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Global Banking: Risk Taking and Competition

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Keywords: global bank, oligopoly, oligopsony, endogenous risk taking, expectation of rents extraction, appetite for leverage
JEL codes: G21; G32; L13

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1 Introduction

In a well known contribution in 2005 Rajan [29] highlighted the potential increase in risk contagion emerging from finance and banking globalization. This view, visionary at the time, seemed to be confirmed when in 2008 the failure of one big globalized bank, Lehmann Brothers, had large cascading effects on the entire banking system. While venturing into foreign markets might foster banks' opportunities to improve risk-sharing and to increase profits' margins, globalization might have unintended consequences in terms of risk-taking. A recent IMF Financial Stability Report [24] as well as several other studies (reviewed in the next section) provide a more nuanced view. Empirical evidence shows that, prior to the 2007 financial crisis, global risk had increased since much of the financial globalization had taken place through cross-border activity with little involvement of global banks into local retail activity. On the contrary, after 2007 there has been a shift in the business model of global banks, which currently tend to operate more through subsidiaries (and occasionally through branches). Banks' direct involvement in the local retail activity implies that local competition can exert a higher discipline role. Evidence shows that this type of foreign banks' entry (so called 'bricks and mortar') may indeed reduce risk-taking.

While the complex and multifaceted nature of banking globalization is high in the agenda of academics and policy makers working on crisis prevention, the literature still lacks a theoretical framework to examine those issues in a unified way. The aim of this paper is to make a first step in that direction. In particular, we propose a model of multinational banking in which imperfectly competitive banks operate simultaneously in different national markets being directly involved in local retail activities both on the deposits' and the loans' sides. Key elements are an endogenous risk-taking and an endogenous dynamic entry decision. Our main goal is to study the impact of multinational banking on risk-taking through its effects on local competition in the deposit and loan markets. In doing so we also examine how entry barriers affect endogenous entry and risk-taking, which gives insights into the role of international agreements such as those on pass-porting rights within the European Union. We develop our analysis in deterministic and stochastic environments with systematic and idiosyncratic shocks as well as perfectly and imperfectly correlated loan failures. We show that multinational banking can reduce risk-taking by promoting local competition.

This happens as long as the expansionary impact of competition on multinational banks' aggregate profits through larger scale is strong enough to offset its parallel contractionary impact through lower lending-to-deposit rate spread. This result holds with both perfectly and imperfectly correlated loans' failures. When multinational banking reduces risk-taking, its also moderates the credit crunch that follows a deterioration in the investment climate. We also show that, compared with multinational banking, the beneficial effect of cross-border lending on risk-taking is weaker.

Our benchmark model features a banking industry with endogenous entry and endogenous risk taking in which home and foreign multinational banks co-exist in segmented national markets. In examining the interactions among competition, risk taking and globalization, we model globalization as a fall or a removal of the additional costs of banks' foreign operations leading to an increase in their relative market share in foreign markets. Lower costs of foreign operation can be interpreted as the result of signing an agreement such as those on EU pass-porting rights. In each national market banks raise funds through deposits and use them to finance firms' projects through loans. Banks are thus directly involved in local loans' monitoring activity and compete for local funds. Firms acquire bank loans to invest in risky investment projects, with higher investment returns being associated with higher failure probability. Given the return on loans, firms choose both the amount of loans and the projects' risk-return profiles. Due to moral hazard originating from limited liability, when confronted with higher loan rates firms' incentives toward risk-shifting are higher. This endogenously increases risk-taking as firms invest more in tail risk. Banks act as Cournot oligopolist in the loan market and as Cournot oligopsonist in the deposit market. Entry decisions in each national market are endogenous as banks compare the sum of future discounted profits with entry costs. Banks face additional costs when operating in a foreign market due to less efficient monitoring. This assumption is introduced to capture the idea that banks' monitoring abilities in foreign jurisdictions are typically impaired. As a result high monitoring costs are associated with a smaller market share for foreign banks. However, as those costs fall due to globalization, banks' market shares in foreign markets increase thereby fostering competition for domestic banks.

In general tougher competition has an ambiguous impact on risk-taking. Ambiguity arises from the presence of two opposite effects associated with banks being simultaneously oligopsonist in the market for short-term funding and oligopolist in the loan market. On the one hand, tougher competition in the deposit market increases the return on deposits. Banks have to offer higher deposit rates to attract funds. In isolation this first effect would trigger an increase in loan rates, which in turn would increase risk-taking due to firms' limited liability. On the other hand, tougher competition in the loan market decreases the return on loans. Banks have to offer lower loan rates to attract firms. In isolation this second effect would mitigate firms' risk-taking. Hence, in general, whether banks' internationalization reduces or increases risk-taking through tougher competition depends upon the balance in the extent of competition in the deposit and the loans' market. Under generally accepted functional forms,[1] the second effect tends to prevail so that the predictions of the model are consistent with the findings by the IMF [24] report, namely that banking globalization with direct involvement in retail activities reduces risk-taking.[2] We show that, in the deterministic equilibrium of the benchmark model with no shocks, an increase in banking globalization (measured by a fall in monitoring costs) increases loan supply and decreases firms' risk-shifting incentives, thus reducing risk-taking. This result is confirmed in a stochastic equilibrium of the benchmark model in which firms are hit by aggregate shocks happening before banks make their loan portfolio decisions.

For comparison, we also explore the deterministic equilibrium of a variant of the benchmark model in which banks cannot raise deposits abroad and thus operate as cross-border lenders. We show that also competition through cross-border lending reduces risk-taking, though to a smaller extent than multinational banking. Finally, we introduce partially correlated projects' failures modelled as in Vasicek [31]. With general functional forms for downward-sloping loan demand and upward-sloping deposit supply, we show that the return on loans falls with the intensity of competition as long as the aggregate profit of the banking sector increases. This happens when the scale enhancing effect of competition on aggregate deposits dominates its downward pressure on banks' profit margins.

The rest of the paper is organized as follows. Section 2 compares our paper with the existing literature. Section 3 describes the benchmark model of multinational banking. Section 4 solves the

[1] We follow Boyd and De Nicolo [4] and Martinez-Miera and Repullo [26] in assuming linear functional forms for the demand of loans, the supply of deposits and the relation between projects' returns and risk, an assumption compatible with decreasing hazard rates.

[2] Further evidence on the fact that banks' expansion through bricks and mortar business model reduces risk is given in Goetz, Laeven and Levine [20] and Levine, Lin and Xie [25] for the US and by Faia, Ottaviano and Sanchez-Arjona [18], who construct a novel dataset for European GSIBs.

model and analyzes its predictions analytically and numerically in the deterministic and stochastic environments. Section 5 and 6 extend the benchmark model to compare multinational banking with cross-border lending and to allow for imperfectly correlated projects' failures. Section 7 concludes.

2 Related Literature

Our paper is primarily connected to the banking literature that studies the role of competition for risk-taking. This literature focuses on Cournot-Nash competition in closed economy. Allen and Gale [1] analyze competition among banks that can choose the level of assets' risk and show that more competition leads to more risk-taking. Their model hinges on competition in the deposit market. Banks seeking to attract deposits in a tougher competitive setting are forced to offer higher deposit rates. This forces banks to search for yield in assets, thus encouraging risk-taking. Furthermore, Allen and Gale [2] use a general equilibrium model of financial intermediation to show that instability in competitive banking systems is constrained efficient, thereby concluding that there is no trade off between risk and efficiency. Differently, Boyd and De Nicolo [4] highlight a different channel through which more competition in the loan market reduces loan rates, thus inducing firms to select projects with lower returns but also lower risk. Through this channel, competition may improve the average quality of the loans' applicants and reduce adverse selection (see also Stiglitz and Weiss [30]). In the same vein, Martinez-Miera and Repullo [26] revisit the insights of Boyd and De Nicolo [4] when the correlation of projects' failures is imperfect as in Vasicek [31] rather than perfect as in the original paper. They note that lower loan rates reduce banks' profit margins from non-defaulting loans, which generates a U-shaped relation between competition and banks' aggregate failure rate (systemic risk). In all these papers changes in competition are only exogenous, while we also consider endogenous entry and how this interacts with endogenous risk-taking. Also in none of the above paper the bank has the choice between domestic and foreign markets, something which in our case creates 'dumping' incentives as in Brander and Krugman [5]: in the presence of monitoring costs that hamper foreign operations banks are willing to accept a smaller lending-to-deposit rate spread in their foreign than in their domestic markets.

Our paper speaks to the emerging empirical literature on the role of global banks in the recent crisis. For instance, Cetorelli and Goldberg [9] and [10] study liquidity management by global banks during the Great Recession and focus on the interaction with the monetary policy transmission mechanism. They show that banks manage liquidity optimally on a global scale by shifting it where it is most needed. They focus on banks that are already global and do not investigate the factors that might induce banks to enter foreign markets.[3]

More generally, our model also helps rationalize a number of results obtained by the empirical literature studying global banking. First and foremost, many papers find that negative shocks like the crisis tend to reduce cross-border lending, but not the presence of foreign banks (see, e.g., the survey by Claessens and van Horen [11] and Claessens and van Horen [12]). That is why, even after 2007, banks' globalization has remained a widespread phenomenon with far reaching consequences for risk and financial stability. This literature also explores the link between bank globalization on the one hand and credit condition or financial stability on the other. Evidence shows that the presence of foreign banks helps reduce the cost of credit and risk-taking and thus facilitate financial stability, the more so the lower the entry barriers and the higher the information efficiency of the destination markets.[4] Lower entry barriers increase competition. If the loan competition channel prevails, banks' risk-taking falls. Further evidence exists on the fact that expansion through 'bricks and mortar' activity might reduce risk-taking. For instance, in the case of US banks Goetz, Laeven and Levine [20] and Levine, Lin and Xie [25] find that geographic expansion (within the US) reduces banks' risk-taking due to a diversification channel. In the case of European GSIBs, Faia, Ottaviano and Sanchez-Arjona [18] test the impact of banks' foreign expansion on both individual bank risk (measured through CDS prices and/or loan loss provisions over assets) and systemic risk (measured with metrics of marginal capital short-fall and/or CoVaR) comparing the roles of the competition, the diversification and the regulation channels. They find that foreign expansion (though 'bricks and mortar') reduces all risk metrics. Our paper provides a theoretical underpinning to these empirical findings as well as to the observed asymmetric reactions of cross-border lenders and multinational banks to negative shocks in the destination market, with the former typically retreating more than the latter.[5]

Finally, very few papers analyze the theoretical underpinnings of global banking. Bruno and

[3]See also the papers in Buch and Goldberg [8] for a recent overview.

[4]See Claessens et al. [14], Berger et al. [3], Giannetti and Ongena [19].

[5]See Claessens and van Horen [13].

