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Regulation of multinational banks: A theoretical inquiry ☆

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ABSTRACT

This paper examines national regulators' incentives to intervene in a multinational bank's activities and the extent to which these incentives differ with the bank's foreign representation choice (branch or subsidiary). Shared liability leads to higher incentives for intervention than legal separation. Cross-border deposit insurance, on the other hand, yields less intervention than when regulators compensate local depositors only. Based on these results, we derive implications for multinational banks' and regulators' preference on foreign expansion and representation.

1. Introduction

Multinational banking has expanded significantly as barriers to international capital flows have been progressively dismantled and entry to foreign markets has eased.[2] The rapid development of mul-

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[2] Total assets held by the overseas units of US banks doubled from 1992 to 1996. In the United States, foreign banks accounted for almost 10 percent of deposits (Buch and Golder, 2001), 20 percent of total bank assets and 26 percent of total business loans (Federal Reserve Board, 2002) in 2000. In Central Europe, bank assets controlled by foreign banks rose from 8 percent in 1994 to 59 percent in 1999 and today they reach as much as 80 per cent in some countries. Almost 50 percent of total bank assets in some Latin American countries are controlled by foreign banks (IMF, 2000). Retail activities of cross-border banks have been increasing steadily since 2000, particularly in the Single European Market. Local claims on foreign-owned banks in the EU27 as a percentage of GDP went from 10% in 2000 to 30% in 2007 (source: BIS). For more details, see Calzolari and Loranth (2003).

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tinational banks (MNBs hereafter) represents a source of new concerns for regulators. Regulation of an MNB in one country may well affect the behavior of the bank and of regulators in other countries, as shown, for example, in the rescue of Belgian–Dutch bank Fortis in 2008. This paper provides a simple framework for examining regulation of an MNB by independent national authorities and the extent to which foreign representation affects both regulatory actions and the bank's choice of foreign expansion.

Banks pursuing a full range of activities abroad can be represented in the foreign countries through branches or subsidiaries.[3] Representation affects both the liability structure between the home and foreign units, and the allocation of supervisory responsibilities between regulators of the home and host countries. One can think of branches as extensions of the home bank: the two institutions share joint liability for the failure of their assets and they call upon the same deposit insurance fund. Branch-represented MNBs are usually overseen by the regulator of the home bank. Subsidiary banks are the assets of the home bank: while the subsidiary and home bank share liability for the home bank's assets, the home bank has no liability in case of subsidiary failure. Reflecting the higher independence of subsidiaries relative to branches, national regulators have independent power over the locally incorporated units, and depositors are covered by the local deposit insurance fund in the event of bankruptcy.[4]

In this paper, we address two related questions. How does the liability structure between the home and foreign units and the allocation of supervisory responsibilities affect regulators' incentives to intervene in bank units? How does regulation influence a bank's decision regarding foreign expansion and its choice of foreign representation?

We consider a setup where an MNB operates in two countries. The bank is legally incorporated in the 'home country' (with a home unit) and operates an additional unit in the 'foreign country' (foreign unit). Each unit collects deposits and invests locally in risky and illiquid projects that are uncorrelated across countries. Bank regulators have two mandates: they (fully) insure depositors and exercise prudential intervention over the unit they are in charge of. We first consider a setup in which regulators exercise their mandates with the aim of minimizing costs stemming from their deposit insurance function.[5] Regulators thus face the following trade-off: early intervention results in a positive liquidation value for a unit's assets, but leads to certain deposit insurance costs; letting a unit continue might lead to no costs for the regulator if the unit's investment pays out, but might result in a higher deposit insurance cost if it does not.

We show that there is a material difference in the likelihood of regulatory intervention in a domestic bank and an MNB represented abroad by either a branch or a subsidiary. The differences can be attributed to two effects: (i) the extent to which the regulator of a given unit of an MNB can draw upon the (residual) assets of the other unit if the unit's assets fall short of liabilities; and (ii) the regulator's responsibility for insuring depositors located in the other country.

Where it occurs, shared liability among the MNB's units provides higher incentives for regulatory intervention than with a domestic bank or when units are legally separate. This is because residual assets from the other unit have a higher value to the regulator when it intervenes in the unit it is in charge of than when it does not. In the former case, residual assets available in the other unit lower the regulator's deposit insurance costs with certainty. With no intervention, however, those assets are valuable to the regulator only if the unit it is in charge of eventually fails (i.e., the residual assets are valued with a probability smaller than one). Hence, this effect, which we dub the *liability effect*, induces a regulator to intervene, a 'tough response'. On the other hand, insuring depositors in both countries, as with branch representation, makes a regulator internalize the full costs of its decision. In particular, the regulator takes into consideration that intervention in one unit leaves fewer or no as-

[3] 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.

[4] This description closely follows current EU regulations (see Dermine, 2002). In the United States, 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). Although the terminology differs between the States and the EU, what matters for our analysis is the liability structure and the allocation of regulatory powers.

[5] The FDIC in the United States 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, the regulators' role in insuring deposits has been emphasized by Mailath and Mester (1994) and Repullo (2000, 2001), among others. As an extension, we will also consider welfare-maximizing regulators.

sets to support the other unit in case of need: this *internalization effect* reduces the regulator's incentives to intervene in a unit, a 'soft response'. These two effects are the main drives of a number of interesting implications concerning regulators' behavior.

We show that the home unit faces tougher regulation when it is part of a subsidiary MNB than when it is simply a domestic bank (i.e., regulatory decisions either coincide, or the home unit of the MNB faces intervention when the domestic bank does not). This is due to the liability effect that is at play in an MNB. On the contrary, the home unit in a branch MNB falls under softer regulation than the same unit in a subsidiary MNB (i.e., either intervention takes place in both representations or it does so with subsidiary but not with branch MNBs). This is because the liability effect is present with both representations, but the internalization effect is only at work with a branch MNB. Furthermore, the home unit of a branch MNB may face a softer or tougher regulation than a domestic bank depending on the foreign unit's prospects since it determines which of the two effects prevails.

Concerning regulation of the foreign unit, the rule for intervention in the subsidiary coincides with that in a domestic bank since the foreign regulator is affected neither by the liability nor by the internalization effects. Furthermore, as regulation of the subsidiary then coincides with that of a domestic bank, it follows that a subsidiary faces softer regulation than a branch if the home unit's prospects are good (i.e., its probability of failure is low), but faces tougher regulation if those prospects are bad (i.e., its probability of failure is high).

The different regulatory regimes a bank faces are often said to be relevant to the choice of foreign representation, even if these are certainly not the sole drivers of the decision (see Houpt, 1999; Calzolari and Loranth, 2003; Focarelli and Pozzolo, 2006). By comparing the likelihood of intervention under foreign expansion and the type of foreign representation, we can examine the extent to which regulation alters bank's profit and thereby the bank's choice of whether to expand abroad, and if so the choice of foreign representation. In our model, in the absence of regulation, a domestic bank would always choose to expand abroad with a subsidiary, as projects in the two units are uncorrelated and the home unit is shielded from the subsidiary's losses. However, this intuition does not carry over when the bank is subject to regulation. In particular, we show that a subsidiary structure is only preferred if the home unit has a sufficiently high probability of success. The reason is that the presence of a subsidiary makes the home regulator tougher on the home unit, hence the subsidiary's additional profit may not compensate for the lower expected profit of the home unit. The bank might also prefer a branch structure to the subsidiary structure when the home unit has a sufficiently high failure probability project. This again may seem counterintuitive at first glance, as given the joint liability of units for losses, by adopting a branch structure, the bank ceteris paribus increases the risk of losing profit compared to a subsidiary structure. We show that the reason for a branch structure being preferred is that the bank can elicit softer regulation.[6]

In addition to costs, regulators may also be concerned about bank profits as a consequence of successful lobbying or because profits affect the financial stability of the local banking sector. As one may expect, profit concerns shift regulatory decisions towards softer behavior. More interestingly, we find that when regulators care about bank profits in their jurisdiction the liability effect can make the regulator *softer*, contrary to the case of cost-minimizing regulators. We also show that in this case a domestic bank can no longer hope for softer regulation when it expands with a branch abroad. The implication of this is that the subsidiary structure will become more desirable from the bank's point of view.

The present work is part of a growing literature on the regulation of MNBs. Calzolari and Loranth (2003) provide a general introduction to the issue. [7] Holthausen and Rønde (2003), Acharya (2003), Dell'Ariccia and Marquez (2006) and Dalen and Olsen (2003) address the problem of divergent interests and lack of coordination between national regulators. Our new insight is that divergence of interests (and decisions) between regulators might result from the representation choice of the MNB. Unlike earlier work, 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 representation choice. The question

[6] We then contrast the bank's optimal choice with (home and foreign) regulators' preferences over foreign expansion and representation and show the possibility of conflicting interests.

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

of whether the form of MNB representation affects regulation has also been raised by Harr and Rønde (2004) and Loranth and Morrison (2007).[8] These papers focus on optimal capital requirements, while our contribution instead focuses on regulators' incentives to take disciplinary actions. In an early contribution, Repullo (2001) addresses the problem of the 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 from these in studying the effects on regulation of the form of MNB representation and in endogenizing the MNB's choice of representation.

