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Conference Paper Multinational banking: The crisis and its policy response

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2019: 30 Jahre Mauerfall - Demokratie und Marktwirtschaft - Session: Finance, No. G02-V1

Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

Suggested Citation: Müting, Miriam (2019) : Multinational banking: The crisis and its policy response, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2019: 30 Jahre Mauerfall - Demokratie und Marktwirtschaft - Session: Finance, No. G02-V1, ZBW - Leibniz-Informationszentrum Wirtschaft, Kiel, Hamburg

This Version is available at: https://hdl.handle.net/10419/203647

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Multinational Banking: The Crisis and Its Policy Response

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September 8, 2019 Work in progress

Stylized data shows a structural break in the integration of lending markets which coincides with the global financial crisis. During and after the crisis, banks actively reduced their share of foreign relative to domestic banking activity and lending in particular. This increase in lending 'home bias', which is thought to have been driven by a reduction of overall loanable funds, has curiously persisted throughout the recovery stage of the crisis and consequent policy interventions.

We propose a simple theoretical framework to retrace the decision making of multinational banks in a changing regulatory and financial environment. We show that regulatory and monetary policy measures, as enacted after the crisis, have a differential effect on the profitability of banks' domestic and foreign lending operations. Due to lower inherent information costs, banks' domestic lending operations become disproportionally safer and more profitable following a tightening of equity requirements and loosening of monetary policy. This quantitative difference leads to an increase in the share of banks' domestic lending in total lending.

Keywords: international lending, financial integration, banking regulation **JEL Codes:** F34, G11, G21, G28, L10

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1 Introduction

With the increasing liberalization of commercial banking in the past decades, multinational banks have emerged as important players in lending markets outside of their home country. Given this role, the observation of a persistent reduction of foreign relative to domestic lending activity, which started during the 2007 - 2008 financial crisis, causes concern over a new systematic pattern of national lending market segmentation ¹.

Empirical studies such as Giannetti and Laeven (2012b) find the deterioration of banks' funding conditions to be central to the relative reduction in foreign lending during the crisis with the collapse of the interbank funding market as the main driver. In addition, the declining market value of banks' equity as documented by Demirguc-Kunt et al. (2010) and Baron et al. (2018) played a significant role in constraining lending decisions. Yet, the exact mechanisms by which funding conditions skew the allocation of credit towards domestic lending remain unclear.

In the aftermath of the crisis, regulators identified lacking capital regulation as a main cause of excessive risk-taking that lead to the crisis. Many of the banks that were eventually rescued appeared to comply with minimum capital requirements before and even during the crisis. In the ensuing academic and policy debate (e.g. Danielsson et al. (2015)), regulators therefore proposed tighter capital requirements as an essential tool in ensuring bank stability. In July 2010, a consensus was forged around a stringent set of capital standards named Basel III as summarized in Bank for International Settlements (2010). All changes were phased in gradually and the transition is set to be completed in 2019. Empirical evidence shows that the implementation of regulatory changes from 2010 onwards did not mitigate and in some cases exacerbated the lending 'home bias'. Bremus and Fratzscher (2015), for instance, find that an increase in capital stringency in the recovery period of the crisis 2009 – 2010 led to a greater subsequent reduction in the share of foreign lending.

With time, the financial crisis started to also affect the real economy mainly via a sharp

¹Giannetti and Laeven (2012a), Claessens and van Horen (2012) and Bremus and Neugebauer (2018) are prominent examples of this literature.

decline in corporate credit supply (Aiyar, 2012). In response, central banks 'loosened' monetary policy in order to provide commercial banks access to liquidity (Rajan, 2013). Alongside unconventional policy tools such as open market operations, the central banks gradually phased in ultra low interest rates.

In this paper, we propose a two-country trade framework of imperfectly competitive multinational banks. Each country is headquarters to one bank, which can grant risky loans to corporate borrowers in its domestic market and via an affiliate in the foreign market. The banks' local affiliates decide on the level of monitoring that determines the riskiness of the respective local operation. In line with the literature (e.g. Degryse and Ongena (2005)), we assume the costs of the associated information gathering to be greater in the foreign market. This monitoring cost asymmetry leads to a lower level of optimum information gathering and therefore greater credit risk for the foreign compared to the domestic lending operation.

