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Regulation of Multinational Banks: A Theoretical Inquiry*

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Abstract

This paper examines the prudential supervision of multinational banks. We show that the liability structure between home and foreign units and the division of regulatory tasks among national regulators are crucial to the incentives to monitor bank's activities and to regulatory intervention. Shared liability among the bank's units results in higher incentives for monitoring and intervention than when units are legally separate entities. Cross-border deposit insurance by a single national authority results in lesser incentives to intervene, but may improve monitoring as compared with a situation in which regulators only compensate local depositors. We also draw implications on the multinational banks' preferences over the representation form for foreign units, and consider the effects on regulators' behavior of bank's lobbying and international cross-ownership.

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1 Introduction

Multinational banking has expanded significantly as barriers to international capital flows and to foreign market entry have been progressively dismantled.[1] The rapid development of multinational banks (MNBs hereafter) represents a source of new concerns for regulators. An MNB consisting of a home bank and a number of foreign-located banks can easily take advantage of ill-harmonized national supervisors. Furthermore, regulation of an MNB in one country may well affect the behavior of the bank and of regulators in other countries. This paper provides a simple framework for examining regulatory actions by independent national authorities in a multinational bank setting. We analyze national regulators' incentives to monitor and intervene in bank units, and the extent to which these incentives differ with the type of foreign incorporation chosen by the MNBs.

The model posits an MNB that operates in two countries, collecting money from depositors and investing locally in risky and illiquid projects. On the basis of available information, regulators decide whether or not to intervene in the unit for which they are responsible (e.g. to protect the assets of a given unit and to limit the MNB's exposure to certain categories of risk). Intervention, however, is a partial remedy for two reasons. First, the information upon which regulators act is imperfect so that intervening might stop valuable investments (a type I error), or might allow the continuation of bad projects (a type II error). Second, even if it secures some minimal amount of assets, intervention always has some costs for the regulators.

A clear understanding of the supervision of MNBs also requires a full description of the liability structure between the home and foreign units and of the division of regulatory tasks between national regulators. These two dimensions are generally implied by the representation or incorporation form chosen for units in foreign countries; in this respect we consider two types of representation for the foreign unit, namely branch and subsidiary.[2] We are interested in exploring how regulatory intervention is affected by the MNB's foreign representation.

The bank constitutes a single legal entity when its business abroad is conducted via branches, so that the home unit shares joint liability with the foreign branch for its losses (and viceversa). Subsidiaries, on the other hand, are separately incorporated entities. The home unit is shielded from losses of subsidiaries, but as subsidiaries are themselves assets of the home bank, a subsidiary shares liability with the home bank for losses in the home country. The higher independence of subsidiaries relative to branches is also reflected in the allocation of supervisory tasks. For branch MNBs, supervision is centralized at the home regulator, who also provides deposit insurance for all depositors (independently of their location). In subsidiary MNBs, the home and foreign

[1] Total assets held by the overseas units of US banks doubled from 1992 to 1996. In the US, foreign banks accounted for almost 10 percent of deposits in 2000 (Buch and Golder, 2001) and, in 2001, for 20 percent of total bank assets and 26 percent of total business loans (Federal Reserve Board, 2002). In Central Europe bank assets controlled by foreign banks rose from 8 percent in 1994 to 59 percent in 1999. Almost 50 percent of total bank assets in some Latin American countries are controlled by foreign banks (IMF, 2000). For more details, see Calzolari and Loranth (2003).

[2] Other forms (e.g. correspondent banks, representative offices and agencies) do not allow the full range of banking activities and are thus much less pertinent to our analysis.

regulators have independent power over the locally incorporated unit, and depositors call upon the local deposit insurance scheme in the event of bankruptcy.[3]

We show that there is a material difference in the likelihood of intervention between branch and subsidiary MNBs. The difference can be attributed to (i) *a liability effect* and (ii) *a lack of coordination* among regulators. Where it occurs, shared liability among the MNB's units provides more incentive for regulatory intervention than when units are legally separated, since regulators can reduce the cost of intervention in one unit by taking assets from the other. This liability effect applies to branch representation and also to the behavior of the home regulator with subsidiary representation. On the other hand, for a given liability structure, responsibility for insuring depositors in both countries (as with branch representation) makes a regulator internalize the full costs of its decisions. In particular, the regulator knows that although intervention in a given unit secures some assets, these are typically not sufficient to cover also possible losses in the other unit, thus making intervention more costly. This reduces the incentive to intervene, as compared to a situation where regulators only compensate local depositors and do not coordinate their actions as with subsidiary representation).

These considerations carry a number of implications concerning regulators' behavior who are assumed to minimize the (expected) costs of the deposit insurance fund, in the base model.[4] When the MNB is via subsidiary, the home regulator is 'tougher' than the foreign one (i.e. it intervenes in the home unit for a larger set of parameters than the foreign regulator in the unit abroad). Joint liability makes the home regulator a residual claimant on foreign assets and the value of this claim is greater if intervention occurs at home than if the regulator takes no action: intervention makes the claim certain, while with no action the claim is only valuable if the home unit fails. Further, as the value of this claim is larger if there is no foreign intervention, the home regulator is more likely to step in by no foreign intervention. On the contrary, there is no such effect for the foreign regulator because in subsidiary representation the home unit is shielded from foreign losses.

We also show that the home unit falls under 'softer regulation' (i.e. intervention takes place for a smaller set of parameters) with branch than with subsidiary representation. As the home regulator with subsidiary is not responsible for foreign depositors, it does not internalize the impact of its decision on foreign costs; that is, there is lack of coordination, inducing more intervention on the home unit. On the other hand, foreign subsidiary faces softer regulation than a foreign branch if the home unit's prospects look good but tougher if they look bad. As discussed above, the liability effect pushes the regulator to a tougher stance towards the foreign branch, while the coordination effect should induce softer behavior: in the end, the balance depends on the

[3] This description closely follows current EU regulations (see Dermine 2002). In the US, branches of foreign banks are treated as separate entities and supervised by US authorities, similarly to subsidiaries under the EU rules (for more details see Houpt 1999 and Bain et al. 2003). Albeit the terminology is different between the US and the EU, what matters for our analysis is the liability structure and the allocation of regulatory powers.

[4] The FDIC in US was given this type of objective function by the FDICI Act of 1992, which mandated a least-cost resolution method and prompt resolution approach. The FSA in the UK shares a similar mission. In the academic literature, regulators' role in insuring deposits has been emphasized by Mailath and Mester (1994) and Repullo (2000, 2001), among others.

prospects of the home unit (i.e. its probability of success). When these are poor, intervention is likely at home and only the second effect is relevant, whilst if home prospects improve, the first effect prevails.

The different regulatory regimes a bank faces are often said to be relevant to the choice of foreign representation (even if it is certainly not the sole driver of the decision: see Houpt 1999, Calzolari and Loranth 2003, Focarelli and Pozzolo 2003). By comparing the likelihood of intervention with a foreign subsidiary or branch, we can show that when the prospects of the home unit are not very good, a branch representation is preferred, as it induces more lenient regulation over all units; otherwise, a foreign subsidiary is preferred.

On the basis of these results, we also examine regulators' incentives to monitor and learn the real prospects of the unit they are in charge of. We show that with a subsidiary MNB, the foreign regulator has more incentive to monitor the local unit than the home regulator. Further, the incentive to monitor is larger with a branch MNB because the regulator in this case centralizes monitoring decisions over both units and internalizes the full value of monitoring.

Beside costs, regulators may also be concerned with a bank's profits as a consequence of successful lobbying, say, or because bank's profits affect the financial stability of the local banking sector. One would expect profit concerns to shift regulators' decisions towards greater forbearance, and we show that this is indeed the case with branch representation. However, the impact of profit concerns on the regulation of a subsidiary MNB is much less clear-cut, often leading to (unexpected) strategic interaction among national and independent regulators. Our analysis also shows that anticipating regulators' behaviors, a subsidiary MNB prefers to concentrate its lobbying effort on the home regulator, because by increasing the latter's stake in profits, it may induce both regulators to be more lenient. For the same reason, if the bank can control the international distribution of its ownership shares, it may prefer to concentrate ownership in the home country.

Finally, comparing these results with efficient regulation that would maximize welfare in the two countries, we show that unless the home project is particularly promising, cost-minimizing regulators reach more efficient decisions with branch representation than with subsidiary one. Furthermore, this is always the case with regard to monitoring decisions and also when regulators put a sufficiently high weight on the MNB's profitability.

Our paper is part of a growing literature on the regulation of MNBs. Calzolari and Loranth (2003) provide a general introduction to the issue.[5] Holthausen and Rønde (2002), Acharya (2002), Dell'Ariccia and Marquez (2005) and Dalen and Olsen (2003) address the problem of divergent interests and lack of coordination between national regulators. Our new insight is that divergency of interests (and decisions) between regulators might be the result of the type of representation chosen by the MNB. Unlike to those papers, we examine in detail the interplay between the MNB's liability structure and the allocation of supervisory functions and their effect on prudential supervision and monitoring. The question of whether the form of MNB representation makes a difference for regulation has also been raised by Harr and Rønde (2004) and by Loranth and

[5] See also Calzolari (2001) and (2004) for an analysis of regulation of multinational enterprises in the context of public utilities.

Morrison (2003).[6] Those papers focus on optimal capital requirements, however, our contribution focusses on regulators' incentives to acquire information and take disciplinary actions. In an early analysis Repullo (2001) addresses the problem of domestic regulator's limited information (for supervision and deposit insurance) and offers some conclusions concerning the incentives that lead to cross-border takeovers. Our paper differs in studying the effects on regulation of the form of MNB representation and in endogenizing regulators' information, with a more general objective function for regulators. Finally, our modelling choice of supervision also relates to Mailath and Mester (1994) who were the first to analyze regulatory closure decisions of bank's activities.

The rest of the paper is organized as follows. Section 2 presents the base model. Section 3 analyzes regulators' incentives to intervene under the two representations. Section 4 compares regulations and discusses bank's representation preference. Section 5 extends the base model to regulatory monitoring and regulators who are also concerned by MNB's profit. Section 6 concludes. All proofs are in the Appendix.

