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## Banks' Internationalization Strategies: The Role of Bank Capital Regulation

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Strategies: The Role of Bank  
Capital Regulation**

*Diemo Dietrich  
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# Banks' Internationalization Strategies: The Role of Bank Capital Regulation

## Abstract

This paper studies how capital requirements influence a bank's mode of entry into foreign financial markets. We develop a model of an internationally operating bank that creates and allocates liquidity across countries and argue that the advantage of multinational banking over offering cross-border financial services depends on the benefit and the cost of intimacy with local markets. The benefit is that it allows to create more liquidity. The cost is that it causes inefficiencies in internal capital markets, on which a multinational bank relies to allocate liquidity across countries. Capital requirements affect this trade-off by influencing the degree of inefficiency in internal capital markets.

**Keywords:** incomplete financial contracting; cross-border financial services; multinational banking; liquidity allocation; capital regulation.

**JEL-Codes:** F21, F23, G21

## Zusammenfassung

Diese Studie untersucht, wie Eigenkapitalregulierungen die Internationalisierungsstrategien von Banken beeinflussen. Es wird ein Modell einer international operierenden Bank entwickelt, die Liquidität schafft und länderspezifische Liquiditätsschocks ausgleicht. Der Vorteil von Auslandsdirektinvestitionen von Banken gegenüber grenzüberschreitenden Bankdienstleistungen hängt von den Vor- und Nachteilen lokaler Marktkenntnisse ab. Während diese Kenntnisse es erlauben, mehr Liquidität zu schaffen, führen sie zu Ineffizienzen auf internen Kapitalmärkten, auf die eine multinationale Bank angewiesen ist, um die Liquidität zwischen Ländern auszugleichen. Eigenkapitalregulierungen beeinflussen diesen trade-off, indem sie das Ausmaß von Ineffizienzen interner Kapitalmärkte verändern.

**Schlagwörter:** unvollständige Finanzverträge; grenzüberschreitende Finanzdienstleistungen; Auslandsdirektinvestitionen im Bankensektor; Liquiditätsallokation; Eigenkapitalregulierung.

**JEL-Codes:** F21, F23, G21

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# 1 Introduction

This paper analyzes the following three interrelated questions: What determines the internationalization strategies of internationally active banks? What effects do the different internationalization strategies have on the stability and efficiency of the international banking system? How do capital requirements influence the internationalization strategy of internationally active banks? As regards the internationalization strategies, we contrast the two conceivable modes of foreign market entry. The first is supplying cross-border financial services, in which a globally operating banker offers deposit-taking and lending services directly to foreigners. The second mode is multinational banking, in which a bank establishes and operates through legally and organizationally independent foreign subsidiaries, each run by a local bank manager.

These questions aim at reassessing whether the Basel framework for the international convergence of capital measurement and capital standards for internationally active banks is appropriately designed to achieve its objectives. According to the Basel Committee on Banking Supervision, the main objective is to further strengthen the soundness and stability of the international banking system, while ensuring that it will not cause competitive inequality among internationally active banks (Basel Committee 2005). When formulating the rules, the Committee decided to not distinguish between banks with different modes of foreign market entry. But what if the stability of the international banking system depends on the banks' internationalization strategies, and if, in addition, the existing rules do have an effect on these strategies? The Basel framework then needs not be in accordance with competitive equality and may impair the stability of the international banking system.

Our starting point is the incomplete contracts approach to banking developed in a series of papers by Diamond and Rajan (2000, 2001, 2005), where banks exist because they create liquidity. They argue that financial claims are illiquid because of limited pledgeability of returns, which arises when specific skills of the borrower are needed to generate them while he cannot commit to contributing his human capital for the whole lifetime of the claim. A banker, who specializes on acquiring skills to extract payments from those borrowers by maintaining a strong lending relationship, transforms these otherwise illiquid loans into liquidity by issuing demandable deposits. Deposits allow her not only to pay out depositors when they need it most, but—since they are associated with the risk of a run on a bank's assets—also to commit herself to pledge her specific knowledge for future dates.

In order to advance this approach and to apply it to an internationally active bank, we take two further aspects into account. First, we consider a need for an allocation of liquidity across countries. Although we do not allow for aggregate liquidity shortages, we assume that liquidity may be in short supply in one of the countries where the bank operates. The function of the bank is thus not only to create liquidity (as in Diamond and Rajan, *op. cit.*) but also to allocate it across countries. Second, we

take into account that, in order to allocate liquidity, an internationally active bank needs to draw on its internal capital market, the efficiency of which depends on the bank's organization design. With cross-border financial services, a globally operating banker simply raises funds wherever available and allocates liquidity efficiently. In the case of a multinational banking firm with legally independent subsidiaries, the bank's managers are operating locally. As they are thus intimately linked to borrowers, local bank managers can create more liquidity than a globally operating banker. However, in this case there are additional inefficiencies associated with the brought up of an internal capital market. According to Stein (2002), local bank managers may not be able to transmit soft information to her superior or any other agent inside the bank. This is because soft information cannot be directly verified by anyone other than the agent who produces it. Yet, the ability of a banker to create liquidity necessarily rests on her superior soft information. The potential benefit of multinational banking arising from local intimacy of bank managers is thus at the same time a source of dysfunctionality of internal capital markets as a local bank manager may not be able to fully pledge her loan earnings to bank managers operating in other regional markets.

We show that capital regulation affects a bank's decision on its mode of entry into foreign markets, as it influences the degree of inefficiency in internal capital markets for three reasons. The first is that, when the imposed capital-to-asset ratio is high, the investors of a multinational bank bear some of the risk that liquidity is in short supply when they want to consume. This lowers the need of a local bank manager, who experiences a regional liquidity shortage, to draw on an inefficient internal capital market. Second, it also means that, even in the liquidity-rich country, those investors with a liquidity need cannot squeeze as much out of the potentially supporting bank manager. Hence she has more internally generated funds available to support the other. Third, as the amount that can be raised against a bank-internal claim in the liquidity-rich country decreases, the supporting bank manager has less external funds available.

The idea of imperfect internal capital markets builds on several earlier work on manufacturing firms comprising several divisions. The basic assumption in this line of research is that headquarters exerts control rights over the resources pooled in a multidivisional firm (Gertner, Scharfstein and Stein, 1994). Stein (1997) points to the general benefit of internal capital markets. He argues that headquarters can create value by picking up winners out of a firm's divisions. Albeit this strategy aims at improving the efficiency of capital allocation, it also generates additional adverse incentives. For example, incentives to exert effort may be weak on the divisional level (Brusco and Panunzi 2005), or power struggles among division managers may take place, which hamper efficient allocations (Rajan, Servaes and Zingales 2000). Concerning disincentives for headquarters, it may not be willing to provide necessary incentives for division managers by means of a wage schedule but by assigning inefficient capital budgets (Scharfstein and Stein, 2000). In addition, integrating projects may allow headquarters to turn its back on external financiers once the pooling of internally generated cash flows suffices in order to ensure follow-up fi-



nances for at least some of its projects, thereby lowering headquarters' incentive to meet its obligations vis-a-vis financiers (Inderst and Müller, 2003). However, none of these papers considers bank-internal enforcement problems and analyzes the effect of banking regulation on the efficiency of internal capital markets, which is the main focus of our paper.

Another related strand of literature is about the question of why manufacturing firms make foreign direct investments (FDI) rather than exporting goods.<sup>1</sup> As regards the international banking firm, Gray and Gray (1981), Yannapoulos (1983), Sagari (1992) and Williams (1997) make use of the standard eclectic paradigm of FDI—originally developed by Dunning (1977, 1981)—to explain the internationalization of banks on the basis of location-specific, ownership-specific and internationalization advantages. Similarly, Buch and Lipponer (2004) directly apply a framework for non-financial firm's FDI to banks' internationalization strategies. Yet, because these approaches do not take into account the specific functions that banks (unlike manufacturing firms) fulfill, they cannot justify the existence of banks at all, whereas in the model presented below internationally active banks emerge endogenously.

The paper proceeds as follows. In section 2, we introduce a basic model of an internationally active banking firm. Section 3 deals with the case where the bank provides cross-border financial services to its customers, while section 4 focuses on multinational banking. In section 5 we further discuss our results, and section 6 summarizes the results.

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<sup>1</sup> This has been extensively treated in the literature, see, e. g., *Markusen* (1995), *Markusen and Venables* (1998), *Helpman, Melitz and Yeaple* (2003).

## 2 A model of an internationally active banking firm

We consider an internationally active bank headquartered in, say, London, which possesses no funds on its own. Since we want to focus only on the comparative advantage of different ways to do business abroad, we abstract from a home bias in banking activities. The bank is thus assumed to provide its financial services to foreign customers only. Customers consist of investors and entrepreneurs who live in, e. g., Toulouse and Torino. They are assumed to be resident in the same currency area, there is thus no exchange rate risk. Besides the operation of the internationally active bank, financial markets of these two regions are assumed to be separated from each other.<sup>2</sup> Although there is only one single bank, the markets for deposits and other claims on the bank are assumed to be contestable ex ante. All agents are risk neutral, and the interest rate on an alternative asset (storage) is zero.

There is a continuum of mass 1 of entrepreneurs, one half resident in Toulouse and the other in Torino. Entrepreneurs have project ideas but no funds on their own. A single project requires an initial investment of 1 unit of the single consumption good at  $t = 0$ . If the entrepreneur contributes his human capital, his project will yield a non-verifiable return  $C > 1$  either at  $t = 1$  (early projects) or at  $t = 2$  (late projects). At  $t = 0$  nobody knows the type of a project, but it is common knowledge that in each region half of the projects turn out to be early.

At  $t = 0$  a continuum of mass 1 of investors lives in both regions, one half in Toulouse and the other in Torino. Each investor is endowed with 1 unit of the single consumption good. Although all initial investors need to consume at  $t = 1$ , there are new investors born at  $t = 1$  who may fill in for them. The new generation of investors is sufficiently rich such that there is no aggregate liquidity shortage at  $t = 1$ . However, one of the regions may suffer from a region-wide liquidity shortage as new investors are born either in Toulouse or Torino. The probability that the new generation will emerge in Toulouse is 0.5.

