Multinational Banks and Supranational Supervision

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Abstract

We study the supervision of multinational banks (MNBs), allowing both for national and supranational supervisions. 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. 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 at all, 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), i.e., banks operating in several countries, 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]

The issue is particularly acute in economic and financial areas, such as the European Union, in which many banking groups have cross-border activities and thus face different supervisory authorities and are covered by different national safety nets. The suspicion that this fragmentation can be strategically exploited by MNBs and lead to improper supervision triggered the creation of the European Banking Union.[3] Its first component, the Single Supervisory Mechanism, entered into force in November 2014 as the European Central Bank took over the supervision of the 123 most significant banks in the Euro area, representing 80% of total Euro area banking assets. The Banking Union is a first-order change in European banking, and will have a lasting impact on multinational banks.

The objective of this paper is to understand how new supervisory arrangements, such as the Single Supervisory Mechanism, are likely to affect the way MNBs operate, the funding conditions they face and possibly also their very decision to operate cross-border. In turn, these consequences ultimately affect the costs of insuring depositors of large cross-border banks in some unexpected directions. In particular, we show that supranational supervision encourages MNBs to adopt a representation form that is more costly to their home deposit insurer.

In our framework, 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.

Supervisors are in charge of monitoring the bank, which we model as uncovering bad assets

[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 *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.

and liquidating 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 to not 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 fails. 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 can reconsider its organizational structure and reorganize as a branch MNB, or as a stand-alone bank present in one country only. If the MNB chooses to become a stand-alone bank instead, 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 decisions 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.

The changes in organizational forms affect both the total expected losses and its 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 be borne by the home deposit insurance fund. This reallocation of deposit losses is particularly damaging as 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 funds end 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.

We also complete this analysis by considering the effects of moving towards a common deposit insurance, as it is currently debated for the European Banking Union. We show that leveling up the credibility of the home and foreign deposit insurance funds does not necessarily lead to more monitoring in both countries. More precisely, the credibility of a common deposit insurance, increased with respect to that of a weak national deposit insurance, may induce more monitoring in the latter country and thus, for the externality discussed above, less monitoring in the other country.

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 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. The implications will be different for the case of a MNB incorporated in a crisis country subsidiaries in a surplus country with credible deposit insurance, and for the symmetric case of an MNB incorporated in a surplus country that expands in a crisis country.

The present work is part of a growing literature on the regulation of MNBs. Calzolari and Loranth (2003) provide a general introduction to the issue. Holthausen and Rønde (2004), Acharya (2003), Dell'Ariccia and Marquez (2006), and Dalen and Olsen (2003) study the problem and implications of divergent interests and lack of coordination between national regulators. The empirical studies of Agarwal *et al.* (2014) and Rezende (2011) focus on the same issue by looking at the decisions of different supervisors in the United States.

Following the creation of the European Banking Union, a few papers have looked at the frictions between national and supranational supervisors. Colliard, J.-E. (2014) compares supranational to national supervision, focusing on the trade-off between worse quality information, but less biased incentives. Beck and Wagner (2013) also study common supervision, but examine the problem of different regional preferences regarding financial stability. Gornicka and Zoican (2014) focus on the resolution stage and the different incentives of national and supranational authorities to bail-out defaulting banks. On the empirical side, Beck, Todorov, and Wagner (2013) analyze the distortions in regulatory interventions triggered by the bank's representation form and its funding mixture in terms of foreign and home liabilities.

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, and their effects on prudential supervision and the bank representation choice.

Harr and Rønde (2004) and Loranth and Morrison (2007) consider the impact of the MNB representation form (subsidiary or branch) on optimal capital regulation.[4] While the focus of this paper is on capital regulation, we study bank supervision, including on-site monitoring and disciplinary actions.

Dell'Ariccia and Marquez (2010) identify different sources of risk, such as economic and political risks, that determine the bank's representation form when expanding into new markets. They argue that subsidiary structures are better equipped to cope with economic risk due to limited liability, but are more exposed to capital expropriation than branches. Several empirical papers study the choice of foreign representation by multinational banks (Focarelli and Pozzolo (2005), Cerutti *et al.* (2007)). However, these papers do not consider regulation as a factor driving the choice between branches and subsidiaries.

Finally, Calzolari and Loranth (2011) use a model similar to the one employed in the present paper to investigate the different attitude of a regulator facing a subsidiary or branch represented MNB. Their paper is not concerned with the effect of central supervision on the bank's strategic decisions. Moreover, they do not consider supervisory monitoring and disregard the credibility of the deposit insurance schemes.

More importantly, and differently from most of the previous papers, our model provides a framework for policy design. Our results provide insight on the current developments in the European Banking Union, which is a unique laboratory to explore the broader issue of how to optimally

[4]In a different setting, Kahn and Winton (2004) also examine the effect of financial institutions' structure (subsidiary or unitary) on risk-taking and project selection.

supervise globally active MNBs.

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 $1 - p$. The premature liquidation of a portfolio guarantees a sure payoff $L \in [0, 1)$. Returns on the portfolios of the illiquid investment 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 price of $P_i \geq 1$.

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.[5]

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 on an equal basis in both countries.

Supervision. Supervisors perform two tasks: *on-site monitoring* and *intervention*. Supervisors are 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

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

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.[6] However, credibility is essential for bank supervisors, which drastically limits their willingness to misrepresent ex-post verifiable information.[7]

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

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

- At $t = -1$: the supervisory architecture is announced. The bank either faces a centralized supervision 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.

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

[7]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)).

- 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 repays depositors with probability α_i.

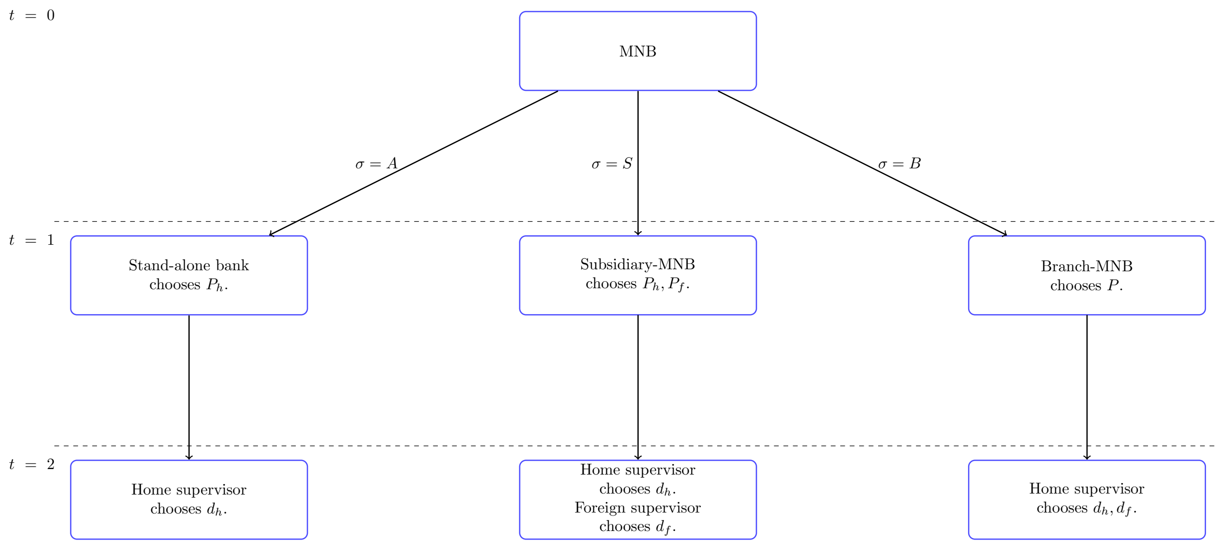

Figure 1: Periods $t = 0$ to $t = 2$.

