Multinational Banks and Supranational Supervision*

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Abstract

We study the supervision of multinational banks (MNBs), allowing for either national or supranational supervision. National supervision leads to insufficient monitoring of MNBs due to a coordination problem between supervisors. Supranational supervision solves this problem and generates more monitoring. However, this increased monitoring can have unintended consequences, as it also affects the choice of foreign representation. Indeed, supranational supervision encourages MNBs to expand abroad using branches rather than subsidiaries, resulting in more pressure on their domestic deposit insurance fund. In some cases, it discourages foreign expansion altogether, so that financial integration paradoxically decreases. Our framework has implications on the design of supervisory arrangements for MNBs, the European Single Supervisory Mechanism being a prominent example.

Keywords: Cross-border banks, Multinational banks, Supervision, Monitoring, Regulation, Banking Union.

JEL classification: L51, F23, G21, G28.

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Introduction

The number and importance of multinational banks (MNBs) have increased significantly over the past two decades.[1] These banks operate in complex, often uncoordinated and dissimilar regulatory regimes, involving several national supervisors which tend to act in the interest of their own countries. In such an environment, cross-border banks might be able to escape tight monitoring and regulation.[2] Similarly, Agarwal *et al.* (2014) show that State supervisors in the United States are systematically more lenient than Federal ones, underlining conflicts of objectives between different supervisory authorities.

Is integrated supervision a solution to this global problem? The Euro area offers a perfect laboratory to answer this question. Indeed, the extent of banks' cross-border activities and the fragmentation of supervisory responsibilities led to the suspicion that MNBs could strategically exploit the lack of coordination between supervisors. As a result, the European Commission fostered the creation of a European Banking Union, whose first component is supranational supervision.[3] The so-called Single Supervisory Mechanism entered into force in November 2014, when the European Central Bank took over the supervision of the 129 most significant banks in the Euro area, representing 80% of total Euro area banking assets. The Banking Union is a first-order change for European MNBs, and the first example of a supranational bank supervisor.

The objective of this paper is to understand how supranational supervision can affect the way MNBs operate, the funding conditions they face and possibly also their very decision to operate cross-border. We show that supranational supervision indeed solves coordination problems and generates more monitoring of banks. However, this increased monitoring leads to an adjustment in the choice of foreign representation by multinational banks. Supranational supervision encourages MNBs to convert their foreign subsidiaries into branches, or even to revert to a purely domestic activity altogether. In turn, this change in the MNB's representation form affects how potential losses are allocated to the national and the foreign deposit insurance funds. In particular, it necessarily leads to higher pressure on the deposit insurer of the country of origin.

To properly assess the impact of supranational supervision, we explicitly account for the differ-

[1] See Claessens and Van Horen (2013).

[2] A prominent example is the case of Dexia which, despite being supervised by the authorities of Beligum, France, Luxembourg and the Netherlands, suffered a catastrophic failure which led to a bail-out for 6 bln EUR in 2011.

[3] See the *Report and Recommendations of the Cross-border Bank Resolution Group* , Basel Committee on Banking Supervision, March 2010 and the *Proposal for a Council regulation conferring specific tasks on the European Central Bank concerning policies relating to the prudential supervision of credit institutions*, European Commission, September 12, 2012.

	Subsidiary	Branch
Deposit insurer (DI) of the home unit	Home DI	Home DI
Deposit insurer (DI) of the foreign unit	Foreign	Home
Supervisor of the home unit	Home supervisor	Home supervisor
Supervisor of the foreign unit	Home supervisor	Foreign supervisor
Home unit responsible for foreign unit's liabilities	No	Yes
Foreign unit responsible for home unit's liabilities	Yes	Yes

Table 1: Branches and subsidiaries.

ent liability structures that a cross-border banking group may choose from. In particular, banks can operate abroad via subsidiaries or branches. Subsidiaries are foreign incorporated stand-alone entities, which are protected by limited liability. Under national supervision, deposits in each country are insured by the local deposit insurance fund, and supervision is similarly split between a home and a host supervisors. Branches share liabilities and profits with the parent bank. Deposits are insured by the home country deposit insurance fund, and supervision in both units is exerted by the home country supervisor. These differences are summarized in Table 1.

Supervisors are in charge of monitoring the bank, which enables them to uncover poorly performing assets and liquidate them. Monitoring has a cost, which the supervisor trades off with the informational value of monitoring. If monitoring is expensive and the assets have a high probability of being of low quality, it is optimal for a supervisor not to monitor the bank and liquidate its assets. This decision has different consequences depending on the organizational structure of the MNB. In particular, when the supervisor of a foreign subsidiary monitors and this unit returns a positive payoff, part of it can be used to repay depositors in the home country if the home unit is unsuccessful. On the contrary, when the foreign unit is liquidated, its assets cannot be used to offset losses in the home country. As a result, the foreign supervisor exerts a negative externality on the home supervisor when he liquidates the foreign unit, and a positive externality when he chooses to monitor. For this reason, there can be too little monitoring in the foreign unit in equilibrium.

Due to this externality, the introduction of supranational supervision unequivocally leads to more monitoring for banks with a subsidiary structure, while it does not alter decisions for banks with a branch structure. The supranational supervisor internalizes the fact that monitoring the foreign unit is valuable for the home unit, which is a desirable outcome of supranational supervision.

However, there can be a second, unintended effect. For some parameter values, the MNB chooses the subsidiary structure under national supervision precisely because it leads to low monitoring of the foreign unit. When supranational supervision is introduced and leads to more monitoring, the MNB will reconsider its organizational structure and can reorganize as a branch-MNB, or as a stand-alone bank present in one country only. When the MNB chooses to become a stand-alone bank, supranational supervision has the paradoxical impact of decreasing financial integration.

More generally, the message of our paper is that, in the long-run, MNBs will strategically react to the structure of supervision by adapting their decision to expand abroad and their organizations to the structure of supervision. In our model, they do it with a view to extracting more benefits from their liability structure and the deposit insurance fund.

The changes in organizational forms affect both the total expected losses and their allocation to the national deposit insurance funds. When supranational supervision induces a switch to branches, total losses to the deposit insurance funds are reduced, but will entirely be borne by the home deposit insurance fund. This reallocation of losses is particularly damaging as we also show that a branch-MNB is only profitable if the home deposit insurance fund is less well funded than the foreign one. The higher burden can then undermine the credibility of the home deposit insurance, leading to higher deposit rates and lower profits for multinational banks. When the MNB reverts to a standalone domestic bank, losses will be supported by the home deposit insurance, but again will be larger than the part corresponding to the home deposit insurance under the subsidiary form. Hence, in both cases the home deposit insurance fund ends up with more liabilities. As many countries' deposit guarantee systems are already overstretched, centralization might have the long-run effect of further reducing the credibility of some countries' deposit insurance. Our model enables us to derive implications about which countries would more likely be affected by the introduction of a supranational regulator.

We also complete this analysis by considering the effects of moving towards a common deposit insurance, as is currently debated for the European Banking Union. In particular, we show that introducing a common deposit insurance does not eliminate the paradoxical result that supranational supervision may induce the MNB to close its foreign unit.

Finally, the model can also be used to deliver empirical implications about the funding conditions of MNBs, depending on their organizational structure. While funding costs for foreign subsidiaries are only affected by the credibility of the foreign deposit insurance, the home unit funding costs will be influenced by both the credibility of the home and that of the foreign deposit insurance. Branches' funding costs, instead, are determined by the credibility of the home deposit insurance fund. Higher credibility results in lower funding rates and higher profits for banks. An MNB should thus react differently to a switch to supranational supervision depending on the credibility of the deposit insurance fund in the home and the host countries. We show how the implications will be different for the case of a MNB incorporated in a crisis country with subsidiaries in surplus countries with credible deposit insurance, and for the symmetric case of an MNB incorporated in a surplus country that expands in crisis countries.

Our paper builds on two strands of the literature. First, some papers have studied frictions and conflicts of objectives between national regulators. Externalities lead independent national regulators to choose suboptimal regulatory standards, in the form of too low capital requirements (Dalen and Olsen (2003), Dell'Ariccia and Marquez (2006)), too lax intervention thresholds (Acharya (2003)), or too coarse information sharing (Holthausen and Rønde (2004)). Beck, Todorov, and Wagner (2013), Agarwal *et al.* (2014), and Rezende (2011) provide empirical support for the divergence of objectives hypothesis by looking at the decisions of different supervisors while controlling for bank fundamentals.

Second, there is a literature looking at the endogenous choice of representation form of financial intermediaries based on the differences in liability structure between branches and subsidiaries (Kahn and Winton (2004), Dell'Ariccia and Marquez (2010), Luciano and Wihlborg (2013)). However, these papers do not consider supervision as a factor driving the choice between branches and subsidiaries. Harr and Rønde (2004), Loranth and Morrison (2007), and Calzolari and Loranth (2011) analyze optimal regulation taking into account the bank representation form. Calzolari and Loranth (2003) analyze optimal closure policies for branches and subsidiaries and their impact on the choice of representation form by the bank. Focarelli and Pozzolo (2005) and Cerutti, Dell'Ariccia, and Martinez Peria (2007) empirically investigate the determinants of the MNBs' organizational choice.

We combine these two strands of the literature in a model in which regulatory treatment and frictions in supervision are key drivers of the choice of representation form by the MNB. In particular, the optimal supervisory actions depend on the bank's representation form and, in turn, the bank's representation form optimally responds to the anticipated supervisory actions. We make two main contributions to the literature mentioned above. First, we show that centralizing supervision has the unintended consequence of changing the MNB's representation form, in a way that increases losses to the weaker deposit insurance fund. Second, we emphasize new determinants of the MNBs' optimal representation form and derive testable implications to enrich the empirical literature.

As our main example of supranational supervision is the Single Supervisory Mechanism, we also contribute to a growing literature on the possible effects of this new architecture. Colliard (2014) compares supranational to national supervision, focusing on the trade-off between worse quality information and less biased incentives of supranational supervisors. Carletti, Dell'Ariccia, and Marquez (2016) argue that local supervisors will have lower incentives to collect information if decisions are taken by a central regulator. Beck and Wagner (2016) also study common supervision, but examine the problem of different regional preferences regarding financial stability. Górnicka and Zoican (2016) focus on the incentives for competent authorities to bail-out defaulting banks.

Our paper provides a new insight into the effects that drive the difference between the national and supranational supervisors' decisions. In particular, we examine in detail the interplay between the MNB's liability structure, the allocation of supervisory functions and the credibility of the deposit insurance fund. More importantly, we argue that centralization of supervision might not achieve its indented benefits once the MNB's incentives are also taken into consideration. The possibility of the MNB reorganizing its corporate structure will limit any potential benefit coming from centralization. In addition, centralization might lead to a suboptimal allocation of losses to national deposit insurance funds.

1 Model

1.1 Assumptions

We consider a multinational bank (MNB) operating units in two countries: the home country h (where the MNB is incorporated) and the foreign country f. Each unit invests locally in a portfolio of illiquid and risky projects that pay out $R > 1$ with probability p, or return 0 with probability $1 - p$. Premature liquidation of a portfolio guarantees a sure payoff $L \in [0, 1)$. Returns on the portfolios in the two countries are uncorrelated. Investments are financed by one unit of deposits in each country, which is insured by the national deposit insurance fund (DI). The DI fund in country i can repay with probability α_i. Since actual reimbursement may be partial, depositors ask for a risk premium: depositors are willing to lend at an endogenous interest rate $P_i \geq 1$.

Liability structure. 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.[4]

A *subsidiary* shares liability for the home unit's losses, but the reverse is not true. More precisely, after foreign depositors are paid out, the remaining assets in a solvent subsidiary must be used against the home unit's outstanding liabilities. No such transfer is legally required from a solvent home unit to an insolvent subsidiary. With a subsidiary-MNB, each national supervisor supervises its local unit. Similarly, deposits in each country are insured by the local deposit insurance fund.

A *branch* can be thought of as an extension of the home unit, thus forming a single entity. Insolvency occurs when the total assets of the MNB in both units fall short of total liabilities. The supervisor in the home country is in charge of supervision and insures depositors in both countries. In insolvency, the MNB's assets are distributed to depositors pro-rata in both countries.

Supervision. Supervisors perform two tasks: *on-site monitoring* and *intervention.* They are assumed to be risk neutral and minimize all (expected) costs that may arise as a consequence of monitoring, intervention, or failure of the local unit.

National supervisors non-cooperatively elect whether to monitor and intervene in their local unit. Monitoring the local unit in country i costs c_i and results in a perfect signal on the success or failure of the unit. In the absence of monitoring, the supervisor only knows that an asset in country i pays out with probability p_i. To obtain sensible comparisons, we consider the case $p_h = p_f = p$.

Based on the available information, supervisor i then makes a decision on whether or not to intervene in the local unit. We think of intervention as conservatorship or ring-fencing activity that results in early liquidation of the project with the payoff L. Alternatively, the supervisor can decide to take no action, i.e., let the unit continue until the asset matures. Each unit can thus be in one of three *states*: success s, liquidation l, or failure f.

Information. We assume that information generated by monitoring is truthfully shared between supervisors before any prudential decision is taken. This is clearly a simplification of the complex monitoring task faced by supervisors who may also be motivated by different and conflicting interests.[5] However, credibility is essential for bank supervisors, which drastically limits their willingness to misrepresent ex-post verifiable information.[6]

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

[5] See for example Repullo (2001) and Holthausen and Rønde (2004) on information sharing.

[6] Even if a supervisor could conceal the information obtained with monitoring, information could still "unravel" and be perfectly inferred by the other supervisor, as shown in persuasion games (Grossman (1981) and Milgrom (1981)).

Centralized Supervision. The central supervisor faces the same information structure and costs, c_h and c_f, as national supervisors. Its objective is an equally weighted sum of the expected payoffs that the national supervisors would adopt in the two countries.

Timeline. The following timeline summarizes the environment. Graph 1 shows the tree of the game for periods 0 to 2 when supervision is national.

- At $t = -1$: the supervisory architecture is announced. The bank faces either supranational or national supervision.

- At $t = 0$: the MNB first chooses whether to expand abroad with a *subsidiary* or a *branch* or, alternatively, to remain a *stand-alone* bank in the home market. These strategies are respectively denoted by $\sigma = S$, $\sigma = B$ and $\sigma = A$.

- At $t = 1$: The bank offers payments of P_h and P_f (deposit rates) to depositors in the two countries, and depositors choose whether to deposit 1 unit or invest in a safe outside option returning 1.

- At $t = 2$: The supervisor in charge decides whether to monitor the unit(s) under his jurisdiction or not. Monitoring the unit in country i costs c_i for either supervisor.

- At $t = 3$: The supervisors learn the state of units that were monitored in $t = 2$. On the basis of available information, the supervisor(s) decides whether to intervene in the unit or not.

- At $t = 4$: Payoffs realize. Liquidated assets are worth L, successful assets return R, and failed assets return 0. Depositors of a successful unit i are repaid P_i. For an unsuccessful unit, the deposit insurance fund in country i fully repays depositors with probability α_i, and partially repays them with probability $(1 - \alpha_i)$.