2 A model of the regulation of multinational banks

Consider an MNB incorporated in country h (the home country) and with a unit in country f (the foreign country). The MNB raises fully insured deposits of amount 1 in each country and invests them locally. Deposits pay an interest rate that is normalized to zero. Each unit runs an illiquid and risky project that pays out either R (in case of success) or 0 (in case of failure) at the last stage of the game $t = 2$.

At $t = 1$ the probability of project $i = f, h$ returning R at $t = 2$ is $p_i \in (0, 1)$ and, acting upon this knowledge, regulators decide whether or not to intervene in the unit for which they are responsible. We refer to this as prudential regulation. Intervention (indicated by I) results in early liquidation of the project, yielding $L \in [0, 1)$; more generally it can be thought of as conservatorship, or ring-fencing, i.e. a move to protect the assets of a given unit or to limit the exposure of the MNB to certain categories of risk. Alternatively, the regulator may decide to take no action, which we indicate with O (for open). We assume that (i) at $t = 2$ a successful project returns more than the amount invested, i.e. $R > 1$, but (ii) if one project is liquidated at $t = 1$ or fails at $t = 2$, the MNB's assets are insufficient to reimburse depositors in both countries, regardless of the other project's realization, i.e. $R + L < 2$.[7]

Regulators' objective. The appropriate objective function for a bank regulator is debatable. The mission of the FDIC in the US, for example, is to minimize the expected costs of bank failures. However, regulators in other countries might also be concerned with bank's profitability. We consider both scenarios. First, we assume that regulators minimize the (expected) deposit reimbursement costs that may arise as a consequence of intervention at $t = 1$ (named intervention costs) or failure at $t = 2$ (named failure costs). In Section 5.2, we discuss prudential regulation

[6] In a different setting, Kahn and Winton (2003) also examine the effect of financial institutions' structure (subsidiary or unitary) on risk-taking and project selection.

[7] When assumption (ii) is not verified, regulators are induced to extreme and not particularly interesting behavior. In the following we will briefly discuss the consequences of relaxing assumption (ii).

under the assumption that regulators are concerned with national welfare and also care about the MNB's profits.

Foreign Representation. We examine two types of representation for the foreign unit: subsidiary and branch.

A foreign *subsidiary* is a separately incorporated entity in the foreign country that shares the liability for the home bank' s losses, but for whose losses the home bank is not liable. More precisely, in case of home failure all remaining residual assets in a solvent foreign unit - after foreign depositors are paid off - must be used against home liabilities. No such transfer from a solvent home unit to an insolvent foreign subsidiary is required. With a subsidiary MNB, each national regulator performs prudential regulation over its local unit and insures local depositors. Regulators' decisions are assumed to be taken non-cooperatively.

Branches can be thought of as extensions of the "mother" bank, thus forming a single entity. In this case, insolvency occurs when the total assets of the MNB in both units fall short of total liabilities. The regulator in the home country performs prudential regulation and insures depositors in both countries. In an insolvency, local depositors are paid off first from local assets (if there are any), and the regulator collects the remaining assets to reduce the deposit insurance fund losses in the other country. This particular description is only for convenience because, as noted, the home regulator insures depositors in both countries. At $t = 1$ the regulator's decision is for intervention in one, both or neither of the two units.[8]

Regulators and bank managers are risk-neutral and there is no discounting. We summarize our base model with the following timing of the moves:

Timing

- At $t = 0$: The bank collects deposits in both countries and invests them in risky projects.
- At $t = 1$: Regulators decide whether to intervene in the project of the unit under their respective jurisdiction.
- At $t = 2$: Payoffs are realized and depositors are repaid.

In what follows we refer to the regulator by location. Thus, the single regulator of a branch MNB and the home unit of a subsidiary MNB is the *home regulator*. The regulator of the foreign unit in a subsidiary MNB is the *foreign regulator*. For any pair of regulatory decisions, the first letter will refer to unit h and the second to unit f, e.g. (I, O) means that the regulator in charge of unit h intervenes, and the one in charge of unit f does not.

Finally, our aim is to analyze regulators' decisions when they face an MNB that operates actively in both countries, the manager investing in both projects so as to lead an MNB. To imagine such a situation, one may postulate that the manager is motivated by profit maximization,

[8] Current EU regulations follow the principle of home country supervision. Hence, the competent authority supervising the bank is the country where the bank is initially licensed. Supervisory responsibilities cover the activities which are carried out in the form of branches throughout the EU or by cross-border supply of services. See the Second EU Banking Coordination Directive issued in 1989 and made effective on January 1, 1993.

and at the time he decides whether to run one, two or neither of the projects (i.e. $t = 0$), the information available induces him to undertake both. Alternatively, he has private benefits from running a large international bank.[9]

3 Prudential regulation

We first define two useful benchmarks. *Efficient prudential regulation* means maximization of the joint welfare of the two countries. As returns from investment in the two units are independent, the optimal intervention rule in country i does not depend on the information or the decision on the unit in country j. For a probability of success p_i, no intervention in unit i yields expected welfare $-(1-p_i)1 + p_i(R-1)$ and intervention results in $-(1-L)$ (recall that reimbursing depositors in one country costs -1). Thus, when the expected returns p_iR are larger than the liquidation value L, or $p_i \geq L/R$, the optimal course of action is no intervention. Clearly, this decision rule is efficient regardless of the number of units and projects. On the other hand, the *cost-minimizing regulator of a single-unit bank* faces the following trade-off. Early intervention at $t = 1$ leads to cost $-(1-L)$, while taking no action might lead to zero costs if the project yields returns R, but might result in a regulatory cost of -1 if it returns zero. The regulator, therefore, compares the liquidation value L that can be obtained from intervention with the unitary (reimbursement) cost saving that can be expected with probability p_i in the case of non-intervention. Hence, for $p_i \geq L$ non-intervention is optimal. It is immediate to see that, as the cost-minimizing regulator cares only about the downside but not the upside of returns, intervention occurs more often than under a welfare-maximizing regulator.

3.1 Branch MNB

Joint liability among the units of a branch MNB implies that decisions concerning one unit affect decisions about the other, and the regulator internalizes the cost of intervention in either unit, being responsible for depositors in both countries.

Assume the regulator intervenes in unit j. Assets will then fall short of liabilities so that the regulator becomes residual claimant for assets (if any) in unit i, as if it were an equity holder in that unit. Thus, the regulator prefers intervention in unit i if the liquidation value L is larger than the expected return p_iR. Meanwhile, if the regulator does not intervene in unit j, it incurs a lower cost in unit i when project j pays out, because the units are jointly liable. Further, upon intervention in unit i, the expected value of the residual assets from j is $p_j(R-1)$; and with no intervention in unit i the residual assets $(R-1)$ are only useful if project i fails, i.e. with overall probability $(1-p_i)p_j$. Hence, residual assets in unit j have a higher value for the regulator when it intervenes in unit i than when it takes no action which is then optimal only if $p_i \geq \varphi_i$ where $\varphi_i \equiv \frac{L}{R-2(R-1)p_j} \geq L/R$. The potential "equity" returns in one country (implied by shared liability) may increase regulator's incentives to intervene in the unit of the other country.

[9] Note that information at the investment stage $t = 0$ is not necessarily the same as that available to regulators at the decision stage $t = 1$, so that the manager may choose to run an MNB.

Accordingly, the decision to take no action in one unit tends to make the regulator tougher on the other unit (i.e. to intervene more often or for a larger set of parameters). We refer to this as a *liability effect* because it is induced by shared liability.

To summarize, if $p_k \geq \varphi_k$ for both units (i.e. $k = h, f$) there will be no intervention at all and for $p_j > L/R$ but $p_i < \varphi_i$ there is intervention in unit i but not in unit j. Finally, for $p_j < L/R$ in both units, intervention occurs in both of them. This is described in the following figure where we indicate all possible pairs of decisions according to the probabilities of success for the projects (p_h, p_f). Note also that the regulator's decision process is symmetric with respect to the two projects. Hence, along the 45° degree lines, either the decisions are the same, or the regulator is indifferent between (I, O) and (O, I).[10]

[Insert Figure 1 here]

Clearly, better prospects for a unit always induce the regulator to be more lenient with that unit because lower costs are expected. Furthermore, a higher probability p_j of success in project j lowers the regulator's expected cost for the other unit i for any decision, because expected residual assets available from unit j increase. However, as explained above those residual assets have a greater value upon intervention than non-intervention in unit i.

The following proposition summarizes the results and discusses the effects of information on decisions.

Proposition 1 (Regulation of a Branch MNB) *(i) Regulatory decisions for the branch MNB units are substitutes, so that intervention in one unit tends to trigger less intervention in the other. (ii) Better prospects for one unit induces the regulator to be softer on that unit but tougher on the other. Similarly, poorer prospects induce the regulator to be tougher on that unit but softer on the other.*

As discussed above, the regulator's decision on a branch MNB unit coincides with efficient regulation as long as the other unit has poor prospects, so that intervention takes place. This no longer holds when prospects (i.e. p_h and p_f) in both units are sufficiently good to make it optimal not to intervene in at least one. In this case, a regulator of branch MNB is tougher than a welfare maximizing regulator. This is because intervention in unit i, makes the claim to the residual assets of the other unit j certain, but with non-intervention in i this claim will be good only if unit i fails. Furthermore, responsibility for depositors in both countries makes the regulator more lenient with unit i when it intervenes in unit j, as compared with the cost-minimizing regulator of a single-unit bank. On the other hand, the opposite may occur when the regulator takes no action in unit j because the equity stake in unit j may make it tougher on unit i.

[10] If $R + L > 2$ the payoffs from decisions (I, O) and (O, I) increase and the associated areas in figure 1 become larger. In fact, the boundary for decisions (O, O) becomes $p_i \geq \tilde{\varphi}_i \equiv \frac{L - p_j R}{R - 2(R-1)p_j + L - 2} \geq \varphi_i$ so that the regulator becomes tougher as compared with the case in the text. It also follows that decisions (O, O) may never occur, reducing the relevance of this case.

3.2 Subsidiary MNBs

With a subsidiary MNB regulation is decentralized; that is at $t = 1$ the home and the foreign regulators make decisions about the local unit simultaneously and non-cooperatively.