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 can 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 of monitoring the 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. Strategies $d_i = O$ and $d_i = I$ consist of not monitoring unit i and always keeping it open or always closing it, respectively, regardless of any 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 expected payoffs to deposit insurers associated with these strategies and $W_h(d_h)$ that of the home deposit insurance when the bank remains a national bank in the home country. 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.

Supervisor's Objective Function. We posit that supervisors minimize expected costs when they make decisions. The objective of minimizing expected losses is consistent with the provision of deposit insurance. A prominent example of a regulator with a loss-minimizing objective is the Federal Deposit Insurance Corporate (FDIC) in the US. Demirguc-Kunt *et al.* (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. *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. Despite the higher legal and administrative burdens, however, many banks still choose to establish subsidiaries with separate capital (Cerutti *et al.* (2007)) and with foreign supervision.[8] In 2007, roughly 28 percent of banking assets were held in branches in the EU.[9] Since January 2014, the banking system in Europe is split into two groups. The most significant credit institutions are supervised directly by the European Central Bank (ECB). The 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

[8] In the US, although units of foreign banks are called branches, they are effectively supervised as subsidiaries.

[9] 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.

the "national" level) and a Federal supervisor, either the Fed or the FDIC (corresponding to the "supranational" level).

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 deposit relative to GDP, the ability of the government to honor its commitment to depositors raises doubt. In a recent IMF working paper, Demirguc-Kunt *et al.* (2014) show that in many countries there is a significant wedge between the amount of coverage promised and the amounts of funds available, measuring the (inverse) ability of the government to backstop the DI funds with the government debt-to-GDP ratio.

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.[10]

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. 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 bank 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

[10] In Colliard, J.-E. (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.

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 P_i is strictly larger than 1.

Although with full information, in a given state, supervisory decisions will be the same across all the possible organization forms, deposit rates might differ 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. Similarly, 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. Hence, the deposit rate P_h is implicitly defined by

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

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

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

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.

Under a branch representation, each unit is liable for the losses of the other unit. Furthermore, the home country deposit insurance covers depositors in the branch. The next expression shows the determination of the deposit rate P under branch representation:

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

In a branch represented MNB, 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. This implies that the deposit rate can in general be higher or lower in a subsidiary than in a branch.

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

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

while the subsidiary represented MNB yields a profit of

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

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

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

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 much lower than the home insurance fund's. In this case, the deposit rate will be much 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 c_h and c_f are not null, whether to monitor a bank or not 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 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 action independently of the organizational form. When only one or none of the units are monitored, instead, the home and the foreign supervisors may take different prudential decisions. This difference is due to 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 in the home unit by using the foreign residual assets. The availability of foreign residual assets affects both the incentives to intervene under limited information and 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 1 *The equilibrium decisions (d_h^*, d_f^*) of the supervisors of a subsidiary represented MNB are (qualitatively) described as follows:*

		Costs of monitoring			
		Both low	*c_h high, c_f low*	*c_h low, c_f high*	*Both high*
Liquidation	*L small*	(M, M)	(O, M)	(M, O)	(O, O)
Value	*L large*	(M, M)	(C, M)	(M, O)	(I, O)

Precise thresholds for the different cases are given in the Appendix.

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. Thus, in the absence of monitoring, $W_f(O) > W_f(I)$. The associated payoff with monitoring is $W_f(M) = p \times 0 - (1 - p)\alpha_f(1 - L) - c_f$ as assets are only liquidated if the unit is about to fail. Thus, the equilibrium choice of foreign supervisor is monitoring if $c_f \leq \alpha_f(1-p)L$, and leaving the unit open otherwise.

Monitoring here serves to identify and intervene a failing unit, thus saving the liquidation value L. It thus avoids a *type-II error*, or false negative, i.e., not intervening in a failing unit with a certain cost of 1, versus the correct decision to intervene with associated lower cost of $(1-L)$. 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 pays off, and there are residuals assets, they 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:

Corollary 1 *The home supervisor's incentives to intervene in the home unit are higher the higher is the value (expected or certain) of the foreign residual assets available to him.*

- *Monitoring in the home unit?* Third, foreign monitoring affects the home supervisor's decision to monitor ($d_h = M$) or not ($d_h \in \{O, I\}$), and also opens the possibility to intervene in the home unit only if foreign assets are good, and keep it open if they are bad ($d_h = C$). C is the only conditional strategy that can be optimal: 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 supervisor will be less likely to intervene than when the foreign unit is revealed to be bad than when it is good.

As the home supervisor can condition his best response to 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 2 *All else equal, the availability of foreign residual assets 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 3 *A more credible foreign deposit insurance, a higher α_f, increases the availability of foreign residual asset to the home supervisor and thus reduces his incentives to monitor the home unit.*

When the foreign deposit insurance is more credible, foreign depositors ask for a lower risk 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. We thus neglect $(d_h, d_f) = (O, I)$ from the analysis, as it is equivalent to (I, O). The case (C, M) is not equivalent to (M, C), but it is clear that $W_b(C, M) \geq W_b(M, C)$ if and only if $c_f \leq c_h$, and similarly for (O, M) and (M, O). Furthermore, strategies (I, I) or (I, M) are dominated by (I, O) or (C, M), respectively: leaving one unit open brings pR, while closing it yields L. Since $pR > L$, the result follows.

The next proposition shows the optimal decisions for the case of $c_f \leq c_h$. The results for $c_f > c_h$ are symmetric.

Proposition 2 *Assume $c_f \leq c_h$. The optimal decisions (d_h^b, d_f^b) of the supervisor of a branch represented MNB are qualitatively described as follows:*

		Costs of monitoring		
		Both low	*c_h high, c_f low*	*Both high*
Liquidation Value	*L small*	(M, M)	(O, M)	(O, O)
	L intermediate	(M, M)	(C, M)	(O, O)
	L large	(M, M)	(C, M)	(I, O)

Precise thresholds for the different cases are given in the Appendix.

Although the complete characterization is lengthy, the intuition behind Proposition 2 is simple. In the absence of monitoring, the liquidation value L determines whether it is optimal to always intervene in one unit or not (strategies (I, O) vs. (O, O)). 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, M) vs. (O, M)). 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).

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

Corollary 4 *(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 of one unit ceteris paribus 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, as we will further explore in the next subsection.

2.3 Monitoring in branches versus subsidiaries

This section compares monitoring incentives for the branch and the subsidiary. Note that a difference between the branch and the subsidiary is who insures deposits in the home unit. It is quite intuitive that if $\alpha_h > \alpha_f$ a foreign branch gives more incentives to monitor than a foreign subsidiary, because there is a greater probability that the deposit insurer in charge will have to reimburse depositors. Controlling for this effect by assuming $\alpha_h = \alpha_f$, we have the following:

Corollary 5 *Assume $\alpha_h = \alpha_f$.*

1. *No monitoring at all is more likely with a subsidiary than with a branch: if $d_i^b \neq M$ for all $i \in \{h, f\}$, then necessarily $d_i^* \neq M$ for all $i \in \{h, f\}$.*

2. *Monitoring of both units is more likely with a subsidiary than with a branch: if* $(d_h^b, d_f^b) = (M, M)$*, then necessarily* $(d_h^*, d_f^*) = (M, M)$.

The two results of the corollary correspond to two distinct effects:

Internalization effect: Monitoring the foreign unit allows the supervisor to take a decision in the home unit conditionally on the information he receives in the foreign unit. When c_f is low and c_h high for instance it can be optimal to choose strategy (C, M) and adopt the cheap monitoring in the foreign unit to alleviate losses in the home unit without having to monitor it. 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. The typical outcome would then be (O, O) or (I, O) (i.e. not monitoring at all) with subsidiary representation and (C, M) with branch. The same internalization effect will play an important role when considering supranational supervision.