We find that banks respond to a negative funding shock as well as more stringent equity capital requirements and a policy of low central bank interest rates with a decrease in overall credit risk. This prediction is in line with the empirical finding of a 'flight to quality' of portfolio investments and bank lending activity during and after the crisis (Beber et al. (2008), Albertazzi and Marchetti (2010)). Further, the model is consistent with the pattern of an increased post-crisis home bias as documented by Bremus and Fratzscher (2015). In the model, a reduction in funding supply as well as above mentioned policy measures imply a relative decrease in the marginal profitability of foreign lending and thus its share of total lending activity. We therefore conclude, that the implemented policy measures, while being crucial for banking sector stability and continued overall credit supply, exacerbated international lending retrenchment.

The rest of the paper is organized as follows. Section 2 reviews the mostly theoretical literature that this paper builds on. Section 3 introduces our model of lending competition and solves for banks' endogenous choice variables in equilibrium. Section 4 discusses implications of a negative funding supply shock on banks' decision making. Section 5 analyses the impact of the enacted policy measures. Section 6 concludes.

2 Literature Review

This paper draws from methodology and findings of several strands of research, namely the traditional literature on banks' credit assessment technology and credit market competition as well as a novel literature of international banking models based on trade theory. Contributions to the credit assessment literature focus largely on the informational externalities of screening under various market and informational structures. Examples include Gehrig (1998) and Fishman and Parker (2015). Early research by Broecker (1990) analyses the effect of credit market competition on loan screening intensity. Banks engage in Bertrand competition, offering credit interest rates conditioned on the results of costless creditworthiness tests. Later works such as Gehrig (1998) consider costly information gathering. Our approach to modelling a bank monitoring choice also includes information costs. Differing from this strand of literature, we consider Cournot not Bertrand competition. This allows us to avoid corner solutions and non-existence of equilibria. Additionally, we set up our model in such a way that a bank's monitoring activity has no adverse effect on other banks' loan applicant quality.

Classical models of credit market competition are for instance given by Hauswald and Marquez (2006) and literature cited therein. Examples of international banking models based on a trade framework are e.g. De Blas and Russ (2013), Faia and Ottaviano (2017)), Niepmann (2015) or Haufler and Wooton (2018).Niepmann (2015) presents a perfectly competitive model of banking where international lending patterns emerge due to differences in relative factor endowments or efficiency. This framework however, does not leave room for strategic interaction between domestic and foreign banks as modelled here. Our work is most closely related to the framework of Faia and Ottaviano (2017) and Haufler and Wooton (2018) who also consider Cournot competition in the credit market.

A large strand of recent empirical literature analyses possible determinants of international lending flows and banks' flows in general (see e.g. Buch and Goldberg (2015) for an overview). The studies consider a variety of determinants such as the regulatory environment as in Houston et al. (2012) or bank operational variables as in De Haas and Van Horen (2012).

3 Model

We present a simple model of duopolistic bank lending competition in two symmetric markets indexed $i \in \{A, B\}$. Each country is headquarters to a single bank. The two national banking sectors are financially integrated in the sense that each national bank can extend loans to corporate borrowers in either country. Banks can choose to exert monitoring effort to reduce credit risk in both markets. Their choice of monitoring effort together with the allocation of loan supply to their home and foreign operation determines banks' overall profit.

The timing of our model follows a predefined sequence of events. First, the banks engage in competition for loans by simultaneously announcing the share of their fixed amount of loanable funds to be allocated to their domestic and foreign lending operation. The local loan rate is then determined from the anticipated loan demand and supply in the corresponding national market. All loans offered in a given market are identical. In the second stage, each affiliate decides on the monitoring effort to be exerted in their respective local market. In stage three, firms decide on whether to apply for a loan at loan interest rate r_i in their local market. We solve the model by backward induction.

3.1 Credit market environment

In this work, we model the interaction between two advanced economy credit markets. Therefore, we set the credit market environment to be symmetric in the two countries. We assume prospective borrowers in each national market to be individual entrepreneurs or small firms. This population of firms is atomistic in nature and of measure \bar{R} . Each firm is risk neutral and has access to a constant-return risky technology ('project') with a random gross return R. Firms draw a realization of R from the continuous, uniform distribution $R \sim \text{unif}(0, \bar{R})$. This realization can be credibly signaled to the banks via the firm's willingness to pay for a loan. We interpret R as the exogenous quality of the project that an entrepreneur has access to at a given point in time.

All projects require a fixed amount of initial external investment I. We assume that

firm location is fixed but firms can receive a loan from either the domestic or the foreign multinational bank. Hence, firms may only finance their projects by taking a loan offered in their local market. Further, firms may only apply for a loan once. Firms realize their gross return with a probability $s \in (0, 1)$ and receive a return of zero otherwise.

