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Working Paper

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Munich Discussion Paper, No. 2020-2

Provided in Cooperation with:

University of Munich, Department of Economics

Suggested Citation: Müting, Miriam (2020) : Multinational lending retrenchment after the global financial crisis: The impact of policy interventions, Munich Discussion Paper, No. 2020-2, Ludwig-Maximilians-Universität München, Volkswirtschaftliche Fakultät, München, <https://doi.org/10.5282/ubm/epub.72612>

This Version is available at:

<https://hdl.handle.net/10419/224122>

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Online at <https://doi.org/10.5282/ubm/epub.72612>

Multinational lending retrenchment after the global financial crisis: The impact of policy interventions*

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This version: June 29, 2020

Did policy interventions contribute to the gradual segmentation of lending markets starting with the 2007 – 2008 global financial crisis? We investigate this question in an international Cournot duopoly model under an equity constraint. Two symmetric multinational banks compete for corporate lending via local affiliates in two separate national lending markets. Their credit risk in each market is determined by their choice of monitoring effort, which is more costly for foreign lending. Under a binding equity constraint, our model predicts shocks to bank equity, regulatory standards and monetary policy, such as occurred during and after the crisis, to increase the home bias of multinational lending. We interpret this lending retrenchment as a flight to informationally closer or better understood lending. Our results under a non-binding equity constraint are largely identical.

Keywords: financial integration, banking regulation, multinational banking

JEL Codes: F23, F36, G21, G28

*This paper has been presented at seminars and conferences in Marseille, Leipzig and Munich. I thank Franziska Bremus, Nicolas Coeurdacier, Gianni De Nicolo, Andreas Haufler, Bernhard Kassner, Jochen Mankart, Monika Schnitzer and other participants for many helpful comments. Financial support by the German Research Foundation (DFG) via Grant No. HA 3195/9-1 is gratefully acknowledged.

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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 respective domestic market¹. Given this role, the observation of a persistent reduction of foreign relative to domestic lending activity, which started during the 2007 – 2008 global financial crisis, has caused concern over a new systemic pattern of national lending market segmentation (Buch et al., 2014). Evidence shows a continuous reduction in the share of multinational banks' foreign lending activity starting with the default of Lehman Brothers in September 2008 (see figure (1) for the case of German banks)². This gradual segmentation of national lending markets has persisted well throughout the post-crisis regulatory and monetary policy interventions implemented 2008 – 2015 as well as the European sovereign debt crisis. Indeed, policy makers have been concerned about the potential role of their interventions in hindering continued financial integration (European Central Bank, 2010).

While banks' reallocative responses to policy measures have received some empirical attention, the literature still lacks a theoretical treatment of this issue. Our paper offers a first approach to the topic. To this end, we model multinational banking in an international Cournot duopoly under an equity constraint. Two multinational banks compete for corporate lending via local affiliates in two separate national lending markets. Each local market houses the headquarters of one bank and the foreign affiliate of the other. Our model includes a full coverage deposit insurance in both countries. We initially assume the regulatory equity constraint to be binding. Thus constrained, banks choose the share of their fixed lending volume to be allocated to each market. The affiliates then determine the credit risk of their lending operation via a choice of monitoring effort.

¹During the period of 1995–2009, the share of foreign owned banks increased by 70% globally (Claessens and Van Horen, 2014). Lending by foreign owned banks has been found to widen and deepen local lending markets as well as provide additional channels of financing in case of an interbank market or local economic shock (see e.g. Allen et al. (2017), Schnabl (2012)).

²Works such as De Haas and Van Lelyveld (2014), Cetorelli and Goldberg (2012) or Frey and Kerl (2015) document the post-crisis retrenchment of multinational lending.

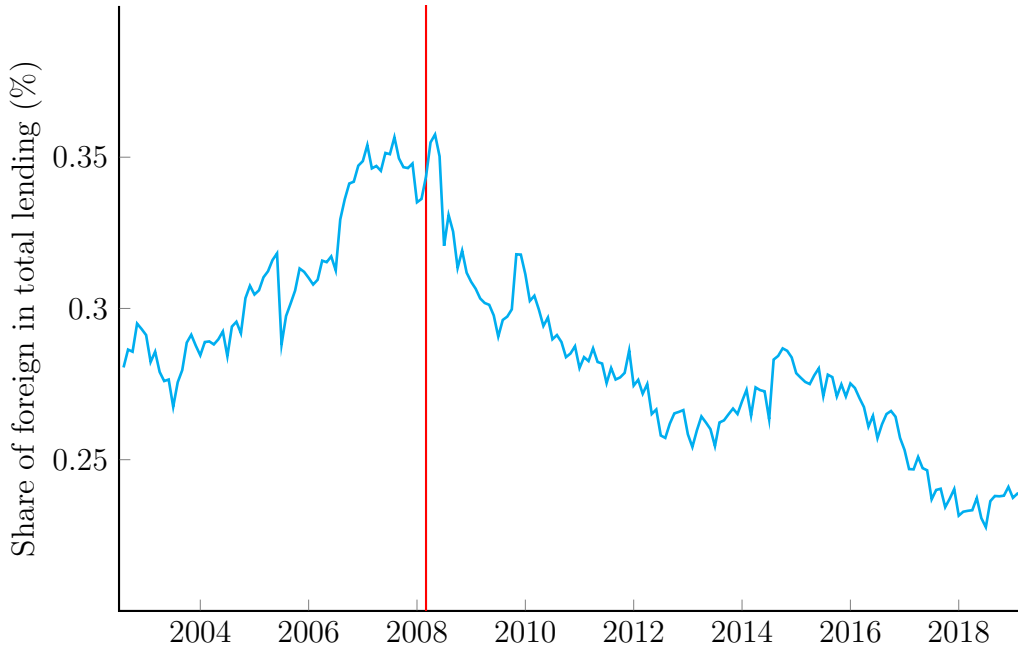


Figure 1: Share of lending to foreign counterparties (non-financial corporations and households) via local affiliates in total lending of German multinational banks. The vertical red line indicates the default of Lehman Brothers on September 15th, 2008. Source: Deutsche Bundesbank, own calculations.

Central to our analysis, we assume borrower monitoring to be more costly to the foreign affiliate.

Indeed, empirical studies show that a greater geographical, linguistic, cultural or legal distance between banks and borrowers amplifies the information frictions in the lending process³. Such costly frictions arise due to asymmetric information between banks and borrowers in the screening, monitoring, and contract enforcement process. Central to our analysis, Beck et al. (2018) find evidence for greater information frictions for lending by foreign owned banks. The authors show that loans originated by foreign banks are more likely to have repayment issues and a greater loss given default. In turn, the reduction of these frictions is more costly to foreign banks, especially to those headquartered in geographically and culturally distant countries (Brüggemann et al., 2012)⁴. This information cost differential between foreign and domestic lending became

³Agarwal and Hauswald (2010) show that a greater geographical distance to a loan applicant increases the likelihood of the loan being rejected. Further, the quality of banks' proprietary information on their existing borrowers decreases with the bank-borrower distance.

⁴As shown by Karceski et al. (2005) and Sapienza (2002), the greater information cost of foreign or geographically distant banks persists even after an acquisition of or merger with a local bank. This

especially relevant in the financial crisis. For the case of Italy, Albertazzi and Bottero (2014) find a greater post-crisis lending retrenchment of foreign banks headquartered in geographically distant countries⁵.

This paper considers equity constrained multinational banking in particular. From 2007 to 2009, most advanced economy banks lost a significant share of their equity buffers above regulatory requirements, increasingly constraining their lending activity (Ivashina and Scharfstein, 2010). This drop was particularly severe for the largest banks, with US banks of more than 500 billion USD in assets approaching the required minimum of 4.5% common equity under Basel II (Walter, 2019). Equity buffers gradually recovered in all advanced economies from 2009 (Buch and Dages, 2018). Linking equity buffers and the retrenchment of multinational lending, De Haas and Van Lelyveld (2014) find a greater post-crisis reduction in foreign lending of poorly capitalized banks. We investigate this dependency formally by comparing multinational banks' lending retrenchment for the case of a non-binding and binding equity constraint.