Shared liability effect: When the foreign unit is successful and the home unit fails, the residual assets are only $R - P_f$ in the subsidiary case. However, in the branch case, when one unit fails and the other is successful the entire R can be used by the supervisor to pay out depositors. The incentives to liquidate the home unit conditionally on the foreign unit being successful are thus higher in the branch case than in the subsidiary case. As a result,it is less likely to have both units monitored in the branch case than in the subsidiary case. Typically, (C, M) will be obtained in the former case and (M, M) in the latter.

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 4.3 for a discussion about common DI) and the supranational supervisor faces the same costs of collecting information than national supervisors. 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.

Our goal is to explore to what extent supranational supervision will lead to a different outcome than national supervision. 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. Hence, in what follows we look at the difference between the decisions of the supranational supervisor and national supervisors in the case of a subsidiary represented MNB. Denoting (d_h^{**}, d_f^{**}) the optimal decision under supranational supervision, we have:

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.

The previous lemma thus 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 $d_f^{**} = O$. However, as shown below, only the former is possible:

Lemma 2 *Supranational supervision with a subsidiary represented MNB leads to more monitoring in the foreign unit: if* $d_f^* \neq d_f^{**}$*, then necessarily* $d_f^* = O, d_f^{**} = M$*.*

The intuition for this result is that the foreign supervisor does not internalize that monitoring the foreign unit is beneficial to the home deposit insurer. In contrast, the supranational supervisor does take this into account. Building on these preliminary results, the next proposition summarizes the cases in which national and supranational supervision lead to different decisions:[11]

Proposition 3 *If decisions under national and supranational supervision in a subsidiary represented MNB differ, we have one of the following cases: (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* $(d_h^{**}, d_f^{**}) = (C, M)$*. The exact conditions are given in the Appendix.*

[11]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^{**}).

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.[12] 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).

It is also interesting to identify the consequences in terms of profitability for a subsidiary represented MNB that faces an (unexpected) institutional reorganization from national to supranational supervision. The implications of Proposition 3 are unambiguous. First, with decisions $(d_h^*, d_f^*) = (I, O)$ a subsidiary represented MNB would not be profitable with national supervisors. Second, in the other two cases mentioned in the proposition, the introduction of the supranational supervisor leads to lower profit for existing subsidiaries.

Corollary 6 *Introduction of a supranational supervisor leads to lower profit for existing subsidiary represented MNBs.*

Corollary points out the negative impact of a supervisory change on the subsidiary profit. Clearly, as a consequence, banks may also decide to change their foreign representation and or may prefer to become standalone domestic banks. In the next section will discuss the full-fledged consequences of these institutional changes that require a long-term perspective.

4 Long-run implications of supranational supervision

In this section we look at the long-run implications of the introduction of supranational supervision. In particular, in subsections 4.1 and 4.2 we aim to understand to what extent it affects the organizational form chosen by the MNB for its foreign expansion, and the likelihood of foreign expansion. 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. In

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

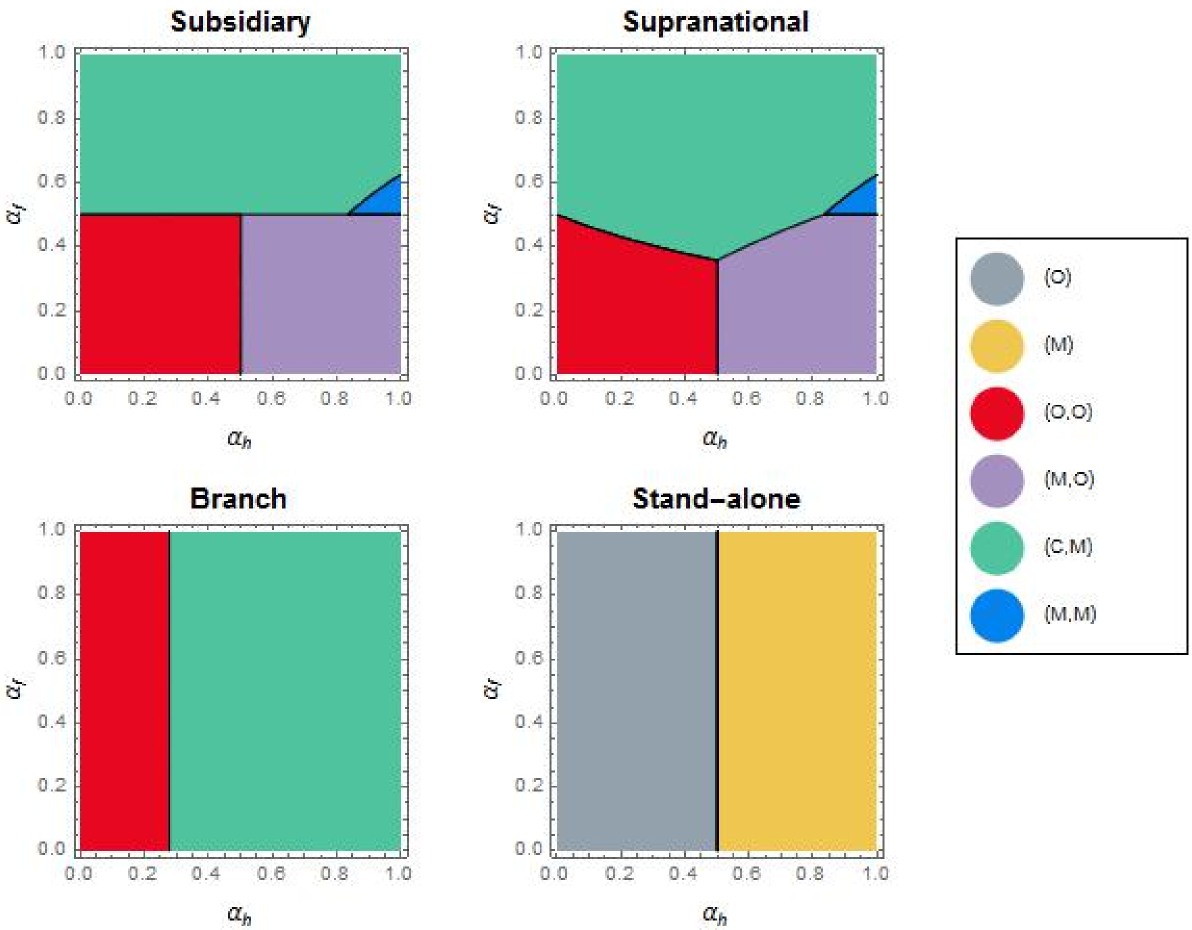

Figure 2: Equilibrium supervisory decisions.

subsection 4.3 we investigate the introduction of a Common Deposit Insurance that may substitute the different national DI with supranational supervision.

4.1 Comparing supervision choices

To study the decision of the bank to use a branch, a subsidiary, or remain a standalone bank, we need to compare the choices made by the supervisor(s) for the different organizational forms and the same parameters.