The foreign regulator's decision is no different from that of the cost-minimizing regulator of a single-unit bank. Due to the limited liability of the home unit for the foreign subsidiary's losses and the precedence of foreign depositors as regards the subsidiary's assets, the decision of the foreign regulator is not affected by the prospects of the home unit or by the decision of the home regulator. The foreign regulator elects intervention in the subsidiary if the liquidation value L is larger than the expected cost reduction from leaving it open, i.e. p_f.

The situation for the home regulator is different. If the foreign unit is successful at $t = 2$, the home regulator can use the residual assets from that unit to reduce home costs. Intervention in the foreign unit, by contrast, leaves no foreign assets to transfer home. Thus, the home regulator would prefer the foreign regulator to be lenient, leaving additional assets to safeguard home deposits. In other words, the home regulator's decision does depend on the foreign regulator's decision. In particular, if there is no intervention abroad, the home regulator intervenes if $-(1-L)+p_f(R-1)$ (its payoff upon intervention) is smaller than $-(1-p_h)+(1-p_h)p_f(R-1)$ (its payoff by keeping the unit open) or, $p_h \leq \delta_h$ where $\delta_h \equiv \frac{L}{1-p_f(R-1)} \geq L$. On the other hand, with foreign intervention, the decision of the home regulator clearly coincides with the regulator of the single unit and intervention is optimal if $p_h \leq L$.[11]

It is plain to see that non-intervention in the foreign unit tends to make the home regulator tougher with the home unit. If the home regulator intervenes in the home unit at $t = 1$ it has a certain claim to the residual assets of the foreign unit, while upon non-intervention this claim materializes only if the home unit fails. Thus, the ex ante value of this claim is greater upon intervention than without. This corresponds to the liability effect illustrated for branch MNBs.

Combining the regulators' decisions, we can draw the following figure to describe the unique equilibrium decisions for any pair of probabilities (p_h, p_f).[12]

[Insert Figure 2 here]

Concerning the effect of information on regulation, note that the foreign regulator's decision is clearly unaffected by p_h, as it cannot benefit from any home residual assets. On the contrary, better prospects for the foreign project (i.e. higher p_f) makes it more likely that the home regulator can reduce its costs and, as illustrated for the branch MNB, this effect is more pronounced on the regulator's payoffs associated with intervention.

[11] If $R + L > 2$, regulators' payoffs are unaffected, except with decisions (I, O) where the payoff to the home regulator increases (as compared with the case in the text) and the boundary for the home regulator becomes $\tilde{\delta}_h \equiv \frac{L(1-p_f)+p_f(2-R)}{1-p_f(1-R)} \geq \delta_h$. Clearly, if the home regulator expects costs to be "bailed out" completely by foreign residual assets, it will be tougher on the home unit.

[12] In Section 5.2 we discuss how restriction to pure strategies is without loss of generality when regulators are cost minimizers.

The following proposition summarizes the results and discusses the effects of information on decisions.

Proposition 2 (Regulation of a Subsidiary MNB) *With subsidiary representation, (i) more lenient foreign regulation induces tougher home regulation; (ii) Ceteris paribus (i.e. for $p_h = p_f$), the home regulator is tougher than the foreign one; (iii) Favorable information on the foreign unit (i.e. higher p_f) induces the home regulator to be tougher and in all other cases, favorable information induces softer regulation (the inverse applies when information is unfavorable).*

Regulation of a subsidiary MNB is expected to differ from efficient regulation. First, cost-minimizing regulators are clearly tougher in general than social-welfare maximizing ones and the potential equity stake in the foreign unit makes this bias even more pronounced for the home regulator. Second, the potential equity stake in the foreign unit makes the bias even more pronounced for the home regulator, as explained above.[13] Finally, the foreign regulator acts precisely as a regulator of a single-unit bank (with cost-minimizing objective), whilst the home regulator is tougher because of the equity stake in foreign residual assets.

4 Prudential regulation and foreign representation

Our previous analysis allows to identify two main drivers for different regulations with branch and subsidiary MNBs.

Coordination effect. In a subsidiary MNB national regulators, each being responsible only for claims in its own country and acting independently, fail to internalize the effect of their decisions on the other country, unlike the regulator of a branch MNBs, who insures depositors in both countries.

Liability effect. The home unit is not liable for the losses of the foreign subsidiary, so the foreign regulator cannot count on residual assets located at home. In the branch representation, this asymmetry does not apply.

For a convenient decomposition of different decisions into these two effects, we consider a fictitious representation with two national regulators but with the symmetrical liability structure of a branch MNB. This hybrid representation differs from a subsidiary MNB in that the foreign regulator can draw on residual home assets when foreign assets fall short of deposit liabilities. By comparing decisions in a subsidiary MNB with those in the hybrid representation, we can isolate the pure *liability effect*. It is easy to see that in the hybrid representation the foreign regulator is tougher on the foreign unit than with a subsidiary MNB. As explained above, the regulator's equity stake in the home unit has greater value with intervention than without. For the same reason, therefore, the foreign regulator is tougher when it can use home assets to safeguard foreign depositors. In response to tougher behavior on the foreign unit in the hybrid representation, the

[13] In section 5.2 we show that even if the home regulator cares about the MNB's profits, Proposition 2 still stand as long as it weights profit less than costs.

home regulator may go softer on the home unit, as compared with the home regulator of a subsidiary MNB.

Next we compare decisions in the hybrid representation with those under a branch MNB. Any difference that emerges can be attributed only to the *lack of coordination* when two independent regulators act instead of a single one. The single regulator of a branch MNB internalizes all the potential benefits of keeping unit i open in terms of the residual assets that this unit may provide to reduce costs in unit j. Hence, full responsibility for deposit insurance in both countries induces the regulator of a branch MNB to be more lenient than the two regulators under the hybrid representation.

Adding the liability effect and the lack of coordination effect together, we get the overall comparison between decisions with subsidiary and branch MNBs.

Proposition 3 (Regulation: Subsidiary versus Branch) *The home unit is subject to softer regulation with the branch than the subsidiary representation. The foreign unit is subject to softer regulation with branch than subsidiary if* $p_h \leq \max\{L, 1/2\}$, *and to stricter regulation otherwise.*

Consider first the decision on the home unit. By adding the liability and the lack of coordination effects discussed above, it is immediate to see that regulation is softer with a branch than with a subsidiary MNB: both the effects point in this direction.[14]

With the foreign unit, things are more complicated. Because of shared liability, foreign branches face tougher regulation than subsidiaries. On the other hand, a single regulator that cares for deposit insurance costs in all countries tends to be softer on all units, i.e. also on the foreign one. Hence, the liability effect and the lack of coordination effect have opposite impacts on the decision. Interestingly, Proposition 3 shows that the probability of success of the home unit's project discriminates between these two countervailing forces. When p_h is low, intervention in the home unit takes place. Coordination makes regulation more lenient under the branch representation, while the liability effect vanishes because there are no residual assets in the home unit. On the contrary, when p_h is large enough there is no intervention in the home unit and both effects are present. But the higher p_h, the more attractive is intervention in the foreign unit when home assets can be exploited. Moreover, a higher p_h also implies that the lack of coordination effect is limited, because it is unlikely that foreign residual assets will be needed to reduce losses of the home unit. Hence, with a higher value of p_h the liability effect dominates lack of coordination, and regulation on the foreign unit is tougher with a branch than a subsidiary MNB.

4.1 Foreign representation: bank's choice and welfare implications

What is the MNB's preferred foreign representation and what are its consequences in terms of regulatory costs and welfare?

Several factors may play a role in banks' choice of foreign representation. The empirical literature has emphasized the importance of regulation (see Ursacki and Vertinsky 1992, Blandon

[14] For extreme values of p_f and p_h decisions necessarily coincide with the two representations. Hence, the statement of the Proposition 3 should be intended with a "weakly" qualifier.

1999 and Houpt, 1999). In this respect Proposition 3 may provide some indications. Consider a bank that is run by managers who maximize profits or want as many units as possible reaching the last stage with no intervention (say because they derive private benefits on managing projects up to $t = 2$). Anticipating regulators' decision in $t = 1$, the banker may then choose subsidiary or branch.[15]

If $p_h \leq \max\{L, 1/2\}$, one can expect softer regulation for both units and greater expected profits with branch than with subsidiary. But, if $p_h > \max\{L, 1/2\}$, countervailing forces arise because a branch MNB may enjoy more lenient regulation at home, but a foreign branch may face a tougher regulation than a subsidiary. In fact, if $p_f \geq p_h$ the home unit faces tougher regulation with subsidiary MNB, while the foreign unit faces the same decision irrespective of the representation form; if $p_f < p_h$ the home unit faces the same decision for both representations, while a foreign branch is subject to tougher regulation than a subsidiary. Hence, we can state the following.

Proposition 4 (Bank's choice of representation) *Assume that the bank maximizes profits or has a bias for continuation of projects. It prefers a foreign branch if the units are ex-ante identical (i.e. $p_h = p_f$), or the home unit is risky (i.e. $p_h \leq \overline{p}_h \equiv \max\{L, 1/2, p_f\}$). On the contrary, when the home unit is sufficiently safe (i.e. $p_h > \overline{p}_h$) the bank will prefer a subsidiary.*

Europe has a "single passport" scheme (EEC, 1989) designed to reduce protective barriers to entry by allowing any EU bank to establish branches elsewhere in the EU. This legislation notwithstanding, many banks have preferred to expand by establishing subsidiaries within the EU (Dermine, 2002). Similarly, subsidiaries of EU and US banks dominate in both Latin America and Eastern Europe, where banks may choose freely between branch and subsidiary. Though our stylized model fails to consider other important factors in banks' choice, it does explain this behavior on the assumption that banks in the EU and the US hold quite a safe portfolio of projects at home and that foreign projects available in Latin America or Eastern Europe are on average riskier. On the other hand, there is evidence that Asian banks prefer branches for expansion outside Asia.[16] This conforms with our prediction that branches should be more common when the home investment is not sufficiently safe.

Banks are not always free to chose the preferred representation for foreign units. In some cases, host regulators restrict this choice by imposing a specific representation(s) on foreign banks. It is thus interesting to study the properties of representations in terms of welfare, independently of whether they are obtained as the bank's choice or as a restriction adopted by national regulators. As previously discussed, cost-minimizing regulators intervene too much with respect to what

[15] For the sake of the exposition, here we simply consider the case in which the banker knows p_h and p_f. Alternatively, assuming that the manager does not know them, one could have to specify a probability distribution for p_h and p_f and calculate the probability of ending in one of the regions associated with different regulatory decisions. However, the analysis would remain qualitatively unaffected.