We investigate the reallocative impact of equity, regulatory and monetary policy shocks on multinational lending in each case. We model the impact of the financial crisis on banks' balance sheets as a negative shock to bank equity, either as a decrease in the available volume or an increase in the cost of equity. Under a binding equity constraint, our model predicts banks to increase their lending home bias in response to such a shock. Banks similarly increase their lending home bias following a tightening of regulatory standards or expansionary monetary policy.

Banks' response to a reduction in bank equity or tightening of regulatory standards is robust to relaxing the equity constraint. Following expansionary monetary policy, however, well capitalized banks reduce their lending home bias due to an additional increase in lending volumes and subsequent reduction in the credit interest rate. This result is in direct opposition to the case of a binding equity constraint, where the effect

can be attributed to a greater 'hierarchical distance' between borrower and loan officer within a larger banking organization (Stein, 2002).

⁵Sette and Gobbi (2015) and others show a similar post-crisis retrenchment in lending to informationally distant borrowers within countries.

on the credit supply is fully frustrated⁶. These results are consistent with the empirical findings of e.g. Baskaya et al. (2017). For the case of Turkey, the authors show that well capitalized foreign-owned banks increase their local lending supply more than poorly capitalized ones in response to an increased access to external financing.

In both cases, the domestic lending operations bear a smaller credit risk than their foreign counterparts due to their lower cost of monitoring local corporate borrowers. Building on this difference, the model shows two effect channels by which the impact of the policy shocks is intermediated. First, a reduction in bank equity reduces the credit supply to each market and subsequently increases the local credit interest rate. In expectations, increase is particularly valuable to the less risky domestic lending operation⁷. A second effect channel stems from the government subsidy implicit in the deposit insurance. In expectations, this subsidy is greater for the riskier foreign lending operation giving banks an incentive to go abroad. The value of the subsidy decreases with an increase in the regulatory equity ratio or expansionary monetary policy. The two channels point to the information cost differential between domestic and foreign lending as being central to the reallocative impact of the shocks. We thus conclude, that the policy interventions following the crisis likely contributed to the observed multinational lending retrenchment. We can interpret this retrenchment as a flight to informationally closer or better understood lending.

Our paper connects and contributes to three separate strands of theoretical literature, namely multinational banking, financial regulation, and borrower monitoring. In particular, we connect to recent works on multinational banking which build on frameworks of international trade. Examples of this literature are Niepmann (2015), who studies banks' choice of entry mode into foreign markets as a consequence of national differences in factor endowments and banking sector efficiency, or De Blas and Russ (2013), Bremus (2015) and Corbae and D'Erasmus (2015) who study how the foreign bank entry mode affects local banking market structure and market power. Our work is most closely related

⁶Gambacorta and Shin (2018) show that well capitalized banks increase their lending supply more strongly in response to expansionary monetary policy.

⁷The existence of such a *credit interest rate channel* is evidenced by the sharp and persistent increase in banks' corporate lending margins following the default of Lehman Brothers, see figure (2).

to those of Faia and Ottaviano (2017) and Haufler and Wooton (2019). Faia and Ottaviano (2017) set up an oligopolistic regional banking sector with an endogenous number of multinational banks operating under Cournot competition. Similarly to Haufler and Wooton (2019), we simplify this framework to two countries and banks while additionally introducing a binding regulatory equity constraint for the multinational bank as a whole. This modification allows our model to focus on multinational bank decision making under a regulatory constraint.

In explicitly modeling a binding equity constraint, we account for the highly regulated nature of the commercial banking business. In this, we draw from the sizable literature on banking regulation which assesses the impact of equity on bank risk taking and allocative decisions (see Hellmann et al. (2000), Repullo (2004))⁸. For the most part, the regulatory literature solely considers closed economies. One notable exception is the small literature on regulatory competition (see e.g. Acharya (2003) or Haufler and Maier (2019)). Within this literature, we relate most closely to Dell’Ariccia and Marquez (2006) from whom we adopt the application of a binding equity constraint. In this paper, we primarily understand equity requirements as a constraint to banks’ lending choice. Indeed, Kopecky and VanHoose (2004) predict that under a binding equity constraint, shocks to regulatory bank equity lead to short-term credit contractions⁹. We build on this result, in that we assess the impact of shocks on the equity constrained allocation of lending between bank affiliates.

We further relate to the literature on borrower monitoring and bank-borrower distance. Banks manage the riskiness of their current investments by monitoring the quality and project progress of existing borrowers at a cost (Freixas and Rochet, 2008). This information cost generally increases with the bank-borrower distance as modeled by Hauswald and Marquez (2006). In this model, we apply their distance dependent cost parameters to the context of lending to national markets of differing informational distance.

⁸Recent contributions to the regulatory literature focus for instance on the cyclicity of the Basel regulations (Chami and Cosimano, 2010; Repullo and Suarez, 2012; Mankart et al., 2019). Their dynamic modeling frameworks allow for positive equity buffers to emerge endogenously.

⁹Empirical findings corroborate this result in that the lending supply of poorly capitalized banks reacts more severely to negative equity or regulatory shocks (see e.g. Bonaccorsi di Patti and Sette (2012), Fraise et al. (2020)).

The remainder of this paper is organized as follows. Section 2 introduces our theoretical framework of multinational banking under a binding equity constraint while section 3 illustrates the constrained banks' equilibrium lending allocation between national affiliates. Section 4 analyzes the reallocative effect of a negative shock to regulatory equity or expansionary monetary policy as after the financial crisis. Section 5 compares our baseline model of multinational banking under a binding equity constraint with the case of a slack constraint. Section 6 concludes.

2 Multinational banking under a binding equity constraint

2.1 General setup

We present a model of multinational banking under an equity constraint. Therein, we consider a two-country regional banking sector in which two symmetric multinational banks offer credit via national affiliates. Each country $i \in \{A, B\}$ is headquarters to one multinational bank $i \in \{A, B\}$ and houses the foreign affiliate of the other. The affiliates present in each country engage in Cournot duopolistic competition for local corporate lending. All credit offered in a country is identical. In this choice of market structure, we follow the model of international trade via Cournot duopolistic incentives of Brander and Krugman (1983)¹⁰. In this framework, international trade arises from the exporters' expectation of higher returns in the foreign market, due to less pre-existing supply. Variants of this framework have previously been applied to the subject of international banking by Faia and Ottaviano (2017) and Hauffer and Wooton (2019)¹¹. We analyze the case of symmetric banks and markets.

We depart from Brander and Krugman's framework of goods trade to account for the inherently risky nature of the commercial lending business. This risk is generally not

¹⁰Head and Spencer (2017) give an overview of recent applications of oligopolistic models of international trade.

¹¹In our model, we abstract from entry costs in foreign markets as in Faia and Ottaviano (2017). This describes an integrated regional banking sector where affiliate subsidiaries are already established and entry costs are sunk.

observable by the bank without exerting effort and incurring cost (Berger et al., 1999). In our model, we attribute this information cost to the effort exerted by banks in monitoring corporate projects. By exerting costly monitoring effort s_i , a bank i can affect the success probability of its borrowers' projects¹². We assume monitoring effort and project success probability to have a linear relationship of slope one, such that a bank monitoring effort s_i yields a success probability of the borrowers' projects of $s_i \in (0, 1)$. Research on lending relationships shows that gathering information about borrowers becomes increasingly costly with the bank-borrower distance (e.g. Agarwal and Hauswald (2010)). Beck et al. (2018) and Brüggemann et al. (2012) show that this concept also applies to lending to foreign borrowers, especially ones located in countries that are geographically and culturally distant to a bank's headquarters. We take up this finding by modeling a greater cost multiplier of monitoring foreign compared to domestic borrowers $b_f > b_d$.

Our model further differs from those of Faia and Ottaviano (2017) and Haufler and Wooton (2019) in that it assumes bank equity E to be fixed. It thereby describes a situation where banks are limited in their ability to raise equity such as during the global financial crisis. In the short-term, this difficulty in raising additional equity, together with strict equity requirements k , implies a binding equity constraint on banks' lending decisions. Here, a bank i 's strategic choice of lending volume in its domestic or foreign market reduces to the share γ_i or $1 - \gamma_i$ of its fixed lending capacity $L_i = E/k$ which to allocate to that market. We model the local markets for deposit financing as perfectly competitive.