A first observation is that for $\alpha_h \geq \alpha_f$ the branch can never be a viable option for the MNB when the introduction of the supranational supervisor leads to different decisions for the subsidiary represented MNB.[13]

Corollary 7 *If* $(d_h^*, d_f^*) \neq (d_h^{**}, d_f^{**})$ *and* $\alpha_h \geq \alpha_f$*, then* $(d_h^b, d_f^b) = (C, M)$*.*

In the branch case, there are higher transfers from the foreign to the home unit when the home unit is liquidated than with a subsidiary. This effect makes the strategy (C, M) more attractive for the supervisor of a branch. Moreover, if $\alpha_h \geq \alpha_f$, using monitoring to reduce potential losses is more profitable for a supranational supervisor who pays back depositors with probability α_h than for a foreign supervisor who pays back with probability α_f. The two effects make (C, M) even more attractive compared to the absence of monitoring. Since the branch represented MNB only makes profit if both units are open, the MNB would never choose to open a foreign branch if it leads to the decisions (C, M). Hence, a necessary condition for a branch to be a viable alternative is $\alpha_h < \alpha_f$. The following proposition summarizes the cases when supranational supervision leads to different outcomes and the branch is a viable option.

Proposition 4 *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 excluding) possibilities:*

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

(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 proposition 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

[13] Notice that with decisions (C, M) the home unit will be kept open only if the foreign unit is discovered to fail.

Table 1: 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)	(I,O)	(C,M)	(O,O)	O
(iii)	(O,O)	(C,M)	$\emptyset$	O
(iv)	(I,O)	(C,M)	$\emptyset$	O
(v)	(I,O)	(C,M)	$\emptyset$	M
(vi)	(M,O)	(C,M)	$\emptyset$	M

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.[14] Table 1 summarizes the different possibilities.

4.2 Foreign expansion and representation form

We now turn to the MNB's representation choice following the introduction of a supranational supervisor. We start with case when the branch structure is a viable representation form for foreign expansion, i.e., (i) and (ii) in Table 1: the possible decisions for the subsidiary are (I,O) or (O,O), while the supranational regulator makes decision (C,M). The branch, instead leads to decisions (O,O). With subsidiary representation, the expected profit with decisions (O,O) can be written as follows:[15]

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

and for (C,M),

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

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

[15] Clearly, for the bank the identity of the regulator does not matter and profits are uniquely affected by actual supervisory decisions.

Clearly, in all these expressions the deposit rate $P_h(S, d_h, d_f)$ depends on the actual supervisory decisions and, as in the benchmark case of the stand-alone bank, it is higher the less monitoring supervisors exercise. Under branch representation, instead, for (O, O) profits can be written as

$$\Pi(B, O, O) = 2p^2(R - P(B, O, O)),$$

The decision for the standalone is O, with profit of

$$\Pi(A, O) = p(R - P_h(A, O)).$$

We can then state the following:

Lemma 3 *Assume $\alpha_f > \alpha_h$. Bank's profits with the different organizational choices can be ranked as follows:*

$$\Pi(S, O, O) > \Pi(B, O, O) \;\; > \Pi(A, O) > \Pi(S, C, M) > \Pi(S, I, O) = 0$$

The intuition is simple: the liability structure of the subsidiary representation guarantees higher profits whenever deposit rates paid by the bank are the same or lower with subsidiary than with branch representation. This is the case here because cases (i) and (ii) imply that $\alpha_f > \alpha_h$. At the same time, a standalone bank is dominated when foreign expansion is expected to induce no intervention. With national regulators, we should thus only see branches when subsidiaries are not viable. Introduction of the supranational supervisor alters both the profitability and the viability of subsidiaries, while leaving the branches profit unaltered. Thus it increases the attractiveness of branches.

Let us now turn to cases (iii) and (vi). Under national supervision, the subsidiary structure is more profitable than standalone banks, with decisions O and M, respectively. Indeed, the decision for the home unit is the same under the two organizational structures and the subsidiary provides an additional sources of profit, without putting strain on the home unit profit. The introduction of the supranational regulator reverses this ordering of profits. The probability with which a subsidiary represented MNB generates profits decreases from p to $p(1 - p)$. This reduction is too large to be compensated by the lower deposit rate that must be offered to depositors, i.e., $\Pi(A, M) > \Pi(A, O) > \Pi(S, C, M)$. The long-run effect of supranational supervision here is that subsidiary represented MNBs revert to domestic banking.

Finally, in cases (iv) and (v) the standalone structure dominates both the subsidiary structure and the branch structure irrespective of how supervision is organized, so that supranational supervision has no impact in this case, as the MNB never chooses to expand abroad.

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.

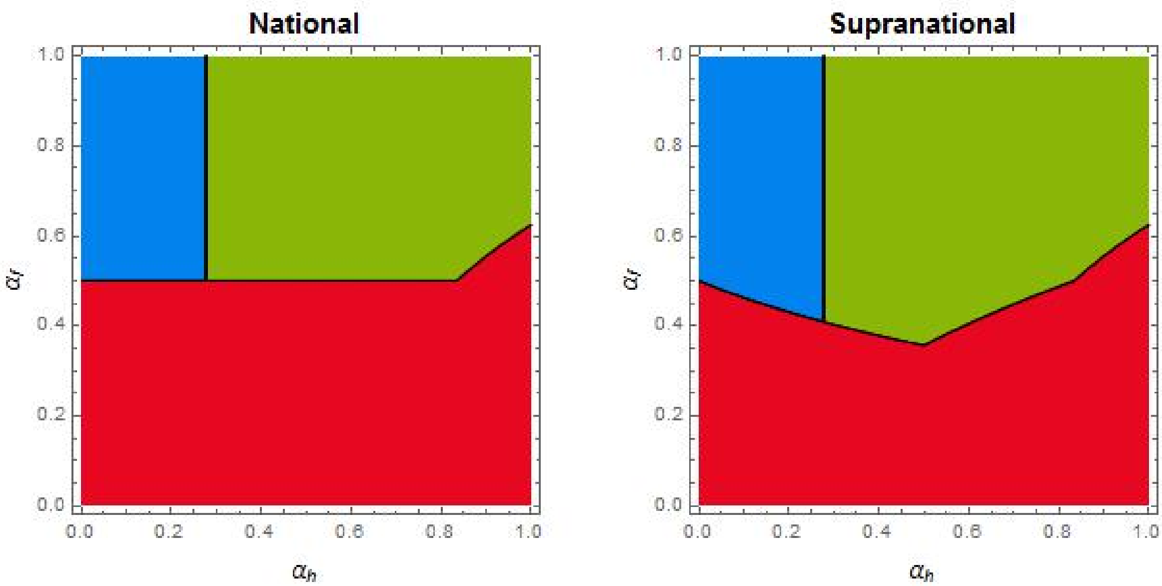

Figure 3: Equilibrium representation for of the MNB: branch (blue), subsidiary (red) and stand-alone (green). (Same parameters as in Fig. 2.)

Proposition 5 *When supranational supervision changes the optimal representation form of the MNB, it induces the bank either to operate with a branch rather than a subsidiary, or to shut down a subsidiary unit to become a national (stand-alone) bank.*

The implication of the results in Proposition 5 is 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 higher probability of no 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.

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 branch representation, total losses to the DI are reduced,[16] but will entirely fall on the shoulder of the home deposit insurance fund. Furthermore, as branch representation is only viable for $\alpha_f > \alpha_h$, losses will be born 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 funds end up with more liabilities. As many countries' deposit guarantee systems are already overstretched, centralization (with national deposit insurances) can have the long-run effect of further reducing the credibility of some countries' deposit insurance.

Corollary 8 *When the change from national to supranational supervision impacts on monitoring and prudential decisions, considering the induced change in the bank's organizational form, centralization increases the expected burden supported by the home deposit insurance.*

4.3 Common deposit insurance

The analysis of common supervision developed so far assumed that the deposit guarantee scheme remains national. However, a common deposit guarantee scheme could be conceived, contributed by the many countries involved, as it is currently in the agenda of reforms for MNB supervision in the EU. Here we address this possibility by assuming that the supranational supervisor relies on a common deposit insurance (CDI) with credibility parameter α_c which conceivably depends on the credibility of national deposit insurances, α_h, α_f.