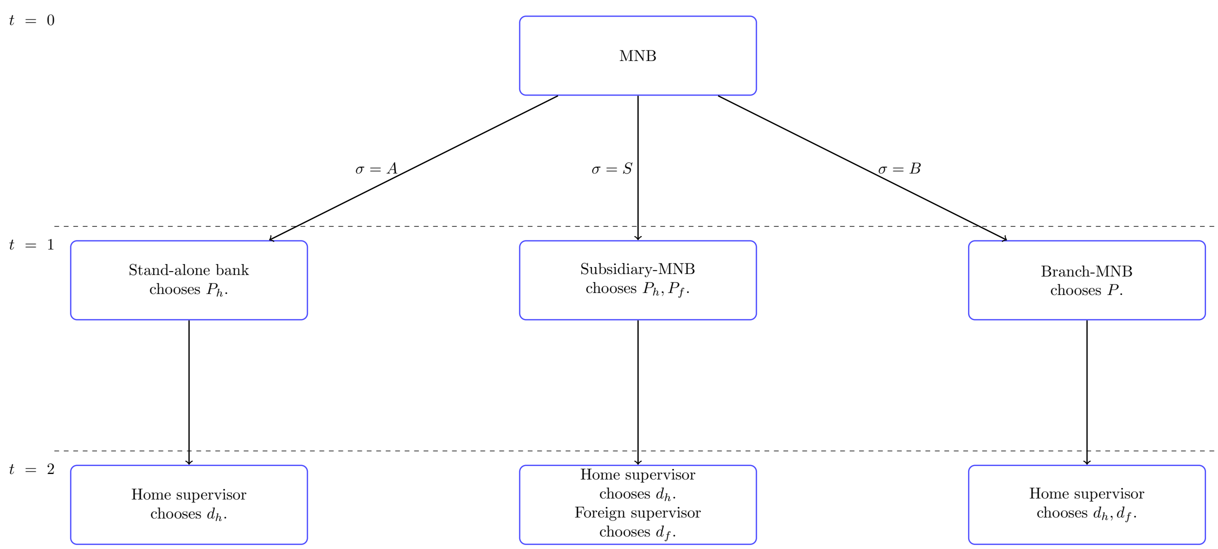

Figure 1: Periods $t = 0$ to $t = 2$.

So as to rule out trivial cases, we make two parametric assumptions: An unmonitored unit creates economic surplus (H1) and a successful foreign unit cannot repay all depositors if the home unit is liquidated or fails (H2).

$$pR > 1 \tag{H1}$$

$$R + L < 2 \tag{H2}$$

Notations.

We denote by (d_h, d_f) the supervisory decisions for the home and foreign units.

As we will show later, we need to consider four strategies only (compacting actual strategies referring to $t = 2$ and $t = 3$), denoted $d_i \in \{M, I, O, C\}$, $i = f, h$: Strategy $d_i = M$ consists in monitoring unit i, keeping it open when the assets are good, closing it when they are bad, irrespective of the signal received about the other unit (which is in fact optimal, as we will show). Strategies $d_i = O$ and $d_i = I$ consist in not monitoring unit i and always keeping it open or always closing it, respectively, regardless of the signal received about the other unit. With strategy $d_i = C$, unit i is not monitored but is kept open when the other unit's assets are bad, and closed when they are good.

$W_h(d_h, d_f)$, $W_f(d_f)$, and $W_b(d_h, d_f)$ denote the supervisors' expected payoffs associated with these strategies in the subsidiary (the first two) and in the branch (the third), and $W_h(d_h)$ is that of the home supervisor when the bank remains domestic. Similarly, $\Pi(\sigma, d_h, d_f)$ denotes the expected profit of a MNB with the representation form $\sigma \in \{S, B\}$ and $\Pi(A, d_h)$ the profit of a stand-alone bank only present in country h. The interest rates paid to depositors in countries h and f are denoted $P_h(S, d_h, d_f)$ and $P_f(S, d_f)$ for the subsidiary case, $P(B, d_h, d_f)$ for the branch case, and $P_h(A, d_h)$ for the stand-alone case.

Discussion.

Bank supervision. The role of bank supervisors in our model is in line with the classical "representation hypothesis" of Dewatripont and Tirole (1994): the costs of monitoring the bank are too high for scattered depositors, so that in the absence of supervision the expected payoff from each unit is $pR + (1 - p) \times 0$. For a cost of $c \in \{c_h, c_f\}$, a supervisor can monitor the unit and obtain a payoff of $pR + (1 - p)L$ instead.

A way to ensure that the supervisor has incentives to correctly monitor the bank is to allocate this task to the deposit insurance fund. In line with this idea, we posit that the supervisor's objective is to minimize the expected losses of the deposit insurance fund. A prominent example of a regulator with a loss-minimizing objective is the Federal Deposit Insurance Corporate (FDIC) in the US. Demirguc-Kunt, Kane, and Laeven (2014) find that 57 percent of DI funds in the world have extended powers or responsibilities including a responsibility to minimize losses or risk to the fund.

If the deposit insurance fund pays out with probability 1, the supervisor of a stand-alone bank suffers expected losses equal to $(1-p)$ if he does not monitor, compared to $(1-p)(1-L)$ if he does. Thus, monitoring takes place if and only if $(1-p)L > c$, which is also the solution that maximizes aggregate payoffs in this economy.

The model introduces two frictions relative to this benchmark. First, under stress conditions, the deposit insurance fund might be under-funded, and the probability that the fund can repay depositors is lower than 1. This reduces the incentives to monitor the banks, as the supervisor cares less about future losses.[7] Second, multinational banks can face several supervisors responsible for different units, which can act in a non-coordinated way. We interpret the European Single Supervision Mechanism as the removal of this second friction.

Allocation of Supervisory Responsibilities. An important element of our analysis is that we consider an array of organizational forms available for the bank. The organizational form defines a liability structure and an allocation of supervisory responsibilities. Our modeling assumptions reflect real-life arrangements. The Second Banking Directive of 1993 introduced home-country control and mutual recognition for branching across the EU. Indeed, for the supervision of branches the competent authority is the one where the bank is initially licensed. However, despite the higher legal and administrative burdens, many banks still choose to establish subsidiaries with separate capital and foreign supervision (Cerutti, Dell'Ariccia, and Martinez Peria (2007)). In 2007, roughly 28 percent of banking assets were held in branches in the EU.[8] In the US, although units of foreign banks are called branches, they are effectively supervised as subsidiaries, thus reproducing the dispersed supervisory responsibilities in our model.

Since November 2014, the banking system in the Euro area is split into two groups. The 129 most significant credit institutions are supervised directly by the European Central Bank (ECB). The

[7] This mechanism partly explains the behavior of the FSLIC during the Savings & Loan crisis, e.g., Kane (1989).

[8] After the crisis, there has been a move towards subsidiaries, partly triggered by regulatory pressures. In the absence of effective cross-border cooperation of authorities in cases of bank failures, resolution can be easier with subsidiaries that can fail independently from the mother bank.

less important ones are still in the hands of national authorities. The situation of State-chartered commercial banks in the United States is somewhat similar: they are supervised both by a State supervisor (corresponding to the "national" level) and a Federal supervisor, either the Fed or the FDIC (corresponding to the "supranational" level).

Resolution. A key element of our model is that banks and subsidiaries have different resolution rules, which give different monitoring incentives to national and supranational supervisors. The relevance of these rules is illustrated by recent policy debates. In November 2015, the Financial Stability Board issued general principles on the loss-absorbing capacity required from global systemically important banks, under both the so-called "Single Point of Entry" and "Multiple Points of Entry" approaches for resolution. The former approach relies on international cooperation which, if properly functioning, should transfer powers to the home resolution authority of the parent bank. If credible, this approach would make the environment of a subsidiary-MNB similar to that of a branch-MNB. However, since the pre-positioned capital required from the parent bank of a foreign subsidiary is limited to 16% of the subsidiary's total assets, the home unit's liabilities towards foreign subsidiaries is still very limited, as we assume in our setup. See Faia and Weder di Mauro (2016) for an analysis of this issue.

Deposit Insurance Fund. A significant feature of our model is that the deposit insurance (DI) fund in country i can only pay out with probability α_i. This can be seen as a measure of the robustness and credibility of the deposit insurance fund in country i. Indeed, in many countries DIs appear underfunded. In countries with high levels of government debt and with a large amount of deposits relative to GDP, the ability of the government to honor its commitment to depositors raises doubt (Demirguc-Kunt, Kane, and Laeven (2014)). It is also possible to interpret the formal deposit insurance of our model as representing informal government guarantees more generally, in which case α_i can be interpreted as the probability of a bail-out in country i. However, we do not endogenize the bail-out decision.

Monitoring costs. The parameter c_i is interpreted as a cost faced by the supervisor i when it decides to acquire information. We allow c_i to vary between the home and the foreign country. It should be thought of as mostly related to a bank's complexity and opacity. The Basel Committee on Banking Supervision, for example, uses three proxies for complexity, namely the amounts of over-the-counter derivatives, level 3 assets, and trading and available-for-sale securities (BCBS (2013)). However, heterogeneity can also arise from a different reliance of economies on banks, from differences in market structures or from the different legal and institutional framework. Note that we abstract from potential differences of expertise or cost-efficiency between national and supranational supervisors, so as to focus the analysis on the different incentives of these two levels.[9]

1.2 Benchmark: Full information

To setup the scene and exemplify payoffs, here we briefly illustrate the special case in which $c_h = c_f = 0$. Strategy M being then optimal for both units, intervention decisions are taken under full information. In this case, the optimal decisions for any unit will not depend on whether national regulators or a supranational regulator is in charge. We solve the game backwards.

At $t = 3$, the supervisor in charge of a given unit learns whether the unit is successful or insolvent. In the former case, the supervisor lets the unit continue; in the latter, he intervenes as waiting would reduce the liquidation value of the asset from L to 0.

At $t = 2$, depositors anticipate the supervisor's decision in each contingency. When the bank is insolvent, with probability α_i depositors receive their deposit back. With probability $1 - \alpha_i$ they are partially repaid from the assets collected from the corresponding bank unit and, whenever the bank's liability structure allows for it, also from the residual assets of the other unit. Note that, when $\alpha_i < 1$, the corresponding interest rate is strictly larger than 1.

Although with full information, supervisory decisions in a given state are the same across all the possible representation forms of the MNB, deposit rates depend on the representation form for two reasons: (i) the extent of the reimbursement in case the deposit insurance does not pay; (ii) the probability with which the deposit insurance fund in a given country will be able to pay. In particular, shared liability between units allows a higher reimbursement in case the deposit insurance cannot pay, and thereby lowers the deposit rate in a given country. Furthermore, a more credible deposit insurance, i.e., a higher α_i, reduces the loss to the depositor from bank insolvency and therefore leads to lower deposit rates in a given country.

In the case of the stand-alone bank, only the credibility of the home deposit insurance matters and the deposit rate P_h is implicitly defined by

$$pP_h(A, M) + (1 - p)[\alpha_h + (1 - \alpha_h)L] = 1. \tag{1}$$

For the subsidiary, a similar equation pins down $P_f(S, d_f)$ as the home unit does not share liability

[9] In Colliard (2014) it is sometimes inefficient to rely on supranational supervisors because they are assumed to be more costly. In contrast, in our model supranational supervision may sometimes be undesirable because it leads the bank to shut down its foreign operations. This obtains even though the supranational level has the same costs as the national level and solves an externality problem.

for the subsidiary's losses, with the difference that the rate is now determined by the deposit insurance fund's credibility in the host country, α_f. As for the home unit, P_h satisfies:

$$pP_h(S,M,M) + (1-p)p[\alpha_h + (1-\alpha_h)(L + R - P_f)] + (1-p)^2[\alpha_h + (1-\alpha_h)L] = 1. \qquad (2)$$

This equation takes into account that with probability $p(1-p)$ the home unit fails but the foreign unit is successful. In such a case there are *residual assets*, worth $R - P_f$, in the foreign unit that are left after local depositors have been reimbursed P_f. This implies that $P_h(A,M) \geq P_h(S,M,M)$.

Under branch representation, each unit is liable for the losses of the other unit. Insolvency occurs with a higher probability than in any of the units of the subsidiary represented MNB because both units need to succeed in order to pay depositors the promised rate. Furthermore, the home country deposit insurance covers depositors in the foreign unit, which implies that the deposit rate can in general be higher or lower in a subsidiary than in a branch, depending on α_h and α_f. The next expression shows the determination of the deposit rate P under branch representation:

$$p^2P(B,M,M) + 2p(1-p)[\alpha_h + (1-\alpha_h)(R+L)/2] + (1-p)^2[\alpha_h + (1-\alpha_h)L] = 1. \qquad (3)$$

At $t = 1$ the bank will choose the representation form, anticipating the supervisory decisions at $t = 3$ and the deposit rate at $t = 2$. The difference between a domestic bank and an MNB in generating profits is two-fold. First, an MNB can potentially make twice as much profit as a domestic bank. Second, having a successful project may not guarantee that a unit can retain its profit because of shared liability for the other unit's losses.

Formally, the stand-alone profit can be written as

$$\Pi(A,M) = p(R - P_h(A,M)), \qquad (4)$$

while the subsidiary represented MNB yields a profit of

$$\Pi(S,M,M) = p(R - P_h(S,M,M)) + p^2(R - P_f(S,M)). \qquad (5)$$

As $P_h(A,M) \geq P_h(S,M,M)$, with full information it is always worthwhile for the bank to go abroad with a subsidiary as opposed to remaining a stand-alone. First, the subsidiary is a source of additional profit while the home unit's profit is shielded from the subsidiary's losses due to limited liability. Second, the home deposit rate is lower than in the stand-alone because of the additional repayments that may be available from the foreign unit with the subsidiary represented MNB.

The profit in the branch case can be written instead as

$$\Pi(B, M, M) = 2p^2(R - P(B, M, M)). \tag{6}$$

Comparing $\Pi(B, M, M)$ and $\Pi(S, M, M)$, the next proposition summarizes the optimal organizational choice of the bank under full information.

Proposition 1. *With full information (i.e.* $c_h = c_f = 0$*), for any* $\alpha_h > 0$*, there exists an* $\widehat{\alpha}_f(\alpha_h) \in [0, \alpha_h]$ *such that for* $\alpha_f \geq \widehat{\alpha}_f(\alpha_h)$ *operating through a subsidiary is more profitable than operating through a branch. Otherwise, the reverse is true.*

It is easy to see that for the same deposit rates the subsidiary representation always dominates. Branch representation can only dominate subsidiary representation if the foreign deposit insurance fund's credibility is sufficiently lower than the home insurance fund's. In this case, the deposit rate will be lower with a branch than with a subsidiary, which compensates for the lower probability with which the bank obtains a positive profit under the branch representation.

2 National supervisors and the multinational bank

Differently from Section 1.2, when there are informational frictions, i.e., c_h and c_f are not zero, monitoring becomes a non-trivial strategic decision for supervisors. Moreover, by choosing whether to organize as a subsidiary or a branch, the MNB effectively decides whether it faces two uncoordinated supervisors, or a single supervisor. In this section, we study the monitoring and prudential decisions of independent national supervisors both in the subsidiary and in the branch cases.

2.1 National supervision in the subsidiary case

As explained in the previous section, when units are monitored, supervisors take the same prudential decision in a given state. When only one or none of the units are monitored, instead, the home and the foreign supervisors may act differently. This difference arises from the asymmetric liability structure of a subsidiary-represented multinational bank. Since foreign depositors have priority over the subsidiary's assets and the home unit has limited liability for the subsidiary's losses, the decision over the home unit affects neither the intervention nor the monitoring decision of the foreign supervisor. The situation for the home supervisor is different. If the foreign unit is kept open, the home supervisor may be able to reduce its costs by using the foreign residual assets. The availability of foreign residual assets affects both the incentives to intervene under limited information and those to monitor. The incentives to monitor will be measured by the value of information (or of monitoring), which is the difference $W_h(M, d_f) - W_h(d_h, d_f)$ with $d_h \neq M$ for the home unit, and $W_f(M) - W_f(d_f)$ for the foreign unit.

The next proposition gives us the full characterization of the equilibrium outcome in the subsidiary case:

Proposition 2. *The equilibrium decisions (d_h^*, d_f^*) of the supervisors of a subsidiary represented MNB are qualitatively described as follows (the precise thresholds are in the Appendix).*
- The foreign supervisor chooses $d_f^* = M$ if c_f is low, otherwise $d_f^* = O$;
- The home supervisor chooses $d_h^* = M$ if c_h is low. If c_h is high, a small L induces $d_h^* = O$, and a large L induces either $d_h^* = C$ if c_f is low (i.e., when the foreign supervisor monitors) or $d_h^* = I$ otherwise.

