(-0.24)	(0.02)
Controls	Yes	Yes
Bank FE	Yes	Yes
Year FE	Yes	Yes
Observations	4,852	4,852
Cluster	0.077	0.132

Note. Table 7 presents Monte Carlo simulations in Panel A and Panel B. We estimate the regression $\Delta y_{ijkt} = \alpha_i + \beta Placebo_{ijkt} + Type_i + \delta_{jkt} + \varepsilon_{ijkt}$, where in Panel A, *Placebo* is a binary variable randomly set to 1 for banks in the treatment group (affected foreign banks' branches) in periods preceding actual change in macroprudential regulation. In Panel B, we randomly assign banks to placebo treatment status setting *Placebo* equal to 1 for banks in countries where no changes to macroprudential regulation occurred during our sample period. We estimate the regression and save the p-value on the coefficient β and repeat this process 1,000 times and compute the rejection rates of the null hypothesis β=0 at the 1%, 5%, and 10% levels. Panel C presents results of tests where we examine the effect of macroprudential regulation on UK-owned banks. Here, only UK-owned banks are included in the sample. We estimate the following regression $\Delta y_{it} = \alpha_i + \beta Placebo_{it} + BC_{it} + \delta_i + \gamma_t + \varepsilon_{ijkt}$, where our dependent variable denotes a growth rate in lending provided to non-bank borrowers (*Non-bank lending*) and other banks (*Interbank lending*). $Placebo$ takes a value of one for periods in which variable $Regulation_{kt}$ in specification 1 is equal to 1, and 0 otherwise. We generate Placebo variable for each type of macroprudential regulation. Regressions include variables controlling for the size of the institution and share of intrbank loans on its balance sheet, and bank and quarter fixed effects. Standard errors are clustered at the banks' home country level. Robust *t*-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8
Regressions with standard errors clustered on the banking group level

	Non-bank lending				Interbank lending			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Capital regulation*Type	-0.059	-0.065			-0.063**	-0.068***		
	(-0.52)	(-0.66)			(-2.27)	(-4.13)		
Lending standards*Type	0.034		0.037		0.020		0.024	
	(0.51)		(0.40)		(0.20)		(0.60)	
Reserve requirements*Type	0.025			0.026	0.084			0.085
	(0.26)			(0.28)	(1.21)			(1.08)
Type	0.030	0.031*	0.030*	0.030	-0.042*	-0.041**	-0.041**	-0.042**
	(1.54)	(1.76)	(1.89)	(1.70)	(-1.82)	(-2.30)	(-2.31)	(-2.40)
Bank size (ln)	0.001	0.001	0.001	0.001	0.005	0.005	0.005	0.005
	(0.19)	(0.20)	(0.19)	(0.19)	(1.23)	(1.58)	(1.59)	(1.57)
Wholesale	-0.101**	-0.101**	-0.101**	-0.101**	0.039	0.039	0.038	0.039
	(-2.40)	(-2.24)	(-2.19)	(-2.25)	(0.81)	(1.02)	(1.01)	(1.03)
Observations	4,107	4,107	4,107	4,107	4,107	4,107	4,107	4,107
R-squared	0.529	0.529	0.529	0.529	0.515	0.514	0.514	0.514
Bank Group*Quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Group	Group	Group	Group	Group	Group	Group	Group