Limiting a firm's business activity to one project - as is the case here - necessarily leads to the firm's default if this project is unsuccessful. If we now assume limited liability, the firm's willingness to take a loan only depends on its valuation of the loan in the state of project success. Hence, a firm under limited liability borrows if its gross return R is larger or equal to the loan interest rate r_i in local market i, such that $R - r_i \ge 0$. This inequality holds true for all gross returns $R \in [r_i, \bar{R}]$. Assuming a uniform distribution of gross returns $R \sim \text{unif}(0, \bar{R})$ across firms and firm population measure \bar{R} , the number of borrowers willing to take out a loan at a given loan interest rate r_i is

$$L_i^D(r_i) = \bar{R} - r_i,\tag{1}$$

defining the aggregate loan demand function. Hence, total loan demand $L_i^D(r_i)$ for a given loan interest rate r_i is solely determined by borrowers' willingness to pay in the state of project success. Under market clearing, an increase of the loan supply in market i would drive down r_i .

3.2 Banks

We consider a duopolistic model of bank lending competition in two large and symmetric national credit markets. Within the regional banking sector, each country $i \in \{A, B\}$ is headquarters to one multinational bank. Both multinationals can operate in their domestic as well as in the respective foreign market via a subsidiary. Both banks choose which fraction of their loanable funds to allocate to the domestic and the foreign lending operation, behaving as Cournot-Nash competitors in each national credit market.

Since borrowers are confined to their local market, we can assume national credit markets to be separate, in the sense that the local demand functions are independent of each other. In this choice of market structure, we follow the model of international trade via 'dumping' incentives of Brander and Krugman (1983). In this framework, international trade arises from the exporters' expectation of higher returns in the foreign market, due to less existing supply. Variants of this framework have previously been applied to the subject of international banking by Haufler and Wooton (2018) and Faia and Ottaviano (2017). In this model, we abstract from entry costs in both markets as in Faia and Ottaviano (2017) and 'iceberg' type trade costs as in Haufler and Wooton (2018). This describes a regional banking sector where individual financial intermediaries are already established and entry costs are sunk. We further assume, that the regulatory framework is similar in both countries, as is the case in the EU. This minimizes the additional compliance cost of abiding to foreign regulation which can be modeled as variable trade costs.

We depart further from Brander and Krugman's framework of goods trade to account for the special nature of the corporate loan business. In particular, commercial banks' clients, i.e. corporate borrowers, are inherently at risk of default. This risk is generally not observable by the bank without exerting effort and incuring cost (Berger et al., 1999). Here, we attribute this information cost to the effort exerted by banks in assessing credit risk and guiding firms. The success probability $s \in (0, 1)$ of a firm's project then reflects the choice of monitoring effort of the loan giving bank. The empirical literature on distance and lending relationships shows that gathering information about borrowers becomes more costly with an increase in bank-borrower distance (e.g. Degryse and Ongena (2005)). Hence, we assume additional costs to arise in assessing and monitoring foreign borrowers.

Bank financing

Banks finance their lending operation in part via their current equity capital and in part by raising deposits. We assume that bank *i*'s overall volume of equity E_i is difficult to raise and thus fixed in the short run as discussed for instance in Stein et al. (1998). While bank *i* may not independently choose local lending volumes, it can decide on the share γ_i of equity to be allocated to its domestic market *i*. Conversely, the share $(1 - \gamma_i)$ of equity is allocated to the foreign affiliate.

The local regulator in country *i* imposes a capital adequacy standard k_i , which represents the minimum share of equity financing (henceforth 'equity ratio') required for all bank subsidiaries in country *i*. For a binding equity ratio, the amount of equity allocated to the domestic market, $\gamma_i E_i$, and k_i determine the volume of loanable funds $L_{id}^S = \gamma_i E_i/k_i$ of bank *i* in market *i*. Analogously, bank *i*'s loanable funds in the foreign market *j* are given by $L_{if}^S = (1 - \gamma_i)E_i/k_j$. Equity holders require an average return per unit investment that is equal to an equity premium $\rho > 0$ in addition to a reference deposit rate. This captures the idea that equity capital is a particularly costly form of financing (see DellAriccia and Marquez (2006) or Hellmann et al. (2000) for similar assumptions).