If capital markets were perfect, liquidity could be efficiently allocated: At  $t = 1$  retired investors would be partly replaced by new investors, irrespective whether they are born in Toulouse or Torino, and entrepreneurs with late projects would thus be shielded from region-specific liquidity shortages. However, no agent can commit to contribute his specific skills in the remote future, which may hamper this solution. This is because the inalienability of human capital gives an agent the opportunity to hold up his financiers (investors or a bank) by threatening to not making use of his specific skills (Hart and Moore, 1994). How financiers deal with such opportunistic behavior depends on what they can do by assuming control over the assets in the case of default. Following Diamond and Rajan (2005) we assume that financiers have the following two alternatives: First, they may replace

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<sup>2</sup> Even in the Euro area, the degree of financial integration is still low (*Baale et al.*, 2004).

the original entrepreneur by handing out the assets to another one. The substitute will then yield only  $\gamma C$  with  $\gamma < 1$ , while the time structure of cash flows remains unchanged. Second, assets may be seized and liquidated at  $t = 1$ , where liquidation yields immediate proceeds of  $L$ . We assume

$$L < 1 < \gamma C < 2L. \quad (1)$$

The difference between replacement and liquidation is thus twofold. First, by means of liquidation financiers get some revenues at  $t = 1$  even if the project turns out to be late. Second, replacing the entrepreneur yields a higher net present value than liquidation irrespective whether the project is early or late, and only replacement can guarantee that the initial investment actually pays out. The last inequality in (1) means that liquidation is, however, generally worthwhile when only half of the returns associated with replacement can be pledged to ultimate investors.

Both alternative uses require specific skills. According to Diamond and Rajan (2001), acquiring these skills is feasible only if a financier establishes a strong and long-lasting lending relationship right from the beginning of the project.<sup>3</sup> Investors, who need to consume early, however, cannot maintain such a strong lending relationship with entrepreneurs beyond  $t = 1$ , while new investors do not share the information with the retired population of investors. It is therefore optimal to mandate a banker, who acquires loan collection skills and acts on behalf of investors in financial contracting with the entrepreneur.

As the banker has specific skills to collect loans, she gains power over her investors and might hold them up by threatening to not making use of her skills. However, Diamond and Rajan (2001) have shown that a deposit contract allows the banker to commit herself to refrain from doing so. This is because the deposit contract creates a collective action problem among investors that exposes a banker to a run on her assets if she tries to renege on her obligations vis-a-vis depositors. When, instead, the banker raises funds by means of equity capital she can extract some rents at the expense of shareholders. As in Diamond and Rajan (2000) we assume that if a banker refuses to pay out shareholders the latter come into possession of the banker's assets with probability of 0.5. Shareholders can in this case force the banker to collect the maximum liquidity that is immediately achievable and to fully pass it on to them. But, shareholders will then also become responsible for paying out depositors. If shareholders cannot assume control over the banker's assets, they get nothing from the banker. In the end, shareholders expect to get half of the maximum liquidity that is achievable immediately net of deposits.

The effectiveness of skills to find an appropriate substitute for the original entrepreneur depends on the organization design of the internationally active bank. We differentiate between two basic organizational forms. The first is when the banker offers cross-border financial services, which refers to a situation where investors deposit their funds with a globally operating banker in London from where

<sup>3</sup> Without loss of generality there are no other costs to acquire loan collection skills.

she directly grants loans to entrepreneurs in Toulouse and Torino. The second is multinational banking, where headquarters first establishes subsidiaries in Toulouse and Torino. Investors deposit funds with their local subsidiaries and a local bank manager is then to grant loans to the entrepreneurs in her respective region.

These two organizational forms differ with respect to the degree of intimacy with entrepreneurs and their respective projects. A bank manager in Toulouse or Torino is locally close to the entrepreneur and has thus more information about how to find the best substitute. Hence, a substitute found by a local bank manager can extract  $\gamma^h C > 1$  on behalf of the bank. With cross-border financial services, however, a globally operating banker in London cannot maintain a very strong lending relationship and her ability to find a substitute is more restricted. She is therefore only able to find someone who can extract only  $\gamma^l C > 1$ , where  $\gamma^l < \gamma^h$ . While these two organizational forms differ with respect to the ability to find a substitute for an entrepreneur, both a globally operating banker and a local bank manager will yield the same liquidation proceeds  $L$ .

The benefit of setting up foreign subsidiaries against providing cross-border financial services is therefore an improvement in the ability to collect loans. The drawback is that it also requires an active internal capital market, i. e. a mechanism by which funds have to be allocated across subsidiaries at  $t = 1$  (and reallocated at  $t = 2$ ). As will be shown, this mechanism suffers from an additional inefficiency, as local bank managers in Toulouse and Torino have superior private information. Hence, they cannot commit to always fully pass on to other agents inside the bank what they can squeeze out of the entrepreneur.

### 3 Cross-border financial services

At  $t = 0$ , the globally operating banker in London raises funds from outside investors in Toulouse and in Torino. Investors provide these funds either by means of demandable deposits or equity capital. Accordingly, we differentiate depositors from bank shareholders. Contestability of the banking market implies that the banker is forced to commit herself at  $t = 0$  to pay out the maximum pledgeable amount to initial investors at  $t = 1$ . Given that investors can also invest into a storage technology, they will supply their funds only if expected repayments at least cover this opportunity cost.

Since all agents perfectly anticipate that half of the projects will be late and that a sufficiently rich new generation of investors will emerge—although in one country only—there is no aggregate risk for the bank as a whole. The need to issue equity shares therefore arises from regulatory requirements only, implying that a bank's actual capital-to-asset ratio does not vary over time.

After raising funds, the banker grants loans to entrepreneurs in Toulouse and Torino. At  $t = 1$ , investors need to consume. Depositors can simply withdraw their deposits. In the course of renegotiations, shareholders can force the banker to pay them out half of the available liquidity (net of deposits). Liquidity available at  $t = 1$  for meeting the demands of investors has three sources. First, early entrepreneurs will each repay  $\gamma^l C$  to the banker, which gives the banker some internally generated funds at hand. Second, the banker may raise liquidity by means of liquidating a share  $\lambda$  of late projects, which gives her  $\frac{1}{2}\lambda L$ . Third, she may also borrow against her future loan earnings from those late projects that will not be liquidated prematurely. In this case she will collect  $\frac{1}{2}(1 - \lambda)\gamma^l C$  at date  $t = 2$  from remaining late projects.<sup>4</sup> But what she can borrow against her remaining claims on entrepreneurs depends on the capital-to-asset ratio  $k_1$  that holds between  $t = 1$  and  $t = 2$ , which is defined as (see Diamond and Rajan 2005)

$$k_1 = \frac{\frac{1}{2}((1-\lambda)\gamma^l C - d_1)}{\frac{1}{2}((1-\lambda)\gamma^l C - d_1) + d_1} = \frac{(1-\lambda)\gamma^l C - 2d_1}{(1-\lambda)\gamma^l C + 2d_1}, \quad (2)$$

where  $d_1$  denotes the volume of deposits raised from investors at  $t = 1$ . The numerator in the left fraction is thus the value of what shareholders can expect to extract from the banker, while the denominator is the total value of the bank from an investors' perspective.

Payments to depositors at  $t = 2$  are thus given by  $d_1 = \frac{1}{2} \frac{1-k}{1+k} (1-\lambda)\gamma^l C$ , while shareholders get  $\frac{1}{2} \frac{k}{1+k} (1-\lambda)\gamma^l C$ . In total, the banker can commit herself to pay

<sup>4</sup> A natural question is where these fresh funds come from at  $t = 1$ . *Diamond and Rajan* (2005) argue that new depositors are those entrepreneurs who have already finished their projects at  $t = 1$  and can thus reinvest their rents. In line with this view, a regional liquidity shortage, as the one in our paper, can be characterized by a situation, where in one region the entrepreneurs with early projects have a common liquidity need. Hence they are not willing to re-deposit their funds with the bank.

$\frac{1-\lambda}{2} \frac{\gamma^l C}{1+k}$  at  $t = 2$  to new investors, who—given their access to storage—will thus be willing to provide exactly this amount at  $t = 1$ .

Liquidity available to the banker at  $t = 1$  therefore sums up to

$$W(\lambda) := \frac{1}{2} \gamma^l C + \frac{1}{2} \left[ \lambda L + (1 - \lambda) \frac{\gamma^l C}{1+k_1} \right], \quad (3)$$

where  $W$  is a value function that maps the liquidation rate  $\lambda$  onto the banker's disposable liquidity.

But how many late projects will be prematurely liquidated? Both the banker and entrepreneurs with late projects prefer borrowing against the late project rather than liquidating assets: The entrepreneur benefits because he keeps possession of the assets and is thus able to extract a rent of  $C - \gamma^l C$ , and the banker gains because she can extract a rent of  $\frac{k_1}{1+k_1} \gamma^l C$  at  $t = 2$ . Investors have the same interests as the banker if the liquidation value is smaller than what the banker can raise externally by borrowing against them, i. e. if  $\frac{\gamma^l C}{1+k_1} > L$ . Otherwise, i. e. if the imposed capital-to-asset ratio is too high, a conflict of interests between the banker and investors arises and the banker is tempted to hold up her shareholders. If she tries to renegotiate with shareholders, the latter will come into possession of loans with probability 0.5 and ask the banker to put loans to their best use. From a shareholders' perspective loans are best used when they yield the maximum achievable payment immediately. Hence, shareholders demand  $\lambda = 1$  when  $\frac{\gamma^l C}{1+k_1} < L$ . The banker will therefore set  $\lambda$  such that liquidity available to her suffices to refrain shareholders from assuming control over her assets, i. e.

$$W(\lambda) \geq \frac{1}{2} [W(1) - d_0] + d_0, \quad (4)$$

where, with  $k_0$  being the capital-to-asset ratio applied in the first period, deposits  $d_0$  are—in analogy to (2)—given by

$$d_0 = \frac{1-k_0}{1+k_0} W(1). \quad (5)$$

Hence, the banker is required to set  $\lambda$  according to

$$W(\lambda) \geq \frac{W(1)}{1+k_0}. \quad (6)$$

Given that the capital-to-asset ratio is the same in each period, i. e.  $k_0 = k_1 = \hat{k}$ , we now conclude:

**Proposition 1** *When the bank provides cross-border financial services, there is no need to liquidate late projects at  $t = 1$  irrespective of the capital-to-asset ratio.*

**Proof.** See Appendix. ■

A banker who lends directly abroad will never liquidate loans even when they turn out to be late, although changes in the capital-to-asset ratio have two opposing

effects: At first, a rising capital-to-asset ratio lowers what the banker can credibly commit to pay at date  $t = 2$ . Hence, the amount of funds a banker can raise externally at  $t = 1$  by borrowing against late loans decreases, thereby rising the banker's need to obtain cash by liquidating loans. At second, an increasing capital-to-asset ratio also implies that payments to investors to be made at  $t = 1$  decreases thereby leaving the banker with more internally generated funds even without any liquidation of loans. Hence, the banker's leeway to take her own preferred action at  $t = 1$  (namely keeping the liquidation rate as small as possible) becomes greater as a higher capital-to-asset ratio gives the banker a higher protection by means of her rents. According to proposition 1, the latter effect always dominates.