Shin [6] build a model of the international banking system where global banks raise short term funds ('deposits') at worldwide level, but interact with local banks for loans production. Differently from us they focus on banks' leverage cycle. Niepman [28] proposes a perfectly competitive model of banking across borders, in which the pattern of foreign bank asset and liability holdings emerges endogenously because of international differences in relative factor endowments and banking efficiency. Competition and risk-shifting are not part of the analysis. De Blas and Russ [15] investigate whether foreign participation in the banking sector increases real output. Using a general equilibrium model of heterogeneous, Bertrand competitive lenders and a simple search process, they show that lending-to-deposit rate spreads can increase with FDI whereas the lending rates remain largely unchanged or even fall. They also contrast the competitive effects from cross-border bank takeovers with those of cross-border lending. Differently from us, they do not emphasize risk-shifting in the presence of limited liability.[6]

3 A Model of Multinational Banking

Consider a banking sector that operates in two symmetric national markets, called H and F. Banks raise deposits from households and extend loans for investment projects. They are headquartered in only one of the two markets but can operate in both, choosing the risk-return profile that maximizes local profits. However, when they operate in the market they are not headquartered in, banks face an additional monitoring cost on loans $\mu > 0$. We use $N^a_{t,H}$ and $N^a_{t,F}$ to denote the numbers of active banks that at any time t are headquartered in H and F respectively, and $N^a_t = N^a_{t,H} + N^a_{t,F}$ to denote the resulting total number of active banks. These numbers are determined by endogenous entry at fixed cost $\kappa > 0$, which subsumes a bank entry cost $\kappa^b > 0$ and a subsidiary setup cost $\kappa^d > 0$ for each market the bank operates in ($\kappa = \kappa^b + 2\kappa^d$). The model will therefore feature both endogenous entry and endogenous risk-taking. As the two markets are symmetric, for conciseness of exposition we will focus on the description of market H with analogous expressions holding for market F.

[6] See Hale and Russ [16] for a recent overview of related works.

3.1 Banks' Entry and Exit

In each period t the number of active banks is determined endogenously by entry and exit as follows. Entry requires establishing a headquarter in one of the two national markets and a subsidiary in each market at the overall fixed cost $\kappa > 0$. A constant discount factor $\beta \in (0,1)$ captures the exogenous per period opportunity cost associated with financing κ in an un-modelled international capital market. The fact that β is constant means that the two national banking markets we focus on are 'small' with respect to the international capital market and thus financing conditions in the latter are not affected by banks decisions in the former. Banks become active as soon as they enter. Exit does not incur any additional cost. It can be voluntary when it is a bank that decides to leave, or involuntary as long as each period banks face an exogenous death rate $\varrho \in (0,1)$.

Accordingly, active banks consist of incumbents that survived from the previous period and new entrants. If we use $N_{t-1,H}$ and $N^e_{t,H}$ to denote the numbers of incumbent and entrant banks headquartered in H in period t, we have that the corresponding number of active banks is:

$$N^a_{t,H} = N_{t-1,H} + N^e_{t,H} = \frac{N_{t,H}}{1-\varrho} \tag{1}$$

Note that, due to exogenous death, the number of incumbents in any period is only a share $1-\varrho$ of the number of active banks in the previous period.

In deciding whether to enter or not, banks compare the fixed entry cost κ with the total present expected value of future per-period profits. Let $\Pi_{z,HH}$ and $\Pi_{z,HF}$ be the per-period profits that a bank headquartered in H earns in period z from operations in markets H and F. Then, if we use $V_{t,H}$ to denote the value of being active at time t for a bank headquartered in H, we can write the total sum of its future discounted profits recursively as:

$$V_{t,H} = \Pi_{t,HH} + \Pi_{t,HF} + \beta(1-\varrho)E_t\left\{V_{t+1,H}\right\}. \tag{2}$$

As entry happens instantaneously, the model will feature no transitional dynamics. Free entry therefore implies that in any instant t the value of being active will be equal to the overall entry cost: $V_{t,H} = \kappa$. We will consider two cases, a stochastic environment and a deterministic environment in which banks' profits per period are constant and equal to the annuity value of that cost:

$$\Pi_{HH} + \Pi_{HF} = \left[1-\beta(1-\varrho)\right]\kappa, \tag{3}$$

which shows that the larger are the fixed entry cost κ, the opportunity cost β of financing entry and the death rate ϱ, the larger profits have to be in order to justify entry. Analogous results hold for banks headquartered in country F.

3.2 Banks, Firms and Depositors

Banks act as intermediaries between depositors and investors ('firms'), acting as oligopsonist vis-à-vis the former and as oligopolist vis-à-vis the latter. In both cases they behave as Cournot-Nash competitors. For simplicity, we assume that: (i) firms do not have internal funds and banks are their only source of funds; (ii) banks can only finance firms using own deposits; (iii) depositors can only use their funds for deposits. Moreover, we assume that both home and foreign banks can finance home firms using local deposits only. This assumption reflects well the reality of the bricks and mortar business model, in which liquidity cannot be moved easily across branches/subsidiaries. Banks optimize in each destination markets separately. Markets will be linked only through the banks' free entry condition. Note that strategic interactions and firms' and banks' optimization takes place within a period, hence in what follows we will leave the time index implicit.

While banks and firms are risk neutral, depositors are risk averse households with concave utility function of their consumption. Deposits are insured by banks at a flat rate deposit insurance premium $\xi > 0$. This implies that in market H the total supply of deposits D_H^T as well as the return on deposits r_H^D do not depend on the riskiness of banks' portfolios: depositors only care about the expected return of deposits, as they will not bear banks' asset losses due to the insurance. Notice that the presence of the insurance, by expanding the bank's limited liability region, also contributes to the banks' risk-taking incentives. We will return on this point later again. Thus, the (inverse) supply of deposits can be characterized as a return function of D_H^T only. This function $r_H^D = r^D\left(D_H^T\right)$ is assumed to satisfy $r^D(0) \geq 0$ and to be twice differentiable with $r^{D\prime}\left(D_H^T\right) > 0$ and $r^{D\prime\prime}\left(D_H^T\right) \geq 0$. Using D_{HH} and D_{FH} to denote the deposits raised by home and foreign banks respectively, we have $D_H^T = D_{HH} + D_{FH}$.

Notice that households could potentially invest in firms' projects by themselves. In this case, however, they would receive a risky return. By investing in insured banks' deposits, they receive instead a fixed return, which better suits their risk averse preferences. Hence, the main role of banks in the model is that of risk insurance providers. Risk neutral banks collect deposits, invest them in risky assets by diversifying and provide a fixed returns to risk averse depositors. Importantly the deposit insurance plays the role of bank capital in our model: the insurance fee is proportional to assets and the insurance fund is the first in the pecking order of loss absorbing assets.

In each national market firms have access to a set of constant-return risky technologies ('projects') with fixed output normalized to 1. For market H, projects are indexed r_H^I yielding ar_H^I with probability $p(r_H^I, a)$ for $r_H^I \in [0, \bar{r}^I]$ and 0 otherwise, where a is an aggregate shock. We assume that this shock is common across markets in order to insulate our analysis of the effects of global banking on risk-taking channeled through competition from those channeled through risk diversification. Probability $p(r_H^I, a)$ satisfies $p(0, a) = 1$, $p(\bar{r}^I, a) = 0$, $p_1(r_H^I, a) < 0$, $p_{11}(r_H^I, a) \leq 0$ for all $r_H^I \in [0, \bar{r}^I]$ so that $p(r_H^I, a)ar_H^I$ is strictly concave in r_H^I. It also satisfies $p_2(r_H^I, a) > 0$ and $p_{12}(r_H^I, a) \geq 0$. Accordingly, for given a, the probability of success decreases more than proportionately as projects' returns increase, while it (weakly) increases as a increases. Moreover, the positive impact of larger a on r_H^I is (weakly) stronger for larger r_H^I so that higher return projects with lower probability of success benefit (weakly) more than proportionately from favourable aggregate shocks. The choice of projects by firms is unobservable to banks, which can only observe (at no cost) whether projects have been successful ($r_H^I > 0$) or not ($r_H^I = 0$). As firms are risk neutral, in each national market the total demand of loans $L_H^T = L_{HH} + L_{FH}$ (with L_{HH} and L_{FH} denoting the supply of loans from home and foreign banks respectively) as well as their return r_H^L do not depend on the riskiness of firms' projects. The (inverse) demand of loans can then be characterized as a return function of L_H^T only. This function $r_H^L = r^L\left(L_H^T\right)$ is assumed to satisfy $r^L(0) > 0$ and to be twice differentiable with $r^{L\prime}\left(L_H^T\right) < 0$, $r^{L\prime\prime}\left(L_H^T\right) \leq 0$ and $r^L(0) > r^D(0)$.

Finally, as banks can only finance loans through deposits and firms can only finance projects through bank loans, the total amounts of firms' investments I_H^T, banks' loans L_H^T and deposits D_H^T have to be the same: $I_H^T = L_H^T = D_H^T$, where the total amount of investments financed by home and foreign banks is $I_H^T = I_{HH} + I_{FH}$.

3.3 Firms' Decisions

The firms' decisions can actually be characterized in two stages. In the first stage firms choose the risk-return profile of their investment. This leads to the endogenous risk characterizing the economy. Given the investment decisions in a second stage firms decide on their loans' demand.

3.3.1 Firms' Risk and Investment Decisions

We introduce moral hazard by assuming that firms have limited liability in that they repay their loans only if their projects are successful. Those elements imply that firms have an incentive to risk-shifting, the more so the higher is the cost of credit. We follow in this respect the tradition of Stiglitz and Weiss [30] or Jensen and Meckling [22]. This implies that, given risk neutrality, a firm (in the H market) chooses r_H^I in order to maximize expected per period profits:

$$p(r_H^I, a)(ar_H^I - r_H^L), \tag{4}$$

as failure happens with probability $1 - p(r_H^I, a)$ but does not require any loan repayment.[7] Note that, given the monotonic relation between $p(r_H^I, a)$ and r_H^I, choosing r_H^I is equivalent to choosing $p(r_H^I, a)$. In this respect, firms choose the 'risk-return profile' of investments for given return on loans r_H^L (and given a).

The first order condition for a firm maximizing (4) is:

$$p(r_H^I, a)a + p_1(r_H^I, a)(ar_H^I - r_H^L) = 0, \tag{5}$$

which shows that firms trade off higher return ($p(r_H^I, a)a > 0$) and lower success probability ($p_1(r_H^I, a)(ar_H^I - r_H^L) < 0$). Making the dependence of r_H^L on L_H^T explicit allows us to rewrite (5) as:

$$\frac{p(r_H^I, a)a}{p_1(r_H^I, a)} + ar_H^I = r^L\left(L_H^T\right), \tag{6}$$

which expresses the return on investment r_H^I (and thus also risk $1 - p(r_H^I, a)$) as an implicit function of aggregate loans L_H^T with exogenous parameter a. In particular, (6) shows that, by

[7] We could alternatively assume that firms earn a fixed amount $(1 - c)$ with probability $1 - p(r_H^I, a_H)$. This, however, would not change the main incentives faced by firms and banks. Indeed, in case of failure firms would be unable to repay the loans, banks would repossess the amount left $(1 - p(r_H^I, a_H))(1 - c)$ and firms would receive zero. The proceeds earned by banks would then enter banks' profits and their first order conditions would be simply scaled up by $(1 - p(r_H^I, a_H))(1 - c)$.

affecting L_H^T, banks indirectly command the return-risk profile chosen by firms. Specifically, given the functional properties of $r^L\left(L_H^T\right)$ and $p(r_H^I, a)$, a contraction in bank credit (smaller L_H^T) induces firms to select a more 'aggressive' investment profile characterized by higher return and higher risk (i.e., larger r_H^I and larger $p(r_H^I, a)$).[8] Larger a has the same qualitative effects on firms' choice due to its disproportionate boost to high-return high-risk projects.[9] Hence, by disproportionately boosting the probability on the upper tail of the projects' returns distribution, larger a increases firms' 'exuberance'. The choice of firms in the F market is equivalent.

