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ABSTRACT

Cooperation in International Banking Supervision*

This paper analyses cooperation among national supervisors in the decision to close a multinational bank. The supervisors are asymmetrically informed and exchange information through 'cheap talk'. It is assumed that they consider domestic welfare only. We show that: (1) the supervisors will commit mistakes both of 'type I' and 'type II' in the closure decision; (2) the more aligned national interests are, the higher is welfare resulting from the closure decision; (3) the bank can allocate its investments strategically to escape closure; (4) allocating the decision right to an uninformed supranational supervisor can improve closure regulation, especially when interests are very disaligned.

JEL Classification: F36, G21, G28 and L51
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1 Introduction

The troubles surrounding the supervision, and later closure, of the multinational bank 'Bank of Credit and Commerce International' (BCCI) was a wake-up call for banking supervisors worldwide. It demonstrated how opportunistic behavior by national banking supervisors could create loopholes in the supervision that allowed multinational banks to hide from close supervisory scrutiny.[1] At the same time, prudent supervision of multinational banks is increasingly important as banking becomes more and more international. Amihud et al. (2002), for example, find that the number of cross-border bank mergers has increased steadily, and more than quintupled from 1985 until 1998. Similarly, in the euro area one can observe a significant increase in international merger activity involving credit institutions: Between 1996 and 2001, the number of M&As between domestic and foreign banks increased by 77% to 55 per year.[2] This trend towards more multinational banks is expected to continue as new technologies, such as Internet banking, and deregulation lower the barriers to entry into the previously protected national markets.

Financial regulators have long been aware of the problems surrounding the supervision of multinational banks, and considerable efforts have been invested in developing a sound regulatory framework. Most of this work has taken place under the aegis of the Bank of International Settlements (BIS). The key document is the so-called 'Basel Concordat' (BIS, 1983) that consists of recommended guidelines of best practices. Together with the 'Core Principles for Effective Banking Supervision' (BIS, 1997) that were established following the BCCI crisis, they are now followed by many countries.

With the implementation of the Basel guidelines, responsibilities between different national authorities in banking supervision are now clearly divided. Moreover, many countries have established bilateral agreements (Memoranda of Understanding) that specify how information exchange should be organized. Still, in this paper we argue that these types of agreements are not sufficient to guarantee a complete flow of information between banking supervisors. While 'hard' information such as information contained in balance sheets is easily transmitted, supervisors also have access to 'softer' information that may not be easily quantified. This could, for instance, be informal information about borrowers or possible difficulties of a financial institution. Such information can be important in assessing the financial health of a bank. However, because of its nature, it may not automatically be reported to the foreign authorities engaged in the supervision of the institution.

In this paper we analyze voluntary exchange of soft information between national authorities in the supervision of a multinational bank. The setup of the model is as follows: A bank is operating in two countries. The bank is legally incorporated in the 'home country', and conducts all business in the 'host country' through a branch. In line with the Basel rules, its consolidated

[1] The liquidation of Bank of Credit and Commerce International has been running for more than 11 years and the cost has passed $1.2bn (*The Guardian*, May 15, 2003).

[2] Source: SDC Thompson Financial

activities are supervised by the home country supervisor. We consider closure regulation, and the home country supervisor has the choice of closing the bank or leaving it open. Both supervisors have access to private information that is relevant for the closure decision. The home country supervisor will thus base its decision on its own information and on information transmitted by the host country supervisor. It should be noted that we restrict our analysis to banks that operate through branches, but not subsidiaries.[3] International bank subsidiaries can be closed down independently by host country authorities, so the analysis would be a different one.

We take a political economy approach to supervision and assume that supervisors seek to maximize the welfare of their own country, disregarding the welfare of the other country. It is shown that the supervisors do not always agree whether to close the bank, because generally the two countries will be affected differently by the closure decision. The costs and benefits of closing the bank may differ across countries for a number of reasons. First, the bank may conduct different activities in the two countries, therefore the exposure of stakeholders that the supervisors care about could differ. Furthermore, the bank may not be of equal systemic importance in the two countries. Finally, the institutional environment plays a role. In Europe, for example, depositors in host countries are typically insured by the home country deposit insurance (exceptions arise when the coverage differs in home and host country), which could create a further asymmetry in interests.

The supervisors are both sovereign and have to cooperate as equals. To capture this idea, the communication is modelled as a 'cheap talk' game in the spirit of Crawford and Sobel (1982). The host country supervisor reports, orally or written, to the home country supervisor about the state of the branch located in its jurisdiction. However, as talk is cheap, the host country supervisor reveals only as much information as serves its own interest.

In the first part of the paper, we analyze the information exchange between the supervisors. Unlike the signaling game analyzed by Crawford and Sobel, both the sender and the receiver have access to private information. Nevertheless, we show that the main result of Crawford and Sobel extends to such a setup: As long as the interests of the supervisors do not perfectly coincide, the host country supervisor does not reveal all the information that it possesses. More accurately, it does not reveal as detailed information as it could. Because of this, it is not possible to implement the first best closure regulation. The closure regulation is not unambiguously too soft or too hard. Rather, it is an inherent feature of the equilibrium that there will be mistakes both of 'type I' (the bank is left open where it should be closed) and 'type II' (the bank is closed where it should be left open). Finally, it is shown that the better aligned the interests of the supervisors are, the more detailed information can be exchanged, and the higher is the welfare resulting from the closure decision.

[3] Branches represent an important mode of internationalization for banks. Dermine (2002), for example, reports that around half of all foreign bank establishments in Europe are branches. In the US branches represent around three quarters of all foreign depository institutions, see http://www.newyorkfed.org/aboutthefed/fedpoint/fed26.html.

In the second part of the paper we apply the analysis of the information exchange to different questions. It is first analyzed how the equilibrium closure regulation influences the bank's investment decision. The idea is that by allocating its investments strategically across the two countries, the bank decides how much information is available to the home and to the host country supervisor. When the interests of the two countries are relatively closely aligned, the bank concentrates its investments in the country that is least inclined to close it. The supervisor in the stricter country would, of course, like to close the bank more often, but without (private) information concerning the bank's activities it has no say in the closure decision. More surprisingly, we show that the bank invests in both countries when the interests are sufficiently disaligned. This forces the home country supervisor to base its closure decision partly on information received from the host country supervisor. As this information is imprecise, it results in lower probability of closure and higher expected profits for the bank. The strategic behavior by the bank has adverse welfare effects when there is a serious conflict of interests between the two countries.

It has been argued that the problem of opportunistic behavior by national supervisors could be avoided by creating a supranational supervisory body. We study whether this is true if important information is available only to national supervisors, the basic assumption of our analysis. To compare national and supranational supervision, it is assumed that a benevolent supranational supervisor takes the closure decision but collects itself no soft information about the bank. The supranational supervisor must therefore consult the national supervisors before taking the closure decision. We show - with a few minor qualifications - that the closure regulation under national supervision can also be sustained under supranational supervision. Furthermore, when the interests of the two countries are very disaligned, a system of supranational supervision can sometimes do strictly better than one of national supervision. The intuition is that the ignorance of the supranational supervisor works as a commitment device. The supranational supervisor has less possibilities to exploit the information that it receives to its own advantage than the better informed home country supervisor, which alleviates the incentive problems in the information exchange. In terms of policy, the analysis of supranational supervision suggests that even if the countries involved are not prepared to give the local supervisory oversight to a supranational body - for political or other reasons - supranational supervision may still lead to better regulation.

The outline of the paper is as follows: Below we survey the related literature. In section 2, we describe the model setup and find the supervisors' preferences for closure. In section 3, we start by deriving the first and second best closure rules. Afterwards, the information exchange between the supervisors is analyzed. We determine the equilibria of the game and discuss the welfare implications. Section 4 looks at the bank's ex ante investment decision and section 5 compares national and supranational supervision. Section 6 contains some concluding remarks.

1.1 Related Literature

The assumption that national supervisors have access to some local information is also the point of departure in work by Holthausen and Rønde (2002) and Repullo (2001). Holthausen and Rønde show that public involvement in the regulation of large-value payment systems is desirable in spite of opportunistic behavior by the national regulators. Repullo demonstrates how lack of cooperation among national supervisors can lead to softer closure regulation for internationally active banks. This creates, in turn, an incentive for banks to become international through mergers or takeovers. We also look at closure of international banks here, but our focus is quite different. In particular, Repullo assumes away information exchange among the supervisors whereas it is the endogenous communication that is at the heart of this paper.

In the analysis we draw upon the literature on closure regulation of banks: Acharya and Dreyfus (1989) derive the optimal closure rule in the presence of deposit insurance; Maliath and Mester (1994) look at subgame perfect closure rules; Fries et al. (1997) analyze different ways of resolving financial distress. These papers generally consider a richer environment than we do but look at domestic banks only.

Other recent papers look at complementary issues related to international banking regulation. Harr and Rønde (2004) as well as Loranth and Morrison (2004) study how the legal structure of a multinational bank affects its risk-taking incentives and derive implications for capital regulation. Calzolari and Loranth (2004) also focus on banks' legal structure but compare the supervisors' incentives to take corrective action under a branch and a subsidiary structure. Lastly, international regulatory competition in capital standards have been studied by Acharya (2003) and Dell'Ariccia and Marquez (2003) among others.

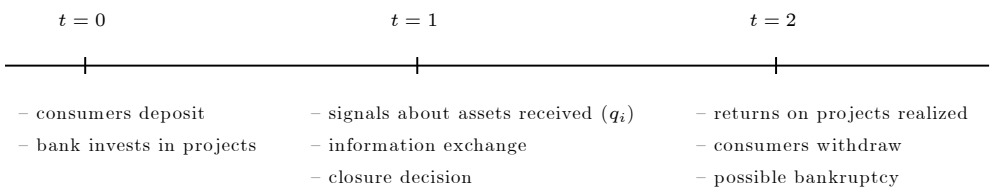
Several papers have discussed the merits of having a supranational supervisor as a response to the increasing cross-border integration of financial systems. A centralization of supervisory activities would avoid duplication of activities (Belaisch et al. 2001), cross-border information could be pooled quicker so that reaction times for a Lender of Last Resort action in times of a liquidity crisis would be lower (Vives, 2001), and decision making would be closer to the optimum (Kahn and Santos, 2004). Also Lannoo (1999) argues that in the European context, the circulation of information between the various national supervisors is essential. However, in his view a better coordination is preferable to a centralized approach.

The theoretical setup that we use is related to the increasing number of papers that extend upon Crawford and Sobel (1982). Both Glazer and Rubinstein (2003) and Levy and Razin (2003) analyze games with multidimensional cheap talk. However, in their settings, information on all dimensions is held by the sender, while the receiver does not have any private information. Harris and Raviv (2004) consider a setup that is close to ours insofar as the optimal decision depends on both the sender's and the receiver's private information but apply it to questions in corporate finance.

2 The Model

We consider an international bank operating in two countries, A and B. The bank is incorporated in country A; i.e., country A is the 'home country' whereas country B is the 'host country'. The activities in country B are operated through a branch, so the offices in the two countries are jointly liable.

Before explaining the details of the model, it useful to sketch the timing. At time 0, the bank collects deposits of 1 in each of the two countries. The deposits are invested in risky and illiquid assets. At time 1, the supervisors observe a signal about the quality of the assets located in their jurisdiction. The home country supervisor consults the host country supervisor about the financial health of the branch in country B. That is, there is an information exchange between the supervisors. Afterwards, the home country supervisor decides whether to close the bank or to let it continue.[4] If the bank is closed, all assets are liquidated. If the bank is allowed to continue, the assets pay out at time 2. At this point in time, the depositors wish to withdraw their funds. Therefore, the bank goes bankrupt if the return on the assets is not enough to cover the withdrawals. The timing is illustrated below:



We start by analyzing to what extent voluntary cooperation between national supervisors can achieve efficient closure regulation. To focus on this aspect, in the next section we look at the game starting from $t = 1$ where the bank's portfolio is given. In section 4, we discuss how the equilibrium closure regulation affects the bank's portfolio choice. In the following, we explain the details of the model.

2.1 The Bank

The ownership of the bank is divided among shareholders in country A and B. Shareholders in country A own a fraction s_A of the bank, and profits are split accordingly. It is for now assumed that the bank collects deposits of size 1 in each country and invests them into a local portfolio (the latter assumption will be relaxed in section 4). The bank has no other assets. The depositors are covered by a deposit insurance and receive no interests. Thus, they withdraw a total amount of 2 at time 2.

[4] Closure is of course a rather drastic measure of supervisory action. Instead, one can also interpret our model as being one of bank restructuring.

If the bank is closed at time 1, the assets are liquidated prematurely. A portfolio pays then L, $L \leq 1$. If the bank is allowed to continue, the return depends both on the quality of the portfolio and the macroeconomic conditions. In country j, there are 'good times' with probability p_j and 'bad times' with probability $1 - p_j$. Each portfolio consists of a 'good' and a 'bad' fraction. The good fraction pays 2 in good times and 1 in bad times per unit invested. The bad fraction pays 1 in good times and 0 in bad times.

The fraction of good assets in country j, denoted $\widetilde{q}_j$, is uncertain, $j = A, B$. The fraction $\widetilde{q}_j$ is uniformly distributed on $[0, 1]$. We assume that $\widetilde{q}_A$ and $\widetilde{q}_B$ are independently distributed. The realization of $\widetilde{q}_j$ is denoted q_j, which we sometimes will refer to as the 'type'. q_j is thus a measure of the quality of the assets in country j.

We assume that the macro shocks are perfectly correlated across the two countries. With probability p, the bank experiences good times in both countries and with probability $1 - p$ bad times.[5] This assumption is adopted for simplicity, but is not crucial for the results.[6] The realization of the macro shock is not known until time 2 where the projects pay out. The pay-off structure implies that the return is $2 + \widetilde{q}_A + \widetilde{q}_B$ with probability p and $\widetilde{q}_A + \widetilde{q}_B$ with probability $1 - p$, i.e. the bank is solvent in good times but not in bad times.

2.2 The Supervisors

We take a political economy approach to closure regulation and assume that the supervisor in country j maximizes the aggregate welfare of all parties located in country j and disregards the welfare of agents in the foreign country. The depositors are not affected by the success or failure of the bank, because they are covered by a deposit insurance. The other parties affected by the performance of the bank are risk-neutral. Therefore, we assume that aggregate welfare can be measured as the expected monetary pay-off to all agents in the country other than the depositors.