In our model, the national governments provide a full-coverage deposit insurance for local bank affiliates. This reflects the current practice in most developed and developing countries, which have implemented either an explicit or implicit deposit insurance scheme¹³. In case of default of a bank affiliate, local taxpayers must pay off its depositors. The deposit insurance signifies an implicit subsidy to the bank. The subsidy increases

¹²One rationale for this relationship is that increased bank monitoring reduces the entrepreneurs' moral hazard problem, inducing him to exert a greater managerial effort (Holmstrom and Tirole, 1997).

¹³See Barth et al. (2013) for a recent global overview of deposit insurance schemes.

with the affiliate's default probability. Hence, the existence of the deposit insurance gives the affiliates a disincentive to exert monitoring effort.

The timing of our model follows a predefined sequence of events. In the first stage, the banks simultaneously set the share of their fixed lending volume L_i to be allocated to their domestic and foreign affiliates γ_i and $1 - \gamma_i$. The local credit interest rates r_i are then determined from the anticipated credit demand and supply in the national markets i . In stage two, the affiliates decide on their optimal monitoring effort s_{di} or s_{fi} . In stage three, firms decide on whether to apply for a loan at the local credit interest rate r_i . We solve the model by backward induction.

2.2 Firms

We consider prospective borrowers in each local lending market $i \in \{A, B\}$ to be individual entrepreneurs or small firms. The 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 $R \sim \text{unif}(0, \bar{R})$. Each entrepreneur is aware of the gross return of his own project. All projects require a fixed amount of initial external investment which we normalize to $I = 1$. Firms can finance their projects by taking a loan offered by the local affiliate of either the domestic or foreign multinational bank¹⁴. In addition, firms can only apply for a loan once.

A firm realizes its gross return with a success probability $s \in (0, 1)$, determined by the loan monitoring effort of its creditor bank, and receives a return of zero otherwise. In the latter case, the firm defaults on its bank loan. Under this assumption of firm limited liability, a firm's willingness to borrow depends on its valuation of the loan only in the state of project success. Consequently, a firm borrows if its gross return R is larger or equal to the credit interest rate r_i in its local market i , such that $R - r_i \geq 0$. This inequality holds true for all gross returns $R \in [r_i, \bar{R}]$. Assuming a uniform distribution of

¹⁴Due to their inherent opacity, small and young businesses have limited access to capital markets and rely largely on local bank credit for external financing (see Berger and Udell (1998) for a summary of the literature). As shown by Beck et al. (2018), even larger and mature firms are twice as likely to receive credit from domestic than foreign banks.

gross returns across firms, the number of borrowers willing to take out a loan at a given credit interest rate r_i is

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

defining the aggregate credit demand function. With firms confined to borrowing from a local bank affiliate, the national credit markets are separated and local credit demands are independent. Under symmetry of banks, the market clearing credit interest rates are identical $r_i(L_i^D) = r_j(L_j^D)$.

2.3 Banks

The two multinational banks $i \in \{A, B\}$ finance their lending in part via equity capital and in part by raising deposits. We summarize a bank i 's unit costs from these two forms of financing as

$$C_{di}^C(s_{di}) = (\delta + \rho)k + \delta(1 - k)s_{di} \quad (2)$$

$$C_{fi}^C(s_{fi}) = (\delta + \rho)k + \delta(1 - k)s_{fi}, \quad (3)$$

respectively for domestic and foreign lending. Here, s_{di} and s_{fi} denote the credit success probabilities of the domestic and foreign affiliate and thereby the probabilities with which the insured deposits have to be repaid.

Equity holders require a return per unit investment that is equal to a risk premium $\rho > 0$ for the uninsured equity in addition to the risk free interest rate δ . We can interpret the unit cost of equity $\rho + \delta$ as the existing shareholders' opportunity cost of retaining earnings instead of paying them out immediately as dividends¹⁵. Banks' share of equity financing is determined by minimum regulatory requirements. A national regulator i imposes a capital adequacy standard k_i , which represents the minimum share of equity financing (henceforth 'equity ratio') required for all bank affiliates operating in country

¹⁵Equivalently, the greater cost of equity can be interpreted as the significant underpricing required in issuing new equity. Both interpretations capture the idea that equity capital is a particularly costly form of financing (see Dell'Ariccia and Marquez (2006) or Hellmann et al. (2000) for similar assumptions).

i. We assume symmetric regulation $k_i = k_j = k$ across countries, such as within the Euro zone.

The banks' national affiliates have access to an unlimited amount of locally raised deposits. Depositing with a bank is risk free in both countries due to deposit insurance schemes by the national governments. Deposits are consequently priced at the risk free interest rate δ determined by international capital markets. More importantly for the borrowing banks, deposits only have to be repaid if the local bank affiliate does not default. The affiliates' use of this cheaper form of financing is constrained by the regulatory equity ratio k . We assume individual corporate credit risks to be perfectly correlated within each national lending market ¹⁶. This implies, that the credit success probability of its borrowers, s_{di} or s_{fi} , directly reflects an affiliate's default probability and the probability with which it must repay its depositors.

3 Banking sector equilibrium

A bank headquartered in country i maximizes the sum of its expected profits from domestic and foreign lending $\Pi_i = \Pi_{di} + \Pi_{fi}$. To this end, the bank optimally chooses the lending volumes and credit risk in the two markets. This decision making is constrained by regulatory equity requirements. At the multinational level, bank i chooses the shares γ_i and $1 - \gamma_i$ of its fixed equity to be allocated to its domestic and foreign affiliate. The amount of equity allocated to the domestic market, $\gamma_i E$, as well as k in turn determine the lending volume $L_{di} \leq \gamma_i E/k$ of bank i in market i . Analogously, bank i 's lending volume in the foreign market j is given by $L_{fi} \leq (1 - \gamma_i)E/k$. This sums up to the overall lending volume of bank i , $L_i = L_{di} + L_{fi} \leq E/k$. For the case of a binding equity constraint, as assumed here, these expressions hold with equality. In turn, the bank affiliates take on deposits $D_{di} \leq E\gamma_i(1 - k)/k$ and $D_{fi} \leq E(1 - \gamma_i)(1 - k)/k$, respectively¹⁷.

The bank affiliates then choose the credit monitoring effort s_{di} and s_{fi} to decrease the credit risk of their respective lending operation. The choice of monitoring and lending

¹⁶Perfect correlation of credit risks is a common assumption in the regulation literature, see e.g. Dell'Ariccia and Marquez (2006) or Boyd and De Nicolo (2005).

¹⁷For a binding equity constraint, these expressions hold with equality.

allocation determines bank i 's overall expected profit

$$\begin{aligned} \Pi_i(\gamma_i, s_{di}, s_{fi}) &= L_{di}^S(\gamma_i) (s_{di}r_i - C_{di}^M(s_{di}) - C_{di}^C(s_{di})) \\ &\quad + L_{fi}^S(\gamma_i) (s_{fi}r_j - C_{fi}^M(s_{fi}) - C_{fi}^C(s_{fi})) \\ \text{s.t.} \quad L_{di}^S(\gamma_i) &\geq \frac{E}{k}\gamma_i \\ L_{fi}^S(\gamma_i) &\geq \frac{E}{k}(1 - \gamma_i). \end{aligned} \tag{4}$$

Here, $C_{di}^M(s_{di})$ and $C_{fi}^M(s_{fi})$ describe the monitoring cost per unit of domestic and foreign lending given bank i 's choice of monitoring efforts s_{di} and s_{fi} . Further, the unit capital costs are as given in (2) and (3). We consider the case of a binding regulatory equity constraint in optimum.

In banking sector equilibrium, the sum of lending supplied to market i , $L_i^S = L_{di} + L_{fi} = E/k[\gamma_i + (1 - \gamma_j)]$, equals the local credit demand (1). The equilibrium credit interest rate in market i is then given by

$$r_i = \bar{R} - \frac{E}{k}[\gamma_i + (1 - \gamma_j)]. \tag{5}$$

An analogous expression for r_j applies to market j . Under symmetry of banks and markets, the interest rates take the same value $r_i = r_j = r$ in equilibrium.