3.3.2 Firms' Loans Decisions

Given the risk-return decisions on investment firms formulate their optimal loan demand. Firms get funds and invest only in one country. We assume that there is continuum of entrepreneurs whose outside option h follows a distribution $G(h)$. Each entrepreneur will fund investment with outside funding to the extent that their expected optimal profit is larger than their outside option. In this context the total demand for loans is equal to the total mass of entrepreneurs that invest:

$$L_H^T = G(\bar{h}_H) = G(p(r_H^I, a)(ar_H^I - r_H^L)). \tag{7}$$

Additional details on how to derive this result can be found in Appendix A, where we also show that the loan demand implicitly defined by (7) satisfies $r^{L\prime}(L_H^T) < 0$ and $r^{L\prime\prime}(L_H^T) \leq 0$. Intuitively, as the mass of borrowing firms rises, the surplus of the marginal firm falls. In turn, this firm will be willing to pay lower rates.

3.4 Banks' Decisions on Deposits and Loans

As banks can only finance local loans by own local deposits, in market H the loans $L_{r,HH}$ ($L_{r,FH}$) of any home (foreign) bank r have to exactly match its deposits $D_{r,HH}$ ($D_{r,FH}$). This implies $L_{r,HH} = D_{r,HH}$ ($L_{r,FH} = D_{r,FH}$) with $D_{HH} = \sum_{r=1}^{N_H} D_{r,HH}$ ($D_{FH} = \sum_{r=1}^{N_H} D_{FH}$) so that $L_{r,HH}$ or $D_{r,HH}$ ($L_{r,FH}$ or $D_{r,FH}$) can be equivalently chosen as a home (foreign) bank's choice variable. In what follows, we will choose $L_{r,HH}$ ($L_{r,FH}$). Then, Cournot-Nash behavior requires each home (foreign) bank r to take into account its individual impacts through L_H^T on both the return on

[8] The crucial restriction here is $p_{11}(r_H^I, a_H) < 0$.
[9] The crucial restriction here is $p_{12}(r_H^I, a_H) \geq 0$.

deposits $r^D\left(L_H^T\right) = r^D\left(D_H^T\right)$ and the return on loans $r^L\left(L_H^T\right)$ when choosing its amount of loans $L_{r,HH}$ $(L_{r,FH})$.

Each period starts with a certain number of incumbent banks operating in both markets. The timing of ensuing events for market H is as follows. First, the aggregate shock a is realized. Second, based on the number of incumbents and the realization of a, new banks may decide to enter bringing the total number of active banks to $N^a = N/(1-\varrho)$ with $N_H^a = N_H/(1-\varrho)$ and $N_F^a = N_F/(1-\varrho)$ (see the law of motion (1)). Third, active banks simultaneously choose the amounts of loans $L_{r,HH}$ $(L_{r,FH})$ in market H separately from market F (due to their segmentation). Aggregation of these simultaneous individual decisions up to L_H^T determines loans and deposits returns r_H^L and r_H^D. Fourth, based on r_H^L and the realization of a, firms design their risk-return profiles by choosing r_H^I or equivalently $p(r_H^I, a)$. Fifth, uncertainty over projects' outcomes is resolved. Successful firms repay their loans and, whatever happens, depositors receive return r_H^D thanks to full insurance. Finally, exogenous exit takes place at rate ϱ. Surviving banks become the incumbents at the beginning of the next period.

Given this timing, the backward solution of the model requires us first to characterize the Cournot-Nash equilibrium of loan extension (deposit collection) for given numbers of active banks and then to endogenize those numbers through the entry condition (3).

3.4.1 Banks' Optimization Problem

Due to market segmentation, banks maximize profits independently in the to markets. In the case of market H, a bank r headquartered in H chooses $L_{r,HH}$ to maximize

$$\Pi_{r,HH} = p(r_H^I, a)\left(r^L\left(L_H^T\right)L_{r,HH} - r^D(D_H^T)D_{r,HH} - \xi D_{r,HH}\right),$$

whereas a bank s headquartered in F chooses $L_{s,FH}$ to maximize:

$$\Pi_{s,FH} = p(r_H^I, a)\left(r^L\left(L_H^T\right)L_{s,FH} - r^D(D_H^T)D_{s,FH} - \xi D_{s,FF} - \mu L_{s,FH}\right),$$

subject to the constraint that local loans must match deposits loans:

$$L_{r,HH} = D_{r,HH},\ L_{s,FH} = D_{s,FH}$$

as well as to the firms' first order condition (6), which implicitly defines the return of investment chosen by firms as a function of the loan rate: $r_H^I = r^I\left(r^L\left(D_H^T\right)\right)$. In doing so, firms are aware that their individual decisions affect aggregate loans (deposits):

$$\begin{aligned} L_H^T &= \sum_r L_{r,HH} + \sum_s L_{s,FH} \\ D_H^T &= \sum_r D_{r,HH} + \sum_s D_{s,FH} \end{aligned}$$

with $L_H^T = D_H^T$.

The first order condition for domestic bank r (for the domestic market) is:

$$\begin{aligned} \frac{d\Pi_{r,HH}}{dL_{r,HH}} &= p(r_H^I, a)\left(r^L\left(L_H^T\right) - r^D(L_H^T) - \xi\right) + \\ &\quad + p(r_H^I, a)\left(r^{L\prime}\left(L_H^T\right) - r^{D\prime}(L_H^T)\right) L_{r,HH} + \\ &\quad + p_1(r_H^I, a) r^{I\prime}\left(r^L\left(L_H^T\right)\right) r^{L\prime}\left(L_H^T\right)\left(r^L\left(L_H^T\right) - r^D(L_H^T) - \xi\right) L_{r,HH} = 0 \end{aligned} \tag{8}$$

After the first equality, the first term is the 'scale effect'. It is positive and represents the marginal gain from increasing one unit of bank scale (as measured by the total amount of loans and deposits). The second term is the 'competition effect'. It is negative and captures the impacts of larger bank scale on deposit return $(r^{D\prime}\left(L_H^T\right) > 0)$ and loan return $(r^{L\prime}\left(L_H^T\right) < 0)$. More deposits and loans lead to a rise in the rate on deposits and a fall in the rate on loans. The third and last term is the 'risk-taking effect'. It is positive and captures the effects of competition on the risk-return investment profile of firms. More loans decrease the loan rate and this in turn induces firms to select profiles associated with lower return and higher probability of success.

The profit maximizing choice of loans by foreign bank s (for the domestic market) satisfies an analogous first order condition:

$$\begin{aligned} \frac{d\Pi_{s,FH}}{dL_{s,FH}} &= p(r_H^I, a)\left(r^L\left(L_H^T\right) - r^D(L_H^T) - \xi\right) + \\ &\quad + p(r_H^I, a)\left(r^{L\prime}\left(L_H^T\right) - r^{D\prime}(L_H^T)\right) L_{r,FH} + \\ &\quad + p_1(r_H^I, a) r^{I\prime}\left(r^L\left(L_H^T\right)\right) r^{L\prime}\left(L_H^T\right)\left(r^L\left(L_H^T\right) - r^D(L_H^T) - \xi - \mu\right) L_{s,FH} = 0 \end{aligned} \tag{9}$$

which differs from (8) only for the presence of the additional monitoring cost μ. Analogous conditions hold for market F.

3.4.2 Cournot-Nash Equilibrium

We focus on a symmetric outcome in which in each market all home banks achieve the same scale $L_{r,HH} = L_{s,FF} = \ell$ and all foreign banks achieve the same scale $L_{s,FH} = L_{r,HF} = \ell^*$. In this case, in each market total loans (and deposits) are:

$$L^T = \frac{N}{1-\varrho}\left(\ell + \ell^*\right). \tag{10}$$

For given N, in each market the Cournot-Nash equilibrium (in any period t) is characterized by the solution of the following system of two equations in the two unknown scales ℓ and ℓ^*:

$$\begin{aligned} & p(r^I, a)\left(r^L\left(L^T\right) - r^D(L^T) - \xi\right) + \\ & + p(r^I, a)\left(r^{L\prime}\left(L^T\right) - r^{D\prime}(L^T)\right)\ell + \\ & + p_1(r^I, a) r^{I\prime}\left(r^L\left(L^T\right)\right) r^{L\prime}\left(L^T\right)\left(r^L\left(L^T\right) - r^D(L^T) - \xi\right)\ell = 0 \end{aligned} \tag{11}$$

and

$$\begin{aligned} & p(r^I, a)\left(r^L\left(L^T\right) - r^D(L^T) - \xi\right) + \\ & + p(r^I, a)\left(r^{L\prime}\left(L^T\right) - r^{D\prime}(L^T)\right)\ell^* + \\ & + p_1(r^I, a) r^{I\prime}\left(r^L\left(L^T\right)\right) r^{L\prime}\left(L^T\right)\left(r^L\left(L^T\right) - r^D(L^T) - \xi - \mu\right)\ell^* = 0 \end{aligned} \tag{12}$$

where, exploiting symmetry between markets, we have dropped the market index from all variables.

3.4.3 Free Entry Equilibrium

With explicit time dependence, the values of ℓ_t and ℓ_t^* that solve system (11)-(12) determine the maximized values of domestic profits Π_t and foreign profits Π_t^*. These are the same for all banks ($\Pi_{t,HH} = \Pi_{t,FF} = \Pi_t$ and $\Pi_{t,HF} = \Pi_{t,FH} = \Pi_t^*$) and are functions of the number of active banks N_t^a. In turn, the equilibrium number of active firms is pinned down by the free entry condition described in Section 3.1, which with symmetry becomes:

$$\Pi_t + \Pi_t^* = \left[1 - \beta(1-\varrho)\right]\kappa. \tag{13}$$

in the determinist environment and:

$$V_t = \Pi_t + \Pi_t^* + \beta(1-\varrho)E_t\left\{V_{t+1}\right\} = \kappa \tag{14}$$

in the stochastic environment. Finally, the equilibrium values of ℓ_t, ℓ_t^* and N_t^a determine the equilibrium deposit return r_t^D, loan return r_t^L, and risk-return profile $(r_t^I, p(r_t^I, a_t))$. Given the number of incumbents, they also determine the equilibrium number of entrants by (1). The fact that the equilibrium of the two national markets can be characterized by such a parsimonious set of equations is obviously due to the assumption that the two markets are symmetric.

4 Qualitative and Quantitative Implications of the Model

We want to understand how competition and risk taking change when the parameters of the model change. In particular, we want to analyze the equilibrium behavior of our model in the two environments described in Section 3.1: a deterministic environment without aggregate shocks ($a_t = 1$) and a stochastic environment in which aggregate shocks make a_t follow a Markov stationary process. We will first characterize some analytical results for the more tractable deterministic case, and then resort to numerical simulations for a broader investigation of both the deterministic and stochastic environments. In doing so, we will work with specific functional forms satisfying the assumptions on $r^L\left(D^T\right)$, $r^D(D^T)$ and $p(r^I, a)$ laid out in the previous section.

4.1 Parametrization

To investigate the equilibrium behavior of the model (both analytically and numerically), it is useful to specify simple functional forms that comply with the properties detailed in Section 3.2. In the wake of Boyd and De Nicolo [4], we assume that the demand of loans and the supply of deposits take the following forms:

$$\begin{array}{ll} r^L\left(L_t^T\right) = \frac{a_t}{\alpha} - \beta_1 L_t^T & \text{with} \quad \beta_1 > 0, \\ r^D(D_t^T) = \gamma D_t^T & \text{with} \quad \gamma > 0. \end{array} \tag{15}$$

We also assume that investment projects succeed with probability:

$$p(r_t^I, a_t) = \begin{cases} a_t\left(1-\alpha r_t^I\right) & \text{for } r^I \in [0, 1/\alpha] \\ 0 & \text{otherwise} \end{cases} \tag{16}$$

Hence, for given returns, larger a_t increases the demand of loans by (15), the productivity of projects by (4) as well as their success probability by (16). Accordingly, we will refer to larger (smaller) a_t as better (worse) 'investment climate'. Differently, larger α decreases loan demand as well as projects' success probability without affecting their productivity.