Although one could conceive different institutional arrangements, here we consider the 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 than the foreign one so that $\alpha_c = \alpha_h \geq \alpha_f$ and the effects of the CDI can be determined by the

[16] Recall that the home regulator of a branch represented MNB minimizes total losses, thus internalizing all effects of the supervisory decisions, differently from the independent national supervisors of a subsidiary represented MBN.

simple comparative statics of a higher α_f.[17]

Proposition 6 *Consider the introduction of a common deposit insurance with $\alpha_c = \alpha_h \geq \alpha_f$.*

- *Supervision of a branch represented MNB does not change.*
- *With a subsidiary represented MNB, (i) the incentives to monitor the foreign subsidiary increase; (ii) monitoring incentives for the home unit may increase or decrease. If the decision on the foreign unit is unaffected, the home unit faces less monitoring and more intervention.*

With branch representation a CDI has no effect at all since the home DI is also in charge with national DI and there is thus no change in credibility.

The effect of a CDI is more articulate in the case of a subsidiary represented MNB. The increased credibility of the DI faced by the foreign subsidiary and by its depositors (i.e.α_c instead of α_f) can result in more monitoring in the unit. Indeed, the value of monitoring increases with the credibility of the DI in charge. The consequences on the home unit are in general ambiguous. When the increase from α_f to α_h is small,i.e.monitoring incentives for the home unit get dampened. The more credible CDI faced by foreign depositors reduces the deposit rate in the foreign country which in turn increases the residual assets the supervisor can count on for the home unit. When the increase from α_f to α_h is large,i.e., the decision on the foreign unit change from $d_f = O$ to $d_f = M$, the home unit could face higher or lower monitoring.

The important message of this section is that the introduction of a common DI does not necessarily result in higher overall monitoring and therefore lower losses for both units. In fact, monitoring might decrease for the unit with more credible deposit insurance, which would lead to higher losses to the DI upon failure or default.

5 Implications

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

Short-term implications.

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

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 *et al.* (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; they are lower when the foreign unit is monitored, and do not depend on α_h nor on the monitoring of the home unit. The borrowing costs of the home unit are lower when the unit is monitored, are decreasing in α_h and P_f, and are thus indirectly reduced by α_f and the monitoring of the foreign unit.

- In a branch-MNB, borrowing costs of the integrated bank are decreasing in α_h, do not depend on α_f, and are decreasing in the number of units monitored by the supervisor.

These implications directly follow from the liability structure of the MNB in both cases and from who insures deposits. An interesting implication 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.

- The foreign unit of a subsidiary is more likely to be monitored when α_f is larger. The home unit is more likely to be monitored when α_h is higher and when α_f is smaller.

- There is more monitoring in the branch case when α_h is larger.

- Supranational supervision makes it more likely that the foreign unit will be monitored.

The impact of α_h and α_f on monitoring incentives reflects the fact that there is less at stake for the deposit insurance fund i when α_i is lower, so that monitoring is less valuable. A recent illustration of the fourth 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.[18]

Long-term implications. In the long-run, the organization 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 higher α_h and a lower α_f make the branch form more profitable than the subsidiary form.*

- Supranational supervision makes the branch form more profitable compared to the subsidiary form, and can discourage cross-border expansion altogether.

Interestingly, 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

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

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.[19]

The second point comes from Proposition 5. It 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.

6 Conclusion

We propose a framework for understanding the interaction between the structure of bank supervision (whether it is organized at the national or supranational level) 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 they adopt a branch or a subsidiary structure. Conversely, these 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 done in the context of 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 the 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.

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

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

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. In future research, we plan to study who benefits from common relative to fragmented deposit insurance, and derive the implications for the future of the European banking union.

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 2: 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.

Proof of Proposition 1. 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 $\lambda_1, \lambda_2, \kappa_1, \kappa_2$, and κ_3 are as follows:

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

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

$$\kappa_1 = \alpha_h(1-p)L \tag{A.3}$$

$$\kappa_2 = \alpha_h(L-\lambda_1) \tag{A.4}$$

$$\kappa_3 = p\alpha_h[1+(1-p)(1-\alpha_f)](L-\lambda_2) \tag{A.5}$$

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:

$$\begin{aligned} W_h(M,O) - W_h(O,O) &= p(1-p)[w_h(l,s) - w_h(f,s)] + (1-p)^2[w_h(l,f) - w_h(f,f)] - c_h \\ &= \alpha_h(1-p)L - c_h \end{aligned} \tag{A.6}$$

$$\begin{aligned} W_h(O,O) - W_h(I,O) &= p(1-p)[pw_h(s,s) + (1-p)w_h(f,s) - w_h(l,s)] \\ &+ (1-p)[pw_h(s,f) + (1-p)w_h(f,f) - w_h(l,f)] \\ &= p - L - p^2(R - P_f(S,O)) \end{aligned} \tag{A.7}$$

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

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:

$$\begin{aligned}
W_h(M,M) - W_h(O,M) &= p(1-p)[w_h(l,s) - w_h(f,s)] + (1-p)^2[w_h(l,l) - w_h(f,l)] - c_h \\
&= \alpha_h(1-p)L - c_h \qquad \text{(A.9)} \\
W_h(O,M) - W_h(C,M) &= p[pw_h(s,s) + (1-p)w_h(f,s) - w_h(l,s)] \\
&= p - L - p(R - P_f(S,M)) \qquad \text{(A.10)} \\
W_h(M,M) - W_h(C,M) &= p^2[w_h(s,s) - w_h(l,s)] + (1-p)^2[w_h(l,l) - w_h(f,l)] - c_h \\
&= \alpha_h[(1-2p)L + p^2(1 + P_f(S,M) - R)] - c_h \qquad \text{(A.11)}
\end{aligned}$$

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. ∎

Proof of Corollary 3. Taking the derivatives of κ_1, κ_2, and κ_3 with respect to α_h and α_f give us the corollary. ∎

Proof of Proposition 2. If $c_f \leq c_h$, 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 $c_{high} \leq \kappa_1$, (O,M) if $c_{high} > \kappa_1$ and $c_{low} \leq \kappa_1$, 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 $c_{high} \leq \kappa_1 - \kappa_4$, (C,M) if $c_{high} > \kappa_1 - \kappa_4$ and $c_{low} \leq \kappa_1 + \kappa_4$, 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 $c_{high} \leq \kappa_1 - \kappa_4$, (C,M) if $c_{high} > \kappa_1 - \kappa_4$ and $c_{low} \leq \kappa_4 + \kappa_5$, and (I,O) if $c_{low} > \kappa_4 + \kappa_5$.