The equilibrium decisions (d_h^*, d_f^*) can be seen as the outcome of three different comparisons.

- *Monitoring in the foreign unit?* First, the foreign monitoring cost c_f determines whether the foreign supervisor chooses to monitor ($d_f = M$) or to keep the foreign unit unmonitored and open ($d_f = O$). In the absence of monitoring, the foreign supervisor obtains $W_f(I) = -\alpha_f(1 - L)$ with intervention ($d_f = I$), and $W_f(O) = p \times 0 - (1 - p)\alpha_f$ with no intervention. As $p > L$, the foreign DI's expected losses are lower if the unit is left open than with intervention.

Monitoring serves to identify and intervene a failing unit, thus saving the liquidation value L. Since failure occurs with probability $1 - p$ from an ex ante perspective, the value of information obtained with monitoring is $(1-p)L$. As the deposit insurance can credibly pay only with probability α_f, the expected benefit of monitoring will be $\alpha_f(1 - p)L$, which is then contrasted with the cost of monitoring c_f.

- *Liquidating a non-monitored home unit?* Second, the home supervisor's prudential decision to liquidate ($d_h = I$) or leave open ($d_h = O$) a non-monitored home unit is affected by the availability of residual assets in the foreign unit. When the foreign unit is successful, the residual assets reduce the home supervisor's costs for any decision. However, the expected value of those assets will be higher for the home supervisor upon intervention than with no intervention. Indeed, with intervention the home supervisor expects to obtain these foreign residual assets with probability p, while with no intervention these assets are only useful upon failure of the home unit, hence with the lower probability $p(1-p)$. As a consequence (despite $p > L$), intervention can take place in the home unit when the liquidation value L is large enough.

- *Monitoring in the home unit?* Third, foreign monitoring opens the possibility to condition the home supervisor' strategy on the outcome of monitoring in the foreign unit. The only conditional strategy that can be optimal is to intervene in the home unit if foreign assets are good, and leave it open if they are not (strategy $d_h = C$). Indeed, bad news about the foreign unit eliminates the possibility for the home supervisor to reduce home costs with assets from the foreign unit. Hence, the home supervisor will be less likely to intervene than when the foreign assets are good.

As the home supervisor can condition his best response on the information on foreign monitoring, his cost associated with no monitoring decreases. In fact, it is easy to see that $W_h(C, M) > \max\{W_h(I, M), W_h(O, M)\}$. At the same time, foreign monitoring reduces P_f, and hence increases the available assets to the home supervisor for any decision. This means that $W_h(M, M) - W_h(C, M) < W_h(M, M) - max\{(W_h(I, M), W_h(O, M)\} < W_h(M, O) - max\{W_h(I, O), W_h(O, O)\}$. Thus, with foreign monitoring the home supervisors' payoff from monitoring and therefore his monitoring incentives are reduced.

Corollary 1. *All else equal, the availability of foreign residual assets (i) increases the incentives to intervene in an unmonitored home unit; (ii) reduces the value of monitoring for the home supervisor compared to the foreign supervisor: if $\alpha_h = \alpha_f$ and $c_h = c_f$, then if $d_h^* = M$ we necessarily have $d_f^* = M$.*

Clearly, if the home supervisor has a lower monitoring cost than the foreign supervisor, $c_h \leq c_f$, or if the probability that the home deposit insurance fund ends up paying depositors is higher, $\alpha_h \geq \alpha_f$, this makes the home supervisor more likely to exert monitoring than the foreign supervisor. However, controlling for these two effects, the home supervisor actually exerts less monitoring.

Finally, since foreign residual assets are decreasing in the deposit rate P_f promised to foreign depositors, and P_f decreases in α_f, we have the following:

Corollary 2. *A more credible foreign deposit insurance increases the availability of foreign residual assets to the home supervisor and thus reduces his incentives to monitor the home unit.*

When the foreign deposit insurance is more credible, foreign depositors demand a lower premium when lending to the foreign unit. As a result, when the foreign unit is successful, the quantity $R - P_f$ that can be used to reimburse potential losses to home depositors is greater. A higher α_f

thus decreases the value of monitoring for the home supervisor relative to strategies I and C. A higher credibility of the local deposit insurance, α_h, instead increases the value of monitoring, as does an increase of α_f for the foreign supervisor.

2.2 National supervision in the branch case

Under branch representation, there are three differences with the subsidiary case: (i) a single supervisor now takes the decisions (d_h, d_f) for both units; (ii) the assets of the home unit can be used to pay back depositors when the foreign unit defaults; (iii) both the domestic and foreign depositors are covered by the home deposit insurance. Note that, except for the monitoring costs c_h and c_f, the two units are now completely symmetric. The next proposition shows the optimal decisions:

Proposition 3. *The optimal decisions of the supervisor of a branch represented MNB are qualitatively described as follows (the precise thresholds are in the Appendix).*
- If monitoring costs are both low, then $d_h^b = d_f^b = M$;
- If monitoring costs are both high, there is no monitoring at all. A low L induces $d_h^b = d_f^b = O$, and a large L induces $d_h^b = d_f^b = I$;
- If c_i is low and c_j is high, only unit i is monitored. A small L induces $d_j^b = O$, and a large L induces $d_j^b = C$.

Although the complete characterization is lengthy, the intuition behind Proposition 3 is simple. In the absence of monitoring, the liquidation value L determines whether it is optimal to always intervene in one unit or not. If one unit is monitored, L determines whether it is preferable to intervene in the other unit conditionally on success in the monitored unit or not (strategies C). Then, when monitoring costs are low in both units the optimum is to exert monitoring in both, when monitoring costs are both high there is no monitoring at all, and if one cost is low and the other high, only the "cheaper" unit is monitored.

As in the case of the subsidiary, a high liquidation value increases monitoring incentives in the first unit that the supervisor decides to monitor. Indeed, the supervisor can avoid a type II error if he monitors an open unit. However, the supervisor's ability to make decisions for both units introduces an additional effect. The supervisor internalizes the fact that by monitoring one unit, it can potentially lower the costs associated with the other unmonitored unit. For example, he can condition his strategy on information on the monitored unit (strategy C). No such type of internalization occurs in the case of subsidiary where national regulators take independent uncoordinated decisions.

The next corollary summarizes the main effects that shape the equilibrium decisions:

Corollary 3. *(i) High liquidation values increase the likelihood of an intervention decision in an unmonitored unit, and the likelihood that at least one unit is monitored; (ii) Monitoring one unit reduces the value of monitoring the second unit.*

With one unit monitored, expected costs decrease for the other unmonitored unit. This in turn reduces incentives to collect information on the second unit. This effect is similar to the one we discussed for the home supervisor's in a subsidiary represented MNB. This reduction in incentives is stronger for high liquidation values: a higher L reduces the deposit rate by more in the monitored unit, and therefore increases the residual assets available for the other unmonitored unit. However, the branch liability structure magnifies the effect of the residual assets on the monitoring decisions. In particular, as assets from the two units are pulled together in case of a failure of a unit, the larger quantity of residual assets further reduces monitoring incentives compared to the subsidiary. Hence, the value of monitoring the second unit will be lower in a branch organization compared to the subsidiary.

3 Supranational supervision

We now turn to the case of a subsidiary-MNB with supranational supervision: instead of two supervisors taking monitoring and prudential decisions non-cooperatively, a single entity is responsible for both units and minimizes the total expected losses for deposit insurers in both countries. The setup is otherwise unchanged. In particular, deposit insurance is still national, potentially with unequal credibility in both countries (see Section 5.1 for a discussion about common DI) and the supranational supervisor faces the same costs of collecting information than national supervisors.

3.1 Short-run implications of supranational supervision

Our goal is to explore to what extent supranational supervision will lead to a different outcome than national supervision in the short-run, that is, without taking into account that the representation form of the MNB may react to the supervisory architecture. Formally, a supranational supervisor takes a joint decision (d_h, d_f) in order to maximize the sum of the expected payoff of the home and of the foreign DI. We denote by (d_h^{**}, d_f^{**}) the optimal decisions.

Lemma 1. *National and supranational supervision with a subsidiary represented MNB may lead to a different outcome only if the decision in the foreign unit is different: If* $d_f^* = d_f^{**}$*, then* $d_h^* = d_h^{**}$*.*

The intuition for this lemma is that the foreign supervisor exerts an externality on the home supervisor, while the opposite is not true. For a given strategy in the foreign unit, minimizing the losses of the home deposit insurance fund is equivalent to minimizing the total losses of both funds. Hence, supranational supervision can lead to a different outcome only if it affects the supervision of the foreign unit.

Why could the monitoring decision of the foreign supervisor differ from the supranational supervisor's? The foreign supervisor does not internalize that monitoring the foreign unit is beneficial to the home deposit insurer. Monitoring the foreign unit allows the home supervisor to take a decision in the home unit conditionally on the information he receives on the foreign unit. This effect is not taken into account by the foreign supervisor when the MNB is organized as a subsidiary, since the foreign supervisor only cares about the losses to the foreign deposit insurance fund.

In contrast, the supranational supervisor does take this into account and thus, when decisions differ in the foreign unit, we have $d_f^* = O$ and $d_f^{**} = M$. Building on these preliminary results, the next proposition summarizes the cases in which national and supranational supervision lead to different decisions:

Proposition 4. *If decisions under national and supranational supervision in a subsidiary represented MNB differ, we have one of the following cases (for a given set of parameters): (i)* $(d_h^*, d_f^*) = (O, O)$ *and* $(d_h^{**}, d_f^{**}) = (C, M)$*; (ii)* $(d_h^*, d_f^*) = (I, O)$ *and* $(d_h^{**}, d_f^{**}) = (C, M)$*; (iii)* $(d_h^*, d_f^*) = (M, O)$ *and* $(d_h^{**}, d_f^{**}) = (C, M)$*.*

All three cases rely on the same logic, only the choice of the home supervisor in case of national supervision is different. In particular, in all cases obtaining a different outcome with supranational supervision requires that c_f is high enough, so that the foreign supervisor chooses not to monitor, but not too high, so that the monitoring is useful once the internalization effect is taken into account. Conversely, c_h must be high, so that the supranational supervisor prefers to rely on monitoring the foreign unit only rather than both units.

Fig. 2 shows the supervisory decisions reached for each representation form and organization of supervision as a function of α_h and α_f. Comparing the subsidiary case with the supranational case, one can see how, for intermediate values of α_h and α_f, introducing a supranational supervisor shrinks the regions (M, O) and (O, O) and expands the region (C, M).[10]

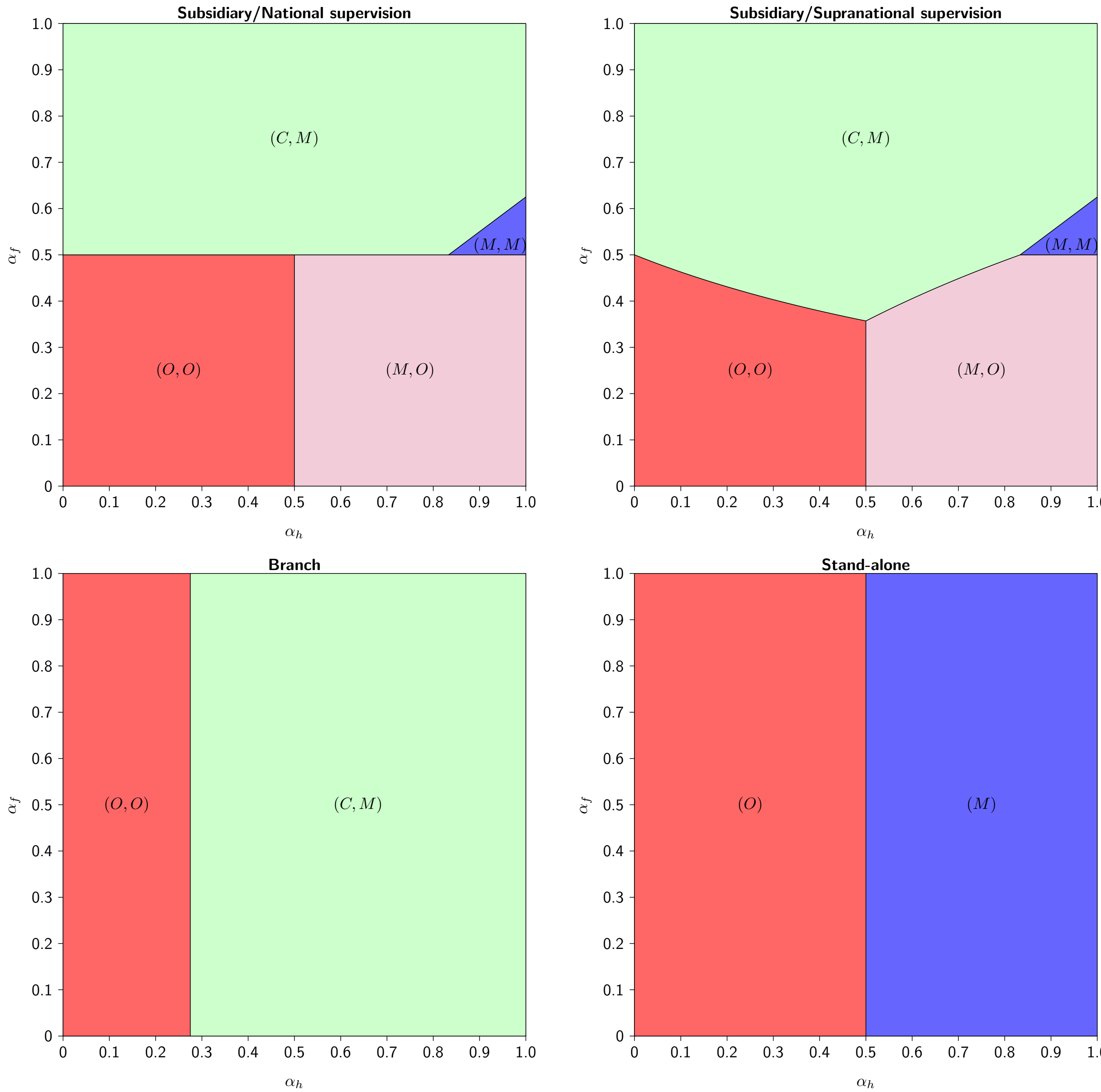

Figure 2: Equilibrium supervisory decisions.

It is interesting to identify the consequences of a switch to supranational supervision on the profitability of a subsidiary represented MNB. The profit implications of Proposition 4 are unambiguous. First, note that with decisions $(d_h^*, d_f^*) = (I, O)$ a subsidiary represented MNB is not viable with national supervisors. Second, in the other two cases of the proposition, the introduction

[10]The parameters are $p = 0.8$, $R = 1.5$, $L = 0.5$, $c_h = c_f = 0.05$.

of the supranational supervisor unambiguously leads to lower profit for existing subsidiaries.

Corollary 4. *Holding the representation form of the MNB constant, introducing a supranational supervisor leads to lower profit for existing subsidiary represented MNBs.*

Corollary 4 points out the negative impact of a supervisory change on the subsidiary's profit. Clearly, as a consequence, banks may also decide to change their foreign representation or become standalone domestic banks. The next section discusses the consequences of such changes.

3.2 Long-run implications of supranational supervision

We now analyze the long-run implications of supranational supervision, taking into account how the bank responds to a change in supervision. We need to compare the choices made by the supervisor(s) for the different organizational forms under the same parameter values. To streamline the discussion, we concentrate on the parameter region where the introduction of the supranational supervisor leads to different decisions than the ones with national supervisors.

It is easy to see that a supranational supervisor does not lead to different decisions in the case of the branch represented MNB. Indeed, the branch representation attributes all the costs to the home deposit insurance and thus the (single) home supervisor internalizes all costs and benefits from the two units. Thus, we need to compare the outcomes with a subsidiary supervised either at the national or the supranational level, with those of a branch, or a stand-alone bank.