[16] Japanese banks, for example, seemingly preferred branches in their expansion into the US and the EU. See the BIS Report (2001) on the activities of multinational banks in emerging markets. See also Focarelli and Pozzolo (2003).

welfare maximization would prescribe. If $p_h \leq \max\{L, 1/2\}$ the branch representation induces softer regulation for both units as compared with subsidiary-MNB and it is thus closer to the welfare maximizing decision than the subsidiary one. This is also true if $p_h > \max\{L, 1/2\}$ but $p_h \leq p_f$. On the contrary, if $p_h > \overline{p}_h$ the two representations lead to the same decision on the home unit and there will be intervention with branch but not with subsidiary representation. Thus, the subsidiary representation brings closer to welfare maximizing decisions.

5 Extensions of the base model

In the previous sections, regulatory information was assumed to be cost-free and exogenously given. However, information acquisition is crucial in drawing a balance between centralized and decentralized MNB supervision. In Section 5.1 we extend the base model by adding an information acquisition stage and examine regulators' incentives to acquire information on the units' prospects.

Unlike the base model, regulators may be concerned with the MNB's profits for several reasons. In section 5.2 we then discuss how profit concerns change regulators' decisions in a multinational setting.

5.1 Information acquisition

Assume that before acting on the unit(s) under their jurisdiction, regulators can decide whether to investigate with a cost c and learn a perfect signal so that at $t = 1$ p_i becomes either $p_i = 1$ or $p_i = 0$.[17] As in the base model, all available information is shared truthfully by the regulators before any regulatory intervention. This is clearly a simplification of the regulators' complex monitoring task. Information may be far from perfect and, since regulators' interests most likely differ, information sharing may not be easily accomplished. Nevertheless, we believe our simplified information game can provide some insight into regulators' monitoring incentives, because, among other reasons, credibility is essential for bank regulators, which drastically limits their willingness to conceal or misrepresent information. We come back to this point in Section 6.

We define the *value of information* V^i on a given unit $i = h, f$ as the difference between the regulator's expected payoff with and without the information. Our aim is to show how much the form of the foreign unit matters for the value of information and regulators' incentives to collect it. We restrict the probabilities p_h and p_f with no monitoring to be symmetrical and equal to $p \in (0, 1)$ so that the comparisons will not be induced by asymmetries between the two projects.

In general, with two units operating in two different countries, the value of information on unit i is influenced by three effects:

Cost-saving effect. Information on unit i permits saving on intervention or failure costs for the same unit, by avoiding type I errors (intervening in a unit when with full information the optimal

[17] A regulator has no authority to investigate a unit for which it is not responsible; or alternatively, the cost of such information is too high. Note that with a branch MNB, in our model foreign authorities have no stake and they should not be expected to search for any costly information. Furthermore, considering signals that are not fully informative would provide qualitatively similar results.

decision would be no intervention) and type II errors (no intervention when the full-information decision would be intervention).

Coordination effect. When a regulator is responsible for depositors in both countries, it internalizes that information on a unit may affect the regulator's costs and decision on the other unit. In particular, monitoring unit i may result in non-intervention and, if the project succeeds, in additional assets that can safeguard depositors in unit j.

Liability effect. When unit j is liable for the losses of unit i, monitoring unit i may alter the decision on that unit and then also the value of residual assets from j. In particular, when information changes a regulators' decision on unit i from certain intervention to intervention only if monitoring discovers failure of unit i (thus avoiding a type I error), this liability effect is negative (residual assets from j have value $(1-p)p(R-1)$ with monitoring, and $p(R-1)$ with no monitoring so that the net effect is $-p^2(R-1)$). Symmetrically, the liability effect is positive when information enables the regulator to detect and avoid type II error.

With branch MNBs, the regulator is liable for intervention costs and is entitled to residual assets in both countries, so that the value of information on a given unit may well be affected by all three effects discussed above. With subsidiary MNBs, regulators are not liable for losses in the other country, so there is no coordination effect. Nor can the foreign regulator claim home residual assets, so the liability effect is irrelevant to it.

Combining the three effects lead to the following intermediate results.

Lemma 1 *With a branch MNB, monitoring one unit acts as a substitute for monitoring the other. With a subsidiary MNB, the home regulator perceives foreign monitoring as a substitute for home monitoring, but this is not the case for the foreign regulator.*

To understand this result on substitutability, note first that if there is monitoring on unit j, the expected value of residual assets available from that unit is (weakly) larger than if unit j is not monitored (information avoids type I error). In addition, these larger expected assets will be useful to reduce costs in unit i with larger probability if i is not monitored. It then follows that monitoring unit j procures more residual assets that have greater value when unit i is not monitored. Clearly, substitutability in monitoring is a consequence of the liability effect induced by a liability structure that allows regulators to claim residual assets from units located in other countries.[18]

The next Proposition thus states our main results on monitoring MNBs.

Proposition 5 (Monitoring a multinational bank) *(i) Under subsidiary MNB, the value of information is less for the home regulator than for the foreign regulator, who has greater incentive to monitor. (ii) Information is more valuable for regulators when the bank's foreign unit is a branch rather than a subsidiary so that more monitoring takes place in both units with branch representation.*

[18] Also note that with subsidiary MNB the decision to monitor (or not) one unit does not influence the other regulator's decision at $t = 1$, which implies that neither regulator engages in "strategic monitoring", such as by delaying information acquisition.

As for result (i), note that with subsidiary representation V^h and V^f differ solely in the liability effect and Lemma 1 shows that this reduces monitoring effort for the home regulator. Part (ii) of the Proposition compares monitoring incentives under the two representations. Consider first monitoring on the home unit. The liability effect equally affects V^h in both representations, because the foreign unit is always liable for losses of the home unit. However, with a branch, the home regulator, being responsible for depositors in both countries, takes into account that acquiring information on the home unit may increase the (expected) value of residual assets which can be used to reduce intervention or failure costs in the foreign unit. Clearly, because of lack of coordination, all this is irrelevant with a subsidiary so that information on the home unit is more valuable for the home regulator in branch than subsidiary representations.[19]

Consider now the value of information on the foreign unit V^f. Note that for the foreign regulator of a subsidiary V^f is influenced only by the cost-saving effect of monitoring. On the contrary, for the home regulator of a foreign branch, a coordination effect (positive) and a liability effect (negative) also determine V^f. These effects are relevant only if, with no monitoring on the foreign unit, the home regulator decides to intervene in the foreign branch at $t = 1$, i.e. when p is sufficiently low.[20] When this is the case, the coordination effect with branch representation is equal to the additional assets in the foreign unit that can be used to reduce intervention costs at the home unit (i.e. $p(1-p)(R-1)$); comparing this with the liability effect (which is $-p^2(R-1)$, as shown above), we have that the sum of the two (i.e. $p(R-1)(1-2p)$) is positive precisely when p is small. It follows that information on the foreign unit is more valuable for the regulator in charge under branch than under subsidiary representation.

Summarizing, with subsidiary representation the lack of coordination certainly reduces the value of information on both the home and the foreign unit compared with branch representation. The liability effect works in the opposite direction, increasing the value of information for the foreign subsidiary compared to the branch. However, this is always outweighed by the coordination effect, so the value of information on any unit is systematically larger with branch than with subsidiary.

Is it the case that the larger incentives to acquire information with branch representations may also lead to too much monitoring? Interestingly, this is never the case (see the Appendix for a formal proof). The explanation for this result is that the larger incentives to monitor with branch representation have also the effect of reducing the probability of intervention. Given that with both representations regulators intervene too often compared with welfare maximizing regulation, the value of information with branch representation is closer to the value associated with welfare maximization than with subsidiary representation.

[19] Independently of the representation form, information on a monitored unit may lead to a different decision on the other unit, so that the cost saving effect of information is irrelevant. As proven in the Appendix, considering different decisions in the two representations simply reinforces the results.

[20] Otherwise, with no intervention both the internalization and the equity stake effects are nil, because the expected value of the residual assets of the home unit are the same regardless of monitoring in the foreign unit.

5.2 Welfare maximizing regulators and banks' lobbying

Regulators may also be concerned by the MNB's profits, for several reasons. Their mandate may explicitly embrace banking profitability, as when the financial stability of the local banking industry could be jeopardized by a drastic reduction in banks' profits. Alternatively, lobbying may induce the regulator to be concerned with profits (particularly in cases of imperfect delegation to regulators with private agendas).[21] This also happens when considering profits paid to local citizens who own the bank (at least in part).

We model this possibility by adding total MNB profits to the regulators' objective function, evaluated according to weights α_h and α_f, respectively for the home and the foreign regulator. Thus, regulators will be concerned for deposit insurance costs, as before, and now also, albeit to a smaller extent, for the bank's profits. Indeed, the interpretations of regulators' concern for profits suggest that costs should count no less than profits, so we here assume $\alpha_i \leq 1$ for $i = d, f$.

With a subsidiary, the new feature of the game is that when the foreign regulator is interested in the MNB's profits, the decision is affected by the status of the home unit. Recall that the MNB makes no profit if the home regulator intervenes, so that non-intervention at home induces the foreign regulator to be softer; a strategy that enables it to benefit from the MNB's profit. Meanwhile, for non-intervention abroad, the home regulator's decision is shaped by two forces. As in the base model, the home regulator's claim to the residual resources of the foreign unit has a higher value with intervention than without. With home intervention on the other hand, MNB's profit are nil at home and abroad. Costs counting no less than profits, the first effect has a greater impact on the decision so the home regulator is tougher when the foreign regulator is softer, exactly as in the base model.

The following Proposition illustrates the effects of regulators' concern with profits under the two representations.

