

Regulating financial conglomerates

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Abstract

We analyze the risk-taking incentives of a financial conglomerate that combines a bank and a non-bank financial intermediary. The conglomerate's risk-taking incentives depend on the level of market discipline it faces, which in turn is determined by the conglomerate's liability structure. We examine optimal capital regulation for standalone institutions, for integrated conglomerates and holding company conglomerates. We show that, when capital requirements are set optimally, capital arbitrage within holding company conglomerates can raise welfare by increasing market discipline. Because they have a single balance sheet, integrated conglomerates extend the reach of the deposit insurance safety net to their non-bank divisions. We show that the extra risk-taking that this effect causes may wipe out the diversification benefits within integrated conglomerates. We discuss the policy implications of these results.

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1. Introduction

The emergence of financial conglomerates is one of the major financial developments of recent years.¹ Financial conglomerates are institutions that provide under a single corporate umbrella banking, insurance and other financial products. Conglomeration has been motivated by cost advantages from economies of scale and scope in insurance sales and securities underwriting, and by the perceived advantages of risk diversification.² The recognition of the importance of conglomeration for the financial sector has led the Group of Ten to study its potential implications for public policy. Their study is inconclusive regarding risk taking and risk assumption.³ This paper is concerned with risk taking and risk shifting in financial conglomerates, and their implications for optimal capital regulation.

We analyze the extent to which risk-taking incentives in financial conglomerates and their optimal capital regulation are affected by organizational form. Dierick (2004) and Shull and White (1998) discuss the different legal structures available to conglomerates. Although the choice of legal structure may be restricted by regulation,⁴ it is essentially a choice between structuring the conglomerate as an integrated entity subject to a unique liability constraint, or structuring it as a holding company and allowing its various divisions to fail independently. For example, universal banks are structured as integrated entities and are engaged in the same activities as bank holding companies. The conglomerate's capital regulation is constrained by its organizational form. Integrated entities face a single capital requirement, while the regulator can set separate capital requirements for each division of a decentralized conglomerate.

Decentralized conglomerates can take advantage of the separate capital requirements for their constituent divisions by transferring assets between divisions in order to avoid high capital charges. This process is popularly referred to as *regulatory*, or *capital*, *arbitrage*. Regulators usually regard capital arbitrage as a *risk* of conglomeration: see for example Dierick (2004). The Joint Forum (2001) provides an extensive discussion of regulatory arbitrage and is ambivalent as to its effects, concluding that it must be accompanied by evidence of adequate risk management

¹ The November 1999 Gramm–Leach–Bliley Act dismantled legal barriers to the integration of financial services firms which had been erected by the 1933 passage of the Glass–Steagall Act. Its passage made conglomeration legal in the United States. The Gramm–Leach–Bliley Act was a response to market forces which had already resulted in the Federal Reserve Board's approval in 1998 of the merger of Citicorp and Travelers. Conglomeration in Europe, which was subject to fewer regulatory hurdles, followed the same trend: between 1985 and 1999 the value of merger and acquisition deals involving a commercial bank and an insurance company was \$89.6 billion, or 11.6% of all acquisitions by European financial institutions. See Lown et al. (2000) for detailed discussion of and statistics concerning the development of the European Bancassurance market. A detailed discussion of conglomeration experience in the Benelux countries is provided by the National Bank of Belgium (2002).

² For a detailed discussion for the rationale behind conglomeration, see Berger et al. (2000), Milbourn et al. (1999) and Dierick (2004). Santos (1998) discusses mergers between banks and insurance firms. A substantial literature considers conglomeration in non-financial firms. This literature examines rationales such as improved asset allocation and managerial perquisite consumption, but does not consider the effects which we discuss in this paper: see for example Inderst and Müller (2003) and Scharfstein and Stein (2000).

³ “The potential effects of financial consolidation on the risk of individual institutions are mixed, the net result is impossible to generalize, and thus a case-by-case assessment is required. The one area where consolidation seems most likely to reduce firm risk is the potential for (especially geographic) diversification gains. Even here, risk reduction is not assured, as the realization of potential gains is always dependent upon the actual portfolio held” (Group of Ten, 2001, p. 3).

⁴ Within Europe, it is illegal to combine insurance with banking, securities or any other commercial business in the same legal entity (Dierick, 2004, p. 17: see Article 6(1)(b) of the Life Assurance Directive and Article 81(b) of the Non-Life Assurance Directive).

practices.⁵ In contrast, because integrated conglomerates have a consolidated balance sheet, they cannot engage in regulatory arbitrage. They can however achieve inter-divisional diversification (see Mälkönen, 2004 and Allen and Jagtiani, 2000). Practitioners have argued that conglomerate diversification will reduce bankruptcy risk and therefore that it should be rewarded with reduced capital requirements (see Oliver et al., 2001).

This raises two questions:

- (i) Does diversification within integrated conglomerates indeed reduce risk taking? and
- (ii) What are the effects of the capital arbitrage that accompanies decentralized conglomeration?

Our answers to these questions challenge some commonly-held views on conglomeration. First, we show that diversification within integrated conglomerates increases risk-taking incentives. As a result, it may even *lower* welfare relative to the standalone institution case. Second, we show that capital arbitrage within holding company conglomerates can *raise* welfare by increasing market discipline. This effect is further strengthened to the extent that the non-bank divisions in conglomerates have a lower social cost of failure than banks.

The intuition for our results is as follows. In our model, banks are specialist investors in hard-to-evaluate assets. As a result, neither regulators nor other market participants are able to observe bank risk levels, and hence they cannot contract precisely upon bank risk levels. Furthermore, bank depositors have privileged access to deposit insurance. As a consequence of bank asset opacity, deposit insurance prices are insufficiently risk-sensitive, so that market discipline is weakened for banks.⁶ This biases bank shareholders towards excessive risk-taking. Regulators respond to bank risk taking by setting capital requirements that force financial institutions to internalize costs that they would otherwise ignore.⁷

Capital requirements are therefore higher in banks than in financial institutions that have no access to the deposit insurance fund. However, because regulators cannot easily observe the properties of bank assets, and because they are constrained by law to base their regulations upon hard and verifiable data, bank capital requirements cannot precisely reflect bank risk levels. Capital requirements are consequently an imperfect substitute for market discipline; welfare would be enhanced if regulations were designed so as to ensure that risky assets were held by institutions that were subject to market discipline, and hence that required lower capital requirements. One way to accomplish this would be to encourage banks to transfer their assets to institutions without deposit insurance protection via arm's-length securitization. However, this type of trade is impeded by the informational opacity of the bank's asset base: potential purchasers require compensation for the adverse selection costs that they face, and these costs may be so large as to preclude any securitization.

⁵ Loss transfer from a sound conglomerate division to a division close to financial distress is a distinct issue, which, subject to the passage of the necessary legislation, regulators can deal with.

⁶ Chan et al. (1992) demonstrate that, unless banks earn sufficient rents from their depositors, it is not possible to design an incentive compatible direct revelation mechanism that induces banks to reveal the risk profile of their loan portfolio. Hence, in the absence of such rents, fair pricing of deposit insurance is not possible. Even when banks earn sufficient rents by virtue of their special "know-how", Freixas and Rochet (1998) demonstrate that fair pricing of deposit insurance is socially undesirable, because it involves a cross-subsidization of inefficient bankers by efficient ones, which encourages entry by low-quality bankers.

⁷ Other papers have stressed the role of capital adequacy requirements in protecting depositors and in providing incentives to banks: see for example Dewatripont and Tirole (1993) and Morrison and White (2005).

Starting with Coase's (1937) pioneering work, a body of literature has developed arguing that organizations are able to provide more nuanced incentives than those that are possible in arm's-length, court-enforced, contracts.⁸ For example, it is possible within organizations to impose punishments, perhaps by withholding promotion, based upon observable but non-verifiable returns data. The resultant incentive structures are often referred to as "implicit contracts." We argue that implicit contracting is possible within financial conglomerates, and we show that this ameliorates the adverse selection problem sufficiently to facilitate asset transfers between the bank member of the conglomerate and the other divisions. In a holding-company conglomerate, where each division is separately capitalized, this type of asset transfer can be incentivized by setting high capital requirements for the bank so as to encourage regulatory arbitrage. When the bank transfers its assets to other, non-bank, divisions, imprecise regulatory contracts are replaced with the precise disciplining of the marketplace, and hence welfare is raised.

Since the divisions of an integrated conglomerate share a single balance sheet, regulatory arbitrage of this type is impossible in such a conglomerate. In contrast to holding-company conglomerates, however, integrated conglomerates are able as a result of their single balance sheet to achieve inter-divisional diversification. For a given investment portfolio, this diversification reduces the costs of deposit insurance, and hence raises welfare relative to the standalone bank case. But risk levels are selected endogenously: they will change in response to conglomerate formation. Because they have a common balance sheet, the divisions of the integrated conglomerate have common liabilities. Large-scale losses in non-bank divisions therefore harm bank depositors, and so result in a call upon the deposit insurance fund. This mechanism extends the reach of the deposit insurance fund, and hence reduces market discipline relative to the standalone case in non-bank divisions. Depending upon the benefits derived from diversification, this reduction in market discipline may even justify *higher* capital requirements for the conglomerate than for its stand alone constituents.

In contrast with commonly received opinion, regulatory arbitrage in our model has three unambiguously positive effects. First, the investment distortions induced by the deposit insurance fund will no longer occur. Second, marginal projects in which the standalone bank's shareholders would not invest will now attract funds, because of the lower capital requirement. Third, risky assets are transferred to an institution with lower social costs of failure. Regulatory arbitrage therefore reduces the extent of the safety net and, by allowing for a more efficient use of capital, results in a greater degree of bank credit extension.

We conclude from the above discussion that, contrary to the majority view, holding-company conglomerates allow for a more efficient allocation of resources than integrated ones. Our analysis is therefore supportive of existing legislative restrictions upon the integration of banking and insurance activities (see footnote 4), *provided capital arbitrage is permitted*.

Although we derive our results in a simple framework in which each institution effectively manages a single scalable project, we believe that our intuition is robust to alternative set-ups. For example, a reasonable alternative framework would be one in which risk-averse banks selected their investment portfolios according to the Capital Asset Pricing Model (see Hart and Jaffee, 1974).

Our work demonstrates that the diversification benefits of financial conglomeration may be overturned simply by allowing for the endogeneity of risk levels in financial institutions. A simi-

⁸ See also Macaulay (1963), Dixit (2004), Baker et al. (2002), and references therein.

lar point is made by [Boot and Schmeits \(2000\)](#), in a model of conglomeration without deposit insurance. In their paper, market discipline is reduced because diversification reduces the sensitivity of aggregate cash flows to divisional investment decisions. Unlike us, Boot and Schmeits are not concerned with capital regulation.

More closely related to our paper is the work of [Dewatripont and Mitchell \(2005\)](#), who also examine the regulation of financial conglomerates in which one division has access to a deposit insurance safety net. Like us, they find that the conglomerate may take excessive risks in order to extend the reach of the deposit insurance safety net. Unlike us, they assume that project return is either exogenous or has a given relationship to riskiness, and they allow for endogenous selection of project correlations. Dewatripont and Mitchell use their model to consider conglomerate formation incentives, rather than capital regulation. When every divisional manager has a veto over conglomerate formation and each division has to share its marginal product, they find that conglomerates will form ex ante only when they will ex post elect to diversify and to reduce risk.