Banks' local affiliates further have access to an unlimited amount of locally raised deposits at an average risky deposit rate δ . In order to maintain symmetry across national banking environments, we assume δ to be the same in both countries. The banks' use of this cheaper form of financing is constrained by the share of equity financing k_i or k_j , required by the local regulator. This leads the banks' domestic operations to each take on a deposit volume of $D_{i,d} = E_i \gamma_i (1 - k_i)/k_i$. The foreign operations take on a deposit volume $D_{i,f} = E_i (1 - \gamma_i)(1 - k_j)/k_j$. To ensure the tractability of our analysis, we assume credit risks to be perfectly correlated within each national credit market. This implies, that an affiliate's monitoring effort s also reflects its default probability. In case of default of the affiliate, local taxpayers must pay off the local depositors of the bank. This tax financed deposit insurance can be seen as an implicit subsidy to the bank. The subsidy increases with a bank's default probability. Hence, the existence of a deposit insurance gives the bank disincentives to exert monitoring effort s.

The total capital costs of bank i's domestic and foreign operations are then given by

$$C_{di}^{C}(s_{di},\gamma_{i}) = \frac{E_{i}}{k_{i}}\gamma_{i}\{(\delta+\rho)k_{i} + \delta(1-k_{i})[s_{di} + (1-\alpha)]\}$$
(2)

$$C_{fi}^{C}(s_{fi},\gamma_{i}) = \frac{E_{i}}{k_{j}}(1-\gamma_{i})\{(\delta+\rho)k_{j}+\delta(1-k_{j})[s_{fi}+(1-\alpha)]\},$$
(3)

where s_{di} and s_{fi} denote the monitoring efforts of the domestic and foreign affiliate respectively.

A bank headquartered in country *i* maximizes its total expected profit Π_i over the share of domestic loans γ_i , monitoring effort in the domestic market s_{di} and monitoring effort in the foreign market s_{fi} . Hence, total expected profit is given by

$$\Pi_{i}(\gamma_{i}, s_{di}, s_{fi}) = \frac{E_{i}}{k_{i}} \gamma_{i} s_{di} r_{i} - C_{di}^{M}(s_{di}, \gamma_{i}) - C_{di}^{C}(s_{di}, \gamma_{i}) + \frac{E_{i}}{k_{j}} (1 - \gamma_{i}) s_{fi} r_{j} - C_{fi}^{M}(s_{fi}, \gamma_{i}) - C_{fi}^{C}(s_{fi}, \gamma_{i}).$$
(4)

Here, $\frac{E}{k}\gamma_i s_{di}r_i$ denotes the gross expected return of domestic lending. It depends on the volume of loanable funds allocated to domestic lending $\frac{E}{k}\gamma_i$, as well as the success probability of the domestic operation s_{di} and the equilibrium loan interest rate r_i in market *i*. The gross return of bank *i*'s foreign operation $\frac{E}{k}(1-\gamma_i)s_{fi}r_j$ can be interpreted analogously. $C_{di}^M(s_{di},\gamma_i)$ and $C_{fi}^M(s_{fi},\gamma_i)$ describe the monitoring cost of domestic and foreign lending given *i*'s choice of monitoring effort s_{di} and s_{fi} respectively. Further, the capital costs of bank *i* are as given in (2) and (3).

3.2.1 Bank monitoring decision

Banks have access to a costly monitoring technology. This technology allows them to choose the projects' success probability with certainty by adjusting their monitoring effort. We assume marginal monitoring cost to increase with this effort $s \in [0, 1]$. This captures, that the cost of an additional increase in project success probability via monitoring increases with the existing success probability. We specify the monitoring cost of bank *i* in the domestic market

$$C_{di}^{M}(s_{di},\gamma_{i}) = \frac{1}{2} \frac{E_{i}}{k_{i}} \gamma_{i} b_{d} s_{di}^{2}, \qquad (5)$$

where b_d defines a cost multiplier. As discussed in 3.2, we assume banks' foreign operation to be subject to a greater marginal information cost relative to the domestic lending activity. This asymmetry enters the model via a greater monitoring cost multiplier $b_f > b_d$ for the banks' foreign operation. Bank i's monitoring cost in the foreign market is then given by

$$C_{fi}^{M}(s_{fi},\gamma_{i}) = \frac{1}{2} \frac{E_{i}}{k_{j}} (1-\gamma_{i}) b_{f} s_{fi}^{2}.$$
(6)

In this model, we assume that banks do not exploit their market power via their monitoring decision. The reason for this assumption is that the risk and return of one firm's project are independent. Credit demand only depends on the distribution of gross returns among the pool of firms. Therefore, banks cannot influence the loan interest rate by adjusting their monitoring effort. The monitoring and equity allocation decisions are independent.