3.1 Bank monitoring decision

We specify the monitoring cost of bank i per unit of domestic and foreign lending as

$$C_{di}^M(s_{di}) = \frac{1}{2}b_d s_{di}^2 \tag{6}$$

$$C_{fi}^M(s_{fi}) = \frac{1}{2}b_f s_{fi}^2. \tag{7}$$

In line with Hauswald and Marquez (2006), we model monitoring costs as convex. The greater information cost of monitoring borrowers in the foreign market enters our model via a greater cost multiplier $b_f > b_d$ of foreign monitoring. We partially differentiate

bank i 's expected profit (4) with respect to the monitoring efforts to receive the optimal monitoring

$$s_{di}^* = \frac{r - (1 - k)\delta}{b_d} \quad (8)$$

$$s_{fi}^* = \frac{r - (1 - k)\delta}{b_f}. \quad (9)$$

In its choice of monitoring, an affiliate trades off the credit success probability with the monitoring cost and the expected value of the local deposit insurance¹⁸. Consequently, the first term in the numerator of equations (8) and (9) denotes the equilibrium credit interest rate or marginal revenue from monitoring in the respective national lending market. The second term describes the opportunity cost of monitoring as the expected value of the national deposit insurance. The cost multiplier in the denominator describes the marginal cost of monitoring of the respective affiliate. The domestic monitoring decision has no bearing on bank i 's profit in the foreign market and vice versa.

In banking sector equilibrium $r_i = r_j = r$, the two banks choose symmetric levels of monitoring $s_{di}^* = s_{dj}^*$ and $s_{fi}^* = s_{fj}^*$ (henceforth s_d^* and s_f^*). Due to the greater information cost of the foreign operation, modeled as $b_d < b_f$, domestic monitoring takes a greater value in optimum

$$s_d^* - s_f^* = \frac{(b_f - b_d)(r - (1 - k)\delta)}{b_d b_f} > 0. \quad (10)$$

This directly translates to a greater credit risk and therefore default risk of the foreign affiliate. We may say qualitatively that the domestic lending operation is 'safer' than the foreign one or that the credit risk differential $s_d^* - s_f^*$ between affiliates is positive. The informational advantage of the domestic operation increases with the difference in information cost $b_f - b_d$.

¹⁸In our model, the local credit interest rates depend on the distribution of firms' gross rather than expected revenue from investment (see eq. (1)). In consequence, the banks' choice of local monitoring effort and thus credit risk is independent of the local credit volume and their share therein.

3.2 Equity allocation decision

We now formally assess the impact of the lending allocation decision on bank i 's overall profits. To do so, we insert the expression for the local credit interest rates (5) into bank i 's expected profit function (4) and take the first order derivative with regards to the lending share allocated to the domestic affiliate γ_i . This yields the condition for an optimal lending allocation

$$\begin{aligned} \frac{\partial \Pi_i}{\partial \gamma_i} = & \frac{E}{k} s_{di} \left(\bar{R} - \frac{E}{k} [2\gamma_i + (1 - \gamma_j)] \right) - \frac{E}{k} s_{fi} \left(\bar{R} - \frac{E}{k} [2(1 - \gamma_i) + \gamma_j] \right) \\ & - \frac{1}{2} \frac{E}{k} [b_d s_{di}^2 - b_f s_{fi}^2] - \frac{E}{k} (1 - k) \delta [s_{di} - s_{fi}] = 0. \end{aligned} \quad (11)$$

The bank takes the lending allocation decision of its Cournot competitor in a given market as exogenous. Hence, an increase in the share of bank i 's domestic lending γ_i decreases the credit interest rate in the domestic market r_i and increases the credit interest rate in the foreign market r_j , which denote the respective gross revenues from local lending. For an optimal choice of monitoring efforts (6) and (7), the domestic lending operation bears a lower default risk than its foreign counterpart $s_d^* > s_f^*$. For a given credit interest rate, domestic lending then generates greater expected marginal revenue. On the other hand, monitoring costs are greater for the more intensely monitored domestic lending operation. Further, the deposit insurance takes a smaller expected value for the 'safer' domestic affiliate. This implies that deposit financing is more expensive domestically. A bank i 's choice of lending allocation γ_i can thus be interpreted as reflecting the trade-off in expected profitability between the domestic and foreign operation.

The banks decide on their lending allocation simultaneously and symmetrically. Inserting the optimal monitoring (6) and (7) into the first order condition (11) and solving for $\gamma_i = \gamma_j^* = \gamma^*$ yields the expression

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

for the equilibrium share of domestic lending. We argue that the banks' foreign presence is driven mainly by the expectation of higher expected revenue from foreign lending rather than the greater value of the deposit insurance in the 'riskier' foreign market. Under this assumption, which we can formalize as

$$[\bar{R} - 2E/k - (1 - k)\delta] > 0, \quad (13)$$

equation (12) represents a lending home bias $\gamma^* > 0.5$ which increases with the informational distance of the foreign to the domestic lending market $b_f - b_d$. The lending home bias decreases with the total amount of credit E/k supplied to each market which drives down the equilibrium credit interest rate $\bar{R} - E/k$ and thus the value of the informational advantage of the domestic operation. Further, γ^* decreases with the opportunity cost of exerting one more unit of monitoring effort $(1 - k)\delta$ ¹⁹.

We summarize these findings in the following proposition.

Proposition 1. *In banking sector equilibrium, the following properties hold.*

- (i) *The banks' domestic affiliates exert greater monitoring effort than their foreign affiliates $s_d^* > s_f^*$. This implies a smaller credit risk of domestic relative to foreign lending.*
- (ii) *The banks allocate a greater share of lending to the domestic affiliate $\gamma^* > 0.5$ (lending home bias).*
- (iii) *Both, the share of domestic lending γ^* and the difference between domestic and foreign monitoring $s_d^* - s_f^*$, increase with the difference in information costs $b_f - b_d$.*

¹⁹A binding constraint on banks' overall lending volume can potentially give rise to an additional equilibrium in autarky $\gamma_i = \gamma_j = 1$. We find that our model does not support this. Banks' choice of a greater monitoring effort in the domestic market leads to a greater marginal cost of domestic lending. The cost savings of the first unit of foreign lending subsequently overcompensate a possibly smaller unit revenue, eliminating the possibility of an autarky solution.

4 Comparative statics

4.1 Negative equity shock

In the 2007 – 2008 financial crisis, banks experienced a systemic, negative shock to the value of their equity caused by unexpected losses ((Demirguc-Kunt et al., 2013; Baron et al., 2020))²⁰. In this analysis, we abstract from the exact cause of this devaluation. Rather, we take bank equity and the negative equity shock to be exogenous to the banks' commercial lending business which is at the center of our analysis.

We first consider the effect of a negative shock to bank equity on the optimal choice of credit risk in the domestic and foreign market. To do so, we differentiate the optimal monitoring efforts (8) and (9) with respect to bank equity E

$$\frac{\partial s_d^*}{\partial E} = -\frac{1}{kb_d} < 0 \quad \frac{\partial s_f^*}{\partial E} = -\frac{1}{kb_f} < 0. \quad (14)$$

Following a negative equity shock, monitoring increases for both lending operations, causing their credit risk to decrease²¹. This is especially the case for the domestic lending operation, for which increasing the monitoring effort is less costly. Consequently, domestic credit risk decreases by a disproportionate amount. The domestic operation becomes relatively 'safer'. The increase in monitoring is caused by an increase in the marginal revenue from monitoring, i.e. the equilibrium credit interest rate $r = \bar{R} - E/k$, due to the decrease in the equilibrium supply of credit to each market E/k .

In a second step, we analyze the effect of a negative shock to bank equity on the lending home bias. Differentiating the optimal share of domestic lending γ^* (12) with respect to bank equity E yields

$$\frac{\partial \gamma^*}{\partial E} = -\frac{(b_f - b_d) [\bar{R} - (1 - k)\delta]}{E^2/k(b_f + b_d)} < 0. \quad (15)$$

²⁰In the United States, banks experienced losses as early as 2007, most prominently from direct exposure to mortgage lending. European banks on the other hand experienced losses mostly through the exposure of their securities portfolios to US mortgage backed securities and stocks of US financial intermediaries. Investors priced this devaluation of investments into the banks' market valuation starting with the Lehman Brothers default.