Proof. We consider the case $c_f \leq c_h$, the other case being symmetric. When no unit is monitored, we need to compare (I,O) and (O,O), which gives:

$$\begin{aligned}
W_b(O,O) - W_b(I,O) &= p[pw_b(s,s) + (1-p)w_b(s,l) - w_b(l,s)] + (1-p)[pw_b(s,f) + (1-p)w_b(f,l) - w_b(l,f)] \\
&= pR(1-p) + p^2(2-R) - L \qquad \text{(A.12)}
\end{aligned}$$

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

$$\begin{aligned} W_b(O,M) - W_b(C,M) &= p[pw_b(s,s) + (1-p)w_b(f,s) - w_b(l,s)] \\ &= p(2-R) - L \end{aligned} \tag{A.13}$$

Define:

$$\lambda_3 = p(2-R) \tag{A.14}$$

$$\lambda_4 = pR(1-p) + p^2(2-R) \tag{A.15}$$

Since $\lambda_4 > \lambda_3$, we have three cases to consider:

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

$$\begin{aligned} W_h(M,M) - W_h(O,M) &= p(1-p)[w_b(l,s) - w_b(f,s)] + (1-p)^2[w_b(l,l) - w_b(f,l)] - c_h \\ &= \kappa_1 - c_h \end{aligned} \tag{A.16}$$

$$\begin{aligned} W_h(O,M) - W_h(O,O) &= p(1-p)[w_b(s,l) - w_b(s,f)] + (1-p)^2[w_b(f,l) - w_b(f,f)] - c_f \\ &= \kappa_1 - c_f \end{aligned} \tag{A.17}$$

$$\begin{aligned} W_h(M,M) - W_h(O,O) &= p(1-p)[2w_b(s,l) - w_b(s,f)] + (1-p)^2[w_b(l,l) - w_b(f,f)] - c_f - c_h \\ &= 2\kappa_1 - c_h - c_f \end{aligned} \tag{A.18}$$

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 $(d_h^b, d_f^b) \in \{(O,O),(C,M),(M,M)\}$. We have to introduce two new comparisons:

$$\begin{aligned} W_h(M,M) - W_h(C,M) &= p^2[w_h(s,s) - w_h(l,s)] + (1-p)^2[w_h(l,l) - w_h(f,l)] - c_h \\ &= \kappa_1 - \kappa_4 - c_h \end{aligned} \tag{A.19}$$

$W_h(C,M) - W_h(O,O) = p[w_b(l,s) - pw_b(s,s) - (1-p)w_b(f,l)] + p(1-p)[w_b(s,l) - w_b(s,f)]+$
$(1-p)^2[w_b(f,l) - w_b(f,f)] = \kappa_1 + \kappa_4 - c_f$ (A.20)

with $\kappa_4 = p\alpha_h(L - \lambda_3)$ (A.21)

(M,M) is optimal when $c_h \leq \kappa_1 - \kappa_4$ and $c_h + c_f \leq 2\kappa_1$ (equation (A.18)), 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.18), these comparisons give us the second part of the proposition.

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

$$
\begin{aligned}
W_h(C,M) - W_h(I,O) &= (1-p)[pw_b(s,l) + (1-p)w_b(f,l) - w_b(l,f)] - c_f \\
&= \kappa_4 + \kappa_5 - c_f && \text{(A.22)} \\
W_h(M,M) - W_h(I,O) &= p^2[w_b(s,s) - w_b(l,s)] + (1-p)[pw_b(s,l) + (1-p)w_b(l,l) - w_b(l,f)] - c_h - c_f \\
&= \kappa_1 + \kappa_5 - c_h - c_f && \text{(A.23)} \\
\text{with } \kappa_5 &= \alpha_h(\lambda_4 - pL). && \text{(A.24)}
\end{aligned}
$$

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. ■

Proof of Corollary 4. The result follows from comparing the boundaries on c_h and c_f: κ_1, κ_4 and κ_5 are all positive, and $\kappa_5 > \kappa_1$. ■

Proof of Corollary 5. Assume we have (M,M) in the branch case. The condition depends on whether L is larger than λ_3. In the subsidiary case, it depends on whether L is larger than λ_2. Direct computation shows that $\lambda_3 \leq \lambda_2$. When $L < \lambda_3$, the conditions for having (M,M) are the same with both structures. When $L \in [\lambda_3, \lambda_2]$, (M,M) in the branch case requires $c_h \leq \kappa_1 - \kappa_4$ and $c_f \leq \kappa_1 - \kappa_4$, whereas (M,M) in the subsidiary only requires $c_f \leq \kappa_1$ and $c_h \leq \kappa_1$. Finally, when $L > \lambda_4$, in the branch case we have both c_h and c_f lower than $\kappa_1 - \kappa_4$. Direct computation shows that this quantity is lower than $\kappa_1 - \kappa_3$. As (M,M) in the subsidiary requires $c_f \leq \kappa_1$ and $c_h \leq \kappa_1 - \kappa_3$, we have the desired result. Conversely, assume we have no monitoring in the branch case. Since $\kappa_1 + \kappa_4 \geq \kappa_1$ when $L \in [\lambda_3, \lambda_4]$ and $\alpha_h p(1-p)R \geq \kappa_1$, in all cases we necessarily have $c_f \geq \kappa_1$ and $c_h \geq \kappa_1$. Using Proposition 1, this guarantees that we cannot have any monitoring in the subsidiary case either. This concludes the proof. ∎

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

$$W_h(d_h^{**}, d_f^{**}) + W_f(d_f^{**}) \geq W_h(d_h^*, d_f^{**}) + W_f(d_f^{**}), \tag{A.25}$$

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

$$W_h(d_h^*, d_f^{**}) \geq W_h(d_h^{**}, d_f^{**}). \tag{A.26}$$

Both inequalities cannot hold unless $d_h^* = d_h^{**}$, a contradiction.[20] This concludes the proof. ∎

Proof of Lemma 2. 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. 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:

$$W_h(d_h^{**}, O, P_f(S, O)) + W_f(O) \geq W_h(d_h^{**}, M) + W_f(M). \tag{A.27}$$

Simplifying and rearranging, we thus have:

$$0 \leq W_f(M) - W_f(O) \leq W_h(d_h^{**}, O, P_f(S, O)) - W_h(d_h^{**}, M, P_f(S, O)) \tag{A.28}$$

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. ∎

Proof of Proposition 3. We will prove that the three cases in which decisions under national

[20] 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.

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 Lemma 1 and 2 that $d_f^* \neq O$ 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:

$$W_h(d_h^{**}, M) + W_f(M) \geq W_h(d_h^{**}, O) + W_f(O) \tag{A.29}$$

$$\Leftrightarrow \quad W_h(d_h^{**}, M) - W_h(d_h^{**}, O) \geq W_f(M) - W_f(O) > 0. \tag{A.30}$$

As already used in the proof of Lemma 2, 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 1 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:

$$\begin{aligned}
&W_h(C, M) + W_f(M) - W_h(O, O) - W_f(O) - c_f \geq 0 \\
\Leftrightarrow &p[w_h(l, s) - (1-p)w_h(f, s)] + (1-p)^2[w_h(f, l) - w_h(f, f)] + W_f(M) - W_f(O) - c_f \geq 0 \\
\Leftrightarrow &\alpha_f(1-p)L + \kappa_3 \geq c_f.
\end{aligned} \tag{A.31}$$

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):

$$
\begin{aligned}
& W_h(C,M) + W_f(M) - W_h(I,O) - W_f(O) - c_f \geq 0 \\
\Leftrightarrow \quad & (1-p)[(1-p)w_h(f,l) - w_h(l,f)] + W_f(M) - W_f(O) - c_f \geq 0 \\
\Leftrightarrow \quad & \alpha_f(1-p)L + \alpha_h(1-p)(p-L) \geq c_f, \qquad \text{(A.32)}
\end{aligned}
$$

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:

$$
\begin{aligned}
& W_h(C,M) + W_f(M) - W_h(M,O) - W_f(O) + c_h - c_f \\
= & p^2 w_h(l,s) + (1-p)^2[w_h(f,l) - w_h(l,f)] + W_f(M) - W_f(O) + c_h - c_f \\
= & \alpha_f(1-p)L + \kappa_3 - \kappa_1 + c_h - c_f \qquad \text{(A.33)}
\end{aligned}
$$

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 $L \geq \lambda_2$. ∎

Proof of Corollary 6. With a subsidiary representation and national regulators the expected profit with decision (O, O) and $(M, O$ can be written as follows:

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

and for (C, M),[21]

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

Clearly, in all these expressions the deposit rate $P_h(S, d_h, d_f)$ depends on the actual regulatory decisions and, it is higher the less monitoring regulators exercise.