Proposition 6 (Effects of Profits on Regulation) *With a foreign branch, larger profit weights α_h and α_f induce softer regulation on both units. With a foreign subsidiary, larger profit weights induce softer regulation, except for the home regulator who becomes tougher when α_f increases. For $\alpha_f > 0$, $\alpha_h < 1$ and intermediate values of p_h and p_f, regulators follow mixed strategies.*

As one would expect, the regulator of a branch MNB is more lenient when more importance is attached to the bank's profits. Less obvious is what happens with a subsidiary. Certainly, each regulator becomes less strict when it cares more about profits. Also, the foreign regulator tends to be more lenient if the home regulator does not intervene. Hence, by inducing the home regulator to be softer, a larger α_h makes the foreign regulator softer as well. On the other hand, by inducing the foreign regulator to be lenient, a larger α_f makes the home regulator tougher.[22]

[21] Grossman and Helpman (1994), Feenstra and Lewis (1991) and Calzolari (2004) use this interpretation for regulators' stake in profits of firms.

[22] If $R + L > 2$, regulators' payoff is unaffected except for strategies $d_h = I$, $d_f = O$, in which case it increases as compared with the case discussed in the text. Hence, the home regulator gets tougher and the foreign regulator softer, so that areas (O, O) and (I, I) contract whilst (I, O) expands. With a branch MNB the same effects occur,

An interesting consequence of this is the emergence of mixed strategies. Assume, for example, that the home regulator elects to intervene. As discussed above, this may prompt the foreign regulator to intervene, which, in turn, may make the home regulator change its decision to non-intervention. This cyclical pattern of decisions shows that a pure strategy equilibrium may not exist.[23] The presence of mixed-strategy equilibria is interesting; it is not unreasonable that a regulator may want to intervene with positive probability but not with certainty (the equilibrium is unique either in pure or in mixed strategies, as show in the Appendix). In the bank regulation literature, Freixas (1999) suggests that, to improve bankers' *ex-ante* incentives, the lender of last resort may employ mixed strategies to create a measure of "constructive ambiguity" with respect to the bail-out decision. Interestingly, the kind of ambiguity that emerges in our model for the regulator's decision is clearly independent of this motivation and is a consequence of strategic interaction between two independent national regulators.

To some extent, the weights that regulators assign to profits may also be conditioned by the MNB's own activities, such as lobbying or modifying the international distribution of ownership shares. In this respect, Proposition 6 sheds light on bank's preferences concerning these weights, as the following Corollary shows.

Corollary 1 (Lobbying and Ownership Structure) *With a subsidiary, a multinational bank prefers to lobby and / or concentrate ownership at home rather than abroad.*

By allocating its lobbying resources so as to increase the home regulator's concern with profit, the MNB may induce both regulators to be softer and expect larger profits. On the other hand, lobbying the foreign regulator may have the adverse effect of inducing the home regulator to intervene, leaving zero profits. For the same reason, if the bank can control the international distribution of its ownership shares, then it may prefer to concentrate ownership in the home country.

Now let us examine how introducing a regulatory concern with profits may affect the comparison between the two representations.

Proposition 7 (Subsidiary versus. Branch with profits) *In cases where regulators also value profits: (i) For a given decision in the foreign unit, the home unit faces more lenient regulation with branch than with subsidiary representation; (ii) For intervention in the home unit, the foreign unit faces softer regulation under branch representation; for non-intervention in the home unit this is the case if and only if the probability of success of the home project is sufficiently low (i.e.* $p_h \leq \tilde{p}_h \equiv 1/\left[2\left(1-\alpha_h\right)+\alpha_f\right]$*).*

and in addition area (O, I) also expands symmetrically to (I, O). Further, regulators tend to be tougher when the probability of success of projects is high and more lenient when it is low. With both type of representations, our analysis remains qualitatively unaffected.

[23] For extreme values of p_h and p_f, each regulator would either prefer to intervene or not to intervene at all, regardless of the other's decision. Hence, no mixed strategies occur. A full characterization of pure and mixed strategies is in the proof of Proposition 6.

With a subsidiary MNB, the mixed-strategy equilibria make the comparison of regulation under the two representations not particularly informative, with regard to "actual" decisions (i.e. decisions that are made on the basis of the mixed-strategy equilibrium). Accordingly, the Proposition 7 takes a different approach, determining the decision of one regulator for a given decision of the other. As can be seen, the results of this analysis are consistent with Proposition 3.

The effect of information on regulators' decisions is the same as in the base model with both representations (i.e. Propositions 1 and 2) when one considers (parametric regions with) pure strategies, except for subsidiary MNB, where the foreign regulator becomes more lenient when p_h increases (whilst in the base models it is unaffected by p_h). On the contrary, with mixed strategies some significant differences arise. A larger p_h increases the payoff the foreign regulator may expect (*via* the profits) by keeping the foreign unit open. Hence, to restore the foreign regulator's indifference between the two decisions when p_h increases, unexpectedly the home regulator must intervene with higher probability (recall that the foreign regulator's payoff for intervention increases if the home regulator also intervenes). The same effect applies also for p_f, so that in a mixed-strategy equilibrium the foreign regulator increases its probability of intervention when the foreign unit becomes safer.

It is also interesting to note that the difference in the value of information for the two regulators (Proposition 5) is reduced but not eliminated if regulators also care about profits. Additionally, in this case the home regulator may be motivated by strategic monitoring so as to affect the foreign regulator's decision.[24]

We finally conclude this section by briefly inspecting how decisions of regulators compare with efficient (joint welfare maximizing) ones when they also care about profits. It is immediate to see that as long as profit weights are not too high all the results of Section 3 hold: decisions with branch representation are closer to efficient ones unless p_h is large enough, in which case subsidiary representation is preferable. Furthermore, with branch representation, the larger is α_h, the less substantial is the bias towards intervention as compared with efficient regulation and, in the limit, when $\alpha_h = 1$ the regulator behaves efficiently. Similarly, with subsidiary for any $\alpha_h < 1$, $\alpha_f < 1$ both regulators pursue stricter rules than in the first best. In the limit, with subsidiary MNB the home regulator behaves efficiently when $\alpha_h = 1$. However, this is never the case for the foreign regulator, which intervenes more than the first best rule would require even for $\alpha_f = 1$: this is because it only benefits from the foreign unit's profit if the home unit is successful. We can thus conclude that with sufficiently large profit weights the branch representation is always more efficient than the subsidiary one.

[24] In fact, assume that with no monitoring on the home unit the foreign regulator intervenes. By monitoring and discovering $p_h = 1$, the home regulator can also induce the foreign regulator to change its decision and induce larger expected profit. This is never the case for the foreign regulator because the home regulator becomes more lenient when foreign monitoring shows that $p_f = 0$. However, in this case the foreign regulator intervenes in any case so that it will never be motivated to monitor by the strategic prospect of making the home regulator more lenient.

6 Discussion and Concluding Remarks

Our understanding of the complex issues surrounding the regulation of multinational banks is still rudimentary and the results of this theoretical paper and its stylized model should certainly not be accepted unquestioningly, particularly as regards policy implications. Nevertheless, our simple model does prove versatile enough to deal with several important issues in MNB regulation.

We have shown that different organizational or representation forms can generate different regulatory responses. We argue that the liability structure on MNB units and the regulator's responsibility for foreign depositors induced by a particular representation form play a crucial role in explaining these differences. With regulators concerned with deposit insurance costs, branch representation leads to more lenient regulation for the home unit than does subsidiary representation, while the regulation of the foreign unit depends on the prospects of the home unit. With these indications concerning regulatory attitude towards the two representation forms, our model also predicts that MNBs should prefer branch representation when the home unit is risky and the foreign unit is safe.

We then endogenize regulators' monitoring activity and show that with a subsidiary the foreign regulator has greater incentive to monitor than does the home regulator, while the incentive to monitor is greater for branch than for subsidiary MNBs. We also discuss the effects on prudential regulation and monitoring decisions of regulators being also concerned with the MNB's profitability. In this case, we find a rich set of results for the subsidiary representation, among them showing also that an MNB may prefer to concentrate lobbying on the home regulator. We then argue that our results on the comparison between the two representation forms in terms of prudential regulation and monitoring are not quantitatively affected by the introduction of profit concerns.

We also show that with cost-minimizing regulators, unless the home project is particularly promising, branch representation leads to more efficient regulation than the subsidiary one. Furthermore, this is always the case when bank's monitoring is an issue and when regulators put a sufficiently large weight on the MNB's profitability.

With a subsidiary MNB monitoring and prudential supervision are typically unified under the responsibility of national regulators. However, the regulator in charge of prudential supervision of a branch MNB may not be the same one that can actually monitor the foreign unit, which naturally creates misalignments between regulators, inefficient decisions and potential problems in sharing relevant informations.[25] In our analysis we abstracted from the information-sharing issue, partly because we think that the blurring of supervisory information is more likely to be a problem between countries at different levels of institutional development. In those countries, however, MNBs are more likely to choose the subsidiary form (to limit the risk exposure of the home unit) which in turn implies less need to rely on foreign supervisory information because the liability structure naturally insulates the home unit from foreign risk.

We have also abstracted from the possible direct negative spill-over from a troubled to a sound unit. One could envisage situations in which intervention by the home institutions of a

[25] See for example Repullo (2001) and Holthausen and Rønde (2002).

subsidiary MNB would produce withdrawal of assets from the subsidiary, thereby affecting the latter's chances of survival. If such negative spillover were incorporated in the model, this would create an additional problem of coordination between regulators.

We assumed that the home regulator of a subsidiary MNB makes its intervention decision without consulting the foreign regulator. Similarly, we abstract from any reputational concerns that may restrain regulators (and the bank) from making decisions with severe negative impact on other regulators. However, we believe our assumptions capture the less centralized nature of decision-making between national regulators under subsidiary representation.

In an earlier version of this paper (Calzolari and Loranth, 2004) we also allowed the MNB to move resources from country to another to save a failing unit. With resource shifting, the coordination of regulatory decisions becomes even more important. We have shown that subsidiaries might be subject to less strict regulation than branches, because resource shifting produces benefits greater for the foreign regulator of a subsidiary than of a branch: it might give the foreign regulator a way to use home assets to reduce its own costs. We also show that the results of the base model, qualitatively, also carry over in this setting. We plan to extend this analysis in a follow up of our research.

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7 Appendix

In this appendix we will refer to regulators' decisions with $d^i \in \{I, O\}$, where $d^i = I$ means that the regulator in charge of unit i intervenes on that unit and $d^i = O$ that she leaves it open (or does not intervene). By convention, the first letter in any pair of decisions (d^h, d^f) will refer to project h and the second to project f, i.e. for (d, d') we have $d^h = d$ and $d^f = d'$.

Proof of Proposition 1.