²¹This is in line with the empirical finding of Albertazzi and Marchetti (2010) of a general 'flight to quality' of banks during the crisis.

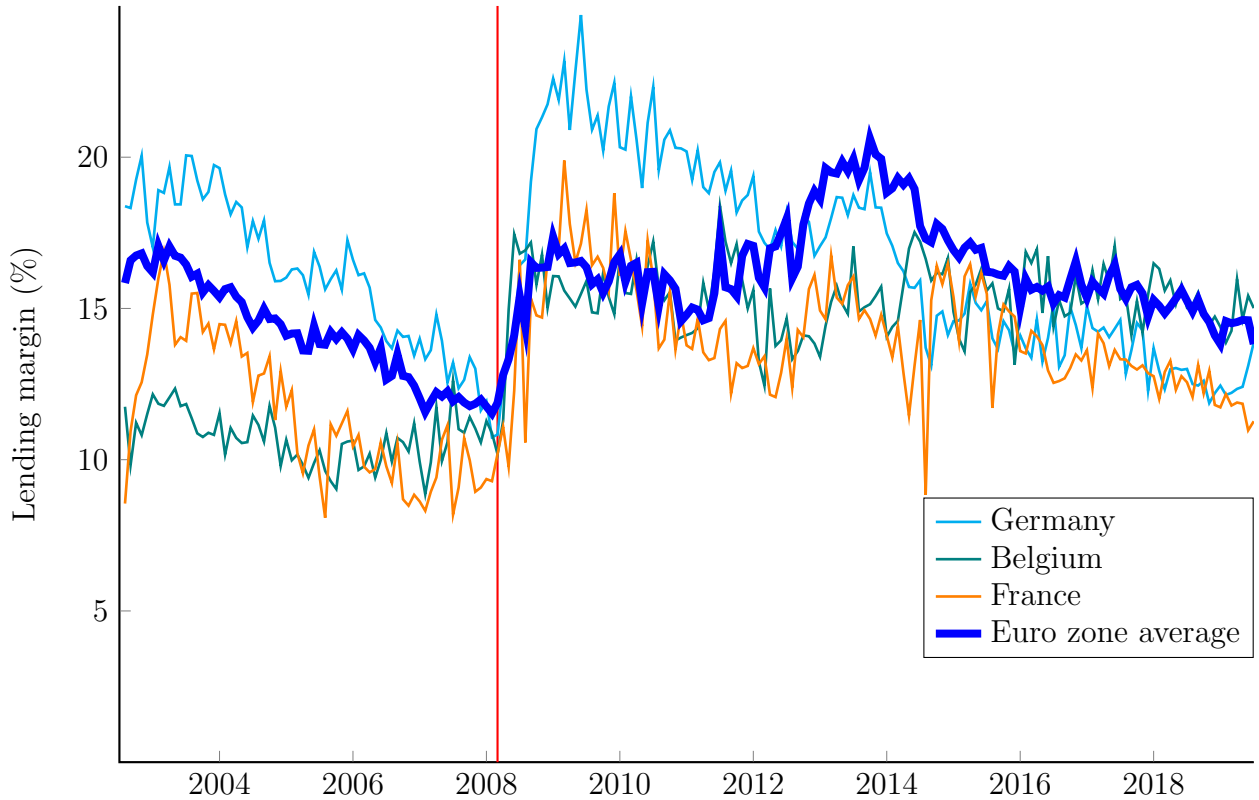


Figure 2: Lending margins for non-financial corporations in % by Euro zone member state. The Euro zone average is calculated using an unweighted average of the initial members. The vertical red line indicates the date of the Lehman Brothers default, September 15th, 2008. Source: ECB Risk Assessment Indicators data set, own calculations.

A reduction in bank equity E decreases the supply of credit to each market which in turn increase the credit interest rate and thus the gross marginal revenue from domestic and foreign lending. Since the domestic operation bears less default risk $s_d^* > s_f^*$, the increase in the interest rate is in expectations more valuable for the domestic affiliate. Hence, lending in the domestic market becomes relatively more profitable. We call this the *credit interest rate channel*. Empirically, a post-crisis increase in credit interest rates is clearly observed. Figure (2) charts the lending margins for non-financial corporate borrowers within the Euro zone. From the early 2000s on, lending margins in the Euro zone were steadily decreasing until September 2008, coinciding with the default of Lehman Brothers. Lending margins increased by an average of 5 % in the following year and have not returned to their level of 2007 since.

We further asses how the informational distance between banks' foreign and domestic markets affects the magnitude of the negative equity shock. We proxy this distance by a

larger value of the foreign information cost multiplier b_f . As shown by the derivative of (15) with regards to b_f ,

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

we find a larger lending retrenchment effect following a negative equity shock for more distant foreign affiliates. This is in line with the empirical consensus, showing that after the crisis banks withdrew lending especially from markets that were geographically farther away from banks' domestic markets (Emter et al., 2019).

4.2 Regulatory requirements

As a consequence of the financial crisis, regulators started to improve on the existing Basel II regulatory framework, leading to the ratification of Basel III in 2010. Central to the revised framework, which was implemented in the Euro zone from 2013 on, is the increase of the required common equity ratio from 2% to 4.5%. Basel III additionally requires a minimum leverage and liquidity ratio (Bank for International Settlements, 2010). We examine the impact of the tightening of regulatory equity requirements as an increase in the regulatory equity ratio k . The impact of an increase in k on the monitoring efforts is given by

$$\frac{\partial s_d^*}{\partial k} = \frac{\frac{E}{k^2} + \delta}{b_d} > 0 \quad \frac{\partial s_f^*}{\partial k} = \frac{\frac{E}{k^2} + \delta}{b_f} > 0. \quad (17)$$

An increase in the required equity ratio decreases the credit risk of both affiliates via an increase in the marginal revenue from monitoring²². The greater equity requirement increases the credit interest rate in both local lending markets, making monitoring universally more profitable. Additionally, an increase in the share of equity financing k decreases the value of the national deposit insurance schemes. This decreases the marginal opportunity cost of monitoring $(1 - k)\delta$. Due to the smaller unit cost of domestic monitoring, the domestic credit risk decreases disproportionately.

²²The negative relationship of equity requirements and credit risk is in opposition to the result of Hakenes and Schnabel (2011). This is due to our modeling of borrower monitoring, which eliminates the entrepreneurs' choice of project risk.

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

$$\frac{\partial \gamma^*}{\partial k} = \frac{(b_f - b_d)(\bar{R} + k\delta)}{E(b_f + b_d)} > 0. \quad (18)$$

An increase in k increases the lending home bias in that it reduces the credit supply and thus increases the credit interest rate in both national credit markets. As for a negative equity shock, the increase in banks' gross marginal revenue from lending is in expectations more valuable to the less risky domestic lending operation. In addition to this *credit interest rate channel* of lending reallocation, we identify a *liability channel*. The greater required share of internal financing forces the banks to make less use of refinancing via insured deposits. Due to the greater default probability of the foreign affiliate, the limited liability implied in the deposit insurance signifies an additional incentive for lending abroad. An increase in the equity ratio reduces this incentive. This reduction is stronger for more distant and thereby riskier foreign markets²³.

4.3 Monetary policy

From 2008 to 2016, the ECB gradually lowered its bank refinancing rate from 3.75% to 0%. This was accompanied by unconventional measures of expansionary monetary policy such as quantitative easing and targeted asset purchase programmes, some of which remain to the present day (Hartmann and Smets, 2018). We assess the effect of expansionary monetary policy on the decision making of multinational banks as a decrease in the bank refinancing rate²⁴. In our model the bank refinancing rate is represented by the riskless deposit rate δ . We find the effect of monetary policy changes on the monitoring efforts to be

$$\frac{\partial s_d^*}{\partial \delta} = -\frac{1-k}{b_d} < 0 \quad \frac{\partial s_f^*}{\partial \delta} = -\frac{1-k}{b_f} < 0. \quad (19)$$

²³Similarly, Cappelletti et al. (2019) find that banks respond to increases in equity requirements by shifting their lending to less risky counterparties within the corporate sector.

²⁴Unconventional expansionary monetary policy can be modeled as the reduction of a "shadow policy rate" as introduced by Lombardi and Zhu (2014).