It is easy to see that

$$\min\{\Pi(S, M, O), \Pi(M, O, O)\} \geq \Pi(A, O) \geq \Pi(S, C, M),$$

which proves the corollary. ∎

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

Proof of Corollary 7. Denote $\delta(s_h, s_f) = w_b(s_h, s_f) - w_h(s_h, s_f) - w_f(s_f)$. We have:

$$\begin{array}{lll} \delta(s,s) = 0 & \delta(l,s) = \alpha_h(P_f - 1) & \delta(s,l) = \alpha_h(R-1) - (\alpha_h - \alpha_f)(1-L) \\ \delta(f,f) = -(\alpha_h - \alpha_f) & \delta(f,s) = \alpha_h(P_f - 1) & \delta(s,f) = \alpha_h(R-1) - (\alpha_h - \alpha_f) \\ \delta(l,f) = -(\alpha_h - \alpha_f) & \delta(f,l) = -(\alpha_h - \alpha_f)(1-L) & \delta(l,l) = -(\alpha_h - \alpha_f)(1-L) \end{array}$$

According to Proposition 3, 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. We have:

$$\Delta_{CM-OO} = p(1-p)[\delta(s,l) - \delta(s,f)] + p\delta(l,s) + (1-p)^2[\delta(f,l) - \delta(f,f)] - p(1-p)\delta(f,s) = (\alpha_h - \alpha_f)(1-p)L + p^2\alpha_h(P_f - 1). \tag{A.34}$$

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:

$$\begin{aligned} \Delta_{CM-IO} &= p(1-p)\delta(s,l) + (1-p)^2\delta(f,l) - (1-p)\delta(l,f) \\ &= (\alpha_h - \alpha_f)(1-p)L + p(1-p)\alpha_h(R-1). \end{aligned} \tag{A.35}$$

$$\begin{aligned} \Delta_{CM-MM} &= p^2\delta(l,s) + (1-p)^2[\delta(f,l) - \delta(l,l)] \\ &= p^2\alpha_h(P_f - 1). \end{aligned} \tag{A.36}$$

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. ∎

Proof of Proposition 4. We start by excluding all the other cases.

According to Proposition 3, we need $c_f \geq \alpha_f(1-p)L$. Using Corollary 7, 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 3, 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 3, we need $c_h \leq \kappa_1$ in such a case, but according to Proposition 2 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:

$$
\begin{aligned}
L &\in [\lambda_2, \lambda_1] && \text{(A.37)}\\
L &\in [\lambda_3, \lambda_4] && \text{(A.38)}\\
c_h &\geq \kappa_1 && \text{(A.39)}\\
c_h &\geq \kappa_1 + \kappa_4 && \text{(A.40)}\\
c_f &\geq \alpha_f(1-p)L && \text{(A.41)}\\
c_f &\geq \kappa_1 + \kappa_4 && \text{(A.42)}\\
c_f &\leq \alpha_f(1-p)L + \kappa_3 && \text{(A.43)}
\end{aligned}
$$

We first notice that $\lambda_4 \geq \lambda_1$ and $\lambda_3 \leq \lambda_2$. We can thus neglect (A.38), which is implied by (A.37). If $L \geq \lambda_3$, we have $\kappa_4 \geq 0$. Hence, (A.37) and (A.40) imply (A.39), 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 (A.41), (A.42) and (A.43). This requires at least that these inequalities are compatible. This is clearly the case for (A.41) and (A.43) because $\kappa_3 \geq 0$ when $L \geq \lambda_2$. For (A.42) and (A.43), we need:

$$
\begin{aligned}
& \kappa_1 + \kappa_4 \leq \alpha_f(1-p)L + \kappa_3 \\
\Leftrightarrow \quad & L \geq \frac{\alpha_h p(1-\alpha_f)}{\alpha_f - \alpha_h + p\alpha_h(1-\alpha_f)} = \bar{L}_1. && \text{(A.44)}
\end{aligned}
$$

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 (A.37) 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:

$$\bar{L}_1 \leq 2 - R \quad \Leftrightarrow \quad R \leq 1 + \frac{\alpha_f - \alpha_h}{\alpha_h p(1-\alpha_f) + (\alpha_f - \alpha_h)} = \bar{R}_1 \tag{A.45}$$

$$\bar{L}_1 \leq \lambda_1 \quad \Leftrightarrow \quad R \leq \frac{2 - \alpha_f(1-p)}{p} - \frac{\alpha_h(1-\alpha_f)}{p[\alpha_f - \alpha_h + p\alpha_h(1-\alpha_f)]} = \bar{R}_2 \tag{A.46}$$

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 $1/p$:

$$\bar{R}_1 \geq 1/p \quad \Leftrightarrow \quad (2-p)(\alpha_f - \alpha_h) + \alpha_h(1-\alpha_f)p(1-p) \geq 0 \tag{A.47}$$

$$\bar{R}_2 \geq 1/p \quad \Leftrightarrow \quad [1 - \alpha_f(1-p)][\alpha_f - \alpha_h + p\alpha_h(1-\alpha_f)] - \alpha_h(1-\alpha_f) \geq 0. \tag{A.48}$$

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:

$$\alpha_h \leq \frac{\alpha_f(1 - \alpha_f(1-p))}{[1 - \alpha_f(1-p)][1 - p(1-\alpha_f)] + (1-\alpha_f)}, \tag{A.49}$$

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:[22]

$$\begin{aligned}
p &\geq 1/2,\ \alpha_f \in [0,1] && \text{(A.50)}\\
\alpha_h &\leq \frac{\alpha_f(1-\alpha_f(1-p))}{[1-\alpha_f(1-p)][1-p(1-\alpha_f)] + (1-\alpha_f)} && \text{(A.51)}\\
R &\in [1/p, \min(\bar{R}_1, \bar{R}_2, 2)] && \text{(A.52)}\\
L &\in [\lambda_1, \min(2-R, \bar{L}_1, \lambda_2)] && \text{(A.53)}\\
c_h &\geq \kappa_1 + \kappa_4 && \text{(A.54)}\\
c_f &\in [\max(\kappa_1 + \kappa_4, \alpha_f(1-p)L), \alpha_f(1-p)L + \kappa_3], && \text{(A.55)}
\end{aligned}$$

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 $(d_h^b, d_f^b) = (O, O)$.

[22]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:

$$L > \lambda_1 \quad \text{(A.56)}$$

$$L \in [\lambda_3, \lambda_4] \quad \text{(A.57)}$$

$$c_h \geq \kappa_1 - \kappa_2 \quad \text{(A.58)}$$

$$c_h \geq \kappa_1 + \kappa_4 \quad \text{(A.59)}$$

$$c_f \geq \alpha_f(1-p)L \quad \text{(A.60)}$$

$$c_f \geq \kappa_1 + \kappa_4 \quad \text{(A.61)}$$

$$c_f \leq \alpha_f(1-p)L + (1-p)\alpha_h(p-L) \quad \text{(A.62)}$$

We have $\lambda_3 \leq \lambda_1$, so that (A.56) and (A.57) is equivalent to $L \in [\lambda_1, \lambda_4]$. Then it is clear that we can always find c_h sufficiently high to satisfy (A.58) and (A.59). In order to find a c_f satisfying (A.60), (A.61), and (A.62), these three inequalities must be compatible, which is clear for (A.60) and (A.62). For (A.61) and (A.62) to be compatible, we need:

$$\gamma_1 + \gamma_4 \leq \alpha_f(1-p)L + (1-p)\alpha_h(p-L) \quad \text{(A.63)}$$

$$\Leftrightarrow \quad L[\alpha_h - (\alpha_f - \alpha_h)(1-p)] \leq p[1+p-pR]. \quad \text{(A.64)}$$