In Section 2 we present a model of standalone financial intermediaries and derive optimal capital requirements. Section 3 examines asset securitization and we present our analysis of holding-company and integrated conglomerates in Section 4. Section 5 discusses the robustness of our results. Section 6 discusses some additional policy implications of our results. Section 7 discusses the empirical implications of our work. Section 8 concludes.

2. Standalone financial intermediaries

In this section we analyze a one-period interaction between a regulator, a financial intermediary, and the investors in the intermediary. All of the players in our model are risk-neutral and we normalize the risk-free interest rate to zero.

Financial intermediaries in our model have an investment project which requires an initial investment of 1, and which yields an expected return R . Intermediaries can select the riskiness of their project: *safe* projects yield a certain return of R , and *risky* projects return $R + \bar{B}$ or $R - \bar{B}$, each with probability $\frac{1}{2}$. We indicate the riskiness of the project with the choice variable B , where $B = 0$ for safe projects and $B = \bar{B}$ for risky projects. Hence, every project returns $R \pm B$ with equal probabilities.

We analyze two types of financial intermediary. *Deposit-Financed Intermediaries*, which we will also refer to as DFIs or *banks*, specialize in relationship lending to small corporations. As a consequence of their relationships, banks have a superior ability to identify the quality of their clients' investment opportunities. This statement is in line with a large banking literature.⁹ The superior information-gathering abilities of the bank are captured in our model by the following assumption:

Assumption 1. The expected return R and the riskiness B of the bank's loans can be observed at no cost by the bank, but they cannot be observed by the regulator or by any other intermediary.

We assume in addition that bank debt-holders, whom we call *depositors*, are protected by a deposit insurance fund, which will make good any losses that they experience. A large literature

⁹ See for example [Ramakrishnan and Thakor \(1984\)](#) and [Allen \(1990\)](#). A discussion of the relevant literature is presented by [Bhattacharya and Thakor \(1993\)](#).

justifies the existence of deposit insurance,¹⁰ but we do not attempt to derive its existence from more primitive assumptions in this paper. As a result of deposit insurance, the willingness to invest of bank depositors is independent of their bank's investment choices.

The second type of financial intermediary in our model is the *Market-Financed Intermediary*, or MFI. The MFIs within financial conglomerates are either insurance or securities firms. Unlike banks, these intermediaries largely rely upon publicly available information when investing. As a result, there is a less pronounced adverse selection problem between MFIs and their investors than between DFIs and theirs: we formalize this in [Assumption 2](#), which rules out adverse selection problems between MFIs and their investors.

Assumption 2. All of the information that an MFI has about its investments is observable at no cost by other market participants and by the regulator.

The MFI debt-holders do not have deposit insurance, and so condition their willingness to invest upon the riskiness of their intermediary's investment choices. For convenience we will sometimes refer to MFI debt-holders as *bondholders*. We denote the face value of the MFI's debt by ρ .

Before the intermediary is endowed with its project, the return R is drawn by nature from a distribution that is common knowledge. [Assumptions 1 and 2](#) allow us to derive clear-cut results, but, provided the DFI suffers from a worse adverse selection problem than the MFI, we do not believe that our qualitative conclusions would be affected by weaker informational assumptions. Similarly, the precise distribution from which nature draws R does not affect our intuitions. To ensure tractability of our model for conglomerates, we assume that for both MFIs and DFIs, R is drawn from $[R_l, R_h]$ according to the uniform distribution. We write $\Delta \equiv R_h - R_l$, and we assume that $R_l < 1 < R_h$.

All financial intermediaries raise an amount $\$C$ of equity capital from shareholders, and an amount $\$(1 - C)$ from debt-holders. Debt-holders have priority in the event of project failure, and we assume that there are no bankruptcy costs. Every financial intermediary aims to maximize its shareholder wealth.

Equity has high issue costs and in most jurisdictions it is at a tax disadvantage relative to debt. These observations are in line with statements made by practitioners, who regard equity capital as costly. [Assumption 3](#) formalizes the transaction costs of raising equity capital.

Assumption 3. To invest $\$C$ of equity capital, it is necessary to raise $\$C(1 + \kappa)$.

As a consequence of [Assumption 3](#), intermediaries would prefer to raise a minimal level of equity capital. However, we assume that they are subject to minimum capital adequacy regulations. The regulator sets the minimum capital requirement C so as to maximize the expected present value of investments, net of the social costs of failure.

While project parameters may be observable (as they are in this model for MFIs), they are in practice hard to verify in court and hence formal contracts are likely based upon coarser data than can be reflected in market prices.¹¹ We incorporate this observation in [Assumption 4](#).

¹⁰ See for example Bryant (1980), Diamond and Dybvig (1983) and Freeman (1988).

¹¹ For another model in which banking regulations are designed to profit from the more precise data incorporated into market signals see Decamps et al. (2004).

Assumption 4. Contracts that are contingent upon the *ex ante* expected return R or riskiness B of an intermediary's investment are not court-enforceable.

Assumption 4 is an extreme one, which ensures the tractability of our model. Note that it does not prevent the settlement of claims after returns realize, since this does not depend upon a knowledge of R and B . Provided formal contracts continued to be based upon coarser data than that available to an informed investor, relaxing the assumption would generate qualitatively the same results, at the cost of greater complexity.

We make two assumptions about the types of regulations that can be enforced. First, we assume that regulators are constrained by legislation to use only verifiable information:

Assumption 5. Regulators can only impose regulations based upon hard data that are verifiable in court.

Assumption 5 is consonant with observed regulation: if perfect contracting were possible, command-and-control regulation would be optimal. Together with Assumption 4, it implies in our model that deposit insurance premia and capital regulation are both risk-insensitive: for simplicity, we set deposit insurance premia equal to zero. Hence in our model, capital requirements can distinguish only between investment and non-investment: in the latter case, the depositors' funds are entirely cash-collateralized and the regulator will clearly choose to set the capital requirement equal to zero.

Second, although debt and equity contracts are contingent upon realized returns, we argue that it would in practice be hard to condition regulations upon realized returns. Penalties imposed in the wake of very poor performance would have minimal incentive effects, and might cause financial fragility that had destabilizing systemic consequences; although very high returns could be construed as evidence of risk-taking, the difficulty of distinguishing risk from efficiency *ex post* would probably make a threat to punish high returns incredible. Hence we assume:

Assumption 6. Contracts cannot be conditioned upon *ex post* realized returns.

We assume that the intermediary has a private cost $\zeta \geq 0$ of bankruptcy. We interpret ζ as representing the intermediary's charter value: it is clearly a function of policy choices such as competition levels, but in our model we leave it as an exogenous variable. We ensure that financial institutions will sometimes elect to risk insolvency by assuming that $\bar{B} > \zeta$. Finally, we assume that intermediary failure has a social cost $\phi > 0$. When the intermediary is a bank, ϕ includes such exogenous factors as the impact of the bank's failure upon the payment system, and the costs of destroying informational assets which have a value in the relationship with the bank's clients.¹² We assume that the social failure cost ϕ includes any social effects that the intermediary cares about. That is, the social costs of ζ are included in ϕ .

Table 1 summarizes the symbols used in this section. We summarize the game that we study in Fig. 1.

At time 0 the regulator selects the capital requirement C . At time 1 nature presents the intermediary with safe and risky projects, each of which returns R in expectation. At time 2 the

¹² See James (1991) for an estimation of the cost of bank failure, and Slovin et al. (1993) for the estimation of the cost of the Continental Illinois bankruptcy to its clients.

Table 1
Symbols used for modeling standalone financial intermediaries

Symbol	Meaning
R	Return from investment
$[R_l, R_h]$	Support of R distribution
ΔR	$R_h - R_l$
B	Risk level: 0 or $\bar{B} > 0$
C_M	Capital level for MFI
C_D	Capital level for DFI
ρ	Face level of MFI debt
κ	Cost of equity capital
ζ	Charter value
ϕ	Social cost of failure

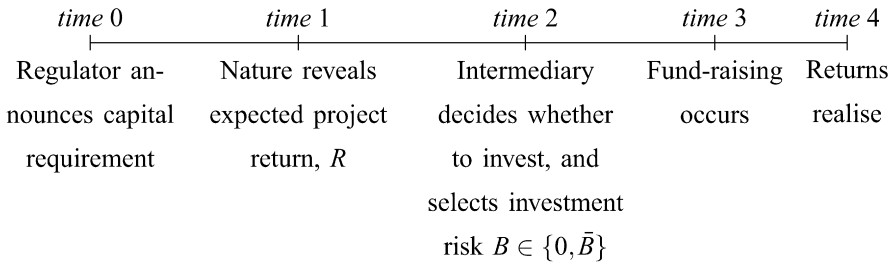


Fig. 1. Time line for the operation of the standalone intermediary.

intermediary decides whether to invest, and if so, whether to make a safe or a risky investment. If investment occurs the funds are raised at time 3. The project’s returns realize at time 4 and are distributed to the investors.

We define a *fragile* intermediary to be one that will fail with non-zero probability. Because failure comes at a social cost ϕ , we say that such an intermediary is assuming *systemic risk*. A *sound* intermediary is one that will never fail. The decision to run a fragile intermediary is endogenous and non-observable.

We now compute the respective optimal capital requirements C_M^* and C_D^* for market- and deposit-financed intermediaries.

2.1. Market-financed intermediaries

To determine the optimal time 0 capital requirement C_M^* for an MFI, we solve our model by backward induction, starting with the MFI’s time 2 investment decision.

First, we characterize the MFI’s debt contract. Suppose that the regulator has set a capital requirement C . The intermediary will be fragile precisely when condition (1) is satisfied, so that it will fail in the event that the project returns $R - B$:

$$R - B < \rho. \tag{1}$$

Recall that $B \in \{0, \bar{B}\}$ is a choice variable and hence that fragility is an endogenous intermediary characteristic.

Assumption 2 implies that the MFI’s bondholders are able perfectly to observe both R and B at time 3. Since they are risk-neutral it follows that the MFI’s promised payment ρ must satisfy

$$\rho = \rho_S \equiv 1 - C$$

when the intermediary is sound, and $\frac{1}{2}\rho + \frac{1}{2}(R - \bar{B}) = 1 - C$, or

$$\rho = \rho_F \equiv 2(1 - C) - R + \bar{B},$$

when the intermediary is fragile.

Recall that the MFI aims to maximize its shareholder payoffs. The expected shareholder profit in a sound MFI is

$$\pi_S(C, R) \equiv \frac{1}{2}(R + B - \rho_S) + \frac{1}{2}(R - B - \rho_S) - C(1 + \kappa) = R - (1 + C\kappa), \tag{2}$$

which yields the following individual rationality constraint for sound MFIs:

$$R \geq R_S(C) \equiv 1 + C\kappa. \tag{SIR}$$

The expected shareholder profit in a fragile MFI is

$$\pi_{M,F}(C, R) \equiv \frac{1}{2}(R + \bar{B} - \rho_F) - \frac{1}{2}\zeta - C(1 + \kappa) = R - (1 + C\kappa) - \frac{1}{2}\zeta.$$

Notice that $\pi_{M,F} < \pi_S$. The strict inequality obtains because the intermediary faces a private cost of bankruptcy. It therefore follows that the MFI will never choose to be fragile. This observation is a consequence of the second Modigliani–Miller proposition (Modigliani and Miller, 1958): provided perfectly-informed debt holders are able precisely to price the debt, the effect of additional risk taking is completely reflected in the additional cost of debt. Consequently, additional risk-taking cannot transfer wealth from debt- to equity-holders.