Our modelling choice of bank supervision is most closely aligned with that of Mailath and Mester (1994), who also consider a positive theory of regulatory intervention. In their paper, a (domestic) bank invests sequentially in two projects, and regulatory intervention may prevent the financing of the second project. The (single) regulator anticipates future bank's asset choice (over safe or risky assets) in case it is permitted to remain open and, understanding that the initial investment decision will affect the regulator's policy, the bank modifies its first period risk-taking behavior. Considering both a cost-minimizing and welfare-maximizing regulator, this paper shows some analogies with our analysis. In particular, the authors show that the regulator might leave open a bank with negative expected value, if the returns of the second project will allow the regulator to reduce the reimbursement costs of the first-period project. Thus, in their paper, too, regulatory decisions might be driven by the possibility of getting some equity out of the second project. However, the main driver for this effect is different in the two papers. In their paper, it is generated by a dynamic interaction between the bank and the regulator, and an essential ingredient is the commitment problem on the side of the regulator to punish the bank after having chosen a risky (negative net present value) project. This also explains why the issue still remains when the regulator maximizes welfare. In our paper, however, the liability effect arises because of shared liability between two (geographically) separate units. This effect is present as long as units are separately supervised and even when regulators maximize welfare. However, the effect vanishes with a single regulator maximizing welfare in two countries. Finally, our analysis of an MNB with subsidiary representation brings in strategic interaction among independent national regulators, which is clearly absent from Mailath and Mester (1994).

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 discusses banks' and regulators' preferences over foreign expansion and representation. Section 5 extends the base model to regulators that have an interest in the MNB's profit. Section 6 concludes. Proofs are in Appendix A.

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 one unit of fully insured deposits 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 $t = 2$. Projects in the two countries are assumed to be uncorrelated.

At $t = 1$ the probability of unit i returning R is $p_i \in [0, 1], i = f, h$, and, acting upon this knowledge, regulators decide whether or not to intervene in the unit for which they are responsible. We refer to this activity as *prudential regulation*. Intervention 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. In what follows, the decision of the regulator on unit i will be indicated with $d_i \in \{I, O\}$ where $d_i = I$ stands for intervention and $d_i = O$ stands for an open decision.[9]

We assume that (i) at $t = 2$ a successful project returns more than the amount invested, i.e., $R > 1$, but (ii) returns of a single project are insufficient to reimburse depositors in both countries i.e., $R < 2$.

[8] In a different setting, Kahn and Winton (2005) also examine the effect of financial institutions' structure (subsidiary or unitary) on risk-taking and project selection.

[9] The desirability of early intervention, so as to secure some assets instead of risking larger losses in case of failure, is consistent with the doctrine of "Prompt Corrective Action" adopted, for example, in the United States.

Regulators' objective. Regulators minimize the (expected) deposit reimbursement costs that may arise as a consequence of intervention at $t = 1$ (*intervention costs*) or failure at $t = 2$ (*failure costs*). In Section 5, we discuss prudential regulation under the assumption that regulators care about the MNB's profits as well as deposit insurance costs.

Foreign representation. We examine the two types of representation for the foreign unit, subsidiary and branch, that allow the bank to perform the (complete) set of activities described above.[10]

A *subsidiary* is a separately incorporated entity in the foreign country that shares liability for the home bank's losses, but for whose losses the home bank is not liable. More precisely, in the case of home unit failure, all remaining residual assets in a solvent subsidiary – after foreign depositors are paid off – must be used against home liabilities. No such transfer from a solvent home unit to an insolvent subsidiary is legally 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.

A *branch* can be thought of as an extension of the home unit, 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 losses in the other country.[11] At $t = 1$ the regulator's decision can be intervention in one, both, or neither of the two units.[12]

In what follows, we refer to the regulator by location. Thus, the regulator of a branch MNB, as well as that of 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: for example, (I, O) means that the regulator in charge of unit h intervenes, and the one in charge of unit f does not.

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

- At $t = 0$: The bank decides whether to expand abroad and chooses foreign representation; it collects deposits in countries in which it is active and invests them in local risky projects.
- At $t = 1$: Regulators decide whether to intervene in the unit under their jurisdiction.
- At $t = 2$: Payoffs are realized and depositors are repaid.

We first analyze regulatory decisions at $t = 1$, assuming that an MNB is formed and is active in both countries. We subsequently discuss the $t = 0$ decision by a domestic bank (with a single unit) of whether to form a multinational bank and, if so, what foreign representation to choose.

Finally, to save on notation and for concreteness, in what follows when we state that "*regulator i is tougher in case A than in case B*", we refer to a situation when either regulator i's decisions at $t = 1$ coincide in the two cases, or the optimal decision is $d_i = O$ in case B, and it is $d_i = I$ in case A (conversely when the regulator is instead *softer*). A consistent locution will also be used when comparing the home and the foreign regulators' decisions, so that, for example, " *Regulator i is tougher than regulator j*" means that either decisions coincide, or they are $d_i = I$ and $d_j = O$.

[10] In the following we will indicate the foreign unit simply as "the subsidiary" or "the branch" depending on the representation form.

[11] Since the regulator insures depositors in both countries, the particular rule for asset allocation in case of insolvency does not affect the regulator's costs. Assuming that the MNB's assets are distributed to depositors on an equal basis results in the same costs for the regulator.

[12] Current EU regulations follow the principle of home country supervision for branch MNBs, according to which the competent authority supervising the MNB is the country where the bank is initially licensed. Supervisory responsibilities cover the activities 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.

3. Prudential regulation

In this section, we examine regulators' decisions whether to intervene at $t = 1$ in the unit(s) under their respective jurisdiction. We first analyze regulation of a single unit bank, which we call a *domestic bank*. We then turn to the analysis of an MNB that operates via a subsidiary abroad, and subsequently to the case when the MNB has a branch abroad. At the end of the section, we compare regulatory incentives to intervene across different organizational structures. In addition to being interesting per se, this analysis on prudential regulation is a necessary step to understand the reason why a domestic bank may elect to expand abroad, and how regulation can influence the preferred mode of entry into foreign markets.

Domestic bank. The trade-off faced by a cost-minimizing regulator of a domestic bank is as follows: early intervention at $t = 1$ leads to a certain cost $-(1 - L)$, while taking no action might lead to zero costs if unit i yields returns R, but might result in a higher cost of -1 if it returns 0. The regulator thus 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, intervention is optimal if and only if $p_i < L$.

This trade-off in an MNB is affected by two additional considerations: (i) the extent to which units share liability for their losses, and (ii) a regulator's responsibility in insuring depositors in the other country.

Subsidiary MNB. In a subsidiary MNB, regulation is decentralized: at $t = 1$ the home and the foreign regulators make decisions about the local unit simultaneously and non-cooperatively.

Consider first the foreign regulator's decision. Because foreign depositors have priority over the subsidiary's assets and the home unit has limited liability for the subsidiary's losses, the foreign regulator's decision is neither affected by the prospects of the home unit nor by the home regulator's decision. The rule for intervention is thus no different from that of the cost-minimizing regulator of a domestic bank. The foreign regulator intervenes if and only if $p_f < L$.

The situation for the home regulator is different. First, if the foreign unit is kept open at $t = 1$ and is successful at $t = 2$, the home regulator can use the residual assets in the foreign unit to reduce costs in the home unit. Intervention in the foreign unit at $t = 1$, by contrast, leaves no foreign assets to transfer to the home unit.

Second, the value of foreign residual assets to the home regulator differs for the two possible decisions for the home unit. With an open home unit, those residual assets are only useful if the home unit *fails*, and therefore are worth $p_f(1 - p_h)(R - 1)$ in expectation at $t = 1$. With intervention, the home regulator has a *certain* claim on the residual assets of a *successful* foreign unit, and the expected value of this claim is thus $p_f \min\{R - 1, 1 - L\}$. If $R + L \leqslant 2$ the home regulator obtains all the residual assets $(R - 1)$ from the foreign unit; if $R + L > 2$ the home regulator is only entitled to the amount $(1 - L)$ of foreign assets that makes up for the shortfall in the home unit.

Table 1 summarizes the strategic interaction between regulators, where in each cell the payoff to the left is the home regulator's payoff and the payoff to the right is that of the foreign one.

The analysis of this game is simplified by the fact that the foreign regulator's decision is independent of that of the home regulator. When $R + L \leqslant 2$, at $t = 2$ the home regulator receives the same amount $(R - 1)$ from a successful foreign unit whether it intervenes in the home unit or does not and the home unit subsequently fails. Hence, it is immediately clear that at $t = 1$ the home regulator's claim on foreign residual assets has a higher value upon intervention (the claim is certain) than upon an open decision (the claim is weighted by the probability of home failure). The implication is that the home regulator's claim on foreign residual assets tilts the decision towards more intervention when the foreign unit is open than when it is not For the same reason, the claim on foreign residual assets also induces the home regulator in a subsidiary MNB to be tougher than it would be with a domestic bank. In what follows, we will indicate the effect of the claim on foreign residual assets on the home regulator's decision as the *liability effect*.

This effect is also at play when $R + L > 2$, although the argument is more subtle. On the one hand, the home regulator now gets a higher share of the foreign unit's residual assets if it keeps the home unit open but it fails at $t = 2$ than with intervention. On the other hand, from an *ex-ante* point of view,

Table 1
Subsidiary representation: the regulatory game.