Note that the branch represented MNB only makes profit if (with a positive probability) both units are open. The supervisor of a branch-MNB is close to the situation of the supranational supervisor of a subsidiary-MNB, in that both internalize the effect that monitoring the foreign unit has on the home unit. We know from the previous section that, when the supranational supervisor and the national supervisor take different decisions for the subsidiary, then the supranational supervisor chooses (C, M). As a result, the decision in the branch case will often also be (C, M), and the branch won't be viable.[11] The only exception is that under some parameter values the supervisor of a branch may choose (O, O). The following lemma summarizes the possible cases in which supranational supervision leads to different outcomes and the branch is a viable option.

Lemma 2. *If* $(d_h^*, d_f^*) \neq (d_h^{**}, d_f^{**})$ *and* (d_h^b, d_f^b) *is neither* (C, M) *nor* (I, O)*, then we have the following (mutually exclusive) possibilities:*

(i) $(d_h^*, d_f^*) = (O, O)$, $(d_h^b, d_f^b) = (O, O)$ *and* $(d_h^{**}, d_f^{**}) = (C, M)$.

[11] Recall that the bank's profits of a branch represented MNB are nil when either (C, M) or (I, O).

Table 2: Possible combinations of supervisory decisions, for the different organizational forms, when national and supranational outcomes differ.

Case	Subsidiary National	Subsidiary Supranational	Branch	Stand-alone
(i)	(O,O)	(C,M)	(O,O)	O
(ii)	(O,O)	(C,M)	$\emptyset$	O
(iii)	(M,O)	(C,M)	$\emptyset$	M
(iv)	$\emptyset$	(C,M)	(O,O)	O
(v)	$\emptyset$	(C,M)	$\emptyset$	O
(vi)	$\emptyset$	(C,M)	$\emptyset$	M

(ii) $(d_h^*, d_f^*) = (I,O)$, $(d_h^b, d_f^b) = (O,O)$ *and* $(d_h^{**}, d_f^{**}) = (C,M)$.

Both cases require $\alpha_f > \alpha_h$ *and the full characterization of the corresponding sets of parameters is in the Appendix.*

This lemma identifies two cases of particular interest. In the first case, in the absence of supranational supervision the MNB can be organized as a subsidiary or as a branch, leading to the same supervisory outcomes. The introduction of supranational supervision leads to more monitoring with the subsidiary structure, and does not affect the branch. In the second case, the home unit of a subsidiary-organized MNB is always closed with national supervision, and supranational supervision actually leads to liquidating less often. These results will be used to assess the implied changes of bank's profitability in the ensuing analysis.

To complete the picture, we add possible supervisory decisions for the subsidiary and the standalone in cases when the branch leads to either (C,M) or (I,O) and thus cannot be active.[12] Table 2 summarizes all the cases in which supranational supervision makes a difference to the supervision of the subsidiary-MNB, and thus can encourage the MNB to change its representation form. Comparing the MNB's profits across different representation forms, we obtain the following:

Proposition 5. *When supranational supervision changes the optimal representation form of the MNB, it either induces a subsidiary-MNB to become a branch-MNB (case (i) of Table 2), or it induces a subsidiary-MNB to become a stand-alone bank (cases (ii) and (iii)).*

Assume that the parameters of the model are such that we are in case (i) of Table 2. Under national supervision, the MNB can choose between a subsidiary, a branch, or a stand-alone, all leading to the same outcome of any unit being left non-monitored and open. As case (i) requires

[12]This decision is easily deduced from the conditions defining the supervisory decisions in the other cases.

$\alpha_f > \alpha_h$, the subsidiary structure allows to benefit from the high-quality foreign deposit insurer and is the most profitable structure. However, when supranational supervision is introduced, the coordination problem between the two supervisors of the subsidiary is solved, which leads to tighter monitoring of the subsidiary structure and reduced profits. As a result, this structure becomes less profitable than the branch, and the MNB adopts this latter representation form instead.

In cases (ii) and (iii), a branch structure is not viable, so that under national supervision the MNB chooses between a subsidiary structure and a stand-alone bank. If the supervisory decision in the home unit is the same, the subsidiary structure is more profitable than a standalone bank, as the subsidiary provides an additional sources of profit without putting strain on the home unit's profit. As in case (i), supranational supervision changes the supervisory decision in the home unit, thereby reducing the profits of the subsidiary structure. However, the MNB cannot fall back to the branch structure in cases (ii) and (iii), and its best response is actually to close the foreign unit and revert to domestic banking.

Finally, in cases (iv) to (vi) of Table 2, the subsidiary is not viable with national regulators. A switch to a supranational regulator increases the profitability of subsidiaries and make them a viable alternative. However, either the branch structure with (O, O) (as in case (iv)) or the standalone structure (in cases (v) and (vi)) will still dominate. Supranational supervision thus has no impact on the choice of organization in these cases.

Proposition 5 implies that centralization of supervision could have unintended effects. With national supervisors the MNB can adopt a subsidiary structure in order to face low monitoring and thus a low probability of intervention. When supervision becomes supranational, the MNB prefers a branch structure instead to avoid the increased monitoring induced by supranational supervision. In other instances, when the branch structure is not profitable, the lower profitability of the subsidiary structure (due to supranational supervision) implies that the MNB prefers to entirely forego foreign expansion reverting to a national bank: supranational supervision has the paradoxical effect of decreasing financial integration.

3.3 Supranational supervision and national deposit insurance costs

Figure 3 illustrates the bank's choice of representation as a function of α_h and α_f for the entire parameter space. The parameters are the same as on Fig. 2, so that the choice of the MNB can be compared to the supervisory decisions associated with each structure. In particular, we see that introducing a supranational supervisor expands the region where a subsidiary faces the decision (C, M), so that the MNB optimally chooses to switch to a stand-alone or a branch structure instead. An important question to address is for which countries a switch to a supranational regulator can

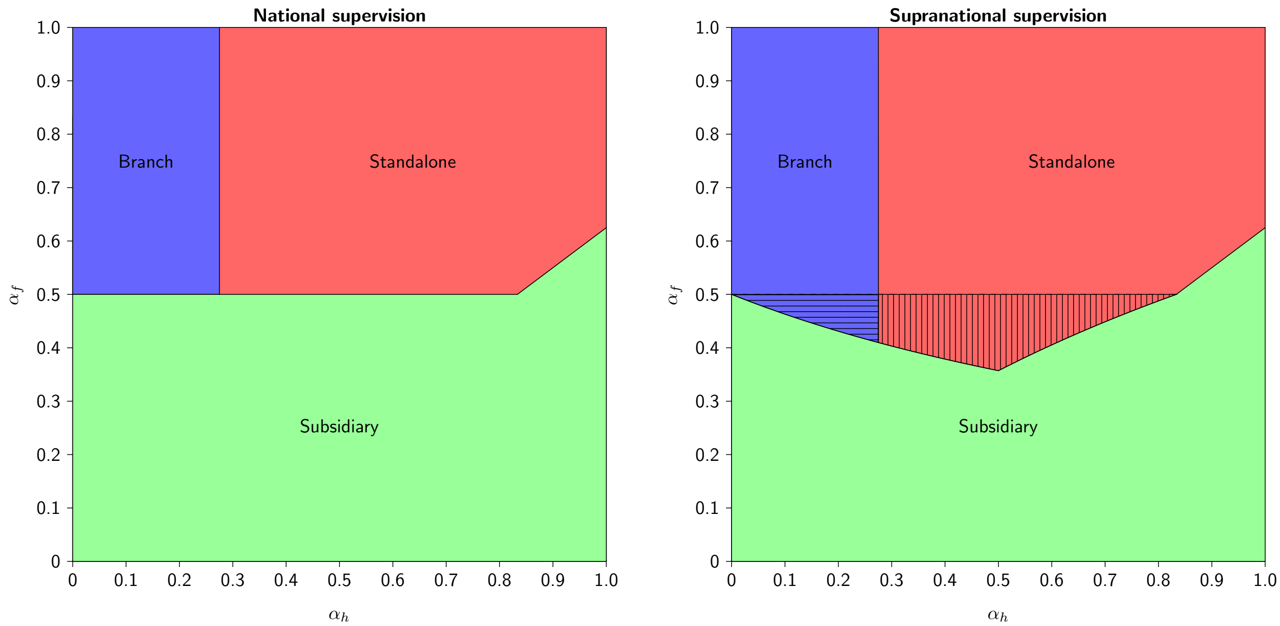

Figure 3: Equilibrium representation for of the MNB. The area with vertical (resp., horizontal) dashed lines represents a switch from subsidiary to stand-alone (resp., branch) induced by centralized supervision.

make a difference. The next proposition provide us with predictions in this respect.

Proposition 6. - *Symmetric countries: when $c_h = c_f$ and $\alpha_h = \alpha_f$, then centralizing supervision either has no impact on the MNB's representation form or it induces a switch from subsidiary to stand-alone.*

- Robust home deposit insurance: Moving to centralized supervision, a switch to stand-alone is more likely than a switch to branch when the home country has a more robust deposit insurance.

The first shows that when integrating similar countries, if centralized supervision has an impact then it is a switch from subsidiary to a stand-alone structure. Graphically, this means that on the 45 degree line in Fig. 3 we are necessarily in the vertically-dashed region or in a non-dashed region. The reason is that if the internalization effect makes it optimal to obtain (C, M) under supranational supervision, it will lead to the same outcome with the branch, so that a branch is not profitable for the MNB in such a case.

The second point follows from a high α_h making the supervisor of a branch tougher, so that this representation form is less profitable for the MNB. Graphically, this means that the blue dashed region is necessarily on the left of the red dashed region on Fig. 3.

The change in organizational form affects both the total losses of the deposit insurance fund and their allocation to the national deposit insurance funds. Since the MNB's representation form changes from subsidiary to branch or stand-alone, the home deposit insurance fund always suffers, while the foreign fund is not liable anymore.

Corollary 5. *When supranational supervision changes the MNB's optimal representation form, it increases (resp., reduces) the losses borne by the home (resp., foreign) deposit insurance.*

In addition, recall that if centralized supervision leads to a switch from subsidiary to branch, it has to be the case that $\alpha_f > \alpha_h$. Losses will thus be borne by the deposit insurance fund with lower credibility. Although in our model α_i is exogenous, it is clear that the higher burden can further undermine the credibility of the home deposit insurance (i.e. a reduction of α_h), leading to higher deposit rates and lower profits for multinational banks. When the MNB reverts to a national bank, losses will be supported by the home deposit insurance, but will be larger than the part corresponding to the home deposit insurance under the subsidiary representation form. Hence, in both cases the home deposit insurance fund ends up with more liabilities. As many countries' deposit guarantee systems are already overstretched, centralization (with national deposit insurance) can have the long-run effect of further reducing the credibility of some countries' deposit insurance.

Finally, we study the aggregate effect of centralized supervision on deposit insurance costs. For this, we take into account that the same country can be home and host to different MNBs. Corollary 5 implies that supranational supervision decreases losses on units owned by foreign MNBs, and increases them on domestic MNBs with subsidiaries abroad. The total impact is given by the following:

Corollary 6. *Assume that centralizing supervision changes the optimal represention form symmetrically for domestic and foreign MNBs. Then, if a country has at least as many subsidiary units of foreign MNBs as it has domestic MNBs, centralizing supervision decreases losses to the deposit insurance fund.*

This corollary implies in particular that centralizing supervision for two symmetric countries is beneficial for both. If these countries are asymmetric instead, the one which headquarters more MNBs may lose out from central supervision (in terms of losses to the deposit insurance fund).

4 Implications

We briefly review the main testable implications of the model in this section. We separate them into two groups: (i) short-term implications, that predict changes in observables holding the representation form of the MNB constant; (ii) long-term implications, that take into account that MNBs may adapt their representation form over time.

4.1 Short-term implications

Borrowing costs. The variables P_h, P_f and P in the model measure the borrowing costs of banks. They can be deposit rates if one interprets α_h and α_f as measuring the credibility of deposit insurance in a narrow sense. More generally, these variables can measure the rates at which each unit of the bank borrows on the wholesale market, in which case the αs measure implicit safety net guarantees. In both cases, Demirguc-Kunt, Kane, and Laeven (2014) offer proxies that can be used to measure α_h and α_f. In particular, they use the government debt-to-GDP ratio as an inverse proxy for the ability of the government to backstop the DI fund. Our analysis shows the following:

Implication 1. *Holding the organizational form of the MNB constant:*

- Borrowing costs are decreasing in R, p, and L.

- In a subsidiary-MNB, the borrowing costs of the foreign unit are decreasing in α_f, but do not depend on α_h. The borrowing costs of the home unit are decreasing in α_h and α_f.

- In a branch-MNB, borrowing costs are decreasing in α_h, but do not depend on α_f.

These implications directly follow from the liability structure of the MNB in both cases and from who insures deposits (see section 1.2). An interesting application is the European sovereign debt crisis, which can be interpreted as a negative shock to the αs of some countries: the model predicts that subsidiaries of foreign banks in a crisis-hit country will see their borrowing costs rise similarly to local banks, whereas subsidiaries of crisis country banks in non-hit countries won't be as affected. Similarly, the borrowing costs of the parent bank may increase when its foreign subsidiaries are located in countries hit by a sovereign debt crisis.

Monitoring. The amount of monitoring exerted by a supervisor is of course not a simple binary variable, and is not readily observable by outsiders. However, it is possible to find proxies and indirect measures for the decision M. For instance, Beck, Todorov, and Wagner (2013) propose to measure the delay with which a supervisor acts by the CDS spread of the troubled bank at the time the supervisor intervened. In the model, banks with bad assets are closed earlier when they are monitored (decision M) than when they are left open (decision O), so that the measure proposed by the authors can also be interpreted as a proxy for the monitoring intensity chosen by the supervisor. Our model implies that:

Implication 2. *Holding the organizational form of the MNB constant:*
- Monitoring of unit i is more likely when c_i is lower. A higher L makes monitoring more attractive compared to leaving the unit open but less attractive compared to closing it (Proposition 2).
- Monitoring of the subsidiary's foreign unit is more likely when α_f is higher. Monitoring of the home unit is more likely when α_h is higher and α_f smaller (Corollaries 1 and 2).
- Monitoring of the subsidiary's foreign unit is more likely under supranational supervision (Proposition 4).

A recent illustration of the last point is given by the Greek crisis: it seems that bank supervisors of Greek banks' subsidiaries in Romania and Bulgaria considered liquidating these subsidiaries. This would have worsened the situation of their parent banks, but this externality is not taken into account by the subsidiaries' supervisors: from their point of view, the liquidation decision is more attractive than costly monitoring. The ECB had to extend credit lines to these subsidiaries to avoid this outcome.[13]

4.2 Long-term implications

In the long-run, different organizations of supervision can give a competitive advantage to MNBs with different organizational structures. Whether a MNB chooses to expand abroad via a subsidiary or a branch can be observed empirically. Moreover, the model delivers predictions on the choice of whether to expand abroad at all. The literature on cross-border bank acquisitions typically considers the choice between a stand-alone structure and a subsidiary-organized MNB (e.g., Karolyi and Taboada (2015)).

Implication 3. *- All else equal, a lower α_h and a higher α_f make the subsidiary representation form more profitable than the branch form (Proposition 1).*
- Supranational supervision makes the branch form more profitable compared to the subsidiary form, and can discourage cross-border expansion altogether (Proposition 5).

[13] See "ECB puts in place secret credit lines with Bulgaria and Romania", Financial Times Online, July 16, 2015.