A decrease in the bank refinancing rate increases affiliate monitoring and consequently decreases credit risk. The decrease in δ decreases the value of the subsidy implicit in the deposit insurance, increasing the affiliates' incentive to monitor. Due to the smaller unit cost of domestic monitoring, the domestic credit risk decreases disproportionately.

Differentiating the share of domestic lending γ^* as in (12) with respect to the bank refinancing rate δ yields

$$\frac{\partial \gamma^*}{\partial \delta} = -\frac{1}{2} \frac{(b_f - b_a)(1 - k)}{E/k(b_f + b_a)} < 0. \quad (20)$$

A decrease in δ disproportionately reduces the capital costs of the less risky domestic operation. Hence, the profitability of domestic lending increases more than that of foreign lending. Accordingly, expansionary monetary policy leads to a greater lending home bias. This effect is more pronounced for informationally distant foreign markets.

We summarize these results for equity constrained multinational banks in the following proposition.

Proposition 2. *Under binding equity requirements, a reduction in bank equity E , an increase in equity requirements k , and a decrease in the bank refinancing rate δ , all*

- (i) increase the monitoring effort exerted by both bank affiliates. This increase is greater domestically, implying a greater decrease in credit risk for the domestic lending operation.*
- (ii) increase the lending home bias.*

We summarize, that all considered shocks increase the lending home bias and decrease the credit risk of equity constrained banks. A reduction of regulatory bank equity increases the credit interest rate in both markets. In expectations, this increase in the marginal revenue from lending is more valuable for the less risky domestic operation. A regulatory or monetary policy shock reduces the expected value of the deposit insurance. This reduction is greater for the riskier foreign lending operation. The two mechanisms define the *credit interest rate channel* and *liability channel* of lending reallocation, respectively.

5 Multinational banking under a non-binding equity constraint

In a situation where equity can be raised without difficulty, the minimum equity requirements of equation (4) do not bind. This describes the situation of many advanced economy banks after 2009, which were able to gradually increase their equity buffers in the first post-crisis years (Walter, 2019; European Central Bank, 2013). In our model, equity unconstrained banks $i \in \{A, B\}$ separately choose their optimal lending volumes in the domestic and foreign market L_{di} and L_{fi} , rather than shares of a fixed total. This decision is made jointly and simultaneously with the choice of monitoring effort of the respective affiliate. As above, we consider banks and markets to be symmetric.

5.1 Bank monitoring and lending allocation decision

We derive the equilibrium monitoring efforts and lending volumes of the equity unconstrained banking sector in appendix A. In contrast to the constrained lending decision of section (3.2), the unconstrained equilibrium credit supply $L^S = L_d^\dagger + L_f^\dagger$ and interest rate $r = \bar{R} - L^S$ in each market are endogenously determined rather than fixed by the equity constraint. We find the equilibrium credit supply to each market to be

$$L^S = \frac{3 [\bar{R} - \delta(1 - k)] - \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}}{4}. \quad (21)$$

Using this definition, we can simplify the expressions for optimal monitoring and lending (A.1)–(A.4) to

$$s_d^\dagger = \frac{(\bar{R} - L^S) - \delta(1 - k)}{b_d} \quad (22)$$

$$s_f^\dagger = \frac{(\bar{R} - L^S) - \delta(1 - k)}{b_f} \quad (23)$$

$$L_d^\dagger = L^S \left(\frac{1}{2} + \frac{1}{2} \frac{(b_f - b_d) [\bar{R} - 2L^S - \delta(1 - k)]}{L^S(b_d + b_f)} \right) \quad (24)$$

$$L_f^\dagger = L^S \left(\frac{1}{2} - \frac{1}{2} \frac{(b_f - b_d) [\bar{R} - 2L^S - \delta(1 - k)]}{L^S(b_d + b_f)} \right), \quad (25)$$

which match the expressions (8)–(10) of the constrained case. As above, the monitoring efforts directly reflect the credit risk and default probability $1 - s^\dagger$ of the respective affiliate. In optimum, the credit risk of the domestic affiliate takes a lower value

$$s_d^\dagger - s_f^\dagger = \frac{(b_f - b_d) [\bar{R} - L^S - \delta(1 - k)]}{b_d b_f} > 0. \quad (26)$$

For the share of domestic lending $\gamma^\dagger = L_d^\dagger / L^S$ we find

$$\gamma^\dagger = \frac{1}{2} + \frac{1}{2} \frac{(b_f - b_d) [\bar{R} - 2L^S - \delta(1 - k)]}{L^S(b_d + b_f)} \quad (27)$$

equivalent to the constrained result (12) and implying a lending home bias $\gamma^\dagger > 0.5$ ²⁵. All of the above equilibrium expressions must by definition be non-negative.

5.2 Comparative statics

We evaluate the impact of shocks to regulatory bank equity and monetary policy on the monitoring and lending allocation decision of equity unconstrained multinational banks. The comparative static analysis we conduct is comparable to that of the equity constrained case of section 4. One exception is the definition of the negative bank equity shock, which we model here as an increase in the equity premium ρ . Such an increase

²⁵Expression (27) reflects a lending home bias under the assumption that banks' foreign lending activity is predominantly driven by the expectation of greater lending revenue rather than that of a reduced liability in the riskier foreign market, or $[\bar{R} - 2L^S - \delta(1 - k)] > 0$.

reflects an increase in the cost of equity e.g. via a deterioration of banks' market valuation such as in the financial crisis²⁶.

Due to the comparable structure of the constrained and unconstrained optima, we expect similar effect channels to be present in both cases. In the constrained case, shocks to regulatory equity affect banks' decision making by tightening the regulatory constraint on their overall lending capacity. This mechanical effect is absent here. Rather, the shocks affect the unconstrained affiliates' financing costs, impacting optimal lending volumes and thereby the credit supply to both markets. To better assess this additional structure, we first present the comparative statics of the equilibrium local credit supply L^S

$$\frac{\partial L^S}{\partial \rho} < 0 \quad (28) \qquad \frac{\partial L^S}{\partial k} \gtrless 0 \quad (29) \qquad \frac{\partial L^S}{\partial \delta} < 0. \quad (30)$$

We find that both an increase in the refinancing rate δ and the equity premium ρ universally decrease the credit supply L^S (see full derivatives as well as proofs of the derivative signs in appendix B). In general, the effect of an increase in the equity ratio k on the credit supply cannot be signed. Under sufficiently low equity requirements however, L^S decreases with k , $\lim_{k \rightarrow 0} \frac{\partial L^S}{\partial k} < 0$. Considering the limit case, the effect signs with regards to ρ and k carry over from our analysis of poorly capitalized banks. Our finding of a nonzero effect for a change in monetary policy, is however contradictory to the equity constrained case. The negative effects of ρ and δ on the credit supply are intermediated by an increase in the affiliates' internal and external financing costs, (2) and (3). An increase in k increases the affiliates' financing costs by increasing the share of costly equity financing.

Drawing on these results, we assess the impact of the shocks to regulatory bank equity and monetary policy on optimal monitoring. The corresponding parameters enter the affiliates' monitoring decision directly in the value of the deposit insurance and indirectly

²⁶ Buch and Dages (2018) document an increase in the cost of equity for banks of all advanced economies during the crisis. This increase was most persistent for European banks, whose cost of equity returned to pre-crisis levels only in 2014.

via the credit interest rate $r = \bar{R} - L^S$ i.e. the marginal revenue from monitoring. We present the comparative statics for the affiliates' monitoring effort

$$\frac{\partial s_d^\dagger}{\partial \rho} = \frac{1}{b_d} \left(-\frac{\partial L^S}{\partial \rho} \right) > 0 \quad \frac{\partial s_f^\dagger}{\partial \rho} = \frac{1}{b_f} \left(-\frac{\partial L^S}{\partial \rho} \right) > 0 \quad (31)$$

$$\frac{\partial s_d^\dagger}{\partial k} = \frac{1}{b_d} \left(-\frac{\partial L^S}{\partial k} + \delta \right) > 0 \quad \frac{\partial s_f^\dagger}{\partial k} = \frac{1}{b_f} \left(-\frac{\partial L^S}{\partial k} + \delta \right) > 0 \quad (32)$$

$$\frac{\partial s_d^\dagger}{\partial \delta} = \frac{1}{b_d} \left(-\frac{\partial L^S}{\partial \delta} - (1 - k) \right) \geq 0 \quad \frac{\partial s_f^\dagger}{\partial \delta} = \frac{1}{b_f} \left(-\frac{\partial L^S}{\partial \delta} - (1 - k) \right) \geq 0. \quad (33)$$

An increase in the equity premium ρ and ratio k universally increases the monitoring effort. For a decrease in the bank refinancing rate, the effect sign depends on regulatory standards. We show the full derivatives in appendix C. An increase in ρ increases the affiliates' monitoring incentives via a decrease in the credit supply L^S . The subsequent increase in the credit interest rate increases the affiliates' marginal revenue from monitoring. The increase in monitoring is greater for the domestic affiliate, leading to a disproportionate decrease of the domestic credit risk.