It has thus been shown that the imposition of a regulatory capital requirement does not affect the ability of an internationally active bank to shield borrowers from country-specific liquidity shortages if the bank offers cross-border financial services. The reason is that a globally operating banker can allocate liquidity across countries without suffering from additional internal leakages. These leakages will, however, be present if there is an imperfectly functioning internal capital market as it is in the case of multinational banking.

## 4 Multinational banking

### 4.1 Leakages in internal capital markets

The alternative to cross-border financial services is multinational banking, a case where the bank consists of two foreign subsidiaries in Toulouse and Torino. The benefit of this organizational form is that a local bank manager is better informed than a globally operating banker about how to make use of a borrower's assets. This is because the former has local expertise. The cost is that at the intermediate date  $t = 1$  a local bank manager may rely on additional funds provided via the internal capital market to avoid a premature liquidation of loans. The returns on these funds, however, cannot be fully pledged to the other local bank manager because of bank-internal enforcement problems. As a consequence, there is a leakage inside the multinational bank.

We integrate this leakage into the model in the following way. At  $t = 0$ , local bank managers raise funds from local investors and grant loans to entrepreneurs in their respective regions. At  $t = 1$ , all original investors retire, but only one of the two subsidiaries can raise fresh funds from new investors. Owing to the symmetry of countries in the model, we can restrict our focus to the case where new investors are born in Torino. By means of an internal capital market, new funds can in principle be transferred from Torino to Toulouse. This transfer at  $t = 1$  is hereinafter denoted by  $T_1$ .

But how much will the local bank manager in Toulouse repay at  $t = 2$ ? At this date she collects  $\frac{1}{4}(1 - \mu)\gamma^h C$  from her remaining late projects, where  $\mu$  is the share of late projects in Toulouse that have been already liquidated at  $t = 1$ . The only obligation that still exists at  $t = 2$  is the repayment of the transfer. But Toulouse will repay  $T_1$  only if the local bank manager is not better off by holding up her Torino counterpart. Assuming that both bank managers will agree on equally sharing the remaining loan earnings during the course of renegotiations, the Toulouse bank manager will pay back at most  $\frac{1}{4}(1 - \mu)\frac{\gamma^h C}{2}$ .<sup>5</sup> Transfer repayments  $T_2$  are therefore given by  $T_2 = \min\{T_1, \frac{1}{4}(1 - \mu)\frac{\gamma^h C}{2}\}$ . To keep things tractable, we also assume that at  $t = 1$  Torino is to make a one-off offer regarding the transfer  $T_1$ , which is valid only if there are no renegotiations at  $t = 1$  between the local bank manager in Toulouse and her investors.<sup>6</sup> The Toulouse banker can either accept this offer or not. Our assumption, as made in inequation (1) thus implies that, given the leakage

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<sup>5</sup> The assumption that the peer bank manager has the same bargaining power as external shareholders is made for the sake of simplicity only. Similar results will hold as long as a banker cannot fully extract loan earnings from her counterpart.

<sup>6</sup> This is also not crucial. If investors were also allowed to collect the transfer, they would be obliged to pay it back to Torino at  $t = 2$ . Given that investors need to consume at  $t = 1$ , either the transfer has no value to them (when they store it for later repayment) or the supporting banker is unwilling to make the transfer (when investors do not store but consume).



in internal capital markets, the liquidation of late projects in Toulouse instead of postponing loan repayments is generally worthwhile.

Against this background, three questions arise. First, how does the offered transfer  $T_1$  affect the liquidation policy in Toulouse? Second, in anticipation of the induced liquidation policy, what transfer  $T_1$  will be offered by Torino and how many projects will be liquidated in Torino? And finally, what effect does a minimum capital-to-asset ratio have on liquidation policies in both regions? We answer these questions stepwise.

## 4.2 Liquidation policy in Toulouse

As regards the first question, one has to take into account that Toulouse has two strategic objectives. First, by the choice of  $\mu$  she influences what she has to repay to Torino at  $t = 2$ . For example, when she has already called in all loans to entrepreneurs with late projects there are no loan earnings left at  $t = 2$  and she will then save on any repayment to Torino.<sup>7</sup> Second, while offering a liquidation rate  $\mu$ , the banker takes into account that shareholders may refuse this offer and enter into renegotiations. When renegotiations take place, the transfer  $T_1$  is no longer available and the banker and shareholders are each to make a take-it-or-leave-it offer with equal probability. When shareholders assume control over the loans, they force the banker to generate the maximum liquidity that is immediately available, i. e. to set  $\mu = 1$ .

Let  $V$  denote the value function that maps the liquidation rate  $\mu$  and the offered transfer  $T_1$  onto the liquidity available to the Toulouse bank manager at  $t = 1$ :

$$V(\mu, T_1) := \frac{1}{4}\gamma^h C + \frac{1}{4}\mu L + T_1. \quad (7)$$

With  $d_0$  being the volume of deposits raised at  $t = 0$ , investors then expect to get  $\frac{1}{2}[V(1, 0) - d_0] + d_0$  if  $d_0 \leq V(1, 0)$  or (almost) nothing otherwise (because in this case depositors will run, implying that the value of the banker's assets will completely melt down). The banker prevents investors from rejecting her offer  $\hat{\mu}$  if

$$V(\hat{\mu}, T_1) \geq \frac{1}{2}[V(1, 0) + d_0] \quad (8)$$

or

$$\hat{\mu} \geq \min \left\{ 1, \max \left\{ 0, \frac{\frac{1}{2}(L - \gamma^h C) + 2d_0 - 4T_1}{L} \right\} \right\} \quad (9)$$

respectively.

<sup>7</sup> Assuming that the banker liquidates loans in order to keep repayments to Torino  $t = 2$  as low as possible may appear to be somewhat awkward. However, in the sense of *Rajan, Servaes and Zingales* (2000) the banker might be seen to have an alternative, so-called defensive investment opportunity, which fully protects her against future claims of other subsidiary managers.

The optimization problem of a bank manager, who wants to maximize total rents, is thus

$$\max_{\hat{\mu} \in [0,1]} R_1(\hat{\mu}) + R_2(\hat{\mu}) \quad s.t. \quad (8), \quad (10)$$

with her rents  $R_1(\hat{\mu})$  and  $R_2(\hat{\mu})$  being given by

$$R_1(\hat{\mu}) = V(\hat{\mu}, T_1) - \frac{V(1,0)}{1+k_0} \quad (11)$$

$$\begin{aligned} &= \frac{1}{8}\gamma^h C + \frac{1}{4}\left(\hat{\mu} - \frac{1}{2}\right)L + T_1 - \frac{1}{2}d_0 \\ R_2(\hat{\mu}) &= \frac{1}{4}(1 - \hat{\mu})\gamma^h C - \min\left\{T_1, \frac{1}{4}(1 - \hat{\mu})\frac{\gamma^h C}{2}\right\} \\ &\geq \frac{1}{4}(1 - \hat{\mu})\frac{\gamma^h C}{2}. \end{aligned} \quad (12)$$

The solution to program (10) is:

**Lemma 1** *Let  $M$  denote the function that maps the offered transfer  $T_1$  and the volume of deposits  $d_0$  onto the fraction  $\mu^*$  of late projects that will be prematurely liquidated in the liquidity-poor region. This function is characterized by*

$$\mu^* = \begin{cases} 0 & \text{if } T_1 \in \left[\max\left\{\frac{d_0}{2} - \frac{\gamma^h C - L}{8}, 0\right\}, \frac{\gamma^h C - L}{4}\right] \\ 1 & \text{if } T_1 > \min\left\{\frac{\gamma^h C - L}{4}, \max\left\{\frac{(L + \gamma^h C - 4d_0)(\gamma^h C - L)}{8(2L - \gamma^h C)}, 0\right\}\right\} \\ \frac{L - \gamma^h C}{2L} + \frac{2d_0 - 4T_1}{L} & \text{otherwise} \end{cases} \quad (13)$$

where

$$\frac{\partial \mu^*}{\partial T_1} = \begin{cases} 0 & \text{if } T_1 > \max\left\{0, \min\left\{\frac{d_0}{2} - \frac{\gamma^h C + L}{8}, \frac{(L + \gamma^h C - 4d_0)(\gamma^h C - L)}{8(2L - \gamma^h C)}\right\}\right\} \\ -\frac{4}{L} < 0 & \text{otherwise} \end{cases} \quad (14)$$

and

$$\frac{\partial \mu^*}{\partial d_0} = \begin{cases} 0 & \text{if } T_1 > \max\left\{0, \min\left\{\frac{d_0}{2} - \frac{\gamma^h C + L}{8}, \frac{(L + \gamma^h C - 4d_0)(\gamma^h C - L)}{8(2L - \gamma^h C)}\right\}\right\} \\ \frac{2}{L} > 0 & \text{otherwise} \end{cases} \quad (15)$$

**Proof.** See Appendix. ■

Figure 1 illustrates these findings. There, the dark area displays those combinations of deposits  $d_0$  and the offered transfer  $T_1$ , where Toulouse sets  $\mu^* = 0$ . In that area, a zero liquidation rate suffices to prevent investors from assuming control over the bank's assets. This is because deposits are sufficiently low while the transfer is sufficiently high to give the banker enough bargaining power and funds at hand to enforce her own interests. At the same time, the transfer is not too high in this area such that it does not pay for the banker to liquidate loans in order to strategically improve her bargaining position for renegotiations with Torino at  $t = 2$ .