The proof is in two steps.

Step 1. Optimal decisions are described by the following non-empty regions in the probabilities space $(p_h, p_f) \in [0,1]^2$,

$$(I,I) \equiv \left\{(p_h,p_f) : \tfrac{L}{R} \geq p_i, i = h, f\right\} \qquad (O,O) \equiv \left\{(p_h,p_f) : p_i > \varphi_i, i = h, f\right\}$$
$$(O,I) \equiv \left\{(p_h,p_f) : p_h > \max\left\{\tfrac{L}{R}, p_f\right\}, \varphi_f \geq p_f\right\} \qquad (I,O) \equiv \left\{(p_h,p_f) : \varphi_h \geq p_h, p_f > \max\left\{\tfrac{L}{R}, p_h\right\}\right\}$$

where $\varphi_i \equiv \frac{L}{R-2(R-1)p_j}$ for $i \neq j$.

To prove this note that at $t = 1$, if the regulator intervenes in unit i, the MNB will be unable to pay back depositor at $t = 2$ (because $R + L < 2$). Further, if the regulator does not intervene in the other unit j and this unit ends up with a successful project (with probability p_j), the total assets of the bank will be $R + L < 2$ so that the regulator incurs a cost of $-2 + (R + L)$. On the contrary, if unit j ends up in a bad state (with probability $1 - p_j$), the bank's total

assets will be L from unit i. In instead, both units are allowed to proceed, the regulator has to reimburse all depositors if both projects turn out to be bad, with an expected cost equal to $-(1-p_h)(1-p_f)2$. Alternatively, one of the two project may turn out to succeed while the other fails (with probability $(1-p_i)p_j$) so that the regulator's cost amounts to $-(2-R)$. Hence, the home regulator's payoffs associated with available decisions are summarized in the following table.

	$d^f = I$	$d^f = O$
$d^h = I$	$-2(1-L)$	$-(1-L)+p_f(R-1)-(1-p_f)$
$d^h = O$	$-(1-L)+p_h(R-1)-(1-p_h)$	$-[(1-p_h)p_f+(1-p_f)p_h](2-R)+$ $-(1-p_h)(1-p_f)2$

Consider first decision (I,I). For this decision to be optimal it must be that $-2(1-L) \geq -(1-L)+p_i(R-1)-(1-p_i)$ for $i=h,f$ and $-2(1-L) \geq -[(1-p_h)p_f+(1-p_f)p_h](2-R)-(1-p_h)(1-p_f)2$. However, this second condition is implied by the first so that it is simply needed that $p_i \leq \frac{L}{R} < 1$ so that region (I,I) is non-empty. For decision (O,I) to be optimal it must be that the payoff associated with (I,I) is smaller, i.e. $p_h > \frac{L}{R}$, as well as that associated with (O,O), i.e. $p_f \leq \varphi_f = \frac{L}{R-2(R-1)p_h}$ and that associated with (I,O), i.e. $p_h \geq p_f$. By symmetry, for decision (I,O) to be optimal it must be $p_f > \frac{L}{R}$, $p_h \leq \varphi_h = \frac{L}{R-2(R-1)p_f}$ and $p_h \leq p_f$. Moreover, note that the condition $p_h \leq \varphi_h$ can be rewritten as $p_f \leq \varphi'_h = \frac{Rp_h-L}{2p_h(R-1)}$. Boundaries φ'_h and φ_f are both increasing and may intersect at $p_h = c_\pm \equiv \frac{R \pm \sqrt{R^2-8L(R-1)}}{4(R-1)}$ if the discriminant in $c_\pm$ is positive, i.e. $L \leq \frac{R^2}{8(R-1)}$. This is always the case because $L+R \leq 2$ which also implies that $c_+ > 1$ and then the two curves φ'_h and φ_f intersect only once in the $[0,1]^2$ space of probabilities (p_h, p_f). Hence, regions (I,O), (O,I) and (O,O) are non-empty.

Finally, regions do not intersect so that there is no indifference for decisions except along the 45° degrees lines where either the decisions are the same, or, otherwise, the regulator is indifferent between (I,O) and (O,I).

Step 2. To prove result (i) in the Proposition we then simply need notice that for any i we have $\varphi_i \geq L/R$. For result (ii), consider first boundary L/R. A higher (lower) p_i can only induce a decision change from $d^i = I$ to $d^i = O$, if any. On the contrary, φ_i is increasing in p_j and this implies that with a higher p_j the home regulator needs to face a higher p_i in order to take decision $d^i = O$. Hence, ceteris paribus, if a change of p_j affects the home regulator's decision at all, it induces a change from $d^i = O$ to $d^i = I$. ■

Proof of Proposition 2. The proof is in three steps.

Step 1. We first show that with subsidiary MNBs the unique equilibrium is in pure strategies and equilibrium decisions are described by the following non-empty regions in the probabilities space $(p_h, p_f) \in [0,1]^2$,

$$(I,I) \equiv \{(p_h,p_f) : p_i \leq L, i=h,f\} \quad (O,O) \equiv \{(p_h,p_f) : p_h > \delta_h,\ p_f > L\}$$
$$(O,I) \equiv \{(p_h,p_f) : p_h > L \geq p_f\} \quad (I,O) \equiv \{(p_h,p_f) : \delta_h \geq p_h, p_f > L\}$$

where $\delta_h \equiv \frac{L}{1-p_f(R-1)}$.

To prove this note that with decisions (O,O), if the home project fails (with probability $(1-p_h)$) and the foreign project succeeds (probability p_f), the home regulator can recover some of her costs. In fact, if the home project fails, the home regulator is entitled to all the foreign assets left after foreign depositors are reimbursed $(R-1)$, and bears a cost of $-1+(R-1)$. Foreign regulator's payoffs are similar except that when the foreign project fails and the home succeeds, the foreign regulator cannot expect any resources from the mother bank. Payoffs associated to different decisions are immediate so that we obtain the following normal form representation of the regulation game (in each cell the top payoff relates to the foreign regulator and the bottom to the home regulator).

	$d^f = I$	$d^f = O$
$d^h = I$	$-(1-L)$ $-(1-L)$	$-(1-p_f)$ $-(1-L)+p_f(R-1)$
$d^h = O$	$-(1-L)$ $-(1-p_h)$	$-(1-p_f)$ $-(1-p_h)\left[p_f(1-(R-1))+(1-p_f)\right]$

Necessary conditions for a pair of decisions to be a (pure-strategy) Nash equilibrium can now be simply derived from the previous matrix. Uniqueness and non-mixed strategies are guaranteed by the foreign regulator having a dominant strategy (note 25 in the proof of Proposition 6 also clarifies this point). All the regions associated with different pair of decisions are non empty. Indeed, boundary δ_h takes value $L/(2-R)$ with $L < L/(2-R) < 1$ for $p_f = 1$ so that regions (I,O) and (O,O) are non empty. Regions (I,I) and (O,I) are also trivially non empty.

Step 2. Result (i) simply follows from $\delta_h \geq L$. For result (ii) one simply has to verify how the two regulators act when $p_h = p_f$, i.e. along the 45° line in figure 2. As long as $p_h = p_f \leq L$ they both prefer to intervene on the local unit. Moreover, boundary δ_h takes value L at $p_f = 0$, takes value $L/(2-R)$ with $L \leq L/(2-R) \leq 1$ at $p_f = 1$ and finally it is an increasing function of p_f. Hence, δ_h crosses the 45° line once. This suffices to show that there are values of p_h and p_f with $p_h = p_f$ such that equilibrium decisions are (I,O). Finally, for the remaining values $p_h = p_f$ equilibrium decisions are (O,O).

Step 3. As for result (iii), first note that δ_h is an increasing function of p_f. On the contrary, all the other boundaries defining the regions with different decisions in step 1 do not depend on p_h nor on p_f. Hence, the proof can be immediately obtained from simple inspection of Figure 2. Fixing the level of p_i and increasing p_j with $i,j = h,f$ and $i \neq j$, one can check how regulators decisions are adapted to signals that affect the probability of success of any project. ■

Proof of Proposition 3. For the same values of the parameters, we need to compare the decisions that the home and the foreign regulator would take with subsidiary or branch representation. Note first that φ_h and φ_f cross each other at $p_h = c_-$ (Proof of Proposition 1) which is smaller than L iff $L \leq 1/2$. Furthermore, $\varphi_f = L$ for $p_h = 1/2$, with φ_f increasing in p_h.

Case $L \leq 1/2$. Consider first decisions concerning the home unit. For $p_f \geq L$ decisions coincide with the two representation forms except for $p_h \in [\delta_h, \varphi_h]$ where there is intervention on

the home unit with with subsidiary but not branch representation. For $p_f < L$, note that $L \leq 1/2$ implies that φ_h and φ_f cross each other in the area $\{p_i \leq L, i = h, f\}$ which corresponds to decisions (I, I) for subsidiary MNB. Hence, either decisions coincide with the two representations or, if $p_f \leq \max\{p_h, \varphi_h\}$ and $p_h \in [L/R, L]$, they are O and I respectively for branch and subsidiary MNB.

Consider now decisions for the foreign unit. For $p_h \geq 1/2$, so that $\varphi_f \geq L$, either the foreign unit is kept open for both representations or the decision is I and O respectively for branch and subsidiary MNB if $p_f \in \left[L, \varphi_f\right]$. On the contrary, for $p_h < 1/2$ either decisions coincide for both representations, or the decision is I and O respectively for subsidiary and branch MNB if $p_f \in \left[\min\left\{\varphi_f, p_h\right\}, L\right]$ for any $p_h \in [L/R, L]$, and if $p_f \in [L/R, L]$ for any $p_h < L/R$.

Case $L > 1/2$. Note that $L > 1/2$ implies φ_h and φ_f cross each other in the area $\{p_i > L, i = h, f\}$. Consider decisions concerning the home unit. For $p_f \geq L$ decisions coincide with the two representations except for $p_h \in [\min\{\delta_h, p_f\}, \varphi_h]$ where the home unit is intervened with subsidiary and kept open with branch. For $p_f < L$, either there is intervention in the home unit with the two representations or, if $p_f \leq p_h$ and $p_h \in [L/R, L]$, decisions are O and I respectively for branch and subsidiary MNBs.