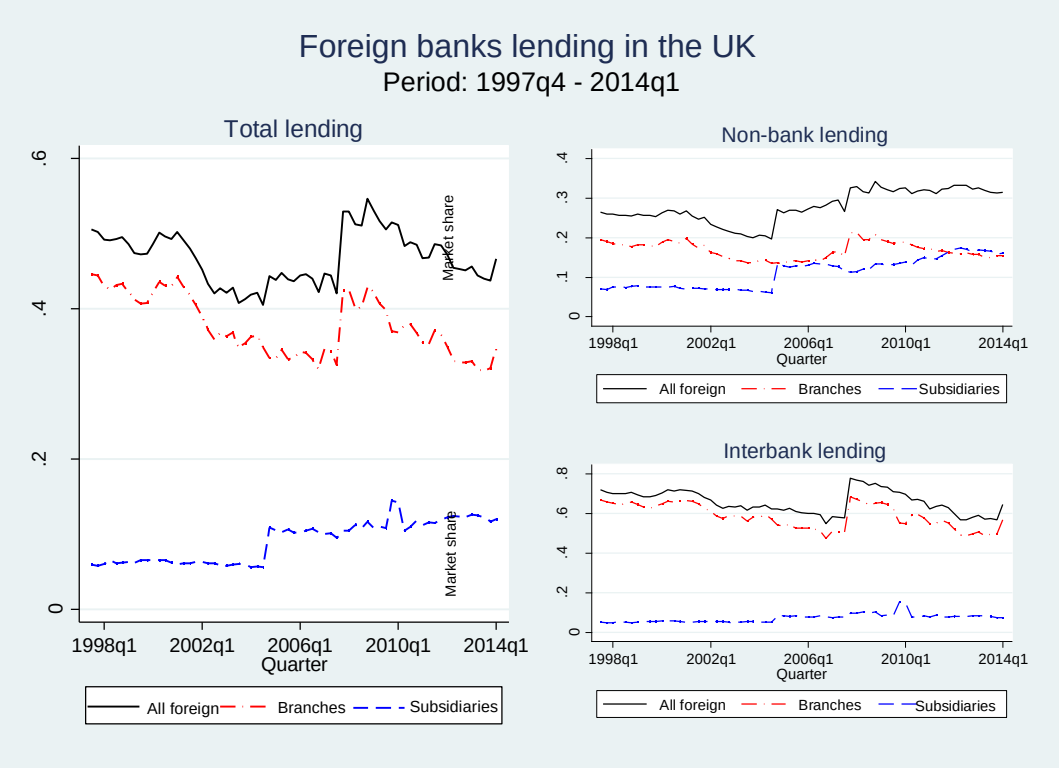
Notes. Table 8 presents results of difference-in-difference regressions examining the effect of macroprudential regulatory changes on lending of foreign banks in the UK. We estimate the following model: $\Delta y_{ijkt} = \alpha_i + \beta\left(Regulation_{kt} * Type_{ijk}\right) + Type_i + BC_{ijkt} + \delta_{jkt} + \varepsilon_{ijkt}$. Our dependent variables include foreign banks' lending to the UK non-bank sector and foreign banks' interbank lending in the UK. All dependent variables are in percentage point growth rates. The main explanatory variable is an interaction term between *Regulation* and *Type*. *Regulation* is a dummy for regulatory change, equal to 1 if regulation is tightened in country *i* at quarter *t*, and 0 for all other periods. *Type* is a dummy variable equal to 1 if foreign bank operates in the UK as a branch, and 0 if it operates as a subsidiary. The coefficient β provides information about the effect of macroprudential regulation tightening. The set of bank-time varying control variables BC include the logarithm of banks' total assets (Bank size (ln)), and the share of interbank lending (Wholesale). Additionally, regressions include banking group-quarter-fixed effects. Standard errors are clustered at the banking group level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 9
Duration analysis

	Non-bank lending			Interbank lending		
Capital requirements*Type (t+1)	0.072			-0.173		
	(0.66)			(-1.37)		
Capital requirements *Type (t+2)		-0.037			-0.114	
		(-0.61)			(-0.87)	
Capital requirements *Type (t+3)			0.102			-0.036
			(1.40)			(-0.26)
Type	0.030	0.031	0.031	-0.040**	-0.039**	-0.039**
	(1.71)	(1.58)	(1.44)	(-2.24)	(-2.31)	(-2.22)
Observations	4,093	3,999	3,904	4,093	3,999	3,904
R-squared	0.529	0.534	0.538	0.515	0.515	0.515
Controls	YES	YES	YES	YES	YES	YES
Bank Group*Quarter FE	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country
	Non-bank lending			**Interbank lending**		
Lending standards*Type (t+1)	-0.012			0.069		
	(-0.26)			(1.72)		
Lending standards *Type (t+2)		0.038			-0.060	
		(1.18)			(-0.55)	
Lending standards *Type (t+3)			0.026			0.040
			(0.88)			(0.70)
Type	0.030*	0.030	0.031	-0.042**	-0.038**	-0.040**
	(1.75)	(1.56)	(1.48)	(-2.39)	(-2.26)	(-2.27)
Observations	4,093	3,999	3,904	4,093	3,999	3,904
R-squared	0.529	0.535	0.538	0.515	0.515	0.515
Controls	YES	YES	YES	YES	YES	YES
Bank Group*Quarter FE	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country
	Non-bank lending			**Interbank lending**		
Reserve requirements*Type (t+1)	0.056			-0.072		
	(0.84)			(-0.82)		
Reserve requirements*Type (t+2)		-0.002			-0.006	
		(-0.01)			(-0.05)	
Reserve requirements*Type (t+3)			-0.032			0.117
			(-0.37)			(1.31)
Type	0.029	0.031	0.032	-0.040**	-0.039**	-0.040**
	(1.67)	(1.56)	(1.49)	(-2.18)	(-2.33)	(-2.31)
Observations	4,093	3,999	3,904	4,093	3,999	3,904
R-squared	0.529	0.534	0.538	0.514	0.515	0.515
Controls	YES	YES	YES	YES	YES	YES
Bank Group*Quarter FE	YES	YES	YES	YES	YES	YES
Cluster	Country	Country	Country	Country	Country	Country

