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Supervision of financial conglomerates

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Abstract

This paper studies how the institutional structure of supervision affects the incentives of financial supervisors to monitor both stand-alone financial institutions and financial conglomerates. It is shown that, even in case of financial conglomeration, decentralized supervision can be as effective as integrated supervision. However, since the monitoring intensities under integrated and decentralized supervision do not always coincide, the conglomerate form can also be used opportunistically by the financial intermediaries in search for less comprehensive supervision. The analysis of this paper has implications for factors like the price and availability of funding, the desired level of fund insurance policies and the need to harmonize supervisory structures.

JEL Classification: G21, G22, G28

Keywords: financial supervision, financial conglomerates, banking, insurance.

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1 Introduction

To facilitate supervisory cooperation in response to the emergence of financial conglomerates, multinational financial institutions and new financial products, there has been an increasing trend in Europe to integrate financial supervision. This is exemplified by the tendency of various countries to decrease the number of authorities in charge of the supervision of banking, insurance and securities business.[1] By using the popularity of financial conglomerates in Europe and, especially, in Scandinavia as a starting point, this paper applies economic theory to analyze how the incentives of a financial supervisory authority to oversee financial intermediaries depend on the institutional structure of supervision as well as the type of financial intermediaries that exist on the market.[2] In this paper, the supervisory effort of an authority is derived endogenously from the model so as to compare how the supervisory incentives of an integrated supervisory authority differ from those of sectorally separated supervisors when the financial intermediaries to be overseen can be either stand-alone institutions or financial conglomerates combining several financial product lines (e.g., banking and insurance) under a single roof.

To analyze these issues, I apply insights from monitoring in a bank-firm

[1] Finland has also followed this trend by combining two formerly separate agencies (the Financial Supervision Authority and the Insurance Supervision Authority) so as to create a single national authority responsible for the supervision of banking, securities business and insurance.

[2] In terms of market shares in year 2001, financial conglomerates held 57% of deposits and 61% and 37% of premium income in the Finnish banking, life insurance and non-life insurance markets, respectively (see Holopainen (2007)).

relationship (e.g., Carletti (2004), Carletti et al. (2007), Cerasi and Daltung, S. (2000)) to construct a simple one-period model inspired by Holmström and Tirole (1997). A financial intermediary has access to a risky project for which it raises the funds from debt-holders. Instead of exerting effort to increase the success probability of the project, the intermediary may misbehave so as to enjoy a private benefit. The intermediary's incentives to exert effort can be increased through costly monitoring by a supervisory authority. Monitoring reduces the risk of intermediary's failure and, consequently, the associated failure costs borne by the supervisor in form of fund insurance payout and social bankruptcy costs. The supervisor's monitoring incentives depend not just on the institutional structure of supervision (integrated vs decentralized) but also on the type of the financial intermediary (stand-alone vs conglomerate) as these factors together determine whether the supervisory authority is the sole supervisor of the financial intermediary or monitors it together with another agency. In contrast to a sole supervisor, multiple supervisors have the potential to benefit from diseconomies of scale in monitoring but are also tempted to free-ride on the supervisory effort of the other agency. For this trade-off to realise it does not however suffice that the supervision is decentralized but it also requires that the financial intermediary to be overseen is a financial conglomerate instead of a stand-alone financial institution. Consequently, financial conglomeration is equivalent to making the supervisory incentives sensitive to the institutional structure of supervision. In case of a financial conglomerate, decentralized supervision has then the potential to be equally effective as integrated supervision if the benefits from sectoral supervision in terms of the diseconomies of scale in monitoring

can overcome its downsides in the form of the incentives of the supervisors to free-ride on each other's monitoring effort.

The analysis of this framework delivers several result. First, the analysis suggests that, even in the absence of conglomeration, measures like fund insurance policies should be coordinated with the nature and the design of the supervisory system. Otherwise, the financial intermediaries may be unable to raise funding from the debt-holders. This threat is especially true in environments characterized by high cost of monitoring (e.g., because of deficiencies in the regulatory and legal framework) since in these situations the level of official supervision will not necessarily be high enough to compensate for ungenerous fund insurance in protecting the interests of the debt-holders. As a result, the level of fund insurance becomes critical since a too low level may threaten the flow of credit to and from financial intermediaries.

Second, this paper shows that decentralized supervision can be as effective in supervision of financial conglomerates as integrated supervision. However, while integrated supervision is not necessary for the effective supervision of financial conglomerates in all circumstances, it is at least as effective in terms of the monitoring intensities as decentralized supervision. Consequently, the results are both supportive to the recent trend in Europe to replace sectoral supervision with integrated supervision but also indicative of the possibility that the two supervisory structures can coexist in different countries and be equally effective also in the supervision of financial conglomerates.

Third, this paper illustrates that although decentralized supervision may lead to a lower monitoring intensity that handicaps the financial conglomerate by lowering the success probability of the project and raising the interest

rate requirement by the debt-holders, the profits from financial conglomeration may still be higher under sectoral supervision especially if the private benefits are high. Consequently, the analysis suggests that financial intermediaries may be tempted to adopt the conglomerate form or, if already operating as a financial conglomerate, tempted to migrate to environments that posit sectoral supervision so as to benefit from the potentially less comprehensive supervision. This in turn has implications for the value of different policy measures like the need to harmonize supervisory structures, the importance of ensuring the competitiveness of the financial sector as well as the usefulness of limiting the corporate forms available for financial intermediaries.

The main insight of this paper is to analyze how the institutional structure of supervision interacts with the type of financial intermediary in determining the incentives of the financial supervisor to monitor the financial intermediary and how these interactions translate into the price and availability of funding as well as the desire of financial intermediaries to use the conglomerate form so as to benefit from a certain monitoring intensity. Since the move towards integrated supervision is often justified by the expected increase in the effectiveness of supervision especially in case of financial conglomerates, it is important to explicitly look at the supervisory incentives to see whether (and under which conditions) this will happen. Understanding the relative advantages of integrated and sectorally separated supervision is also important since, despite the tendency towards more integrated supervision in Europe, the supervisory structures around the world do yet

posit a great deal of heterogeneity.[3] A more detailed knowledge of the supervisory dynamics between separate supervisors is also justified since, in addition to significant cross-sectoral activities, large financial conglomerates (e.g., Nordea) often have extensive cross-border activities too which require supervisory cooperation between different national authorities. As a result, the supervisory interactions analyzed here could help to shed some light on the supervisory challenges arising among competing national supervisors.