Consider now decisions for the foreign unit. For $p_h \geq L$, so that $\varphi_f \geq L$, either the foreign unit is kept open for both representations or the decision is I and O respectively for branch and subsidiary MNB if $p_f \in \left[L, \min\left\{\varphi_f, p_h\right\}\right]$. On the contrary, for $p_h < L$ either decisions coincide for both representations, or the decision is I and O respectively for subsidiary and branch MNB if $p_f \in [\max\{L/R, p_h\}, L]$. ■

Proof of Proposition 4. First recall that the home unit always faces softer regulation with branch representation. For part (i) we need to show that when $p_h = p_f = p$ the foreign unit also faces softer regulation with branch representation. From the Prof of Proposition 3 we know that two cases can arise. (a) When $c_- < L$ (or equivalently $L < 1/2$), we have $\varphi_f = L$ at $p = 1/2$ so that for any $p \in [c_-, L]$ the decision on the foreign unit is $d^f = O$ with branch and $d^f = I$ with subsidiary MNB and decisions coincide for any other p. In fact, (b) When $c_- \geq L$ (or equivalently $L \geq 1/2$) it follows that decisions always coincide, irrespective of representation.

Finally, part (ii) does not rely on $p_h = p_f = p$ and follows immediately from the results in Proposition 3. ■

Proof of Lemma 1 and Proposition 5. To prove the results we need first to identify, for any pattern of decisions that is admissible when no information is available (i.e. $p_h = p_f = p$, along the 45° lines in Figures 1 and 2), all the cases that induce different decisions when information is acquired on at least one unit. We then can calculate the value of information in any of those regions and make the relevant comparisons. Let V_h^i be the value of information on unit $i = h, f$ when monitoring takes place in the other unit $j \neq i$ and the representation form is either branch, indicated by $h = B$, or subsidiary, indicated with $h = S$. Similarly, we indicate with $\bar{V}_h^i$ the value of that information when monitoring does not take place in the other unit j.

Subsidiary representation. For the foreign regulator we can identify only two regions associated with different decisions as a function of the information available on the foreign project

(recall that in any case the foreign regulator's decision is unaffected by the decision and the information available on the home project so that $V_S^f = \bar{V}_S^f$). They are delimited by $p \in [0, L]$ and $p \in (L, 1]$. In the first region the value of the information is $V_S^f = p(1-L)$ and in the second region it is $V_S^f = L(1-p)$.

As for the home regulator, on the contrary, we have to distinguish the cases in which the foreign regulator does and does not monitor. If she does not monitor, then we can identify three regions associated with different decisions when no information is available on both units. If $p \in [0, L]$ then decisions with no monitoring are (I, I) and $\bar{V}_S^h = p(1-L)$; if $p \in (L, \frac{1-\sqrt{1-4L(R-1)}}{2(R-1)}]$, decisions are (I, O) and $\bar{V}_S^h = p(1-L) - p^2(R-1)$; if instead $p \in (\frac{1-\sqrt{1-4L(R-1)}}{2(R-1)}, 1]$, decisions are (O, O) with $\bar{V}_S^h = L(1-p)$.

When, on the other hand, the foreign regulator does monitor (so that depending on $p_f = 0, p_f = 1$ we may have $d^f = I$ or $d^f = O$), then the value of information on the home unit V_S^h is as follows.

If $p \in [0, L]$, decisions with no monitoring on unit h are (I, I) if $p_f = 0$ and (I, O) if $p_f = 1$ so that $V_S^h = p(1-L) - p^2(R-1)$. If $p \in (L, L/(2-R)]$, decisions with no monitoring on unit h are (O, I) if $p_f = 0$ and (I, O) if $p_f = 1$. In this case we have $V_S^h = L(1-p) + p\left[p - L - p(R-1)\right]$. Finally, if $p \in (L/(2-R), 1]$ then decisions with no monitoring on unit h are (O, I) if $p_f = 0$ and (O, O) if $p_f = 1$ and then $V_S^h = L(1-p)$.

It is immediately see that in the relevant regions $\bar{V}_S^h \geq V_S^h$ so that information on the foreign unit is a substitute for information on the home unit for the home regulator.

Comparing the value of information for the foreign regulator, in the relevant regions $\bar{V}_S^h \leq V_S^f$, so that to determine the equilibria of the information acquisition game we simply need to compare V_S^h with V_S^f. Given that in all the relevant regions $V_S^h \leq V_S^f$, then either monitoring decisions coincide or the foreign regulator monitors and the home regulator does not monitor.

Branch representation. The reasoning is similar as with subsidiary. First we determine the value of information in one unit when information is and is not available on the other unit, respectively V_B^i and $\bar{V}_B^i$. Then, we show the existence of substitutability in information acquisition. When no information is collected in unit j, there are four relevant regions associated with different decisions with and without information in unit i.

If $p \in [0, L/R]$ then $\bar{V}_B^i = p(R-L)$ and $V_B^i = p[R-L-2p(R-1)]$. If $p \in (L/R, c_-]$, where c_- is calculated in the proof of Proposition 1, then $\bar{V}_B^i = (1-p)pR$ and $V_B^i = L(1-2p) + p^2(2-R)$. If $p \in (c_-, L/(2-R)]$ then $\bar{V}_B^i = L - p^2(2-R)$ and $V_B^i = L(1-2p) + p^2(2-R)$. Finally, if $p \in (L/(2-R), 1]$ then $\bar{V}_B^i = L(1-p)$ and $V_B^i = L(1-p)$. Comparing in the relevant regions, we then have $V_B^i \leq \bar{V}_B^i$.

Now, we compare monitoring under the two representation forms. Having proved substitutability in monitoring with both representations and that $V_S^h \leq V_S^f$, we simply need to compare (i) the value of information for a single unit in the branch representation with the value of information for the foreign regulator in the subsidiary representation, (ii) the value of two pieces of informations in the branch MNB with the value of information for the home regulator in the

subsidiary MNB. In the relevant regions we have $\bar{V}_B^i \geq V_S^f$, $V_B^i \geq V_S^h$ and this concludes the proof.

Finally, the value of information in each of the two units in case of welfare maximization is as follows $V_W = p(R-L)$ if $p \leq L/R$ and $V_W = (1-p)L$ otherwise. Using the previous results which tell that $\bar{V}_B^i \geq \max\{V_B^i, V_S^h, V_S^f\}$ and comparing V_W with $\bar{V}_B^i$ in the relevant regions of the previous table, we finally have that for $p \in [0, L/R]$ then $V_W - \bar{V}_B^i = 0$, for $p \in (L/R, c_-]$ then $V_W - \bar{V}_B^i = (1-p)(L-pR) \geq 0$, for $p \in (c_-, L/(2-R))]$ $V_W - \bar{V}_B^i = p\left[p(2-R) - L\right] \geq 0$ and, finally, if $p \in (L/(2-R), 1]$ then $V_W - \bar{V}_B^i = 0$. It then follows that in any case $V_W \geq \bar{V}_B^i$. ■

Proof of Proposition 6.

Branch representation. Studying the effect of α_h on the boundaries defining the regions associated with different decisions simply gives the result. If intervention in unit i takes place, profits are nil so that the relevant boundary for the decision in the other unit i is unchanged and equal to L/R. When unit j is kept open, we now have to consider boundary

$$\varphi_i \equiv \frac{L}{R - 2\,(R-1)\,p_j\,(1-\alpha_h)}$$

φ_i is increasing in p_j as long as $\alpha_h \leq 1$ and decreasing otherwise. Moreover, $\frac{\partial \varphi_i}{\partial \alpha_h} \geq 0$ for $1 \geq \alpha_h$ and $\frac{\partial \varphi_i}{\partial \alpha_h} \leq 0$ for $1 < \alpha_h$.

Subsidiary representation. Let δ_i be the boundary such that for $p_i \geq (<)\delta_i$ regulator i does not intervene in unit i (intervenes in it) if the other regulator does not intervene in the other unit. We have $\delta_h = \frac{L}{1-(R-1)\left[p_f(1-\alpha_h)-\alpha_h\right]}$ which is increasing in p_f and $\delta_f = \frac{L}{1+(R-1)p_h\alpha_f}$ decreasing in p_h and smaller than L for any $\alpha_f > 0$. Similarly, let δ_i' be the boundary such that for $p_i \geq (<)\delta_i'$ regulator i does not intervene (intervenes) if regulator j intervenes in unit j. We see that for any $\alpha_h > 0$ $\delta_h' = \frac{L}{1+(R-1)\alpha_h} < L$ and $\delta_f' = L$. This shows that $\delta_h' \leq \delta_h$ and δ_h is increasing in p_f; if $\alpha_f > 0$, then $\delta_f \leq \delta_f'$ and δ_f is decreasing in p_h. It follows that, as long as $\alpha_f > 0$, there exists a non empty region

$$M = \left\{(p_h, p_f) : p_f \in \left[\delta_f, \delta_f'\right], p_h \in \left[\delta_h', \delta_h\right]\right\}$$

such that there are no pure strategy equilibria. Equilibrium mixed strategies in this area are

$$\begin{aligned}\sigma_h &= \tfrac{L-p_f}{(R-1)p_h p_f \alpha_f} \\ \sigma_f &= \tfrac{p_h[1+(R-1)\alpha_h]-L}{(R-1)p_h p_f (1-\alpha_h)}\end{aligned}$$

where σ_i is the probability assigned to the decision of no intervention in unit i by regulator i. Simple derivation shows that $\frac{\partial \sigma_h}{\partial \alpha_h} = 0$, $\frac{\partial \sigma_h}{\partial \alpha_f} \leq 0$, $\frac{\partial \sigma_f}{\partial \alpha_f} = 0$ and $\frac{\partial \sigma_f}{\partial \alpha_h} = \frac{Rp_h - L}{(R-1)p_h p_f (1-\alpha_h)^2} > 0$ where the sign comes from the fact that in the no-pure-strategies area we have $p_h \geq \frac{L}{1+(R-1)\alpha_h}$ which implies that $Rp_h \geq L$ because $\frac{L}{1+(R-1)\alpha_h} \geq \frac{L}{R}$.