	$d_f = I$	$d_f = O$
$d_h = I$	$-(1-L); -(1-L)$	$-(1-L) + p_f \min\{R-1, 1-L\}; -(1-p_f)$
$d_h = O$	$-(1-p_h); -(1-L)$	$-(1-p_h) + (1-p_h)p_f(R-1); -(1-p_f)$

foreign residual assets are worth $p_f(1-L)$ upon intervention, and, they are worth $p_f(1-p_h)(R-1)$ upon an open decision, as in the latter case they are weighted by the probability of home failure. A higher failure probability $1-p_h$ increases the value of the claim associated with an open decision and might potentially push the home regulator towards no intervention. Nevertheless, p_h should be so low for this to happen that the home regulator for this value of p_h prefers intervention independently of the decision on the foreign unit.[13]

Lemma 1 (Subsidiary representation). *(i) The claim on foreign residual assets makes the home regulator tougher on the home unit than the regulator of a domestic bank would be. The foreign regulator's decision coincides with the decision of a domestic bank's regulator.*

(ii) In equilibrium, an increase of p_f *softens the foreign regulator but toughens the home regulator; an increase in* p_h *softens the home regulator and leaves the foreign regulator unaffected.*

As for point (ii) note that the foreign regulator's decision is clearly unaffected by p_h as the regulator cannot benefit from the home (residual) assets. On the contrary, the prospect of an open foreign unit does affect the home regulator's decisions through the liability effect. In particular, better prospects for the foreign unit (i.e., higher p_f) make it more likely that the home regulator can reduce its costs for any decision on the home unit. As discussed above, the expected value of the subsidiary's residual assets is larger upon home intervention than with an open home unit, and this difference increases with p_f. Thus, better prospects for the subsidiary raise the threshold value of p_h above which no intervention becomes optimal in the home unit. Finally, as expected, a larger $p_i (i = f, h)$ makes the regulator in country i softer.

Fig. 1 describes the equilibrium decisions for any pair of probabilities (p_h, p_f) for the case of $R + L \leqslant 2$. If the foreign unit is subject to intervention, the best response of the home regulator clearly coincides with that of a domestic bank's regulator, and intervention is optimal if and only if $p_h < L$. If instead the foreign unit is open, the best response is to intervene if and only if $p_h < \delta_h(p_f)$ where $\delta_h(p_f)$ is an increasing function of p_f (the exact expression is in Appendix A), and $\delta_h(p_f) > L$ because of the liability effect.

It is also worth noting that, ceteris paribus, the home regulator is tougher than its counterpart, i.e., for equal probabilities $p_h = p_f$, due to the liability effect.

Branch MNB. With respect to a subsidiary MNB a branch MNB differs along two dimensions. First, units share liability for their losses. Hence, unlike in the subsidiary MNB, residual assets from a successful home unit will reduce the amount the regulator pays out to foreign depositors. Second, at $t = 1$ the home regulator makes decisions for both units and provides deposit insurance to depositors in both countries. This brings in a new effect, which we refer to as *internalization effect*: when deciding about a given unit, the home regulator takes into consideration that an open unit can potentially support an insolvent (other) unit. Intervention in turn leaves no assets to reduce the regulator's costs in the other unit. The internalization effect, which stems from the regulator's responsibility for depositors in both countries, thus makes the regulator softer on any unit compared to a domestic bank.[14]

At the same time, joint liability between units allows the home regulator to reduce costs for any decisions in a given unit with residual assets from the other unit. This is the same liability effect that features in the home regulator's decision with a subsidiary MNB, making it tougher than a domestic banks' regulator.

[13] We thank a referee for pointing out some of the possible differences when $R + L$ is larger or smaller than 2.

[14] With a subsidiary MNB, although the foreign unit is liable for the home unit's losses, the foreign regulator is not responsible for the home unit's costs. Thus, given the seniority of foreign depositors, the foreign regulator does not internalize the impact of its decisions on the costs associated with the home unit.

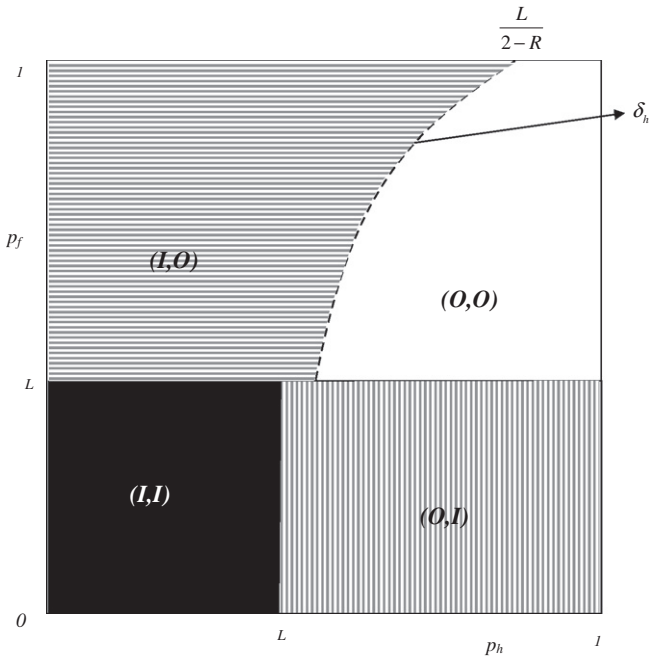

Fig. 1. Regulators' decisions (d^h, d^f) with subsidiary MNB $(R + L \leqslant 2)$. (Decisions of the form (*home decision*, *foreign decision*), where *I* = intervention, and *O* = no intervention).

Table 2
Branch representation: the home's regulator payoffs.

$d_h = I$, $d_f = I$	$-2(1-L)$
$d_h = O$, $d_f = I$	$-(1-L) - (1-p_i) + p_i \min\{1-L, R-1\}$
$d_h = O$, $d_f = O$	$-(2-R)\sum_{i\neq j}(1-p_i)p_j - (1-p_h)(1-p_f)2$

Table 2 summarizes the home regulator's payoffs for any pair of decisions.

To see how the internalization and the liability effects interact, consider the decision on the foreign unit. Given the symmetric nature of a branch MNB, the same reasoning below applies to the decisions on the home unit.

Assume first that the regulator intervenes in the home unit so that home assets fall short of liabilities. The regulator then prefers intervention in the foreign unit if its liquidation value L is larger than the expected cost savings with an open foreign unit: namely, the unitary cost saving for the foreign unit p_f, and the cost saving for the home unit $p_f \min\{1-L; R-1\}$. Hence, intervention is optimal if $p_f < L/(\min\{1-L, R-1\}+1)$. The right hand side of the inequality is strictly lower than L, which in turn implies that, conditional on intervention in the home unit, the home regulator will be more forbearing in the foreign unit than it would be with a domestic bank. With intervention in one unit, only the internalization effect is at work, which makes the regulator softer on the other unit.

Assume now that no intervention occurs in the home unit. Besides the internalization effect, in this case the liability effect also plays a role: residual assets in the home unit can be used to reduce the shortfall between assets and liabilities in the foreign unit. This in turn pushes the home regulator towards being tougher on the foreign unit, since the expected value of those assets (from the home unit) is higher with foreign intervention than without. Which of the two effects (internalization and liability) dominates depends on the prospects p_h of the home unit. In particular, if p_h is low, it is more likely that the home regulator may have to use residual assets from the foreign unit to support a failing home unit than the other way around. Thus, the internalization effect outweighs the liability effect,

leading to softer regulation on the foreign unit than would be imposed on a domestic bank. On the other hand, when p_h is large, the liability effect prevails, making the regulator tougher on the foreign unit than it would be with a domestic bank.

The following lemma summarizes these findings and illustrates how regulatory decisions depend on probabilities (p_h, p_f) :

Lemma 2 (Branch representation). *(i) Consider the decision on unit i. There exists a* $\bar{p} \in [0,1]$ *such that for* $p_j < \bar{p}$ *the branch MNB's regulator is softer on unit i than a domestic bank's regulator (the internalization effect prevails). For* $p_j \geqslant \bar{p}$*, the branch MNB's regulator is tougher on unit i than a domestic bank's regulator (the liability effect prevails).*

(ii) An increase of p_i *softens the regulator on unit i but makes it tougher on unit j.*

Clearly, better prospects for a unit always make the regulator softer on the unit, since lower costs are expected from an open decision. A higher probability of success of unit *j*, *ceteris paribus*,makes the liability effect stronger and the internalization effect weaker when the regulator makes a decision on unit *i*, which explains point (ii) of the proposition.

Fig. 2 illustrates optimal decisions for any pair of probabilities (p_h, p_f) for the case of $R + L \leqslant 2$.[15]

The figure also shows that, since the internalization effect is present independently of the decision concerning the home unit, whilst the liability effect is only at work with an open home unit, the home regulator is clearly tougher on the foreign unit when the home unit is open than when it is subject to intervention. In other words, when $d_h = O$ the home regulator intervenes in the foreign unit if $p_f < \varphi_f(p_h)$ where $\varphi_f(p_h)$ is an increasing function in p_h (the exact expression is in the Appendix); $\varphi_f(p_h)$ is larger than the hurdle rate $L/(\min\{1-L, R-1\}+1)$ that is relevant when $d_h = I$.

3.1. Prudential regulation and foreign representation

Our previous analysis identified two main drivers of the regulation of an MNB: the internalization effect that makes a regulator softer and the liability effect that makes a regulator tougher. The interaction between these two effects leads to the following differences in the regulation of a branch and a subsidiary represented MNB.

Proposition 1 (Branch vs. subsidiary). *The MNB's* **home unit** *is subject to softer regulation when the foreign unit is a branch than when it is a subsidiary.*

The **foreign unit** *is subject to softer regulation when it is a branch than when it is a subsidiary if* $p_h \leqslant \bar{p} \in [0,1]$*, and to stricter regulation otherwise.*

Consider first the home unit. The regulator's decision is affected by both the liability and the internalization effects when the MNB is represented with a branch, while it is only affected by the liability effect when it is represented with a subsidiary. Since the internalization effect, that makes the regulator softer, is only at work with a branch MNB, the first result of Proposition 1 immediately follows.

Regarding the foreign unit, the foreign regulator of the subsidiary is neither affected by the liability effect nor by the internalization effect: its decision rule thus coincides with that of a domestic bank's regulator. Hence, the comparison between branch and subsidiary regulation is the same as that between a branch and a domestic bank. When p_h is low, the internalization effect prevails and makes regulation more lenient under branch representation. When p_h is large, the internalization effect is reduced and the liability effect becomes stronger thus resulting in tougher regulation for a branch than for a subsidiary.