Bank *i*'s monitoring decision affects its profits (4) in several ways. It affects the local loan success probability and thus the affiliate's default probability on the revenue side and monitoring costs as well as the expected value of the local deposit insurance on the cost side. The monitoring decision affects only the profits of the corresponding local bank affiliate. It has no bearing on bank *i*'s operation in the other country. Differentiating equation (4) with respect to the monitoring effort yields first-order conditions for the profit-maximizing monitoring effort of both affiliates

$$s_{di}^* = \frac{r_i - (1 - k_i)\delta}{b_d} \tag{7}$$

and

$$s_{fi}^* = \frac{r_j - (1 - k_j)\delta}{b_f}.$$
(8)

The numerator of equations (7) and (8) denotes the net marginal revenue from monitoring one unit of credit. The first term in the numerator is the loan interest rate or gross marginal revenue from monitoring. The second term describes the marginal decrease in the value of the deposit insurance for an increase in monitoring effort. The cost multiplier in the denominator describes the marginal cost of monitoring for each affiliate. As it is larger for the foreign operation, $b_f > b_d$, the marginal cost of monitoring is greater for the foreign affiliate. Hence, in the optimum, monitoring effort in the domestic market is greater than in the foreign market $s_{di}^* > s_{fi}^*$. This directly translates to a greater credit and therefore default risk of the foreign operation. This relative advantage of the domestic operation increases with the difference of the cost multipliers $b_f - b_d$.

Due to the assumed symmetry of the credit markets, the loan interest rates and therefore gross marginal revenues from monitoring take the same value in credit market equilibrium $r_i = r_j$. In this paper, we analyze the interaction of similar national economies and regulatory environments, linked via their banking sectors. Accordingly, the following analysis assumes symmetry in the behavior of the national banking regulators $k_i = k_j = k$. In this case, the net marginal revenue from monitoring is symmetric across banks and operations. The two banks then choose the same level of monitoring for their domestic and foreign operations $s_{di}^* = s_{dj}^*$ and $s_{fi}^* = s_{fj}^*$, respectively (henceforth s_d^* and s_f^*).

3.2.2 Bank lending decision

According to the framework of duopolistic competition of Brander and Krugman (1983), the two banks $i \in \{A, B\}$ take the equity and thus loan allocation the other bank as exogenous. Hence, they will base their allocation only on the fall in the local loan interest rates caused by their own lending activities. Without additional cost asymmetries, the duopolistic competitors thus divide their funds equally between the two markets.

The banks decide on their loan allocation simultaneously and symmetrically. Under market clearing, the sum of loanable funds supplied to e.g. market i, $E/k[\gamma_i + (1 - \gamma_j)]$, must equal the aggregate local loan demand L_i^D , as defined in equation (1). This condition yields an expression for the inverse demand function for loans in market i

$$r_i = \bar{R} - \frac{E}{k} [\gamma_i + (1 - \gamma_j)]. \tag{9}$$

An analogous expression for r_j applies to market j. Due to the symmetry of banks and markets, the loan interest rates in both markets must take the value $r_i = r_j = \bar{R} - E/k$ in equilibrium, with $\gamma_i = \gamma_j$.

We now want to assess the impact of the loan allocation decision on bank *i*'s profits. To do so, we insert the loan interest rate (9) into bank *i*'s expected profit function (4) and take the first order derivative with regards to the share of domestic lending γ_i . This yields the condition for the optimum loan allocation

$$\frac{\partial \Pi_i}{\partial \gamma_i} = \frac{E}{k} s_d \{ \bar{R} - \frac{E}{k} \left[2\gamma_i + (1 - \gamma_j) \right] \} - \frac{E}{k} s_f \{ \bar{R} - \frac{E}{k} \left[2(1 - \gamma_i) + \gamma_j \right] \} - \frac{1}{2} \frac{E}{k} \left[b_d s_d^2 - b_f s_f^2 \right] - \frac{E}{k} (1 - k) \delta \left[s_d - s_f \right] = 0.$$
(10)

Unlike the choice of monitoring effort, bank i's loan allocation links its domestic and foreign profits π_{di} and π_{fi} . Accordingly, the first and second term in equation (10) denote the marginal revenue from lending of the domestic and foreign affiliate, respectively. An increase in the share of domestic lending activity γ_i mechanically increases the overall revenue from domestic lending and decreases that of foreign lending. An increase in γ_i further has an impact on the loan interest rates r_i and r_j in both markets. A greater loan supply γ_i drives down the loan rate in the domestic market, and increases the loan rate in the foreign market. Hence, domestic lending becomes relatively less profitable with an increase in γ_i . The third and fourth term of equation (10) denote the difference in the cost of monitoring and cost of financing one unit of credit between the domestic affiliate and the foreign affiliate. The costs to the foreign operation enter negatively into the calculation being avoided costs. For the optimum choice of monitoring levels $s_d^* > s_f^*$, the monitoring costs are greater and deposit financing is more expensive domestically. For small values of γ_i , domestic lending is more profitable than foreign lending in expected terms. This is due to the relatively smaller default risk of the domestic operation. We find the optimum share γ_i^* of domestic lending activity by trading off this informational advantage with the decreasing loan interest rate due to the duopolistic competition and the greater relative cost in the domestic market. Solving the first order condition (10)for γ_i and accounting for symmetry $\gamma_i = \gamma_j$ (henceforth γ) yields the expression