The MFI will therefore select any investment whose return exceeds $R_S(C)$. Fig. 2 illustrates the standalone MFI’s investment choices as a function of C and R : for a given C , the MFI will accept any investment with expected return in excess of $1 + C\kappa$, and will select B so as to ensure that the intermediary is sound, as indicated on the figure by the script \mathcal{S} .

Proposition 1, whose proof is immediate from Fig. 1, states that market discipline will induce market-financed intermediaries to adopt a first-best investment strategy in the absence of capital regulation.

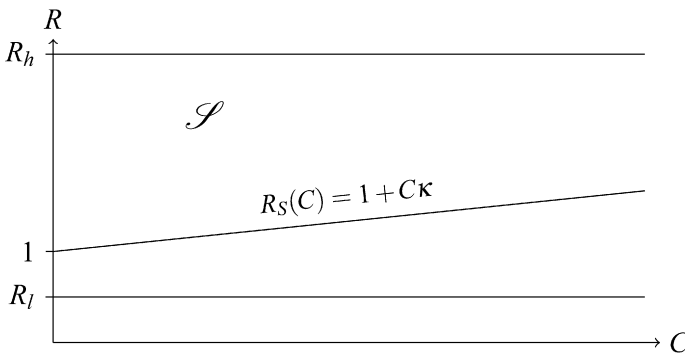


Fig. 2. Investment choices for a standalone market-financed intermediary.

Proposition 1. *When capital is set in accordance with Eq. (3), the intermediary accepts all projects for which $R \geq 1$ and is always sound:*

$$C_M^* = 0. \tag{3}$$

2.2. Deposit-financed intermediaries

Because the DFI’s depositors are protected by deposit insurance, the DFI need only promise to repay $1 - C$. A bank is therefore fragile precisely when

$$R - B < 1 - C, \tag{4}$$

and is otherwise sound.

The DFI works to maximize its shareholders’ wealth. The expected return to a sound bank is again given by $\pi_S(C)$, and the sound banking IR constraint is therefore $R \geq R_S(C)$, as in Eqs. (2) and (SIR).

Shareholders’ expected profit from running a fragile bank is

$$\begin{aligned} \pi_F(C, R) &\equiv \frac{1}{2}(R + \bar{B} - (1 - C)) - \frac{1}{2}\zeta - C(1 + \kappa) \\ &= \frac{1}{2}(R + \bar{B} - \zeta - 1 - C(1 + 2\kappa)), \end{aligned} \tag{5}$$

which yields the following individual rationality constraint for fragile banking:

$$R \geq R_F(C) \equiv 1 + \zeta - \bar{B} + C(1 + 2\kappa). \tag{FIR}$$

The shareholders will prefer fragile to sound banking precisely when $\pi_F - \pi_S > 0$: equivalently, when

$$R < \bar{B} + 1 - C - \zeta. \tag{6}$$

The bank shareholders’ equilibrium risk choice is summarized in Fig. 3, which shows for different combinations of the expected project return R and the regulator’s choice of C how bank shareholders will resolve their moral hazard problem. For (C, R) pairs below the lines labeled (FIR) and (SIR), shareholders will choose not to invest. Above these lines, investment will occur. In region \mathcal{F} shareholders make a risky investment and the bank is fragile. The bank is sound in region \mathcal{S} .

The intuition behind this figure is straightforward. Since risk-taking is not reflected in the cost of funds, shareholders in highly-leveraged banks have a strong incentive to incur more risk. Nevertheless, when the bank’s project has a sufficiently high expected return R , the bank will not jeopardize this by selecting the risky project ($B = \bar{B}$). The critical level of return above which safe projects are preferred is decreasing in the bank’s capital level C (see Eq. (6)).

As the bank receives an implicit subsidy from the deposit insurance fund, shareholders have an incentive to invest even when confronted with a project whose present value, net of the total cost $1 + C\kappa$ of investment, is negative. Since the subsidy is decreasing in the bank’s capital exposure C , there will be a point at which the subsidy is insufficient to compensate for the risk of capital loss: this is the point ($C_S^* = \frac{\bar{B} - \zeta}{1 + \kappa} > 0$) in Fig. 3 at which (SIR) and (FIR) cross. For C to the right of this point, investment occurs only in safe projects whose return exceeds the total cost of funds, $1 + C\kappa$.

The regulator correctly anticipates the shareholder response to a capital requirement C , and hence can determine the optimal capital requirement.

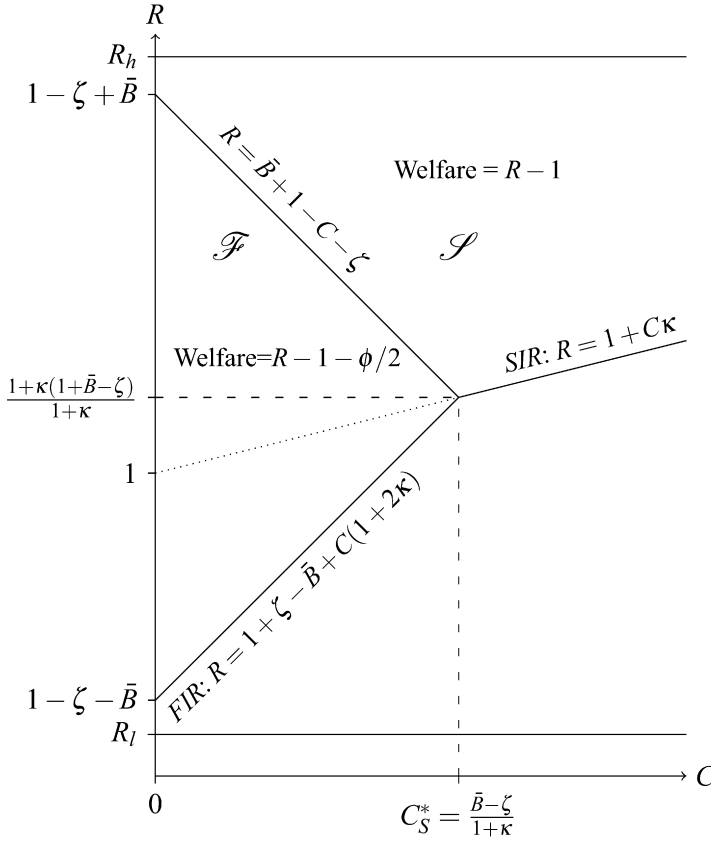


Fig. 3. Stand alone banks: IR constraints and welfare.

Proposition 2. *When regulating a standalone bank the optimal capital requirement C^* is given by*

$$C^* = \begin{cases} C_F^*, & \phi < \bar{\phi}; \\ C_S^*, & \phi \geq \bar{\phi}, \end{cases}$$

where C_F^* , C_S^* and $\bar{\phi}$ are given by Eqs. (7), (8) and (9) respectively:

$$C_F^* \equiv \frac{\bar{B} - \zeta}{1 + 2\kappa} + \phi \frac{1 + \kappa}{(1 + 2\kappa)^2}; \tag{7}$$

$$C_S^* \equiv \frac{\bar{B} - \zeta}{1 + \kappa}; \tag{8}$$

$$\bar{\phi} \equiv \frac{\kappa(1 + 2\kappa)}{(1 + \kappa)^2} (\bar{B} - \zeta). \tag{9}$$

In the case where $C^ = C_F^*$ the regulator chooses optimally to introduce financial fragility; in the case where $C^* = C_S^*$ the regulator sets capital at precisely the minimum level to wipe out systemic risk.*

Proof. See [Appendix A](#). \square

The optimality of financial fragility is somewhat surprising. Raising capital requirements reduces investment profitability for two reasons: first, it reduces the risk-shifting incentive generated by risk-insensitive deposit insurance premia; second, because capital is costly, it induces under-investment in safe projects. When capital is lowered from the level C_S^* at which the bank is safe the second of these effects outweighs the first and hence, when the social cost ϕ of bank failure is low enough, welfare is raised. In fact, we demonstrate in [Appendix A](#) (Eq. (A.1)) that when $\phi = 0$, a capital level C exists for which the welfare W_F with fragile banks is equal to the socially first best level. This capital requirement ensures that over- and under-investment incentives cancel out and that the hurdle rate $R_F(C)$ is equal to 1. For higher values of ϕ , the marginal cost in terms of lost revenue from small increases of the capital requirement are outweighed by the social benefit in terms of reduced bankruptcy probability and so the (constrained) optimal hurdle rate exceeds 1.

Finally, note that Eqs. (7) and (8) imply that capital adequacy requirements and charter value ζ are substitutes. This observation is in line with earlier work (e.g., [Keeley, 1990](#), and [Repullo, 2004](#)): we discuss its relevance for competition policy in Section 6, which is devoted to policy implications.

2.3. Numerical example of standalone financial intermediaries

We now provide a simple numerical example that illustrates the results of this section. Consider a simplified version of the model in which R is non-stochastic, with $R = 1.1$, $\bar{B} = 0.8$, $\kappa = 0.2$ and $\zeta = 0.07$.¹³ We firstly analyze a standalone deposit-financed intermediary with this parameterization, and then compare it to a market-financed intermediary.

If the regulator wishes to induce risk-taking in a DFI the optimal capital requirement is $C_F^* = 0$; it is easy to demonstrate that the optimal capital requirement that results in safe investment is $C_S^* = \bar{B} - R + 1 - \zeta = 0.63$. In our model, setting the capital requirement equal to C_S^* results in underinvestment. [Proposition 2](#) demonstrates that, when the social cost of failure ϕ is low enough, the regulator will accept some financial fragility in order to avoid this dead-weight cost. The first line of [Table 2](#), where $\phi = 0.18$, illustrates this effect. When the capital requirement is set equal to C_S^* the high cost of capital renders investment unattractive to DFI shareholders: it therefore does not occur and social welfare is zero. The regulator can induce investment in this case by setting the capital requirement equal to C_F^* : although this results in a fragile intermediary, social welfare remains positive. This result corresponds to the case in [Proposition 2](#) with a low social cost of failure, $\phi < \bar{\phi}$.

In the second line of [Table 2](#), $\phi = 0.21$: this corresponds to the case in [Proposition 2](#) with a high social cost of failure, $\phi > \bar{\phi}$. In this case setting a capital requirement of C_F^* results in an expected social loss. The regulator therefore prefers to set the capital requirement equal to C_S^* , even though this suppresses DFI investment.

¹³ In restricting R to a single value we sacrifice the continuity of our main results. In our model, any increase in the capital requirement C raises the investment hurdle rates $R_F(C)$ and $R_S(C)$: when R has continuous support, this reduces the expected level of investment and hence has a social effect. In contrast, changing C has an effect upon investment decisions in this example only when the sole available investment is marginal. In line with our more detailed model, we nevertheless assume that the regulator will adopt the lowest possible capital requirement that is consonant with its target risk-taking behavior.

Table 2
Standalone deposit-financed intermediary: numerical example

ϕ	$C = C_F^*$ (fragile)		$C = C_S^*$ (safe)	
	Shareholder wealth	Social welfare	Shareholder wealth	Social welfare
0.18	0.415	0.010	-0.026	0
0.21	0.415	-0.005	-0.026	0

Notes. When $R = 1.1$, $\bar{B} = 0.8$, $\kappa = 0.2$, and $\zeta = 0.07$, the expected shareholder wealth and social welfare are shown for $C = C_S^*$ and $C = C_F^*$. The first line corresponds to the case in Proposition 2 where $\phi < \bar{\phi}$; the second corresponds to the case where $\phi \geq \bar{\phi}$.