- *Supranational supervision increases the interest rate offered to depositors in both the home and the foreign unit if the MNB switches from subsidiary to branch.*

The first point seems consistent with a recent case. The Greek Central bank indicates that as of March 2015 all foreign units of Greek banks were subsidiaries, with the unique exception of Alpha Bank, organized with branch representation in Romania and Bulgaria. Facing the deterioration of the credibility of the Greek national deposit insurance, the foreign branches of Alpha Bank faced the largest withdrawal of deposits of all foreign units of Greek banks (all the others being subsidiaries). Even more interestingly, these foreign branches of Alpha Bank have been recently acquired (July 2015) by foreign subsidiaries of other Greek banks which would then manage them as subsidiaries backed-up by the more solid Romanian and Bulgarian national deposit insurance.[14]

The second point implies that in the long-run the European Single Supervisory Mechanism should lead to a different organization of MNBs in Europe, with more MNBs choosing a branch form and, potentially, fewer cross-border banks. The second possibility comes from the fact that under national supervision coordination failures between supervisors can lead to the bank not being monitored at all, whereas under supranational supervision it is optimal to monitor the foreign unit and liquidate the home one conditionally on the foreign unit having good assets. This can make a subsidiary-MNB less profitable than a stand-alone bank. This apparently paradoxical result is typically obtained when the liquidation value L is high.

The third point follows from the observation that $P_h(S, O, O) < \min(P_h(B, O, O), P_h(A, O)$ (see the proof of Lemma 2). For given supervisory decisions, depositors in the home unit of a subsidiary are more protected because they can recover part of the profits of the foreign unit. As centralized supervision can result in a move away from the subsidiary structure, this benefit disappears and the interest rate offered to depositors has to increase.

5 Extensions

5.1 Common deposit insurance

The analysis of common supervision developed so far assumed that the deposit guarantee scheme remains national. However, a common deposit insurance (CDI) may seem another natural step to go, and is currently in the Banking Union agenda in the EU. Here we address this possibility by

[14] See for example "Greek Eurobank Takes over Alpha Bank's Branch Network in Bulgaria," July 18, 2015, at www.novinite.com.

assuming that the supranational supervisor relies on a CDI fund with a credibility parameter α_c, which conceivably depends on the credibility of national deposit insurance funds, α_h and α_f.

Although one could conceive different institutional arrangements, here we consider on purpose the rather "optimistic" case in which the more reliable national deposit insurance scheme transfers its credibility to the less reliable one. In particular, to fix ideas, we assume the home national DI insurance scheme is more reliable, so that $\alpha_c = \alpha_h \geq \alpha_f$ and the effects of the CDI can be determined by comparative statics on α_f.[15] Considering a MNB that is already supervised at the supranational level, the following proposition shows the impact of introducing a common deposit insurance:

Proposition 7. *When supervision is already supranational, adding a common deposit insurance scheme with $\alpha_c = \alpha_h \geq \alpha_f$:*

- Does not affect the supervision of a branch-MNB;

- Increases monitoring incentives in the foreign unit of a subsidiary-MNB;

- Decreases monitoring incentives in the home unit of a subsidiary-MNB.

With branch representation, a CDI has no effect at all since the home DI is already in charge under national deposit insurance. With a subsidiary-MNB, deposits in the foreign unit are more likely to be covered by the common deposit insurance fund than they were to be covered by the foreign fund, so that potential losses increase. The value of monitoring the foreign unit is thus higher. Both the higher credibility of the foreign unit and the increase in monitoring imply that deposits in the foreign unit are safer, so that P_f decreases. As a result, the foreign unit has larger residual assets, which reduces the value of monitoring in the home unit (Corollary 1). Thus, even if one optimistically assumes that the CDI inherits the credibility of the more reliable deposit scheme, the introduction of common deposit insurance can have the unintended consequence of decreasing monitoring in one unit. This also implies the following:

Corollary 7. *Introducing supranational supervision together with common deposit insurance can still induce a subsidiary-MNB to close its foreign unit and become a stand-alone bank.*

Indeed, Proposition 7 shows that if the supranational supervisor chooses the strategy (C, M), introducing a common deposit insurance only reinforces this choice (i.e., the foreign unit is monitored but the home unit is not). Moreover, the result in Corollary 4 that supranational supervision makes

[15] Alternatively, one could assume α_c is between $\min\{\alpha_h, \alpha_f\}$ and $\max\{\alpha_h, \alpha_f\}$, which requires to study the effects of an increase in DI credibility for one unit and a decrease for the other unit.

the subsidiary-MNB less profitable holds true for any value of α_h and α_f, and thus irrespective of whether the deposit insurance is common or not. Hence, more monitoring on the subsidiary with supranational supervision and CDI can still make stand alone banking more profitable.

5.2 Representation form-sensitive insurance premia

As is already well known, risk-based insurance premia, while not commonly used, can go a long way into alleviating moral hazard in banking (see, e.g., Rochet (1992)). In this model, one needs to go even further to align incentives with the social optimum and introduce premia that also depend on the representation form of the bank. Indeed, a subsidiary-MNB enjoys an implicit subsidy from the government, when compared to a branch or a stand-alone: with probability $\alpha_f \times p(1-p)$, its foreign creditors are repaid by the foreign deposit insurance fund, even though the home unit redistributes profits to shareholders. This is the reason why centralized supervision can lead the MNB to close its foreign unit: in some cases, it might be profitable for the MNB to expand abroad only if it enjoys this implicit subsidy. If centralized supervision suppresses it, then the best reaction of the MNB is to revert to domestic banking.

To see how a premium based on the representation form can align the incentives of the bank with the social optimum, assume that the MNB needs to pay fees $F_h(k)$ and $F_f(k)$ upfront to the deposit insurers of countries h and f, respectively, where $k \in \{S, B, A\}$ stands for the representation form chosen by the MNB. A fairly priced deposit insurance would imply that the bank pays exactly the expected costs to each deposit insurer. This is equivalent to having:

$$\begin{aligned}
F_h(S) = &\quad -W_h(d_h^*, d_f^*), \quad F_f(S) = -W_f(d_f^*) \\
F_h(B) = &\quad -W_b(d_h^b, d_f^b), \quad F_f(B) = 0 \\
F_h(A) = &\quad -W_h(d_h^*), \qquad F_f(A) = 0.
\end{aligned}$$

Under supranational supervision, (d_h^*, d_f^*) is simply replaced by (d_h^{**}, d_f^{**}). To see why this implies that the bank's organizational form is now optimal, observe that both deposit insurers are now indifferent regarding the choice of the bank (in particular, centralized supervision no longer creates "winners" and "losers"). The bank will for instance choose S over B if and only if $\Pi(S, d_h^*, d_f^*) - F_h(S) - F_f(S) \geq \Pi(B, d_h^b, d_f^b) - F_h(B)$, which is simply equivalent to $\Pi(S, d_h^*, d_f^*) + W_h(S, d_h^*, d_f^*) + W_f(d_f^*) \geq \Pi(B, d_h^b, d_f^b) + W_b(d_h^b, d_f^b)$: the bank is in effect maximizing aggregate welfare.

Note that, while theoretically natural, this solution may be difficult to implement, as it requires to have a good understanding of the often complicated structure of the entire MNB. However, this structure has a first-order impact on the distribution of losses in case the MNB defaults, and should thus be correctly priced by the deposit insurance fund. An additional difficulty is that the proper pricing of deposit insurance also requires to correctly anticipate the optimal supervisory decisions.

Finally, note that this approach does not make centralized supervision redundant or useless, quite the opposite: centralized supervision still has the impact of changing $(d_h^*, d_f^*) = (O, O)$ into $(d_h^{**}, d_f^{**}) = (C, M)$. What representation form-sensitive deposit insurance achieves is to charge the MNB for switching from subsidiary to branch when this is not socially optimal in this case.

6 Conclusion

We propose a framework for understanding the interaction between the structure of bank supervision and the organizational form of multinational banks. We show that national and supranational bank supervisors take different monitoring and prudential decisions in MNBs depending on whether these adopt a branch or a subsidiary structure. Conversely, the differences in supervisory actions affect the MNB's choice of whether to expend abroad using a branch, a subsidiary, or not at all.

This interaction has important implications for regulatory reforms in banking. In particular, we show that the centralization of bank supervision at a supranational level, as recently implemented with the European banking union, can have unintended consequences on the organization of MNBs. Our results indicate that supranational supervision can in some instances reduce the willingness of banks to expand abroad, which clearly runs against the objective of any banking union. Another possibility is that supranational supervision gives a competitive advantage to branches over subsidiaries. As both types of foreign units may differ in their lending technologies, this effect can also imply undesirable consequences of supranational supervision, "un-leveling" the playing field.

Finally, our approach can also be used to compare the current situation in Europe, with supranational supervision but fragmented deposit insurance, to a full banking union in which both are supranational. Actually, the discrepancy in Europe between the level of supervision and the level of deposit insurance is a unique phenomenon. In the United States for instance, access to the Federal deposit insurance automatically implies supervision by a Federal authority. We have shown that centralization may bring about unexpected consequences also in this case. In particular, introducing supranational supervision can still have the same paradoxical effect of decreasing financial integration when common deposit insurance is in place.

A Appendix

We define some additional notation. For each state $(i,j) \in \{s,l,f\}^2$, in the subsidiary case we denote $u_h(i,j)$ and $u_f(j)$ the payoffs to depositors in countries h and f, $w_h(i,j)$ and $w_f(i,j)$ the payoffs to the deposit insurers, and $\pi(i,j)$ the bank's payoff. In the branch case we can aggregate all agents and we similarly use the notations $u_b(i,j), w_b(i,j), \pi_b(i,j)$. In the stand-alone case we will use the following notation, $u_h(i)$, $w_h(i)$ and $\pi(i)$.

Table 3: Payoffs for depositors, supervisors, and the MNB, for the different organization forms.

State (i,j)	$w_h(i,j)$	$u_h(i,j)$	$\pi(i,j)$
(s,s)	0	P_h	$2R - P_h - P_f$
(f,s)	$-\alpha_h(1 - R + P_f)$	$\alpha_h + (1-\alpha_h)(R - P_f)$	0
(l,s)	$-\alpha_h(1 - L - R + P_f)$	$\alpha_h + (1-\alpha_h)(L + R - P_f)$	0
(s,f) and (s,l)	0	P_h	$R - P_h$
(f,f) and (f,l)	$-\alpha_h$	α_h	0
(l,f) and (l,l)	$-\alpha_h(1-L)$	$\alpha_h + (1-\alpha_h)L$	0

(a) Subsidiary representation.

State i	$w_h(i)$	$u_h(i)$	$\pi(i)$
s	0	P_h	$R - P_h$
l	$-\alpha_h(1-L)$	$\alpha_h + (1-\alpha_h)L$	0
f	$-\alpha_h$	α_h	0

(b) Stand-alone bank. Note that $w_f(i)$ and $u_f(i)$ for the foreign unit of the subsidiary are equal to $w_h(i)$ and $u_h(i)$ in the stand-alone case, replacing α_h with α_f.

State (i,j)	$w_b(i,j)$	$u_b(i,j)$	$\pi_b(i,j)$
(s,s)	0	P	$2(R-P)$
(f,f)	$-2\alpha_h$	α_h	0
(l,l)	$-2\alpha_h(1-L)$	$\alpha_h + (1-\alpha_h)L$	0
(s,l) and (l,s)	$-\alpha_h(2 - R - L)$	$\alpha_h + (1/2)(1-\alpha_h)(R+L)$	0
(s,f) and (f,s)	$-\alpha_h(2-R)$	$\alpha_h + (1/2)(1-\alpha_h)R$	0
(l,f) and (f,l)	$-\alpha_h(2-L)$	$\alpha_h + (1/2)(1-\alpha_h)L$	0

(c) Branch representation.

A.1 Proof of Proposition 1

Using equations (5) and (6), we write the difference in profits between the subsidiary and the branch representation forms as:

$$\begin{aligned}
\Pi(S,M,M)-\Pi(B,M,M) &= p(R-P_h(S,M,M))+p^2(R-P_f(S,M,M))-2p^2(R-P(B,M,M)) \\
&= p^2(P(B,M,M)-P_f(S,M,M))+p(P(B,M,M)-P_h(S,M,M)) \\
&+ p(1-p)(R-P(B,M,M)). \qquad \text{(A.1)}
\end{aligned}$$

Notice in particular that this expression is positive when $P(B,M,M)=P_h(S,M,M)=P_f(S,M,M)$: for the same interest rates, the subsidiary structure is more profitable than the branch.

As $P_f(S,M,M)$ enters positively in $P_h(S,M,M)$, it is clear that $\Pi(S,M,M)-\Pi(S,M,M)$ decreases in $P_f(S,M,M)$. α_f enters only in $P_f(S,M,M)$, and enters negatively. As a result, $\Pi(S,M,M)-\Pi(B,M,M)$ is increasing in α_f: all else equal, a more credible foreign deposit insurance makes the subsidiary structure more profitable.

Using equations (2) and (3), we can replace $P_h(S,M,M)$ and $P(B,M,M)$ by their actual values, and after simplification we obtain:

$$\Pi(S,M,M)-\Pi(B,M,M)=(1-p)[\alpha_f(1-L)(1-\alpha_h(1-p))-\alpha_h p(2-R-L)]. \qquad \text{(A.2)}$$

When $\alpha_f=0$, we have $\Pi(S,M,M)-\Pi(B,M,M)=-\alpha_h p(2-R-L)<0$, using Assumption H2. When $\alpha_f=1$, we have $\Pi(S,M,M)-\Pi(S,M,M)=(1-L)(1-\alpha_h)+\alpha_h p(R-1)>0$. Since $\Pi(S,M,M)-\Pi(S,M,M)$ is increasing in α_f, there exists a unique value $\hat{\alpha}_f\in(0,1)$ such that the difference is positive for $\alpha_f\geq\hat{\alpha}_f$ and negative otherwise. ■

A.2 Proof of Proposition 2

We will show that the equilibrium decisions of both supervisors are as follows:

- If foreign monitoring costs are high, i.e., $c_f\geq\alpha_f(1-p)L$, then $d_f^*=O$ and:
  - If the liquidation value is small, $L\leq\lambda_1$: then $d_h^*=M$ if $c_h\leq\kappa_1$, and $d_h^*=O$ otherwise.
  - If the liquidation value is large, $L>\lambda_1$: then $d_h^*=M$ if $c_h\leq\kappa_1-\kappa_2$, and $d_h^*=I$ otherwise.
- If foreign monitoring costs are low, i.e., $c_f<\alpha_f(1-p)L$: then $d_f^*=M$ and:

– If the liquidation value is small, $L \leq \lambda_2$: then $d_h^* = M$ if $c_h \leq \kappa_1$, and $d_h^* = O$ otherwise.

– If the liquidation value is large, $L > \lambda_2$: then $d_h^* = M$ if $c_h \leq \kappa_1 - \kappa_3$, and $d_h^* = C$ otherwise.

where the values of λ_1, λ_2, κ_1, κ_2, and κ_3 are as follows:

$$\lambda_1 = p^2(2-R) + p(1-p)(2-\alpha_f) \tag{A.3}$$

$$\lambda_2 = \frac{p(2-R) + (1-p)(1-\alpha_f)}{1+(1-p)(1-\alpha_f)} \tag{A.4}$$

$$\kappa_1 = \alpha_h(1-p)L \tag{A.5}$$

$$\kappa_2 = \alpha_h(L - \lambda_1) \tag{A.6}$$

$$\kappa_3 = p\alpha_h[1+(1-p)(1-\alpha_f)](L-\lambda_2) \tag{A.7}$$

Proof. As shown in the text, $d_f^* = O$ or M depending on whether c_f is higher than $\alpha_f(1-p)L$. It remains to compute the best response of the home supervisor in each case.