4. The choice on cross-border expansion and foreign representation

In the previous section we have shown the impact of foreign expansion and foreign representation form on regulation; we are now equipped with all the results to address the following important ques-

[15] Along the 45° line (i.e., for $p_h = p_f$) either the decisions are the same for the two units, or the regulator is indifferent between decisions (I, O) and (O, I).

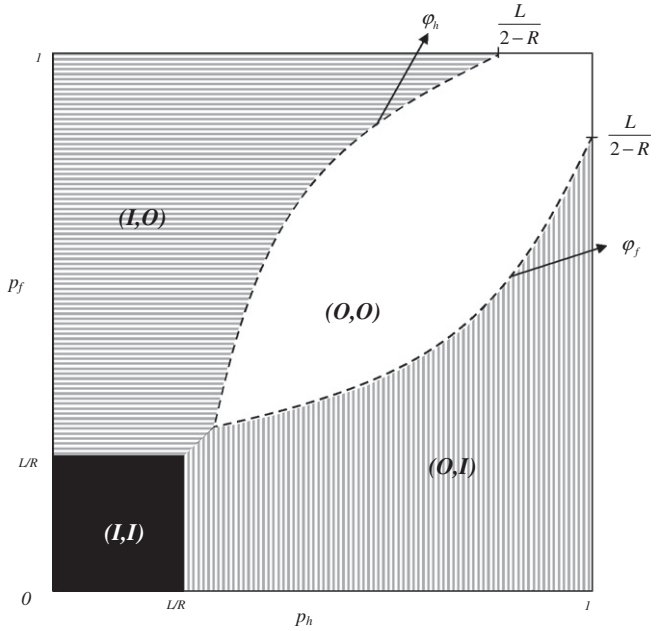

Fig. 2. Regulator's decisions (d^h, d^f) with branch MNB $(R + L \leqslant 2)$. (Decisions of the form (*home decision*, *foreign decision*), where *I* = intervention, and *O* = no intervention).

tions. Is foreign expansion profitable for a domestic bank? What is the preferred foreign representation if the bank decides to expand abroad? What are the consequences of foreign expansion for regulators?

Consider a domestic bank, which at $t = 0$ receives a signal p_h about its prospects. The bank subsequently makes a decision whether to remain domestic or to expand abroad and is uncertain about the foreign unit's prospects with p_f being a random variable with c.d.f. $F(p_f)$ over the support $[0, 1]$. The continuation of the game after $t = 0$ is as outlined in the previous section.

In Section 4.1, we analyze the case in which regulators impose no restriction on the foreign representation, so that the bank is free to choose whether to expand at all and, if it does, whether to do so *via* a branch or a subsidiary. Anticipating regulators' $t = 1$ prudential regulation, at $t = 0$ the bank chooses the representation form that guarantees the maximum expected profit. We indicate with D, B, and S the bank's $t = 0$ decisions, respectively for remaining domestic, and expanding abroad with a branch, or with a subsidiary.

In Section 4.2, we examine regulators' preferences on whether the bank should expand abroad and with what representation form. We discuss to what extent the home and host regulators may have diverging interests over the desirability of MNBs and their representation form.

4.1. Bank's preference

For a domestic bank to generate any profit two necessary conditions are to be met: the unit must be kept open at $t = 1$ and the unit's project must succeed. We can thus write the expected profits of the domestic bank as $\Pi_D = (R - 1)\pi_D$, where π_D is the probability of the joint event of the unit being open and being successful, with $\pi_D = p_h$ if $p_h \geqslant L$ and $\pi_D = 0$, otherwise.

The difference between a domestic bank and an MNB in generating profits is three-fold. First, an MNB can potentially make twice as much profit as a domestic bank. Second, a regulatory decision on an MNB's given unit may depend on the decision on the other unit. Third, having a successful pro-

ject may not guarantee that a unit can retain its profit because of shared liability for the other unit's losses. These three effects ultimately drive the bank's preference towards decisions D, S and B, as we now show.

Let us compare first a subsidiary MNB with a domestic bank. The profit Π_S is the sum of the expected profits generated by the two units, respectively Π_S^f for unit f and $\Pi_S^h = (R-1)\pi_S^h$ for unit h. The probability π_S^h that the home unit is kept open *and* pays out now also depends on p_f and on the regulatory decision of the foreign unit. The difference in expected profits between a domestic bank and a subsidiary MNB is then

$$\Pi_S - \Pi_D = (R-1)(\pi_S^h - \pi_D) + \Pi_S^f.$$

The first term of the right hand side is non-positive, as the liability effect makes the regulator tougher with the home unit than it would be with a domestic bank, i.e., $\pi_S^h \leqslant \pi_D$. The expected profit of the subsidiary is clearly non-negative, but it might be insufficient to make up for the lower expected profit of the home unit (e.g., when $R + L \leqslant 2$, $\Pi_S^f = 0$ unless the home unit is kept open and is successful). Conversely, if the home unit is kept open in any case, so that $\pi_S^h = \pi_D$, then expanding abroad with a subsidiary is (at least weakly) desirable from the bank's point of view.

Comparing now a branch MNB with a domestic bank, Lemma 2 shows that a unit of a branch MNB may face softer regulation than a domestic bank because the regulator internalizes the costs of its decision on the other unit. At the same time, a branch MNB may only generate a higher expected profit than a domestic bank if *both* units are kept open and successful. In fact, with intervention in one unit, a branch MNB's profits are either nil (when $R + L \leqslant 2$) or smaller than $R - 1$ (when $R + L > 2$). This suggests that a branch MNB is expected to be preferable to a domestic bank either (i) if p_h is low so that by turning into a branch MNB the bank would elicit softer regulation, or (ii) for values of p_h and p_f such that no unit of the branch MNB is expected to face intervention.

For the comparison between expanding with a branch or subsidiary, Proposition 1 shows that for low values of p_h a branch MNB faces softer regulation on any units than a subsidiary MNB. Hence, the branch structure is expected to result in a higher profit in this case. As the branch MNB makes zero (or low) profits if one of the two units is subject to intervention, and when $p_h > \bar{p}$ the branch is subject to stricter regulation than the subsidiary, it follows that for high values of p_h a subsidiary representation is preferable to a branch representation.

The next proposition summarizes the bank's optimal choice conditional on the value of p_h.

Proposition 2. *The bank's choice over foreign expansion and representation is characterized by the following four regions (I)–(IV) defined from low to high p_h in the set $[0, 1]$:*

Region (I): for low p_h, profits are nil in any representation and the bank is indifferent between D, S and B; this region is empty if $R + L > 2$.

Region (II): for low-intermediate p_h, the bank expands abroad with a branch; this region is empty if both $R + L \leqslant 2$ and $L > 1/2$.

Region (III): for intermediate-high p_h, the bank either remains domestic or goes abroad with a branch.

Region (IV): for large p_h, the bank expands abroad with a subsidiary.

Clearly, if p_h is very low (the exact boundaries defining the regions are in the Appendix), intervention takes place in the home unit and when $R + L \leqslant 2$ the expected profits are nil under any representations, which explains Region (I).

If instead $R + L > 2$, the bank may earn positive profits if it expands abroad even with intervention in the home unit; whilst it gets zero profit if it remains domestic. Moreover, since for low p_h a branch MNB faces softer regulation in all units than a subsidiary MNB (Proposition 1), the bank prefers to expand abroad with a branch; this explains Region (II).[16]

When the probability p_h is instead sufficiently high, the home unit does not face intervention with any foreign representation form. Thus, expanding with a subsidiary becomes better than remaining

[16] Region (II) is non-empty if $R + L > 2$ as explained in the text, and also if $R + L \leqslant 2$ and $L < 1/2$ since in this case too the branch MNB faces softer regulation than the subsidiary MNB, as explained with detail in the proof.

domestic since $\pi_S^h = \pi_D$. Furthermore, by Proposition 1 for high values of p_h the branch faces stricter regulation than the subsidiary so that expanding abroad with a subsidiary is the overall preferred choice; this explains Region (IV).

The analysis of the residual Region (III) is more complex and the optimal bank's decision may depend on the probability distribution of p_f. In this region, a subsidiary MNB is dominated since (for such values of p_h) both units of the subsidiary MNB face tougher regulation than they do in a branch MNB or in a domestic bank. The comparison between a domestic bank and a branch MNB, however, is ambiguous, and three cases can be relevant depending on the distribution of p_f. (i) Expectation of high values for p_f will make the home regulator tougher with unit h of a branch MNB than it would be with a domestic bank (result (ii) in Lemma 2), and the bank is better off remaining domestic. (ii) Expectation of intermediate values of p_f leads to the same open decision on the home unit both in a domestic bank and in a branch MNB, and to an open decision for the branch; hence a branch MNB yields higher expected profit than a domestic bank. (iii) Expectation of low p_f results in the same open decision on the home unit but now the branch is likely to face intervention: profits will be larger in a domestic bank as the home unit of a branch MNB has to share liability for the branch losses.

Proposition 2 illustrates some interesting and counterintuitive results. At first sight one may think that expanding abroad with a subsidiary should always be the preferred choice for the bank. After all, the foreign subsidiary is a source of additional profits for a domestic bank, and the home unit here is shielded from foreign losses contrary to a branch MNB. However, this reasoning does not take into account regulatory decisions, that clearly impact on bank's profits, and thereby affect the bank's choice of being active abroad (see Lemma 1, 2 and Proposition 1). Indeed, we have shown that, due to the liability effect, expanding abroad with a subsidiary systematically makes regulation on the home unit tougher, thus potentially reducing profits. It is only when the home unit is safe enough that the regulator prefers no intervention, and foreign expansion with a subsidiary is indeed the bank's preferred option.