We now consider a standalone market-financed intermediary for which $\phi = 0.21$. When the capital requirement is $C_M^* = 0$ the payoff to bond holders in the bad state of the world will be $1.1 - 0.8 = 0.3$, and in return for their investment of 1 they will therefore demand a return of 1.7 in the good state. The shareholders experience a loss of $\zeta = 0.07$ in the bad state, and receive an income of $1.1 + 0.8 - 1.7 = 0.2$ in the good state: the corresponding expected return of 0.065 is less than the expected return of 0.1 that they would receive from playing safe. Hence there is no need for the regulator to set a positive capital requirement in this case. Indeed, were it to require a capitalization of C_S^* , the shareholders would lose 0.026 from playing safe, and hence would not participate.

3. Securitization

Section 2 examined regulation and investment policies for entirely separate standalone MFIs and DFIs. In this section we allow a limited degree of risk transfer via arm’s-length *securitization contracts*. Securitizations are financial vehicles that allow transfer of title to the income from financial assets. In this paper we abstract away from the legal and structuring complexities of these deals, and simply consider their pricing and their effect upon equilibrium behavior.

We consider the sale of an asset with expected return R and riskiness B by a DFI. By Assumption 1, the price P at which the sale occurs cannot be contingent upon either R or B . While P is fixed, the value to the DFI of retaining the asset is increasing in R . Hence either there exists some $R^* \in (R_l, R_h]$ with the property that the DFI sells its asset precisely when $R \leq R^*$, or the DFI never sells its asset, in which case we adopt the convention that $R^* = R_l$.¹⁴

We assume that there are many potential MFI purchasers, and hence that the asset will be sold at its expected NPV:

$$P(R^*) \equiv \frac{1}{2}(R^* + R_l) - 1. \tag{10}$$

¹⁴ Greenbaum and Thakor (1987) study a model of securitization with partial recourse to the originating bank and uninsured risk-averse depositors. In their model, the degree of recourse signals the quality of the underlying asset to securitization investors, so that they do not have to incur screening costs. This saving outweighs the disutility that they experience from bearing the residual asset risk for assets of sufficiently high quality. Hence, in contrast to us, they find that only the highest quality bank assets will be securitized. Benveniste and Berger (1987) also study securitization with recourse. Because securitization investors retain a claim on their asset in the wake of bank failure, Benveniste and Berger argue that recourse allows for superior risk-sharing.

MFI's will participate only if $P(R^*)$ is non-negative: in other words, provided Eq. (11) is satisfied:

$$R^* \geq 2 - R_l, \tag{11}$$

and the DFI will sell precisely when its income from securitization exceeds its income from retaining the asset:

$$P(R^*) - \max\{\pi_F(R, C), \pi_S(R, C)\} \geq 0. \tag{12}$$

Recall that $\pi_F(R, C) \geq \pi_S(R, C)$ precisely when $C \leq C_S^* = \frac{\bar{B} - \zeta}{1 + \kappa}$. When this is the case, condition (12) reduces to condition (13):

$$R - R^* \leq (C - \hat{C})(1 + 2\kappa), \tag{13}$$

where

$$\hat{C} \equiv \frac{1 - R_l + \bar{B} - \zeta}{1 + 2\kappa}.$$

Since by definition securitization occurs precisely when $R - R^* \leq 0$, it follows immediately from condition (13) that when $C \leq C_S^*$,

$$R^* = \begin{cases} R_l, & \text{if } C < \hat{C}; \\ R_h, & \text{if } C > \hat{C} \end{cases} \tag{14}$$

and that $R^* \in (R_l, R_h)$ if $C = \hat{C}$.¹⁵

Assumption 1 introduces an adverse selection problem between the DFI and its counterparts. The price received by the DFI is discounted to reflect this informational asymmetry. As a result, the DFI will only elect to sell its assets when it is sufficiently compensated for the discount by the reduction it achieves in its capital requirements. Equation (14) demonstrates that when C is sufficiently small, the adverse selection problem outweighs the cost savings from reduced capital adequacy requirements so that securitization does not occur. **Proposition 3** provides a sufficient condition for optimal standalone capital requirements to be small, and hence incompatible with securitization.

Proposition 3. *If condition (15) is satisfied then the DFI will not securitize any of its assets:*

$$\bar{B} < (1 - R_l) \frac{(1 + \kappa)}{\kappa} + \zeta. \tag{15}$$

Proof. See Appendix A. □

For the remainder of the paper we assume that condition (15) is satisfied.

¹⁵ Note that securitization investors and banks are both entirely rational in our model: securitization will occur precisely when it is weakly welfare-enhancing for both parties. In line with this assumption, Thomas (1999, 2001) finds that securitizations are wealth-enhancing for shareholders, and that they do not reduce bondholder wealth.

3.1. Numerical example

Adverse selection cannot be considered within the numerical example of Section 2.3, because in that section we considered a non-stochastic $R = 1.1$. We introduce adverse selection into that example by allowing R to be uniformly distributed in a range centered on 1.1: the difference $\Delta = R_h - R_l$ can be thought of as a measure of the extent of adverse selection. Then with the other values from Section 2.3 condition (15) is satisfied, and hence securitization is impossible, whenever $R_l \leq 1.01167$, or $\Delta \geq 0.177$. Since we have already assumed that $R_l < 1$ this does not impose an additional constraint upon our example parameters.

4. Financial conglomerates

We now analyze the optimal capital regulation of a financial conglomerate, which we define to be an intermediary that combines an MFI with a DFI. We consider two types of conglomerate: *holding-company* conglomerates, and *integrated* conglomerates. Holding-company conglomerates consist of a DFI and an MFI with separate balance sheets, both owned by an umbrella corporation. Integrated conglomerates consist of a DFI and an MFI with a single balance sheet. As in Section 2, conglomerates aim to maximize the returns to their shareholders.

The divisions of a holding-company conglomerate have separate balance sheets and hence the regulator can set separate capital requirements for the MFI and the DFI. The debt-holders in the DFI are protected by deposit insurance; all of the debt-holders for MFI investments are uninsured bondholders.

The two divisions of a holding-company conglomerate could in principle trade projects with one another. In moving an asset from one balance sheet to another, the holding-company conglomerate would change the capital requirement for that asset. This type of trade therefore takes advantage of differences in the respective capital regimes of the MFI and the DFI: we refer to it as “regulatory arbitrage.” In contrast, regulatory arbitrage is impossible in an integrated conglomerate, which has only a single balance sheet.

We argue in this section that an important difference between holding company and integrated conglomerates is in the level of diversification that they can achieve. A holding-company conglomerate can allow its divisions to fail independently of one another: failure in one will never be offset by success in another. It follows that a holding-company conglomerate experiences no benefits from portfolio effects. However, we will argue that, when capital requirements are set appropriately, capital arbitrage within holding-company conglomerates can nevertheless achieve the social first best.

In contrast, an integrated financial conglomerate with two risky investments benefits from diversification effects: the returns on a failing project may be canceled out by those on a successful one. Thus, *ceteris paribus*, diversification effects in integrated conglomerates may serve to diminish the likelihood of failure and hence of the associated systemic costs. However, as we have already noted, insured depositors always provide some of the debt for integrated conglomerates. As a result, integration extends the coverage of the deposit insurance safety net. We will show that in some circumstances, this raises risk-taking incentives within the MFI to such an extent that diversification benefits are lost, and optimal capital requirements *exceed* those of standalone institutions.

We begin our formal modeling with an analysis of holding-company conglomerates.

4.1. Holding-company conglomerates

In this section we determine the optimal capital requirements for holding-company conglomerate divisions. By Assumption 5, the regulator is constrained to condition capital requirements only upon verifiable data, so that the optimal capital requirement will be 0 for a completely cash-collateralized division, and will otherwise be risk-insensitive.

We analyze holding-company conglomerates in an extension of Section 2’s model. The time line for the model we consider appears in Fig. 4. At time 0 the regulator announces capital requirements C_{HD} and C_{HM} for the deposit-financed and the market-financed divisions, respectively. At time 1 nature makes independent draws R_D and R_M from the uniform distribution on $[R_l, R_h]$ for the expected returns for the DFI and the MFI, respectively. At time 2 each division decides whether to invest, and selects the riskiness of its investments. We denote by B_D and B_M the respective riskiness of the DFI and the MFI projects. If either division is indifferent between risk 0 and risk \bar{B} then we assume that it takes no risk. At time 3 fund-raising occurs. At time 4 there is an opportunity for inter-divisional trade; each division is able to raise additional funds to finance its trade. Returns realize at time 5.

Table 3 summarizes the variables used in this section. Note that we assume that the conglomerate’s charter value is again ζ ,¹⁶ and that the systemic cost of failure is ϕ per division. This implies that the total systemic cost of conglomerate failure is 2ϕ .

Time 4 trades between the conglomerate divisions will be anticipated at time 3. If the DFI expects to sell its asset it will therefore raise no capital against it at time 3 and hence its total investment outlay will be \$1. An MFI that receives a DFI asset through an inter-divisional trade finances its purchase through a time 4 bond issue. By Assumption 1, neither the MFI nor its bondholders is able to observe the asset’s properties and hence both will value it conditional only upon the fact that inter-divisional trade occurred.

If the MFI has to pay a competitive market price for the DFI’s assets then condition (15) guarantees that inter-divisional trade cannot occur through court-enforceable contracts. However, we assume that the MFI and the DFI have more contracting scope than do the DFI and its arm’s-length capital market counterparts. Several authors, starting with the seminal work of Coase (1937), have argued that organizations may be able to act on information that is too soft to serve

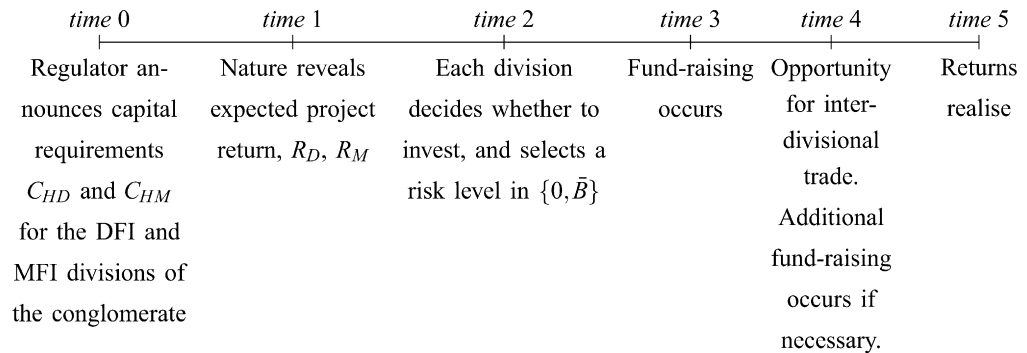


Fig. 4. Time line for holding-company conglomerates.

¹⁶ This reflects an assumption that charter value is mostly derived from banking license rents. Assigning a charter value ζ to the non-bank division as well would not change our qualitative results.