In the white area, the banker will liquidate all late loans prematurely, i. e.  $\mu^* = 1$ , for one of the following three reasons: First, when deposits  $d_0$  are higher than

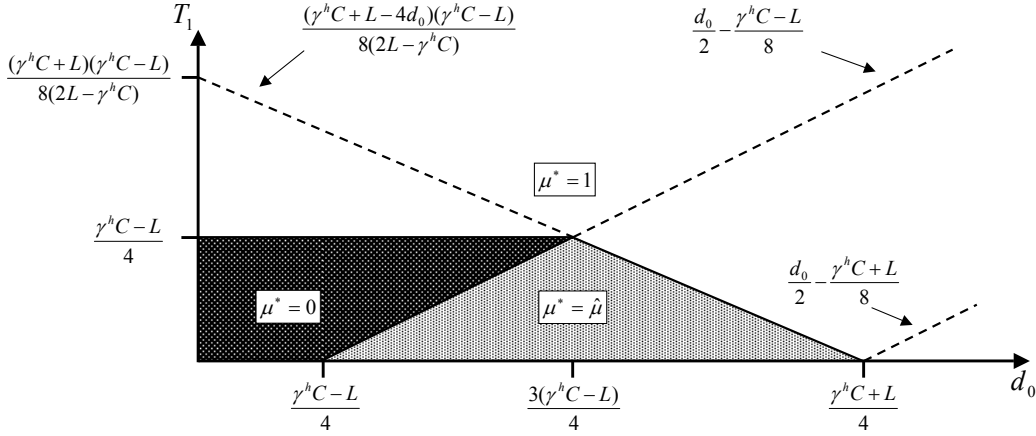


Figure 1: Liquidation regimes for the liquidity-poor region.

$\frac{1}{4}(\gamma^h C + L)$ , the bank manager cannot raise enough liquidity to prevent investors from assuming control over her assets without setting  $\hat{\mu} = 1$  even though she gets a transfer  $T_1$ . Second, even when deposits are small and the banker in Toulouse has thus sufficient power vis-a-vis investors to keep the liquidation rate small, she will set  $\mu^* = 1$  if the transfer  $T_1$  offered by Torino is higher than  $\frac{1}{4}(\gamma^h C - L)$ . This is because it is then best for the bank manager in Toulouse to collect the transfer and to liquidate all loans, as she will not have to pay back anything to Torino at  $t = 2$ . Third, when deposits  $d_0$  are neither small nor too large, i. e. if  $\frac{3}{4}(\gamma^h C - L) \leq d_0 \leq \frac{1}{4}(\gamma^h C + L)$  the banker is generally forced to liquidate some of her loans in order to meet the demands of investors as payments owed to depositors imply that the banker is only weakly protected vis-a-vis her investors by her rents. When, however, the transfer  $T_1$  is relatively high, it is even better for her to liquidate not only some but all of her loans. In so doing she shifts her rents completely to  $t = 1$ . This strategy is advantageous because, as the share of loans being called in is already high, rents extractable at the expense of Torino at  $t = 2$  would be small. Hence, it is best for her to collect the transfer and to liquidate all late loans and to keep what has been left after repaying investors at  $t = 1$ .

Finally, in the gray area the banker calls in some of her loans to borrowers with late projects, i. e.  $\mu^* > 0$ . In so doing, investors will be just indifferent to accept that offer, while—as  $T_1$  is comparatively small in this area—it neither pays for the banker to head for renegotiations with Torino nor does it allow her to completely avoid the premature liquidation of assets.

### 4.3 Liquidation and transfer policy in Torino

Having analyzed the liquidation policy in Toulouse, we next turn to the issues of how many projects will be liquidated in Torino and what transfer will be offered

to Toulouse. In so doing, we bear in mind that, according to the Basel framework, capital requirements will be applied on a consolidated basis to internationally active banks and to all internationally active banks at every tier within a banking group, also on a fully consolidated basis. In our setting, this means that only the internationally active bank as a whole is required to meet capital regulations at each point in time.

To begin with, we have to determine how much liquidity is available to the Torino bank manager at  $t = 1$  to pay out her impatient investors and to make the transfer. She obtains  $\frac{1}{4}\gamma^h C$  as returns from early projects and  $\frac{1}{4}\nu L$  as proceeds from liquidating a share  $\nu$  of her late projects. In addition, she may raise funds externally from newly born investors by borrowing against her remaining late loans and against what she will get repaid from Toulouse at  $t = 2$ .

Given that the local bank manager in Torino offers a transfer  $T_1$  to Toulouse, liquidity at hand to pay out impatient investors is thus given by

$$U(T_1, \nu) = \frac{1}{4}(\gamma^h C + \nu L) - T_1 + \frac{\frac{1}{4}(1-\nu)\gamma^h C + \min\left\{T_1, \frac{1}{4}[1-M(T_1)]\frac{\gamma^h C}{2}\right\}}{1+k_1}, \quad (16)$$

where  $U$  is a value function mapping the rate  $\nu$  of prematurely liquidated projects in Torino and the transfer payment  $T_1$  onto the value of liquidity (from investors perspective), taking into account the liquidation policy of the Toulouse bank manager.

As the capital-to-asset ratio  $k_1$ , applied between  $t = 1$  and  $t = 2$ , determines the returns on borrowing against late projects rather than liquidating them, we have to distinguish between high and low capital-to-asset ratios. When the capital-to-asset ratio  $k_1$  is small and satisfies

$$0 \leq k_1 \leq \frac{\gamma^h C}{L} - 1, \quad (17)$$

then the local bank manager as well as investors in Torino do not want to have late loans in Torino to be prematurely liquidated, i. e.  $\nu = 0$ . When the imposed capital-to-asset ratio is, however, too large, investors want the banker to liquidate all late projects in Torino, while the banker still prefers a continuation of all late projects.

Besides the liquidation rate, there may be an additional conflict of interest between the local bank manager and investors, which refers to the transfer  $T_1$  offered to Toulouse. The bank manager is in principle indifferent regarding the transfer—as long as it does not make her counterpart in Toulouse set  $\mu^* = 1$ . This follows from inspecting the respective rents  $Q_1(T_1, \nu)$  and  $Q_2(T_1, \nu)$  of the Torino bank manager

$$\begin{aligned} Q_1(T_1, \nu) &= U(T_1, \nu) - \frac{1}{2}[U(0, \nu) + d_0] \\ Q_2(T_1, \nu) &= \frac{k_1}{1+k_1} \left( \frac{1}{4}(1-\nu)\gamma^h C + T_2 \right) \end{aligned}$$

which sum up to  $Q$  with

$$Q = \begin{cases} \frac{1}{8} \frac{2+3k_1}{1+k_1} \gamma^h C - \frac{1}{8} \nu \left( \frac{1+2k_1}{1+k_1} \gamma^h C - L \right) - \frac{1}{2} d_0 & \text{if } M(T_1) < 1, \\ \frac{1}{8} \frac{2+3k_1}{1+k_1} \gamma^h C - \frac{1}{8} \nu \left( \frac{1+2k_1}{1+k_1} \gamma^h C - L \right) - \frac{1}{2} d_0 - T_1 & \text{if } M(T_1) = 1. \end{cases} \quad (18)$$

Hence, as long as  $T_1$  does not induce the Toulouse bank manager to liquidate all late loans, changes in the transfer  $T_1$  merely imply a one-to-one shift of rents between the two dates. If, however,  $T_1$  already incites the Toulouse bank manager to call in all loans, a further increase in the transfer  $T_1$  implies lower rents for the Torino bank manager as she would simply waste funds when nothing could be recovered from Toulouse. In accordance with these insights, we assume for the remainder of this paper that the Torino bank manager is in principle willing to supply the highest value of  $T_1$  for which the Toulouse bank manager will marginally abstain from setting the liquidation rate equal to 1.<sup>8</sup>

However, making a transfer is not only a matter of willingness of the Torino bank manager, but also a matter of her capability to get it accepted by her investors. These investors always want  $T_1 = 0$  because making no transfers maximizes the available liquidity and, therefore, investors utility at  $t = 1$ , as the latter is always strictly decreasing in  $T_1$ :

$$\frac{\partial}{\partial T_1} U(T_1, \nu) = \begin{cases} -1 & \text{if } T_1 > \min \left\{ \frac{\gamma^h C - L}{4}, \frac{1}{8} \frac{(L + \gamma^h C) - 4d_0}{2L - \gamma^h C} (\gamma^h C - L) \right\}, \\ -\frac{k_1}{1+k_1} & \text{otherwise.} \end{cases} \quad (19)$$

Therefore, investors in Torino cannot gain from transferring funds across regions.

Keeping in mind that the bank manager is at best indifferent with respect to the transfer while she does strictly prefer to not liquidating late projects, her preferences are strictly ordered. First of all she seeks to minimize the liquidation rate  $\nu$ , and only if she is able to enforce  $\nu = 0$  vis-a-vis her investors, she will think about making a transfer to Toulouse. Given the aforementioned structure of the renegotiations game between a local bank manager and her investors, the latter can extract  $\frac{1}{2} [U(0, 0) + d_0]$  from the Torino bank manager if (17) is met, and  $\frac{1}{2} [U(0, 1) + d_0]$  otherwise. The bank manager has, therefore, to create sufficient liquidity in order to restrain investors from assuming control over her loans. Her choice of  $T_1$  is thus restricted by

$$U(T_1, 0) \geq \frac{1}{2} [U(0, 0) + d_0] \quad \text{if } 0 \leq k_1 \leq \frac{\gamma^h C}{L} - 1, \quad (20)$$

<sup>8</sup> At  $t = 0$ , neither local bank manager knows whether she or her peer will be short of liquidity at  $t = 1$ . Ex post, the Torino bank manager will be indifferent about the size of the transfer; ex ante, however, she may also benefit most from the highest possible transfer. So there might be an implicit agreement among bank managers to support each other to the largest possible extent.

and

$$U(T_1, 0) \geq \frac{1}{2} [U(0, 1) + d_0] \quad \text{if} \quad \frac{\gamma^h C}{L} - 1 \leq k_1 \leq 1. \quad (21)$$

Rearranging and combining both conditions finally yields

$$T_1 \leq \frac{2+k_1}{8k_1} \gamma^h C - \frac{1+k_1}{2k_1} d_0 - \max \left\{ \frac{(1+k_1)L - \gamma^h C}{8k_1}, 0 \right\}. \quad (22)$$

To sum up we have

**Lemma 2** *The transfer policy  $T_1^*$  is given by*

$$T_1^* = \min \left\{ \frac{1}{4} (\gamma^h C - L), \max \{ \Omega, 0 \}, \max \{ \Psi, 0 \} \right\}, \quad (23)$$

where

$$\Omega := \frac{(\gamma^h C + L - 4d_0)(\gamma^h C - L)}{8(2L - \gamma^h C)}$$

and

$$\Psi := \frac{(2+k_1)\gamma^h C}{8k_1} - \frac{(1+k_1)d_0}{2k_1} - \max \left\{ \frac{(1+k_1)L - \gamma^h C}{8k_1}, 0 \right\}.$$

We thus find that transfers, offered to Toulouse, must not be too large for two reasons. First, it needs to be small to make the Torino bank manager willing to make the transfer. If, instead, the transfer implies that the Toulouse bank manager has an incentive to liquidate all of her late projects, funds transferred to Toulouse would simply be wasted. The volume of deposits  $d_0$  influences the willingness of the Torino bank manager to offer a transfer as large deposits imply that Toulouse needs a lot of funds at  $t = 1$ . The local bank manager there has then to liquidate already some of her late projects such that even small transfers may induce her to liquidate all of them to save on the repayment of the transfer.