Similarly, expanding with a branch abroad may seem counterintuitive, since given the joint liability of units in a branch MNB, the bank *ceteris paribus* increases the risk of losing profit compared to a subsidiary MNB. It is regulation again that alters the bank choice: a branch MNB may yield a higher expected profit than a subsidiary MNB because with the former the bank may elicit softer regulation.

4.2. Regulators' preferences

Although Proposition 2 gives a clear picture of the bank's preference on foreign expansion, banks are not always free to choose the preferred representation for foreign units (see Ursacki and Vertinsky, 1992; Blandon, 1999; Houpt, 1999). Indeed, in some cases, host regulators restrict this choice by imposing specific representation(s) on foreign banks. Within the EU, for example, a home regulator can refuse to give a licence to a bank that wishes to expand abroad *via* a branch. We now focus on the representation choice from the regulators' point of view by addressing the question of what mode of entry the home and foreign regulator would prefer for the multinational bank, if any. In both cases, we will also consider the possibility that the bank remains domestic.

To make the analysis symmetric for the home and foreign regulators, we will assume that each national regulator knows the prospects of the local unit whilst being uncertain about the prospects of the other unit. In particular, regulator i' s priors on the prospects of unit j are distributed according to a c.d.f. $F_i(p_j)$ over the support [0,1].

To make the decision problem symmetric for regulators, we also posit that a domestic bank with a single unit exists in the foreign country and the foreign regulator has to decide whether to allow it to be acquired by a bank from another country, thus becoming either a branch or a subsidiary of an MNB. Since we aim to analyze regulators' preferences over representation, we will not explicitly consider

the representation choice as a game between regulators. Consistently, we also assume that regulators cannot share their information.[17]

Within our framework, the foreign regulator's choice is immediate: it always prefers the branch representation to the subsidiary (or to blocking the acquisition of a domestic bank), since a branch MNB lifts the foreign regulator's responsibility towards local depositors.[18]

Comparing a subsidiary MNB with a domestic bank, the home regulator clearly prefers the former to the latter. Indeed, for the home regulator, the presence of the foreign unit is simply a source of additional resources that could be used to reduce deposit insurance payouts at home but without generating additional costs.

The comparison between a subsidiary and a branch for the home regulator is more complex. For values of p_h that elicit the same or softer regulation for the subsidiary than for the branch, the home regulator prefers foreign expansion with a subsidiary. The reason for this is that for the same or lower (expected) benefit in terms of foreign residual assets, the branch also generates costs for the home regulator. For $p_h > \bar{p} \in [0,1]$ Proposition 1 shows that the subsidiary faces softer regulation than the branch, hence for these values of p_h the home regulator clearly prefers a subsidiary MNB. However, regulatory decisions might differ in the two representations in a way that makes the comparison potentially ambiguous for the home regulator. For $p_h \leqslant \bar{p}$ the subsidiary faces tougher regulation than a branch, and there exists a range of intermediate values of p_f for which the home regulator can expect either very small or no additional assets from the subsidiary because of foreign intervention. For example, when $p_h < L/R$ and $p_f \in [L/R, L]$, the home unit faces intervention under both representations while the foreign unit is subject to intervention if it is a subsidiary but not if it is a branch. Consequently, a probability distribution that puts sufficient weight on these values of p_f could make a branch MNB preferred to a subsidiary MNB.

Proposition 3. *The foreign regulator always prefers a branch MNB. The home regulator always prefers the bank to expand abroad. For $p_h > \bar{p} \in [0,1]$, it prefers the bank to establish a subsidiary. Otherwise, depending on the distribution $F(p_f)$, it either prefers the bank to go abroad with a branch or with a subsidiary.*

Although a subsidiary may simply be seen as a source of additional assets to reduce home deposit insurance cost, a home regulator may not always prefer the bank to elect a subsidiary representation. As explained above, the reason is that in this case the home regulator has no control over the decision on the foreign unit. Hence, the home regulator's costs will be bounded below by the foreign regulator's decision; in the case of the branch, although the regulator potentially faces deposit insurance claims from both units, it can choose the joint cost-minimizing decision for both units.

It is also interesting to note that when regulators minimize expected deposit insurance cost they always prefer a domestic bank to expand abroad whilst this is not necessarily the case from the bank's point of view. Indeed, expansion abroad may lead to adverse regulatory decisions for the bank (e.g. in region (III) of Proposition 2). However, from the regulator's viewpoint it either shifts the regulatory burden to another country or allows the securing of foreign residual assets that can be used to reduce local deposit insurance costs.

5. Regulators and bank's profits

Regulators can be concerned about bank's profits in addition to the costs of deposit insurance. For example, their mandate may explicitly embrace banking profitability, as the financial stability of the local banking industry could be jeopardized by a drastic reduction in banks' profits. Alternatively, lob-

[17] See for example Repullo (2001) and Holthausen and Rønde (2003) on information sharing. In the present paper, we abstracted from this 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 of 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.

[18] This may seem at odds with the case, for example, of the recent failure in 2008 of Icelandic banks that were represented with branches in the UK. The British regulator (and public opinion) opposed branch representation fearing that the Icelandic deposit guarantee fund was not sufficient. Although important, this type of issue is clearly beyond the scope of our model.

bying could induce the regulator to consider profits. Hence, in this section we examine to what extent our previous results *change* when regulators also care about the profits generated by the MNB's unit(s) within their jurisdiction.

For a regulator in charge of both units of a branch MNB and maximizing the sum of deposit insurance costs and profits in the two countries, it does not matter whether local profits remain in the country or are channelled to the other country to reduce the shortfall between assets and liabilities. Since returns from investment in the two units are independent, for the single regulator of a branch MNB the optimal intervention rule in country i no longer depends on the decision in country j. An open decision in unit i yields $-(1-p_i)+p_i(R-1)$, and intervention results in $-(1-L)$. Thus, for $p_i \geqslant L/R$, the optimal course of action for the home regulator is no intervention.[19] It follows that the decision rule for any units of a branch MNB coincides with that for a domestic bank. Furthermore, it is easy to see that profit concerns make a regulator softer than when the regulator only cares about expected deposit insurance costs, since profits are negatively affected by intervention.

On the contrary, for national regulators in charge of a single unit of a subsidiary MNB, local profit might only count to the extent to which it remains in the country (e.g., they are reinvested or redistributed locally). Hence, the foreign regulator of a subsidiary values profits less than the regulator of a branch, and this leads to the subsidiary facing systematically tougher regulation than the branch, contrary to what happens with cost-minimizing regulators.

Another important difference with the case of cost-minimizing regulators is that a subsidiary's foreign regulator is now affected by the decision of the home regulator. In particular, it becomes softer when the home unit is open (as compared with $d_h = I$) since the expected profits for the foreign regulator are larger if the subsidiary is also kept open.

This effect is also at work for the home regulator of the subsidiary MNB but it interacts with the liability effect that makes it tougher if the subsidiary is open than when it is not: hence, we have two countervailing effects. As long as the liability effect prevails, then as in the previous sections, the home unit of a branch MNB is subject to softer regulation than the same unit in a subsidiary MNB. If instead the profit effect is strong, contrary to the previous sections, the home unit of a branch MNB is subject to stricter regulation than the same unit in a subsidiary MNB.[20]

Proposition 4. *Concerns for the MNB' s profits induce the following changes in regulatory decisions with respect to costs-minimizing regulators: (i) both the home and the foreign regulators become softer ; (ii) the branch always faces softer regulation than the subsidiary; (iii) the home unit may be subject to stricter regulation with branch than with subsidiary representation.*

How do the different regulatory decisions in Proposition 3 affect foreign expansion and representation choices?

Consider first the bank's choice. Clearly, for sufficiently high values of p_h, the bank still prefers to expand abroad with a subsidiary rather than to remain domestic. Furthermore, since now the home regulator might respond to softer foreign regulation by also being softer at home (when $R+L>2$), the subsidiary MNB, in this case, obtains positive profits for a larger set of p_h. It then follows that the subsidiary foreign representation now becomes even more attractive for the bank.

Comparing a domestic bank and a branch MNB, recall first that regulatory decisions coincide (intervention occurs in unit i if $p_i < L/R$). Hence, contrary to the case of cost-minimizing regulators, the bank cannot elicit softer regulation by going abroad with a branch. As the advantage of a branch MNB in terms of softer regulation disappears when regulators care about profits, foreign expansion with a branch becomes less desirable for the bank (still the bank may prefer foreign expansion with a branch so as to double its profits).

[19] We assume that the regulator of a branch MNB cares about the profits of all units as if the profits of the branch were repatriated in country h; this is not unreasonable since a branch MNB is in fact a single entity. If one assumes instead that the regulator cares about profits only in the home country, then our results on the branch MNB in the previous section still hold.

[20] Interestingly, mixed-strategies may emerge with subsidiary representation for intermediate values of p_f and p_h. A decision $d_h = I$ might prompt $d_f = I$ which in turn might induce $d_h = O$ so that the optimal decision on the foreign unit changes to $d_f = O$, and a pure strategy equilibrium fails to exist. Mixed-strategy equilibria have been illustrated in bank regulation in terms of "constructive ambiguity" for bail-out decisions (Freixas, 1999). The kind of ambiguity that emerges here is novel and independent of this motivation, it is a consequence of strategic interaction between independent national regulators.

The results on the bank's preferred choice are thus similar to those in Proposition 2, but with the subsidiary MNB now being the best option for a larger set of (high) p_h and the branch MNB for a smaller set of (low) p_h.