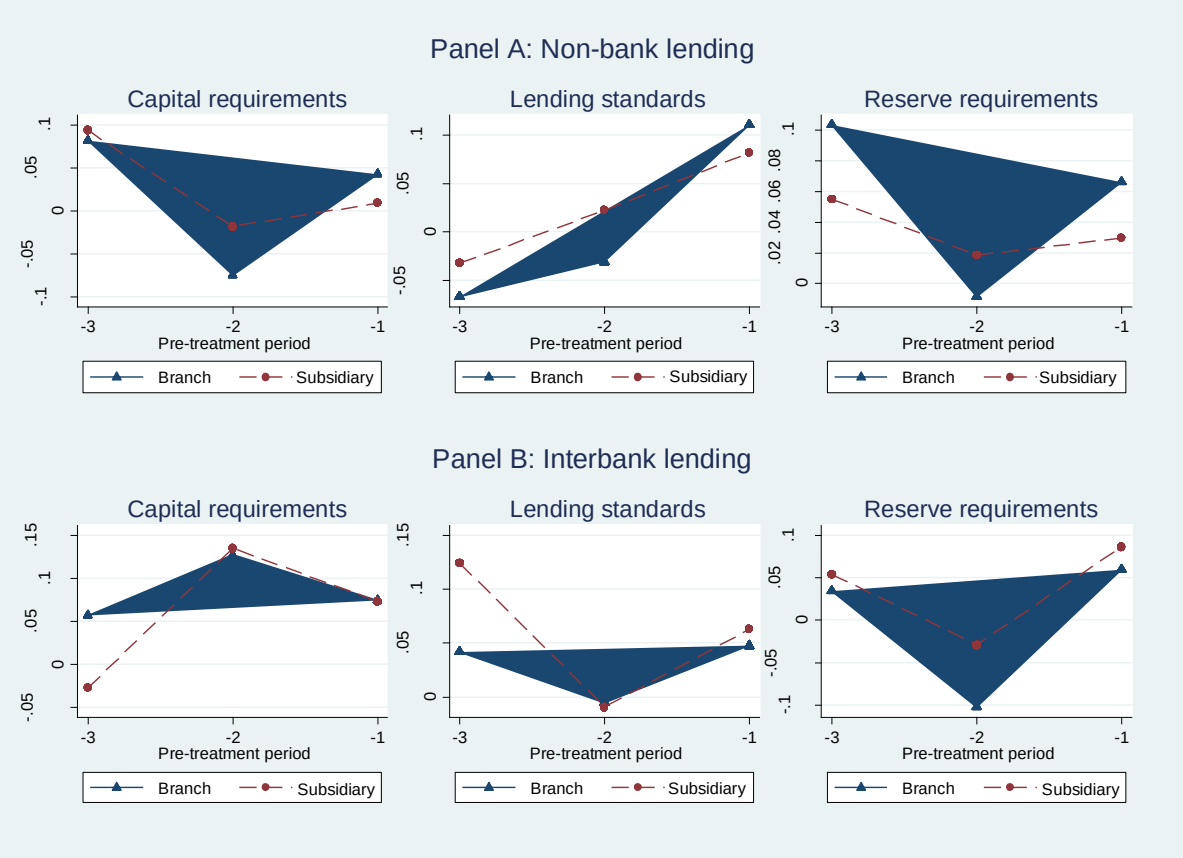
Notes. Table 9 presents results examining the duration of the effects found in Table 4. We replicate regressions in Table 4 replacing treatment dummy with its three lag. Standard errors are clustered at the banks home country level. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure 1
Foreign banks' lending in the UK