4.2 Deterministic Equilibrium without Monitoring Costs

We characterize the deterministic equilibrium in two steps. In this section we provide an analytical assessment for the simpler case in which $\mu = 0$. In the next section we assess the role of banking globalization (as captured by an reduction of μ) through numerical simulations.

As with $a_t = 1$ all variables are constant, we drop the time subscript. We can then use (15) and (16) with $a = 1$ and $D^T = D^T$ to rewrite firms' first order condition (6) as:

$$r^I = \frac{1}{\alpha} - \frac{\beta_1}{2} L^T, \tag{17}$$

with associated success probability:

$$p = \frac{\alpha\beta_1}{2} L^T. \tag{18}$$

These expressions show that more loans (and thus more deposits) make firms choose investments with lower return and higher probability of success (i.e. with more cautious risk-return profile). As for banks' first order conditions, (11) and (12) can be rewritten respectively as

$$L^T \left[\frac{1}{\alpha} - (\beta_1 + \gamma) L^T - \xi\right] + \left[\frac{1}{\alpha} - 2(\beta_1 + \gamma) L^T - \xi\right] \ell = 0 \tag{19}$$

and

$$L^T \left[\frac{1}{\alpha} - (\beta_1 + \gamma) L^T - \xi - \mu\right] + \left[\frac{1}{\alpha} - 2(\beta_1 + \gamma) L^T - \xi - \mu\right] \ell^* = 0, \tag{20}$$

where we again focus on the symmetric Cournot-Nash equilibrium in which in both national markets all home banks choose the same amount of loans ℓ_{ss} and all foreign banks choose the same amount of loans ℓ^*_{ss}. Henceforth, we will use subscript ss to denote the values of all variables in the deterministic equilibrium. Note that conditions (19) and (20) imply that in such equilibrium, foreign banks facing the additional monitoring cost $\mu > 0$ end up being smaller than their home competitors. Indeed, for any given L^T, if the (19) holds for $\ell = \ell_{ss}$, then (20) can hold only for

$\ell^* = \ell^*_{ss} < \ell_{ss}$. Moreover, larger μ is associated with smaller ℓ^*_{ss} relative to ℓ_{ss}, with ℓ^*_{ss} going to zero for large enough μ. To summarize, when foreign banks face an additional monitoring cost, they are smaller than their home competitors. The more so, the higher the monitoring cost. When the monitoring cost is high enough, foreign banks do not operate in the home market.

Having discussed the role of $\mu > 0$, in order to further understand the role of the other parameters of the model, it is useful to focus on the special case in which foreign banks face no additional monitoring cost ($\mu = 0$). In this case, (19) and (20) are identical and can be solved for:

$$L^T_{ss}(N^T_{ss}) = N^T_{ss} d_{ss}(N^T_{ss}) = \frac{\frac{1}{\alpha} - \xi \, \frac{N^T_{ss}}{1-\varrho} + 1}{\beta_1 + \gamma \, \frac{N^T_{ss}}{1-\varrho} + 2} \tag{21}$$

with $N^T_{ss}(1-\varrho)$ denoting the total number of active banks and $N_{ss}/(1-\varrho) = N^T_{ss}(1-\varrho)/2$ denoting the common number of home and foreign banks. Expression (21) shows that, as the number of active banks $N^T_{ss}(1-\varrho)$ increases, total loans $L^T_{ss}(N^T_{ss})$ also increase. Expressions (17) and (18) then imply that, when more banks are active, firms target projects with lower return $r^I_{ss}(N^T_{ss}) = 1/\alpha - \beta_1 L^T_{ss}(N^T_{ss})/2$ and higher success probability $p_{ss} = \alpha\beta_1 L^T_{ss}(N^T_{ss})/2$. This is the net outcome of two opposing forces. On the one hand, increasing the number of banks strengthens banks' competition for deposit funds, weakening their oligopsony power in the deposits market and thus raising the return on deposits as well as the total amount of deposits. For a given spread of the loan rate over the deposit rate $r^L - r^D$, a larger number of active banks would increase the deposit rate r^D, therefore inducing firms to take more risk as r^L would also increase. On the other hand, a larger number of active banks also strengthens competition in loans provision, weakening their oligopoly power in the loan market and thus reducing the return on loans r^L for any given deposit rate r^D. With the assumptions embedded in the chosen functional forms, the downward pressure on the loan rate dominates the upward pressure on the deposit rate, which induces firms to reduce return and risk. Hence, more competition due to a larger number of home and foreign banks makes firms target investments with lower return and lower probability of failure.

Thus far we have taken the number of active banks as exogenously given. Free entry implies, however, that this number is endogenously determined by (13):

$$\pi_{ss}(N_{ss}^{T}) = \frac{\alpha\beta_1\left(\frac{1}{\alpha}-\xi\right)^3}{(\beta_1+\gamma)^2}\frac{\left(\frac{N_{ss}^{T}}{1-\varrho}+1\right)^2}{\frac{N_{ss}^{T}}{1-\varrho}\left(\frac{N_{ss}^{T}}{1-\varrho}+2\right)^3} = [1-\beta(1-\varrho)]\,\kappa. \tag{22}$$

Implicit derivation of (22) shows that stronger demand of loans by firms and higher success rate of their investments (as captured by lower α) cause a rise in the number of active banks given $dN_{ss}^{T}/d\alpha < 0$. This is accompanied by a higher number of entrants as in equilibrium (1) implies $N_{e,ss}^{T} = \varrho N_{ss}^{T}/(1-\varrho)$. By (21), larger N_{ss}^{T} leads to a rise in both total and per-bank loans: $dL_{ss}^{T}/d\alpha < 0$ and $d\ell_{ss}/d\alpha < 0$. Then, by (15), falling α and rising L_{ss}^{T} lead (on net) to higher rates on deposits and loans: $dr_{ss}^{D}/d\alpha < 0$ and $dr_{ss}^{L}/d\alpha < 0$. Finally, by (17) and (18), falling α and rising L_{ss}^{T} also determine (on net) a rise in firms' success rate and in their return on investment: $dp_{ss}/d\alpha < 0$ and $dr_{ss}^{I}/d\alpha < 0$. Hence, stronger demand of loans by firms and higher success rate of their investments lead to an expansion of the banking sector along both the extensive margin (number of active banks) and the intensive margin (deposits and loans per bank). Returns to deposits, loans and investment all rise. Firms target less risky projects.

The effects of lower insurance premium ξ are similar, though less complex as they are channeled only through smaller N_{ss}^{T} and L_{ss}^{T} (as ξ appears only in (21) and (22)). Those of lower entry cost κ are also similar but even more straightforward as they are channeled only through N_{ss}^{T} (as κ appears only in (22)).

4.3 Deterministic Equilibrium with Monitoring Costs

When banks face additional monitoring costs for their foreign operations, we have to resort to numerical investigation as analytical results are hard to obtain for $\mu > 0$. In particular, we compute the deterministic equilibrium through Newton-Raphson iterations of the model system of equations. Parameter calibration is summarized in Table 1 below. Notice that we have chosen parameter values for the loan and deposit demand such that the second is less elastic than the first. The discount factor β is set so as to generate a 4% annual risk-free rate. The banks' exit probability is set so as to generate an annual exit rate of 4% consistently with data from the FDIC for the 2000s (see also Hayashi, Grace Li and Wang [21]). The insurance costs are compatible with quarterly Initial

Table 1: Calibration of parameters.

Free Parameters	Mnemonics	Value
Discount factor	β	0.985
Success probability parameter	α	0.7
Loan rate function	β_1	2
Deposit demand	γ	3
Insurance cost	ξ	0.53
Entry cost	κ	1.1
Exit probability	ρ	0.025
Monitoring cost	μ	0.02

Basel Assessment rates (for Category I of risk) as of 2011. Monitoring costs are set according to the quarterly loan loss provisions of banks in the U.S. and Europe.[10]

Our 'endogenous risk' refers to the overall default probability $1-p(r^I,a)$. If projects are perfectly correlated across firms, this probability corresponds also to the aggregate default risk, hence to endogenous systemic risk. More generally, however, when projects are imperfectly correlated across firms, systemic risk is not necessarily equivalent to $1-p(r^I,a)$. Martinez-Meira and Repullo [26] show how the aggregate endogenous risk metric shall change when idiosyncratic project failures are driven by a latent factor à la Vasicek [31] and projects are imperfectly correlated. In Section 5.2 we will show that changing the risk metric can quantitatively affect the responses of the risk variables, but does not change the agents' optimization behavior and the incentives behind the model mechanics. For this reason, in this section we focus on the simpler limiting case of perfectly correlated projects as our baseline.

Figure 1 describes how 'banking globalization' (lower μ) affects all the endogenous variables in the model. In the panels of this figure the different variables are reported on the vertical axis while μ increases rightward along the horizontal axis. Hence, the effects of banking globalization can be read moving leftward. The figure show that, as already argued, falling μ is accompanied by an increase in the market share of foreign banks: deposits and loans per capita increase for foreign banks and fall for domestic banks (second panel in the right column). Intensified competition leads to an increase in the total amount of deposits and loans, a decrease in the return on loans and an increase in the return on deposits. As the spread between loan and deposit rates shrinks, the

[10] See Bankscope data.

number of banks falls causing a consolidation of the banking market. As for firms, lower loan rates make them more cautious, targeting projects with lower return and higher probability of success. Despite more caution the spread between the returns on investment and loans increases, whereas the spread between the returns on loans and deposits decreases. Finally, note that for all values of μ the spread between loan and deposit rates is smaller for foreign than home banks once the the monitoring cost is netted out. This reveals that banks practice 'dumping' in the sense of Brander and Krugman [5]: they are willing to accept a lower spread for their foreign operations than for their domestic ones and thus do not pass on the full additional costs of foreign operations to their customers. This happens as banks perceive higher elasticities of loans demand and deposits supply in their foreign market given that their market share is smaller there, and explains why costly cross-hauling of identical banking services by banks headquartered in different national markets arises in equilibrium despite monitoring costs. The partial absorption of monitoring costs by foreign banks becomes less pronounced as μ falls driving the perceived elasticities of loans demand and deposits supply in their foreign market closer to the ones in their home market.

4.4 Stochastic Equilibrium with Monitoring Costs

We now investigate how the banking sector reacts when the investment climate is subjected to shocks modelled through a Markov stationary process. The obvious difference with respect to the deterministic equilibrium will be that in a stochastic environment expectations will play a role. Specifically, we choose an autoregressive process for shocks and look at the impulse responses of endogenous risk (firm default probability), bank entry, deposits/loans of domestic and foreign banks, and the return on loans. We study how these responses change depending on the monitoring cost (μ), the deposit insurance premium (ξ), the entry cost (κ) and the demand of loans (α).