By analyzing the supervisory effects of financial conglomeration, I am able to expand the existing regulatory literature on financial conglomerates that has concentrated on the capital regulation of these institutions. Both Freixas et al. (2007) and Mälkönen (2009) illustrate a need for either higher or lower capital requirements for financial conglomerates arising either from the problem of regulatory arbitrage or from the intensified competition in the markets for financial services. Neither of these papers however takes up the issue of official supervision of financial conglomerates. In this respect, this paper also departs from Boot and Schmeits (2000) and Dewatripont and Mitchell (2005) who analyze the effects of conglomeration on the incentives of conglomerate divisions to take risk. Here the emphasis is on the effects of financial conglomeration on the incentives of financial supervisors to limit risk through official oversight.

In considering the strategic interaction between several supervisors, this paper is also linked to the literature on the supervision of multinational

[3]For example, in the United States the supervisory system is still built upon the general principle of sectorally separated supervision (for more on the differences between the European and the US approach, see Holopainen (2007)).

banks. Closest in spirit is the paper by Holthausen and Rønde (2005) which shows that a supranational authority can lead to improved decisions to close a multinational bank especially when the interests of the national supervisors are very divergent. They also demonstrate that a bank may allocate its investments strategically across countries so as to escape closure. In a similar vein, this paper highlights in context of financial conglomerates that integrated supervision can be superior to a more decentralized solution, and that variance in the supervisory policies may be exploited by the financial intermediaries in search for certain monitoring intensity. However, in contrast to Holthausen and Rønde, I explicitly consider the incentives of the supervisory authorities to gather costly monitoring information and show how, in presence of not just banks but different types of financial intermediaries, these incentives depend on whether the supervisory authority is solely responsible for the supervision or carries it out in cooperation with another agency. As a result, the potential differences in the supervisory policies are derived here from the underlining differences in the supervisory structures and financial institutions.[4]

Finally, by touching the issue of whether a more harmonized approached should be taken with respect to financial supervision, this paper is also related to Dell'Ariccia and Marquez (2006) and, especially, Acharya (2003) who analyze the need for more coordinated approach in bank regulation. In spirit of their work, this paper also implies that lack of harmonization may

[4]In analyzing the question of how many supervisors to have, this paper is also connected to that of Kahn and Santos (2005) on bank regulation. In their paper, Kahn and Santos consider whether to keep the deposit insurance and lending of last resort functions separate, and whether to allocate one of these authorities also the right to close banks down.

lead to worsening of regulatory standards in terms of how comprehensively financial institutions are supervised.

The remainder of the paper is organized as follows. Section 2 describes the basic model in terms of a stand-alone financial intermediary. Section 3 contains the main results concerning stand-alone intermediaries. Section 4 extends the analysis to cover financial conglomerates under two alternative supervisory structures. Finally, Section 5 concludes. All the proofs are in the Appendix.

2 The basic model

Consider a two-date economy ($t = 0, 1$) with three types of risk-neutral parties: a financial intermediary, numerous debt-holders and a supervisory authority. The financial intermediary has access to a risky project requiring an investment of one unit at date 0. The project generates a cash flow R if it succeeds and 0 if it fails at date 1. The success probability of the project depends on the behavior of the financial intermediary: it is p_L, if the intermediary misbehaves and p_H, where $p_H > p_L$, if it behaves well. The intermediary may choose to misbehave in order to enjoy a non-transferable private benefit B. This can be interpreted as running unprofitable pet projects or, alternatively, as opportunity costs from managing projects diligently. There is a moral hazard problem as the intermediary's behavior is not observable.

The financial intermediary has no initial capital but raises funds from debt-holders at a gross interest rate r. The debt-holders are (partially) protected by a fund insurance scheme securing fraction $\alpha \in [0, 1]$ of the debt-

holders' funds in case the intermediary fails. For simplicity, fund insurance premium is taken to be zero.[5] The debt-holders are willing to provide funds as long as they expect to at least break-even; that is, if they expect a return at least equal to the gross return $y \geqslant 1$ from an alternative (safe) investment.[6]

In what follows, I assume that the intermediary's project is creditworthy only if the intermediary behaves; i.e.,

$$p_H R > y > p_L R. \tag{A1}$$

As the expected cash flow of the intermediary's project is higher than the safe return when the intermediary behaves and lower if it misbehaves, I sometimes refer to the former type of project as the good project and the latter type as the bad project.

Secondly, I assume that the private benefit B is sufficiently high to induce the financial intermediary to misbehave even if the interest rate r is set at the lowest possible level $r = \frac{y-(1-p_H)\alpha}{p_H}$ that just allows the debt-holders to break-even. Formally, this translates to condition

$$p_H (R - r) < p_L (R - r) + B,$$

[5] Evidence from the United States' banking sector suggests that until recently insurance premiums collected from banks were either risk-insensitive or virtually non-existent. In particular, during the 1996-2006 period, majority of the U.S. banks were categorized in the lowest risk category exempted altogether from the insurance premiums as long as the insurance fund reserves kept exceeding a prespesified threshold level (Acharya et al. (2010)).

[6] In assuming that the financial intermediary is able to extract all the surplus, the approach taken here corresponds to that in Carletti et al. (2007), Cerasi and Daltung (2000) and Freixas et al. (2007). It can be interpreted as reflecting scarcity in the ability to identify profitable investment projects.

where $r = \frac{y-(1-p_H)\alpha}{p_H}$. This can be rewritten as

$$B > \underline{B} \equiv \frac{\Delta_p \left(p_H R + (1-p_H)\,\alpha - y\right)}{p_H}, \tag{A2}$$

where $\Delta_p = (p_H - p_L)$. Assumption (A2) implies a lower limit on the level of private benefits.

In this setting, the level of fund insurance will have important implications for the role of supervision by affecting the willingness of debt-holders to provide funds. In particular, there exists a threshold level of fund insurance, denoted by $\underline{\alpha}$, below which paying out the whole cash flow R in case of success won't be enough to allow the debt-holders to break-even when the intermediary misbehaves:

$$\begin{aligned} p_L R + (1-p_L)\,\alpha - y < 0, \\ \alpha < \underline{\alpha} \equiv \frac{y - p_L R}{1-p_L}. \end{aligned} \tag{C1}$$

Consequently, when $\alpha < \underline{\alpha}$, simple lending is not feasible. Put differently, it follows from assumptions (A1) and (A2) that, when $\alpha < \underline{\alpha}$, the moral hazard problem of the financial intermediary prevents funding to take place since the financial intermediary will misbehave in which case the debt-holders cannot expect to break-even.