Expansionary monetary policy and a regulatory tightening additionally affect monitoring incentives directly via changes in the value of the deposit insurance. For an increase in k , both, the increase in the credit interest rate and the reduction in the share of insured deposits, lead to an increase in monitoring effort and thus a decrease in credit risk. Conversely, the effect channels take opposite signs for expansionary monetary policy. A decrease in δ increases monitoring incentives due to a reduction in the value of the deposit insurance while at the same time decreasing monitoring incentives due to a lower credit interest rate. The latter effect channel is not present in the equity constrained case, where the overall effect of expansionary monetary policy can be signed positively without ambiguity. Here, we find that in the limit of only deposit financing, the domestic monitoring effort decreases with the refinancing rate $\lim_{k \rightarrow 0} \frac{\partial s_d^\dagger}{\partial \delta} < 0$, in line with the constrained result. Conversely, in the limit of no insured deposit financing, the relationship is positive $\lim_{k \rightarrow 1} \frac{\partial s_d^\dagger}{\partial \delta} > 0$. The effect magnitude increases monotonously with the share of equity financing $\frac{\partial^2 s_d^\dagger}{\partial \delta \partial k} > 0$ (see appendix D for the full equation). We argue that the former

case of predominantly external financing is the economically relevant one. Equivalent inequalities hold for foreign monitoring.

We assess the effects of shocks to bank regulatory equity and monetary policy on the optimal lending home bias

$$\frac{\partial \gamma^\dagger}{\partial \rho} = \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial \rho} [\bar{R} - \delta(1 - k)] \right) > 0 \quad (34)$$

$$\frac{\partial \gamma^\dagger}{\partial k} = \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial k} [\bar{R} - \delta(1 - k)] + \delta L^S \right) > 0 \quad (35)$$

$$\frac{\partial \gamma^\dagger}{\partial \delta} = \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial \delta} [\bar{R} - \delta(1 - k)] - (1 - k)L^S \right) > 0. \quad (36)$$

The lending home bias increases with the equity premium ρ and ratio k and decreases with the bank refinancing rate δ (we present the full derivatives in appendix C). An increase in ρ increases the lending home bias in that it increases the credit interest rate and thereby the gross marginal revenue from lending in the banks' domestic and foreign market. Due to the greater success probability of the domestic lending operation, this increases the expected domestic revenues more strongly²⁷.

An increase in k similarly increases the credit interest rate. At the same time it reduces banks' ability to make use of insured deposit financing, reducing their incentive for lending in the riskier foreign market. Here, both the *credit interest rate channel* and the *liability channel* lead to an increase in the lending home bias.

For expansionary monetary policy, two equivalent effect channels are present albeit with opposing signs. A decrease in δ decreases the credit interest rate, decreasing the home bias. At the same time, the value of the governmental deposit insurance decreases, decreasing banks' incentive for foreign lending due to a reduced liability. We algebraically find that the *credit interest rate channel* overcompensates the *liability channel* of expansionary monetary policy, leading to an unambiguous decrease in the lending home bias.

²⁷While banks reduce their lending volume in both markets in response to an increase in ρ , this reduction is less pronounced in the domestic market, leading to an increase in the lending home bias. Indeed, domestic lending L_d^\dagger only decreases only under the assumption of a moderate information cost differential $b_f - b_d < 2b_d$ while the decline of the foreign lending volume L_f^\dagger is unambiguous.

We summarize our findings for the equity unconstrained case in the following proposition.

Proposition 3. *Under a non-binding equity constraint,*

(i) banks increase (decrease) their monitoring efforts (affiliate credit risk) following an increase in the equity premium ρ or equity ratio k or a decrease in the bank refinancing rate δ .

(ii) banks increase their lending home bias following an increase in the equity premium ρ or equity ratio k .

(iii) banks decrease their lending home bias following a decrease in the bank refinancing rate δ .

Our results for equity constrained banks largely carry over to the unconstrained case. The exception is banks' reallocative response to monetary policy changes. Under expansionary monetary policy, the effect of a smaller deposit insurance, which increases the lending home bias, is now overcompensated by a simultaneous negative effect due to an increase in credit supply. This latter effect is not present under a binding constraint, leading to opposing derivative signs in the two cases. Hence, the sign of the overall effect of monetary policy changes on the lending home bias depends on bank capitalization above the regulatory minimum. This is consistent with empirical findings on the lending supply of foreign-owned banks. For the case of Turkey, Baskaya et al. (2017) show that well capitalized foreign-owned banks increase their local lending supply more than poorly capitalized ones in response to a positive funding shock.

6 Conclusion

We have proposed a model of multinational banking under an equity constraint which analyzes the role of policy interventions in the persistent lending retrenchment beginning with the 2007 – 2008 global financial crisis. The model predicts negative equity shocks, a tightening of regulatory standards and expansionary monetary policy, as occurred during and after the financial crisis, to increase the lending home bias of multinational banks.

The reallocative effect is greater for foreign lending markets that are informationally distant to the banks' respective home market. We additionally find all considered shocks to decrease bank credit risk, especially that of the domestic lending operations. Our results are largely independent of bank capitalization with the exception of banks' reallocative response to monetary policy. Following expansionary monetary policy, well capitalized banks decrease their lending home bias. This is consistent with the result of Baskaya et al. (2017), who show that the increase in foreign lending following a positive funding shock increases with the foreign bank's capitalization.

Central to our analysis is the assumption of a greater cost of monitoring foreign compared to domestic borrowers. This give rise to a greater equilibrium credit risk of foreign lending. Based on this risk differential, we propose two channels by which the impact of regulatory equity or monetary policy changes is intermediated: the *liability channel* and the *credit interest rate channel*. Increased regulatory standards and expansionary monetary policy decrease the expected value of the deposit insurance. The reduction of the government subsidy implicit in this insurance is greater for the riskier foreign affiliate, leading to a reduced share of foreign lending. Negative shocks to regulatory equity further increase the credit interest rate, disproportionately increasing the expected revenue from lending of the less risky domestic affiliate. Under a non-binding equity constraint, this latter effect is also present for monetary policy shocks, reversing the sign of the equity constrained response.

We conclude, that the policy interventions following the crisis likely contributed to the observed post-crisis retrenchment of multinational lending. This retrenchment can be interpreted as a flight to informationally closer or better understood lending. The result of a reduction in credit risk following all policy interventions additionally points towards their role in the observed 'flight-to-quality' within lending categories.

We have presented a positive study of the effects of policy changes on banks' international lending allocation. This study has not however answered the normative question on how the predicted effects affect the stability of the banking sector and overall welfare. On the one hand, our model predicts an increased segmentation of lending markets to

lower the credit risk in each local market. The smaller average bank-borrower distance decreases monitoring costs and thus borrower default probabilities (Agarwal and Hauswald, 2010). At the same time, the literature on multinational banking has shown that foreign-owned banks continue to supply credit in a local market experiencing a negative domestic shock (Allen et al., 2017). Further, multinational banking provides an alternative to the interbank market in channeling capital between countries (Schnabl, 2012).

Our model can be extended to answer interesting additional questions. One such question is the lending allocation between banking sectors of differing monitoring efficiency and access to capital. Under a heterogeneity in the monitoring efficiency, the result that a greater lending market segmentation must be accompanied by a lower local credit risk may not hold, allowing for a more differentiated view of the presence of foreign banks. In turn, modeling a heterogeneity in capital endowment would allow studying banks' reaction to local or asymmetric funding shocks. An extension to individual risk-based equity requirements would additionally shed light on the reallocative impact of risk-based regulatory tools.