A major assumption of the model is that the supervisors collect different and complementary information. Hence, there is a need for an exchange of information between the home and the host country supervisor, a point that has been stressed repeatedly in the various BIS documents. We model this by assuming that the supervisor in country A observes q_A but not q_B and vice versa. We prefer to think of q_j as 'soft' information that only the local supervisor has access to. This could, for example, be information about local borrowers or market conditions. If there are strong secrecy laws in place that deny foreign authorities access to detailed information about the bank's operations, q_j could contain both hard and soft information. Still, even if hard information was available to both supervisors, it is not unlikely that the foreign authority has more difficulty in interpreting the available data than its national counterpart. Thus, it seems

[5] This can, for example, be thought of as a situation where the bank has specialized in an industry that is strongly affected by input or output prices on the world market.

[6] Were shocks only imperfectly correlated, it would depend on the realizations of q_A and q_B whether the bank would fail if only one of the branches faced bad times. The equilibrium of the game could be derived in a similar manner, but it would not always be possible to obtain closed form solutions.

not unreasonable to assume that the foreign supervisor has less precise information than the domestic one. Except from q_A and q_B, all other aspects of the game are common knowledge.[7]

In accordance with the principle of home country supervision, it is assumed that the home country supervisor takes the closure decision. Before taking this decision, the home country supervisor consults the supervisor in the host country. The timing is the following: First, the supervisors in country A and B observe q_A and q_B, respectively. Then, the host country supervisor sends a signal about q_B to the home country supervisor. We have in mind a situation where the home and the host country supervisor are sovereign and are not directly subject to any international authority. Therefore, it is assumed that the signal sent by the host country supervisor is 'cheap talk', e.g., a written or an oral report, and it is not possible to use transfers to elicit the supervisors' private information. As a benchmark for a welfare assessment, we use the outcome that prevails when it is possible to set up a mechanism and use transfers to regulate closure. We discuss the signalling game in more detail later. Finally, based on the available information about q_A and q_B, the home country supervisor decides whether to close the bank or to let it continue.

2.3 Further Assumptions

Deposit Insurance We assume that the deposit insurance company in the home country covers a fraction d_A of the losses incurred by the depositors in country B, $d_A \in [0, 1]$. This allows us to encompass both a situation with and without home country deposit insurance.

The Bankruptcy Rule If the bank is closed or fails, the remaining assets are allocated according to *the single entity* doctrine. This implies that depositors in country A and B are treated in the same way. As a bankruptcy rule, we assume that all depositors have the same seniority and split the proceeds according to the deposited amount.

Systemic Effect of Failure It is assumed that it makes a difference whether the bank is closed by the supervisors or fails. If the bank fails unexpectedly, this may have serious systemic effects. It could, for example, lead to interruptions in the payment system, trigger a bank panic, or induce liquidity shortages in other areas of the financial system. If, on the other hand, the bank is closed by the supervisors, it is possible to liquidate the bank orderly and in such a way that the systemic impact is minimized. As a normalization, we assume that a failure has a systemic cost of G_j in country j whereas a closure has no systemic cost.

2.4 Derivation of the Supervisors' Preferences

In this section, we determine the (q_A, q_B) for which the supervisor in the home and in the host country prefer the bank to be closed or to stay open. To this purpose, we define a function

[7] This implies, in particular, that both supervisors have access to aggregate information about the bank's operations and know that one unit of deposits is collected and invested in each country.

$f_B^j(q_A)$ that determines for each q_A the minimum value of q_B for which the supervisor in country j prefers the bank to stay open. We will also sometimes use $f_A^j(q_B)$, which is defined as $f_A^j(\cdot) \equiv (f_B^j)^{-1}(\cdot)$.

Consider the home country supervisor first. The payoffs to local stakeholders are summarized in Table 1 (depositors always obtain 1):

Table 1. *The payoffs to home country stakeholders.*

Home Country	Deposit Insurance Company	Shareholders	Systemic Cost
Open			
- Success (prob. p)	0	$s_A(q_A+q_B)$	0
- Failure (prob. $(1-p)$)	$-(1+d_A)(1-\frac{q_A+q_B}{2})$	0	$-G_A$
Close	$-(1+d_A)(1-L)$	0	0

Entries in this table are derived in the following way: If the bank is left open and times are good, the profits after having paid depositors, q_A+q_B, are distributed to shareholders. If times are bad so that the bank fails, the return q_A+q_B is absorbed by the deposit insurance company, who covers the remainder in order to pay back depositors. Additionally, there is a systemic cost G_A that arises from the unorderly closure of the bank. If, on the other hand, the bank is closed beforehand, the project is liquidated yielding L[8], which again goes to the deposit insurance company.[9]

A regulator thus faces the following trade-off: Bank closure implies foregoing the (possibly high) returns from the projects if times are good. However, if the bank is left open and fails, the home country has to incur the systemic cost of failure. Furthermore, it might have to pay more to the depositors in the host country.

A country's welfare is calculated as the expected sum of all local agents' pay-off. Denote by ΔW_A the gain of country A from leaving the bank open instead of closing it. From Table 1, it is given by

$$\begin{aligned}\Delta W_A(q_A,q_B) &\equiv W_A^{open}(q_A,q_B) - W_A^{close} \\ &= ps_A(q_A+q_B) - (1-p)\left((1+d_A)\left(1-\frac{q_A+q_B}{2}\right)+G_A\right)+ \\ &\quad -(1+d_A)(1-L).\end{aligned}$$

The home country supervisor prefers to leave the bank in operation if and only if $\Delta W_A(q_A,q_B) \geq 0$, that is, if

$$q_B \geq f_B^A(q_A) \equiv Max\{0, a-q_A\}. \tag{1}$$

[8] The parameter L could reflect the difficulties that the supervisor faces when it wants to sell the bank's assets. It could be seen as a proxy for the sophistication of financial markets and instruments as well as the severeness of problems due to informational asymmetries.

[9] In a model with restructuring instead of closure, the supervisor might have the option to take over a bank in trouble, and restructure it by converting all risky assets into safe ones, incurring a cost $1-L$, where $L \geq 0$. The above analysis would go through as before.

where

$$a \equiv 2\frac{(1-p)G_A + (L-p)(1+d_A)}{(1+d_A)(1-p)+2ps_A}.$$

Whenever systemic consequences of a failure are small (G_A small), or many shareholders are located in country A (s_A large), or the probability that times are good is high (p large), the supervisor is willing to let the bank continue for a wider range of (q_A, q_B)-combinations; i.e. a is low. On the other hand, if L is high, the liquidation cost from closing a bank is low. Then, the supervisor is more inclined to close the bank, i.e. a is high. Thus, the value of a is increasing in G_A and L and decreasing in s_A and p.

The payoffs to stakeholders in the host country are derived similarly:

Table 2. *The payoffs to host country stakeholders.*

Host Country	Deposit Insurance Company	Shareholders	Systemic Cost
Open			
- Success (prob. p)	0	$(1-s_A)(q_A+q_B)$	0
- Failure (prob. $(1-p)$)	$-(1-d_A)(1-\frac{q_A+q_B}{2})$	0	$-G_B$
Close	$-(1-d_A)(1-L)$	0	0

The gain from leaving the bank open is denoted

$$\Delta W_B(q_A, q_B) \equiv W_B^{open}(q_A, q_B) - W_B^{close}.$$

The host country supervisor prefers to leave the bank in operation if and only if

$$q_B \geq f_B^B(q_A) \equiv Max\{0, b - q_A\}, \tag{2}$$

where

$$b \equiv 2\frac{(1-p)G_B + (L-p)(1-d_A)}{(1-d_A)(1-p)+2p(1-s_A)}.$$

The value of b is increasing in G_B, L, and s_A and decreasing in p.

For specific values of $(d_A, G_A, G_B, L, p, s_A)$ it is possible to calculate a and b. There is in general no reason to expect that $a = b$ such that the preferences of the home and host country coincide perfectly. Indeed, we will throughout the paper assume that $a \neq b$ as there otherwise is no problem of cooperation between the supervisors. When either the systemic costs differ across countries ($G_A \neq G_B$), shareholders are concentrated in one of the countries ($s_A \neq \frac{1}{2}$), or when there is home country deposit insurance ($d_A > 0$), preferences will diverge. Both $a < b$ and $b < a$ are possible. For instance, when, other parameters being symmetric, $G_A < G_B$ or $s_A > \frac{1}{2}$, we obtain $a < b$, i.e. the supervisor in country A is the more lenient one.

Moreover, notice that whenever there is home country deposit insurance ($d_A > 0$), country A carries a higher share of the losses that arise in case of either closure or failure of the bank. It follows that the supervisor in country A is more inclined to leave the bank open than the one in country B (i.e. $a < b$) whenever the probability of failure is rather low (p large) or the losses in case of closure are high (L low).

We will analyze the game and derive the equilibrium for any combination of a and b, imposing the following restriction for the main analysis:

Assumption 1. $a < b \leq 1$.

The assumption $a, b \leq 1$ serves primarily an expositional purpose, as it reduces the number of different cases that we need to consider in the text. Similarly, assuming $a < b$ allows us to focus on a certain type of equilibrium and thereby reduce the computational complexity of the paper.[10] All our formal results will refer to the case where Assumption 1 holds, but we will indicate where this assumption is crucial for the results that we obtain.

Figure 1 displays an example of the supervisors' preferences for $a < b$. The solid lines indicate the supervisors' indifference curves. The indifference curve of the supervisor in country j indicates combinations of (q_A, q_B) such that the supervisor is indifferent between leaving the bank open or closing it, i.e. $\Delta W_j(q_A, q_B) = 0$. For high expected returns, $q_A + q_B > b$, the supervisors prefer to leave the bank open. Similarly, for low returns, $q_A + q_B < a$, they prefer to close it. In the region $a < q_A + q_B < b$, the supervisors do not agree which action to take. The host country supervisor prefers to close the bank whereas the home country supervisor prefers to keep it open. This region of disagreement plays a crucial role in the later analysis as it impedes the flow of information between the supervisors.

We would like to add one remark on the supervisors' objective functions: In this analysis, we assume that supervisors care about the well-being of all stakeholders of the bank that are located in their own country. However, the statutes of different supervisory agencies quite differ in their objective functions: Some supervisors care primarily about depositor protection, while others have the mandate to protect a larger group of affected parties.[11] It is easy to see, however, that changing the supervisors' objective functions would have no qualitative consequences for our analysis, as long as the realized returns q_A and q_B matter for at least one of the stakeholders that the supervisors care about. The supervisors' preferences would have a similar shape as in our analysis, $\widetilde{f}_B^A(q_A) = \widetilde{a} - q_A$ and $\widetilde{f}_B^B(q_A) = \widetilde{b} - q_B$, but with $\widetilde{a}$ and $\widetilde{b}$ possibly different from a and b. This would not change the derivation of the equilibrium but would, of course, impact on the welfare analysis.

[10] Assumption 1 can be interpreted as the supervisors having a 'positive prior' about the state of the bank. First, since q_A and q_B are independently and uniformly distributed on $[0, 1]$, $E(q_A + q_B) = 1$. The supervisors would therefore prefer to leave the bank open if no additional information about q_A and q_B became available because $a, b \leq 1$. Second, the condition $a \leq b$ is more likely to be satisfied when the probability of bank failure (p) is low.

[11] For example, the primary aim of the Financial Services Authority (FSA) of the UK is the protection of depositors. Contrarily, the German supervisory authority is obliged to care about risk that may affect the return to any investment made in the bank, hence it encompasses both deposits and shareholdings. Also, while some institutions care only about direct stakeholders of the banks being supervised, others - such as the Office of the Comptroller of the Currency (OCC) in the US - explicitly mention the safety of the banking system as a whole as an objective, so clearly care about systemic consequences.

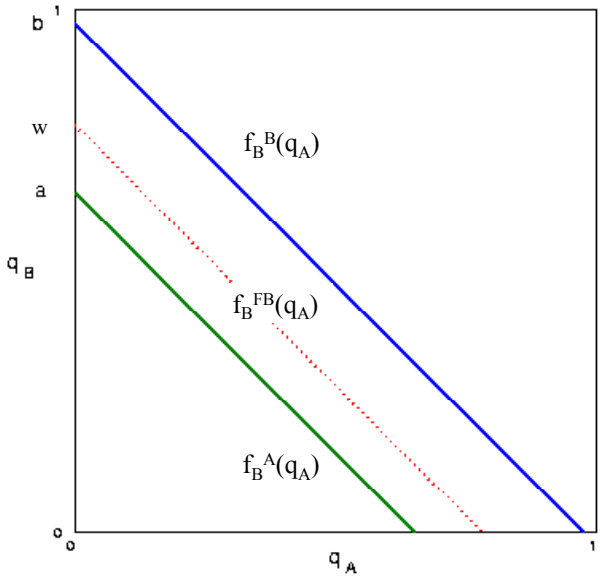


Figure 1: The preferences of the supervisors in country A and in country B. Closure is preferred by country A (resp. B) to the left and below the line $f_B^A(\cdot)$ (resp. $f_B^B(\cdot)$). The dotted line $f_B^{FB}(\cdot)$ represents the first best closure rule.

3 Solving the Game

In this section we analyze the equilibrium of the game set out above. As a benchmark we start by determining the optimal closure rule when the supervisors can use a mechanism with sidepayments to regulate closure. We then continue with the full model where no mechanism can be used and analyze the endogenous communication between the supervisors and the resulting closure regulation.

3.1 First and Second Best Closure

The first best closure rule is defined as the one that maximizes the joint welfare of the two countries. Abusing notation slightly, we denote it $f_B^{FB}(\cdot)$, and it indicates the minimal value of q_B for which the bank should stay open as a function of q_A. $f_B^{FB}(\cdot)$ solves $\Delta W_A(q_A, f_B^{FB}) + \Delta W_B(q_A, f_B^{FB}) = 0$. We have that

$$f_B^{FB}(q_A) \equiv Max\{0, (G_A + G_B)(1-p) + 2(L-p) - q_A\}, \tag{3}$$

and denote

$$w \equiv f_B^{FB}(0) = (G_A + G_B)(1-p) + 2(L-p). \tag{4}$$

The dotted line in figure 1 represents $f_B^{FB}(\cdot)$. Since $f_B^{FB}(\cdot)$ takes into account the welfare of both countries, it lies between $f_B^A(\cdot)$ and $f_B^B(\cdot)$.

The following remark will be useful in the later analysis:

Remark 1 *If $G_A = G_B = G$, $s_A = 1/2$, and $d_A = 0$, the preferences of the supervisors coincide ($a = b$) and are identical to the first best closure rule. The degree of disalignment of interests as measured by b/a is increasing in d_A whereas the first best closure rule is unaffected.*

Proof. In appendix B. ■

We define second best closure as a situation where the supervisors have private information about the activities of the bank in their country, but they can agree ex-ante on implementing a mechanism with sidepayments to regulate closure. The next proposition shows that $f_B^{FB}(\cdot)$ is also the second best closure rule, because it maximizes total surplus and is implementable if sidepayments can be used.