Table 3
 Symbols used for modeling financial conglomerates

Symbol	Meaning
R_D, R_M	Investment returns in DFI, MFI
$[R_l, R_h]$	Support of R_D and R_M distributions
ΔR	$R_h - R_l$
B	Risk level: 0 or $\bar{B} > 0$
C_{HD}	Holding-company DFI capital
C_{HM}	Holding-company MFI capital
κ	Cost of equity capital
ζ	Charter value for DFI
ϕ	Social cost of failure per division

as the basis for arm’s-length court-enforced contracts. Hence organizations may be able to use information that cannot be verified by outsiders as the basis for internal incentive design. We follow this literature and assume that the conglomerate is able to apply sanctions based upon *ex post* return data that could not serve as the basis for arm’s-length contracts. Specifically, we assume the following:

Assumption 7. Holding company conglomerates can design incentive structures that deter their deposit-financed division from selling negative NPV projects to their market-financed division.

While the conglomerate’s divisions are self-interested maximizers, the conglomerate’s shareholders are concerned to maximize the combined value of both divisions and hence will attempt to design the incentive schemes that best accomplish this. Assumption 7 states that it is possible within the conglomerate for shareholders to base incentives upon the realized returns data that are ruled out by Assumption 6 in the context of arm’s-length contracts. Note that this assumption does not contradict Assumption 2, which states that there is no asymmetric information between the MFI, its bondholders and the regulator. All three parties will condition their beliefs upon the same information set, which includes Assumption 7.

The DFI will be unaffected by the riskiness of an asset that it expects to sell to the MFI, and hence by assumption will set the risk equal to zero. Hence DFIs that transfer assets cannot be fragile. Moreover, by Assumption 7, the DFI will never transfer a negative NPV asset to the MFI. Hence first best would be achieved by a regulatory regime that induced the MFI to accept every positive NPV investment, and the DFI to accept every such investment, and then to transfer it to the MFI. Proposition 4 describes a holding-company conglomerate capital adequacy regime that accomplishes this.

Proposition 4. *The following capital requirements for the market- and deposit-financed divisions of a holding company financial conglomerate achieve first best:*

$$C_{HM}^* = 0;$$

$$C_{HD}^* = \max \left\{ \frac{R_h - 1}{2\kappa}, \frac{\bar{B} - \zeta}{1 + 2\kappa} \right\}.$$

With these capital both divisions invest in every positive NPV project and both are sound. The MFI retains all of its projects; the DFI sells all of its projects to the MFI.

Proof. See Appendix A. \square

Recall that with a non-zero social cost ϕ of failure, the best the regulator can do is deliberately to introduce some underinvestment, and when $\phi < \bar{\phi}$ also some fragility, into a standalone DFI. Proposition 4 therefore demonstrates that, because it achieves the first best, capital arbitrage in a decentralized conglomerate is welfare-improving. The intuition for our result follows from a proper understanding of the purpose of capital regulation: it is intended to force financial intermediaries to internalize the costs of actions that they would otherwise ignore. When these costs are already internalized, as they are in the case of an MFI, further capital regulation serves only to impede the intermediary's efficient operation. Hence a regime that encourages a holding-company conglomerate to hold its investments in the division that suffers from the lowest systemic externalities will raise welfare.¹⁷

This goes against the grain of many of the assumptions (implicit and explicit) in regulatory discussions. These tend to focus on concerns that conglomerates will use regulatory arbitrage to shift poor investments into DFIs and so transfer their expected losses to the deposit insurance fund. We have shown that this is only worth doing under a poorly-designed capital adequacy regime. When capital requirements are set optimally, this type of regulatory arbitrage will cost more than it is worth. Capital requirements for holding-company DFIs should therefore be set significantly above those for standalone DFIs precisely in order to *encourage* regulatory arbitrage.

4.2. Numerical example of a holding-company financial conglomerate

We now extend the numerical example of Section 2.3 to demonstrate that holding company conglomerates can achieve first best even when standalone intermediaries could not. Suppose again that $R = 1.1$, $\bar{B} = 0.8$, $\zeta = 0.07$ and $\kappa = 0.2$. Table 2 illustrates regulatory choices when the social cost of failure ϕ is 0.18 and 0.21. In both cases, setting the capital requirement equal to C_S^* suppresses DFI investment. When $\phi = 0.18$ the regulator prefers to set a zero capital requirement so as to induce investment at the cost of financial fragility; when $\phi = 0.21$ she prefers to set $C = C_S^*$. In contrast, a market-financed intermediary with a zero capital requirement will always make the first best investment decision.

Now consider a holding-company conglomerate in our example. If the MFI has a zero capital requirement it will accept every safe positive NPV project. We know from the previous paragraph that if the conglomerate's DFI has capital requirement C_S^* , it will never retain the investment. However, because it is able to transfer it to the conglomerate's MFI, it will accept it, and pass it on, without increasing its riskiness. Hence in this example, as in Proposition 4, a holding-company conglomerate for which the MFI has zero capital requirement and the DFI has capital requirement C_S^* will achieve first best.

¹⁷ Note that, in our simple model, all of the DFI's assets are transferred to the MFI. In a model with varying costs of asset transfer some assets would remain on the DFI's balance sheet. However, the main thrust of our reasoning would not be affected.

4.3. Integrated conglomerates

In this section we use an extension of the Section 2 model to examine the investment behavior of an integrated financial conglomerate. The time line for the model that we examine appears in Fig. 5.

Capital requirements are announced at time 0. The regulator is able to observe whether investment has occurred in each of the conglomerate divisions. Hence when only one division invests, capital requirements are set according to the results derived in Section 2. If both divisions invest the regulator assigns a single capital requirement for the entire conglomerate of $\$C$ per dollar invested.

At time 1 nature makes independent draws R_D and R_M from the uniform distribution on $[R_l, R_h]$ for the expected returns for the DFI and the MFI, respectively. At time 2 the DFI and MFI managers select their project riskiness so as to maximize the value of the conglomerate. By Assumptions 1 and 2, the pair (R_D, B_D) is visible only to the DFI managers, while (R_M, B_M) is immediately visible to investors and to the regulator.

Fund-raising occurs at time 3: for single-division integrated conglomerates the process mirrors the standalone case of Section 2; when both divisions invest we assume that the conglomerate raises debt in equal proportions from bondholders and depositors.¹⁸ At time 4 project returns realize and the financing contracts are settled.

Two effects are at work in integrated financial conglomerates. First, integrated conglomerates can achieve diversification: when both divisions play risky, losses in one may be canceled out by gains in another. Second, because integrated conglomerates have a single balance sheet, the MFI division may assume risk simply to increase the loss magnitude after default, and hence to access the deposit insurance fund. Hence, while diversification effects may appear at first glance to justify integrated conglomerate capital requirements below the combined optimal requirement for standalone institutions, the possibility of MFI risk-shifting could actually result in *higher* optimal capital requirements for integrated conglomerates. In this section we demonstrate that, for certain parameter values, this is indeed the case.

Assume that $\phi \geq \bar{\phi}$. Then separately capitalized conglomerate divisions will be sound; the MFI is always charged for its risk-bearing, and we proved in Section 2 that with capital require-

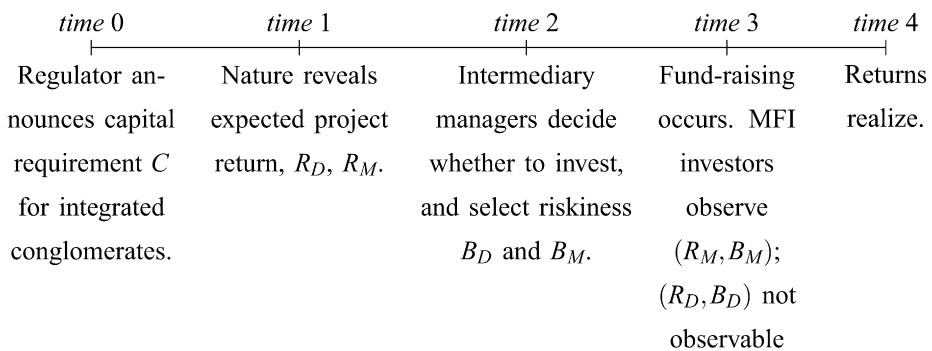


Fig. 5. Time line for integrated conglomerates.

¹⁸ In our model, integrated conglomerates would clearly prefer to maximize the level of insured depositor debt. We rule this out so as to ensure that we compare like-with-like.

ment C_S^* the DFI will be unable to assume a sufficiently large risk to draw upon the deposit insurance fund.

For an integrated conglomerate investing \$1 in an MFI and \$1 in a DFI, we consider a capital requirement per dollar invested of $\frac{1}{2}C_S^*$: this corresponds to a total conglomerate capital requirement of C_S^* , which is precisely the sum of the standalone capital requirements. The conglomerate's bondholders will continue to charge for the risk that they assume. However, for large enough \bar{B} , simultaneous failure by both divisions will be sufficient to trigger a claim on the deposit insurance fund, for which the conglomerate will make no marginal payment. **Proposition 5** demonstrates that, for some values of R_M and R_D , the expected value of the deposit insurance claim is sufficiently large to compensate for the expected loss of charter value, so that the integrated conglomerate chooses to be fragile.

Proposition 5. *Suppose that an integrated conglomerate has a per-dollar capital requirement of $\frac{1}{2}C_S^*$. If condition (16) is satisfied then there exist values of R_M and R_D for which the conglomerate will be fragile:*

$$\bar{B} \geq \max \left\{ \frac{\zeta + 2(1 + \kappa)}{3 + 2\kappa}, \frac{4(1 + \kappa) + \zeta(5 + 3\kappa)}{2(4 + 3\kappa)} \right\}. \quad (16)$$

Proof. See [Appendix A](#). \square

In short, holding capital requirements constant as integrated conglomerates form can result in an *increased* probability of failure. Hence, when the systemic cost ϕ of failure is sufficiently large, capital requirements for integrated conglomerates should *exceed* the sum of their component stand-alone requirements. Furthermore, because holding-company conglomerate structures always achieve first best when capital requirements are properly set, they must dominate integrated structures. This observation clearly has important policy implications, which we will consider in Section 6.

It is easy to show that integrated conglomerates will sometimes be prepared to accept a negative NPV project so as to increase their aggregate risk level and hence to profit from a deposit insurance fund subsidy.

Corollary 1. *Integrated conglomerates accept some negative NPV projects.*

Proof. See [Appendix A](#). \square

Finally, we demonstrate in [Appendix A \(Lemma 3\)](#) that, provided R_l is small enough, conditions (15) and (16) can both be satisfied.

4.4. Numerical example of an integrated financial conglomerate

Proposition 5 shows that when capital requirements are optimally set sufficiently high to guarantee that standalone DFIs are safe, integrated financial conglomerates will nevertheless accept negative NPV projects and play risky when the project riskiness \bar{B} is high enough. In this section we provide a numerical example that illustrates this result.

Table 4
Integrated financial conglomerate: numerical example

\bar{B}	One investment			Two investments		
	Conglom. riskiness	S/holder wealth	Social welfare	Conglom. riskiness	S/holder wealth	Social welfare
0.7	Safe	0.0682	0.1	Safe	0.0582	0.090
0.8	Safe	0.0622	0.1	Fragile	0.08345	0.045

Note. This table illustrates figures for $\bar{B} \in \{0.7, 0.8\}$, $R_D = 1.1$, $R_M = 0.99$, $\phi = 0.18$, $\zeta = 0.07$, $\kappa = 0.06$ and the conglomerate capital requirement equal to C_S^* for a standalone DFI. The riskiness of the conglomerate conditional upon accepting one or both projects is shown, with the expected shareholder wealth and social welfare for each case.