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 (A.61) and (A.62) are automatically compatible, otherwise we need:

$$L \leq \frac{p[1+p-pR]}{\alpha_h - (\alpha_f - \alpha_h)(1-p)} = \bar{L}_2 \quad \text{(A.65)}$$

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:

$$R \leq \frac{2 + p\alpha_f}{1+p} = \bar{R}_3 \quad \text{(A.66)}$$

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

$$R \leq \frac{2\alpha_f(1-p) + p(1+p) - 2\alpha_h(2-p)}{\alpha_f(1-p) + p^2 - \alpha_h(2-p)} \quad \text{(A.67)}$$

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 (A.56) to (A.62) is:

$$
\begin{aligned}
p &\geq \frac{\sqrt{5}-1}{2} && \text{(A.68)}\\
\alpha_h &\geq \frac{(1-p)^2}{p^2(2-p)} && \text{(A.69)}\\
\alpha_f &\in \left[\max\left(\alpha_h, \frac{1-p}{p^2}\right), \min\left(1, \alpha_h\frac{2-p}{1-p}\right)\right] && \text{(A.70)}\\
R &\in [1/p, \bar{R}_3] && \text{(A.71)}\\
L &\in [\lambda_1, \min(2-R, \lambda_4)] && \text{(A.72)}\\
L &\leq \bar{L}_2, \text{ if } \alpha_f < \bar{\alpha}_1 && \text{(A.73)}\\
c_h &\geq \kappa_1 + \kappa_4 && \text{(A.74)}\\
c_f &\in [\max(\kappa_1+\kappa_4, \alpha_f(1-p)L), \alpha_f(1-p)L + \kappa_3], && \text{(A.75)}
\end{aligned}
$$

where all the intervals are non-empty. ∎

Proof of Lemma 3. To calculate profits in the relevant cases, we first report the associated deposit rates:

$$
\begin{aligned}
P_h(A,O) &= \frac{1-(1-p)\alpha_h}{p} && \text{(A.76)}\\
P_f(S,O) &= \frac{1-(1-p)\alpha_f}{p} && \text{(A.77)}\\
P_f(S,M) &= \frac{1-(1-p)[\alpha_f + (1-\alpha_f)L]}{p} && \text{(A.78)}\\
P_h(S,O,O) &= \frac{1-(1-p)[\ \alpha_h + (1-\alpha_h)[pR-1+(1-p)\alpha_f]]}{p} && \text{(A.79)}\\
P_h(S,C,M) &= \frac{(1-\alpha_h)\,(2-pR-L) - \alpha_f(1-\alpha_h)(1-L)(1-p) + \alpha_h p(1-p)}{(1-p)p} && \text{(A.80)}\\
P_h(B,O,O) &= \frac{1-2p(1-p)[\alpha_h + (1-\alpha_h)R/2] - (1-p)^2\alpha_h}{p^2}. && \text{(A.81)}
\end{aligned}
$$

First observe that

$$\Pi(S,O,O) \geq \Pi(A,O) \Leftrightarrow pR + \alpha_f(1-p) \geq 1 \quad \text{(A.82)}$$

where the last inequality is verified because $\Pi(A,O) = pR - 1 + (1-p)\alpha_h$ and we are clearly considering here the case in which the stand-alone bank is profitable.

Consider now the bank's profit with subsidiary representation and supranational supervision,

$$\Pi(S,C,M) = p(1-p)(R-P_h(S,C,M)) = p(1-p)R - [\,1-(1-p)^2 a_h - p(\alpha_h+(1-\alpha_h)(L+R-P_f(S,M))]\,. \tag{A.83}$$

Comparing the profits $\Pi(S,C,M)$ with $\Pi(A,O)$ we have that when $\alpha_h = 1$ then $\Pi(S,C,M) = p(1-p)(R-1)$ and $\Pi(A,O) = p(R-1)$. In this case, clearly, the stand-alone dominates. When instead $a_h = 0$, then $\Pi(A,O) = pR-1$ and $\Pi(S,C,M) = p(1-p)R - (1-p(L+R-P_f(S,M))) = pR-1-p^2R+p(L+R-P_f(S,M))$ and, ultimately, whether $\Pi(A,O) > \Pi(S,C,M)$ depends on the sign of $-pR+(L+R-P_f(S,M))$. As pR is higher than 1 by assumption, and $(L+R-P_f(S,M))$ is lower than 1 because of $(L+R) < 2$ and $P_f(S,M) > 1$, the sign of the expression is negative, and hence $\Pi(A,O) > \Pi(S,C,M)$ for any value of α_h because profit functions are linear in α_h.

Now we need to compare $\Pi(S,O,O)$ and $\Pi(B,O,O)$. Simple calculations show that $\Pi(S,O,O) \geq \Pi(B,O,O)$ is equivalent to

$$(1-p)\left[\alpha_f(1-\alpha_h(1-p)) - \alpha_h p(2-R)\right] \geq 0 \tag{A.84}$$

which is true if and only if $\alpha_f \geq \tilde{\alpha}_f(\alpha_h)$ with $\tilde{\alpha}_f(\alpha_h) = \frac{\alpha_h p(2-R)}{1-\alpha_h(1-p)}$ which is larger than α_h. Finally, observe that

$$\Pi(B,O,O) \geq \Pi(A,O) \Leftrightarrow \frac{(1-\alpha)(1-p)(pR-1)}{p^2} \geq 0 \tag{A.85}$$

which is true because $pR > 1$. ■

Proof of Corollary 8. To prove the result it suffices to compare the expected cost supported by the home DI in the following cases. First, when with national supervision we have decisions (O,O) for a subsidiary MBN, the move to supranational supervision induces the bank to become a branch represented MNB and we have thus to compare the following 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 the bank prefers to revert to a national bank, the relevant comparisons are: $W_h(O) - W_h(O,O) = W_h(M) - W_h(M,O) = -\alpha_h(1-p)(pR-1+\alpha_f(1-p)) < 0$.

Proof of Proposition 6. The following table summarizes the sign of the effect of a higher α_f on supranational supervisor's payoff of the decision indicated in a row as compared with that of the decision indicated in the column (considering all possible decisions).

	MM	CM	OM	MO	IO	OO
MM		$-$	/	$+$	$+^*$	$+$
CM	$+$		$+$	$+$	$+$	$+$
OM	/	$-$		$+$	$+^*$	$+$
MO	$-$	$-$	$-$		$-$	/
IO	$+^{**}$	$-$	$+^{**}$	$+$		$+$
OO	$-$	$-$	$-$	/	$-$	

where the sign associated with * realizes iff $\frac{L}{(1-L)p} > \alpha_h$ and with ** iff $\alpha_h > \frac{L}{p}$ (where $\frac{L}{(1-L)p} > \frac{L}{p}$); the symbol / indicates no effect. (The table is not symmetric because when considering an alternative to a given pair of decisions, the deposit rates already committed to are those associated with the given pairs of decisions and not those of the alternative decisions.)

Consider the foreign unit of a subsidiary represented MNB. If the decision with national DI was $d_f = M$ then it certainly remains such. Indeed the unique alternative could be $d_f = I$ (under some specific conditions) which is however impossible because if c_f was low enough that $d_f = M$ was better than $d_f = I$ with national DI, a fortiori it is so with CDI. When instead $d_f = O$ with national DI, either nothing changes or the decision becomes $d_f = M$.

Consider now the home unit. The signs in the 3x3 sub-matrices north-west and south-est show the result when d_f remains unchanged: if anything happens at all, there is less monitoring and more intervention. When instead the CDI induces a change from $d_f = O$ to $d_f = M$, then the table shows that anything can happen on the home unit, depending on the specific values of the parameters. ■

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