Proposition 1 *Suppose that the supervisors have private information about the activities of the bank in their country. If the supervisors can regulate closure using a mechanism with sidepayments, they implement $f_B^{FB}(\cdot)$.*

Proof. In appendix B. ■

In the proof a simple mechanism of the type analyzed by Jehiel and Moldovanu (2001) is developed and it is shown that $f_B^{FB}(\cdot)$ is implementable as a Bayesian Nash equilibrium.

3.2 Equilibrium Closure Regulation

We now turn to the analysis of the full model where the signal that the host country supervisor sends is costless ('cheap talk') and has real effects only to the extent that it is believed by the home country supervisor and changes the closure decision.

We could solve the cheap talk game directly as in Crawford and Sobel (1982).[12] In turns out that for our purposes there is a more efficient way to proceed. The general idea is the following: First, we characterize the set of incentive compatible closure rules. That is, all direct mechanisms that induce the national supervisors to reveal their information truthfully when there are no sidepayments possible. Clearly, any equilibrium outcome of the cheap talk game can be implemented using a direct mechanism with no sidepayments. However, the opposite is not true. In the second step, we therefore consider which of the incentive compatible closure rules that can be sustained as an equilibrium outcome of the cheap talk game.

The first lemma characterizes the relevant set of incentive compatible closure rules.

Lemma 1 *All closure rules that can be sustained as an equilibrium outcome of the cheap talk game have the following general form: The bank is closed iff. $q_B < \Phi(q_A)$ where the function $\Phi(\cdot) : [0,1] \to [0,1]$. Within this class of closure rules, the incentive compatible rules are characterized as follows:*

[12] Crawford and Sobel consider a game where a sender with private information signals to an uninformed receiver. Here, the game is different as both the sender (the host country supervisor) and the receiver (the home country supervisor) have private information. However, we show in Holthausen and Rønde (2004) that the game can be solved using a methodology very similar to the one developed by Crawford and Sobel.

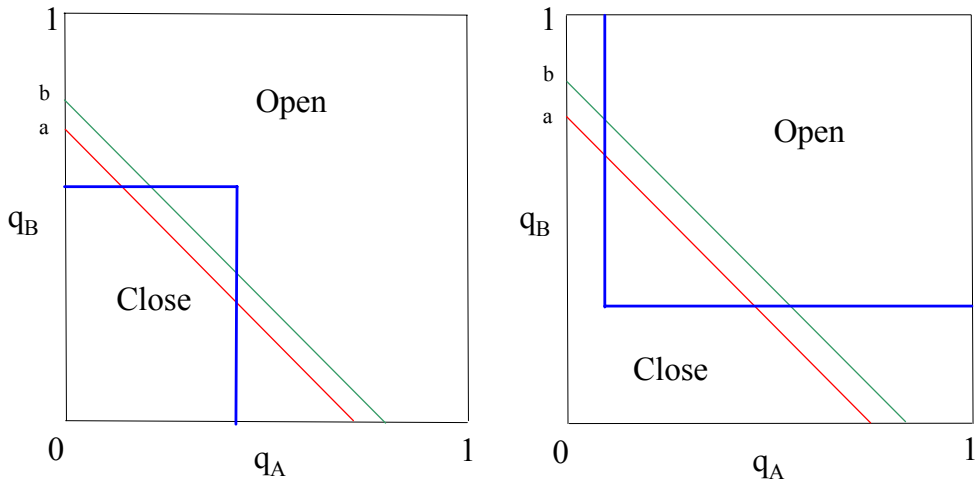


Figure 2: Examples of two incentive compatible mechanisms.

i) The support of $\widetilde{q}_j$ *is divided into* n_j *intervals,* $\{I_j^1, I_j^2, .., I_j^{n_j}\}$ *where* $I_j^i \equiv (q_j^{i-1}(n_j), q_j^i(n_j)]$, $j = A, B$.
ii) The difference in the number of intervals used in country A and B is no more than one, $\mid n_A - n_B \mid \leq 1$.
iii) If $q_j \in I_j^i$, *the bank is closed if* $q_k \in I_k^1 \cup I_k^2 \cup .....\cup I_k^{\widehat{n}-i}$, $\widehat{n} \in \{n_k, n_k + 1\}$, *and otherwise left open,* $j, k \in \{A, B\}$ *and* $j \neq k$.

Proof. In appendix A.

The main insight of the pioneering work by Crawford and Sobel is that when signals are cheap talk, the sender 'scrambles' the information that it sends to the receiver by dividing the type space into intervals. The sender's and the receiver's interests are somewhat aligned, but not perfectly so. Therefore, the sender has an incentive to pretend to be of a type that is not the true one, but close. However, in equilibrium the only possibility is to signal a different interval than the true one. As this requires the sender to pretend to be a type that is far from the true type, this is not a profitable deviation. Truth-telling is in other words achieved by constructing the equilibrium such that only 'big lies' have an effect.

A very similar logic applies when the mechanism designer cannot use payments to elicit the supervisors' information.[13] The incentive compatible closure rules (or, mechanisms) consist of constant parts with 'jumps'; see figure 2 that shows two examples of the rules characterized in Lemma 1. Along the constant parts of a closure rule, it makes no difference if a supervisor tells a 'small lie' (i.e. signals a type that is not the true one but belongs to the same interval). Also here truth-telling is achieved by constructing the closure rule such that only big lies make

[13] Mechanisms with no sidepayments have, e.g., been analyzed by Melumad and Shibano (1991) and Holthausen and Rønde (2002).

a difference.

Since Lemma 1 is mainly an auxiliary result, we will not discuss it further and instead turn to the cheap talk game. First notice that not all outcomes induced by an incentive compatible mechanism can be sustained as an equilibrium outcome of the cheap talk game. The mechanism to the right in figure 2, for example, requires that the bank is closed for $q_A = 1$ if q_B is low. Since $a < 1$, this can never be an equilibrium outcome: The home country supervisor always leaves the bank open for $q_A \geq a$.

In cheap talk games there is generically a problem of multiplicity of equilibria. Throughout the paper, we make the following assumption:

Assumption 2. The supervisors coordinate on the most efficient equilibrium.

The analysis should thus be interpreted as providing an upper bound on the efficiency of the system of national supervision. The next proposition characterizes the relevant set of equilibria of the cheap talk game.

Proposition 2 ***Characterization and existence of the equilibria with information exchange. Equilibrium of type 1 with n intervals:***
i) The host country supervisor signals the interval to which q_B belongs, $I_B^i = (q_B^{i-1}(n), q_B^i(n)]$ where

$$q_B^i(n) = \frac{2i}{2n-1}\left[a + (b-a)(2n^2 - (i+1)(2n-1))\right] \tag{5}$$

ii) After receiving signal I_B^i, the home country supervisor lets the bank continue if and only if

$$q_A \geq q_A^{n-i}(n) = \frac{2(n-i)}{2n-1}\left[b - (b-a)(2n^2 - (n-i+1)(2n-1))\right]. \tag{6}$$

iii) The equilibrium exists if and only if

$$b < \frac{2(n-1)^2}{2(n-1)^2 - 1}a, \tag{7}$$

$$b \geq \frac{n}{n-1}a - \frac{2n-1}{2n(n-1)}. \tag{8}$$

iv) Consider equilibria where the outcome is deterministic once the types are realized ('deterministic equilibria'). Within this class of equilibria, considering a more general cheap talk game would not expand the set of possible outcomes in terms of closure regulation.

Proof. In appendix B. ■

Proposition 2 characterizes equilibria of type 1; i.e. equilibria that lead to the same closure regulation as the mechanisms of type 1 in appendix A. To be precise, there exist also equilibria of type 2 (corresponding to mechanisms of type 2) which for expositional reasons we do not treat in the main section of the paper. In those equilibria, the bank is always closed for very small values of q_A. The parameter range for which type 2 equilibria exist is small. Moreover, it

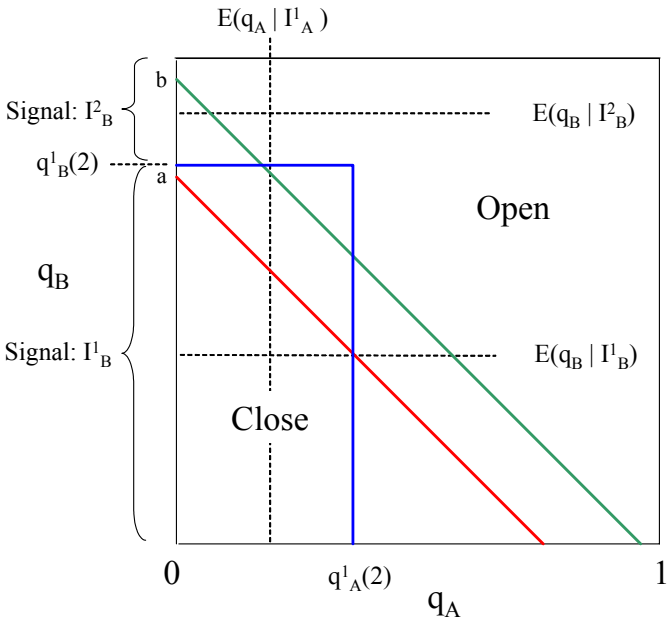


Figure 3: An equilibrium of type 1 with two intervals.

is shown in appendix that under Assumption 1 and 2 the supervisors would never coordinate on an equilibrium of type 2. To facilitate the presentation of our results, all analyses related to these equilibria have been relegated to Appendix C. Since we focus primarily on equilibria of type 1, we will usually refer to these as 'equilibria'. In the following we discuss the results summarized in Proposition 2.

Part i) and ii) of Proposition 2 To understand how the cheap talk game works, consider the equilibrium illustrated in figure 3. The host country supervisor partitions the type space into two intervals, I_B^1 and I_B^2. The bank is closed if the host country supervisor signals I_B^1 and $q_A < q_A^1(2)$. We solve the game backwards, and look first at the closure decision of the home country supervisor. Suppose that the home country supervisor has received the signal I_B^2. Since $E(q_B \mid I_B^2) > a$, it is optimal to leave the bank open for all q_A. Suppose instead that the signal was I_B^1. Notice in figure 3 that the equilibrium is constructed such that $q_A^1(2) + E(q_B \mid I_B^1) = a$. Hence, after receiving the signal I_B^1, the home country supervisor closes the bank if and only if $q_A < q_A^1(2)$. The closure decision is therefore optimal given the signal sent by the host country supervisor.

Let's now turn to the strategy of the host country supervisor. If $q_A \geq q_A^1(2)$, the bank stays open both when the signal is I_B^1 and I_B^2 so the signal does not matter. However, if $q_A < q_A^1(2)$, it makes a difference. The bank is then allowed to continue if and only if the host country

supervisor signals that q_B belongs to I_B^2. The host country supervisor thus decides which signal to send conditional on $q_A < q_A^1(2)$. The equilibrium is constructed such that if $q_B \in I_B^1$ ($q_B \in I_2^B$) the host country supervisor prefers the bank to be closed (to stay open) given that $q_A < q_A^1(2)$. This can be seen from the figure where $q_B^1(2) + E(q_A \mid q_A < q_A^1(2)) = b$. Therefore, the host country supervisor truthfully signals the interval. The strategies of the supervisors constitute an equilibrium, because they are optimal taking the other supervisor's strategy as given. All other equilibria work in a similar manner.

Part iii) of Proposition 2 In appendix A is shown that condition (7) in Proposition 2 is a necessary and sufficient condition for a mechanism of type 1 with n intervals to exist. Therefore, the equilibrium of the cheap talk game that induces the same outcome can also only exist if this condition is satisfied. Not all outcomes induced by mechanisms of type 1 can be sustained as an equilibrium outcome. We show in appendix B that condition (8) is the additional constraint that needs to be fulfilled for this to be the case. The role of (8) is to ensure that the home country supervisor finds it optimal to leave the bank open after receiving the signal I_B^n, even if q_A is very low. Condition (8) is thus an additional constraint that is put on the supervisors' problem, because they cannot commit to a closure rule before the types are realized.

Corollary 1 *The maximal number of intervals that the host country supervisor can use in equilibrium to signal its type is given as the maximal n that satisfies condition (7).*

Proof. In appendix B. ■

Corollary 1 implies that an equilibrium with n intervals can only exist when a and b are not too far apart. Moreover, as $b/a \to 1$, equilibria with more intervals are possible. Hence when the supervisors' interests are more aligned (in the sense that a and b are closer to each other), a more detailed exchange of information is possible. In the limit as $b \to a$, the information exchange is perfect ($n \to \infty$). This is a standard result in cheap talk games (Crawford and Sobel, 1982), and we also find it in our framework.

Corollary 1 tells us that if an equilibrium with two intervals does not exist, neither does an equilibrium with more intervals. This gives an upper bound on how disaligned the interests of the supervisors can be and still allow for the information exchange to impact on the closure decision. In particular, if $b > 2a$ there can be no information exchange between the supervisors.

Part iv) of Proposition 2 We analyze the simplest possible signalling game where only the host country supervisor signals its type. This may seem restrictive in our setup where both the home and the host country supervisor have private information. We show in the proof of Proposition 2 that is not necessarily the case: As long as we restrict attention to deterministic equilibria, which is the type of equilibria considered by Crawford and Sobel (1982) and most of the subsequent literature, any closure regulation that can be sustained when, for example,

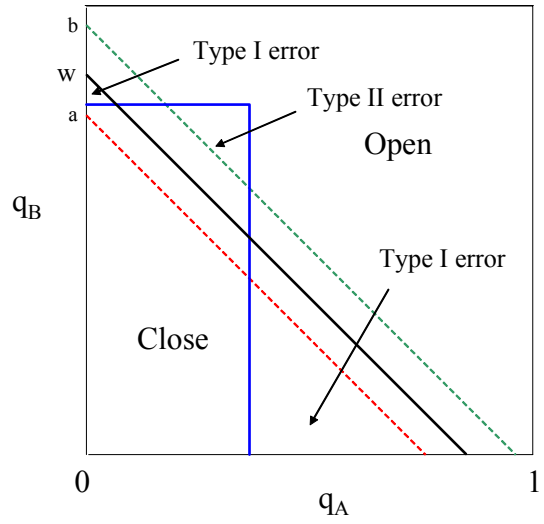


Figure 4: Compared to the first best outcome, any equilibrium with information exchange can lead to too little closure (type I error) or too much closure (type II error).

both parties send signals can also be sustained if only the host country supervisor signals the type.[14]

3.3 Welfare Analysis

The first thing to notice is that because the supervisors have somewhat conflicting interests ($a \neq b$), it is not possible to implement the first best closure regulation. Compared to the first best closure rule, the bank risks being closed when it shouldn't be and may stay open when closing it would be better. To put it differently, the home country supervisor will commit both errors of 'type I' and 'type II'. Figure 4 illustrates this point. Indeed, the equilibrium is constructed in such a way that the bank is closed for some (q_A, q_B) for which $q_B + q_A > b$, and left open for some (q_A, q_B) for which $q_A + q_B < a$. The bank is thus closed in situations where both supervisors would prefer it to stay open and vice versa.