Suppose that $R_D = 1.1$, $\phi = 0.18$, $\zeta = 0.07$ and $\kappa = 0.06$.¹⁹ We know from Proposition 5 that the integrated conglomerate's propensity to accept risky negative NPV projects is increasing in project riskiness, \bar{B} . We therefore employ two different values for \bar{B} to capture this effect. First we set $\bar{B} = 0.7$ so that $C_S^* = 0.53$, and second we increase \bar{B} to 0.8 so that $C_S^* = 0.63$. In both cases it is easy to demonstrate that a standalone DFI with capital requirement C_S^* will invest, so that first best will be achieved. Hence the optimal capital requirement for standalone DFIs with either parametrization is C_S^* .

Consider in this example an integrated financial conglomerate. In this case, because there is a common balance sheet, regulatory arbitrage of the type illustrated in Section 4.2 is impossible. We examine the risk-taking of a conglomerate whose total capital requirement is equal to the sum of the optimal standalone capital requirements for its constituent financial intermediaries. Hence, with our parameterizations, when $\bar{B} = 0.7$ the total capital requirement for an integrated conglomerate is 0.53, and when $\bar{B} = 0.8$ the total capital requirement is 0.63.

We now introduce a negative NPV investment, which in exchange for an investment of 1 yields an expected payout of $R_M = 0.99$. Table 4 illustrates the conglomerate's investment decisions when it is faced with this investment in addition to the original positive NPV investment. In the first line of the table, the maximum project riskiness \bar{B} is 0.7. Whether the conglomerate invests in one or both projects, it chooses to play safe. However, shareholders maximize their wealth by taking only the positive NPV project and so first best is achieved.

The second line of Table 4 illustrates the case where \bar{B} is increased to 0.8. Conditional upon accepting only the positive NPV project, the conglomerate will play safe and generate shareholder wealth 0.0622. However, it can generate shareholder wealth 0.08345 by accepting both projects and playing risky. Hence in this case, setting the capital requirement for the integrated conglomerate equal to the sum of its optimal standalone capital requirements results in suboptimal investment and financial fragility that would not arise with standalone institutions.

5. Robustness

In this section we examine the robustness of our results to our key assumptions.

¹⁹ This parameterization is similar to the one employed in Section 2.3, except that we use a lower value for κ . We do this so as to ensure that investment occurs even when capital requirements are set equal to C_S^* . We note in footnote 13 that when R has a single-element support, as in this example, investment is an all-or-nothing affair. Since in Section 2.3 investment does not occur when C_S^* , it is necessary in this section to adjust the parameterization to ensure that it does.

5.1. Observability

Our Assumptions 1 and 2 state that the distributional characteristics of DFI investments are unobservable by market participants and by the regulator, and that the characteristics of MFI investments are perfectly observable. As a result, market prices perfectly reflect the properties of MFI investments, and are completely insensitive to the properties of DFI investments.

While these assumptions enable us to derive clear-cut results in a relatively simple framework, they could be relaxed. Our qualitative results would remain the same provided firstly that market prices more precisely reflected MFI than DFI asset quality, and secondly that formal contracts could not be contingent upon more precise information than MFI investors bring to bear. The first of these requirements seems reasonable: there is empirical evidence that bank-originated assets are more opaque than those held by market-financed institutions.²⁰ The second requirement is examined in the following subsection.

5.2. Contractability

Assumptions 4 and 6 state that it is impossible to write court-enforceable contracts that are contingent upon R and B ; Assumption 5 constrains regulators to use only contractible data. These assumptions reflect both the practical difficulties that regulators experience in practice in observing key parameters about the portfolios of the entities that they regulate, and also limitations upon the types of information that it is possible to incorporate into regulatory contracts: while market prices can reflect soft and non-verifiable information, this is not true of regulatory requirements that depend critically on a legal dimension.

Provided regulations are based upon a coarser partition of the state space than are market prices, we believe that our results are robust to relaxation of the rather stark assumptions that we make. In particular, while the new Basel Accord goes some way to increasing the risk sensitivity of regulations, it is still based upon specific types of methodologies, such as Value at Risk, and upon specific formulae. Hence it cannot fully reflect all of the nuanced information that is fed into prices.

5.3. Adverse selection problems in securitization

The informational and contractual problems considered above ensure that any attempt to use arm's-length contracts to transfer assets out of the DFI will meet with adverse selection problems. When the maximum asset riskiness \bar{B} satisfies condition (15) such contracts will be impossible. Adopting this assumption in the paper generates very clear results. In practice, of course, securitization *does* occur, even in the presence of adverse selection.²¹ We now consider the impact of such securitization upon our results.

Although relaxation of condition (15) would allow asset securitizations to occur in our model, these trades would still be subject to adverse selection problems. In practice, these problems

²⁰ Morgan (2002) and Iannotta (2006) use evidence of ratings agency disagreement over bank credit quality to provide direct evidence of bank asset opacity. However, Flannery et al. (2004) present microstructure evidence that suggests that large NYSE-traded bank holding companies are not unusually opaque. They suggest that their findings may be evidence of effective regulation.

²¹ Calomiris and Mason (2004) find that bank securitization of credit card receivables is often motivated by regulatory arbitrage. In line with our reasoning, they provide evidence that this type of securitization is motivated by efficiency considerations, rather than abuse of the deposit insurance safety net.

are often addressed by “tranching” asset sales by risk class. Uninformed investors are then attracted to the safest tranches (see for example DeMarzo, 2005), while sophisticated investors are attracted to the riskiest tranches, where they can earn the highest return on their information-gathering skills (see for example Boot and Thakor, 1993).

The information-gathering activities of sophisticated investors may generate benefits which are outside the scope of our model. As prices are refined and updated in secondary market trading valuable information enters the public domain. This information has obvious potential uses in regulation. In our model this information is optimally deployed within holding-company conglomerates because, by Assumption 7, they are able to enforce tacit agreements that would be impossible between arm’s-length counterparts.

Assumption 7 is therefore critical to our conclusion that asset transfers within conglomerates can dominate arm’s-length transactions. Some evidence is supportive of this assumption. For example, recent empirical work by Massa and Rehman (2005) suggests that information flows are better within the divisions of a financial conglomerate than they are between the conglomerate and other market players.

5.4. Costly asset transfers

We assume in our model that transferring assets between divisions is costless. In practice, there may be costs: in particular, suppose that banks are endowed with monitoring skills that are absent in market-financed institutions (Diamond and Rajan, 2001). This introduces two costs, which must be weighed against the benefits of improved market discipline and potentially lower social costs of failure. First, assets that *are* transferred will be less effectively monitored. Second, setting capital requirements sufficiently high to induce regulatory arbitrage will raise the hurdle rate for informationally opaque projects that it is not profitable to transfer. Both of these effects will serve to diminish the optimal capital requirement for depository institutions. The development of securitization techniques that allow for risk but not monitoring responsibility to be transferred will attenuate the effects examined in this paragraph.

5.5. Social costs of failure

Our analysis is predicated upon the assumption that the social cost ϕ of institutional failure is the same for deposit- and market-financed intermediaries. However, a number of authors have argued that the systemic costs of bank failure are significantly higher than those of insurance or security company failure: bank failure may give rise to contagion; bank failure affects the payments system; and bank failure may cause the loss of valuable informational assets. These effects serve to strengthen our conclusions. We have based our argument entirely upon the endogeneity of bank risk-taking and the risk-insensitivity of bank finance. However, our conclusion that a holding company structure is optimal when allowing for regulatory arbitrage could equally be derived in the absence of these effects, provided the social cost of bank failure exceeds that of market-financed institutions. With this assumption, as capital requirements force the internalization of systemic externalities, they will optimally be higher for banks than for market-financed intermediaries. As a result, the bank’s hurdle rate will exceed the market-financed intermediary’s. Thus, regulatory arbitrage will again lower the effective cost of bank investment and hence will raise welfare.

5.6. Collateral²²

Collateral assets are those that a lender can seize from a borrower in the event that its project fails. The financial institutions in our model have no residual value after they fail, and hence they cannot pledge collateral. In this subsection we discuss the effect that collateral would have upon our model. We argue that the ability of an integrated conglomerate to spread its collateral over both divisions could serve to counter some of the risk-shifting problems that we identify in this paper.

The expected cost of collateral loss is lower for borrowers that are less likely to fail. Hence a number of models argue that collateral can resolve adverse selection problems. Another strand of literature examines the role of collateral in mitigating moral hazard problems: because the expected deadweight cost of seizing collateral falls upon the borrowers, they will work hard to avoid it.²³

Ours is a model of moral hazard, so in an extension in which failed institutions had some residual assets, collateral would serve to reduce risk-shifting incentives rather than to counter adverse selection. Conglomeration would not affect incentives in a holding company conglomerate, since creditors of one division would not be able to seize the assets of the other. However, the DFI could pledge its collateral against MFI investments in an integrated conglomerate, thus increasing the income that could be pledged to bondholders. In addition, to the extent that integrated conglomerates achieve diversification, the expected cost of pledging collateral would be lower in integrated conglomerates. By lowering their cost of capital, both of these effects would mitigate more in favor of integrated conglomerates.

6. Policy implications

6.1. Bank conglomerates

We can use our approach to analyze related questions regarding conglomerate regulation. In the United States, statutory responsibility for the regulation of bank holding companies was handed to the Board of Governors of the Federal Reserve by the 1956 Bank Holding Companies Act. The Board is required to approve every application to acquire control of a bank: Section 3(c) of the Act requires it to do so with regard to the managerial resources and the future prospects of the acquiring company. The Board has attempted to use this rule to force bank holding companies to act as a “source of strength” for troubled bank subsidiaries: that is, to assist troubled banks and, if necessary, to draw upon both their bank and their nonbank resources.²⁴

The Board began in the 1970s aggressively to apply the source of strength doctrine when considering holding company applications to acquire or to merge with a bank, and these applications were upheld by the courts. However, attempts to use the doctrine to force holding companies to

²² We thank Anjan Thakor for suggesting this line of inquiry.

²³ A large literature examines collateral. For examples of models in which collateral addresses and adverse selection problem see for example Bester (1985), Chan and Kanatas (1985), Besanko and Thakor (1987) and Inderst and Müller (2006). Examples of collateral models involving moral hazard are Tirole (2006, Chapter 4), Boot et al. (1991), and Boot and Thakor (1994).

²⁴ See Alexander (2004), Keeton (1993), and Weinstein and Albert (1998) for details of the source of strength doctrine and of the case law surrounding the analysis in this section. We are grateful to Kern Alexander for enlightening discussions about this material.

support bank subsidiaries absent such a merger have met with mixed success, and the legal status of the doctrine in these cases is still unclear. However, the 1989 adoption of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) forces each bank in a multi-bank holding company to guarantee the FDIC's claims on its sister banks. Hence, while it may be difficult for the Federal Reserve to force a holding company to use a non-bank subsidiary to support a banking subsidiary, it is certainly able to enforce cross-bank guarantees within a single holding company. Any bank holding company that is unwilling or unable to bear the costs is deemed "unsafe and unsound" and the Federal Reserve Board forces its closure.

The FIRREA regulation was originally intended to discourage ex post loss concentration in distressed divisions in order to maximize the value of the deposit insurance option (see footnote 5). It has been challenged in the courts, but they have consistently upheld it: Ashcraft (2004, footnote 6) cites two significant challenges to the FIRREA provision, in one of which the provision caused a failing bank (Bank of New England) to drag a sister institution (Maine National Bank) under.