A Derivation of equilibrium monitoring efforts and lending volumes (unconstrained case)

We partially differentiate bank i 's expected profit (4) with respect to the monitoring efforts and lending volumes, yielding the first order conditions

$$\frac{\partial \Pi_i}{\partial s_{di}} = L_{di} ([\bar{R} - (L_{di} + L_{fj})] - \delta(1 - k) - b_d s_{di}) = 0 \quad (\text{A.1})$$

$$\frac{\partial \Pi_i}{\partial s_{fi}} = L_{fi} ([\bar{R} - (L_{fi} + L_{dj})] - \delta(1 - k) - b_d s_{fi}) = 0 \quad (\text{A.2})$$

$$\frac{\partial \Pi_i}{\partial L_{di}} = s_{di} ([\bar{R} - (L_{fj} + 2L_{di})] - (\delta + \rho)k - \delta(1 - k) - 0.5b_d s_{di}^2) = 0 \quad (\text{A.3})$$

$$\frac{\partial \Pi_i}{\partial L_{fi}} = s_{fi} ([\bar{R} - (L_{dj} + 2L_{fi})] - (\delta + \rho)k - \delta(1 - k) - 0.5b_d s_{fi}^2) = 0. \quad (\text{A.4})$$

Solving the system of equations (A.1)–(A.4) under bank symmetry, we find the equilibrium monitoring efforts and lending volumes

$$s_d^\dagger = \frac{\bar{R} - \delta(1 - k) + \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}}{4b_d} \quad (\text{A.5})$$

$$s_f^\dagger = \frac{\bar{R} - \delta(1 - k) + \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}}{4b_f} \quad (\text{A.6})$$

$$L_d^\dagger = \frac{(5b_d + b_f) [\bar{R} - \delta(1 - k)] - (3b_d - b_f) \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}}{8(b_d + b_f)} \quad (\text{A.7})$$

$$L_f^\dagger = \frac{(5b_f + b_d) [\bar{R} - \delta(1 - k)] - (3b_f - b_d) \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}}{8(b_d + b_f)}. \quad (\text{A.8})$$

These results include the assumption that the monitoring efforts must take non-negative values in optimum.

B Comparative statics of the credit supply (28)–(30)

The full equations of the comparative statics (28)–(30) of the local credit supply L^S with regards to ρ , δ and k are given by

$$\frac{\partial L^S}{\partial \rho} = -\frac{k(b_d + b_f)}{\sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} < 0 \quad (\text{A.9})$$

$$\frac{\partial L^S}{\partial k} = \frac{\delta \left(3\sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k} - [\bar{R} - \delta(1 - k)] \right) - 4(b_d + b_f)(\delta + \rho)}{4\sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} \geq 0 \quad (\text{A.10})$$

$$\frac{\partial L^S}{\partial \delta} = \frac{(1 - k) \left([\bar{R} - \delta(1 - k)] - 3\sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k} \right) - 4k(b_d + b_f)}{4\sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} < 0. \quad (\text{A.11})$$

While the derivative with regards to ρ is unambiguously negative we must prove that the derivative by δ indeed takes a negative value²⁸. The derivative by k cannot be signed in general. To prove the negative sign of (A.11), we replace the square root in the numerator with square roots of the individual summands yielding the following expression

$$\frac{-(1 - k) \left(2[\bar{R} - \delta(1 - k)] + 3\sqrt{8(b_d + b_f)(\delta + \rho)k} \right) - 4k(b_d + b_f)}{4\sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} < 0. \quad (\text{A.12})$$

Inequality (A.12) is unambiguously negative. Thereby, also the derivative (A.11) must be negative as the sum of square roots is greater than the square root of the summands.

□

²⁸In the following, we make use of the inequality $\sqrt{a+b} < \sqrt{a} + \sqrt{b}$.

C Comparative statics of the monitoring and lending decision (31)–(33) and (34)–(36)

We present the full equations of the comparative statics (31)–(33) of the domestic affiliates' monitoring effort s_d^\dagger

$$\begin{aligned} \frac{\partial s_d^\dagger}{\partial \rho} &= \frac{1}{b_d} \left(-\frac{\partial L^S}{\partial \rho} \right) \\ &= \frac{(b_d + b_f)k}{b_d \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} > 0 \end{aligned} \quad (\text{A.13})$$

$$\begin{aligned} \frac{\partial s_d^\dagger}{\partial k} &= \frac{1}{b_d} \left(-\frac{\partial L^S}{\partial k} + \delta \right) \\ &= \frac{1}{4b_d} \left(\frac{[\bar{R} - \delta(1 - k)] \delta + 4(b_d + b_f)(\delta + \rho)}{\sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} + \delta \right) > 0 \end{aligned} \quad (\text{A.14})$$

$$\begin{aligned} \frac{\partial s_d^\dagger}{\partial \delta} &= \frac{1}{b_d} \left(-\frac{\partial L^S}{\partial \delta} - (1 - k) \right) \\ &= \frac{1}{4b_d} \left(\frac{4(b_d + b_f)k - (1 - k) [\bar{R} - \delta(1 - k)]}{\sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} - (1 - k) \right) \geq 0. \end{aligned} \quad (\text{A.15})$$

The derivatives of the foreign affiliates' monitoring effort s_f^\dagger are defined equivalently. The full equations of the comparative statics (34)–(36) of the share of domestic lending are given by

$$\begin{aligned} \frac{\partial \gamma^\dagger}{\partial \rho} &= \frac{(b_f - b_d) [\bar{R} - \delta(1 - k)]}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial \rho} \right) \\ &= \frac{(b_f - b_d) [\bar{R} - \delta(1 - k)] k^2 \left([\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k \right)^{-\frac{1}{2}}}{\left(3 [\bar{R} - \delta(1 - k)] - \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k} \right)^2} > 0 \end{aligned} \quad (\text{A.16})$$

$$\begin{aligned}
\frac{\partial \gamma^\dagger}{\partial k} &= \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial k} [\bar{R} - \delta(1 - k)] + \delta L^S \right) \\
&= \frac{8(b_f - b_d)(\delta + \rho) [\bar{R} - \delta(1 + k)] \left([\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k \right)^{-\frac{1}{2}}}{\left(3 [\bar{R} - \delta(1 - k)] - \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k} \right)^2} > 0
\end{aligned} \tag{A.17}$$

$$\begin{aligned}
\frac{\partial \gamma^\dagger}{\partial \delta} &= \frac{(b_f - b_d)}{2(b_d + b_f)(L^S)^2} \left(-\frac{\partial L^S}{\partial \delta} [\bar{R} - \delta(1 - k)] - (1 - k)L^S \right) \\
&= \frac{8(b_f - b_d)k [\bar{R} + (1 - k)(\delta + 2\rho)] \left([\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k \right)^{-\frac{1}{2}}}{\left(3 [\bar{R} - \delta(1 - k)] - \sqrt{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k} \right)^2} > 0.
\end{aligned} \tag{A.18}$$

with the latter result holding under the condition $\bar{R} > \delta(1 + k)$.

D Cross derivative of the monitoring effort

We present the cross derivative of the monitoring effort with regards to δ and k for the example of domestic monitoring

$$\begin{aligned}
&\frac{\partial^2 s_d^\dagger}{\partial \delta \partial k} \\
&= \frac{1}{4b_d} \left(1 + \frac{[\bar{R} - \delta(1 - k)]^3 + 4(b_d + b_f) \left([\bar{R} - \delta(1 - k)]^2 + 4(b_d + b_f)(\delta + \rho)k \right)}{\sqrt[3]{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} \right. \\
&\quad \left. + \frac{4(b_d + b_f) \left([\bar{R} - \delta(1 - k)] [\delta(1 - k) + \rho] + [\bar{R} - 3\delta(1 - k)] k(\delta + \rho) \right)}{\sqrt[3]{[\bar{R} - \delta(1 - k)]^2 + 8(b_d + b_f)(\delta + \rho)k}} \right) > 0.
\end{aligned} \tag{A.19}$$

The cross derivative of foreign monitoring is defined equivalently .

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