Suppose now that there exists a party who can monitor the financial intermediary and, consequently, help to reduce the moral hazard problem. For the purpose of this paper, the debt-holders are assumed to be too dispersed (or unsophisticated) to effectively monitor the financial intermediary. Instead, this task is assigned to an official supervisory authority. In particular, monitoring allows the supervisory authority to observe the intermediary's

behavior and to intervene if the intermediary misbehaves.[7] Monitoring with intensity $m \in [0,1]$ costs $C(m) = \frac{1}{2}cm^2$, where m corresponds the probability that the financial intermediary is made to behave well and c measures the importance of diseconomies of scale in monitoring. In applying the approach of Carletti (2004) and Carletti et al. (2007) into the analysis of official supervision, this convex cost function is meant to reflect the idea that it is difficult for the supervisory authority to find out more and more about a financial intermediary due to the scarcity of skilled personnel or, alternatively, the negligence of other duties.[8]

The supervisory authority's monitoring intensity is unobservable. In choosing its monitoring intensity, the supervisory authority acts in a cost-minimizing way; i.e., it is interested in limiting the costs associated with the intermediary's failure.[9] In addition to the fund insurance payout (determined

[7] By allowing the monitor to intervene and prevent misbehavior, the monitoring technology is similar to that in Besanko and Kanatas (1993) and Holmström and Tirole (1997).

[8] Alternatively, the diseconomies of scale could be related to the potential costs of establishing an integrated supervisory authority. In particular, there has been a fear that supervisory integration may threaten the recognition of industry-specific characteristics and expertise in supervision through, for instance, the departure of experienced personnel or because of one agency's approach to supervision becomes overly dominant over that of the other agency. In a study of integrated supervisory agencies, Martínez and Rose (2003) found that demoralization of staff and departure of experienced personnel were commonly encountered in establishing integrated agencies.

[9] By definition, the cost-minimising supervisory authority is solely concerned about limiting the downside. Consequently, its choice of monitoring intensity will generally differ from that of a welfare-maximizing supervisor who cares about the aggregate welfare of the parties and, as a result, also takes into account the upside (for future reference, the monitoring intensity of the welfare-maximizing supervisor is given in the Appendix). In

by α), these include social bankruptcy costs denoted by parameter g.[10] Interestingly, depending on the level of fund insurance, official supervision will now have somewhat different role. When $\alpha < \underline{\alpha}$, supervision is necessary for funding to take place. When $\alpha > \underline{\alpha}$, supervision is no longer essential for funding but is still valuable in limiting the social bankruptcy costs and the fund insurance payout not taken into account by the debt-holders and the intermediary.

The timing of the model is the following. At date $t = 0$ the financial intermediary collects funds from debt-holders by setting an interest rate r. The offered interest rate must satisfy the debt-holders' break-even condition and it must be feasible (i.e., it cannot exceed the cash flow of a successful project). Then the intermediary uses the funds to undertake a project (i.e., chooses its behaviour) and the supervisory authority decides how intensively to monitor the intermediary's project choice.[11] At date $t = 1$ the returns are realized and the claims are settled.

analyzing a cost-minimising supervisory authority, this paper follows the approach taken for instance in Mailath and Mester (1994) and Repullo (2001).

[10] Social bankruptcy costs refer to the negative externalities associated with the intermediary's failure (e.g., the effect of bank failure on payment system). They can also capture the administrative costs of declaring the intermediary bankrupt and closing it down.

[11] This choice of timing does not affect the results as long as the parties' decisions are not observable. The results are affected if a supervisor can commit to a specific monitoring intensity. For more discussion on this, see the section on "Decentralized supervision".

3 Monitoring choice and interest rate

In this section, I first derive the supervisory authority's choice of monitoring intensity given the incentive of the intermediary to misbehave in absence of monitoring. After that, I derive the interest rate offered to the debt-holders by the intermediary. I also check that the interest rate offered is feasible; i.e., that it doesn't exceed the pecuniary return of the project.

The supervisor chooses its monitoring intensity so as to reduce the social bankruptcy costs and the fund insurance payout associated with the intermediary's failure:

$$\max_{m} m\left[-\left(1-p_H\right)\left(\alpha+g\right)\right]+\left(1-m\right)\left[-\left(1-p_L\right)\left(\alpha+g\right)\right]-\frac{1}{2}cm^2. \qquad (1)$$

The interpretation of (1) is the following. Whenever the supervisor succeeds in monitoring (which happens with the probability m), the financial intermediary is made to behave well. This then results to the realization of social bankruptcy costs g and fund insurance payout α only when the intermediary's project fails; this happens with probability $(1-p_H)$. Whenever the supervisor fails in monitoring (which happens with the probability $(1-m)$), the intermediary has incentives to misbehave leading to the realization of bankruptcy costs and fund insurance payout with a higher probability $(1-p_L)$. Solving (1), gives the supervisor's choice of monitoring intensity:

$$m=\min\left\{\frac{\Delta_p\left(\alpha+g\right)}{c},1\right\}, \qquad (2)$$

which can also be expressed as

$$m=\begin{cases} 1 & \text{if } c\leq \underline{c}\equiv\Delta_p\left(\alpha+g\right), \\ \frac{\Delta_p(\alpha+g)}{c} & \text{if } c>\underline{c}\equiv\Delta_p\left(\alpha+g\right). \end{cases}$$

Given that an interior solution obtains, the supervisor's monitoring intensity is increasing in the difference in the project's success probabilities, the extensiveness of the fund insurance coverage and the magnitude of social bankruptcy costs; the monitoring intensity is decreasing in the cost of monitoring (measured by the parameter c). There is a critical level of c, denoted by $\underline{c}$, after which the supervisor monitors with an intensity less than one. If the cost of monitoring do not exceed this threshold, the supervisor monitors with an intensity of one.[12]

Correctly anticipating the supervisor's monitoring decision the financial intermediary sets at date $t = 0$ the interest rate r so as to maximize its expected profit subject to the debt-holders' break-even condition and the contract feasibility condition. This results to an interest rate

$$r = \frac{y - (1 - p_H)\,\alpha}{p_H}, \tag{3}$$

if the supervisor monitors with an intensity of one, and to

$$r = \frac{[y - (1 - p_L)\,\alpha]\,c + \Delta_p^2 \alpha\,(\alpha + g)}{p_L c + \Delta_p^2\,(\alpha + g)}, \tag{4}$$

if the supervisor monitors with an intensity less than one (for a more detailed derivation of the interest rates offered, see the Appendix).