4.4.1 Quantitative Implementation

We study the dynamics of the model and the channels at work through stochastic simulations, which take into account expectations about the future banks' value function. In the presence of random shocks to the investment climate, return to investment (17) becomes:

$$r_t^I = \frac{1}{\alpha} - \frac{\beta_1}{2a_t} L_t^T, \tag{23}$$

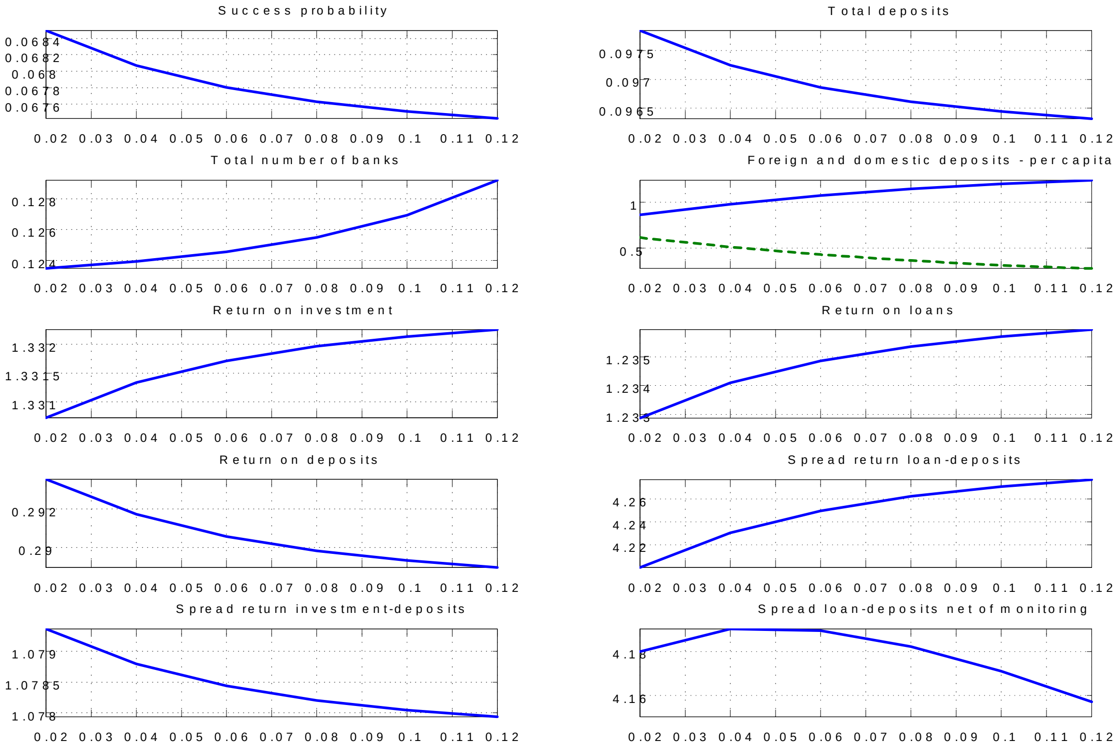

Figure 1: Steady state values of selected variables when changing monitoring cost, μ.

with associated success probability:

$$p_t = \frac{\alpha\beta_1}{2} L_t^T. \tag{24}$$

As in the deterministic equilibrium, these expressions show that, for given a_t, more loans (and thus more deposits) make firms choose investments with lower return $a_t r_t^I$ and higher probability of success (i.e. a more cautious risk-return profile). On the other hand, for given L_t^T, an improvement in the investment climate (larger a_t) makes firm invest in projects with unchanged probability of success but higher return $a_t r_t^I$.

As (23) implies:

$$r_t^{I\prime}\left(r_t^L\left(L_t^T\right)\right) r_t^{L\prime}\left(L_t^T\right) = -\frac{\beta_1}{2a_t}, \tag{25}$$

the banks' first order conditions (19) and (20) become respectively:

$$L_t^T\left[\frac{a_t}{\alpha} - (\beta_1+\gamma) L_t^T - \xi\right] + \left[\frac{a_t}{\alpha} - 2(\beta_1+\gamma) L_t^T - \xi\right] \ell_t = 0 \tag{26}$$

and

$$L_t^T\left[\frac{a_t}{\alpha} - (\beta_1+\gamma) L_t^T - \xi - \mu\right] + \left[\frac{a_t}{\alpha} - 2(\beta_1+\gamma) L_t^T - \xi - \mu\right] \ell_t^* = 0, \tag{27}$$

where we again focus on the symmetric Cournot-Nash equilibrium in which all home banks choose the same amount of loans ℓ_t and all foreign banks choose the same amount of deposits ℓ_t^*.

The complete system of equations consists of: the banks' free entry condition (14); the banks' first order conditions (19) and (20); the definition of total loans (10); the expression of banks' operating profits

$$\Pi_t + \Pi_t^* = \frac{\alpha\beta_1}{2} L_t^T\left[\frac{a_t}{\alpha} - (\beta_1+\gamma) L_t^T - \xi\right]\ell_t + \frac{\alpha\beta_1}{2} L_t^T\left[\frac{a_t}{\alpha} - (\beta_1+\gamma) L_t^T - \xi - \mu\right]\ell_t^*.$$

This is a system of five equations that can be solved numerically in the five unknowns, ℓ_t, ℓ_t^*, L_t^T, N_t and $\Pi_t + \Pi_t^*$. Equation (1) can then be used to find the corresponding number of entrants N_t^e.

4.4.2 Simulation Results

To assess how the banking sector reacts to changes in the investment climate, we present impulse responses of selected variables to a 1% aggregate productivity shock (a_t). We perform stochastic simulations using higher order Taylor expansions of our model around the deterministic equilibrium.[11] Productivity shocks are modelled as AR(1) processes taking the form of $e^{a_t} = e^{a_t} e^{\varepsilon_t}$, where ρ is shock persistence and ε_t is an i.i.d. shock. Following most of the dynamic macro literature, ρ is calibrated to a value of 0.98. The rest of the parameters is calibrated as in the previous section. In each of the figures below we examine the impulse responses for different values of crucial parameters. We do so for two reasons. First, globalization may take place for different motives. Certainly a reduction of monitoring cost (smaller μ) directly favors the entry of foreign banks. However, the entry of foreign banks can also be fostered by stronger loan demand (smaller α), lower entry barriers (smaller κ) and lower insurance premium (smaller ξ). Examining how the response of the banking sector changes for different value of those parameters will allow us to understand how the various channels at work in our model operate.

Figure 2 shows the impulse responses of selected variables to the 1% productivity shock for different values of the monitoring cost μ.

We start by examining the qualitative response of each variables for high and low values of μ. An increase in productivity boosts project returns, hence fosters the entry of both domestic and foreign banks. Both active banks and new entrants increase in number. As the market becomes more competitive, per bank deposits and each bank's market share fall (second panel to the left). Overall credit, however, increases due to the increased number of active banks. This brings about a fall in the loan returns. In turn, the fall in loan returns reduces risk-shifting incentives for firms, which then move to select projects with lower returns and higher success probability. The latter indeed increases on impact (first panel). Hence endogenous risk (default probability) falls. A higher value of μ has a double effect. On the one side, by increasing dumping, it induces banks to apply a higher discount on loans' rates (second panel to the right). This renders competition in the loan market more aggressive. On the other side, higher monitoring costs reduce foreign profits and foreign banks' entry (which is endogenous in our case). Monitoring costs are per period operating costs that affect the banks' intensive margin, namely the amount of deposits to be held in each market. Through this they reduce the sensitivity of the risk profile to the loan rate. There are less active banks and this reduces slightly the firms' risk-shifting incentives. This second effect tends

[11] See Judd [23].

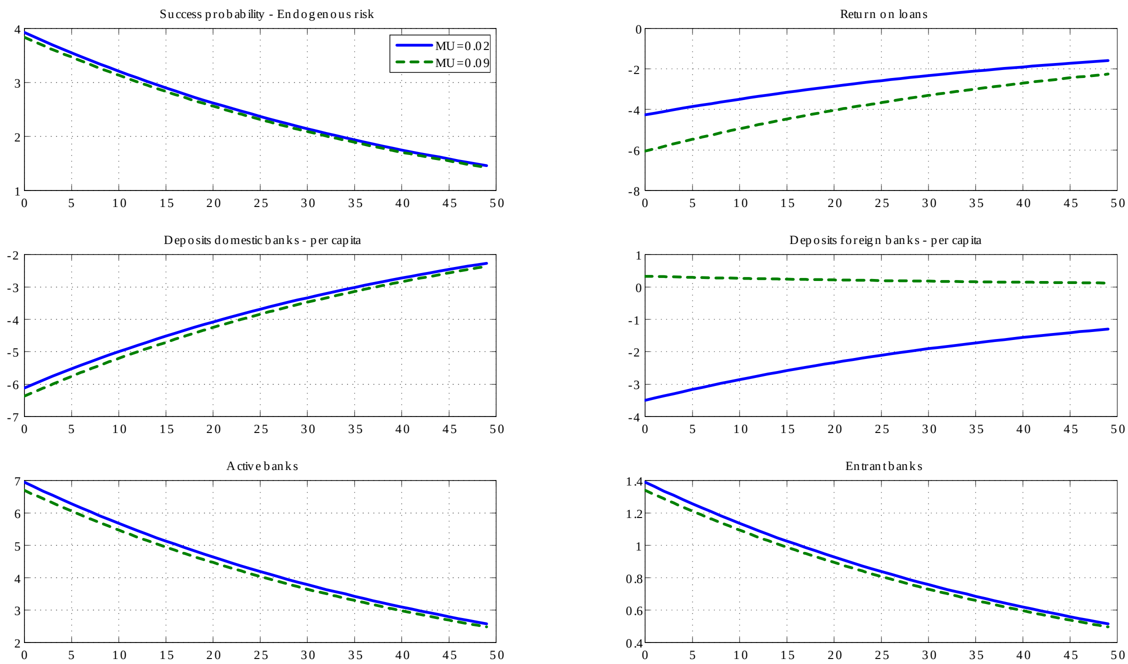

Figure 2: Impulse responses of selected variables to a positive productivity shock for different values of μ ($\xi = 0.53$).

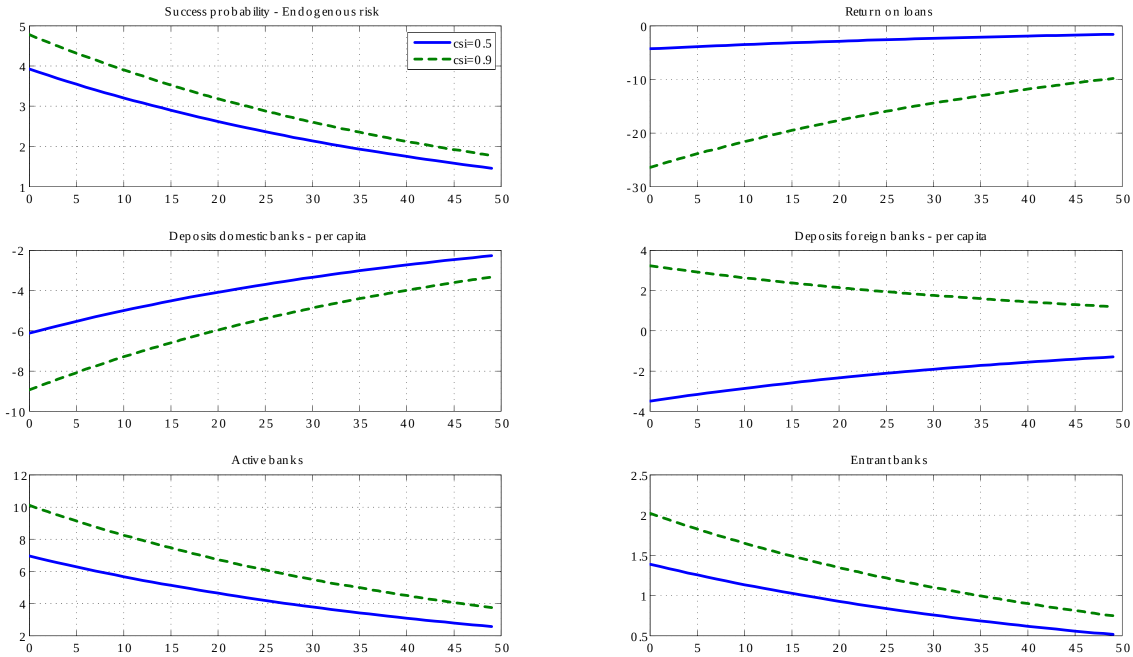

Figure 3: Impulse responses of selected variables to a positive productivity shock for different values of ξ.

to partly counteract the first, so that we observe a smaller increase in the success probability and a smaller increase in the number of new entrants. At last, monitoring costs affect banks' choice on the relative operating scale between the domestic and the foreign markets. Higher monitoring costs induce banks to decrease not only the relative scale of their foreign operations, but also, though to a smaller extent, the absolute scale of their overall operations.