- If $d_f^* = O$. The home supervisor can choose between M, I, and O. We have:

$$\begin{aligned}
W_h(M,O) - W_h(O,O) &= p(1-p)[w_h(l,s) - w_h(f,s)] + (1-p)^2[w_h(l,f) - w_h(f,f)] - c_h \\
&= \alpha_h(1-p)L - c_h \quad (A.8) \\
W_h(O,O) - W_h(I,O) &= p(1-p)[pw_h(s,s) + (1-p)w_h(f,s) - w_h(l,s)] \\
&+ (1-p)[pw_h(s,f) + (1-p)w_h(f,f) - w_h(l,f)] \\
&= p - L - p^2(R - P_f(S,O)) \quad (A.9) \\
W_h(M,O) - W_h(I,O) &= p^2[w_h(s,s) - w_h(l,s)] + p(1-p)[w_h(s,f) - w_h(l,f)] - c_h \\
&= p\alpha_h[1 - L - p(R - P_f(S,O))] - c_h \quad (A.10)
\end{aligned}$$

Using that $pP_f(S,O) = 1 - (1-p)\alpha_f$, these equations yield the first part of the proposition.

- If $d_f^* = M$. The home supervisor can choose between M, I, O, and C. However, it is straightforward to show that $W_h(C,M) > W_h(I,M)$, as there is no reason to close a successful unit, so that we do not have to consider strategy I. For the remaining ones, we have:

$$\begin{aligned}
W_h(M,M) - W_h(O,M) &= p(1-p)[w_h(l,s) - w_h(f,s)] + (1-p)^2[w_h(l,l) - w_h(f,l)] - c_h \\
&= \alpha_h(1-p)L - c_h \qquad \text{(A.11)} \\
W_h(O,M) - W_h(C,M) &= p[pw_h(s,s) + (1-p)w_h(f,s) - w_h(l,s)] \\
&= p - L - p(R - P_f(S,M)) \qquad \text{(A.12)} \\
W_h(M,M) - W_h(C,M) &= p^2[w_h(s,s) - w_h(l,s)] + (1-p)^2[w_h(l,l) - w_h(f,l)] - c_h \\
&= \alpha_h[(1-2p)L + p^2(1 + P_f(S,M) - R)] - c_h \qquad \text{(A.13)}
\end{aligned}$$

Using that $pP_f(S,M) = 1 - (1-p)[\alpha_f + (1-\alpha_f)L]$, these equations yield the second part of the proposition, which concludes the proof. ■

A.3 Proof of Corollary 2

According to the proof of Proposition 2, we have $d_h^* = M$ if and only if $c_h \le \min(\kappa_1, \kappa_1 - \kappa_2)$ when $c_f \ge \alpha_f(1-p)L$, and if and only if $c_h \le \min(\kappa_1, \kappa_1 - \kappa_3)$ when $c_f < \alpha_f(1-p)L$. Using equations (A.3), (A.4), (A.6), and (A.7), it is clear that both $\min(\kappa_1, \kappa_1 - \kappa_2)$ and $\min(\kappa_1, \kappa_1 - \kappa_3)$ are decreasing in α_f, showing the corollary. ■

A.4 Proof of Proposition 3

If $c_f \le c_h$, denote $c_{low} = c_f$, $d^b_{low} = d^b_f$, $c_{high} = c_h$, $d^b_{high} = d^b_h$, and symmetrically if $c_h < c_f$. We will prove that the branch supervisor's optimal decision is:

- If the liquidation value is small, $L < \lambda_3$, (d^b_{low}, d^b_{high}) is equal to (M,M) if $c_{high} \le \kappa_1$, (O,M) if $c_{high} > \kappa_1$ and $c_{low} \le \kappa_1$, and (O,O) if $c_{low} > \kappa_1$.

- If the liquidation value is intermediate, $L \in [\lambda_3, \lambda_4]$, (d^b_{low}, d^b_{high}) is equal to (M,M) if $c_{high} \le \kappa_1 - \kappa_4$, (C,M) if $c_{high} > \kappa_1 - \kappa_4$ and $c_{low} \le \kappa_1 + \kappa_4$, and (O,O) if $c_{low} > \kappa_1 + \kappa_4$.

- If the liquidation value is high, $L > \lambda_4$, (d^b_{low}, d^b_{high}) is equal to (M,M) if $c_{high} \le \kappa_1 - \kappa_4$, (C,M) if $c_{high} > \kappa_1 - \kappa_4$ and $c_{low} \le \kappa_4 + \kappa_5$, and (I,O) if $c_{low} > \kappa_4 + \kappa_5$.

Where the values of λ_3, λ_4, κ_4, and κ_5 are as follows:

$$\begin{aligned}
\lambda_3 &= p(2-R) && \text{(A.14)}\\
\lambda_4 &= pR(1-p)+p^2(2-R) && \text{(A.15)}\\
\kappa_4 &= p\alpha_h(L-\lambda_3) && \text{(A.16)}\\
\kappa_5 &= \alpha_h(\lambda_4-pL). && \text{(A.17)}
\end{aligned}$$

Proof. We consider the case $c_f \leq c_h$, the other case being symmetric. Observe that strategies (I,I) and (I,M) are dominated by (I,O) and (C,M), respectively: leaving one unit open brings pR, while closing it yields L. Since $pR > L$, the result follows.

When no unit is monitored, we need to compare (I,O) and (O,O), which gives:

$$\begin{aligned}
W_b(O,O)-W_b(I,O) &= p[pw_b(s,s)+(1-p)w_b(s,l)-w_b(l,s)]+(1-p)[pw_b(s,f)+(1-p)w_b(f,l)-w_b(l,f)]\\
&= pR(1-p)+p^2(2-R)-L && \text{(A.18)}
\end{aligned}$$

When only one unit is monitored it is unit f, and we need to compare (O,M) and (C,M):

$$\begin{aligned}
W_b(O,M)-W_b(C,M) &= p[pw_b(s,s)+(1-p)w_b(f,s)-w_b(l,s)]\\
&= p(2-R)-L && \text{(A.19)}
\end{aligned}$$

We have thus shown that (O,M) strictly dominates (C,M) if and only if $L < \lambda_3$, and (O,O) strictly dominates (I,O) if and only if $L < \lambda_4$. Since $\lambda_4 > \lambda_3$, we have three cases to consider:

- $L \leq \lambda_3$, so that (C,M) and (I,O) are dominated, and $(d_h^b, d_f^b) \in \{(O,O),(O,M),(M,M)\}$. We have the following comparisons:

$$\begin{aligned}
W_h(M,M)-W_h(O,M) &= p(1-p)[w_b(l,s)-w_b(f,s)]+(1-p)^2[w_b(l,l)-w_b(f,l)]-c_h\\
&= \kappa_1-c_h && \text{(A.20)}\\
W_h(O,M)-W_h(O,O) &= p(1-p)[w_b(s,l)-w_b(s,f)]+(1-p)^2[w_b(f,l)-w_b(f,f)]-c_f\\
&= \kappa_1-c_f && \text{(A.21)}\\
W_h(M,M)-W_h(O,O) &= p(1-p)[2w_b(s,l)-w_b(s,f)]+(1-p)^2[w_b(l,l)-w_b(f,f)]-c_f-c_h\\
&= 2\kappa_1-c_h-c_f && \text{(A.22)}
\end{aligned}$$

These comparisons give us the first part of the proposition: since $c_h \geq c_f$, $c_h \leq \kappa_1 \Rightarrow c_h + c_f \leq 2\kappa_1$, and $c_f \geq \kappa_1 \Rightarrow c_h + c_f \geq 2\kappa_1$.

- $L \in [\lambda_3, \lambda_4]$, so that (O, M) and (I, O) are dominated, and $(d_h^b, d_f^b) \in \{(O, O), (C, M), (M, M)\}$. We have to introduce two new comparisons:

$$\begin{aligned} W_h(M, M) - W_h(C, M) &= p^2[w_h(s, s) - w_h(l, s)] + (1-p)^2[w_h(l, l) - w_h(f, l)] - c_h \\ &= \kappa_1 - \kappa_4 - c_h \end{aligned} \tag{A.23}$$

$$\begin{aligned} W_h(C, M) - W_h(O, O) &= p[w_b(l, s) - pw_b(s, s) - (1-p)w_b(f, l)] + p(1-p)[w_b(s, l) - w_b(s, f)] \\ &+ (1-p)^2[w_b(f, l) - w_b(f, f)] = \kappa_1 + \kappa_4 - c_f \end{aligned} \tag{A.24}$$

(M, M) is optimal when $c_h \leq \kappa_1 - \kappa_4$ and $c_h + c_f \leq 2\kappa_1$ (equation (A.22)), but clearly the former condition implies the latter since $c_f \leq c_h$. Conversely, if $c_f \geq \kappa_1 + \kappa_4$ then we also have $c_f + c_h \geq 2\kappa_1$, so that $c_f \geq \kappa_1 + \kappa_4$ is a necessary and sufficient condition to have (C, M). This proves the second part of the proposition.

Together with (A.22), these comparisons give us the second part of the proposition.

- $L > \lambda_4$, so that (O, O) and (O, M) are dominated, and $(d_h^b, d_f^b) \in \{(I, O), (C, M), (M, M)\}$. We introduce two additional comparisons:

$$W_h(C, M) - W_h(I, O) = (1-p)[pw_b(s, l) + (1-p)w_b(f, l) - w_b(l, f)] - c_f$$

$$= \kappa_4 + \kappa_5 - c_f \tag{A.25}$$

$$W_h(M, M) - W_h(I, O) = p^2[w_b(s, s) - w_b(l, s)] + (1-p)[pw_b(s, l) + (1-p)w_b(l, l) - w_b(l, f)] - c_h - c_f$$

$$= \kappa_1 + \kappa_5 - c_h - c_f \tag{A.26}$$

(A.27)

For (M, M) to be optimal we need both $c_h \leq \kappa_1 - \kappa_4$ and $c_h + c_f \leq \kappa_1 + \kappa_5$. Direct computation shows that $2(\kappa_1 - \kappa_4) \leq \kappa_1 + \kappa_5$ is equivalent to $(1-p)L + p(L - \lambda_3) + pR(1-p)$, which is true as $pR \geq L$. Hence $c_h \leq \kappa_1 - \kappa_4$ and $c_f \leq c_h$ imply $c_h + c_f \leq \kappa_1 + \kappa_5$. Conversely, in order to have (I, O) we need $c_h + c_f \geq \kappa_1 + \kappa_5$ and $c_f \geq \kappa_4 + \kappa_5$. Since $c_h \geq c_f$, $c_f \geq \kappa_4 + \kappa_5$ implies that $c_h + c_f \geq 2(\kappa_4 + \kappa_5)$, which is higher than $\kappa_1 + \kappa_5$ as the previous comparison has shown. This proves the third part of the proposition. ∎

A.5 Proof of Lemma 1

By contradiction, assume this is not the case and we have $d_f^* = d_f^{**}$ with $d_h^* \neq d_h^{**}$. The supranational supervisor chooses a pair of decisions. In particular, since the pair (d_h^{**}, d_f^{**}) is optimal, we must have

$$W_h(d_h^{**}, d_f^{**}) + W_f(d_f^{**}) \geq W_h(d_h^*, d_f^{**}) + W_f(d_f^{**}), \tag{A.28}$$

but since d_h^* is optimal for the home supervisor in the national case, it must be a best response to $d_f^* = d_f^{**}$, and in particular we must have

$$W_h(d_h^*, d_f^{**}) \geq W_h(d_h^{**}, d_f^{**}). \tag{A.29}$$

Both inequalities cannot hold unless $d_h^* = d_h^{**}$, a contradiction.[16] ∎

A.6 Proof of Proposition 4

Lemma 1 allows us to focus on identifying cases in which supranational supervision leads to a different decision in the foreign unit. As $p > L$, the decision in the foreign unit is either M or O, so that we have either $d_f^* = O$ with $d_f^{**} = M$ or $d_f^* = M$ with $d_f^{**} = O$. We first show that only the former is possible:

Lemma 3. *Supranational supervision with a subsidiary represented MNB leads to more monitoring in the foreign unit: if $d_f^* \neq d_f^{**}$, then necessarily $d_f^* = O, d_f^{**} = M$.*

Proof: By contradiction, assume the only other possible case, which is $d_f^* = M, d_f^{**} = O$. Note that the interest rate P_f now depends on the decision on supervision, and is either $P_f(S, M)$ if the foreign unit is monitored, or $P_f(S, O)$ when it is left open.[17] Denote $W_h(d_h, d_f, P_f)$ the payoff to the home deposit insurer (W_f does not depend on P^f). Since $d_f^* = M$, we must have $W_f(M) \geq W_f(O)$. Regarding the supranational supervisor, a necessary condition for O to be optimal is to have:

$$W_h(d_h^{**}, O, P_f(S, O)) + W_f(O) \geq W_h(d_h^{**}, M) + W_f(M). \tag{A.30}$$

[16] Implicitly, the proof assumes that interest rates are the same under both scenarios, which may not be the case. Note that P_f only depends on d_f, so that P_f is indeed equal under both types of supervision when $d_f^* = d_f^{**}$. P_h might be different, but it can easily be checked that this quantity plays no role in W_h and W_f.

[17] Notice that deposit rates are determined before supervisors take their decisions. This implies that for a pair of decisions (d_h^{**}, d_f^{**}) to be optimal for the supranational supervisor, it must be that the other decisions are dominated considering, for these decisions, the same deposit rate that would emerge with (d_h^{**}, d_f^{**}).

Simplifying and rearranging, we thus have:

$$0 \leq W_f(M) - W_f(O) \leq W_h(d_h^{**}, O, P_f(S,O)) - W_h(d_h^{**}, M, P_f(S,O)) \tag{A.31}$$

Neglecting the borderline case in which $c_f = \alpha_f(1-p)L$, the term on the right hand side must be strictly positive. However, since $d_f^{**} = O$ we cannot have $d_h^{**} = C$, and for any other d_h^{**} the term in the right hand side is always null, a contradiction. This concludes the proof. ∎

We can now prove the proposition. More specifically, we will prove that the three cases in which decisions under national and supranational supervision differ are characterized as follows:

- $(d_h^*, d_f^*) = (O,O)$ and $(d_h^{**}, d_f^{**}) = (C,M)$. This case obtains for $L \in [\lambda_2, \lambda_1]$, $c_h \geq \kappa_1$, and $c_f \in [\alpha_f(1-p)L, \alpha_f(1-p)L + \kappa_3]$.

- $(d_h^*, d_f^*) = (I,O)$ and $(d_h^{**}, d_f^{**}) = (C,M)$. This case obtains for $L > \lambda_1$, $c_h \geq \kappa_1 - \kappa_2$, and $c_f \in [\alpha_f(1-p)L, \alpha_f(1-p)L + (1-p)\alpha_h(p-L)]$.

- $(d_h^*, d_f^*) = (M,O)$ and $(d_h^{**}, d_f^{**}) = (C,M)$. This case obtains for $L > \lambda_2$, $c_h \leq \min(\kappa_1 - \kappa_2, \kappa_1)$, $c_f \geq \alpha_f(1-p)L$, and $c_f - c_h \leq \alpha_f(1-p)L + (\kappa_3 - \kappa_1)$.

Assume that $(d_h^{**}, d_f^{**}) \neq (d_h^*, d_f^*)$. We deduce from Lemmas 1 and 3 that $d_f^* \neq M$ and $d_f^{**} = M$. Let us show that $d_h^{**} = C$. By contradiction, assume this is not the case. As (d_h^{**}, M) is optimal for the supranational supervisor, it must in particular be better than (d_h^{**}, O), which writes as:

$$W_h(d_h^{**}, M) + W_f(M) \geq W_h(d_h^{**}, O) + W_f(O) \tag{A.32}$$

$$\Leftrightarrow \quad W_h(d_h^{**}, M) - W_h(d_h^{**}, O) \geq W_f(M) - W_f(O) > 0. \tag{A.33}$$

As already used in the proof of Lemma 3, for $d \neq C$ we have $W_h(d,M) = W_h(d,O)$, so that the inequality cannot hold.