Second, the transfer needs to be small to let the Torino counterpart being able to make this transfer. When, for instance, the Torino bank manager has already to offer a lot of liquidity to her investors (because of large deposits) in order to avoid a run on her loans, only little is left to support her Toulouse counterpart. In addition, for a given volume of deposits, an increase in the capital-to-asset ratio  $k_1$ , which governs the bank's capital structure between the two dates  $t = 1$  and  $t = 2$ , also implies a lower transfer at  $t = 1$ . The reason here is that the bank manager cannot raise as much liquidity externally by borrowing against late projects. This may force her to cut transfers, especially if the capital-to-asset ratio creates an additional conflict of interests regarding the liquidation of late projects in Torino.

Before proceeding, we need to point out two further restrictions implied by the model. First, deposits  $d_0$  cannot be made contingent on the occurrence of liquidity shortages. Hence, payments, which a local bank manager owes to depositors, have to be the same in each region. Second, deposits  $d_0$  must not be larger than  $V(1, 0)$ . If deposits were above  $V(1, 0)$ , a liquidity shortage in one region would trigger a bank run on the subsidiary based in that region. Investors had therefore to expect that with probability 0.5 their funds deposited with the bank could not be repaid.

## 4.4 Capital structure and internal capital markets

The next task is to analyze the effects of the bank's capital structure on the respective liquidation policies in Torino and Toulouse, and we proceed in three steps. First, we determine how much funds can be raised at  $t = 0$  by issuing deposits, depending on the minimum capital-to-asset ratio imposed by regulation. Second, given this relationship, we derive the transfer actually made at  $t = 1$ . Knowing how deposits issued at  $t = 0$  and the transfer made at  $t = 1$  will depend on capital structure, we finally draw conclusions about the effect of capital regulation on the share of prematurely liquidated projects in each region.

To begin with, with  $\hat{k}$  being the minimum capital-to-asset ratio imposed by the regulator and with deposits being the same in both regions and bounded above by  $V(1, 0)$ , the first-period capital-to-asset ratio  $k_0$  is given by

$$k_0 = \frac{\frac{1}{2}[V(1,0)+U(0,0)-2d_0]}{\frac{1}{2}[V(1,0)+U(0,0)-2d_0]+2d_0} \quad (24)$$

when  $\hat{k} = k_1$  is sufficiently small in order to not creating an incentive problem regarding  $\nu$ .<sup>9</sup> For larger capital-to-asset ratios we have to take into account the additional conflict of interest regarding  $\nu$ , and the capital-to-asset ratio in the first period is

$$k_0 = \frac{\frac{1}{2}[V(1,0)+U(0,1)-2d_0]}{\frac{1}{2}[V(1,0)+U(0,1)-2d_0]+2d_0}. \quad (25)$$

Solving (24) and (25) for  $d_0$  allows us to determine how much funds the bank can raise at  $t = 0$  by issuing deposits:

$$d_0^* = \min \left\{ \frac{\gamma^h C + L}{4}, \max \left\{ \frac{1-\hat{k}}{8(1+\hat{k})} \left( \frac{3+2\hat{k}}{1+\hat{k}} \gamma^h C + L \right), \frac{1-\hat{k}}{4(1+\hat{k})} (\gamma^h C + L) \right\} \right\} \quad (26)$$

with

$$\frac{\partial d_0^*}{\partial \hat{k}} = \begin{cases} 0 & \text{if } \hat{k} \leq \alpha, \\ -\frac{7+3\hat{k}}{8(1+\hat{k})^3} \gamma^h C - \frac{L}{4(1+\hat{k})^2} & \text{if } \hat{k} \in (\alpha, \frac{\gamma^h C}{L} - 1], \\ -\frac{\gamma^h C + L}{2(1+\hat{k})} & \text{if } \hat{k} > \frac{\gamma^h C}{L} - 1, \end{cases} \quad (27)$$

<sup>9</sup> The model thus implies that the actual capital-to-asset ratio in the first period will be strictly positive and decreasing in the minimum capital-to-asset ratio, as long as the latter is not already binding at  $t = 0$ . The reason is that the bank has to shield itself from a liquidity risk, which arises in the presence of a region-specific liquidity shortage when the internal capital market works inefficiently. This need to cushion liquidity risk becomes, however, less important for tighter capital requirements because the bank cannot raise as much liquidity externally at  $t = 1$ , which lowers her obligations vis-a-vis initial investors. Since the markets for deposits and other claims on a bank are contestable, the bankers have no incentive to exceed capital requirements in the case where additional capital is not needed to cushion liquidity shocks

where  $\alpha$  is implicitly defined as that capital-to-asset ratio for which

$$\frac{\gamma^h C + L}{4} = \frac{1 - \alpha}{8(1 + \alpha)} \left( \frac{3 + 2\alpha}{1 + \alpha} \gamma^h C + L \right)$$

holds true. Hence,  $\alpha$  is strictly positive but smaller than  $\frac{\gamma^h C}{L} - 1$ .

Equation (26) says that the bank can issue deposits up to a maximum of  $\frac{\gamma^h C + L}{4}$ . If deposits were larger, the bank would fail in one region with certainty at  $t = 1$ , and depositors would thus expect getting nothing back from the bank at  $t = 1$  with probability 0.5.<sup>10</sup> When the imposed capital-to-asset ratio becomes sufficiently large to be binding already at  $t = 0$ , i. e. if  $\hat{k}$  is higher than some  $\alpha$ , deposits are given by  $\max \left\{ \frac{1 - \hat{k}}{8(1 + \hat{k})} \left( \frac{3 + 2\hat{k}}{1 + \hat{k}} \gamma^h C + L \right), \frac{1 - \hat{k}}{4(1 + \hat{k})} (\gamma^h C + L) \right\}$ .

A further increase in  $\hat{k}$  has in principle two effects on deposits. First, it reduces what shareholders collect when they assume control over assets as the banker can borrow less against late loans. The value of capital thus falls and, in order to meet the tightening in capital requirements, deposits also decrease. Second, even for a given amount that shareholders can collect, deposits must decrease as the banker's ability to extract rents builds an obstacle for meeting an increasing capital requirement by issuing more equity shares. The first effect, however, only exists if the imposed capital-to-asset ratio remains sufficiently small to not creating the additional conflict of interest regarding the share of prematurely liquidated projects in the liquidity-rich region. Otherwise, shareholders will demand to not borrowing against these projects but to liquidate them. Thus, the value of capital does not further decrease with tighter capital requirements. Deposits decrease only because of the banker's inability to meet those capital requirements by issuing equity shares.

Knowing the relationship between capital requirements and the volume of deposits issued at  $t = 0$ , we can next derive what transfer will actually be made at  $t = 1$ . According to lemma 2, there will be no transfer at least when  $\Omega = 0$ , which occurs to happen when deposits equal  $\frac{\gamma^h C + L}{4}$ —that is, when the capital regulation is not too strong and  $\hat{k} \leq \alpha$  holds. When  $\hat{k} > \alpha$ , we know from (26) that deposits  $d_0^*$  are strictly smaller than  $\frac{1}{4} (\gamma^h C + L)$ . There is thus room for offering a transfer as the banker is now willing to do so. But she might not be able to get it accepted by her investors. However, the transfer will actually never be restricted by those investors. Inserting  $d_0^*$  according to (26) into the constraint imposed by investors yields for  $\hat{k} \in (\alpha, \frac{\gamma^h C}{L} - 1]$  that  $\Psi$  equals  $\frac{(1 + 7\hat{k} + 4\hat{k}^2)\gamma^h C - (1 - \hat{k}^2)L}{16\hat{k}(1 + \hat{k})}$ , which is positive and strictly decreasing in  $\hat{k}$ .<sup>11</sup> Hence, investors' demands are not a binding constraint

<sup>10</sup> According to lemma 2, no transfer will be made to support the failing bank subsidiary when  $d_0^* \geq \frac{\gamma^h C + L}{4}$ .

<sup>11</sup> The first derivative of  $\Psi$  with respect to  $\hat{k}$  is  $\frac{2\hat{k}(L - \gamma^h C) + (L - \gamma^h C) + \hat{k}^2(L - 3\gamma^h C)}{16\hat{k}^2(1 + \hat{k})^2}$ , which is strictly negative, since  $L < \gamma^h C$  and  $\hat{k} \geq 0$ .



for intermediate values of  $\hat{k}$ , because  $\Psi$  is at least  $\frac{1}{4}(L + \gamma^h C)$ , which is strictly higher than  $\frac{1}{4}(\gamma^h C - L)$ . For even larger  $\hat{k}$ ,  $\Psi$  is given by  $\frac{(1+k)\gamma^h C - L}{4k_1}$ , which is at least  $\frac{1}{4}(2\gamma^h C - L)$  and thus also higher than  $\frac{1}{4}(\gamma^h C - L)$ .

The capital structure thus affects the actual transfer to a bank subsidiary that suffers from a liquidity shortage. When the capital-to-asset ratio imposed by the regulator is small, i. e. if  $\hat{k} \leq \alpha$ , deposits are too large to allow any transfer. With minimum capital-to-asset ratios being of intermediate values, the bank manager in the liquidity-rich region will to some extent support her counterpart, where this support will be higher for tighter capital regulation. But there is a non-negative capital-to-asset ratio, above which it does not pay to further extend financial support as the bank manager in the liquidity-poor region is already allowed to keep all of her late projects. This leads us to the following conclusion.