Consider now the regulators' choice. Contrary to the case of cost minimizing regulators, it is no longer the case that the foreign regulator systematically prefers a branch MNB to a domestic bank. In fact, on the one hand a domestic bank implies some regulatory costs that are avoided in the case of the foreign unit becoming a branch. On the other hand, with a branch MNB, the profits of the foreign unit are channelled towards the home country in the case of home failure or intervention.[21] When the foreign unit's prospects are bad, the cost reducing effect of the branch dominates, since the foreign unit is unlikely to yield any profit. When instead the foreign unit's prospects are good, the opposite occurs.

The home regulator prefers foreign expansion with a subsidiary to a domestic bank, for the same reason illustrated in the previous sections: the subsidiary is simply a source of additional resources that could be used to reduce deposit payout shortfalls at home. However, contrary to cost-minimizing regulators, a large p_h is not sufficient for the home regulator to prefer expansion with a foreign subsidiary (see Proposition 3). Indeed, from Proposition 4 the subsidiary now always faces tougher regulation than the branch. Hence, the higher expected profit from the branch coupled with low expected costs of paying foreign depositors may make the branch the preferred form of foreign representation for the home regulator.

6. Discussion and concluding remarks

Our understanding of the complex issues surrounding the regulation of MNBs 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 model does prove sufficiently versatile to deal with some important issues in MNB regulation.

We show that different representation forms can generate different regulatory responses. We argue that the liability structure of MNB units and a regulator's responsibility for foreign depositors implied by a particular representation form play a crucial role in explaining these differences. With regulators concerned about deposit insurance costs, we find that a branch representation results in softer regulation for the home unit than subsidiary representation; while the foreign unit as a branch can face tougher or softer regulation than as a subsidiary depending on the prospects of the home unit's project.

In the light of these findings, we analyze the bank's decision whether to expand abroad and what representation form to choose. We show that a domestic bank prefers to expand abroad via subsidiaries when the home investment is sufficiently safe. Instead, a bank prefers expansion with a branch if the home investment is unlikely to be successful, so as to make regulation softer. In intermediate cases, the bank may prefer not to expand abroad at all. It is interesting to see how these results fare with casual empirical evidence. Europe has a "single passport" scheme 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 abroad 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 representation. Although our stylized model fails to consider other important factors in the banks' choice, it does explain this behavior under the assumption that banks in the EU and the US hold a safer 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, a fact that could be consistent with the results of Proposition 2, assuming that Asian banks are more likely to face riskier projects in their home countries.[22]

[21] For the same reason, the foreign regulator now systematically prefers a domestic bank to a subsidiary of an MNB: in the former case local profits are safely in the country, unaffected by what happens in the home country.

[22] 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 MNBs in emerging markets. See also Focarelli and Pozzolo (2006).

In our base model, we have abstracted from several issues in MNB regulation that we leave for future research.

In particular, we have not considered the possibility that regulators can improve their knowledge on the bank's prospects by means of monitoring. 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 might not be the same individual that can actually monitor the foreign unit, which naturally creates misalignments between regulators, inefficient decisions and potential problems in sharing relevant information. In our working paper (Calzolari and Loranth, 2004), we consider regulatory monitoring: by incurring a cost, the regulator of a given unit could obtain a perfect signal about the unit's prospects before making a decision. Within the current model setup, we show that with a subsidiary the foreign regulator has greater incentive to monitor than does the home regulator; but the incentives to monitor are greater under branch than subsidiary representation. We further develop these ideas in a companion paper.

We have also not addressed the possible direct negative spill-overs from a troubled unit to one that is sound. One could envisage situations in which intervention in the home unit of a subsidiary MNB would produce the withdrawal of assets from the subsidiary, thereby affecting the latter's survival chances. If such negative spill-overs were incorporated in the model, this would create an additional problem of coordination between regulators.

In the present paper we also 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 could 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.

Appendix A.

Proof of Lemma 1. From the payoffs in Table 1, define $\delta_h(p_f) \equiv \frac{L-p_f M}{1-p_f(R-1)}$ where $M \equiv \max\{0, R+L-2\}$, so that when $d_f = O$ then $d_h = O$ if $p_h \geqslant \delta_h(p_f)$ and $d_h = I$ otherwise. When instead $d_f = I$, then $d_h = O$ if $p_h \geqslant L$ and $d_h = I$, otherwise. Furthermore, independently of d_h, $d_f = O$ if $p_f \geqslant L$ and $d_f = I$ otherwise. Since for any p_f regulator f has a dominated strategy, equilibrium decisions can be derived with iterated elimination of dominated strategies. As a convention, we assume that when a regulator is indifferent between I and O, it keeps the unit open.[23]

The space of probabilities (p_h, p_f) is then partitioned into four non-empty sets with associated equilibrium decisions: $(I,I) \equiv \{(p_h,p_f) : p_i < L, i = h,f\}; (O,I) \equiv \{(p_h,p_f) : p_h \geqslant L > p_f\}; (I,O) \equiv \{(p_h, p_f) : \delta_h(p_f) > p_h, p_f \geqslant L\}; (O,O) \equiv \{(p_h,p_f) : p_h \geqslant \delta_h(p_f), p_f \geqslant L\}$.

(i) It follows that $d_h = O$ iff $p_h \geqslant S_h(p_f)$ where

$$S_h(p_f) \equiv \begin{cases} \delta_h(p_f) \text{ for } p_f \geqslant L \\ L \text{ for } p_f < L \end{cases}$$

with $S_h(p_f) \geqslant L$. As for the subsidiary we have $d_f = O$ iff $p_f \geqslant S_f(p_h) \equiv L$. A domestic bank regulator in country i would instead decide as follows $d_i = O$ iff $p_i \geqslant L$ and $d_i = I$ otherwise, with $L \leqslant \delta_h(p_f)$. Comparing the boundaries, the result immediately follows.

(ii) Equilibrium d_f is unaffected by p_h since $S_f(p_h)$ here does not depend on p_h and an increase of p_f can only induce regulator f to take $d_f = O$ instead of $d_f = I$, but not vice versa. This is also the case for regulator h when $d_f = I$ (i.e. for $p_f < L$). On the contrary, when $d_f = O$, then $S_h(p_f) = \delta_h(p_f)$, which is

[23] Without any effect on the results and interpretations, we will consider the cases in which a particular configuration of parameters makes a regulator indifferent on decisions as non-generic.

increasing in p_f so that a larger p_f can only change equilibrium $d_h = O$ into equilibrium $d_h = I$. Finally, increasing p_h can only change $d_h = I$ into $d_h = O$. □

Proof of Lemma 2. From the payoffs in Table 2, when $d_j = O$ then $d_i = O$ if $p_i \geqslant \varphi_i(p_j) \equiv \frac{L - p_j M}{R - 2(R-1)p_j}$, and $d_i = I$ otherwise. If instead $d_j = I$, then $d_i = O$ if $p_i \geqslant \frac{L}{R-M} (< L)$, and $d_i = I$ otherwise. The set of probabilities (p_h, p_f) is then partitioned into the following sets with associated equilibrium decisions: $(I,I) \equiv \{(p_h,p_f) : p_i < \frac{L}{R-M}, i = h,f\}$; $(d_i = I, d_j = O) \equiv \{(p_h,p_f) : \varphi_i(p_j) > p_i, p_j \geqslant \max\{\frac{L}{R-M}, p_i\},\ i = h,f\}$; $(O,O) \equiv \{(p_h,p_f) : p_i \geqslant \varphi_i(p_j), i = h,f\}$. The set (O,O) is non-empty if either $M = 0$ or $M > 0$ with $L < 2(R-1)$. All other sets are non-empty.

(i) It follows that $d_i = O$ iff $p_i \geqslant B_i(p_j)$, and $d_i = I$ otherwise, where

$$B_i(p_j) \equiv \begin{cases} \min\{\varphi_i(p_j), p_j\} \text{ for } p_j \geqslant \frac{L}{R-M} \\ \frac{L}{R-M} \text{ for } p_j < \frac{L}{R-M} \end{cases}$$

Since $B_i(p_j)$ is weakly increasing in p_j with $B_i(0) = \frac{L}{R-M} < L$ and $B_i(1) = \min\{L/(2-R), 1\} > L$, for the Mean Value Theorem there exists an unique $\bar{p} \in [0,1]$ such that, for $p_j < \bar{p}$, either decisions coincide, or they are $d_i = O$ with a branch MNB and $d_i = I$ with a domestic bank and vice versa for $p_j \geqslant \bar{p}$. For future reference we also note that when $M = 0$ then $\bar{p} = \max\{L, 1/2\}$.

(ii) Since $B_i(p_j)$ is (weakly) increasing in p_j, the effect of p_j on d_i follows. □

Proof of Proposition 1. Consider first the decisions on unit h. To prove the result we need to show that

$$S_h(p_f) \geqslant B_h(p_f) \tag{1}$$

for any p_f so that either d_h is the same with the two representations, or it is I with subsidiary and O with branch representation (for $p_h \in [B_h(p_f), S_h(p_f)]$). Since $L > \frac{L}{R-M}$, the set of probabilities for p_f is partitioned into three subsets and, using the definitions of $S_h(p_f)$ and $B_h(p_f)$, we now show that (1) is verified in each subset. For $p_f > L$, (1) is implied by $\delta_h(p_f) \geqslant \min\{\varphi_h(p_f), p_f,\}$ which follows from $\delta_h(p_f) \geqslant \varphi_h(p_f)$. For $p_f \in [\frac{L}{R-M}, L]$, (1) is implied by $L \geqslant \min\{\varphi_h(p_f), p_f\}$ which follows from $L \geqslant p_f$. Finally, for $p_f < \frac{L}{R-M}$, (1) is implied by $L > \frac{L}{R-M}$.