Finally, we need to determine d_h^*, which can be M, O, or I. All three cases are possible, and we derive a full characterization of each case:

- $(d_h^*, d_f^*) = (O,O)$ and $(d_h^{**}, d_f^{**}) = (C,M)$: By Proposition 2 we know that in order to obtain $(d_h^*, d_f^*) = (O,O)$ we need $L \leq \lambda_1$, $c_h \geq \kappa_1$ and $c_f \geq \alpha_f(1-p)L$. For (d_h^{**}, d_f^{**}), we know from our previous results that if $d_f^{**} = M$ then $d_h^{**} = C$. Moreover, any pair (d_h, O) is necessarily dominated, unless maybe $d_h = I$. We thus need to do one comparison:

$$
\begin{aligned}
&W_h(C,M) + W_f(M) - W_h(O,O) - W_f(O) - c_f \geq 0 \\
\Leftrightarrow & p[w_h(l,s) - (1-p)w_h(f,s)] + (1-p)^2[w_h(f,l) - w_h(f,f)] + W_f(M) - W_f(O) - c_f \geq 0 \\
\Leftrightarrow & \alpha_f(1-p)L + \kappa_3 \geq c_f. \qquad \text{(A.34)}
\end{aligned}
$$

Note that in order to have $W_h(C,M) + W_f(M) - W_h(O,O) - W_f(O) \geq 0$ and $c_f \geq \alpha_f(1-p)L$, we need $\kappa_3 \geq 0$, which is equivalent to $L \geq \lambda_2$. Computations show that $\lambda_2 \leq \lambda_1$ is equivalent to $\alpha^2 p(1-p) + (1-\alpha) + pR(1-p(1-\alpha)) + 2(1-\alpha p(1-p)) \geq 0$, which is true. This shows the first part of the proposition.

- $(d_h^*, d_f^*) = (I,O)$ and $(d_h^{**}, d_f^{**}) = (C,M)$: The reasoning is similar. In order to have $(d_h^*, d_f^*) = (I,O)$, we need $L > \lambda_1$, $c_h \geq \kappa_1 - \kappa_2$ and $c_f \geq \alpha_f(1-p)L$. We just need to compare the supranational supervisor's payoff with (C,M) and (I,O):

$$
\begin{aligned}
& W_h(C,M) + W_f(M) - W_h(I,O) - W_f(O) - c_f \geq 0 \\
\Leftrightarrow \quad & (1-p)[(1-p)w_h(f,l) - w_h(l,f)] + W_f(M) - W_f(O) - c_f \geq 0 \\
\Leftrightarrow \quad & \alpha_f(1-p)L + \alpha_h(1-p)(p-L) \geq c_f, \qquad \text{(A.35)}
\end{aligned}
$$

from which we deduce the second part of the proposition.

- $(d_h^*, d_f^*) = (M,O)$ and $(d_h^{**}, d_f^{**}) = (C,M)$: $(d_h^*, d_f^*) = (M,O)$ is obtained for $c_f \geq \alpha_f(1-p)L$ and $c_h \leq \min(\kappa_1 - \kappa_2, \kappa_1)$. (C,M) is preferred to (M,O) by the supranational supervisor depending on the sign of:

$$
\begin{aligned}
& W_h(C,M) + W_f(M) - W_h(M,O) - W_f(O) + c_h - c_f \\
= & p^2 w_h(l,s) + (1-p)^2[w_h(f,l) - w_h(l,f)] + W_f(M) - W_f(O) + c_h - c_f \\
= & \alpha_f(1-p)L + \kappa_3 - \kappa_1 + c_h - c_f \qquad \text{(A.36)}
\end{aligned}
$$

Notice in particular that we must have $c_f \in [\alpha_f(1-p)L, \alpha_f(1-p)L + \kappa_3]$ so that κ_3 needs to be positive, hence $L \geq \lambda_2$. ■

A.7 Proof of Corollary 4

Using Proposition 4, if a subsidiary is active under national supervision (that is, we do not have $(d_h^*, d_f^*) = (I,O)$), then either supranational supervision does not change the subsidiary's profit, or we have a change from $\Pi(S,O,O)$ or $\Pi(S,M,O)$ to $\Pi(S,C,M)$. We first prove that $\Pi(S,C,M)$ is lower than the other other two quantities. For (d_h,d_f) equal to either (O,O) or (M,O), we have:

$$\Pi(S,d_h,d_f) = p^2(2R - P_h(S,d_h,d_f) - P_f) + p(1-p)(R - P_h(S,d_h,d_f))$$

and for (C,M),[18]

$$\Pi(S,C,M) = p(1-p)(R - P_h(S,C,M)).$$

It is easy to prove that $P_h(S,M,O) \leq P_h(S,O,O)$, so that $\Pi(S,O,O) \leq \Pi(S,M,O)$.

Furthermore, after substituting the deposit insurance rates

$$P_h(S,O,O) = \frac{1-(1-p)[\alpha_h + (1-\alpha_h)[pR - 1 + (1-p)\alpha_f]]}{p} \tag{A.37}$$

$$P_h(S,C,M) = \frac{(1-\alpha_h)(2-pR-L) - \alpha_f(1-\alpha_h)(1-L)(1-p) + \alpha_h p(1-p)}{(1-p)p} \tag{A.38}$$

into the profits we obtain

$$\Pi(S,O,O) - \Pi(S,C,M) = (1-\alpha_h)L[(1-p)\alpha_f - 1] + p[(1+\alpha_h)pR - \alpha_h(1+p-(1-p)\alpha_f)],$$

which is positive in the relevant parameters range.

This concludes the proof that a subsidiary-MNB's profits are always negatively impacted by supranational supervision. ■

A.8 Proof of Lemma 2

The proof can be found in the Online Appendix. ■

A.9 Proof of Proposition 5

We will make use of the following quantities, which complete the values of P_h, P_f given in the previous proofs:

$$P_h(A,O) = \frac{1-(1-p)\alpha_h}{p} \tag{A.39}$$

$$P_h(B,O,O) = \frac{1 - 2p(1-p)[\alpha_h + (1-\alpha_h)R/2] - (1-p)^2\alpha_h}{p^2}. \tag{A.40}$$

[18] Notice that in this case the home unit will be kept open only if the foreign unit is discovered to fail.

Case (i). We need to prove that the MNB finds it optimal to adopt a subsidiary structure under national supervision, $\Pi(S,O,O) \geq \max(\Pi(B,O,O),\Pi(A,O))$, and a branch structure under supranational supervision, $\Pi(B,O,O) \geq \max(\Pi(S,C,M),\Pi(A,O))$.

It is immediate that $\Pi(S,O,O) \geq \Pi(A,O)$: the subsidiary structure is composed of the same home unit, plus a foreign unit that can only bring additional profit. In order to compare $\Pi(S,O,O)$ and $\Pi(B,O,O)$, we can simply follow the proof of Proposition 1 and replace L by 0. Applying this method to equation (A.2) gives us:

$$\Pi(S,O,O) - \Pi(B,O,O) = (1-p)[\alpha_f(1-\alpha_h(1-p)) - \alpha_h p(2-R-L)]. \tag{A.41}$$

Using that case (i) requires $\alpha_f > \alpha_h$ (Lemma 2), we have:

$$\Pi(S,O,O) - \Pi(B,O,O) > (1-p)\alpha_h[1-\alpha_h(1-p) - \alpha_h p(2-R-L)]. \tag{A.42}$$

Since $2-R-L < 1$ by Assumption H2, the term in brackets is larger than $1-\alpha_h(1-p)-\alpha_h p = 0$, which proves that $\Pi(S,O,O) > \Pi(B,O,O)$ and thus that the MNB chooses a subsidiary structure under national supervision.

Direct computations give:

$$\Pi(B,O,O) - \Pi(A,O) > 0 \Leftrightarrow (1-\alpha_h)(1-p)(pR-1) > 0, \tag{A.43}$$

which is true by Assumption H1.

To conclude, we can show that $\Pi(A,O) \geq \Pi(S,C,M)$. Direct computation shows that:

$$\Pi(A,O) - \Pi(S,C,M) = (1-L)(1-\alpha_f(1-p)(1-\alpha_h)) - \alpha_h(1-L+p^2) - pR(1-p-\alpha_h). \tag{A.44}$$

This quantity is increasing in α_h and decreasing in α_f, hence it is higher than what we obtain with $\alpha_h = 0, \alpha_f = 1$:

$$\Pi(A,O) - \Pi(S,C,M) \geq p(1-L-(1-p)R). \tag{A.45}$$

Since $pR > 1$ (Assumption H1), this last quantity is greater than $p(2-L-R)$, which is true by Assumption H2.

Case (ii). As the branch is not viable, we need to prove that the MNB prefers the subsidiary structure under national supervision and the stand-alone structure under supranational supervision.

This is equivalent to $\Pi(S,O,O) \geq \Pi(A,O) \geq \Pi(S,C,M)$, and both inequalities have already been shown (importantly, the proof of $\Pi(A,O) \geq \Pi(S,C,M)$ did not use $\alpha_f > \alpha_h$).

Case (iii). This is very similar to case (ii), we need to prove $\Pi(S,M,O) \geq \Pi(A,M) \geq \Pi(S,C,M)$. Proving the first inequality is immediate. It is also easy to show that $\Pi(A,M) \geq \Pi(A,O)$. Since $\Pi(A,O) \geq \Pi(S,C,M)$, this implies that $\Pi(A,M) \geq \Pi(S,C,M)$. ■

A.10 Proof of Proposition 6

The different cases mentioned in the Proposition correspond to cases (i)-(iii) of Table 2.

1. Cases (i) and (ii) require that $c_f \in [\alpha_f(1-p)L, \alpha_f(1-p)L+\kappa_3]$ (cf. the proof of Proposition 4), but $\kappa_3 = 0$ when $\alpha_h = 0$. Case (iii) requires that $c_h \leq \kappa_1$, but $\kappa_1 = 0$ when $\alpha_h = 0$.

2. Using the proof of Proposition 2, we cannot have $(d_h^*, d_f^*) = (M,O)$ when $c_h = c_f$, so that case (iii) cannot obtain. In order to obtain case (i), we need $c_f \leq \alpha_f(1-p)L+\kappa_3]$ in order to obtain $(d_h^{**}, d_f^{**}) = (C,M)$, but we also need $c_{low} \geq \kappa_1 + \kappa_4$ in order to have $(d_h^b, d_f^b) = (O,O)$. These conditions are not compatible with each other when $\alpha_h = \alpha_f$.

3. We already know that case (ii) is not possible with a sufficiently low α_h. As both cases (i) and (ii) require $(d_h^*, d_f^*) = (O,O)$ and $(d_h^{**}, d_f^{**}) = (C,M)$, the only difference between these two cases comes from the branch case. If parameters are such that case (ii) obtains, we need to have either (C,M) or (I,O). Using the proof of Proposition 3, there are two cases to consider. If $L > \lambda_4$ (notice that λ_4 does not depend on α_h), then case (i) can never obtain: a decrease in α_h will eventually lead to centralized supervision having no impact, but not to case (i). If $L \in [\lambda_3, \lambda_4]$, then case (ii) obtains for $c_{high} > \kappa_1 - \kappa_4$ and $c_{low} \leq \kappa_1 + \kappa_4$, while case (i) obtains for $c_{low} > \kappa_1 + \kappa_4$. Since $\kappa_1 + \kappa_4$ is increasing in α_h, it is impossible to find two values of α_h, say α_{h1} and α_{h2}, with $\alpha_{h1} < \alpha_{h2}$ such that case (ii) obtains with α_{h1} and case (i) obtains with α_{h2}. Notice that since the decision in the branch case does not depend on α_f, this parameter does not have an impact on whether we are in case (i) or in case (ii). ■

A.11 Proof of Corollaries 5 and 6

We first consider the costs to the home deposit insurer. When national supervision leads to a subsidiary with decision (O,O) and supranational supervision leads to a branch with (O,O), we can compute the difference of costs supported by the home DI:

$$W_b(O,O) - W_h(O,O) = -\alpha_h(1-p)(\alpha_f(1-p) + p(2-R)) < 0.$$

When instead centralized supervision leads to a stand-alone bank, we have:

$$W_h(O) - W_h(O,O) = W_h(M) - W_h(M,O) = -\alpha_h(1-p)(pR - 1 + \alpha_f(1-p)) < 0.$$

In both cases, the foreign deposit insurance is not liable anymore after the switch to central supervision, and thus gains from this change.

Turning now to Corollary 6, assume a country with a proportion ϕ of home units and a proportion ϕ of foreign units. Consider the case in which supranational supervision leads to a branch with (O,O). The deposit insurance fund loses $\phi[W_b(O,O) - W_h(O,O)]$ on its home MNBs. However, it also saves $(1-\phi) \times \alpha_h(1-p)$ on the subsidiaries of foreign MNBs. It is clear from Corollary 5 that the sum of both terms is increasing in ϕ, so we just need to show that it is positive when $\phi = 1/2$, which is equivalent to:

$$W_b(O,O) - W_h(O,O) + \alpha_h(1-p) > 0 \Leftrightarrow 1 > \alpha_f(1-p) + p(2-R),$$

which is true, as $p(2-R) < p$ and thus $\alpha_f(1-p) + p(2-R) < (1-p) + p = 1$.

This result is even more direct in the cases (ii) and (iii) of Table 2. In case (ii), the change for the deposit insurance fund is equal to $\phi(W_h(O) - W_h(O,O)) + (1-\phi)\alpha_h(1-p)$. Since $W_h(O) = -\alpha_h(1-p)$ and $W_h(O,O) < 0$, this quantity is positive for $\phi = 1/2$. In case (iii), the change is $\phi(W_h(M) - W_h(M,O)) + (1-\phi)\alpha_h(1-p)$, and we have $W_h(M) > \alpha_h(1-p)$, ensuring again a positive change for $\phi = 1/2$. ∎

A.12 Proof of Proposition 7

The first point of the proposition is straightforward.

As for the second point, denote (d_h^n, d_f^n) the optimal decision with supranational supervision and national deposit insurance, and (d_h^c, d_f^c) the optimal decision with supranational supervision and common deposit insurance. Both with and without common deposit insurance, we know that the optimal decision belongs to the set $\{(O,O),(I,O),(M,O),(O,M),(M,M),(C,M)\}$. We want to show that it is impossible to have $d_f^n = M$ and $d_f^c \neq M$, that is, $d_f^c = O$. By contradiction, assume that this is the case. Then, there are two cases to consider:

- $(d_h^n, d_f^n) \neq (C,M)$: since both (d_h^n, d_f^n) and (d_h^c, d_f^c) are different from (C,M), we know that the same decisions would have been reached under national supervision (Proposition 4). In order for $d_f^c = O$ to be optimal for the foreign supervisor under national supervision, we need to have $\alpha_c(1-p) \leq c_f$. However, in order for d_f^n to be optimal under national supervision, we need $\alpha_f(1-p) \geq c_f$. Since $\alpha_c > \alpha_f$, this is a contradiction.

- $(d_h^n, d_f^n) = (C, M)$: it needs to be the case that (C, M) is preferred to (d_h^c, O) under national deposit insurance, whereas the opposite is true under common deposit insurance. The proof of Proposition 4 contains all the pairwise comparisons between (C, M) and $(I, O), (O, O)$, and (M, O) from the perspective of a supranational supervisor. It can be checked that in each case an increase in α_f improves the payoff of (C, M) over the alternative, which shows that adding common deposit insurance cannot lead the supranational supervisor to prefer any (d_h^c, O) over (C, M).

The reasoning for the third point is similar. By contradiction, assume that we have $d_h^c = M$ and $d_h^n \in \{C, I, O\}$. Again, there are two cases:

- $d_f^n = d_f^c$: it must be the case that $W_h(d_h^n, d_f^n) = W_h(d_h^n, d_f^c) > W_h(M, d_f^n)$ under national deposit insurance. Conversely, we must have $W_h(M, d_f^c) > W_h(d_h^n, d_f^c)$ under common deposit insurance. Since $d_f^n = d_f^c$, the only difference between these two cases is that residual assets in the foreign unit are higher under common deposit insurance. We know from Corollary 1 that this reduces monitoring incentives in the home unit, so that we cannot have $d_h^c = M$ and $d_h^n \neq M$.