The 1989 Act prevents one bank division from walking away from the other in the event of its failure. Hence it forces integration in bank conglomerates. We have demonstrated that such forced integration would be socially sub-optimal in conglomerates containing a non-bank division, as it would prevent risk concentration in the division subject to the most market discipline and the lowest social failure cost. However, these effects are constant across the divisions of a bank conglomerate and hence the above argument does not apply. On the contrary, the legislation ensures that banks internalize as much as possible of the risk that they take. Notwithstanding this observation, a similar argument to that underlying Proposition 5 implies that an integrated bank conglomerate may take more risk than any of its constituents would have done on a stand alone basis.²⁵ The reason is that, when each division is able to bail out the others, a greater degree of risk is required to profit from the deposit insurance put option. If the Act simply incentivizes the holding company to take more risks then it generates no efficiency gains.

If instead liability were limited by the requirement that the failure of one division could not trigger the failure of the other, access to the deposit insurance net would be diminished, and with it risk-shifting incentives. This would clearly be desirable: to the extent that the FIRREA is contestable legislation, it may already be the case. Even with this alteration, though, the Act fails to account for the substitutability of capital regulation and market discipline (i.e., of pillars one and three of the new Basel Accord). We have argued that capital requirements should optimally counter the increased risk-shifting incentives engendered by deposit insurance. As a consequence, when these incentives are ameliorated, capital requirements should be reduced. Since a successful cross-bank guarantee policy would reduce the value to a bank holding company of the deposit insurance put option, it would increase market discipline and hence reduce risk-shifting incentives. Hence, for the FIRREA to increase efficiency it should be accompanied by correspondingly looser capital requirements.²⁶

In summary, our framework indicates the potential for efficiency gains from source of strength-type regulations, but also demonstrates that these gains are currently not fully realized for two reasons. First, one division may take larger risks so that its failure triggers the failure of the other and hence maintains its access to the deposit insurance put option. Second, to the extent

²⁵ Indeed, Demsetz and Strahan (1997) find that, while large bank holding companies are better diversified than smaller ones, they compensate for their greater diversification by taking more risks.

²⁶ A similar effect obtains in branch-organized multinational banks: see Lóránth and Morrison (2003).

that these regulations succeed in increasing market discipline, they should be accompanied by a downward adjustment in capital requirements.

6.2. Level playing fields in capital regulation

Since capital is costly, an essential precursor to fair competition in the financial sector is that no institution should be placed at a relative disadvantage by capital regulation. This is the basis of the Basel Accord's emphasis upon a "level playing field" (see [Basel Committee on Banking Supervision, 1997](#)). A commonly deployed argument in favor of integrated conglomerates is that they reduce systemic risk by diversifying risks across banks and insurance companies. This observation has been used to argue that a level playing field should allocate lower capital requirements to an integrated conglomerate than to either a holding-company conglomerate, or the corresponding standalone institutions.

Provided asset riskiness is exogenous, this argument is perfectly correct. Our model highlights an additional effect that has received less attention: namely, that by extending the reach of the deposit insurance net to the conglomerate's MFI, integration may actually introduce additional risk-taking incentives and hence increase systemic risk. [Proposition 5](#) demonstrates that for certain parameter values, the second of these effects dominates the first. When this happens, level playing fields actually require integrated conglomerate capital requirements to *exceed* those of the corresponding standalone institutions.

It has been acknowledged for some years that charter value forces banks to internalize their costs of failure and hence discourages excessive risk-taking.²⁷ As a result of this effect, charter value and capital are substitutes (in our model, see [Propositions 2 and 4](#)). [Proposition 5](#) establishes a new effect: it demonstrates that optimal integrated conglomerate capital requirements exceed standalone requirements for sufficiently low charter value. In other words, diversification alone is not enough to reduce capital requirements.

6.3. Pro-cyclicality effects in capital regulation

A frequently voiced criticism of the new Basel Accord on capital regulation is that it may serve to amplify the economic cycle.²⁸ As far as we are aware, pro-cyclicality has not featured in discussions of financial conglomeration. In this section we suggest that it may be a concern in integrated conglomerates.

The most important MFIs in financial conglomerates are insurance companies, whose assets are market securities. As such, their investments have the same expected return as the market. In contrast, DFIs hold customer loans which have distinct return characteristics.²⁹

In the light of the observations in the previous paragraph, consider a reinterpretation of our model in which expected MFI returns are equal to those of the market. We know from [Proposition 5](#) that for appropriate R_M and R_D , integrated conglomerates play risky; the probability that this occurs is decreasing in bank charter value ζ and increasing in the maximum invest-

²⁷ The initial paper on this topic was [Keeley \(1990\)](#).

²⁸ For theoretical models of this phenomenon see for example [Catarineu-Rabell et al. \(2005\)](#) and [Estrella \(2004\)](#). However, in an analysis of Spanish panel data [Ayuso et al. \(2004\)](#) find that, under the first Basel Accord, there is a negative relationship between bank capital buffers and the position in the economic cycle.

²⁹ Although loan portfolio returns are correlated with the market, there is some evidence that bank loans have less systematic risk than securities and insurance company portfolios: see [Allen and Jagtiani \(2000\)](#).

ment riskiness \bar{B} . It follows that, if charter value drops and risk-shifting opportunities increase in a slowdown, that the probability of integrated conglomerate fragility increases in economic slowdowns.

In summary, the conglomerate has an increased incentive to play risky in economic downturns, which serves to exacerbate systemic pressures already in the economy. The endogeneity of risk selection therefore reverses the standard assumption that diversification has a stabilizing effect in economic downturns. Conversely, the size of the fragile region is smaller for high expected market returns and the probability that the total conglomerate return lies within it is also reduced.

6.4. Competition and conglomeration

The intuitions in this papers are developed using a model in which the expected return R from investing is drawn from a uniform distribution with support $[R_l, R_h]$. Consider an extension of our model in which R is drawn from an alternative distribution which is first order dominated by the uniform one: in this case the prior likelihood of integrated conglomerate fragility is increased. Moreover, for a given risk level the expected value of the deposit insurance subsidy, and hence the attraction of financial conglomeration, is greater in a fragile integrated conglomerate when R is lower. Similarly, a reduction in the charter value ζ will diminish the costs that conglomerate fragility imposes upon the shareholders, and hence will increase the probability of conglomerate fragility.

These observations suggest that integrated financial conglomerate behavior may be affected by banking sector competition levels. When competition is heightened in response either to technological or regulatory factors the distribution of R shifts to the left and bank charter value ζ drops.³⁰ The argument of the previous paragraph suggests that these factors will serve first to make conglomeration more attractive, and second to increase the fragility of financial conglomerates.

7. Empirical implications

In this section we highlight some empirical predictions of our work.

7.1. Diversification discounts

A substantial literature examines the valuation of non-financial conglomerate firms. Theoretical work suggests that investment decisions in conglomerate firms may be distorted by inter-divisional agency problems (e.g. Scharfstein and Stein, 2000), and early empirical work appeared to support these theories. For example, Lang and Stulz (1994) and Berger and Ofek (1995) both demonstrate that conglomerate firms have a lower Tobin's q than corresponding specialized firms would have. However, more recent work points out that these results may reflect an endogeneity problem. Maksimovic and Phillips (2002) find evidence that firms that are less productive tend to diversify and hence that the diversification discount reflects the characteristics of firms that choose to diversify, rather than the effects of diversification per se. Graham et al. (2002) argue that conglomerate firms tend to acquire discounted firms, and that the Berger and Ofek methodology makes the combined institution appear discounted.

³⁰ Barros et al. (2005) and Degryse and Ongena (2006) both survey the literature concerning competition and integration in the banking sector.

Our paper suggests an explanation for a diversification discount that is specific to financial firms. **Proposition 5** shows that integrated conglomerates may elect to take risks in order to extend the deposit insurance safety net to their market-financed division. The same set-up can be used to consider integrated conglomerates whose divisions have correlated projects. In this case the probability of simultaneous failure would be higher, and hence so would the value of the deposit insurance safety net. In other words, our model suggests that, because they have less access to the deposit insurance fund, diversified financial conglomerates should trade at a discount relative to more specialized institutions. Furthermore, since this discount arises in our model because of deposit insurance, it should be greater in countries where the deposit insurance scheme is more generous.

Recent empirical work by **Laeven and Levine (2005)** examines diversification effects in financial firms and supports our prediction. Laeven and Levine control for the endogeneity problems and merger and acquisition activity that may have affected the findings of the literature on non-financial conglomerate discounts. They find that financial conglomerates trade at a discount, and that the magnitude of the discount is reduced in less-diversified firms.

7.2. Conglomerate activities

We argue in the preceding subsection that diversification in integrated financial conglomerates lowers the value of the deposit insurance safety net. Since the selection of activities within a financial conglomerate is endogenous, it follows that, *ceteris paribus*, financial firms that diversify into new business lines should not at the same time diversify their risks. Hence our work implies that legislation that, like the Gramm–Leach–Bliley Act, broadens the permissible scope of banking activities should not result in a reduction in earnings volatility within the affected institutions. In fact, **Proposition 5** suggests that, by increasing the scope for claims on the deposit insurance fund, such legislation may in some cases result in *increased* risk levels.

Some recent work examines the effect upon the riskiness of bank portfolios of recent moves to increase the proportion of earnings derived from fee-based, as opposed to interest-based, income. **DeYoung and Roland (2001)** examine US commercial bank data between 1988 and 1995 and find that increased fee-based business results in greater earnings volatility. Moreover, they find that earnings volatility is positively related to the degree of leverage, which indicates a greater degree of access to the deposit insurance safety net. Similarly, **Stiroh (2004)** finds in a study of individual and aggregate US bank data from the late 1970s to 2001 that the move into non-interest businesses is associated with higher bank risks. While the authors of these studies argue that their results show that fee-based income does not generate diversification benefits, our results suggest that banks may deliberately choose to expand into correlated business lines so as to retain the benefits of deposit insurance.

8. Conclusion

In this paper we present a model of financial intermediation in which capital requirements serve to force shareholders to internalize failure and deposit insurance costs that they would otherwise ignore. When market discipline is weak, as in a depository institution whose depositors are protected by deposit insurance, the institution will tend to take socially excessive risks. In this case, regulatory capital requirements serve as a costly substitute for market discipline: optimal regulation trades off their costs against their disciplining effects. Hence, our results suggest that pillars one and three of the new Basel Accord are (partial) substitutes.

Integrated conglomerates are diversified and hence may better internalize the risks that they assume. However, they are partially financed by risk-insensitive deposits and this undermines the market discipline of their non-bank division, which may as a result assume larger risks. When the second effect outweighs the first, they will be relatively less efficient than the sum of their standalone parts, and they should be subject to a *higher* aggregate capital adequacy requirement.

In contrast, we find that the ability to set separate capital requirements for each of the divisions of a holding-company conglomerate allows the regulator to induce first-best investment behavior by the conglomerate. This is because the regulator can set capital requirements to reflect the riskiness of each division and hence can encourage the conglomerate to hold assets in the most efficient location. Hence, our results rest upon the existence of regulatory arbitrage, which in our set-up is unambiguously welfare-increasing.

Although our formal analysis examines a conglomerate containing a bank and a non-bank institution, our framework allows us to comment upon the Federal Reserve's "source of strength" doctrine. This forces the holding company or another division within the holding company to bear any costs incurred by the deposit insurance company in the wake of divisional failure. In line with our results on integrated conglomerates, we argue that this regulation may actually serve to *increase* bank risk-taking incentives. Moreover, to the extent that it succeeds in enhancing market discipline, the regulation should be accompanied by reduced capital requirements.