Consider now d_f. With subsidiary representation, $d_f = O$ iff $p_f \geqslant S_f(p_h) = L$, and with branch $d_f = O$ iff $p_f \geqslant B_f(p_h)$. Hence, the comparison is exactly the same as the one between a domestic (foreign) bank and branch MNB analyzed in the proof of Lemma 2. □

Proof of Proposition 2. We identify the four regions (I), (II), (III) and (IV) of Proposition 2 characterized by the different regulatory decisions and different profits. We then show that these regions partition the set of probability $p_h \in [0,1]$ as indicated in Proposition 2.

Region (I). The region is characterized by zero profits for any type of bank. It is defined by $p_h < p_I$ with $p_I \geqslant 0$ to be determined below, and if $p_I = 0$ the region is empty.

Consider first $M = 0$ and let $c \equiv \frac{R - \sqrt{R^2 - 8L(R-1)}}{4(R-1)}$ be such that $\varphi_h(p_f) = \varphi_f(p_h) = c$ for $p_h = p_f = c$. It follows that for any $p_h < \min\{c, L\} d_h = I$ in all cases D, B, S. Hence, since $d_h = I$ implies $\Pi_i = 0$ when $M = 0$, we define $p_I \equiv \min\{c, L\} > 0$. On the contrary, this region is empty for $M > 0$ since expected profits are strictly positive with S and B even for $p_h = 0$, and in this case we set $p_I = 0$.

Region (II). The region is such that B is preferred and $\Pi_D = 0$. It is defined by $p_I \leqslant p_h < p_{II}$ with $p_{II} \equiv L$, and if $p_{II} = p_I$ the region is empty.

Consider first $M > 0$ which implies $p_I = 0$. For $p_h \leqslant L$, S generates a profit of $\Pi_S = M \int_L^1 p_f dF(p_f)$ because decisions are (I,I) for $p_f < L$ and (I,O), otherwise. Consider now B. From the proof of Lemma 2 we know that with B decisions (O,O) are impossible if $L \geqslant 2(R-1)$, and also if $L < 2(R-1)$ and $p_h \leqslant \frac{L}{R-M}$ jointly hold. In both cases decisions are (I,I) if $p_f < \frac{L}{R-M}$ and (I,O) otherwise, resulting in

$$\Pi_B = M \int_{\frac{L}{R-M}}^1 p_f dF(p_f), \tag{2}$$

so that $\Pi_B > \Pi_S$, where the inequality comes from $\frac{L}{R-M} < L$. It remains to compare profits Π_B and Π_S when $L < 2(R-1)$, but $\frac{L}{R-M} < p_h < L$. Recall that Π_S is unchanged since $p_h \leqslant L$ so that we only need to show that in the current case Π_B is even larger than in (2). The intuition for this is that higher values of p_h make the regulator softer for some values of p_f, hence they should results in higher profits. To see this, we must consider two further sub-cases. Let us define $\tilde{c} = \frac{L}{2(R-1)}$ be such that $\varphi_h(p_f) = \varphi_f(p_h) = \tilde{c}$ for $p_h = p_f = \tilde{c}$, and note that $\frac{L}{R-M} \leqslant \tilde{c}$ iff $L \leqslant 2 - 2(R-1)$. Let us also define $\varphi'_h(\cdot)$ as the inverse function of $\varphi_h(p_f)$. For $\frac{L}{R-M} \leqslant p_h < \tilde{c}$ decisions are (O,I) and (I,O) (depending on p_f) so that it is clear that comparing them with decisions (I,I) and $(I,O)\Pi_B$ is strictly larger than in (2): for some values of p_f we replace decisions (I,I) resulting in zero profit with decisions (I,O) resulting in strictly positive profit. Consider now $\max\{\tilde{c}, \frac{L}{R-M}\} \leqslant p_h < L$ such that decisions are (O,I), (O,O) and (I,O) (depending on p_f). For $p_f \leqslant \frac{L}{R-M}$ we now have decisions (O,I) instead of (I,I) that clearly generate a higher profit for B. For $\varphi_f(p_h) \geqslant p_f > \frac{L}{R-M}$ we now have decisions (O,I) instead of (I,O) which are equivalent in terms of profits. For $\varphi'_h(p_h) \geqslant p_f > \varphi_f(p_h)$ we now have decisions (O,O) instead of (I,O) which yield strictly higher profits. (Indeed, for any p_f expected profits with (I,O) are $p_f M$ while with (O,O) are $p_h p_f 2(R-1)$, and the latter expression is larger for $p_h \geqslant \frac{M}{2(R-1)} < \tilde{c}$). Finally, for $\varphi'_h(p_h) < p_f$ decisions are (I,O) in both cases resulting in equal profits. Hence, for $L < 2(R-1)$ and $\frac{L}{R-M} < p_h < L\Pi_B$ is larger than in (2), and it is then a *fortiori*larger than Π_S.

Consider now $M = 0$ which implies $p_I \equiv \min\{c, L\}$. Let first $L \leqslant 1/2$ which implies $L \geqslant c$ so that $p_I = c$. In this case, for $p_h \in [c, L) d_h = I$ with S and D so that $\Pi_S = \Pi_D = 0$, whilst $\Pi_B > 0$ since decisions are (O,O) whenever $p_i \geqslant \varphi_i(p_j)$ for both $i = h, f$ (which is admissible here given the definition of c and $\varphi_f(p_h)$ being increasing in p_h). Summarizing, for $M = 0$ and $L \leqslant 1/2$ we have $p_{II} \equiv L$, and $p_{II} > p_I$. Since in any case $p_{II} > p_I$, the region is non empty. Consider now $L > 1/2$ which implies $p_I = L$ so that for any $p_h > p_I$, $\Pi_D > 0$ implying that this region is empty and we define $p_I = p_{II}$.

Region (IV). The region is such that S is preferred to B and D and it is defined by $p_h \geqslant p_{III}$ where the value of p_{III} will be identified next with the property $p_{II} \leqslant p_{III} < 1$. It suffices to show that indeed for sufficiently large p_h, S is preferred. In fact, for large enough p_h, $d_h = O$ in any case and the presence of the foreign unit with S guarantees additional profits (with respect to D) that are larger with S than B, because with B the foreign unit is kept open for a smaller set of p_f than with S. Indeed, consider the extreme case $p_h = 1$. It follows that $\Pi_S - \Pi_D = \Pi_S^f > 0$ (since $d_h = O$ both in D and S). Furthermore, if $M = 0$ then

$$\Pi_S - \Pi_B = (R-1)\left[1 + \int_L^1 p_f dF(p_f)\right] - 2(R-1)\left[\int_{\varphi_f(1)}^1 p_f dF(p_f)\right] > 0$$

where the sign follows from the fact that (i) $\varphi_f(p_h) > L$ for $p_h = 1$, and (ii) $d_f = O$ iff $p_f \geqslant L$ with S, while $d_f = O$ iff $p_f \geqslant \varphi_f(p_h)$ with B (recall that with B and decisions (O,O), profits are positive only if both units succeed). Similarly, if $M > 0$ and $p_h = 1$ we have $\Pi_S > \Pi_D$ and $\Pi_S > \Pi_B$ since $\Pi_B = R - 1 - (1 - L)$ (the decision being (O,I)). We will show below that this ranking of profits also applies for large enough $p_h < 1$, thus defining the non-empty region (IV).

Region (III). Region III is such that S is dominated by D (the comparison between B and D may depend on the distribution $F(.)$), and it is defined by $p_{II} \leqslant p_h < p_{III}$ with $p_{II} < p_{III} < 1$. The approach is to show first that for $p_h \geqslant p_{II}$ and p_h not too large S is dominated. Second, since we know that S is the best option for $p_h = 1$, by a continuity argument there exists an intermediate $p_{III} \in (p_{II}, 1)$ that defines the upper-bound for region (III).

III-a: $M = 0$. Recall that $p_{II} = L$ and let $c^S \equiv \frac{L}{1 - L(R-1)}$ be the value of p_h such that $\delta'_h(p_h) = L$ and $\delta'_h(\cdot)$ is the inverse function of $\delta_h(p_f)$. For any $p_h \in [p_{II}, c^S)$, $d_h = O$ with D thus leading to profit $\Pi_D = p_h(R-1)$; with S decisions are (O,I) if $p_f < L$ thus leading to a smaller profit $\Pi_S = p_h(R-1)\Pr(p_f < L)$, and (I,O) otherwise, leading to zero profits. Hence, S is never chosen. Consider now B and D. If $L \leqslant 1/2$ (so that $c \leqslant L$) for probabilities $\max\{c, L\} \leqslant p_h < c^S$ (notice that $c < c^S$ because $c^S \geqslant L$) B could be the preferred choice. Indeed, with $M = 0B$ generates profits with decisions (O,O), yielding $\Pi_B = p_h 2(R-1) * \int_{\varphi_f(p_h)}^{\varphi'_h(p_h)} p_f dF(p_f)$. The sign of $(\Pi_B - \Pi_D)$ is then the same as $sign[2\int_{\varphi_f(p_h)}^{\varphi'_h(p_h)} p_f dF(p_f) - 1]$, which is

ambiguous in general and depends on the distribution $F(.)$.[24] For $L > 1/2$ (so that $c > L$) D is better than B for $p_h \in [p_{II}, c)$ since $\Pi_B = 0$. It is instead ambiguous for larger p_h.