- $d_f^n \neq d_f^c$: given the second point, it must be that $d_f^n = O, d_f^c = M$. So there are only two possibilities: (i) $(d_h^n, d_f^n) = (I, O)$, $(d_h^c, d_f^c) = (M, M)$, or (ii) $(d_h^n, d_f^n) = (O, O)$, $(d_h^c, d_f^c) = (M, M)$. In case (i), we need in particular to have $W_h(I, O) \geq W_h(M, O)$ with national deposit insurance, and $W_h(I, M) \leq W_h(M, M)$ with common deposit insurance. These two conditions are equivalent to:

$$
\begin{aligned}
p\alpha_h[1 - L - p(R - P_f(S, O))] &\leq c_h \\
p\alpha_h[1 - L - p(R - P_f(S, M))] &\geq c_h.
\end{aligned}
$$

Both conditions are compatible if and only if $P_f(S, M) \geq P_f(S, O)$, but this is not the case: for a given α_f we have $P_f(S, O) - P_f(S, M) \geq 0$, and taking into account that α_f is larger for $P_f(S, M)$ due to common deposit insurance makes the difference even more positive. Hence, case (i) is impossible. Similarly, for case (ii) we need in particular to have $W_h(O, O) \geq W_h(M, O)$ under national deposit insurance, and $W_h(M, M) \geq W_h(O, M)$ under common deposit insurance. The first condition is equivalent to $c_h \geq \alpha_h(1-p)L$, whereas the second one is equivalent to $c_h \leq \alpha_h(1-p)L$. Hence, we cannot have both, and case (ii) is not possible either. Thus, there is no case in which we can have

$d_h^c = M$ and $d_h^n \in \{C, I, O\}$. ■

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B Supplementary Appendix for "Multinational Banks and Supranational Supervision"

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B.1 Proof of Lemma 2

So as to reduce the number of cases to consider, we first prove the following intermediate result:

Lemma 4. *If $(d_h^*, d_f^*) \neq (d_h^{**}, d_f^{**})$ and $\alpha_h \geq \alpha_f$, then $(d_h^b, d_f^b) = (C, M)$.*

Proof: According to Proposition 4, in order to have $(d_h^*, d_f^*) \neq (d_h^{**}, d_f^{**})$ we need $L \geq \lambda_2$. This implies that $L \geq \lambda_3$ and hence only $(C, M), (M, M), (O, O)$, and (I, O) can be optimal in the branch case. Define $\Delta_{CM-OO} = [W_b(C, M) - W_b(O, O)] - [W_h(C, M) + W_f(M) - W_h(O, O) - W_f(O)]$: this represents the payoff of (C, M) relative to (O, O) under branch, minus the same difference with a supranational supervisor. Denoting $\delta(s_h, s_f) = w_b(s_h, s_f) - w_h(s_h, s_f) - w_f(s_f)$, we have:

$$\begin{aligned}
\Delta_{CM-OO} &= p(1-p)[\delta(s,l) - \delta(s,f)] + p\delta(l,s) \\
&+ (1-p)^2[\delta(f,l) - \delta(f,f)] - p(1-p)\delta(f,s) \\
&= (\alpha_h - \alpha_f)(1-p)L + p^2\alpha_h(P_f - 1).
\end{aligned}$$

If $\alpha_h \geq \alpha_f$ we have $\Delta_{CM-OO} > 0$, which means that if (C, M) dominates (O, O) under supranational supervision, it is also the case with a branch.

We repeat the analysis for the comparison between (C, M) and (I, O) and between (C, M) and (M, M). We have:

$$\begin{aligned}
\Delta_{CM-IO} &= p(1-p)\delta(s,l) + (1-p)^2\delta(f,l) - (1-p)\delta(l,f) \\
&= (\alpha_h - \alpha_f)(1-p)L + p(1-p)\alpha_h(R-1). \qquad \text{(B.1)} \\
\Delta_{CM-MM} &= p^2\delta(l,s) + (1-p)^2[\delta(f,l) - \delta(l,l)] \\
&= p^2\alpha_h(P_f - 1). \qquad \text{(B.2)}
\end{aligned}$$

Again, if $\alpha_h \geq \alpha_f$ we surely have $\Delta_{CM-IO} \geq 0$ and $\Delta_{CM-MM} \geq 0$. We conclude that if (C, M) dominates $(I, O), (O, O)$, and (M, M) in the supranational case and $\alpha_h \geq \alpha_f$, then (C, M) is also optimal in the branch case. ■

We now prove Lemma 2. We start by excluding all the other cases than those mentioned in the Lemma.

According to Proposition 4, we need $c_f \geq \alpha_f(1-p)L$. Using Lemma 4, we have $\alpha_f \geq \alpha_h$ so that $c_f \geq \kappa_1$. It is thus impossible to have $(d_h^b, d_f^b) = (M, M)$. Still using Proposition 4, we need $L \geq \lambda_2$. As $\lambda_2 > \lambda_3$, we have $L \geq \lambda_3$ and hence $(d_h^b, d_f^b) = (M, O)$ or $(d_h^b, d_f^b) = (O, M)$ are impossible. Hence only (O, O) is feasible.

We cannot have $(d_h^*, d_f^*) = (M, O)$: According to Proposition 4, we need $c_h \leq \kappa_1$ in such a case, but according to Proposition 3 we need $c_h \geq \kappa_1 + \kappa_4$ to have $(d_h^b, d_f^b) = (O, O)$.

We now consider the first case, $(d_h^*, d_f^*) = (O, O)$, $(d_h^{**}, d_f^{**}) = (C, M)$ and $(d_h^b, d_f^b) = (O, O)$. Collecting all the conditions for this case to obtain, we have:

$$L \in [\lambda_2, \lambda_1] \tag{B.3}$$

$$L \in [\lambda_3, \lambda_4] \tag{B.4}$$

$$c_h \geq \kappa_1 \tag{B.5}$$

$$c_h \geq \kappa_1 + \kappa_4 \tag{B.6}$$

$$c_f \geq \alpha_f(1-p)L \tag{B.7}$$

$$c_f \geq \kappa_1 + \kappa_4 \tag{B.8}$$

$$c_f \leq \alpha_f(1-p)L + \kappa_3 \tag{B.9}$$

We first notice that $\lambda_4 \geq \lambda_1$ and $\lambda_3 \leq \lambda_2$. We can thus neglect (B.4), which is implied by (B.3). If $L \geq \lambda_3$, we have $\kappa_4 \geq 0$. Hence, (B.3) and (B.6) imply (B.5), which can be neglected.

To satisfy the remaining 5 inequalities, we can pick an arbitrarily high c_h, but c_f needs to simultaneously satisfy (B.7), (B.8) and (B.9). This requires at least that these inequalities are compatible. This is clearly the case for (B.7) and (B.9) because $\kappa_3 \geq 0$ when $L \geq \lambda_2$. For (B.8) and (B.9), we need:

$$\begin{aligned} & \kappa_1 + \kappa_4 \leq \alpha_f(1-p)L + \kappa_3 \\ \Leftrightarrow \quad & L \geq \tfrac{\alpha_h p(1-\alpha_f)}{\alpha_f - \alpha_h + p\alpha_h(1-\alpha_f)} = \bar{L}_1. \end{aligned} \tag{B.10}$$

Notice that these computations show that $\alpha_f > \alpha_h$ is a necessary condition. To summarize, we can find c_h, c_f satisfying all inequalities if and only if $L \geq \bar{L}_1$, L satisfies (B.3) and $L \leq 2 - R$ (our assumption A.3.). These four inequalities need to be compatible. We know that $\lambda_2 < \lambda_1$ and

$\lambda_2 < 2 - R$, hence it remains to show that $\bar{L}_1 \leq 2 - R$ and $\bar{L}_1 \leq \lambda_1$. We have:

$$\bar{L}_1 \leq 2 - R \quad \Leftrightarrow \quad R \leq 1 + \frac{\alpha_f - \alpha_h}{\alpha_h p(1-\alpha_f) + (\alpha_f - \alpha_h)} = \bar{R}_1 \tag{B.11}$$

$$\bar{L}_1 \leq \lambda_1 \quad \Leftrightarrow \quad R \leq \frac{2 - \alpha_f(1-p)}{p} - \frac{\alpha_h(1-\alpha_f)}{p[\alpha_f - \alpha_h + p\alpha_h(1-\alpha_f)]} = \bar{R}_2 \tag{B.12}$$

Both $\bar{R}_1$ and $\bar{R}_2$ can be lower than 2, hence these conditions are not automatically satisfied. Remember that we cannot take R arbitrarily small: due to Assumption A.2., we need at least $R \geq 1/p$. We thus need to check that $\bar{R}_1$ and $\bar{R}_2$ are bother larger than $1/p$:

$$\bar{R}_1 \geq 1/p \quad \Leftrightarrow \quad (2-p)(\alpha_f - \alpha_h) + \alpha_h(1-\alpha_f)p(1-p) \geq 0 \tag{B.13}$$

$$\bar{R}_2 \geq 1/p \quad \Leftrightarrow \quad [1 - \alpha_f(1-p)][\alpha_f - \alpha_h + p\alpha_h(1-\alpha_f)] - \alpha_h(1-\alpha_f) \geq 0. \tag{B.14}$$

The first condition is clearly satisfied. The second one is obtained for α_h low enough. In particular, it can be checked that it is met for $\alpha_h = 0$, and not for $\alpha_h = \alpha_f$. More precisely, we need:

$$\alpha_h \leq \frac{\alpha_f(1 - \alpha_f(1-p))}{[1 - \alpha_f(1-p)][1 - p(1-\alpha_f)] + (1-\alpha_f)}, \tag{B.15}$$

this conditions implying $\alpha_h \leq \alpha_f$. To summarize, if we pick such an α_f, then we can find $R \in [1/p, \min(\bar{R}_1, \bar{R}_2)]$, so that we can find an L satisfying all the conditions we need, which guarantees that there are c_f and c_h as we require. The full characterization of the parameters satisfying all conditions is as follows:[19]

$$\begin{aligned}
p &\geq 1/2, \ \alpha_f \in [0,1] && \text{(B.16)}\\
\alpha_h &\leq \frac{\alpha_f(1 - \alpha_f(1-p))}{[1 - \alpha_f(1-p)][1 - p(1-\alpha_f)] + (1-\alpha_f)} && \text{(B.17)}\\
R &\in [1/p, \min(\bar{R}_1, \bar{R}_2, 2)] && \text{(B.18)}\\
L &\in [\lambda_1, \min(2 - R, \bar{L}_1, \lambda_2)] && \text{(B.19)}\\
c_h &\geq \kappa_1 + \kappa_4 && \text{(B.20)}\\
c_f &\in [\max(\kappa_1 + \kappa_4, \alpha_f(1-p)L), \alpha_f(1-p)L + \kappa_3], && \text{(B.21)}
\end{aligned}$$

where all the intervals are non-empty.

Turning now to the second case, $(d_h^*, d_f^*) = (I, O)$, $(d_h^{**}, d_f^{**}) = (C, M)$ and $(d_h^b, d_f^b) = (O, O)$.

[19] We did not check $p \geq L$, as this conditions is implied by $L \leq 2 - R$ and $pR \geq 1$, which itself implies $p \geq 1/2$.

Collecting all the conditions for this case to obtain, we have:

$$
\begin{aligned}
L &> \lambda_1 && \text{(B.22)}\\
L &\in [\lambda_3, \lambda_4] && \text{(B.23)}\\
c_h &\geq \kappa_1 - \kappa_2 && \text{(B.24)}\\
c_h &\geq \kappa_1 + \kappa_4 && \text{(B.25)}\\
c_f &\geq \alpha_f(1-p)L && \text{(B.26)}\\
c_f &\geq \kappa_1 + \kappa_4 && \text{(B.27)}\\
c_f &\leq \alpha_f(1-p)L + (1-p)\alpha_h(p-L) && \text{(B.28)}
\end{aligned}
$$

We have $\lambda_3 \leq \lambda_1$, so that (B.22) and (B.23) is equivalent to $L \in [\lambda_1, \lambda_4]$. Then it is clear that we can always find c_h sufficiently high to satisfy (B.24) and (B.25). In order to find a c_f satisfying (B.26), (B.27), and (B.28), these three inequalities must be compatible, which is clear for (B.26) and (B.28). For (B.27) and (B.28) to be compatible, we need:

$$
\begin{aligned}
& \kappa_1 + \kappa_4 \leq \alpha_f(1-p)L + (1-p)\alpha_h(p-L) && \text{(B.29)}\\
\Leftrightarrow \quad & L[\alpha_h - (\alpha_f - \alpha_h)(1-p)] \leq p[1+p-pR]. && \text{(B.30)}
\end{aligned}
$$

While the right-hand side is positive, the left-hand side can be negative. There are two cases to consider: if $\alpha_f \geq \frac{\alpha_h(2-p)}{1-p} = \bar{\alpha}_1$ then (B.27) and (B.28) are automatically compatible, otherwise we need:

$$L \leq \frac{p[1+p-pR]}{\alpha_h - (\alpha_f - \alpha_h)(1-p)} = \bar{L}_2 \tag{B.31}$$

We thus have three or four conditions on L: $L \geq \lambda_1$, $L \leq \lambda_4$, $L \leq 2 - R$ and, if $\alpha_f < \bar{\alpha}_1$, $L \leq \bar{L}_2$. We already know that $\lambda_4 \geq \lambda_1$. $2 - R \geq \lambda_1$ if and only if:

$$R \leq \frac{2 + p\alpha_f}{1+p} = \bar{R}_3 \tag{B.32}$$

Finally, when $\alpha_f < \bar{\alpha}_1$, $L \leq \bar{L}_2$ is equivalent to:

$$R \leq \frac{2\alpha_f(1-p) + p(1+p) - 2\alpha_h(2-p)}{\alpha_f(1-p) + p^2 - \alpha_h(2-p)} \tag{B.33}$$

The right-hand side being greater than 2, this equation is actually always satisfied. The last thing to check is that we can have $R \geq 1/p$ and $R \leq \bar{R}_3$, which necessitates $\alpha_f \geq \frac{1-p}{p^2}$. This is compatible with $\alpha_f < \bar{\alpha}_1$ if and only if $\alpha_h \geq \frac{(1-p)^2}{p^2(2-p)}$, which is lower than 1. Finally, $\alpha_f \geq \frac{1-p}{p^2}$ is compatible with $\alpha_f \leq 1$ if and only if $p > \frac{\sqrt{5}-1}{2}$. To summarize, the full characterization of the parameters satisfying equations (B.22) to (B.28) is:

$$
\begin{aligned}
p &\geq \frac{\sqrt{5}-1}{2} && \text{(B.34)}\\
\alpha_h &\geq \frac{(1-p)^2}{p^2(2-p)} && \text{(B.35)}\\
\alpha_f &\in \left[\max\left(\alpha_h, \frac{1-p}{p^2}\right), \min\left(1, \alpha_h \frac{2-p}{1-p}\right)\right] && \text{(B.36)}\\
R &\in [1/p, \bar{R}_3] && \text{(B.37)}\\
L &\in [\lambda_1, \min(2-R, \lambda_4)] && \text{(B.38)}\\
L &\leq \bar{L}_2, \text{ if } \alpha_f < \bar{\alpha}_1 && \text{(B.39)}\\
c_h &\geq \kappa_1 + \kappa_4 && \text{(B.40)}\\
c_f &\in [\max(\kappa_1 + \kappa_4, \alpha_f(1-p)L), \alpha_f(1-p)L + \kappa_3], && \text{(B.41)}
\end{aligned}
$$

where all the intervals are non-empty. ∎