**Proposition 2** *When the internationally active bank operates as a multinational bank, the resulting liquidation policy is given by*

$$\nu^* = 0 \quad (28)$$

and

$$\begin{aligned} \mu^* &= 1 & \text{if } \hat{k} &\leq \alpha \\ \mu^* &< 1 & \text{if } \hat{k} &\in (\alpha, \beta] \\ \mu^* &= 0 & \text{if } \hat{k} &> \beta \end{aligned} \quad (29)$$

with

$$\begin{aligned} \frac{\partial \mu^*}{\partial \hat{k}} &< 0 & \text{for } \hat{k} &\in (\alpha, \beta] \\ \frac{\partial \mu^*}{\partial \hat{k}} &= 0 & \text{otherwise} \end{aligned} \quad (30)$$

where  $\beta$  is implicitly defined as the smallest capital-to-asset ratio for which associated deposits  $d_0^*$  imply

$$\min \left\{ \frac{\gamma^h C - L}{4}, \frac{(\gamma^h C + L - 4d_0^*)(\gamma^h C - L)}{8(2L - \gamma^h C)} \right\} = \frac{\gamma^h C - L}{4}. \quad (31)$$

**Proof.** See Appendix. ■

Proposition 2 is one of the central results of the paper. It shows that a multinational bank operating through local subsidiaries may be forced to liquidate projects with positive NPV. Although local bank managers would be able to squeeze more out of these projects than a globally operating banker ever could, a multinational bank's internal capital market does not always allow to reallocate liquidity properly across countries. The need to raise liquidity locally by means of liquidating projects, however, is less compelling when the capital-to-asset ratio is higher. The reason is that a higher capital-to-asset ratio gives more power to a local bank manager to bring the actual liquidation policy in line with her own interests.

## 5 Implications

The final step in our analysis is to compare the two organizational forms of international banking activities and to further discuss the results. To begin with, we contrast two potential measures for the value of different organizational forms. On the one hand, one may argue that an organization design is socially optimal, when it allows the maximum number of projects with a positive NPV to be financed and orderly finished, irrespective how their returns are distributed among agents. On the other hand, as markets for bank deposits and other claims on a bank are contestable, a prerequisite for a bank to enter foreign markets is to design its organizational form such that expected repayments to initial investors are maximized. Since banks are forced to make this decision irrespective of any social welfare considerations, there might be the case that these two measures point to different directions and a prudent policy of regulating bank capital may effectively work in order to bring them into line.

The market solution—that is, the organizational form that emerges when markets for claims on banks are contestable—is characterized by

**Proposition 3** *Supplying cross-border financial services allows higher repayments to initial investors when the capital-to-asset ratio imposed by a regulator is not too large and when in addition*

$$\frac{\gamma^l C - L}{(\gamma^h - \gamma^l)C} > \frac{5}{3} \quad (32)$$

*holds. In all other cases, multinational banking dominates in terms of expected repayments to initial investors.*

**Proof.** See Appendix. ■

According to this proposition, a necessary condition, for which the provision of cross-border financial services is associated with higher repayments to initial investors, is thus a small regulatory capital-to-asset ratio. Intuitively, if this ratio would be high, liquidity could be allocated across regions by a multinational bank in a similar way as by means of cross-border financial services because the restrictions on transfers between a multinational bank's subsidiaries would be of no relevance. There is thus no additional cost, but the multinational bank can still take its advantage of being better informed, which allows to create more liquidity.

However, even if the regulatory capital-to-asset ratio is small, multinational banks may squeeze those banks offering cross-border financial services out of the market. Only when (32) holds true, cross-border financial services will yield higher repayments at least for  $\hat{k} = 0$ . This condition is more likely to hold if a globally operating banker can already extract much by continuing late projects compared to liquidation (i. e. if  $\gamma^l C - L$  is large), and/or if the additional liquidity created by local bank managers is comparatively small (i. e., if  $\gamma^h - \gamma^l$  is small).

An important aspect of proposition 3 is that the market solution might not correspond to a social optimum. For the borrowing entrepreneurs the advantage of multinational banking is that it improves their ability to commit themselves to repay their debt, which tends to ease their borrowing constraints ex ante. The disadvantage is that, ex post, they have to face a premature liquidation of their assets when their projects turn out to be late. For example, if (32) is not met and if there is no regulatory capital-to-asset ratio, multinational banking will yield higher repayments than cross-border financial services but brings about that 25 percent of all projects will be prematurely liquidated, whereas no projects would be liquidated in the case of cross-border financial services.

Multinational banking may thus also come along with an increase in risks to financial stability. When investors prefer multinational banking although the imposed capital-to-asset ratio implies  $\mu^* = 1$ , one subsidiary has to be closed, whereas in the case of cross-border financial services the bank always survives. This contrasts to, e. g., Allen and Gale (2000) who argue that (almost) perfectly integrated financial systems do not suffer from financial instability when there is no aggregate liquidity risk. Our model shows that there is such a risk even when financial systems are most intensively integrated via multinational banks.<sup>12</sup>

There is thus a potential for capital regulation. When multinational banking dominates and when this comes along with some late projects being prematurely liquidated, there will be an inefficient use of funds in the sense of forgoing returns and, sometimes, even a failure of a bank subsidiary. A cautious increase in the regulatory minimum capital-to-asset ratio may lower the share of liquidated projects. However, this procedure requires the regulator having an intimate and quantitative knowledge of the interlinkages of the markets for bank loans and deposits, the markets for bank capital, and the banks' internal allocation processes. Otherwise the regulator risks that banks cannot provide any cross-border liquidity insurance, because they are given too little incentives to repay investors the gross return on alternative assets.

Said differently, a precondition for a prudent policy of bank capital regulation is to estimate not only the risks on the asset side of a bank's balance sheet, but also risks that stem from the liability side. Both risks may interact and even cause each other (Diamond and Rajan, 2005). In this paper we have been able to show that, even in this case of identical risks to asset values, the assessment of the overall risks should also be made contingent on the bank's organization design. Imposing a one-design-fits-all capital-to-asset ratio, as done by the Basel framework, may thus be inappropriate.

<sup>12</sup> In contrast to *Fecht and Grüner* (2005), an interbank money market is not able to allocate liquidity efficiently here. The reason is that a regional bank that suffers from a liquidity shortage cannot simply borrow from another region's bank without violating minimum capital requirements as this borrowed liquidity does not belong to regulatory capital measures. But as the bank fails to meet capital requirements, it will be closed by the regulator.

## 6 Summary

In this paper we have analyzed the role of bank capital regulation for the internationalization strategy of banks. First, we have derived conditions under which it pays for an internationally active bank to set up subsidiaries abroad instead of supplying cross-border financial services. The argument is that, by setting up a subsidiary, a bank can create more liquidity but has to rely on a bank-internal mechanism in order to allocate liquidity in the case of country-specific liquidity shocks. These allocations take place on an internal capital market. They are, however, associated with some leakages, as local bank managers cannot fully pledge their future loan earnings—not even to another bank manager inside the same multinational banking firm. Owing to this imperfection, a bank's subsidiary suffering from a liquidity shortage may be forced to call in (some of) her loans prematurely, or even to get closed. Therefore, when deciding upon its internationalization strategy, a bank faces a trade-off between creating and allocating liquidity and prefers setting up foreign subsidiaries only if the ability to create more liquidity outweighs the additional costs from its inefficient allocation.

Second, we have shown that capital regulation affects this trade-off in two ways. On the one hand, stronger capital requirements lower the ability of a bank to create liquidity irrespective of the chosen internationalization strategy. On the other hand, they also mitigate the inefficiencies in internal capital markets in the case of multinational banking. This is because high capital requirements buffer against country-specific liquidity shocks, thereby lowering the need to meet liquidity demands of impatient investors and reducing the disincentives of a local bank manager to refuse repaying bank internal transfers. Though the regulation of the international convergence of capital measurement and capital standards does not explicitly discriminate the modes of foreign market entry, it may therefore still affect the respective strategic decision of banks. This result adds to the literature on the effects of banking regulation on banks' internationalization strategies, which basically argues that those regulations have an impact on banks' strategic decisions because they do discriminate one mode of foreign market entry against the other.<sup>13</sup>

Finally, we have been able to uncover effects of different internationalization strategies on the stability and efficiency of the international banking system. Though banks offering cross-border financial services cannot create much liquidity, they do not put the banking sector at risk because they are able to allocate liquidity efficiently across regions, irrespective of capital regulation. Multinational banks, however, though able to create more liquidity, cannot pass it on to investors when imperfections in internal capital markets are severe. Hence, these banks also face substantial risks to their stability as they cannot handle region-specific liquidity

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<sup>13</sup> Repullo (2001), e.g., analyzes how differing national deposit insurance systems influence a bank's incentives for cross-border mergers, while Barth, Caprio and Levine (2006) mention the role of country-specific market entry regulations for banks opening foreign branches instead of setting up subsidiaries abroad.

shocks properly. Given this, the effect of capital regulation on the stability and efficiency of the international banking system is not clear-cut. On the one hand, it may incite banks to do their business abroad by means of multinational banking instead of cross-border financial services, meaning that the risk of premature liquidations increases. On the other hand, as increasing capital-to-asset ratios lowers the need to liquidate projects prematurely in the case of multinational banking, it can also improve on stability and efficiency.

Further research could be directed to an in-depth assessment of the role of internationally active banks for the stability of the global financial system. One issue in this respect is whether internationally active banks act as stabilizers in times of severe financial distress or whether they form an additional risk of contagion. Though financial crisis are very costly events, one may consider them as being rather rare. But our understanding of the role of internationally active banks in even less extreme scenarios is far from being comprehensive. For example, little is known about how these banks contribute to the international transmission of business cycles. By getting deeper into those and related issues, one may draw a more complete picture of what is going on nowadays in an integrated world economy.