Figure 3 examines the response to the1% positive productivity shock for high and low values of the insurance premium ξ.

As before, the increase in expected revenues (today and in the future) induces more banks to enter, reduces their market share (deposits per capita) and increases overall loan supply, which in turn reduces loan rates and risk (the success probability increases on impact, see first panel). Responses are different for different values of the insurance premium. By providing loss coverage, insurance induces higher banks' risk-taking. As the insurance is the first loss absorber in the

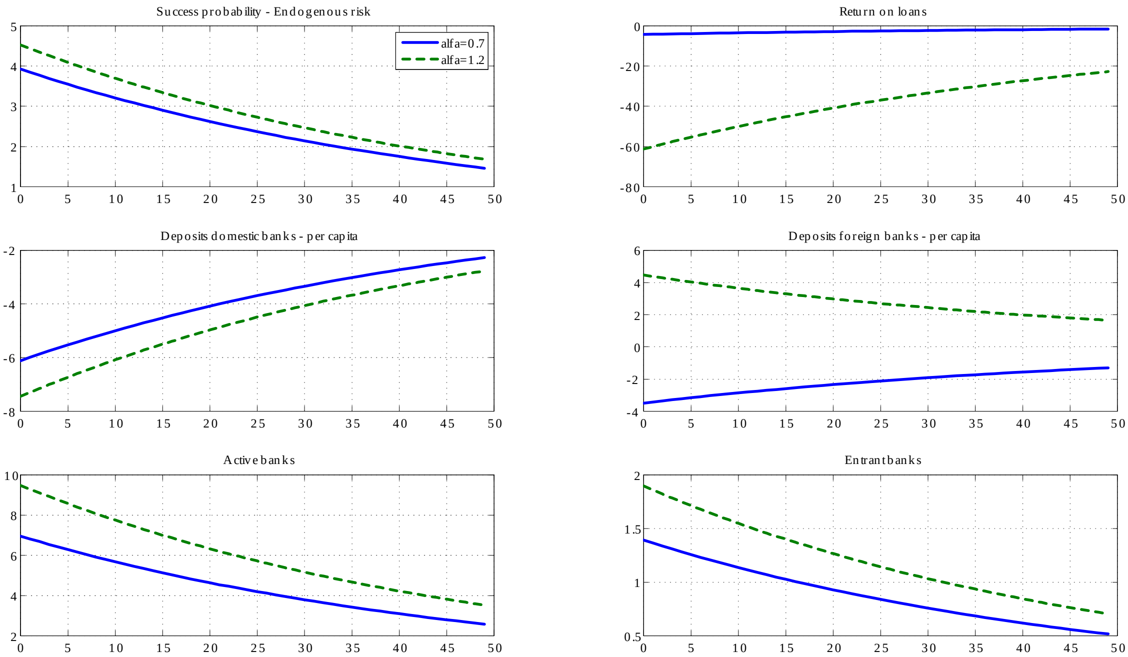

Figure 4: Impulse responses of selected variables to a positive productivity shock for different values of α.

pecking order, its role is mainly that of dispensing banks from bearing any operating loss (beyond the protection guaranteed by the limited liability). The impulse responses show that for higher values of ξ the increase in success (the fall in endogenous risk) is larger. This is due to the fact that the bank has an incentive to follow a more cautious behavior as a higher insurance premium makes the bank share a larger part of the losses from loan default.

Figure 4 shows the response to the positive productivity shock for high and low values of α.

The responses of the selected variables are to be interpreted as before. Regarding the role of α, recall that larger values of this parameter decrease loan demand as well as projects' success probability for given a_t. Hence, larger α reduces investors' hubris leading to less appetite for risk and less banks' entry.

Figure 5 shows the response for different values of the fixed entry cost κ.

To interpret the role of the entry cost we can resort to *option value theory.* Banks enter when

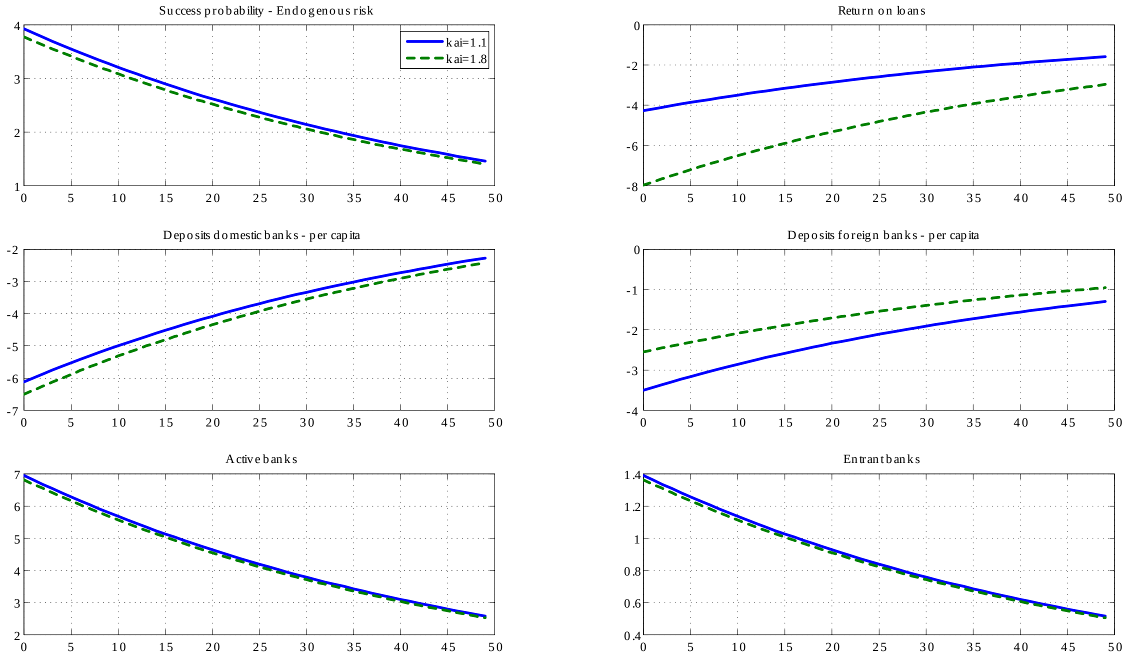

Figure 5: Impulse responses of selected variables to a positive productivity shock for different values of κ.

their future sum of discounted profits equate the entry cost. By solving recursively equation (2) we can express this condition as:

$$\kappa = E_t \left\{ \sum_{z=t}^{\infty} (\beta(1-\varrho))^{z-t} \left(p(r_t^I, a_t) \left(r_t^L \left(L_t^T \right) - r_t^D (L_t^T) - \xi \right) (\ell_t + \ell_t^*) - \mu \ell_t^* \right) \right\} \tag{28}$$

The *option value* of opening a new branch or subsidiary is given by the discounted sum of future banks' rents. The higher is the entry barrier, the higher are the rents which the bank shall extract to satisfy condition (28). Rents' extraction is reflected in the fact that the bank decreases the loan rate (and extracts higher market shares) by a larger extent when κ is higher. In other words, banks' predatory incentives are higher when the initial sunk cost is higher.

At last, it is interesting to notice that the effects of the monitoring costs differ for different values of the insurance premium. Figure 6 shows the impulse responses for different values of μ and a value of ξ larger than in Figure 2. It is interesting to note that in this case an increase in monitoring reduces risk (increases success probability). High insurance costs coupled with high monitoring costs induce foreign banks to reduce their scale. This frees up deposit demand for domestic banks, which on the contrary acquire market share. Overall, the adjustment is amplified by the higher premium. The stronger increase in total loans induces a larger reduction in the loan rate and a larger increase in success probability.

We can summarize all the channels operating in our model as follows. First, an improvement in investment climate, by fostering entry and competition in loan markets reduces risk-shifting incentives and induces banks to select better portfolios (see also Boyd and De Nicolo [4]). Due to this effect, foreign expansion induces a fall in risk. Second, entry in the foreign market fosters banks' predatory incentives or 'dumping' (see Brander and Krugman [5] for a similar effect in the trade literature). This effect taken in isolation would reduce banks' margins for the non-defaulting loans (see Martinez-Miera and Repullo [26]) and jeopardize banks' portfolio sustainability; it would hence increase banks' risk. However, in our model entry is endogenous, this implies that shifts in the loan curves also change the relative market shares of all banks. By reducing loan rates, foreign entrants also increase market shares. Overall, this dampens the fall in per period banks' margins for non-defaulting loans. The increase in market shares raises the value of a bank that continues to do business in the future (i.e. its 'charter value'; see Vives [32]), and this reduces also its overall risk.

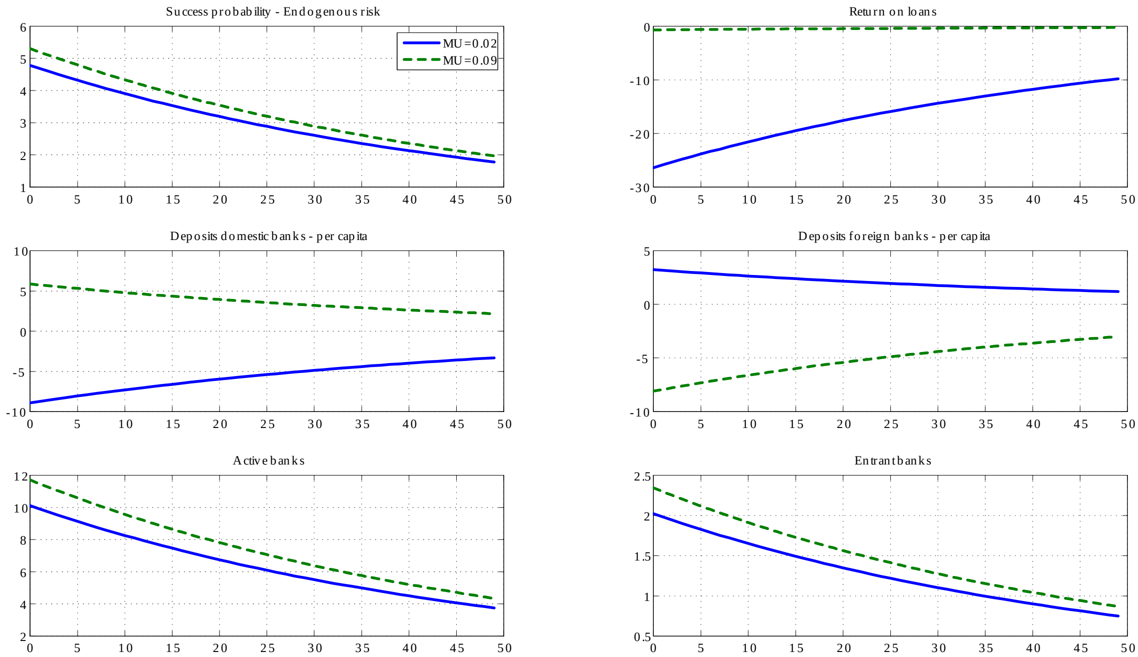

Figure 6: Impulse responses of selected variables to a positive productivity shock for different values of μ ($\xi = 0.9$).