The next proposition shows that supervisors have an interest in coordinating on the equilibrium with the highest possible number of intervals. The intuition for this result is that in an equilibrium where the host country supervisor partitions the information finer, it is possible to approximate the preferences of the supervisors better.

Proposition 3 *Given a and b, the expected welfare of the home and the host country are increasing in the number of intervals used in equilibrium.*

[14] We would like to point out that the restriction to deterministic equilibria is not necessarily innocuous. In recent work on cheap talk games where only the sender has private information, Aumann and Hart (2003) and Krishna and Morgan (2003) have shown that it can lead to a Pareto improvement to introduce a randomizing device that breaks the deterministic link between types and equilibrium outcomes. Whether and when this is also the case in games like ours where both the sender and the receiver have private information is an interesting topic for future research.

Proof. In appendix B. ■

Another factor that is crucial for the quality of the information exchange is the degree of disalignment of the supervisors' preferences. To isolate the effect due to alignment, we do the following exercise: We start from the benchmark case of Remark 1 where $G_A = G_B = G$, $s_A = 1/2$, and $d_A = 0$ so that the preferences of the supervisors coincide ($a = b$). We then consider the effect of increasing d_A. The interests get more disaligned as d_A increases, whereas our benchmark, the first best closure rule, is unaffected. This exercise allows us to determine how the degree of alignment affects the efficiency of closure regulation relative to a constant benchmark. The next proposition shows that supervisors are able to achieve a better closure regulation if their interests are more aligned.

Proposition 4 *Assuming that the supervisors coordinate on the equilibrium with highest possible number of intervals, total expected welfare is decreasing in the disalignment of interests.*

Proof. In appendix B. ■

It is important to notice that it is total welfare of the two countries that decreases. It is possible that the welfare of the host country increases as the deposit insurance company of the home country covers a larger share of the losses in the host country. This increase, however, is more than offset by a decrease in the home country's welfare.

4 Regulatory Arbitrage

Up to now, the bank has played a rather passive role in the analysis. It has collected deposits and invested them, but it has not taken any strategic decisions. In this section, we show how the bank has an incentive to allocate its investments strategically across the two countries in order to exploit the disagreement among the supervisors. There are, of course, many factors that affect the decision of a multinational bank where to invest. The investment climate may, for example, be better in one country than in another.[15] The bank may also spread investments across countries to diversify its portfolio or even concentrate investments in certain countries or regions to increase risk-taking.[16] Here, we want to abstract from these issues and isolate the effect due to the disagreement among supervisors when to close the bank.

We will consider the following variation of the base line model. Investment projects come in the size of 1 and have the payoff described above. However, the bank can now choose either to invest one unit in each of the countries or two units in only one country. If the bank invests everything in country A or B, the local supervisor has an informational monopoly concerning the quality of the bank's assets. The superior information will be used to further the interests of the supervisor's own country. If the bank instead invests in both countries, everything is as

[15] Indeed, one of the intrinsic advantages of multinational banks is the possibility of funneling funds to regions where the expected return is highest.

[16] It is well-known that banks may have an incentive to choose too risky a portfolio due to limited liability. This problem may be alleviated by, e.g., a positive franchise value and capital requirements, see Hellmann et al. (2000).

in the base model and the previous analysis applies. We denote the good fraction of the two projects q_1 and q_2 no matter where the projects are invested.

We consider the bank's profit maximizing investment as a function of the degree of disalignment of interests, b/a. We will use the following notation: $E\Pi^{20}(a,b)$ and $E\Pi^{02}(a,b)$ are the expected profit of the bank, as a function of a and b, if everything is invested in country A and in country B, respectively. If the bank invests one unit in each country, profit is denoted $E\Pi^{11}(a,b,n)$ and is a function of a, b, and the number of intervals used in equilibrium, n.

Suppose first that the bank invests everything in the home country. The home country supervisor does not need to consult the host country supervisor, as it has all the available information about the solvency of the bank. The home country supervisor closes the bank if and only if $q_1 + q_2 \leq a$. If the bank is allowed to continue, it will earn positive profits if times are good. The bank's expected profit is:

$$\begin{aligned} E\Pi^{20}(a,b) &= p\left(\int_0^a \int_{a-q_1}^1 (q_1+q_2)dq_2dq_1 + \int_a^1 \int_0^1 (q_1+q_2)dq_2dq_1\right) \\ &= p\left(1-a^3/3\right). \end{aligned} \tag{9}$$

Suppose now instead that the bank invests everything in the host country. The host country supervisor observes (q_1, q_2) and can decide how much information to reveal to the home country supervisor. Information exchange is relevant if there exists an equilibrium such that (at least) two of the signals used in equilibrium lead to a different closure decision. In such an equilibrium it has to hold that the bank is closed in equilibrium if and only if $q_1 + q_2 \leq b$. Otherwise, the host country supervisor would for some (q_1, q_2) have an incentive to deviate and send the signal that implements its preferred closure decision. The candidate equilibrium is thus one where the host country supervisor sends the signal I_B^1 if $q_1 + q_2 \leq b$ and the signal I_B^2 if $q_1 + q_2 > b$. The closure decision is such that the bank is closed if the signal is I_B^1 and left open otherwise.

To check whether this is indeed an equilibrium, we need to consider the home country supervisor's optimal closure decision. Whenever the signal is I_B^2, the home country supervisor leaves the bank open as $b > a$. However, if the signal is I_B^1, it only closes the bank if $E(q_1 + q_2 \mid I_1^B) = b/2 \leq a$. Therefore, the candidate equilibrium is sustainable if and only if $b \leq 2a$. For $b > 2a$ the interests are so disaligned that communication between the supervisors breaks down. Since $E(q_1 + q_2) = 1 > a$, the bank is then never closed, which, of course, makes investing in the host country a very attractive option. The expected profit of the bank is:

$$E\Pi^{02}(a,b) = \begin{cases} p\left(1-b^3/3\right) & \text{if } b/a < 2, \\ p & \text{otherwise.} \end{cases} \tag{10}$$

The host country supervisor is able to achieve its preferred closure decision for $b < 2a$, as it has private information about q_1 and q_2. Using the terminology of Aghion and Tirole (1997), the host country supervisor has 'real authority' over the closure decision even if it is the home country supervisor that has the 'formal authority'.

Finally, if the bank decides to invest in both countries, the analysis of section 3 applies. Using the intervals defined in Proposition 2, replacing subscript 'A' by '1' and subscript 'B' by

'2', we have that the expected profit of the bank is:

$$E\Pi^{11}(a,b,n) = \begin{cases} p(\sum_{i=1}^{n-1}(\int_{q_1^{i-1}(n)}^{q_1^i(n)}\int_{q_2^{n-i}(n)}^{1}(q_1+q_2)dq_2dq_1 + \\ \int_{q_1^{n-1}(n)}^{1}\int_0^1(q_1+q_2)dq_2dq_1) & \text{for } b/a \leq 2, \\ p & \text{for } b/a > 2. \end{cases} \tag{11}$$

The next proposition derives the optimal investment of the bank taking the equilibrium closure regulation as given.

Proposition 5 *There exists a degree of disalignment* $\overline{b/a} \in ((1+\sqrt{3})/2, 2)$ *such that the bank's profit as a function of* b/a *satisfies the following conditions:*

$$\begin{array}{cc} \Pi^{20}(a,b) > Max\{\Pi^{11}(a,b,n), \Pi^{02}(a,b)\} & \textit{for } b/a \leq \overline{b/a}, \\ \Pi^{11}(a,b,n) > \Pi^{20}(a,b) > \Pi^{02}(a,b) & \textit{for } \overline{b/a} < b/a < 2, \\ \Pi^{02}(a,b) = \Pi^{11}(a,b,n) > \Pi^{20}(a,b) & \textit{for } b/a \geq 2. \end{array}$$

Proof. In appendix B. ■

The bank's profit-maximizing investment strategy shows an interesting pattern. For a and b relatively close ($1 < b/a < \overline{b/a}$), the bank chooses to invest everything in the home country. The bank does here regulatory arbitrage by investing in the country where the supervisor is less inclined to close it. As the distance between a and b gets larger ($\overline{b/a} \leq b/a < 2$), the bank exploits the fact that the communication between the supervisors works poorly due to their disaligned interests. Therefore, it invests in both countries to reduce the probability of being closed. Finally, for $b/a > 2$, the host country supervisor cannot transmit any information to the home country supervisor. The bank invests in the host country and avoids closure altogether.[17]

A few simple calculations can illustrate how the probability of closure indeed changes with the investment decision and b/a. Denote the probability that the banks is closed by $v^z(\cdot)$ where z is the allocation of investments. We have:

$$v^{20}(a) = a^2/2 \text{ and } v^{02}(b) = \begin{cases} b^2/2 \text{ for } b \leq 2a, \\ 0 \text{ otherwise.} \end{cases}$$

Using Corollary 1 and disregarding integer constraints, the maximal number of intervals can be written as $n^{\max}(a,b) = \sqrt{\frac{1}{2}(1+\frac{a}{b-a})}$. For $b/a < 2$, we can then approximate $v^{11}(a,b)$ by $\sum_{i=1}^{n^{\max}-1}(q_1^i(n^{\max}) - q_1^{i-1}(n^{\max}))q_2^{n-i}(n^{\max})$. The probability of closure is

$$v^{11}(a,b) \approx \begin{cases} b(a-b/2) \text{ for } b \leq 2a, \\ 0 \text{ otherwise.} \end{cases}$$

Comparing the probabilities of closure shows that $v^{11}(a,b) < v^{20}(a) < v^{02}(b)$ for $a < b \leq 2a$ and $v^{11}(a,b) = v^{02}(b) < v^{20}(a)$ for $b > 2a$. The bank minimizes the probability that it is closed by investing in both countries. However, the probability of closure does not alone determine the

[17] This particular result hinges on Assumption 1. Notice that Assumption 1 and $b/a > 2$ imply that $a < 1/2$. If we, e.g., relaxed Assumption 1 such that $b/2 > 1 > a > 1/2$, there would still be no information exchange. The home country supervisor would, however, close the bank for $q_A < a - E(q_2) = a - 1/2$ if the bank invested in both countries. The bank would then strictly prefer to invest everything in the host country.

investment choice. For a given probability of closure, the profit is lower when the bank invests in both countries, because the supervisors will commit type I and type II errors when deciding on closure. This explains why the bank invests two units in the home country for $b/a \leq \overline{b/a}$ even if $v^{11}(a,b) < v^{20}(a)$.

The next proposition determines the welfare maximizing investment of the bank. Denote by EW_j^z the expected welfare in country j for the bank's investment allocation z.

Proposition 6 *The preferences of the supervisors concerning the bank's investments are given by the following equations:*
i) $b/a < 2$*:*

$$\begin{array}{rcl} \textit{home country} & : & \begin{cases} EW_A^{20} > EW_A^{02} > EW_A^{11} & \textit{for } b \leq \widetilde{b/a}, \\ EW_A^{20} > EW_A^{11} > EW_A^{02} & \textit{for } b > \widetilde{b/a}, \end{cases} \\ \textit{host country} & : & EW_B^{02} > EW_B^{20} > EW_B^{11}, \end{array}$$

where $\widetilde{b/a} \in (8/7, \overline{b/a})$ *and* $\overline{b/a}$ *is defined as in Proposition 5.*
ii) $b/a \geq 2$*:* $EW_j^{20} > Max\{EW_j^{02}, EW_j^{11}\}$ *for* $j = \{A, B\}$.

Proof. In appendix B. ■

Proposition 6 states that when the supervisor's interests are rather close ($b/a < 2$), each supervisor would prefer the bank to invest everything in its own country, because it then can implement its most preferred closure decision. Moreover, the host country supervisor prefers investment in the home country only to investment in both countries. On the other hand, if the divergence of interests is large ($b/a \geq 2$) both supervisors prefer the bank to invest everything in country A to ensure closure when the quality of the assets is low (recall that in this case, no information exchange is possible).

Comparing the investment decision of the bank and the supervisors' preferences, we find the following: For $b/a \leq \overline{b/a}$ the bank invests everything in the home country, which does not run counter to interests of the supervisors. The host country supervisor prefers that the bank invests two units in the host country, but two units in the home country is preferred to one unit in each country. For $\overline{b/a} < b/a$, it is optimal for the bank to invest one unit in each country. This decision is suboptimal from point of view of welfare. Indeed, the welfare of both countries would have been higher had the bank invested two units in the home country. Our analysis suggests therefore that strategic investment by the bank is more likely to have adverse welfare effects when there is a serious conflict of interests between the home and the host country.

The results in Proposition 6 provide a nice link to recent work by Dessein (2002) that extends on Crawford and Sobel (1982). In the model by Crawford and Sobel there is a principal that takes a decision based on the signal that an agent sends. Dessein shows that it may be optimal for the principal simply to delegate the decision to the agent. The agent, of course, takes the decision that serves her interests best. Still, this might be better for the principal than taking his first best decision based on an imprecise signal. It is shown that the more aligned the

interests of the principal and the agent are, the more attractive is delegation. The intuition is that if the interests of the parties are close, more information is revealed in absolute terms (i.e. more intervals can be used in equilibrium), but less information is revealed relative to the degree of conflict of interests. Therefore, the decision that the principal takes based on the agent's signal becomes worse relative to the decision that the agent would take herself.

Let us reconsider our model in the light of the analysis by Dessein. Suppose that $b/a \leq 2$. If the bank invests in both countries, the home country supervisor has to take the closure decision based on an imprecise signal from the host country supervisor. On the other hand, if the bank invests two units in one country, the closure decision is essentially delegated to the supervisor in the country that receives the investment. The decision based on communication becomes worse relative to delegation as b and a come closer. This can be seen in the following way: Define the degree of conflict of interests as $b - a$.[18] Then, disregarding integer constraints and using $n^{\max}(a, b)$, the average size of an interval is $1/n^{\max}(a, b)$. We can now define the average size of an interval relative to the degree of conflict as a measure of how well the communication works compared to delegation. It is easy to show that $\frac{1}{n^{\max}(a,b)(b-a)}$ is strictly decreasing in $(b - a)$: Less information gets revealed relative to the conflict of interests as interests get more aligned. Notice that delegating the closure decision to the foreign country is more attractive for the host than for the home country, because it is the home country that has to give up authority. Therefore, the host country supervisor prefers that the bank invests everything in the foreign country rather than spreading the investments for all $b/a \leq 2$, whereas the home country supervisor only prefers this if b and a are sufficiently close.