## Appendix

### Proof of Proposition 1

When  $\frac{\gamma^l C}{1+\hat{k}} \geq L$ , i. e.  $\hat{k} \leq \frac{\gamma^l C}{L} - 1$ , there is no conflict of interests between the globally operating banker and investors as both do not want to liquidate and thus prefer  $\lambda = 0$ . When, however,  $\frac{\gamma^l C}{1+\hat{k}} < L$ , i. e.  $\hat{k} > \frac{\gamma^l C}{L} - 1$ , there is such a conflict of interest. With  $\frac{\gamma^l C}{1+\hat{k}} < L$  the function  $W$  is strictly increasing in  $\lambda$ . In order to show that  $\lambda = 0$  holds irrespective of  $\hat{k}$ , it then suffices to prove that  $W(0) > \frac{W(1)}{1+\hat{k}}$  for all  $\hat{k} \in (\frac{\gamma^l C}{L} - 1, 1]$ , i. e.

$$\gamma^l C + \frac{1}{1+\hat{k}} \gamma^l C > \frac{1}{1+\hat{k}} (\gamma^l C + L) \quad (33)$$

or

$$\gamma^l C > \frac{1}{1+\hat{k}} L, \quad (34)$$

which holds true because of  $1 > \frac{1}{1+\hat{k}}$  and  $\gamma^l C > L$ .

### Proof of Lemma 1

To solve program (10) consider first the sum of rents

$$R_1(\hat{\mu}) + R_2(\hat{\mu}) = \frac{3}{8} \gamma^h C + T_1 - \frac{1}{4} \hat{\mu} (\gamma^h C - L) - \frac{1}{8} L - \frac{1}{2} d_0 - \min \left\{ T_1, \frac{1}{4} (1 - \hat{\mu}) \frac{\gamma^h C}{2} \right\}, \quad (35)$$

which has the following property

$$\frac{d}{d\hat{\mu}} (R_1(\hat{\mu}) + R_2(\hat{\mu})) = \begin{cases} \frac{1}{4} (L - \gamma^h C) < 0 & \text{if } T_1 < \frac{1}{4} (1 - \hat{\mu}) \frac{\gamma^h C}{2} \\ \frac{1}{4} (L - \frac{\gamma^h C}{2}) > 0 & \text{if } T_1 \geq \frac{1}{4} (1 - \hat{\mu}) \frac{\gamma^h C}{2} \end{cases} \quad (36)$$

or

$$\frac{d}{d\hat{\mu}} (R_1(\hat{\mu}) + R_2(\hat{\mu})) = \begin{cases} \frac{1}{4} (L - \gamma^h C) < 0 & \text{if } \hat{\mu} < \mu^{crit} \\ \frac{1}{4} (L - \frac{\gamma^h C}{2}) > 0 & \text{if } \hat{\mu} \geq \mu^{crit} \end{cases} \quad (37)$$

where

$$\mu^{crit} := \frac{\gamma^h C - 8T_1}{\gamma^h C}. \quad (38)$$

We proceed by distinguishing four cases:

#### Case 1

If deposits  $d_0$  are too large while the transfer  $T_1$  is too small, depositors hold such a high claim on the banker that no liquidation rate smaller than 1 allows the banker

to raise enough funds that investors can be deterred from forcing the banker to liquidate all late loans. Formally, there is no  $\hat{\mu} < 1$  satisfying (9), i. e.

$$\frac{\frac{1}{2}(L-\gamma^h C)+2d_0-4T_1}{L} \geq 1 \quad (39)$$

holds true. Rewriting this condition yields

$$T_1 \leq \frac{1}{2} \left[ d_0 - \frac{1}{4} (L + \gamma^h C) \right]. \quad (40)$$

Hence  $\mu^*$  is equal to 1 for any  $T_1$  satisfying (40).

### Case 2

If  $\mu_{crit}$ , as defined in (38), is smaller than 0, i. e. if

$$T_1 > \frac{1}{4} \frac{\gamma^h C}{2} \quad (41)$$

holds, it follows that the bank manager's rents are maximized by choosing  $\mu^* = 1$ , since for all  $\hat{\mu} > 0$  we have, according to (36),

$$\frac{d}{d\hat{\mu}} (R_1(\hat{\mu}) + R_2(\hat{\mu})) > 0. \quad (42)$$

It is thus optimal for the bank manager to set  $\mu^* = 1$ , even though a  $\hat{\mu}$ , which satisfies constraint (8) with equality, is smaller than 1. The reason here is that  $T_1$  is too large, so the banker has an incentive to liquidate all late loans for strategic reasons: She simply pockets the high transfer  $T_1$  at  $t = 1$ , but she is not inclined to repay it at  $t = 2$ .

For the remaining two cases, neither the condition for case 1 nor that for case 2 holds, thus we finally consider those cases, where

$$\frac{1}{2} \left[ d_0 - \frac{1}{4} (L + \gamma^h C) \right] < T_1 \leq \frac{1}{4} \frac{\gamma^h C}{2} \quad (43)$$

holds.

### Case 3

If both the constraint (8) is slack for  $\hat{\mu} = 0$  and if

$$R_1(0) + R_2(0) \geq R_1(1) + R_2(1) \quad (44)$$

is fulfilled, the bank manager will set  $\mu^* = 0$ .

To begin with, constraint (8) will not be binding for  $\hat{\mu} = 0$  if

$$\frac{1}{4} \gamma^h C + T_1 \geq \frac{1}{2} \left[ \frac{1}{4} (\gamma^h C + L) + d_0 \right] \quad (45)$$

which is equivalent to require

$$T_1 \geq \frac{1}{2} \left[ d_0 - \frac{1}{4} (\gamma^h C - L) \right]. \quad (46)$$

On the other hand, condition (44) holds true if

$$T_1 \leq \frac{1}{4} (\gamma^h C - L). \quad (47)$$

Hence,  $\mu^* = 0$  follows if  $T_1$  meets conditions (43), (46) and (47) simultaneously, i. e. if

$$\max \left\{ \frac{1}{2} \left[ d_0 - \frac{1}{4} (\gamma^h C - L) \right], 0 \right\} \leq T_1 \leq \frac{1}{4} \min \left\{ \gamma^h C - L, \frac{\gamma^h C}{2} \right\}, \quad (48)$$

where—owing to assumption (1)—we have  $\gamma^h C - L < \frac{\gamma^h C}{2}$ . Hence, (48) simplifies to

$$\max \left\{ \frac{1}{2} \left[ d_0 - \frac{1}{4} (\gamma^h C - L) \right], 0 \right\} \leq T_1 \leq \frac{1}{4} (\gamma^h C - L). \quad (49)$$

#### Case 4

Consider the case where  $T_1 \leq \frac{1}{4} \frac{\gamma^h C}{2}$  holds true but constraint (8) is violated for  $\mu = 0$ . Investors then require the banker to choose  $\mu \geq \hat{\mu}$  where  $\hat{\mu}$  is implicitly defined by (8), i. e.

$$\hat{\mu} = \frac{\frac{1}{2}(L - \gamma^h C) + 2d_0 - 4T_1}{L} \quad (50)$$

Hence, as a consequence of the property (36) of  $R_1(\mu) + R_2(\mu)$ , the banker will set  $\mu^* = \hat{\mu}$  only if

$$R_1(\hat{\mu}) + R_2(\hat{\mu}) \geq R_1(1) + R_2(1) \quad (51)$$

holds and sets  $\mu^* = 1$  otherwise. Since  $\hat{\mu}$  is defined as that  $\mu$  for which available liquidity at  $t = 1$  is just about the liquidity demanded by investors (i. e. for which condition (8) holds with equality), we have  $R_1(\hat{\mu}) = 0$  and condition (51) can be rewritten as

$$\frac{1}{4} (1 - \hat{\mu}) \gamma^h C - \min \left\{ T_1, \frac{1}{4} (1 - \hat{\mu}) \frac{\gamma^h C}{2} \right\} \geq \frac{1}{8} (\gamma^h C + L) + T_1 - \frac{1}{2} d_0. \quad (52)$$

We know from (37) that

$$R_1(\hat{\mu}) + R_2(\hat{\mu}) < R_1(1) + R_2(1) \quad (53)$$

if  $\hat{\mu} \geq \mu^{crit}$  or, equivalently, if

$$T_1 \geq \frac{1}{8} \frac{(L + \gamma^h C) - 4d_0}{2L - \gamma^h C} \gamma^h C. \quad (54)$$

We therefore have  $\mu^* = 1$  if  $T_1$  satisfies (54). But if this condition is violated, we have  $T_1 \leq \frac{1}{4} (1 - \hat{\mu}) \frac{\gamma^h C}{2}$ . In this case (52) reads as

$$\frac{1}{4} (1 - \hat{\mu}) \gamma^h C - T_1 \geq \frac{1}{8} (\gamma^h C + L) + T_1 - \frac{1}{2} d_0,$$



where rearranging yields

$$T_1 \leq \frac{1}{8} \frac{(L+\gamma^h C)-4d_0}{2L-\gamma^h C} (\gamma^h C - L), \quad (55)$$

where the RHS in (55) is even smaller than the expression on the RHS in (54). We therefore conclude: If

$$T_1 > \frac{1}{8} \frac{(L+\gamma^h C)-4d_0}{2L-\gamma^h C} (\gamma^h C - L) \quad (56)$$

holds, we have  $\mu^* = 1$ . If, however,

$$T_1 \leq \frac{1}{8} \frac{(L+\gamma^h C)-4d_0}{2L-\gamma^h C} (\gamma^h C - L) \quad (57)$$

holds, we have  $\mu^* = \hat{\mu} = \frac{\frac{1}{2}(L-\gamma^h C)+2d_0-4T_1}{L}$ .

Comparing the parameter ranges in (40), (43), (49) and (57) yields that (40) is redundant. Hence, three cases are left, which can be summarized as

$$\mu^* = \begin{cases} 0 & \text{if } T_1 \in \left[ \max \left\{ \frac{d_0}{2} - \frac{\gamma^h C - L}{8}, 0 \right\}, \frac{\gamma^h C - L}{4} \right] \\ 1 & \text{if } T_1 > \min \left\{ \frac{\gamma^h C - L}{4}, \max \left\{ \frac{(L+\gamma^h C-4d_0)(\gamma^h C - L)}{8(2L-\gamma^h C)}, 0 \right\} \right\} \\ \frac{L-\gamma^h C}{2L} + \frac{2d_0-4T_1}{L} & \text{otherwise.} \end{cases} \quad (58)$$

## Proof of Proposition 2

The proof regarding  $\nu^*$  is as follows. Since  $\Psi$  is not binding for determining  $T_1$ , and because satisfying  $\Psi$  already allows the local bank manager to enforce  $\nu = 0$ , the bank manager in the liquidity-rich region has no problems to avoid a premature liquidation of loans.