The interest rate is feasible, if $r \leq R$. When $m = 1$, this condition is always met. When $m < 1$ and the level of fund insurance is low (i.e., $\alpha < \underline{\alpha}$), the cost of monitoring has to be sufficiently low (i.e., $c \leq \overline{c} \equiv \frac{\Delta_p^2(\alpha+g)(R-\alpha)}{y-p_L R-(1-p_L)\alpha}$) for the supervisor to monitor with high enough intensity to make the required interest rate feasible; with more generous fund insurance or at intermediate

[12] How the cost-minimizing supervisor's monitoring intensity relates to that of welfare-maximizing one, see the Appendix.

levels of monitoring costs (i.e., $c \in [\underline{c}, \overline{c}]$), the feasibility condition is always met.[13] The following proposition summarizes this result:

Proposition 1 *When the diseconomies of scale in monitoring are high (i.e., $c > \overline{c}$), official supervision is unable to compensate for low fund insurance in protecting the interest of the debt-holders; as a result, the financial intermediary is unable to raise funds if $\alpha < \underline{\alpha}$.*

Proof. See the Appendix. ■

Proposition 1 captures the idea that, from the viewpoint of the debt-holders, fund insurance and official supervision are two alternative instruments to reduce the riskiness of investment. When fund insurance becomes less generous, the importance of monitoring increases. However, the level of monitoring may be insufficient to compensate for a less generous fund insurance if monitoring is very costly. As a result, the financial intermediary may fail to raise funding when its behavior is subject to sufficiently severe moral hazard problem.

Proposition 1 suggests that the design of fund insurance policies should take into account the design and nature of the supervisory framework. Especially in environments characterized with high costs of official supervision

[13] These results would not qualitatively change under competitive banking sector. In this case, the interest rate would equal R for all levels of monitoring. As the private benefit is non-transferable, this would leave the intermediary some rents when $m < 1$ since, due to limited liability, no-one can end up with negative consumption. Under this scenario, there could still be situations when the debt-holders' break-even condition is violated for $m < 1$ (i.e., it is possible to find y so that assumption (A1) holds but the break-even condition is not met).

the level of fund insurance becomes critical since a too low level may threaten the flow of credit to and from financial intermediaries.

Corollary 2 *The design of fund insurance policies should be coordinated with the design of supervisory framework.*

This result implies that in environments where it is not easy for a supervisor to collect and process information about the intermediaries (e.g., because of deficiencies in the regulatory and legal framework), the coordination of policies becomes especially important. This is likely to be true for instance in less well-developed supervisory systems.

The preceding analysis is best suited to describe the supervision of a homogeneous financial intermediary like a stand-alone bank or an insurance company. In the next section, I will extend the basic framework so as to analyze the supervision of a heterogeneous financial intermediary which combines characteristics of two different stand-alone intermediaries. A natural example of a heterogenous financial intermediary is a financial conglomerate that combines banking and insurance under a single roof. In this context, also the organization of supervision becomes relevant. In particular, in contrast to the case where only stand-alone financial intermediaries exist, it matters whether a single integrated supervisor is in charge of the supervision of financial intermediaries or whether supervision is decentralized so that in the case of a financial conglomerate (at least) two agencies are expected to cooperate in its supervision.

4 Monitoring of a financial conglomerate

In this section, I will first discuss the definition of a financial conglomerate. After that I will derive the monitoring intensity of the supervisory authority under two alternative supervisory structures: integrated supervision (i.e., a single supervisor is in charge of supervision) and decentralized supervision (i.e., two supervisors cooperate in supervision).

In this paper, a financial conglomerate is taken to be a financial intermediary that differs from a stand-alone one in two respects. First, instead of raising the funding from a single class of debt-holders, the financial conglomerate collects the funding in equal proportions from two classes of debt-holders who differ in terms of their fund insurance coverage.[14] Formally, this is captured by denoting the fund insurance coverage by α_i, $i = B, I$, where the subscript B is taken to refer to the banking-part of the conglomerate and I to the insurance-part. This then implies that, if one unit of outside funding is needed (and half a unit is collected from each class of debt-holders), a fraction of funds equal to $\frac{1}{2}(\alpha_B + \alpha_I)$ is protected in aggregate by the fund insurance.

Second, the social bankruptcy costs associated with the failure of a fi-

[14] For example, debt-holders (i.e., depositors) in banks tend to have access to more extensive fund insurance than debt-holders in insurance companies. The use of deposit insurance in banking is typically justified by the desire to avoid costly bank runs. On the other hand, claims under insurance contracts are generated by the occurrence of a specified event (exogenous to an economic agent) and, as a result, do not similarly rely on the debt-holders' sense of confidence as the withdrawal of bank deposits. The lack of counterpart to bank runs in insurance tends to lead to less extensive fund insurance (for more on this, see Rees and Kessner (1999)).

nancial conglomerate are allowed to differ depending on where (i.e., which part of the intermediary) the failure takes place.[15] Formally, this is captured by denoting the social bankruptcy costs by g_i, $i = B, I$.[16] To simplify expressions I will use $L_i = \left(\frac{1}{2}\alpha_i + g_i\right)$, $i = B, I$, as a shorthand to denote the failure costs associated with the part i of the conglomerate. Furthermore, to facilitate the subsequent analysis I will assume that

$$L_B \geq L_I. \tag{A3}$$

Assumption (A3) means that the failure costs of the banking-arm of the financial conglomerate are taken to be at least as large as those of the insurance-arm. This assumption is in line with the general conception that bank failures are more risky than insurance failures.

Otherwise, the project and debt-holder characteristics are as before. In particular, the financial intermediary is still assumed to have access to a single risky project requiring one unit of outside funding. To ensure that the financial conglomerate cannot be given monetary incentives to behave well (i.e., high enough share of the project cash flow to ensure good behavior), assumption (A2) is now modified to the following form:

$$B > \underline{B}' \equiv \frac{\Delta_p \left(p_H R + \frac{1}{2}\left(1 - p_H\right)\left(\alpha_B + \alpha_I\right) - y\right)}{p_H}. \tag{A2'}$$

[15] To give an example, the failure of a bank is usually thought to have a larger systemic effect than the failure of an insurance company because of banks' role in the payment system.

[16] Alternatively, the parameter g_i could be taken to measure the political cost of bankruptcy to the supervisory authority i (for more on this approach, see Kahn and Santos (2005)).