5 National versus Supranational Supervision

We have shown that the system of national supervision leads to inefficient regulation when supervisors pursue narrow national interests rather than the common best. Our analysis has illustrated some of the problems that can arise: Poor information exchange, suboptimal closure decisions, and strategic investment decisions by the banks.

Could these problems be avoided by the creation of a supranational supervisory body? Different opinions have been put forward in the literature. In the European context, Vives (2001) argues that centralized supervision is the necessary precondition for an effective cross-border Lender of Last Resort arrangement. Second, and closer to the argument developed in this paper, he argues that in an increasingly integrated banking system centralized supervision dominates coordination of supervisory activities, because it internalizes cross-country externalities. Similarly, according to Kahn and Santos (2004), the overall level of supervision will remain on a suboptimal level if conducted on a national level. Both papers, however, remain silent on the ways in which a supranational supervisor would collect the relevant information. Still, Boot (2003) warns that costs of integration resulting from the heterogeneity of the underlying

[18] We could instead have defined it as $b/a - 1$, which would not have changed the result.

supervisory systems should not be underestimated.

In the comparison between national and supranational supervision, it is essential which assumptions to make on the information set of the supranational supervisor. If it has all the information that the national supervisors have, but pursues overall welfare rather than national welfare, it holds trivially true that supranational supervision does better than national supervision. To our minds, however, this is not the most relevant comparison. The basic assumption of our analysis is that information is localized. That is, important information is available only to the local supervisors. Unless all supervisory powers are transferred to a supranational body, which seems unlikely, there will still be some information that the supranational supervisor does not have access to.

In order to analyze supranational supervision when information is available only to local supervisors, we will consider the following setup: The decision right to close the multinational bank is allocated to a supranational supervisor. The supranational supervisor is benevolent and maximizes total welfare. However, all information about the bank's activities is collected by national supervisors. The national supervisors simultaneously submit a report to the supranational supervisor about the quality of the bank's assets in their country. We consider as before a cheap talk game where the reports consist of non-binding signals. Based on the reports, the supranational supervisor then decides whether to close the bank or to let it continue.

While the assumption that the supranational supervisor collects no information is extreme, it constitutes the natural counterpoint to the case where the supranational supervisor collects all information available to the national supervisors.

5.1 The Analysis

Suppose that the supranational supervisor receives the report s_A from the supervisor in country A and s_B from the supervisor in country B. On the basis of these reports, the supervisor updates its belief about q_A and q_B and decides whether to close the bank. Since the supranational supervisor maximizes total welfare, the bank is closed if and only if

$$E(q_A \mid s_A) + E(q_B \mid s_B) < w,$$

where $E(q_j \mid s_j)$ is the expected value of q_j conditional on receiving the signal s_j and w as defined in (4).

As in section 3, we solve the game by determining which of the incentive compatible closure rules can be sustained as an equilibrium outcome of the cheap talk game outlined above. In the next step, we then compare the possible equilibrium outcomes under national and supranational supervision.

Consider some incentive compatible closure rule as characterized in Lemma 1. Denote by $\mathcal{C}$ the set of tuples $(I_A^i, I_B^{i'})$ such that the bank is closed according to the closure rule if $q_A \in I_A^i$ and $q_B \in I_B^{i'}$. In the same way denote by $\mathcal{O}$ the set of tuples $(I_A^i, I_B^{i'})$ such that the bank is left open according to the closure rule.

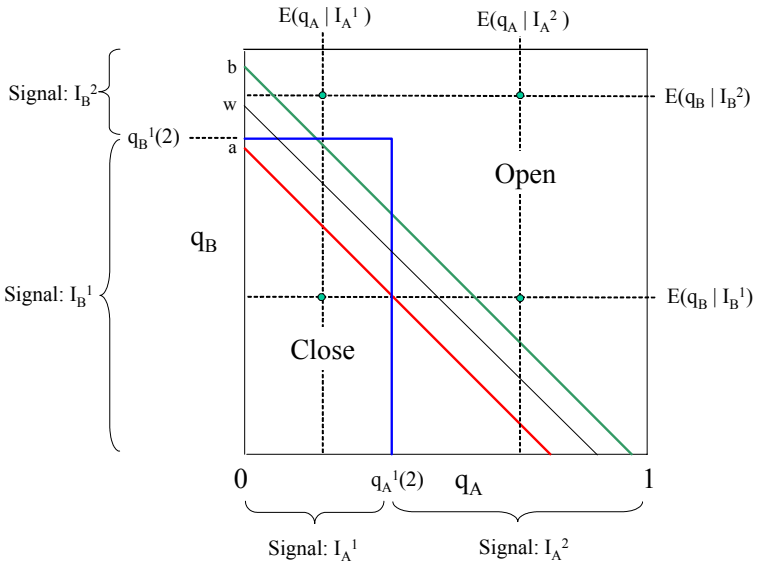


Figure 5: An equilibrium of the cheap talk game under supranational supervsion.

Lemma 2 *Under supranational supervision, an incentive compatible closure rule is implementable as an equilibrium outcome if and only if the following two conditions hold:*

$$E(q_A \mid q_A \in I_A^i) + E(q_B \mid q_B \in I_B^{i'}) \leq f_B^{FB}(0) \text{ for all } (I_A^i, I_B^{i'}) \in \mathcal{C}, \tag{12}$$

$$E(q_A \mid q_A \in I_A^i) + E(q_B \mid q_B \in I_B^{i'}) \geq f_B^{FB}(0) \text{ for all } (I_A^i, I_B^{i'}) \in \mathcal{O}. \tag{13}$$

Proof. In appendix B. ■

Figure 5 shows an equilibrium of the cheap talk game under supranational supervision. The supervisor in country j uses just two signals, I_j^1 and I_j^2. If $q_j < q_j^1(2)$, the national supervisor sends the signal I_j^1 to the supranational supervisor. If instead $q_j \geq q_j^1(2)$, the signal I_j^2 is sent. This signalling rule is incentive compatible if and only if the bank is closed when $q_A \in I_A^1$ and $q_B \in I_B^2$ and otherwise left open. This is indeed the outcome in the example illustrated in figure 5. To see this, notice that $E(q_A \mid I_A^1) + E(q_B \mid I_B^1)$, indicated with the lower left dot, is below the indifference curve of the supranational supervisor. Therefore, the supranational supervisor closes the bank after receiving the signals I_1^A and I_1^B. For all other combinations of signals, the supranational supervisor finds it optimal to leave the bank open.

The next lemma shows that when $a < b$ any equilibrium outcome under national supervision is also an equilibrium outcome under supranational supervision. In that sense, supranational supervision does no worse than national supervision.

Lemma 3 *All equilibrium outcomes that can arise under national supervision are also sustainable as equilibrium outcomes under supranational supervision.*

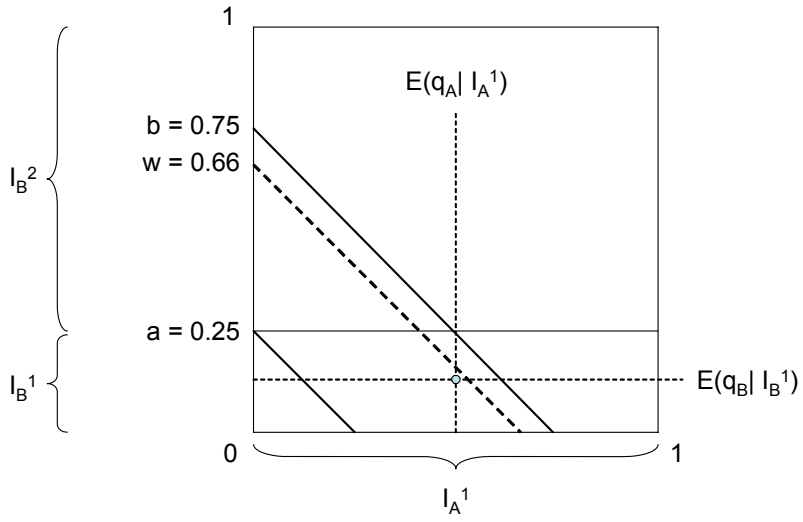


Figure 6: An example where supranational supervision does better than national supervision.

Proof. In appendix B. ■

Figures 3 and 5 illustrate the result of Lemma 3. They show how for identical values of a and b, $b > a$, the same equilibrium outcome can be sustained under national and supranational supervision.

Furthermore, figure 6 shows that there exist parameters such that it is possible to sustain a superior outcome under supranational supervision.[19] Here, $b > 2a$ so there cannot be information exchange under national supervision and the bank is left open for all (q_A, q_B). Under supranational supervision, however, communication is possible. In the example, the supervisor in country B sends the signal I_B^1 if $q_B \in [0, 1/4]$ and I_B^2 if $q_B \in (1/4, 1]$. The supervisor in country A does not reveal any information; or, equivalently, sends the signal I_A^1 for all q_A. The supranational supervisor closes the bank if it receives the signal I_B^1 and leaves it open otherwise. Since $E(q_A \mid I_A^1) + E(q_B \mid I_B^1) = 0.625 < w$, this closure rule is preferable to the outcome under national supervision where the bank is never closed.

The advantage of the system of supranational supervision is the bless of ignorance. In figure 6 the supranational supervisor can commit to closing the bank after receiving the signal $q_B \in I_B^1$, because it is does not know the exact values of q_A and q_B. If, for example, the supranational supervisor could observe q_A, the bank would not be closed if $q_A > w - E(q_B \mid I_B^1)$ so the equilibrium would collapse. We argued above that if the supranational supervisor could observe both q_A and q_B, the problem of efficient closure regulation would vanish. This example illustrates that having only some of relevant information can in fact be worse than having no

[19] In the example $a = 0.25$, $b = 0.75$, and $w = 0.66$. The following values of the underlying parameters would, for example, result in these values: $d = 0$, $L = 0.97$, $p = 0.98$, $s = 0.22449$, $G_A = 0.375$, and $G_B = 26.375$.

information at all.

Supranational supervision can sometimes do better than national supervision, but it is not always the case. It is possible to construct examples where the outcomes than can be sustained under national and supranational supervision are identical.

Proposition 7 *The closure regulation that can be sustained under supranational supervision (weakly) dominates the one that can be sustained under national supervision.*

Proof. In appendix B. ■

For most parts of the paper, it is without loss of insight to focus on $b > a$. In the analysis of supranational supervision it does, however, matter whether $a \gtreqless b$. If $b < a$, Lemma 3 holds no longer true. There exist here parameters such that the type of equilibrium that can be sustained under a national and a supranational regime is not the same. For this reason it is possible to find examples where the closure regulation under national supervision is superior. We do not include these examples as their construction is rather elaborate, but details are available upon request.

Even though Proposition 7 does not hold for $b < a$, a related result holds for all (a, b). The next proposition shows that there can be information exchange for a (weakly) larger set of (a, b) under supranational supervision.[20] Since communication is welfare improving, this implies that supranational supervision tends to dominate in situations where the interests are so disaligned that there can be no information exchange under national supervision.

Proposition 8 *Under supranational supervision, there can be information exchange for a (weakly) larger set of* (a, b) *than under national supervision.*

Proof. In appendix B. ■

The analysis of supranational supervision has direct policy implications. It is possible to construct examples where a system of supranational supervision can do better than one of national supervision (for $b > a$) and vice versa (for $b < a$). Nevertheless, numerical examples suggest that as long as there is information exchange under both systems, welfare differences are almost negligible. This is not the case when the national interests are so disaligned that there only can be communication under supranational supervision. The welfare difference between the two systems can here be substantial and in favor of supranational supervision. For this reason, we think that our analysis provides some support for introducing a supranational supervisory body to regulate multinational banks.

[20] For $b \geq a$ it depends on w whether or not there can be communication for a larger set of (a, b) under supranational supervision. For $b < a$, however, the set of (a, b) for which there can be information exchange is strictly larger with a supranational supervisor for all w. The proof of this result for $b < a$ is available upon request.

6 Conclusion and Discussion

This paper studies conflicts of interests in the supervision of multinational banks. We analyze a situation in which national supervisors have complementary information about the assets of a multinational bank. Taking a political economy approach, it is assumed that the supervisors act in the interest of their respective local economies, but do not care about welfare in other countries. Under this assumption, we study their incentives to exchange information before deciding upon the possible closure of the bank.

The information exchange is modelled as a cheap talk game. Since the supervisors do not always agree on the closure decision, they do not reveal as detailed information as they could. This has several implications. First, the first best closure regulation can never be reached. Second, the less aligned the interests of the countries are, the less detailed information can be exchanged in equilibrium. The joint welfare of the two countries depends thus negatively on the divergence of interests.

We also analyze how the bank's investment decision is influenced by the equilibrium closure regulation. It is found that the bank can allocate its assets strategically across countries to reduce the probability of closure. That is, the supervisors' inability to exchange detailed information creates regulatory slack that the bank can exploit. This problem is again most severe when the interests of the two countries are very disaligned.

We look primarily at a situation where the bank is established in the two countries, has collected deposits and invested them into assets. Here, the investment is already sunk so the closure decision is optimally taken when additional information about the quality of the bank's assets is revealed. It is clear, however, that it could be optimal not to grant the bank a license to operate in the host country in the first place. This would avoid the regulatory problems that arise when supervisors with diverging interests have to cooperate. Our analysis suggests that this possibility is more likely to be welfare improving when the interests of the supervisors are very disaligned so that closure regulation works poorly. The upshot is that banking supervisors should have the right to prevent banks from establishing branches in countries where the interest of the host country supervisor - for whatever reason - is far from the one of the home country supervisor. Such a rule is indeed recommended in BIS' 'Core Principles for Effective Banking Supervision' and would, e.g., caution not to apply the EU 'single passport' model to coalitions of very heterogenous countries.[21]

A criticism to our approach could be that ex post, the signal received by the local supervisor is observed also by the foreign one, and that the possible loss in reputation is incentive enough to report the true signal beforehand. However, one can interpret the signal as a proxy for some noisy information that may contain some error. In this case, it is not possible to verify whether a supervisor has not reported the true type, and the analysis of the paper goes through.