5 Cross-Border Lending and Systemic Risk

To conclude our analysis, we compare our results on the relation between multinational banking and risk with perfectly correlated firm projects' outcomes with those generated by two alternative setups. In the first, we substitute multinational banks with cross-border lenders that extend loans in both markets but can only raise deposits in the market in which they are headquartered. In the second, we revert to multinational banks but introduce systemic risk through imperfectly correlated projects' outcomes.

5.1 A Model of Cross-Border Lending

Internationalization for banks can take place in different forms. So far we have explored the possibility of multinational banking, which materializes through the opening of branches or subsidiaries in a foreign country that raise deposits and extend loans locally. An alternative to this business model is cross-border lending whereby banks foreign operations are restricted to loan provision. The difference between these business models might be relevant in terms of risk-taking behavior. Indeed, a recent IMF Financial Stability Report [24] shows that, prior to the financial crisis of 2007, global risk had increased since much of the financial globalization took place through cross-border activity with little involvement of global banks into local retail activity. The same report shows, however, that after the crisis there has been a shift in the business model of global banks, which currently tend to operate more through subsidiaries (occasionally through branches) and this shift has been associated with a fall in banks' risk. Our benchmark model shows, consistently with evidence in the IMF report, expansion by multinationals can actually reduce risk-taking. It is, therefore, worth examining whether expansion through cross-border activity can instead lead to different conclusions.

We assume that, differently from multinational banks, cross-border lenders have a lighter foreign presence. This can be captured by a lower setup cost for foreign operations, which we normalize to zero. Accordingly, the overall fixed cost of a cross-border lender is $\kappa - \kappa^d$, where κ and κ^d are the overall fixed cost and the subsidiary setup cost of a multinational bank respectively.

A cross-border lender r headquartered in market H raises deposits $D_{r,H}$ in its domestic market and allocates them to domestic loans $L_{r,HH}$ and foreign loans $L_{r,HF}$. We use $D_{r,HH}$ and $D_{r,FH}$ to denote the complementary amounts of deposits allocated to loans in H and F respectively, so that we have $D_{r,HH} = L_{r,HH}$, $D_{r,FH} = L_{r,FH}$ and $D_{r,H} = D_{r,HH} + D_{r,HF} = L_{r,HH} + L_{r,HF}$. The lender then chooses $L_{r,HH}$ and $L_{r,HF}$ so as to maximize expected profit:

$$\begin{aligned}\Pi_H &= p(r_H^I, a_H)\left(r_H^L\left(L_H^T\right)L_{r,HH} - r_H^D(D_H^T)L_{r,HH} - \xi L_{r,HH}\right)\\ &\quad + p(r_F^I, a_F)\left(r_F^L\left(L_F^T\right)L_{r,HF} - r_H^D(D_H^T)L_{r,HF} - \xi L_{r,HF} - \mu L_{r,HF}\right)\\ &\quad - \left(\kappa - \kappa^d\right).\end{aligned}$$

The first order condition for profit maximization is:

$$\begin{aligned}\frac{\partial \Pi_H}{\partial L_{r,HH}} &= p_1(r_H^I, a_H) r_H^{I\prime}\left(r_H^L\right) r_H^{L\prime}\left(L_H^T\right)\left(r_H^L\left(L_H^T\right)L_{r,HH} - r_H^D(D_H^T)L_{r,HH} - \xi L_{r,HH}\right) \\ &\quad + p(r_H^I, a_H)\left(r_H^{L\prime}\left(L_H^T\right)L_{r,HH} + r_H^L\left(L_H^T\right) - r_H^{D\prime}(D_H^T)L_{r,HH} - r_H^D(D_H^T) - \xi\right) \\ &\quad - p(r_F^I, a_F) r_H^{D\prime}(D_H^T)L_{r,HF} = 0\end{aligned} \tag{29}$$

Note that, as higher $L_{r,HH}$ increases interest payments also for deposits used for $L_{r,FH}$, the lender's first order condition can not be separated between markets as it was the case with multinational banks. This generates a novel trade-off. On the one hand, as $r_H^D(D_H^T)$ increases with D_H^T, being forced to tap a single market for deposits drives the deposit return up, which by itself would increase the loan rate. On the other hand, the lack of foreign competition for domestic deposits puts downward pressure on the deposit return, which by itself would decrease the loan rate. Hence, for the same number of banks, it is not obvious whether one should expect cross-border lending to lead to more or less risk taking than multinational banking.

For simplicity, we focus on the symmetric deterministic equilibrium with $\mu = 0$ and $a = 1$. In this case, symmetry implies that in equilibrium the total amount of loans offered by home and foreign banks in a market equals the total amount of deposits raised in the same market ($L^T = D^T$). This is due to the fact that home and foreign banks supply the same amounts of deposits rather than to the fact that banks can finance loans only with local deposits as in the case of multinational banks. Using our functional forms (15) and (16), the first order condition (29) becomes

$$L^T\left[\frac{1}{\alpha} - (\beta_1 + \gamma) L^T - \xi\right] + \left[\frac{1}{\alpha} - 2(\beta_1 + \gamma) L^T - \xi\right]\ell - \gamma L^T \ell = 0.$$

Hence, after imposing $L^T = N^a \ell$, we can solve for the total amount of loans extended by cross-border lenders in each market:

$$L_{cbl}^T = N^a \ell = \frac{\frac{1}{\alpha} - \xi}{\beta_1 + \gamma} \frac{(N^a + 1) - \frac{1}{2}}{(N^a + 2) + \left(N^a + \frac{\gamma}{\beta_1 + \gamma} \right)}, \tag{30}$$

which shows that, also in the case of cross-border lending, a larger number of active banks raises the total amount of loans, thus reducing risk-taking. Expression (30) can be compared with its analogue (21) in the case of multinational banks:

$$L_{mnb}^T = N^a \ell = \frac{\frac{1}{\alpha} - \xi}{\beta_1 + \gamma} \frac{N^a + 1}{N^a + 2}.$$

Three comments are in order. First, for a given number of active banks N^a, cross-border lenders raise a smaller total amount of deposits and thus supply a smaller total amount of loans ($L_{cbl}^T < L_{mnb}^T$). Second, for a given initial number of active banks N^a, the increase in competition caused by the same increase in the number of active banks leads to a smaller increase in deposits and loans with cross-border lenders than with multinational banks ($dL_{cbl}^T / dN_a < dL_{mnb}^T / dN_a$). Hence, for given N^a, multinational banking generates less risk taking than cross-border lending ($p_{cbl} > p_{mnb}$) and more competition reduces risk by a larger extent ($dp_{cbl}/dN_a < dp_{mnb}/dN_a$). Third, when instead the number of active banks is endogenously determined by free entry, multinational banking still generates less risk than cross-border lending provided that the additional fixed cost of setting up a foreign subsidiary is not too large. Too see this, note that, for given N_a and net of the corresponding overall entry cost, the maximized profit of a cross-border lender evaluates to:

$$\Pi_{cbl} = \frac{\alpha \beta_1 \left(\frac{1}{\alpha} - \xi \right)^3}{(\gamma + \beta_1)^2} \frac{(2N^a + 1)^2 \left(\frac{5\gamma + 3\beta_1}{\gamma + \beta_1} + 2N^a \right)}{8N^a \left(\frac{3\gamma + 2\beta_1}{\gamma + \beta_1} + 2N^a \right)^3} - [1 - \beta(1 - \varrho)] \left(\kappa - \kappa^d \right),$$

while, by (22), the profit of a multinational bank evaluates to:

$$\Pi_{mnb} = \frac{\alpha \beta_1 \left(\frac{1}{\alpha} - \xi \right)^3}{(\beta_1 + \gamma)^2} \frac{(N^a + 1)^2}{N^a (N^a + 2)^3} - [1 - \beta(1 - \varrho)] \kappa.$$

Both Π_{cbl} and Π_{mnb} are decreasing in N^a and go to zero as N^a goes to infinity. However, it can be shown that the multinational bank's profit gross of the overall entry cost is larger than the cross-border lender's for any value of N^a. It then follows that for $\kappa^d = 0$ the multinational banking free entry condition $\Pi_{mnb} = 0$ holds for a value of N^a that is larger than the one at which the cross-border lending free entry $\Pi_{cbl} = 0$ holds. By continuity, this also holds for $\kappa^d > 0$ provided that κ^d is not too large. Otherwise, when κ^d is large enough, the reverse happens with $\Pi_{mnb} = 0$ holding for a value of N^a that is smaller than the one at which $\Pi_{cbl} = 0$ holds. Higher risk taking associated with cross-border lending is in line with evidence reported by the IMF [24] that the increase in cross-border lending prior to the 2007 produced larger default after the crisis erupted and this was followed by extensive re-trenchment (see also Milesi-Ferretti and Tille [27]).

5.2 Systemic Risk and Competition

The measure of bank risk we have considered so far is based on the assumption that all projects succeed with probability $p(r^I, a)$ (and fail conversely). Moreover, the fact that realization of the aggregate productivity shock is observed before any decision is made by firms and banks implies that the probability of banks' portfolio failure (the metric for banks' systemic risk) is equal to the simple average of the probability of project failure, which is obviously again $p(r^I, a)$. In reality such an extreme risk correlation across projects is hardly observed and aggregate shocks occur also after banks have made their portfolio decisions, in which case banks' portfolio may fail ex post despite the control banks have on $p(r^I, a)$ through the loan rate ex ante. It is therefore important to check how our findings change when projects have less extreme degrees of risk correlation and additional shocks happen after banks have already made irreversible portfolio decisions. To this purpose we extend our benchmark model of multinational banks to allow for imperfect correlation of projects' outcomes due to common (systematic) and idiosyncratic ex post shocks. In doing so, we follow the established practice in the literature of conditioning projects' outcomes on common and idiosyncratic factors in the wake of Vasicek [31] as, for example, in Martinez-Miera and Repullo [26] and Bruno and Shin [6]. This allows us to capture possible inter-connections, asset commonality or other features that make the probability of banks' portfolio failure different from the simple average of failure probability across projects. By checking the relation between entry and the resulting metric of systemic risk we can also check how competition and risk taking interact in presence of contagion effects. As we will see, our main result on the negative impact of entry on risk taking will stand, albeit with qualification.

We abstract from the aggregate productivity shock ($a_t = a = 1$) but, differently from the deterministic environment we analyzed before, we now allow projects to be subject to a risk of failure determined not only by firms' choices of the risk-return profile but also by the realizations of common and idiosyncratic factors. In particular, as in Martinez-Miera and Repullo [26], we assume that there is a continuum of firms indexed i and that the outcome of the project chosen by any given firm i is determined by the realizations of a random variable y^i defined as

$$y^i = -\Phi^{-1}(1 - p^i) + \sqrt{\rho} z + \sqrt{1 - \rho} \varepsilon^i, \tag{31}$$

where Φ is the cumulative density function of a standard normal distribution while z and ε^i are the common and idiosyncratic risk factors with distributions that are also independently standard normal. The project of firm i fails when the realization of y^i is negative. The parameter $\rho \in [0, 1]$ measures the relative importance of the systematic risk factor with respect to the idiosyncratic one in determining the project's outcome, that is, the degree of risk correlation among projects. For $\rho = 0$ failures are statistically independent across firms; for $\rho = 1$ they are perfectly correlated; for $\rho \in (0, 1)$ they are imperfectly correlated.