Given assumptions (A1) and (A2') and the characterization of the financial conglomerate, I will now move to analyze the monitoring intensities under two alternative supervisory structures. I start by analyzing integrated supervision and then move to decentralized supervision.

4.1 Integrated supervision

Under integrated supervision, a single supervisory authority is in charge of monitoring the behavior of the financial conglomerate. Given that the timing of the model remains the same, the integrated supervisor chooses its monitoring intensity so as to reduce the aggregate fund insurance payout and the aggregate social bankruptcy costs associated with the intermediary's failure:

$$\max_{m} m\left[-\left(1-p_H\right)\left(L_B+L_I\right)\right]+\left(1-m\right)\left[-\left(1-p_L\right)\left(L_B+L_I\right)\right]-\frac{1}{2}cm^2, \quad (5)$$

where I have used the expression $L_i = \left(\frac{1}{2}\alpha_i + g_i\right)$, $i = B, I$, as a shorthand to denote the failure costs associated with the part i of the conglomerate.

The interpretation of equation (5) is the following. Whenever the integrated supervisor succeeds in monitoring (which happens with the probability m), the financial conglomerate is made to choose the good project with success probability of p_H. This then results to the realization of aggregate social bankruptcy costs and aggregate fund insurance payout only when the intermediary's project fails; this happens with probability $(1 - p_H)$. Whenever the supervisor fails in monitoring (which happens with the probability $(1 - m)$), the intermediary has incentives to misbehave leading to the realization of bankruptcy costs and fund insurance payout with a higher probability

$(1-p_L)$. Solving (5), gives the supervisor's choice of monitoring intensity:

$$m = \min\left\{\frac{\Delta_p\left(L_B+L_I\right)}{c}, 1\right\}, \tag{6}$$

which can also be expressed as

$$m = \begin{cases} 1 & \text{if } c \leq \underline{c}' \equiv \Delta_p\left(L_B+L_I\right), \\ \frac{\Delta_p(L_B+L_I)}{c} & \text{if } c > \underline{c}' \equiv \Delta_p\left(L_B+L_I\right). \end{cases}$$

Solving for r_i gives

$$r_i = \frac{y-(1-p_H)\,\alpha_i}{p_H},$$

if the supervisor monitors with an intensity of one, and

$$r_i = \frac{\left[y-(1-p_L)\,\alpha_i\right]c + \Delta_p^2\alpha_i\left(L_B+L_I\right)}{p_L c + \Delta_p^2\left(L_B+L_I\right)},$$

if the supervisor monitors with an intensity less than one.

As before, with ungenerous fund insurance (i.e., $\alpha_i < \underline{\alpha}$) the cost of monitoring has to be sufficiently low (i.e., $c \leq \overline{c}' \equiv \frac{\Delta_p^2(L_B+L_I)(R-\alpha_i)}{y-p_L R-(1-p_L)\alpha_i}$) for the supervisor to monitor with high enough intensity to make the required interest rate feasible. Consequently, the design of fund insurance policies should be sensitive to the characteristics of the supervisory system so as to avoid undesired interruptions in the flow of funds to and from financial conglomerates.

4.2 Decentralized supervision

In the previous section, a single integrated supervisor was in charge of the supervision of the financial conglomerate. Under decentralized supervision, there are two separate authorities each with the task to minimize the fund

insurance payout and the social bankruptcy costs of a particular part (section) of the conglomerate. In particular, a supervisory authority i is in charge of minimizing the fund insurance payout to the debt-holders of class i. In addition, the supervisor i is also in charge of minimizing the social bankruptcy costs associated with the failure in part i of the intermediary. Taken together, a separate sectoral supervisor is concerned about minimizing the total failure costs of a particular part of the conglomerate while an integrated supervisor cares about the total failure costs of the whole conglomerate.

The difference between integrated and decentralized supervision depends also on how the two sectoral supervisors interact in their monitoring decisions. In what follows, I assume that the two sectoral supervisors choose their monitoring intensities simultaneously and non-cooperatively by taking into account that it is sufficient for one of them to detect misbehavior in order to increase the success probability of the *whole* project.[17] As a result, monitoring essentially delivers a public good from which both the supervisors can benefit. The overall monitoring intensity (or detection probability), denoted by M, becomes

$$M = 1 - (1 - m_B)(1 - m_I).$$

The supervisor i chooses its monitoring intensity so as to minimize the social bankruptcy costs and fund insurance payout associated with the debt-holders

[17] Choosing simultaneous moves does not affect the results as long as a supervisor's choice of monitoring intensity remains unobservable to the other supervisor. The results are affected if one of the supervisors chooses its monitoring intensity first, and the other supervisor can observe it before moving. This case corresponds to a situation where a supervisor can commit to a specific monitoring intensity.

of class i:

$$\max_{m_i} M\left[-\left(1-p_H\right)L_i\right]+\left(1-M\right)\left[-\left(1-p_L\right)L_i\right]-\frac{1}{2}cm_i^2. \tag{7}$$

Expression (7) captures the fact that the two supervisors face an externality in monitoring since the success probability of the project is raised unless *both* of them fail in monitoring. In comparison to integrated supervision, decentralized supervision suffers from a free-riding problem (so that an individual supervisor may choose to free-ride on the monitoring effort of another supervisor) but benefits from diseconomies of scale in monitoring. The interaction of these two effects (captured by M and c, respectively) determines how the monitoring intensities of the sectoral supervisors relate to that of the integrated supervisor.

Solving (7), gives the supervisors' choice of monitoring intensity:

$$m_B=\frac{\Delta_p L_B\left[c-\Delta_p L_I\right]}{c^2-\Delta_p^2 L_B L_I}, \tag{8}$$

$$m_I=\frac{\Delta_p L_I\left[c-\Delta_p L_B\right]}{c^2-\Delta_p^2 L_B L_I}. \tag{9}$$

Using the assumption $L_B \geq L_I$, it is easy to show that:

Proposition 3 *When $c<\Delta_p L_I$, both sectoral supervisors monitor with positive intensity less than one given by m_B and m_I in (8) and (9), respectively. When $\Delta_p L_I \leq c<\Delta_p\sqrt{L_B L_I}$, $m_B=0$ and $m_I=1$. When $\Delta_p\sqrt{L_B L_I}<c\leq\Delta_p L_B$, $m_B=1$ and $m_I=0$. When $c>\Delta_p L_B$, both sectoral supervisors monitor with positive intensity less than one given by m_B and m_I in (8) and (9), respectively.*