This last issue that we look at is supranational supervision. We compare the current system

[21] The 'single passport' rule allows any EU bank to expand abroad as long as the bank operates through branches (Second Banking Co-ordination Directive, 1993).

with a system where a benevolent supranational supervisor takes the closure decision based on information from the national supervisors. It is shown that a system of supranational supervision tends to do better when interests are very disaligned. At the more general level, the analysis shows that if the information is collected by the national supervisors, it is their incentive constraints that delimit the set of possible regulatory outcomes; whether there is a supranational supervisor or not. Put differently, it is only within the boundaries of incentive compatibility that the choice between national or supranational supervision makes a difference. The analysis suggests that if a system of supranational supervision is introduced, it would be desirable to have the supranational supervisor collect its own information. This would circumvent the constraint that the supervisors' incentive to manipulate information put on regulation, but would perhaps at the same time result in information of lower quality as the local expertise of the national supervisors is not employed. This and related trade-offs represent interesting topics for future research.

Although our analysis focuses on multinational banks, similar problems arise in other areas. An obvious example are financial conglomerates. In many countries, the different sections of a conglomerate (i.e. banks, insurance companies, etc.) are supervised by separate agencies with different objectives. For example, systemic risks have typically not been considered as important in the insurance sector as they are in banking or even securities industries (Skipper, 1996). Consolidated supervision requires these agencies to cooperate and exchange information.[22] Here, similar conflicts of interests arise that could be studied using the methodology developed in this paper.

[22] BIS have issued guidelines of how this cooperation should work (BIS, 1999). The general principles are essentially the same as for the supervision of multinational banks.

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A Mechanisms without Sidepayments

This appendix contains the proof of Lemma 1. Denote by $\Phi(\cdot)$ a mechanism. It indicates as a function of q_A the values of q_B for which the bank is closed. The timing is the following: The supervisors signal the types simultaneously. Afterwards, the mechanism decides on closure. Invoking the revelation principle, we restrict attention to direct incentive compatible mechanisms.

The ultimate goal of the analysis is to determine the set of closure rules that can be sustained as an equilibrium outcome of a cheap talk game. We are therefore not interested in mechanisms that induce outcomes that can never be sustained as such an equilibrium. The first lemma is an auxiliary result that restricts the class of mechanisms that we need to consider in the analysis.

Lemma 4 *The only mechanisms that can be sustained as an equilibrium outcome of a cheap talk game have the following general form: If $q_B < \Phi(q_A)$, the bank is closed. Otherwise, it is allowed to continue.*

Proof. Consider a direct incentive compatible mechanism. Assume that there exists some $\widehat{q}_A$ for which the bank is closed for q''_B but not for q'_B, $q'_B < q''_B$. We want to show that the outcome induced by this mechanism can never be sustained as an equilibrium outcome of a cheap talk game.

Consider a cheap talk game. Denote by s'_B (s''_B) the signal sent by the supervisor in country B when the type is q'_B (q''_B). A necessary condition for the outcome induced by the mechanism to be sustainable as an equilibrium outcome is

$$E(q_B \mid s''_B) + \widehat{q}_A < a \leq E(q_B \mid s'_B) + \widehat{q}_A.$$

Otherwise, the home country supervisor would not close the bank for $q_B = q''_B$ and leave it open for $q_B = q'_B$. The bank is closed by the home country supervisor if $q_A < Max\{0, a - E(q_B \mid s'_B)\} \equiv q'_A$ after receiving the signal s'_B and if $q_A < a - E(q_B \mid s''_B) \equiv q''_A$ after receiving the signal s''_B, $q'_A \leq \widehat{q}_A < q''_A$.

This constitutes an equilibrium only if the host country supervisor prefers to signal s'_B rather than s''_B when the type is q'_B and vice versa. For the type q'_B this gives rise to the following

incentive constraint:

$$\int_0^{q'_A} W_B^{close} dq_A + \int_{q'_A}^{1} W_B^{open}(q_A, q'_B) dq_A \geq \int_0^{q''_A} W_B^{close} dq_A + \int_{q''_A}^{1} W_B^{open}(q_A, q'_B) dq_A,$$

which reduces to

$$\int_{q'_A}^{q''_A} \Delta W_B(q_A, q'_B) dq_A \geq 0. \tag{14}$$

For the type q'' the incentive constraint is :

$$\int_{q'_A}^{q''_A} \Delta W_B(q_A, q''_B) dq_A \leq 0. \tag{15}$$

Since $\Delta W_B(q_A, q_B)$ is increasing in q_B, the two incentive constraints (14) and (15) cannot be satisfied simultaneously. The outcome induced by the mechanism can thus not be sustained as an equilibrium outcome of a cheap talk game. ■

From now on we will restrict attention to the class of mechanisms defined in Lemma 4.

Lemma 5 *$\Phi(\cdot)$ cannot be continuously increasing or decreasing on an open set.*

Proof. Denote country j's most preferred mechanism $\Phi_j^*(\cdot)$. In particular, $\Phi_A^*(\cdot) : b \equiv a - q_A$ and $\Phi_B^*(\cdot) : q_B \equiv b - q_A$. Suppose that there exists some $\widehat{q}_A$ belonging to the open set $(\underline{q}, \overline{q})$ st. $\Phi(\widehat{q}_A) < \Phi_A^*(\widehat{q}_A)$. If $\Phi(\cdot)$ were strictly decreasing on $(\underline{q}, \overline{q})$, there would exist some ε st. $\Phi(\widehat{q}_A) < \Phi(\widehat{q}_A - \varepsilon) \leq \Phi_A^*(\widehat{q}_A)$. Therefore, if the true type was $\widehat{q}_A$, the supervisor in country A would have an incentive to deviate and signal the type $\widehat{q}_A - \varepsilon$. Similarly, the supervisor would deviate to $\widehat{q}_A + \varepsilon$ if $\Phi(\cdot)$ was strictly increasing on $(\underline{q}, \overline{q})$. A similar argument applies to the case of $\Phi(\widehat{q}_A) > \Phi_A^*(\widehat{q}_A)$. Hence, if $\Phi(\cdot)$ were strictly increasing or decreasing on $(\underline{q}, \overline{q})$, the only mechanism that could induce truth-telling by country A's supervisor would be $\Phi(q_A) = \Phi_A^*(q_A)$ for all $q_A \in (\underline{q}, \overline{q})$. However, as $a \neq b$, $\Phi(q_A) = \Phi_A^*(q_A)$ would not induce truth-telling by the supervisor in country B. ■

We know from Lemma 5 that the mechanism has to consist of constant segments plus 'jumps'. Consider a mechanism where the possible types of country j, $j \in \{A, B\}$, are divided into n_j intervals. Interval i is defined $I_j^i \equiv (q_j^{i-1}(n_j), q_j^i(n_j)]$. We have $q_j^0(n_j) = 0$ and $q_j^{n_j}(n_j) = 1$.

Lemma 6 *Consider two neighboring intervals $I_j^i = (q_j^{i-1}(n_j), q_j^i(n_j)]$ and $I_j^{i+1} = (q_j^i(n_j), q_j^{i+1}(n_j)]$, $q_j^{i-1}(n_j) < q_j^i(n_j) < q_j^{i+1}(n_j)$, where $\Phi(q_j) = q_h$ for $q_j \in I_j^i$ and $\Phi(q_j) = q'_h$ for $q_j \in I_j^{i+1}$, $q_h \neq q'_h$. Two necessary conditions for the mechanism to be incentive compatible are:*
i) $\Delta W_j \left(q_j^i(n_j), (q_h + q'_h)/2\right) = 0$
ii) $q_h > q'_h$.

Proof. Incentive compatibility requires that

$$\int_0^{q_h} W_j^{close} dq_k + \int_{q_h}^1 W_j^{open}(q_j, q_k) dq_k \geq \int_0^{q'_h} W_j^{close} dq_k + \int_{q'_h}^1 W_j^{open}(q_j, q_k) dq_k$$

$\forall\ q_j \in I_j^i$, while the reverse inequality needs to hold for $\forall\ q_j \in I_j^{i+1}$. These constraints reduce to:

$$(q_h - q'_h)\,\Delta W_j\,(q_j, (q_h + q'_h)/2) \begin{cases} \leq 0 & \forall q_j \in I_j^i \\ \geq 0 & \forall\ q_j \in I_j^{i+1} \end{cases} \tag{16}$$

Part *i)* of the lemma then follows from $q_h \neq q'_h$ and continuity of ΔW_j. Since $\partial \Delta W_j / \partial q_j > 0$, it has to hold that $q_h > q'_h$ for (16) to be satisfied for all types in I_j^i and I_j^{i+1}, which proves part ii). ■

There are four different types of mechanisms possible depending on the initial and the terminal value of $\Phi(\cdot)$. We denote these mechanisms $\Phi_z(\cdot)$ where $z \in \{1, 2, 3, 4\}$ indicates the type. Since the mechanisms are constructed such that they satisfy the conditions in Lemma 6, no type will deviate to a neighboring interval. As the single crossing condition $(-)$ is satisfied, $\partial^2 E(W_j(q_j, s_j))/\partial f_j \partial q_j = -x_j < 0$, there is neither an incentive to deviate to any other interval.

A.1 Type 1 Mechanisms

Type 1 mechanisms are characterized by $\Phi_1(0) = q_B^{n-1}(n) < 1$, $\Phi_1(1) = 0$, and $n_A = n_B = n$. Using Lemma 6, we obtain a system of $2(n-1)$ equations and unknowns, which determines the endpoints of the first $n-1$ intervals of the two countries:

$$\Delta W_A\left(q_A^i(n), (q_B^{n-i-1}(n) + q_B^{n-i}(n))/2\right) = 0 \text{ for } i = 1, .., n-1, \tag{17}$$

$$\Delta W_B\left((q_A^{n-i-1}(n) + q_A^{n-i}(n))/2, q_B^i(n)\right) = 0 \text{ for } i = 1, .., n-1. \tag{18}$$

It can be verified that (5) and (6) are the solution to this linear system of equations. If country j signals a q_j that belongs to interval I_j^i, the bank closed if country k signals that $q_k \leq q_k^{n-i}(n)$.

The following conditions need to be satisfied for an equilibrium of type 1 with n intervals to exist: *(i)* $q_B^i(n) > q_B^{i-1}(n)$, $i = \{2, .., n-1\}$; *(ii)* $q_B^1(n) > 0$; *(iii)* $1 > q_B^{n-1}(n)$; and *(iv)* $q_A^1(n) > 0$. The sequence $\{q_B^1(n), .., q_B^{n-1}(n)\}$ defined in Proposition 2 always satisfies condition *(i)*. It is furthermore easy to show that condition *(ii)* holds for all $b > a$, while condition *(iv)* is equivalent to (7). Finally, condition *(iii)* is implied by $q_A^1(n) > 0$, $b < 1$, and $\Delta W_B(q_A^1(n)/2, q_B^{n-1}(n)) = 0$.

A.2 Type 2 Mechanisms

Type 2 mechanisms are characterized by $\Phi_2(0) = 1$, $\Phi_2(1) = 0$, $n_A = n+1$, and $n_B = n$. Using Lemma 6, we obtain a system of $2n-1$ equations and unknowns:

$$\Delta W_A\left(q_A^i(n+1), (q_B^{n-i-1}(n) + q_B^{n-i}(n))/2\right) = 0 \text{ for } i = 1, .., n, \tag{19}$$

$$\Delta W_B\left((q_A^{n+1-i}(n+1) + q_A^{n-i}(n+1))/2, q_B^i(n)\right) = 0 \text{ for } i = 1, .., n-1. \tag{20}$$

It is can be verified that (23) and (24) are the solution to this linear system of equations. If country j signals a q_j that belongs to interval I_j^i, the bank is closed if the country k signals that $q_k \leq q_k^{n+1-i}(n_k)$. The solution to the system of equations always satisfies $q_B^i(n) > q_B^{i-1}(n)$, $i = \{2, .., n-1\}$. For an equilibrium of type 2 with n intervals to exist, the relevant conditions are: *(i)* $q_A^1(n) > 0$ and *(ii)* $q_B^1(n) > 0$. We find that *(i)* is equivalent to condition (25) whereas *(ii)* never binds for $b > a$.

A.3 Type 3 and 4 Mechanisms

The next two types of mechanisms do not play a central role in the analysis so we do not characterize them fully to save on space. Type 3 mechanisms are characterized by $\Phi_3(0) = q_B^{n-1}(n) < 1$, $\Phi_3(1) = q_B^1(n) > 0$, $n_A = n-1$, and $n_B = n$. Using Lemma 6, we obtain a system of $2(n-1)-1$ equations and unknowns:

$$\begin{aligned} \Delta W_A\left(q_A^i(n-1), (q_B^{n-i}(n) + q_B^{n-i-1}(n))/2\right) &= 0 \text{ for } i = 1, .., n-2, \\ \Delta W_B\left((q_A^{n-i}(n-1) + q_A^{n-i-1}(n-1))/2, q_B^i(n)\right) &= 0 \text{ for } i = 1, .., n-1. \end{aligned}$$

If country j signals a q_j that belongs to interval I_j^i, the bank is closed if country k signals that $q_k \leq q_k^{n-i}(n_k)$.

Type 4 mechanisms are characterized by $\Phi_4(0) = 1$, $\Phi_4(1) = q_B^1(n) > 0$, and $n_A = n_B = n$. Using Lemma 6, we obtain a system of $2(n-1)$ equations and unknowns:

$$\begin{aligned} \Delta W_A\left(q_A^i(n), (q_B^{n-i}(n) + q_B^{n-i+1}(n))/2\right) &= 0 \text{ for } i = 1, .., n-1, \\ \Delta W_B\left((q_A^{n-i}(n-1) + q_A^{n-i+1}(n-1))/2, q_B^i(n)\right) &= 0 \text{ for } i = 1, .., n-1. \end{aligned}$$

If country j signals a q_j that belongs to interval I_j^i, the bank is closed if the host country signals that $q_k \leq q_k^{n+1-i}(n)$.

B Proofs of Lemmata, Propositions, and Remarks

B.1 Proof of Remark 1

The proof of the first part follows directly from the expressions for a and b. We have that $\partial a/\partial d_A \leq 0$ and $\partial b/\partial d_A \geq 0$ iff. $L \leq G(1-p)^2/p + p$, which is equivalent to $b \geq a$. Therefore, b/a is increasing in d_A. Finally, it follows from (3) that the first best closure rule is unaffected by d_A

B.2 Proof of Proposition 1

The proof consists in showing that $f_B^{FB}(q_A)$ is implementable. If there exist transfers such that $f_B^{FB}(q_A)$ is implementable, it is the second best mechanism as it replicates the first best closure rule and participation in the mechanism can be ensured through a lump-sum payment ex-ante. Denote the signal that the supervisor in country A (B) sends about q_A (q_B) by s_A (s_B).