Given that both risk factors are generated by independent standard normal distributions, the probability of failure evaluates to $\Pr\left[y^i\right] = 1 - p^i$. Hence, given (4), firm i chooses its risk-return profile $(p^i, r^{I,i})$ to maximizes expected profit $p^i(r^{I,i} - r^L)$ subject to $r^{I,i} = (1 - p^i)/\alpha$ as per (16). As all firms face the same loan return, the first order condition implies that they all choose the same success probability:

$$p = \frac{1 - \alpha r^L}{2} \tag{32}$$

with the same associated return $r^I = (1 + \alpha r^L)/2\alpha$. Once more, the fact that probability p is a decreasing function of r^L reveals the presence of a risk-shifting effect: faced with higher loan return, firms select projects with higher failure rate $1 - p$.

As the (ex ante) risk-return profile chosen by firms before risk factors are realized is the same across firms and we have a continuum of firms, the Law of Large Numbers implies that (ex post) the share of projects that succeed (i.e. the aggregate success rate) depends only the realization of the common risk factor z and coincides with the probability of success of the representative firm conditional on the realization z:

$$\varsigma(z) = \Pr\left[-\Phi^{-1}(1-p) + \sqrt{\rho}z + \sqrt{1-\rho}\varepsilon^i \geq 0 \mid z\right] = 1 - \Phi\left(\frac{\Phi^{-1}(1-p) - \sqrt{\rho}z}{\sqrt{1-\rho}}\right),$$

where we have used the fact that ε^i follows a standard normal distribution. As also z follows a standard normal distribution, the cumulative density of the aggregate success rate $\varkappa$ is then given by:

$$G(\varkappa) = \Pr\left[\varsigma(z) \leq \varkappa\right] = \Phi\left(\frac{\Phi^{-1}(1-p) - \sqrt{1-\rho}\Phi^{-1}(1-\varkappa)}{\sqrt{\rho}}\right). \tag{33}$$

According to (33), the success rate has mean p while ρ regulates the dispersion around the mean with larger ρ associated with more dispersion. In the limit, for $\rho \to 0$, $G(\varkappa)$ becomes a Dirac delta function that is zero everywhere except at $\varkappa = p$: with independent failures a fraction p of projects succeed with probability 1. For $\rho \to 1$, $G(\varkappa)$ converges to p: with perfectly correlated failures all projects succeed with probability p and fail with probability $1-p$ as in our benchmark case.

Having characterized the underlying risk we can now restate the banks' optimization problem, assuming for simplicity that there is no additional monitoring cost for foreign operations ($\mu = 0$) and that markets are characterized by their own un-correlated common risk factors. A typical bank is active as long as the realized success rate is large enough to generate non-negative net cash flow:

$$2\varkappa m(L^T)\ell - \overline{\kappa} \geq 0,$$

where $m(L^T) = r^L\left(L^T\right) - r^D(L^T) - \xi$ is the lending-to-deposit rate spread (net of the insurance premium) and $\overline{\kappa} = \left[1 - \beta(1-\varrho)\right]\kappa$ is the annuity value of the overall fixed cost κ (which the bank finances in the capital market upon entry). This non-negativity condition generates a cutoff rule of survival: the bank will be active as long as the realized success rate $\varkappa$ does not fall short of the threshold:

$$\widetilde{\varkappa} = \frac{\overline{\kappa}}{2m(L^T)\ell}. \tag{34}$$

Note that in our benchmark case ($\rho = 1$) the cutoff would be immaterial ($\widetilde{\varkappa} = 1$). Totally differentiating (34) in the symmetric equilibrium ($\ell = L^T/N^a$) gives:

$$\frac{d\ln\widetilde{\varkappa}}{d\ln N^a} = 1 - \left[1 + \frac{d\ln m(L^T)}{d\ln L^T}\right]\frac{d\ln L^T}{d\ln N^a}, \tag{35}$$

which shows that the sign of the elasticity of the cutoff success rate $\widetilde{\varkappa}$ to changes in the number of active firms N^a is determined by the sign of the elasticity of the lending-to-deposit rate spread $m(L^T)$ to aggregate loans L^T and the sign of the elasticity of aggregate loans L^T to the the number of active firms N^a. With our functional forms (15), the sign of the former is negative as $m'(L^T) = -(\beta_1 + \gamma)$. To sign the latter we have, instead, to analyze the optimization problem of the typical bank. This maximizes profit

$$\Pi(\ell_-, \ell) = h(\ell_-, \ell)\ell - \overline{\kappa},$$

with:

$$h(\ell_-, \ell) = 2\left(1 - G(\widetilde{\varkappa}(\ell_-, \ell))\right) \ E_{\widetilde{\varkappa}(\ell_-,\ell)}(\varkappa)\ m((N^a - 1)\,\ell_- + \ell)$$

where ℓ_- refers to the vector of loans by the other $N^a - 1$ banks (hence $L^T = (N^a - 1)\,\ell_- + \ell$), the dependence of $\widetilde{\varkappa}$ on ℓ_-, ℓ has been made explicit, and $E_{\widetilde{\varkappa}(\ell_-,\ell)}(\varkappa) = \int_{\widetilde{\varkappa}(\ell_-,\ell)}^{1} \varkappa dG(\varkappa)/\left(1 - G(\widetilde{\varkappa}(\ell_-, \ell))\right)$ is the conditional mean success rate. The function $h(\ell_-, \ell)$ is the 'generalized' residual demand in the sense of Martinez-Miera and Repullo [26]. Note however that, differently from their setup, here the bank affects the cutoff success rate $\widetilde{\varkappa}$ not only indirectly through its effect on total loans L^T but also directly through ℓ whereas the profit margin $m(L^T)$ does not depend on $\varkappa$. In the case of perfectly correlated project failures ($\rho = 1$), the bank's problem boils down to the one we already solved for the benchmark case as $(1 - G(\widetilde{\varkappa}(\ell_-, \ell)))\, E_{\widetilde{\varkappa}(\ell_-,\ell)}(\varkappa) = p$ with p given by (32).

The bank's maximization problem is well defined as long as $h(\ell_-, \ell)$ is decreasing and concave in ℓ (i.e. $h'(L^T) < 0$ and $h''(L^T) < 0$) as this ensures that the necessary and sufficient conditions for profit maximization are met. Henceforth, we assume that parameter values are such that those properties hold. The first order condition requires $h_2(\ell_-, \ell)\ell + h(\ell_-, \ell) = 0$, which in the symmetric equilibrium ($\ell_- = \ell = N^a/L^T$) implies:

$$h'(L^T)\frac{L^T}{N^a} + h(L^T) = 0.$$

Total differentiation then yields:

$$\frac{dL^T}{dN^a} = -\frac{h(L^T)}{h''(L^T)L^T + h'(L^T)\,(N^a + 1)} > 0, \tag{36}$$

with the sign granted by $h'(L^T) < 0$ and $h''(L^T) < 0$. Accordingly, given (15) and (32), we have $dr^L/dN^a < 0$ and $dp/dN^a > 0$ respectively. This shows that more competition (due to a larger number of active banks) lowers the probability of default of the loans in banks' portfolios $1-p$. However, as pointed out by Martinez-Miera and Repullo [26], that does not necessarily imply lower probability of failure $\Pr[\varkappa \leq \widetilde{\varkappa}]$.

Indeed, using the cumulative density function (33), the probability of failure can be written as:

$$G(\widetilde{\varkappa}) = \Phi\left(\frac{\Phi^{-1}(1-p) - \sqrt{1-\rho}\Phi^{-1}(1-\widetilde{\varkappa})}{\sqrt{\rho}}\right),$$

which shows that, as N^a increases, the ensuing fall in $1-p$ may be contrasted by a parallel rise in $1-\widetilde{\varkappa}$. This requires $d\ln\widetilde{\varkappa}/d\ln N^a > 0$, which by (35) and (36) in turn requires the negative impact of a larger number of active banks on the lending-to-deposit rate spread to be strong enough relative to the parallel positive impact on the total provision of loans and deposits:

$$\frac{d\ln L^T}{d\ln N^a} + \frac{d\ln m(L^T)}{d\ln N^a} < 1. \tag{37}$$

This is a necessary condition for the probability of portfolio failure to rise despite lower probability of default of the loans in the portfolios. It would hold, for example, if aggregate bank profits fell with bank entry: $d\ln\left(m(L^T)L^T\right)/d\ln N^a = d\ln L^T/d\ln N^a + d\ln m(L^T)/d\ln N^a < 0$. Vice versa, the result of our benchmark model that banks' competition reduces the risk would carry through to the case of imperfectly correlated projects' returns if condition (37) were violated as in such case we would have $d\ln\widetilde{\varkappa}/d\ln N^a < 0$. In other words, a sufficient condition for our benchmark result to extend to the more general setup is that expansionary impact of competition on active banks' profits through total loans and deposits is strong enough to offset its parallel contractionary impact through the lending-to-deposit rate spread. ($d\ln\left(m(L^T)L^T\right)/d\ln N^a \geq 0$).

6 Conclusion

Venturing into foreign markets can enrich banks' opportunities, but can also have unintended consequences for risk-taking. It has, however, been argued that direct involvement in local retail activities promotes competition and, through this channel, reduces risk-taking. We have proposed a model in which imperfectly competitive banks are allowed to operate simultaneously in different national markets with direct involvement in local retail activities both on the deposit and the loan sides. Our banks make endogenous entry decisions and select the risk-return profiles of their loan portfolios anticipating borrowers' risk-shifting due to limited liability. We have shown that, if borrowers' project success exhibits decreasing hazard rate, our model indeed predicts that direct involvement in retail activities reduces risk-taking provided that the expansionary impact of competition on multinational banks' aggregate profits through larger scale is strong enough to offset its parallel contractionary impact through lower loan-deposit return margin. This holds with both perfectly and imperfectly correlated loans' risk. Numerically we have also shown that banking globalization moderates the contraction in the number of banks, in total deposits and loans, in the return on deposits, in the return on loans and in the success probability of firms' projects following a deterioration in the global investment climate. Finally, comparing a version of our model featuring cross-border lending with the benchmark one featuring multinational banks, we have found that also in the former case more competition can reduce risk-taking, but to a lesser extent than in the latter.

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7 Appendix A. Firms' Loan Demand

Assume there is a continuum of entrepreneurs whose outside options h follow a distribution with cdf $G(h)$ for $h \geq 0$. Each entrepreneur can make only one unit investment yielding return

$$p(r^I, a)(ar^I - r^L) \tag{38}$$

As a result investment is governed by a cutoff rule. Only entrepreneurs for whom $p(r^I, a)(ar^I - r^L) \geq \overline{h}_t$ actually invest where $\overline{h}$ corresponds to the outside option of marginal entrepreneurs who are indifferent between investing or not: $\overline{h} = p(r^I, a)(ar^I - r^L)$.

In this setup, the demand for loans is equal to the total number of entrepreneurs that invest

$$L = G(\overline{h}) = G(p(r^I, a)(ar^I - r^L)) \tag{39}$$

where r^I and r^L are linked by the FOC:

$$\frac{d(p(r^I, a)(ar^I - r^L))}{dr^I} = p_1(r^I, a)(ar^I - r^L) + p(r^I, a)a = 0 \tag{40}$$

In order to find under which conditions $r^L(L)$ to satisfies $r^{L\prime}(L) < 0$ and $r^{L\prime\prime}(L) \leq 0$, we can totally differentiate the second last equation and use FOC to obtain

$$\frac{dL}{dr^L} = -g(p(r^I, a)(ar^I - r^L))p(r^I, a) < 0 \tag{41}$$

and then

$$\frac{d^2L}{d\left(r^L\right)^2} = g'(p(r^I, a)(ar^I - r^L))\left(p(r^I, a)\right)^2 \geq 0 \tag{42}$$

as long as

$$g'(.) \geq 0 \tag{43}$$

Note that $d^2L/d\left(r^L\right)^2 \geq 0$ iff $d^2r^L/d\left(L\right)^2 \leq 0$.

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