Proof. See the Appendix. ■

Proposition 2 highlights several important points. First, at low levels of cost of monitoring (i.e., $c < \Delta_p L_I$), the two sectoral supervisors will monitor even in aggregate less than the integrated supervisor.[18] This result follows from the fact that at low levels of c the diseconomies of scale in monitoring do not yet benefit the two sectoral supervisors sufficiently so that they could overcome their free-riding problem.[19]

Second, because of the free-riding problem the two sectoral supervisors may both in turn choose to rely entirely on the monitoring effort of the other supervisor. This happens at the intermediate levels of cost of monitoring (i.e., $\Delta_p L_I \leq c \leq \Delta_p L_B$). Despite the free-riding problem, decentralized supervision will lead (in this region) to equally effective supervision of financial conglomerates as integrated supervision. In particular, while one of the supervisors always free-rides on the monitoring effort of the other supervisor, the two sectoral supervisors are able in aggregate to monitor as effectively as the integrated supervisor (i.e., $M = m = 1$ holds in this region).[20]

[18] To see this, let's first rewrite the aggregate monitoring intensity as $M = m_B + m_I - m_B m_I$. The result then follows simply from the observation that $M < 1$ whenever $m_B, m_I < 1$.

[19] In essence, the two supervisors suffer from a commitment problem since their monitoring efforts are unobservable. In particular, at low levels of c, neither of the supervisors can commit *not* to monitor. Anticipating positive monitoring by the other supervisor leads both supervisors to reduce their monitoring intensities so that even in aggregate the sectoral supervisors monitor less than the integrated supervisor.

[20] At intermediate levels of c one of the supervisors can credibly commit not to monitor. Simultaneously, the cost of monitoring is still sufficiently low so that the other supervisor has incentive to monitor with full intensity. As a result, the two supervisors monitor in aggregate as effectively as the integrated supervisor.

Third, at high levels of cost of monitoring (i.e., $c > \Delta_p L_B$), the sectoral supervisors monitor less in aggregate than the integrated supervisor when $\Delta_p L_B < c \leq \Delta_p (L_B + L_I)$ since (in this region) $M < 1$ and $m = 1$. The high cost of monitoring essentially prevents neither of the supervisors to monitor with high enough intensity so that the supervisors could overcome their free-riding problem.

However, when $c > \Delta_p (L_B + L_I)$, the analysis is more complicated. Since both the integrated supervisor as well as the sectoral supervisors monitor with less than full intensity in this region, the effectiveness of decentralized supervision as compared to integrated supervision depends on how the overall monitoring intensity under decentralized supervision

$$M = \frac{\Delta_p \left[(L_B + L_I) c^3 - 3\Delta_p L_B L_I c^2 + \Delta_p^3 L_B^2 L_I^2 \right]}{\left(c^2 - \Delta_p^2 L_B L_I \right)^2}$$

relates to the monitoring intensity

$$m = \frac{\Delta_p (L_B + L_I)}{c}$$

under integrated supervision. Proposition 3 summarizes the findings from the comparison of M and m:

Proposition 4 *When the cost of monitoring is at the intermediate level (i.e., $\Delta_p L_I \leq c \leq \Delta_p L_B$), the overall monitoring intensity under decentralized supervision equals the monitoring intensity of the integrated supervisor. Otherwise, integrated supervision leads to higher monitoring intensity.*

Proof. See the Appendix. ■

Interestingly, Proposition 3 reveals that contrary to the common belief integrated supervision is not necessarily superior to decentralized supervision in context of financial conglomerates:

Corollary 5 *Decentralized supervision can be as effective in supervision of financial conglomerates as integrated supervision.*

The preceding result suggests that the two supervisory structures could co-exist in different countries and deliver similar results in terms of supervisory intensities and cost and availability of funding for financial conglomerates.[21] In particular, as long as the supervisory structure in question leads to full monitoring intensity, the debt-holders will require the same interest rate from the conglomerate independent of its supervisory structure. Otherwise, the first instinct suggests that the interest rate offered to the debt-holders should in general be at least as high under decentralized supervision as under integrated supervision. To see that this is in fact the case, I take the monitoring intensities m and M as given and use the debt-holders' break-even conditions to solve for the required interest rate under integrated and decentralized supervision, respectively:

$$r_i^{int} = \frac{y - (1 - p_L)\,\alpha_i + \Delta_p \alpha_i m}{p_{L+} \Delta_p m}, \tag{10}$$

$$r_i^{dec} = \frac{y - (1 - p_L)\,\alpha_i + \Delta_p \alpha_i M}{p_{L+} \Delta_p M}. \tag{11}$$

Both (10) and (11) are decreasing with the level of monitoring intensity. Furthermore, $r_i^{dec} \geq r_i^{int}$ if $(M - m)\,(y - \alpha_i) \leq 0$. Since $(M - m) \leq 0$ and $(y - \alpha_i) > 0$, the debt-holders' do indeed require at least as high interest rate

[21] Interestingly, if either the banking or the insurance supervisor could commit *not* to monitor for the low values of c (i.e., $c \leq \Delta_p L_I$), decentralized supervision would be equally effective as integrated supervision also in this range. Whether such commitment would be beneficial for the high values of c (i.e., $c > \Delta_p L_B$) is a more complicated issue and depends on the parameter constellations of the model.

from the financial conglomerate under decentralized supervision as they do under integrated supervision. However, this does not necessarily mean that the profit from conglomeration will be lower under sectoral supervision. In fact, as the following Proposition illustrates, the profit from conglomeration can be higher under sectoral supervision:

Proposition 6 *Despite higher funding costs profit from conglomeration can be higher under decentralized supervision.*

Proof. See the Appendix. ■

Proposition 4 highlights the fact that from the viewpoint of the financial conglomerate monitoring under integrated supervision can be too high in terms of the private benefits that are lost. Although lower monitoring handicaps the financial conglomerate by leading to a lower success probability of the project and to a higher interest rate requirement by the debt-holders, the conglomerate may still benefit from sectoral supervision especially if the private benefits are high.

Consequently, financial conglomerates may be tempted to migrate to environments that posit sectoral supervision so as to benefit from the potentially less comprehensive supervision. This in turn implies that harmonization of the various supervisory structures currently in use in different countries (e.g., in Europe) could be beneficial insofar as it helps to fight this tendency. It also suggests that, in absence of harmonization, ensuring the competitiveness of financial sector could help to fight this tendency by limiting the profits (rents) available from conglomeration. In particular, while not eliminating the differences in monitoring intensities, a more competitive financial sector may

reduce some unwanted consequences (like opportunistic conglomeration) arising from the variation in the supervisory structures. Alternatively, one could of course limit the formation of financial conglomerates under decentralized supervision so as to avoid the use of corporate form to escape comprehensive supervision. Interestingly, this is indeed the policy that the United States with its highly fragmented supervisory system has followed especially in the past (for more on this, see Holopainen (2007)).