Furthermore, $t_A(s_A, s_B)$ ($t_B(s_A, s_B)$) denotes the transfer from country A to B (country B to A) as a function of the signals. Invoking the revelation principle, we restrict attention to direct incentive compatible mechanisms. Consider the following mechanism:

- The supervisors signal the types simultaneously,
- The bank stays open if and only if $s_A + s_B \geq w$,
- The transfers are given as:

$$t_A(s_A, s_B) = \begin{cases} 0 & \text{if} \quad s_A < w - s_B \\ -\Delta W_B(w - s_B, s_B) & \text{otherwise} \end{cases},$$

$$t_B(s_A, s_B) = \begin{cases} 0 & \text{if} \quad s_B < w - s_A \\ -\Delta W_A(s_A, w - s_A) & \text{otherwise} \end{cases}.$$

Assume that the supervisor in country B reveals the type truthfully, $s_B = q_B$. We want to show that the mechanism induces the supervisor in country A to reveal the type truthfully as well. First compare the following two signals: $s_A = \widehat{q}_A < q_A$ and $s_A = q_A$. Then, if $\widehat{q}_A < q_A < w - q_B$ or $q_A > \widehat{q}_A \geq w - q_B$, the two signals have the same payoff. However, if $\widehat{q}_A < w - q_B \leq q_A$, we have:

$$\underbrace{W_A^{open}(q_A, q_B) + \Delta W_B(w - q_B, q_B)}_{\text{Payoff: } s_A = q_A} \geq \underbrace{W_A^{close}}_{\text{Payoff: } s_A = \widehat{q}_A},$$

because $W_A^{open}(q_A, q_B)$ is increasing in q_A, $q_A \geq w - q_B$, and $\Delta W_A(w - q_B, q_B) + \Delta W_B(w - q_B, q_B) = 0$. It can be shown in the same way that i) the supervisor in country A neither has an incentive to signal $s_A = \widehat{q}_A > q_A$, and ii) the supervisor in country B reveals the type truthfully given that $s_A = q_A$. The mechanism therefore implements $f_B^{FB}(q_A)$ as a Bayesian Nash equilibrium.

B.3 Proof of Proposition 2

In appendix A we characterize the set of incentive compatible closure rules when there are no sidepayments possible. The question is thus which of the outcomes induced by the mechanisms in appendix A that can be sustained as an equilibrium outcome of the cheap talk game considered in the text. First, as $a < 1$, the home country supervisor never closes the bank if $q_A = 1$. Therefore, outcomes induced by mechanisms of type 3 and 4 can never be sustained as equilibrium outcomes of a cheap talk game, because $\Phi_3(1), \Phi_4(1) > 1$.

We now turn to mechanisms of type 1 (mechanisms of type 2 are treated in appendix C). Suppose that there exists an equilibrium of the cheap talk game that leads to the same closure regulation as the mechanism of type 1 with n intervals. In particular, consider the following candidate equilibrium:

Signalling rule: The host country supervisor signals the interval to which the type belongs, I_B^i.

Closure rule: After receiving the signal I_B^i, the home country supervisor closes the bank if and only $q_A \leq q_A^{n-i}(n)$.

It follows from the construction of the mechanism that the signalling rule is a best response to the closure rule. Next we find conditions under which the closure rule is a best response to the signalling rule for all q_A. Suppose that the host country supervisor signals I_B^i, $i \leq n-1$. Equation (17) implies that it is indeed a best response for the home country supervisor to close the bank for $q_A \leq q_A^{n-i}(n)$ and to leave it open for $q_A > q_A^{n-i}(n)$. Suppose instead that the signal is I_B^n. The mechanism requires here that the bank is left open for all q_A. This holds if and only if:

$$\Delta W_A \left(0, (q_B^{n-1}(n)+1)/2\right) \geq 0,$$

which correspond to equation (8). The candidate equilibrium is thus sustainable if and if only the mechanism exists, i.e. condition (7) is satisfied, and condition (8) holds. The fact that signals are non-binding imposes therefore an additional constraint, condition (8).

This additional constraint has to be fulfilled in any cheap talk game, not only the one considered in the text. To see this, consider an equilibrium of some general cheap talk game that leads to the same outcome as the mechanism. Consider types in I_B^n. Denote by $\{z_1, .., z_m\}$ the set of signals used by the host country supervisor for some $q_B \in I_B^n$. Since the equilibrium outcome is equivalent to the outcome induced by mechanism, these signals are not used by the supervisor for any $q_B \notin I_B^n$. It has to hold that the home country supervisor wishes to leave the bank open for all q_A and for all signals in $\{z_1, .., z_m\}$: $0 \leq Min_{z_l}\{\Delta W_A(0, E(q_B \mid z_l))\}$, which is (weakly) stricter than (8). Therefore, considering a more general class of cheap talk games would not expand the set of outcomes induced by mechanisms of type 1 that could be sustained as an equilibrium outcome.

B.4 Proof of Corollary 1

To obtain a contradiction, assume that n is the maximal number of intervals that can be used in equilibrium but $b \leq 2n^2a/(2n^2-1)$. Since $b > a$ and $2n^2a/(2n^2-1)$ is decreasing in n, there exists some $\widetilde{n} \geq n+1$ such that

$$\frac{2\widetilde{n}^2 a}{2\widetilde{n}^2-1} < b \leq \frac{2(\widetilde{n}-1)^2 a}{2(\widetilde{n}-1)^2-1}.$$

From $b \leq 1$ follows then that $a \leq (2\widetilde{n}^2-1)/2\widetilde{n}^2$. However, we have:

$$\frac{\widetilde{n}a}{\widetilde{n}-1} - \frac{2\widetilde{n}-1}{2\widetilde{n}(\widetilde{n}-1)} \leq \frac{2\widetilde{n}^2 a}{2\widetilde{n}^2-1} < b \leq \frac{2(\widetilde{n}-1)^2 a}{2(\widetilde{n}-1)^2-1} \text{ for } a \leq \frac{2\widetilde{n}^2-1}{2\widetilde{n}^2}.$$

Therefore, it follows from Proposition 2 that an equilibrium with $\widetilde{n}$ intervals exists, which contradicts that n is the maximal number of intervals. This proves the corollary.

B.5 Proof of Proposition 3

We will show below that whenever the equilibria of type 1 with n and with $n+1$ intervals coexist, the equilibrium with $n+1$ intervals gives the highest welfare in both countries. From Proposition 2, $q_j^{i+1}(n+1) > q_j^i(n) > q_j^i(n+1)$, $j = A, B$ and $i = 1, ..., n$. This implies that there are $2n-1$ areas where the closure decision is different in the two equilibria. In n of these areas, the bank would remain open in the n interval but close in the $n+1$ interval equilibrium. Denote these areas by α_l, $l = 1, .., n$. In the other $n-1$ areas, the bank would be closed in the n interval but remain open in the $n+1$ interval equilibrium. Denote these areas β_l, $l = 1, .., n-1$. The variables α_l and β_l are defined as follows:

$$\begin{aligned}
\alpha_l &\equiv \{(q_A, q_B) \mid q_A \in (q_A^{l-1}(n), q_A^l(n+1)) \text{ and } q_B \in (q_B^{n-l}(n), q_B^{n+1-l}(n+1))\}, \\
\beta_l &\equiv \{(q_A, q_B) \mid q_A \in (q_A^l(n+1), q_A^l(n)) \text{ and } q_B \in (q_B^{n-l}(n+1), q_B^{n-l}(n))\}.
\end{aligned}$$

We denote the probability that the bank belongs to area α_l and β_l by

$$\begin{aligned}
\theta(\alpha_l) &= \left(q_A^l(n+1) - q_A^{l-1}(n)\right)\left(q_B^{n+1-l}(n+1) - q_B^{n-l}(n)\right), \\
\theta(\beta_l) &= \left(q_A^l(n) - q_A^l(n+1)\right)\left(q_B^{n-l}(n) - q_B^{n-l}(n+1)\right).
\end{aligned}$$

Furthermore, denote $E(q_A + q_B \mid (q_A, q_B) \in \alpha_l)$ (resp. $E(q_A + q_B \mid (q_A, q_B) \in \beta_l)$) by $q(\alpha_l)$ (resp. $q(\beta_l)$).

$EW_j(n)$ is the expected welfare of country j in the equilibrium with n intervals. The expected welfare gain of country j when switching from a n to a $n+1$ interval equilibrium is then given by

$$EW_j(n+1) - EW_j(n) = \sum_{l=1}^{n-1} \theta(\beta_l)\Delta W_j(q(\beta_l)) - \sum_{l=1}^{n} \theta(\alpha_l)\Delta W_j(q(\alpha_l)), \tag{21}$$

where ΔW_j has been written as a function of $q(\beta_l)$, because the expected welfare depends only on the sum of q_A and q_B. Undertaking some tedious calculations (details available upon request), we can express $q(\alpha_l)$, $q(\beta_l)$, $\theta(\alpha_l)$, and $\theta(\beta_l)$ as functions of n, a, and b. It is helpful that the expected return in each of the areas turns out not to depend on l, i.e. $q(\alpha_l) \equiv q(\alpha)$ resp. $q(\beta_l) \equiv q(\beta)$. Denoting $\theta_\alpha \equiv \sum_{l=1}^{n} \theta(\alpha_l)$ and $\theta_\beta \equiv \sum_{l=1}^{n-1} \theta(\beta_l)$, equation (21) reduces to

$$EW_j(n+1) - EW_j(n) = \Delta W_j(q(\beta))\theta_\beta - \Delta W_j(q(\alpha))\theta_\alpha$$

Using the definition of a and b, we then find for $j = a, b$:

$$EW_j(n+1) \geq EW_j(n) \Leftrightarrow j \geq \frac{\theta_\alpha q(\alpha) - \theta_\beta q(\beta)}{\theta_\alpha - \theta_\beta} = \frac{a+b}{3}\ . \tag{22}$$

As a final step, from Proposition 2 *iii)* follows that there can only be information exchange if $b \leq 2a$. Hence condition (22) is satisfied when the n interval equilibrium exists.

B.6 Proof of Proposition 4

In the first step we show that for any *given* equilibrium with n intervals, the total expected welfare is decreasing in the degree of disalignment of interests. Consider an equilibrium of type 1 with n intervals. The expected joint welfare of country A and B is

$$\begin{aligned} EW(n) &= \sum_{i=1}^{n-1} \int_{q_A^{i-1}(n)}^{q_A^i(n)} \int_0^{q_B^{n-i}(n)} (W_A^{close} + W_B^{close}) dq_B dq_A + \\ &\quad \sum_{i=1}^{n} \int_{q_A^{i-1}(n)}^{q_A^i(n)} \int_{q_B^{n-i}(n)}^{1} (W_A^{open}(q_A, q_B) + W_B^{open}(q_A, q_B)) dq_B dq_A \\ &= W^{open} - \sum_{i=1}^{n-1} \int_{q_A^{i-1}(n)}^{q_A^i(n)} \int_0^{q_B^{n-i}(n)} \Delta W(q_A, q_B) dq_B dq_A \\ &= W^{open} - \sum_{i=1}^{n-1} \int_{q_A^{i-1}(n)}^{q_A^i(n)} \int_0^{q_B^{n-i}(n)} ((x_A + x_B)(q_A + q_B) - (y_A + y_B)) dq_B dq_A, \end{aligned}$$

where $W^{open} = \int_0^1 \int_0^1 (W_A^{open}(q_A, q_B) + W_B^{open}(q_A, q_B)) dq_B dq_A$ is a constant that is independent of d_A. Here x_A, x_B, y_A, and y_B are positive constants where $a = y_A/x_A$, $b = y_B/x_B$, $x_A + x_B = 1$, and $w = y_A + y_B$. Integration yields then

$$EW(n) = W^{open} - \sum_{l=1}^{n-1} \theta_l \left(q_l - \frac{w}{2} \right),$$

where $\theta_l = (q_A^l(n) - q_A^{l-1}(n)) q_B^{n-l}(n)$ and $q_l = (q_A^{l-1}(n) + q_A^l(n) + q_B^{n-l}(n))/4$. One can interpret q_l as the expected value of $q_A + q_B$ in the area of size θ_l.

When a change in d_A occurs, notice that $w/2$ is not affected. All changes in expected welfare occur through a and b, which affect θ_l and q_l. From the definitions of a and b, we find:

$$\begin{aligned} \frac{\partial a}{\partial d_A} &= -2 \frac{((1-p)(1+G) - 1 - L)(1-p) - (L-p)}{(1 + d_A(1-p))^2} \\ \frac{\partial b}{\partial d_A} &= 2 \frac{((1-p)(1+G) - 1 - L)(1-p) - (L-p)}{(1 - d_A(1-p))^2}. \end{aligned}$$

Since the only difference being the denominator, it is easy to see that $\left| \frac{\partial b}{\partial d_A} \right| \geq \left| \frac{\partial a}{\partial d_A} \right|$. Thus, we can define a constant $\gamma = \frac{(1-\delta(1-p))^2}{(1+\delta(1-p))^2} \in [0, 1]$ so that $\frac{\partial a}{\partial d_A} = -\gamma \frac{\partial b}{\partial d_A}$. We obtain:

$$\frac{\partial EW(n)}{\partial d_A} = \frac{\partial EW(n)}{\partial a} \frac{\partial a}{\partial d_A} + \frac{\partial EW(n)}{\partial b} \frac{\partial b}{\partial d_A} = \frac{\partial b}{\partial d_A} \left(\frac{\partial EW(n)}{\partial b} - \gamma \frac{\partial EW(n)}{\partial a} \right).$$

Tedious calculations show that $\frac{\partial EW(n)}{\partial a} \geq 0$ and $\frac{\partial EW(n)}{\partial b} \leq 0$ (for details see Holthausen and Rønde, 2004). It follows that $\frac{\partial EW(n)}{\partial d_A} < 0$. Thus, for a given equilibrium, more disaligned interests lead to a lower joint welfare of the two countries. This concludes the first part of the proof.

In the second step, we consider the maximal number of intervals that can be sustained in equilibrium before and after an increase in d_A. Suppose that there exists an equilibrium with n

intervals before and after the increase. It follows then from the first part of the proof that the welfare is decreasing in d_A. Suppose instead that there exists an equilibrium with n intervals before the change but only $n-i$ intervals after the change, $i>0$. It follows from (7), (8), and (25) that there also exists an equilibrium with $n-i$ intervals before the change in d_A. Suppose that the equilibrium with $n-i$ intervals is of type 1 before and after the change in d_A. Arguing as above, we have that the welfare of the $n-i$ interval equilibrium is decreasing in d_A. Using Proposition 3, it follows then that the welfare of the n interval equilibrium before the increase in d_A is higher than the welfare of the $n-i$ interval after the increase. It is possible, however, that the equilibrium with $n-i$ intervals is of type 2 before the change in d_A. A similar argument establishes that the proposition also holds in this case.

B.7 Proof of Proposition 5

We derive the optimal investment decision of the bank. To do so, it is necessary to consider different regions.