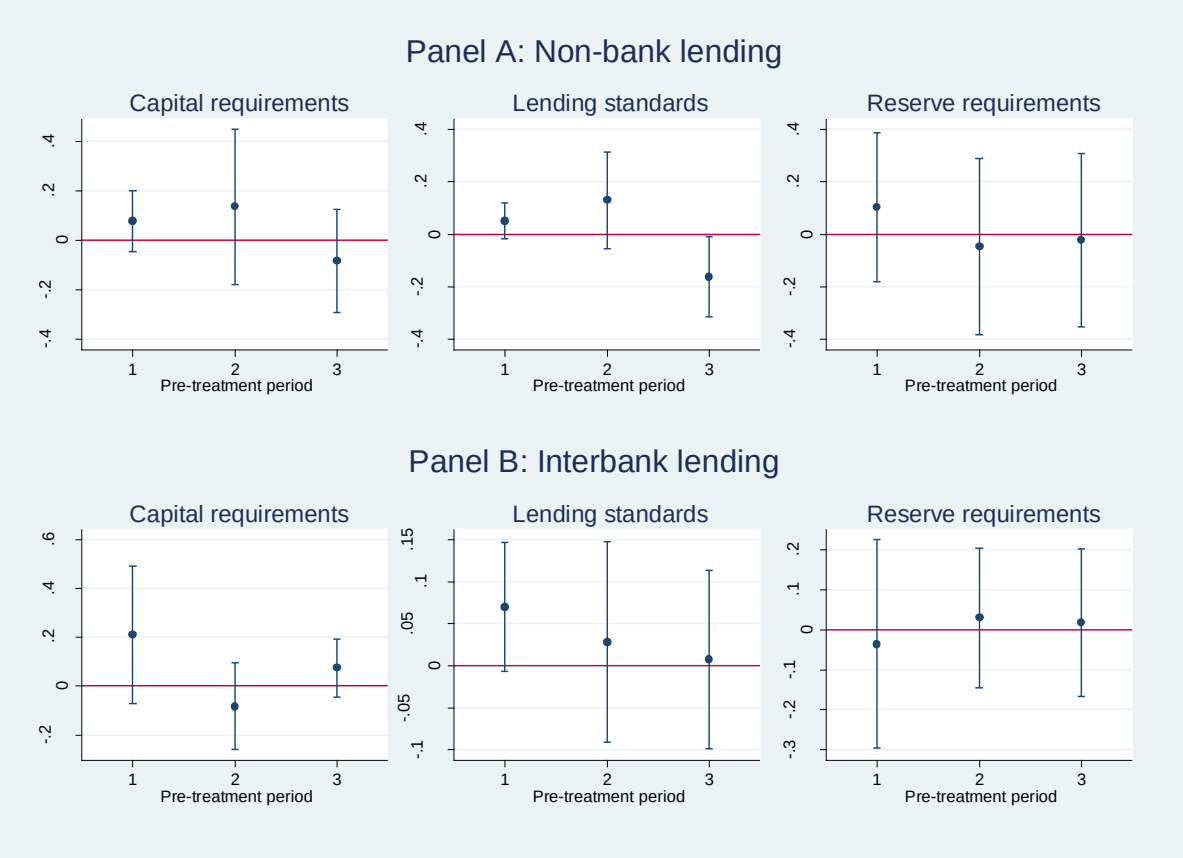
Notes. Figure 1 presents evolution in the market share of total lending, lending to the UK non-bank sector, and interbank lending provided by branches and subsidiaries of foreign banks in the UK.

Figure 2
Parallel trends assumption



Notes: Figure 2 illustrates the behaviour of quarterly changes in the dependent variables, for three quarters preceding changes in macroprudential regulation tightening. Branches of foreign banks (the treatment group) are represented by a triangle and solid line, whereas foreign banks' subsidiaries (the control group) are depicted by a dashed line. Non-bank lending refers to foreign banks' lending to the UK non-bank sector and interbank lending to foreign banks' interbank lending in the UK.

Figure 3
Placebo regressions



Notes: Figure 3 illustrates the results of placebo regressions. We replicate the results from Table 4 replacing the treatment variable in regression specification 1 in Table 4 with its forwarded values by 1, 2 and 3 quarters. We plot the coefficient estimate and the 95% confidence intervals. Non-bank lending refers to foreign banks' lending to the UK non-bank sector and interbank lending to foreign banks' interbank lending in the UK.