$$\gamma^* = \frac{b_d}{b_f + b_d} + \frac{\frac{1}{2}(b_f - b_d) \left[\bar{R} - \frac{E}{k} - (1 - k)\delta\right]}{\frac{E}{k}(b_f + b_d)}.$$
(11)

for the equilibrium share of domestic lending. Equilibrium domestic lending increases with the difference in monitoring efficiency $b_f - b_d$ between the two affiliates. It decreases with the amount of loanable funds E/k supplied to each market which drive down the respective local loan interest rate $\bar{R} - E/k$ and thus the value of the informational advantage in the domestic operation. Further, γ^* decreases with the cost of deposit financing.

If monitoring and financing costs are symmetric across affiliates, $b_f = b_d$ and $s_d^* = s_f^*$, then the allocation of loans is only driven by the 'dumping incentives' of Brander and Krugman (1983). In this case, the banks divide their funds equally between the two markets, $\gamma^* = 0.5$, to enjoy the highest possible loan interest rate in both.

Lending home bias

We now assess whether or not our model predicts a lending home bias. In line with Bremus and Fratzscher (2015), we define a home bias as a disproportionally great or "overinvestment" of a bank's asset portfolio in domestic lending. In our model, this would imply a greater share of loanable funds to be allocated to domestic lending $\gamma^* > 0.5$. For better evaluation we subtract 1/2 from the share of domestic lending of equation (11) yielding the expression

$$\gamma^* - \frac{1}{2} = \frac{1}{2} \frac{(b_f - b_d) \left[\bar{R} - 2\frac{E}{k} - (1 - k)\delta \right]}{\frac{E}{k} (b_f + b_d)} \leq 0.$$
(12)

The sign of equation (12) is ambiguous and depends on the value of the informational advantage in the domestic market, relative to the size of the per loan government subsidy $(1 - k)\delta\alpha$ and the reduction of the domestic loan rate due to a marginal increase in domestic lending activity. For a small value of the latter two effects, expression (12) is positive, implying a positive home bias. Whether or not our model predicts a positive home bias ex-ante has no bearing on the comparative statics analysis conducted in sections 4 and 5.

4 Negative funding shock

In the financial crisis of 2007 - 2009, a systematic negative shock to banks' funding took place. On the side of external financing, this occured through the collapse of the

interbank funding market (Milesi-Ferretti and Tille (2011)). On the internal financing side, a negative shock took place via the deterioration of the market value of bank equity (Demirguc-Kunt et al. (2010), Baron et al. (2018)). We model such a shock as a decrease in the value of current equity E, which we assume to be symmetric across banks. As discussed in 3.2, we consider bank equity capital to be difficult to procure in the short run. Therefore, we think of E as being fixed and capital requirements to be binding in this analysis. Hence, a negative shock to E, such as in a crisis, implies a negative shock to the overall loan supply.

We first consider the effect of a reduction in bank equity capital on the optimum levels of monitoring effort of the two affiliates. To do so, we differentiate the optimum efforts in (7) and (8) with respect to bank equity E yielding

$$\frac{\partial s_d^*}{\partial E} = -\frac{1}{kb_d} < 0 \tag{13}$$

and

$$\frac{\partial s_f^*}{\partial E} = -\frac{1}{kb_f} < 0 \tag{14}$$

respectively. For a negative shock to equity value, such as the financial crisis, monitoring increases and credit risk decreases in both operations. This is in line with the empirical finding of a general 'flight to quality' of portfolio investors and banks (Beber et al. (2008), Albertazzi and Marchetti (2010)) during the crisis. Here, the greater monitoring efforts are caused by an increase in both local loan interest rates due to the decrease in loan supply.

In order to compare the magnitude of both marginal effects we further take the derivative of the difference of monitoring efforts

$$\frac{\partial s_d^*}{\partial E} - \frac{s_f^*}{\partial E} = -\frac{(b_f - b_d)}{kb_d b_f} < 0.$$
(15)

For a negative shock to the value of bank equity, the difference in monitoring effort $s_d^* - s_f^*$ increases. Consequently, domestic credit becomes relatively safer.