The proof regarding  $\mu^*$  is by distinguishing two cases:

1. When  $\hat{k} \leq \alpha$ , deposits  $d_0^*$  are equal to  $\frac{\gamma^h C + L}{4}$ . Thus, according to lemma 2, there will be no transfer and it follows from lemma 1 that  $\mu^* = 1$ .
2. When  $\hat{k} > \alpha$ , deposits are smaller than  $\frac{\gamma^h C + L}{4}$  and monotonically decreasing in  $\hat{k}$ . Since there are no deposits for  $\hat{k} = 1$ , and since

$$\min \left\{ \frac{\gamma^h C - L}{4}, \frac{(\gamma^h C + L - 4d_0^*)(\gamma^h C - L)}{8(2L - \gamma^h C)} \right\} = \frac{\gamma^h C - L}{4}$$

if  $d_0^* = 0$ , the intermediate value theorem implies that there is a critical capital-to-asset ratio, denoted by  $\beta$ , such that

$$\min \left\{ \frac{\gamma^h C - L}{4}, \frac{(\gamma^h C + L - 4d_0^*)(\gamma^h C - L)}{8(2L - \gamma^h C)} \right\} = \frac{\gamma^h C - L}{4}$$

holds for any  $\hat{k} \geq \beta$  and

$$\min \left\{ \frac{\gamma^h C - L}{4}, \frac{(\gamma^h C + L - 4d_0^*)(\gamma^h C - L)}{8(2L - \gamma^h C)} \right\} < \frac{\gamma^h C - L}{4}$$

for any  $\hat{k} < \beta$ . There is thus no need to liquidate loans at all if  $\hat{k} \geq \beta$ , i. e.  $\mu^* = 0$ . For intermediate capital-to-asset ratios satisfying  $\hat{k} \in (\alpha, \beta)$  we have  $\mu^* \in (0, 1)$ . In this case,  $d_0^*$  decreases as  $\hat{k}$  increases, which allows for higher transfers. Both, lower deposits and higher transfers, lead to a lower  $\mu^*$  as shown in lemma 1.

### Proof of Proposition 3

Expected repayments to initial investors depend on the imposed capital-to-asset ratio and are given by table 1. We will show that a necessary condition for repayments associated with cross-border financial services being higher than those associated with multinational banking is that the imposed capital-to-asset ratio  $\hat{k}$  is sufficiently small. Moreover, an increasing capital-to-asset ratio will make the provision of cross-border financial services less favorable. Once multinational banking dominates for some capital-to-asset ratio, there will be no  $\hat{k}$  beyond that ratio where cross-border financial services will dominate again.

	deposits	equity capital	sum
		multinational banking	
$0 < \hat{k} \leq \alpha$	$V(1, 0)$	$\frac{U(0,0) - V(1,0)}{2}$	$\frac{3V(1,0) + U(0,0)}{2}$
$\alpha < \hat{k} \leq \frac{\gamma^h C}{L} - 1$	$\frac{1-\hat{k}}{1+\hat{k}} \frac{V(1,0) + U(0,0)}{2}$	$\frac{\hat{k}}{1+\hat{k}} [V(1, 0) + U(0, 0)]$	$\frac{V(1,0) + U(0,0)}{1+\hat{k}}$
$\frac{\gamma^h C}{L} - 1 < \hat{k} \leq 1$	$\frac{1-\hat{k}}{1+\hat{k}} \frac{V(1,0) + U(0,1)}{2}$	$\frac{\hat{k}}{1+\hat{k}} [V(1, 0) + U(0, 1)]$	$\frac{V(1,0) + U(0,1)}{1+\hat{k}}$
		cross-border financial services	
$0 < \hat{k} \leq \frac{\gamma^l C}{L} - 1$	$\frac{1}{2} \frac{1-\hat{k}}{1+\hat{k}} W(0)$	$\frac{\hat{k}}{1+\hat{k}} W(0)$	$\frac{W(0)}{1+\hat{k}}$
$\frac{\gamma^l C}{L} - 1 < \hat{k} \leq 1$	$\frac{1}{2} \frac{1-\hat{k}}{1+\hat{k}} W(1)$	$\frac{\hat{k}}{1+\hat{k}} W(1)$	$\frac{W(1)}{1+\hat{k}}$

Table 1: Expected repayments to initial investors

Since the critical capital-to-asset ratio  $\alpha$  can be higher than  $\frac{\gamma^l C}{L} - 1$  or not, we have to distinguish two cases.

#### Case 1

Suppose that  $\alpha \leq \frac{\gamma^l C}{L} - 1$  holds.

1. We start with capital-to-asset ratios satisfying  $0 < \hat{k} \leq \alpha$ . Cross-border financial services are then associated with higher payments than multinational banking if

$$\Delta_{0 \leq \hat{k} \leq \alpha} = \frac{W(0)}{1 + \hat{k}} - \frac{3V(1, 0) + U(0, 0)}{2} > 0. \quad (59)$$

In what follows we show that (59) reaches its maximum at  $\hat{k} = 0$  and that this maximum is strictly positive if and only if  $\frac{3}{5} > \frac{(\gamma^h - \gamma^l)C}{\gamma^l C - L}$ .

- (a) Differentiating the expression in (59) yields

$$\frac{d}{d\hat{k}} \Delta_{0 < \hat{k} \leq \alpha} = \frac{C}{2} \left( \frac{\gamma^h}{8\hat{k} + 4\hat{k}^2 + 4} - \frac{(3 + \hat{k})\gamma^l}{3\hat{k} + 3\hat{k}^2 + \hat{k}^3 + 1} \right). \quad (60)$$

The difference will thus have its maximum at  $\hat{k} = 0$  if (60) is negative, or if

$$\frac{\gamma^h}{\gamma^l} < \frac{(8\hat{k} + 4\hat{k}^2 + 4)(3 + \hat{k})}{3\hat{k} + 3\hat{k}^2 + \hat{k}^3 + 1}. \quad (61)$$

This is true as the RHS in (61) is at least 8, while the LHS is smaller than 2. The latter is implied by assumption (1), which requires firstly that  $\gamma^h C < 2L$ , or, equivalently,  $\frac{\gamma^h}{\gamma^l} < \frac{2L}{\gamma^l C}$ , and secondly  $\gamma^l C > L$ , or, equivalently  $\frac{2L}{\gamma^l C} < 2$ .

- (b) For  $\hat{k} = 0$ , rearranging (59) yields that  $\Delta_{0 \leq \hat{k} \leq \alpha} > 0$  if

$$\frac{3}{5} > \frac{(\gamma^h - \gamma^l)C}{\gamma^l C - L}. \quad (62)$$

It can easily be checked that this condition holds for at least some parameters, for instance for  $\gamma^h$  and  $\gamma^l$  being very close to each other.

2. When  $\alpha < \hat{k} \leq \frac{\gamma^l C}{L} - 1$ , cross-border financial services still dominate multinational banking if

$$\Delta_{\alpha < \hat{k} \leq \frac{\gamma^l C}{L} - 1} = \frac{W(0)}{1 + \hat{k}} - \frac{V(1, 0) + U(0, 0)}{1 + \hat{k}} > 0. \quad (63)$$

Differentiating this expression yields

$$\frac{d}{d\hat{k}} \Delta_{\alpha < \hat{k} \leq \frac{\gamma^l C}{L} - 1} = \frac{\frac{1}{4} \frac{\gamma^h - 2\gamma^l}{1 + \hat{k}} C - [W(0) - V(1, 0) - U(0, 0)]}{(1 + \hat{k})^2}, \quad (64)$$

which is strictly negative for  $\Delta_{\alpha < \hat{k} \leq \frac{\gamma^l C}{L} - 1} \geq 0$ . This, however, means that cross-border financial services are associated with higher repayments if multinational banking has not already become dominant for some  $\hat{k} \leq \alpha$ . In that case it also means that the comparative advantage of cross-border financial services

over multinational banking further declines when  $\hat{k}$  increases. Moreover, once multinational banking dominates for some capital-to-asset ratio, there will be no  $\hat{k}$  beyond that ratio for which cross-border financial services will become better again.

3. For all  $\frac{\gamma^l C}{L} - 1 < \hat{k}$  cross-border financial services will always yield lower repayments than multinational banking. If  $\hat{k} \leq \frac{\gamma^h C}{L} - 1$  the respective difference in repayments is

$$\Delta_{\frac{\gamma^l C}{L} - 1 < \hat{k} \leq \frac{\gamma^h C}{L} - 1} = \frac{1}{2} \frac{\gamma^l - \gamma^h}{1 + \hat{k}} C + \frac{1}{4} \frac{L - \frac{\gamma^h C}{1 + \hat{k}}}{1 + \hat{k}} < 0 \quad (65)$$

while for  $\hat{k} > \frac{\gamma^h C}{L} - 1$  we have

$$\Delta_{\frac{\gamma^h C}{L} - 1 < \hat{k} \leq 1} = \frac{1}{2} \frac{\gamma^l C + L}{1 + \hat{k}} - \frac{1}{2} \frac{\gamma^h C + L}{1 + \hat{k}} < 0. \quad (66)$$

## Case 2

Suppose that  $\frac{\gamma^l C}{L} - 1 < \alpha$  holds.

1. If  $0 < \hat{k} \leq \frac{\gamma^l C}{L} - 1$ , cross-border financial services will be associated with higher payments than multinational banking if

$$\Delta_{0 < \hat{k} \leq \frac{\gamma^l C}{L} - 1} := \frac{W(0)}{1 + \hat{k}} - \frac{3V(1,0) + U(0,0)}{2} > 0. \quad (67)$$

By the same arguments as in Case 1, first part, the difference in repayments reaches its maximum at  $\hat{k} = 0$ , which is strictly positive if and only if  $\frac{3}{5} > \frac{(\gamma^h - \gamma^l)C}{\gamma^l C - L}$ .

2. When  $\frac{\gamma^l C}{L} - 1 < \hat{k} \leq \alpha$ , cross-border financial services will never yield higher repayments because

$$\Delta_{\frac{\gamma^l C}{L} - 1 < \hat{k} \leq \alpha} = \frac{2W(1) - (1 + \hat{k}) [3V(1,0) + U(0,0)]}{2(1 + \hat{k})} < 0. \quad (68)$$

3. By the same arguments as in Case 1, third part, cross-border financial services will always yield lower repayments than multinational banking when  $\alpha < \hat{k}$ .

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