Region I: $b/a > 2$. Comparing equations (9), (10), and (11), we see that investing either one or two units in the host country is the profit maximizing strategy.

Region II: $2 \geq b/a > 8/7$. Equations (9) and (10) show that $E\Pi^{20}(a) > E\Pi^{02}(a,b)$, because $b > a$. Let us compare $E\Pi^{11}(a,b,n)$ and $E\Pi^{20}(a)$. Suppose that the bank invests in both countries. From Proposition 2 follows that the only equilibrium with information exchange is the one with two intervals. Using (11) the profits of the bank can be written as:

$$E\Pi^{11}(a,b,2) = p\left(1-(2b-a)(2a-b)(a+b)/27\right).$$

The function $E\Pi^{11}(a,b,2)$ is convex in b and has a minimum at $b = a/2+\sqrt{3}a/2$. We have that $Lim_{b\to 8a/7}(E\Pi^{11}(a,b,2)) = 1-120a^3/343 < E\Pi^{20}(a)$ and that $E\Pi^{11}(a,b,2) = 1 > E\Pi^{20}(a)$ for $b = 2a$. This implies that there exists a $\overline{b/a} \in (1/2+\sqrt{3}/2, 2)$ such that it is optimal to invest two units in the home country for $8/7 < b/a \leq \overline{b/a}$ and one unit in each country for $2 \geq b/a > \overline{b/a}$.

The proof showing that the bank invests everything in the home country for $8/7 > b/a > 1$ where equilibria with more intervals exist follows a similar method. Details are available upon request.

B.8 Proof of Proposition 6

We want to determine the welfare maximizing investment decision of the bank. Suppose first that the bank invests everything in the home country. The bank is then closed if and only if $q_1+q_2 < a$. This results in the following expected welfare of country j:

$$EW_j^{20}(a) = W_j^{close} + \int_0^a \int_{a-q_1}^1 \Delta W_j(q_1,q_2)dq_2dq_1 + \int_a^1 \int_0^1 \Delta W_j(q_1,q_2)dq_2dq_1$$

for all b/a.

Suppose instead that the bank invests at least one unit in the host country. For $2 \geq b/a > 1$ we have that

$$EW_j^{02}(a,b) = W_j^{close} + \int_0^b \int_{b-q_1}^1 \Delta W_j(q_1,q_2)dq_2dq_1 + \int_b^1 \int_0^1 \Delta W_j(q_1,q_2)dq_2dq_1,$$

because the bank is closed if and only if $q_1 + q_2 < b$. If the bank invests in both countries, the expected welfare is

$$EW_j^{11}(a,b,n) = W_j^{close} + \sum_{i=1}^{n-1} \int_{q_1^{i-1}(n)}^{q_1^i(n)} \int_{q_2^{n-i}(n)}^1 \Delta W_j(q_1,q_2)dq_2dq_1.$$

For $b/a > 2$ we have that

$$EW_j^{02}(a,b) = EW_j^{11}(a,b) = W_j^{close} + \int_0^1 \int_0^1 \Delta W_j(q_1,q_2)dq_2dq_1,$$

since the bank is never closed.

When comparing the welfare effects of the different investment decisions, we will use that $\Delta W_j(q_1,q_2) = x_j(q_1+q_2) - y_j$ where x_j and y_j are positive constants. Notice that $y_A/x_A = a$ and $y_B/x_B = b$. Below we consider different regions according to the equilibria that can be sustained.

Region I: $b/a > 2$. In this region there can be no information exchange if the bank invests in the host country. The welfare of the home country is maximized when the bank invests two units in the home country. Turning to the host country, we have that

$$EW_B^{20}(a) - EW_B^{\tilde{z}}(a,b) = \frac{1}{6}(3y_B - 2ax_B) = \frac{x_B}{6}(3b-2a) > 0,\ z \in \{11,02\},$$

which proves the second part of the proposition.

Region II: $2 \geq b/a > 8/7$. The welfare of country j is maximized when the bank invests everything in the country, because the local supervisor can induce its preferred closure decision. To rank the investments, it is thus enough to compare the welfare when the bank invests one unit in each country and when it invests two units in the foreign country.

Notice that if the bank invests one unit in each country, it follows from Proposition 2 that only the equilibrium with two intervals exists. Let us first consider the host country. We have that

$$EW_B^{20}(a) - EW_B^{11}(a,b,2) = \frac{x_B}{54}\left(99a^2b - 96b^2a + 32b^3 - 34a^3\right).$$

Analysis shows that $99a^2b - 96b^2a + 32b^3 - 34a^3$ is increasing and convex in b. Furthermore, as $Lim_{b\to 8a/7}(99a^2b - 96b^2a + 32b^3 - 34a^3) = 522a^3/343$, we conclude that $EW_B^{20}(a) > EW_B^{11}(a,b,2)$ in the region considered. We now turn to the home country. Here

$$EW_A^{02}(a,b) - EW_A^{11}(a,b,2) = \frac{x_A}{54}\left(32a^3 - 96a^2b + 99ab^2 - 34b^3\right).$$

The function $32a^3 - 96a^2b + 99ab^2 - 34b^3$ is decreasing and concave in b. As $Lim_{b\to 8a/7}(99a^2b - 96b^2a + 32b^3 - 34a^3) = 288a^3/343$ and $99a^2b - 96b^2a + 32b^3 - 34a^3 = -36a^3$ for $b = 2a$, we

conclude that there exists a threshold $\widetilde{b/a} \in (8/7, 2)$ such that $EW_A^{02}(a) \geq EW_A^{11}(a,b,2)$ for $b/a \leq \widetilde{b/a}$ and $EW_A^{02}(a) < EW_A^{11}(a,b,2)$ for $b/a > \widetilde{b/a}$. Comparing $\widetilde{b/a}$ to the threshold $\overline{b/a}$ defined in Proposition 5 shows that $\widetilde{b/a} < \overline{b/a}$.

The proof establishing the welfare ranking for $8/7 > b/a > 1$ where equilibria with more intervals exist follows a similar method. Details are available upon request.

B.9 Proof of Lemma 2

Consider some incentive compatible closure rule for which $(I_A^i, I_B^{i'}) \in \mathcal{C}$. Denote by $X_A = \{x_1, ..., x_{m_A}\}$ the set of signals sent by the supervisor in country A with positive probability for some $q_A \in I_A^i$. Also, denote by $Y_B = \{y_1, ..., y_{m_B}\}$ the set of signals sent by the supervisor in country B with positive probability for some $q_B \in I_B^{i'}$. The closure rule is only sustainable as an equilibrium outcome if the supervisor in country A (B) does not use some signal in X_A (Y_B) for any $q_A \notin I_A^i$ ($q_B \notin I_B^{i'}$), as this would lead to the same closure decision for types belonging to different intervals. A necessary condition for the closure rule to be sustainable is that the bank is closed for all (x_i, y_i) such that $x_i \in X_A$ and $y_i \in Y_B$. This requires:

$$E(q_A \mid I_A^i) + E(q_B \mid I_B^{i'}) \leq Max_{x_i \in X_A}\{E(q_A \mid x_i)\} + Max_{y_i \in Y_B}\{E(q_B \mid y_i)\} \leq f_B^{FB}(0).$$

Hence condition (12) is a necessary condition for the closure rule to be sustainable as an equilibrium outcome. It is also a sufficient condition: If condition (12) holds, closure can be ensured by letting the national supervisors signal the interval to which the type belongs. It can be shown in a similar manner that condition (13) is both necessary and sufficient for the closure rule to be sustainable for $(I_A^i, I_B^{i'}) \in \mathcal{O}$.

B.10 Proof of Lemma 3

We want to show that all equilibrium closure regulations that can be sustained with national supervision can also be sustained with supranational supervision. Consider first an equilibrium of type 1 with n intervals, which correspond to a type 1 mechanism with n intervals in appendix A. Here, if country B signals that q_B belongs to interval I_B^i, the bank closed if country A signals that $q_A \in I_A^{i'}$ where $i' \leq n - i$. From equations (5) and (6) we have:

$$E(q_A \mid I_A^{i'}) + E(q_B \mid I_B^i) \leq E(q_A \mid I_A^{n-i}) + E(q_B \mid I_B^i) <$$
$$q_A^{n-i}(n) + E(q_B \mid I_B^i) = a < f_B^{FB}(0) \text{ for } i' \leq n - i, \text{ and}$$

$$f_B^{FB}(0) < q_B^{i-1}(n) + E(q_A \mid I_A^{n-i+1}) = b \leq E(q_A \mid I_A^{i'}) + E(q_B \mid I_B^i) \text{ for } i' \geq n - i + 1.$$

Using Lemma 2, this shows that the outcome induced by an equilibrium of type 1 is also sustainable under supranational supervision. Finally, we need to show that the supranational supervisor leaves the bank open for all I_B^i if $q_A \in I_A^n$. This is obviously true if $E(q_A \mid I_A^n) + E(q_B \mid I_B^1) \geq b > f_B^{FB}(0)$. Using Proposition 2, $E(q_A \mid I_A^n) + E(q_B \mid I_B^1) - b$ reduces to:

$$\frac{2(n-1)(1-b) + 2(b-a)(1 + (n-3)n) + 1}{2(2n-1)} > 0 \text{ for all } n \geq 3.$$

For $n = 2$, $E(q_A \mid I_A^n) + E(q_B \mid I_B^1) - b = 3(1-b) + 2a - b \geq 0$, because $b \leq 1$ and $2a \geq b$ whenever an equilibrium of type 1 with 2 intervals exists. Hence the supranational supervisor leaves the bank open after receiving the signal I_A^n for all I_B^i and for all $n \geq 2$. This proves that outcomes resulting from equilibria of type 1 under national supervision are also sustainable under supranational supervision. It can be shown in a similar manner that outcomes induced by equilibria of type 2 are also sustainable under supranational supervision.

B.11 Proof of Proposition 7

Lemma 2 and the example of figure 6 show that for $b > a$ the set of (a, b) for which there can be communication is no smaller under supranational supervision than under national supervision.

C Analysis of type-2 equilibria

The cheap talk game has as mentioned in the text another type of equilibria. These equilibria, which we will refer to as equilibria of type 2, lead to the same closure regulation as mechanisms of type 2, see appendix A. Arguing as in the proof of Proposition 2, it can be shown that all outcomes induced by mechanisms of type 2 can be sustained as an equilibrium outcome of the cheap talk game considered in the text. It follows trivially that considering a more general class of cheap talk games would not expand the set of equilibrium outcomes.

Proposition 9 ***Characterization of an equilibrium of type 2 with n intervals:***
i) The host country supervisor signals the interval to which q_B belongs, $I_B^i = (q_B^{i-1}(n), q_B^i(n)]$ where

$$q_B^i(n) = 2i(n-i)(b-a) + \frac{i}{n}. \tag{23}$$

ii) After receiving signal I_B^i, the home country supervisor lets the bank continue if and only if:

$$q_A \geq q_A^{n-i+1}(n) = (b-a)(n - 2(n-i+1)i) + b - \frac{2(n-i+1)-1}{2n}. \tag{24}$$

iii) The equilibrium exists if and only if:

$$b < \frac{n}{n-1}a - \frac{2n-1}{2n(n-1)}. \tag{25}$$

iv) Considering a more general class of cheap talk games would not expand the set of possible equilibrium outcomes in terms of closure.

Proof. Follows from the analysis of type 2 mechanisms in appendix A and the discussion above. ■

We want to show that whenever an equilibrium of type 2 exists it is dominated in terms of welfare by an equilibrium of type 1. The next corollary contains two auxiliary results.

Corollary 2 *i) An equilibrium of type 1 with n intervals and an equilibrium of type 2 with $n+1$ intervals, $n \geq 2$, cannot coexist.*
ii) For $b > a$ the equilibrium with the highest number of intervals is of type 1.

Proof. For the first part of the corollary, from (8) and (25) follows that an equilibrium of type 1 with n intervals and an equilibrium of type 2 with $n+1$ intervals can coexist only if $a \leq n/(n+1)$. However, (25) and $b > a$ imply that this condition is never satisfied when the equilibrium of type 2 with $n+1$ intervals exists.

Consider now the second part. Suppose that $b > a$ and that the maximal number of intervals that can be used in an equilibrium of type 2 is n. From (25) this implies that

$$\frac{(n+1)a}{n} - \frac{2n+1}{2n(n+1)} < b, \tag{26}$$

$$b \leq \frac{na}{n-1} - \frac{2n-1}{2n(n-1)}. \tag{27}$$

As method of proof, we want to show that whenever the equilibrium of type 2 with n intervals exists, the equilibrium of type 1 with $n+1$ intervals also exists. From Proposition 2 and equation (26) follow that the equilibrium of type 1 with $n+1$ intervals exists if and only if

$$b \leq \frac{2n^2 a}{2n^2 - 1}. \tag{28}$$

From $b > a$ and (27) plus $b \leq 1$ and (26) we have that $1 - 1/2n \leq a \leq 1 - 1/2(n+1)^2$. First consider the region $1 - 1/2n \leq a \leq 1 - 1/2n^2$. Since $na/(n-1) - (2n-1)/2n(n-1) \leq 2n^2 a/(2n^2-1)$ for $a \leq 1 - 1/2n^2$, (27) and (28) imply that the equilibrium of type 1 with $n+1$ intervals exists whenever the equilibrium of type 2 with n intervals does. Finally, consider the region $1 - 1/2n^2 \leq a \leq 1 - 1/2(n+1)^2$. Here, it follows from (28) and $b \leq 1 \leq 2n^2 a/(2n^2-1)$ that there always exists an equilibrium of type 1 with $n+1$ intervals and proof follows. ■

The next lemma shows that whenever an equilibrium of type 1 with $n+1$ intervals and an equilibrium of type 2 with n intervals coexist, the type 1 equilibrium dominates in terms of welfare. The proof is analogous to the one of Proposition 3 and to save on space it is not included. Details are available upon request.

Lemma 7 *Welfare comparison of equilibria with $n+1$ and n intervals:*
i) Suppose that an equilibrium of type 1 with $n+1$ intervals and an equilibrium of type 2 with n intervals coexist. Then, the equilibrium of type 1 with $n+1$ intervals results in the highest joint welfare of the two countries.
ii) Suppose that equilibria of type 2 with $n+1$ intervals and with n intervals coexist. Then, the equilibrium with $n+1$ intervals results in the highest joint welfare of the two countries.

From Corollary 2 and Lemma 7 follow immediately:

Proposition 10 *For $b > a$ the equilibrium that maximizes the joint welfare of country A and B is of type 1.*

Under Assumption 1 and 2 it is thus sufficient to consider equilibria of type 1 in the main analysis.