Also note that outside this region M, mixed strategies degenerate into pure strategies. This implies that the equilibrium is always unique either in pure or in mixed strategies for any α_h and α_f.[26]

Now we study the effect of an increase of profit weights on regulators' strategies. If α_h increases we observe the following effects. (a) A portion of the region in the probabilities space (p_h, p_f) that was previously associated with (pure) strategies (I, I) is transformed into a mixed strategy equilibrium; (b) Mixed strategies are affected according to $\frac{\partial \sigma_h}{\partial \alpha_h} = 0$ and $\frac{\partial \sigma_f}{\partial \alpha_h} > 0$; (c) A portion of the region with mixed strategies is transformed into pure strategies (O, O). In all these three cases, both regulators clearly become (weakly) softer. With an increase of α_f, (a) a portion of area (O, I) is transformed into mixed strategies; (b) Mixed strategies change according to $\frac{\partial \sigma_h}{\partial \alpha_f} \leq 0$, $\frac{\partial \sigma_f}{\partial \alpha_f} = 0$; (c) a portion of area (O, I) is transformed into decisions (O, O). In all cases, regulator h becomes tougher and regulator f softer. ■

Proof of Proposition 7. (i) Assume that the decision in the foreign unit is $d^f = I$ so that the relevant boundaries for branch and subsidiary representation are respectively L/R and $\delta'_h = \frac{L}{1+(R-1)\alpha_h}$ (see the proof of Proposition 6). Recall that intervention takes place in the home unit if p_h is smaller than boundary δ'_h. We immediately have $L/R \leq \frac{L}{1+(R-1)\alpha_h}$ for any α_h so that, either decisions on the home unit coincide in the two representations, or intervention takes place with branch but not with subsidiary MNB. Similarly, if no intervention occurs in the foreign unit (i.e. $d^f = O$), then the two boundaries become $\varphi_h = \frac{L}{R-2(R-1)p_f(1-\alpha_h)}$ for branch and $\delta_h = \frac{L}{1-(R-1)\left[p_f(1-\alpha_h)-\alpha_h\right]}$ for subsidiary. Again we have $\varphi_h \leq \delta_h$ and the result follows.

(ii) Now consider the foreign unit. With intervention in the home unit (i.e. $d^h = I$), the boundaries are L/R for branch and $\delta'_f = L$ for subsidiary. Recall that in this case we have intervention in the foreign unit if p_f is smaller than the relevant boundary. On the contrary, if $d^h = O$, then the boundaries are $\varphi_f = \frac{L}{R-2(R-1)p_h(1-\alpha_h)}$ and $\delta_f = \frac{L}{1+(R-1)p_h\alpha_f}$ with $\varphi_f \leq \delta_f$, so that, either decisions coincide, or intervention takes place in the foreign subsidiary but not in the foreign branch when $p_h \leq \bar{p}_h \equiv 1/\left[2\left(1-\alpha_h\right)+\alpha_f\right]$. ■

[26] It also follows that when $\alpha_h = 0$ and $\alpha_f = 0$ the unique equilibrium is in pure strategies, as discussed in the proof of Proposition 2.

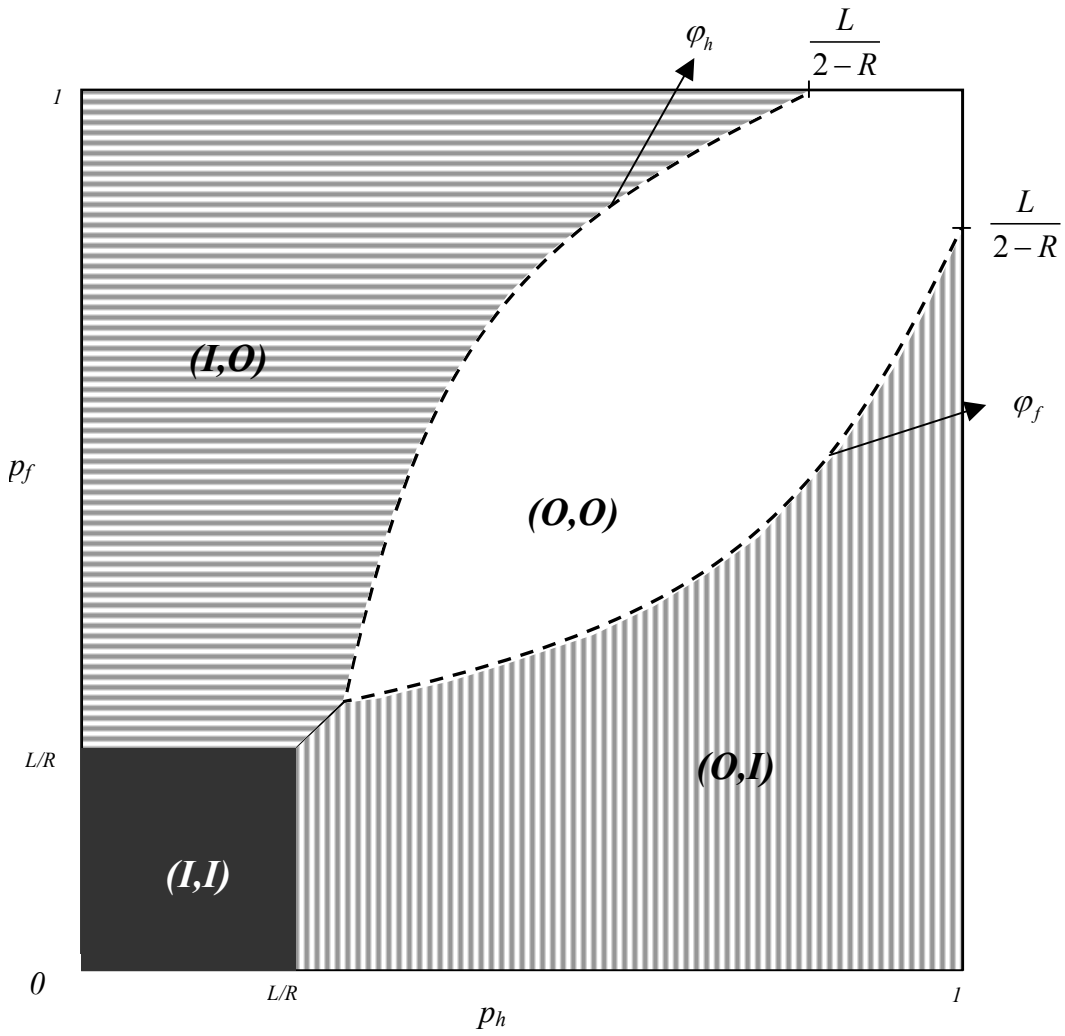

Figure 1: Regulator's decisions with branch-MNB

(Decisions of the form *(home decision, foreign decision)*, where *I*=intervention, *O*=no-intervention)

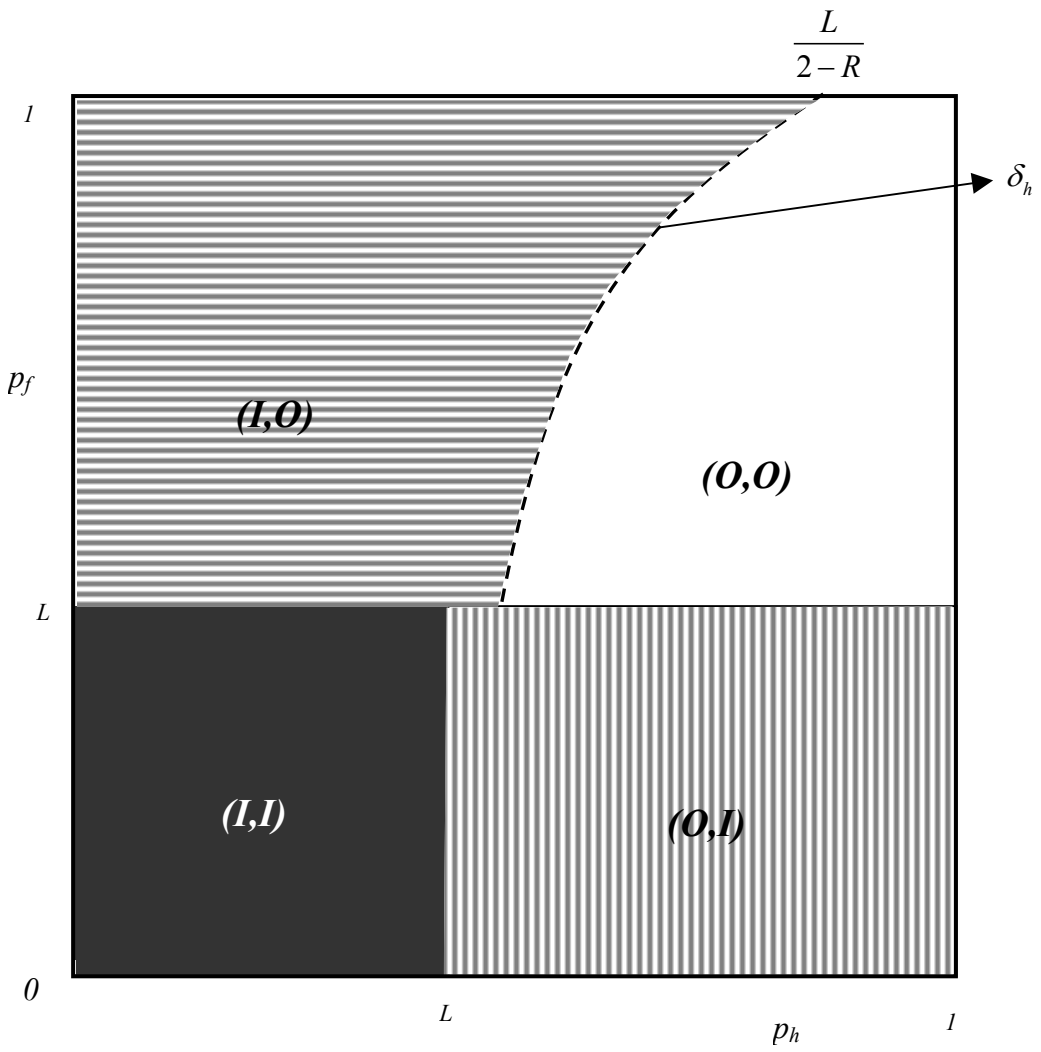

Figure 2: Regulators' decisions with subsidiary-MNB

(Decisions of the form *(home decision, foreign decision)*, where *I*=intervention, *O*=no-intervention)