More generally, the results of this paper are supportive to the recent trend in Europe to replace the traditional sectorally segregated supervisory model with a more integrated one. In particular, while integrated supervision is not necessary for the effective supervision of financial conglomerates in all circumstances, it still leads to at least as comprehensive supervision as decentralized supervision.

Furthermore, the results of this paper highlight the importance of monitoring costs for the comparative effectiveness of the different supervisory models and the flow of credit to (and from) financial intermediaries. In particular, high cost of monitoring reduces the monitoring incentives of the supervisors irrespective of the supervisory structure, diminishes the effectiveness of decentralized supervision relative to integrated supervision and increases the risk of interruptions in the flow of credit to stand-alone financial intermediaries as well as financial conglomerates. Hence, this paper suggests that in any supervisory system a high priority should be given to steps to control these monitoring costs.

5 Concluding remarks

The recent financial crisis has intensified the debate about the desirable structure of financial supervision in Europe. Despite a trend towards more integrated financial supervision over the past decade brought about by the conglomeration, internationalisation and the blurring of distinctions of the financial sector, the existing supervisory structures still exhibit great deal of heterogeneity both inside and outside Europe. This paper studies the challenges these varied structures pose on the quality of supervision when the financial intermediaries to be overseen include not just stand-alone financial intermediaries but also complex financial institutions like financial conglomerates.

In this paper, financial conglomeration is important as it conditions the incentives of the financial supervisors to exert monitoring effort on the institutional structure of supervision. In presence of financial conglomeration, decentralized supervision suffers from the temptation of the supervisors to free-ride on each other's monitoring efforts but has simultaneously the potential to benefit from convexities in the cost function. This paper demonstrates that decentralized supervision can lead to equally effective supervision of financial conglomerates as integrated supervision. However, since the monitoring intensities under integrated and decentralized supervision do not always coincide, this paper simultaneously shows that decentralized supervision is vulnerable to the desire of financial intermediaries to use conglomeration as a way to escape comprehensive supervision.

The model delivers several empirical implications. First, the design of fund insurance policies should be coordinated with the design of the super-

visory framework so as to ensure the flow of credit to and from financial intermediaries especially in environments where it is costly to supervisors to collect and process information about financial institutions. Second, integrated and decentralized supervision can coexist and be equally effective also in the supervision of financial conglomerates. Yet a move towards integrated supervision is justified in terms of financial stability (and equal treatment of financial intermediaries) since decentralized supervision is vulnerable to strategic exploitation by financial intermediaries. Third, the more conservative approach towards financial conglomeration traditionally adopted by the United States may be a reasonable response to its highly fragmented supervisory system so as to avoid deterioration of supervisory standards. This is especially true given the argument that, due to the sheer size of its financial sector, it is unlikely that official supervision of financial intermediaries will become fully integrated in the United States. Fourth, in absence of more harmonized approach in terms of the supervisory structures used, special attention should be paid to controlling the costs of official supervision as well as ensuring the competitiveness of the financial sector.

More generally, this research outline is concerned with the question of how to design an appropriate regulatory and supervisory framework for financial institutions that, through consolidation, have grown both in size as well as in complexity. The importance of this question especially for the financial system stability has been significantly facilitated by the recent financial crisis which has fuelled the policy debate on the ability of large financial institutions to receive implicit subsidies through too-big-to-fail or too-complex-to-fail policies. As some examples of the casualties of the crisis

(e.g., Fortis) demonstrate, the potential systemic implications of problems in these institutions are often even more compounded since, in addition to significant cross-sectoral activities, they may have extensive cross-border activities with varying degrees of significance in different countries. Given the need for supervisory cooperation in these situations, this paper provides one avenue to analyze the supervisory challenges likely to emerge in context of complex financial institutions.

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Appendix:

Monitoring intensity of a welfare-maximizing supervisor:

The monitoring intensity of the welfare-maximizing supervisor is denoted by m^W and is equal to

$$m^W = \min\left\{\frac{\Delta_p(R+g)-B}{c}, 1\right\}.$$

If $B < \overline{B} \equiv \Delta_p(R+g)$, the welfare-maximizing supervisor always monitors with positive intensity. This condition exceeds the lower limit of private benefits given in assumption (A2), and implies an upper limit on the level of private benefits.

Comparison of monitoring intensities between a welfare-maximizing and a cost-minimizing supervisor:

How the welfare maximizing supervisor's monitoring intensity relates to that of cost-minimizing one, depends on the level of private benefit. When $B \in \left(\underline{B}, \overline{B}'\right)$, where $\overline{B}' \equiv \Delta_p(R-\alpha)$, the monitoring intensity of the cost-minimizing supervisor equals that of the welfare-maximizing one if $c \leq \underline{c}$ and is lower otherwise. The lower monitoring intensity for $c > \underline{c}$ results from the fact that the cost-minimizing supervisor does not take into account the positive effect of its monitoring effort on the pecuniary returns generated. When $B \in \left(\overline{B}', \overline{B}\right)$, the monitoring intensities are the same if $c \leq \underline{c}$; otherwise, the cost-minimizing supervisor monitors with higher intensity than the welfare-maximizing one since the former does not take into account the negative effect of its monitoring effort on the private benefits generated.

Derivation of the financial intermediary's interest rate offer at date $t = 0$:

Given the supervisor's monitoring intensity $m = \min\left\{\frac{\Delta_p(\alpha+g)}{c}, 1\right\}$, the financial intermediary sets at date $t = 0$ the interest rate r so as to maximize its expected profit subject to the debt-holders' break-even condition and the contract feasibility condition:

$$\max_r mp_H(R-r) + (1-m)[p_L(R-r) + B],$$
$$\text{s.t. } m[p_H r + (1-p_H)\alpha] + (1-m)[p_L r + (1-p_L)\alpha] - y = 0,$$
$$r \leq R.$$

Inserting $m = 1$ and $m = \frac{\Delta_p(\alpha+g)}{c}$ into the debt-holders' break-even condition gives the interest rates in (3) and (4), respectively.