Consider now $p_h \geqslant c^S$. The comparison between Π_B and Π_D is as before since for any $p_h \geqslant \max\{c, L\}$ decisions are unchanged with B and D. For any $p_h \geqslant c^S$ the profit with S is instead

$$\Pi_S = p_h(R-1)\left[\int_0^{\min\{\delta_h'(p_h),1\}} dF(p_f) + \int_L^{\min\{\delta_h'(p_h),1\}} p_f dF(p_f)\right] \tag{3}$$

because $d_h = O$ iff $p_f \in [0, \delta_h'(p_h)]$ and for the foreign unit $d_f = O$ iff $p_f \geqslant L$, but recall that profits in this case may be still zero when the home operation is subject to intervention which is the case for $p_f > \delta_h'(p_h)$. [25] Now notice that $\partial \Pi_S / \partial p_h \geqslant 0$ as $\delta_h'(p_h)$ is increasing in p_h. We know from Region (IV) that $\Pi_S > \max\{\Pi_D, \Pi_B\}$ for $p_h = 1$, whilst we have shown that for $p_h \in [p_{II}, c^S)$ we have $\max\{\Pi_D, \Pi_B\} > \Pi_S$. Since profits are continuous and monotone in p_h, the Mean Value Theorem implies that there exists a $\tilde{p}_h \in [c^S, 1)$ such that if $p_h < (\geqslant) \tilde{p}_h$ then $\max\{\Pi_D, \Pi_B\} > (\leqslant) \Pi_S$. Hence, we define $p_{III} \equiv \tilde{p}_h$ with $1 > p_{III} > p_{II}$.

III-b: $M > 0$. Consider $p_h \in [p_{II}, c^S]$, where now the expression for c^S is $c^S = \frac{L(-1+M)}{-1+L(R-1)} \in (p_{II}, 1)$. For p_h in this region decisions are as follows: with $Dd_h = O$, with S (O, I) if $p_f < L$, and (I, O) otherwise. The associated profits are then $\Pi_D = p_h(R-1) \geqslant \Pi_S = p_h(R-1) \int_0^L dF(p_f) + M \int_L^1 p_f dF(p_f)$. The difference $\Pi_D - \Pi_S$ is larger than $[p_h(R-1) - M] \int_L^1 dF(p_f)$ which is positive because $p_h \geqslant M/(R-1)$ for $p_h \geqslant p_{II} \equiv L$. In fact, $L \geqslant M/(R-1)$ is equivalent to $(R-2)(1-L)$ is true as $R < 2$ by assumption.

For $p_h \geqslant c^S$, the comparison between Π_D and Π_S is as in case III-a. Hence, for the same reason, there exists a $\tilde{p}_h \in [c^S, 1)$ such that for $p_h < \tilde{p}_h S$ is dominated, and for $p_h > \tilde{p}_h S$ is preferred. □

Proof of Proposition 3. Let W_{ij} be regulator j's payoff with $i = h, f$ and a bank of type $i = D, B, S$. For what is stated in the text, $W_{Bf} \geqslant \max\{W_{Df}, W_{Sf}\}$ and $W_{Sh} \geqslant W_{Dh}$.

We are then left to compare W_{Bh} and W_{Sh}. Let $W_{ih} = w_h + w_i$ where w_h is the home regulator's payoff on the home unit h, and w_i identifies the home regulator's payoff associated with the foreign unit for $i = S, B$. The subsidiary brings

$$w_S \equiv \begin{cases} \min\{1-L, R-1\}\pi_S^f & \text{if} \quad d_h = I \\ (1-p_h)(R-1)\pi_S^f & \text{if} \quad d_h = O \end{cases}$$

where π_S^f is the probability that the subsidiary is kept open and succeeds. In turn, the branch generates

$$w_B \equiv \begin{cases} \min\{1-L, R-1\}\pi_B^f - \tilde{\pi}_B^f - (1-L)(1-\pi_B^f - \tilde{\pi}_B^f) & \text{if} \quad d_h = I \\ (1-p_h)(R-1)\pi_B^f - \tilde{\pi}_B^f - (1-L)(1-\pi_B^f - \tilde{\pi}_B^f) & \text{if} \quad d_h = O \end{cases}$$

where π_B^f is the probability that the branch is kept open and succeeds, $\tilde{\pi}_B^f$ is the probability the branch is kept open but fails and $1 - \pi_B^f - \tilde{\pi}_B^f$ the probability that the branch is subject to intervention.

Consider first the case $\pi_S^f \geqslant \pi_B^f$, which is equivalent to $p_h \geqslant \bar{p}$ where $\bar{p} \in [0, 1]$ is defined in the proof of Proposition 1. It is then immediate that $w_S > w_B$. Furthermore, assume that with S the home regulator takes the same d_h as with B (although this d_h could be suboptimal for S) so that the payoff on the home unit w_h is the same with the two representations. It follows that $W_{Sh} \geqslant W_{Bh}$ which is true, a fortiori, had we considered the optimal d_h with S.

When instead $\pi_S^f < \pi_B^f$, or equivalently $p_h < \bar{p}$, the comparison between w_B and w_S is in general ambiguous. The branch may bring additional costs with respect to subsidiary (the negative terms in w_B) but the branch representation leads to less intervention on the foreign unit.[26] □

[24] When the distribution of p_f is uniform, the latter becomes $\varphi_h^2 - \varphi_f^2 - 1 < 0$ since $\varphi_i < 1$ and then $\Pi_B < \Pi_D$.

[25] The value of $\delta_h'(p_h)$ is smaller than 1 iff $p_h \leqslant L/(2-R)$, otherwise the upper limit of integration in Π_S is clearly 1.

[26] In our working paper we show that with a uniform distribution $W_{Sh} < W_{Bh}$ in this case.

Table 3
Subsidiary representation: the regulators' payoffs.

	$d_f = I$	$d_f = O$
$d_h = I$	$-(1-L); -(1-L)$	$-(1-L) + p_f \min\{R-1, 1-L\}; -(1-p_f) + p_f M$
$d_h = O$	$-1 + p_h R; -(1-L)$	$-1 + p_h R + (1-p_h)p_f(R-1); -(1-p_f) + p_f p_h(R-1)$

Proof of Proposition 4. For what stated in the text, decisions with branch representation are $d_i = I$ iff $p_i < L/R$ for $i = h, f$.

With a subsidiary MNB, regulators' payoffs are: see Table 3

If $d_h = I$, then $d_f = I$ is optimal iff $p_f < \frac{L}{M+1}\left(\in \left(\frac{L}{L+1}, L\right)\right)$; if $d_h = O$ then $d_f = I$ is optimal iff $p_f < \delta_f(p_h) \equiv \frac{L}{1+p_h(R-1)} (\in [L/R, L])$. If $d_f = I$, then $d_h = I$ iff $p_h < L/R$; If $d_f = O$, then $d_h = I$ iff $p_h \leqslant \delta_h(p_f) \equiv \frac{L-p_f M}{R-p_f(R-1)}$. Notice that for $M = 0$, $\delta_h(p_f)$ is increasing in p_f , and this is also the case when $M > 0$ and $(2-R)R \geqslant L$. On the contrary, $\delta_h(p_f)$ is decreasing in p_f if $M > 0$ and $(2-R)R < L$.

We can then identify the following sets with associated equilibrium (pure strategy) decisions: $(I,I) = \{(p_h, p_f) : p_h < \frac{L}{R}, p_f < \frac{L}{M+1}, i = h, f\}$, $(O,I) = \{(p_h, p_f) : p_h \geqslant \frac{L}{R}, p_f < \delta_f(p_h)\}$, $(I,O) = s\{(p_h, p_f) : p_h < \delta_h(p_f), p_f \geqslant \frac{L}{M+1}\}$, $(O,O) = \{(p_h, p_f) : p_i \geqslant \delta_i, i = h, f\}$ and, for probabilities in the set $Mx \equiv \{(p_h, p_f) : p_h \in m_h, p_f \in m_f\}$ the (unique) equilibrium is in mixed-strategies where Mx is defined as follows: if either $M = 0$ or $M > 0$ with $(2-R)R \geqslant L$ then $m_h \equiv [L/R, \delta_h(p_f)]$, $m_f \equiv [\delta_f(p_h), \frac{L}{M+1}]$, if instead $M > 0$ with $(2-R)R < L$ then $m_h \equiv [\delta_h(p_f), L/R]$, $m_f \equiv [\delta_f(p_h), \frac{L}{M+1}]$.[27]

(i) The result is immediate except for the mixed strategy region. However, note that $Mx \subseteq \{(p_h, p_f) : p_i < L, i = h, f\}$ which is the set of probabilities inducing decisions (I,I) with the subsidiary representation for cost-minimizing regulators. The result then follows for any probability pair in Mx.

(ii) Unit f with branch it is kept open if $p_f \geqslant L/R$, whilst with subsidiary $d_f = O$ requires either $p_f \geqslant \frac{L}{M+1}$ or $p_f \geqslant \delta_f(p_h)$, where in both cases $\min\{\frac{L}{M+1}, \delta_f(p_h)\} \geqslant L/R$. Hence, the stricter conditions for the subsidiary imply the result.

(iii) For $M > 0$ and $(2-R)R < L$, $\delta_h(p_f)$ decreases in p_f so that $\delta_h(p_f) < L/R$. Hence, for intermediate $p_h \in [\delta_h(p_f), L/R]$ either $d_h = I$ with both branch and subsidiary or, if $p_f \geqslant \frac{L}{R-(1-L)}$, then $d_h = O$ with subsidiary and $d_h = I$ with branch. Furthermore, the mixed strategy region with S belongs to a set of probabilities such that $d_h = I$ with B. The result then follows if p_f high, p_h intermediate, and $R + L > 2$ with R being sufficiently larger than L. □

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[27] Although the exact characterization of equilibrium mixed-strategies is not needed for the purposes of our results, they can be found in our working paper Calzolari and Loranth (2004).

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