In a second step, we analyse the effect of a reduction in bank equity capital on the

lending home bias. Differentiating the optimum share of domestic lending γ^* with respect to bank equity E yields

$$\frac{\partial \gamma^*}{\partial E} = -\frac{1}{2} \frac{(b_f - b_d) \left[\bar{R} - 2\frac{E}{k} - (1 - k)\delta\right]}{E^2(b_f + b_d)} < 0.$$
(16)

A reduction in total lending capacity E decreases the local loan interest rates which in turn increase the gross revenue of the domestic and foreign operation. Since the domestic operation generally bears less default risk $s_d^* > s_f^*$, the increase in gross revenue is more valuable for the domestic affiliate. Secondly, the decrease in the loan interest rates increases monitoring relatively more in the domestic market, as given by equation (15). Hence, lending in the domestic market becomes even more profitable. This result is in line with the empirical finding of a post-crisis retrenchment or bias of lending activities towards banks' home markets (Bremus and Fratzscher (2015), Bussière et al. (2018)).

5 Policy response

In the aftermath of the financial crisis, several policy measures were implemented to facilitate bank lending and promote stability in the banking sector. In this section, we discuss the impact of equity capital requirements and low central bank interest rates on the lending home bias.

Equity capital requirements

We initially examine the effect of a tightening of equity capital requirements, modelled here by an increase in the equity ratio k. The impact of an increase in the equity ratio on monitoring effort is given by

$$\frac{\partial s_d^*}{\partial k} = \frac{\frac{E}{k^2} + \delta}{b_d} > 0 \tag{17}$$

for the domestic market and

$$\frac{\partial s_f^*}{\partial k} = \frac{\frac{E}{k^2} + \delta}{b_f} > 0 \tag{18}$$

for the foreign market. For a fixed equity capital, an increase in the equity ratio 'tightens' a bank's funding constraint and thus decreases the total loan supply. Under symmetry of the two banks, this increases the loan interest rate in both markets, making monitoring universally more profitable. Additionally, an increase in the share of equity financing k decreases the value of the deposit insurance in each country. In turn, this decreases the implicit government subsidy which banks have to give up if they monitor more. By taking the derivative of the difference of the monitoring efforts

$$\frac{\partial s_d^*}{\partial k} - \frac{s_f^*}{\partial k} = \frac{(b_f - b_d) \left[\frac{E}{k^2} + \delta\right]}{b_f b_d} > 0, \tag{19}$$

we find that the domestic monitoring effort increases relatively more due to the smaller unit cost b_d . Hence, a tightening of equity standards makes domestic lending relatively safer.

We further analyse the effect of regulatory tightening on the lending home bias. To do so, we differentiate the optimum share of domestic lending γ^* with respect to the equity ratio k, yielding

$$\frac{\partial \gamma^*}{\partial k} = \frac{1}{2} \frac{(b_f - b_d) \left[\bar{R} - (1 - 2k)\delta\right]}{E(b_f + b_d)} > 0.$$

$$\tag{20}$$

An increase of equity ratio k affects the loan allocation decision in that it reduces total loanable funds. In this way, the effect a rise in k is similar to a negative shock to the value of bank equity capital as described in section 4.

The decrease in loanable funds mechanically increases the loan rates and thus banks' revenue from lending which is more valuable in the more successful domestic market. Additionally, the relatively larger increase in domestic monitoring, as shown in equation (19), further increases the profitability of the domestic operation. This effect is particularly pronounced for banks with a small volume of equity capital

$$\frac{\partial^2 \gamma^*}{\partial k \partial E} = -\frac{1}{2} \frac{(b_f - b_d) \left[\bar{R} - (1 - 2k)\delta\right]}{E^2(b_f + b_d)} < 0.$$

$$\tag{21}$$

Hence, poorly capitalized banks adjust their loan allocation relatively more following an

increase in equity capital requirements.