Proof of Proposition 1:

The interest rate offered to the debt-holders must not exceed the pecuniary return of the successful project: $r \leq R$. When the supervisor monitors with full intensity, this condition is always met. When the supervisor monitors with an intensity less than one, equation (4) gives the relevant condition:

$$-c[y - p_L R - (1-p_L)\alpha] + \Delta_p^2(\alpha+g)[R-\alpha] \geq 0.$$

The first term in the square brackets is positive only if $\alpha < \underline{\alpha}$. In this case, $c \leq \overline{c} \equiv \frac{\Delta_p^2(\alpha+g)(R-\alpha)}{y-p_L R-(1-p_L)\alpha}$ has to hold for the interest rate to be feasible.

Proof of Proposition 2:

Given $L_B \geq L_I$, the results stated in the Proposition 2 follow simply from a comparison of the signs of the numerator and the denominator of $m_B = \frac{\Delta_p L_B[c-\Delta_p L_I]}{c^2-\Delta_p^2 L_B L_I}$ and $m_I = \frac{\Delta_p L_I[c-\Delta_p L_B]}{c^2-\Delta_p^2 L_B L_I}$. For m_i to be positive it necessitates that either both the numerator and the denominator are negative or both of them are positive. Applying this criterion gives the relevant regions for comparison ($c < \Delta_p L_I$, $\Delta_p L_I \leq c < \Delta_p \sqrt{L_B L_I}$, $\Delta_p \sqrt{L_B L_I} < c \leq \Delta_p L_B$ and $c > \Delta_p L_B$) and the corresponding monitoring intensities.

Proof of Proposition 3:

When $c > \underline{c}' \equiv \Delta_p (L_B + L_I)$, the monitoring intensity under integrated supervision is given by

$$m = \frac{\Delta_p (L_B + L_I)}{c}.$$

On the other hand, the overall monitoring intensity under decentralized supervision is $M = m_B + m_I - m_B\, m_I$, where $m_B = \frac{\Delta_p L_B[c-\Delta_p L_I]}{c^2-\Delta_p^2 L_B L_I}$ and $m_I = \frac{\Delta_p L_I[c-\Delta_p L_B]}{c^2-\Delta_p^2 L_B L_I}$. Substituting the values of m_B and m_I into the equation for M gives

$$M = \frac{\Delta_p \left[(L_B + L_I) c^3 - 3\Delta_p L_B L_I c^2 + \Delta_p^3 L_B^2 L_I^2\right]}{\left(c^2 - \Delta_p^2 L_B L_I\right)^2}.$$

The latter exceeds the former only if

$$3c^3 - 2\Delta_p (L_B + L_I) c^2 - \Delta_p^2 L_B L_I c + \Delta_p^3 L_B L_I (L_B + L_I) < 0.$$

Defining $f(c) \equiv 3c^3 - 2\Delta_p (L_B + L_I) c^2 - \Delta_p^2 L_B L_I c + \Delta_p^3 L_B L_I (L_B + L_I)$ and taking the first derivative of $f(c)$ gives $f'(\underline{c}^1) = 0$ and $f'(\underline{c}^2) = 0$, where

$$\underline{c}^1 = \frac{4\Delta_p (L_B + L_I) - \sqrt{16\Delta_p^2 (L_B^2 + L_I^2) + 68\Delta_p^2 L_B L_I}}{18}$$

and

$$\underline{c}^2 = \frac{4\Delta_p (L_B + L_I) + \sqrt{16\Delta_p^2 (L_B^2 + L_I^2) + 68\Delta_p^2 L_B L_I}}{18}.$$

Both of these are smaller than $\underline{c}' = \Delta_p (L_B + L_I)$.

Taking the second derivative of $f(c)$ and inserting the values $\underline{c}^1$ and $\underline{c}^2$ into $f''(c)$ shows that $f''(\underline{c}^1) < 0$ and $f''(\underline{c}^2) > 0$. Consequently, the value of the function $f(c)$ at $\underline{c}^1$, $f(\underline{c}^1)$, is a relative maximum and at $\underline{c}^2$, $f(\underline{c}^2)$, a relative minimum. Since $\underline{c}^2 < \underline{c}' = \Delta_p (L_B + L_I)$ and $f(c)$ at $\underline{c}'$, $f(\underline{c}') > 0$, the function $f(c) = 3c^3 - 2\Delta_p (L_B + L_I) c^2 - \Delta_p^2 L_B L_I c + \Delta_p^3 L_B L_I (L_B + L_I)$ will be positive for all $c > \Delta_p (L_B + L_I)$. A a result, the sectoral supervisors will monitor even in aggregate less than the integrated supervisor when $c > \Delta_p (L_B + L_I)$.

Proof of Proposition 4:

Given m, M, r_i^{int} and r_i^{dec}, the profits from conglomeration under integrated and decentralized supervision, respectively, are

$$\pi^{int} = mp_H \left(R - \frac{1}{2} r_B^{int} - \frac{1}{2} r_I^{int} \right) + (1 - m) \left[p_L \left(R - \frac{1}{2} r_B^{int} - \frac{1}{2} r_I^{int} \right) + B \right]$$

$$\pi^{dec} = Mp_H \left(R - \frac{1}{2} r_B^{dec} - \frac{1}{2} r_I^{dec} \right) + (1 - M) \left[p_L \left(R - \frac{1}{2} r_B^{dec} - \frac{1}{2} r_I^{dec} \right) + B \right].$$

After rearranging the terms, it follows that $\pi^{dec} > \pi^{int}$, if

$$(m - M)(B - \Delta_p R) - \frac{1}{2} \left\{ \Delta_p \left[M\Sigma^{dec} - m\Sigma^{int} \right] + p_L \left[\Sigma^{dec} - \Sigma^{int} \right] \right\} > 0, \tag{A.1}$$

where $\Sigma^{dec} \equiv r_B^{dec} + r_I^{dec}$ and $\Sigma^{int} \equiv r_B^{int} + r_I^{int}$. After some calculations one can show that the term $-\frac{1}{2}\{\cdot\}$ on the left-hand side of (A.1) reduces to

$$\frac{(m - M)\Delta_p (\alpha_B + \alpha_I) \left[p_L^2 + (m + M) p_L \Delta_p + mM\Delta_p^2 \right]}{2 (p_L + \Delta_p m)(p_L + \Delta_p M)}$$

which is positive. Then, if $B > \Delta_p R$, it is immediately clear that the expression in (A.1) is positive since the first term on the left-hand side is also positive. Since $B > \Delta_p R$ does not violate previous assumptions concerning B, the profit from conglomeration can be higher under decentralized supervision.