Monetary policy

We now assess the effect of loose monetary policy, as implemented after the crisis, on banks' decision making. We model a 'loosening' of monetary policy as a decrease in the central bank interest rate, which we assume to be symmetric across markets. While the central bank interest rate does not appear directly in our model, we assume that the risky deposit rate δ roughly follows it. Thus, the effect of a 'loosening' of monetary policy on optimum efforts is given by the derivatives of (7) and (8) with respect to the the risky deposit rate δ

$$\frac{\partial s_d^*}{\partial \delta} = -\frac{(1-k)}{b_d} < 0 \tag{22}$$

for the domestic market and

$$\frac{\partial s_f^*}{\partial \delta} = -\frac{(1-k)}{b_f} < 0 \tag{23}$$

for the foreign market. The deposit rate enters a bank's monitoring decision in that it affects the value of the subsidy implicit in the deposit insurance. For a 'loosening' of monetary policy in the sense of a decrease in the central bank rate, the value of the subsidy by the local government decreases. The decrease in the subsidy increases the bank's incentive to monitor. Accordingly, the bank lending becomes safer in both markets. As shown by equation

$$\frac{\partial (s_d^* - s_f^*)}{\partial \delta} = -\frac{(b_f - b_d)(1 - k)}{b_d b_f} < 0,$$
(24)

the positive incentive effect of the lowered subsidy is greater in the domestic market. Hence, domestic loans become relatively safer. The effect of the subsidy on monitoring incentives affects the bank's credit risk in the two markets and thereby its choice of loan allocation. Differentiating the share of domestic lending in (11) with respect to the deposit rate δ yields

$$\frac{\partial \gamma^*}{\partial \delta} = -\frac{1}{2} \frac{(b_f - b_d)(1 - k)}{E/k(b_f + b_d)} < 0.$$

$$\tag{25}$$

For a 'loosening' of monetary policy in the form of a decrease of δ , the decrease in subsidy disproportionally affects monitoring incentives in the domestic market. Hence, with a larger increase in credit success probability in the domestic market, the profitability of domestic lending increases disproportionally to that of foreign lending. Accordingly, a loose monetary policy leads to a greater home bias. The magnitude of change in the home bias (25) depends on the banks' capitalization. The effect is smaller for banks with a low volume of equity capital E,

$$\frac{\partial^2 \gamma^*}{\partial \delta \partial E} = \frac{1}{2} \frac{(b_f - b_d)(1 - k)}{E^2 / k(b_f + b_d)} > 0.$$
(26)

Hence, poorly capitalized banks are more reluctant to shift lending activity away from the more profitable domestic market following a loosening of monetary policy. For a given deposit rate δ , the volume of available equity capital E determines how valuable a local government deposit insurance is to a bank. For a lower value of E, the government insurance schemes cover a smaller absolute amount of deposits. Thus, the value of a deposit insurance is lower for poorly capitalized banks. In this case, credit monitoring incentives react less sensitively to a change in the deposit rate.

The policy measures discussed above affect the banks' monitoring and loan allocation decisions via two common mechanisms: First, they impact the value of the deposit insurance and thus monitoring incentives in the two markets. An adjustment in the equity ratio k has an additional impact on the equilibrium loan interest rate in both markets. A decrease in central bank interest rates, which occurred internationally from 2009, decreases the value of the deposit insurance and thus increases the optimum monitoring intensity. This positive incentive effect is larger for the domestic lending operation, increasing its profitability disproportionally to that of foreign lending.

6 Conclusion

We have proposed a model in which two imperfectly competitive multinational banks operate in a regional banking sector. The banks lend to private sector borrowers in two national markets, choosing the loan volume and monitoring effort for each local operation. We have shown that a negative funding shock, modeled as a reduction of overall loanable funds, as well as the policy measures implemented after the crisis increase the share of funds allocated to each bank's respective domestic market. Thus, the proposed model is consistent with the empirical finding of a 'retrenchment' of foreign lending activity after the global financial crisis (Milesi-Ferretti and Tille (2011), Bremus and Fratzscher (2015)). In the model, a reduction in funding supply as well as an increase in the equity ratio, a decrease of the central bank interest rate and an increase in deposit insurance coverage imply a relative decrease in the marginal profitability of foreign lending and thus its share of total lending activity. We thus conclude, that the implemented policy measures, while being crucial for banking sector stability and continued overall credit supply, further contributed to banks' withdrawal from foreign markets.

In addition, we find that a negative funding shock as well as more stringent capital requirements and a 'loose' monetary policy result in a 'flight to quality' in lending allocation. Albertazzi and Marchetti (2010) provide empirical evidence for such a preference for safer lending during and after the crisis. Conversely, an increase in the credibility or coverage of deposit insurance schemes decreases banks' incentives to monitor borrowers and thus increases credit and bank default risk.

As of now, our preliminary work does not take into consideration the observed heterogeneity of post-crisis lending flows across countries and regions. As discussed in section 2, a significant strand of empirical literature investigates determinants of international lending flows. Part of this literature attributes heterogeneity of flows to differences in intra-bank and local banking market efficiency (Berger (2007), Niepmann (2015)). We intend to expand on these findings by extending the existing model with an asymmetry in operational efficiency across multinational banks.

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