Finally, we identify two empirical implications of our work. First, because diversification diminishes access to the deposit insurance fund, financial conglomerates should exhibit a diversification discount. Second, we argue that financial conglomerates will choose deliberately to expand into correlated business lines, so as to maintain earnings volatility and hence to protect their deposit insurance subsidy.

We conclude the paper by noting a direction for further research. In this paper, we abstract away from the details of the interaction between the divisions of financial conglomerates. A detailed analysis of this interaction, based upon more primitive assumptions, would shed light upon the relationship between the organizational form of a conglomerate, the incentives that divisional managers face, the information flows between them, and the tacit contracts that the conglomerate can enforce between its various divisions. Such an analysis would underpin further work into the regulation of financial conglomerates, and of large complex financial intermediaries in general.

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Appendix A

Proof of Proposition 2. Recall that welfare is defined to be the total surplus generated by the bank, net of any social costs. Hence, a sound bank generates welfare $R - 1$ and a fragile one generates welfare $R - 1 - \frac{\phi}{2}$. The regulator’s job is to select C so as to maximize expected welfare:

$$C^* \in \arg \max_C W(C),$$

where for a given C , $W(C)$ is the expected welfare:

$$W(C) \equiv \int_{R_l}^{R_h} \frac{1}{\Delta} \omega(C, R) dR,$$

and the project welfare function $\omega(C, R)$ is as indicated in Fig. 3:

$$\omega(C, R) \equiv \begin{cases} R - 1, & R > \max(\bar{B} + 1 - C - \zeta, R_S); \\ R - 1 - \frac{\phi}{2}, & R_F < R \leq \bar{B} + 1 - C - \zeta; \\ 0, & R \leq \min(R_S, R_F). \end{cases}$$

Straightforward calculations yield

$$W(C) = \begin{cases} \frac{1}{2\Delta} \{(R_h - 1)^2 - (\zeta - \bar{B} + C(1 + 2\kappa))^2\} - \frac{\phi}{\Delta} (\bar{B} - \zeta - C(1 + \kappa)), & C < C_S^*; \\ \frac{1}{2\Delta} \{(R_h - 1)^2 - (C\kappa)^2\}, & C \geq C_S^*, \end{cases}$$

where C_S^* is defined in Eq. (8).

To find C^* , note firstly that

$$\lim_{C \uparrow C_S^*} W(C) = \lim_{C \downarrow C_S^*} W(C) = \frac{1}{2\Delta} \{(R_h - 1)^2 - (C\kappa)^2\},$$

so $W(\cdot)$ is a continuous function on $\mathfrak{R}_{\geq 0}$. Moreover, $W(\cdot)$ is trivially decreasing for $C > C_S^*$. This is intuitively as well as mathematically obvious: since banks are always sound when $C > \frac{\bar{B}-\zeta}{1+\kappa}$, increasing C beyond C_S^* serves simply to increase underinvestment.

For $C < C_S^*$ increasing C has two effects. Firstly, the fragile region \mathcal{F} within which the bank assumes systemic risk shrinks. This serves unambiguously to raise welfare. Secondly, the capital costs $C\kappa$ of investing and hence the hurdle rate FIR increase. This increases welfare provided $FIR < 1$ so that risk shifting is causing overinvestment; conversely, it decreases welfare if $FIR > 1$, in which case high capital costs are already causing underinvestment.

When $C < C_S^*$, $W'(C) = 0$ when $C = C_F^*$, defined in Eq. (7). Note that $C_F^* > 0$ and that $C_F^* < C_S^*$ whenever $\phi < \bar{\phi}$, defined in Eq. (9): when this is the case, it follows because $W(C)$ is concave, continuous at C_S^* and decreasing for $C > C_S^*$ that the regulator will set $C = C_F^*$. Expected welfare is then given by

$$W_F \equiv W(C_F^*) = \frac{1}{2\Delta} (R_h - 1)^2 - \frac{\phi}{2\Delta(1 + 2\kappa)^2} \{2(\bar{B} - \zeta)\kappa(1 + 2\kappa) - \phi(1 + \kappa)^2\}. \tag{A.1}$$

If $\phi > \bar{\phi}$ then $C_F^* > C_S^*$: $W(C)$ is then strictly increasing for $C < C_S^*$ and strictly decreasing for $C > C_S^*$. The regulator will therefore set $C = C_S^*$.

Proof of Proposition 3. Proposition 2 states that $C \leq C_S^*$. Condition (15) is equivalent to $\hat{C} > C_S^*$ and hence implies that $C < \hat{C}$. It follows from Eq. (14) that $R^* = R_l$.

Proof of Proposition 4. By Proposition 1, the MFI will accept every positive NPV investment precisely when its capital requirement is zero, so $C_{HM}^* = 0$. Recall from Assumption 7 that the DFI will never transfer a negative NPV asset to the MFI. As in Section 3 there must exist some R^* such that the DFI transfers all assets with $1 \leq R \leq R^*$. Both the MFI and its bondholders will value asset transfers from the DFI at precisely their expected value conditional upon transfer occurring, so that the transfer price will be $\frac{1}{2}(1 + R^*)$. The DFI compares this price to the profit it generates by retaining the asset. With a capital requirement C this profit is $\pi_S(C, R)$ when the DFI plays safe, and $\pi_F(C, R)$ when it plays risky. Every positive NPV asset will be transferred when $R^* \geq R_h$; this is the case precisely when $\frac{1}{2}(1 + R_h) \geq \pi_S(C, R)$ and $\frac{1}{2}(1 + R_h) \geq \pi_F(C, R)$. The former condition reduces to $C \geq \frac{R_h - 1}{2\kappa}$ and the latter to $C \geq \frac{\bar{B} - \zeta - 2}{1 + 2\kappa}$. Finally, we need the DFI to elect never to purchase and retain a negative NPV project: i.e., that $R_F(C) \geq 1$, or $C \geq \frac{\bar{B} - \zeta}{1 + 2\kappa}$. The result follows immediately.

Proof of Proposition 5. We start by proving two simple results about the portfolio choices of an integrated financial conglomerate.

Lemma 1. *Suppose that an integrated conglomerate has a per-dollar capital requirement of $\frac{1}{2}C_S^*$. If it plays risky with both of its divisions then it will only ever be insolvent when it returns $R_D + R_M - 2\bar{B}$.*

Proof. Suppose that a conglomerate was insolvent when it returned $R_D + R_M$. Then the expected payoff to its shareholders would be

$$\begin{aligned} \frac{1}{4} \left(R_D + R_M + 2\bar{B} - \left(1 - \frac{1}{2}C_S^* + \rho \right) \right) - \frac{3}{4}\zeta - C_S^*(1 + \kappa) &< \frac{1}{2}\bar{B} - \frac{3}{4}\zeta - (\bar{B} - \zeta) \\ &= \frac{1}{4}\zeta - \frac{1}{2}\bar{B} < 0, \end{aligned}$$

where the first inequality is true because $R_D + R_M < 1 - \frac{1}{2}C_S^* + \rho$ and the second is true because $\bar{B} > \zeta$. Hence this conglomerate would not have chosen to invest. Conglomerates that play risky with both divisions must therefore be solvent in the middle state. \square

Lemma 2. *Suppose that an integrated conglomerate has a per-dollar capital requirement of $\frac{1}{2}C_S^*$. Either it plays risky with both divisions, or with neither.*

Proof. Playing risky is valuable because it generates a subsidy from the deposit insurance fund. Let the deposit insurance payout from a conglomerate that plays risky with $i = 1, 2$ projects be δ_i . Then δ_1 is at most \bar{B} , and $\delta_2 = \delta_1 + \bar{B} \geq 2\delta_1$. The expected deposit insurance payout for conglomerates that play risky with one division is therefore $\frac{1}{2}\delta_1$, while the expected payout for conglomerates that play risky with both divisions is $\frac{1}{4}\delta_2 \geq \frac{1}{2}\delta_1$. Hence the expected deposit insurance subsidy from playing risky with two projects is at least as high as that from playing risky with only one. However the shareholders experience a loss of charter value with probability $\frac{1}{4}$ when they play risky with two projects, and with probability $\frac{1}{2}$ when they play risky with only one. Hence they strictly prefer playing risky with two projects rather than with only one. \square

Lemmas 1 and 2 ensure that a fragile conglomerate has two risky divisions, and that it is insolvent only when both of the divisions fail. Hence we restrict our attention to (R_M, R_D) pairs for which

$$0 < R_D + R_M - \left(1 - \frac{1}{2}C_S^* + \rho\right) < 2\bar{B}.$$

The first of these inequalities reduces to condition (A.2), and the second to condition (A.3):

$$R_D \geq \underline{r}(R_M) \equiv -R_M + 1 + \rho - \frac{\bar{B} - \zeta}{2(1 + \kappa)}; \tag{A.2}$$

$$R_D \leq \bar{r}(R_M) \equiv -R_M + 1 + \rho + \frac{\zeta + B(3 + 4\kappa)}{2(1 + \kappa)}. \tag{A.3}$$

When conditions (A.2) and (A.3) are satisfied, we write $p_{RR}(R_M, R_D, \rho)$ for the expected profit that the shareholders generate from playing risky with both projects; $p_D(R_D)$ for the expected profit that they derive from investing only in the DFI, which in this case has capital requirement C_S^* ; $p_M(R_M)$ for the expected profit from investing only in the MFI; and $p_{SS}(R_D, R_M)$ for the expected profit from playing safe with both projects. With a per-dollar capital requirement of $\frac{1}{2}C_S^*$ for a two-division conglomerate, we have after some manipulation that:

$$p_{RR}(R_M, R_D, \rho) = \frac{3}{4}(R_D + R_M - 1 - \rho) + \frac{3\zeta(1 + 2\kappa) - \bar{B}(1 + 4\kappa)}{8(1 + \kappa)};$$

$$p_{SS}(R_D, R_M) = R_D + R_M - 2 - C_S^*\kappa;$$

$$p_D(R_D) = R_D - 1 - C_S^*\kappa;$$

$$p_M(R_M) = R_M - 1.$$

Note that, because we assume the capital requirement for a DFI-only conglomerate to be C_S^* , we can ignore the case where the DFI elects to play risky.

For the integrated conglomerate to elect to play risky, we therefore require conditions (A.2) and (A.3) above and conditions (A.4)–(A.7) below to be satisfied:

$$p_{RR}(R_M, R_D, \rho) \geq p_{SS}(R_D, R_M); \tag{A.4}$$

$$p_{RR}(R_M, R_D, \rho) \geq p_D(R_D); \tag{A.5}$$

$$p_{RR}(R_M, R_D, \rho) \geq p_M(R_M); \tag{A.6}$$

$$p_{RR}(R_M, R_D, \rho) \geq 0. \tag{A.7}$$

After manipulation, conditions (A.4)–(A.7) respectively can be written as conditions (A.8)–(A.11) below:

$$R_D \leq r_{>SS}(R_M) \equiv -R_M + 5 - 3\rho + \frac{\zeta(3 - 2\kappa) - \bar{B}(1 - \kappa)}{2(1 + \kappa)}; \tag{A.8}$$

$$R_D \leq r_{>D}(R_M) \equiv 3R_M - 3\rho + 1 + \frac{\zeta(3 - 2\kappa) - \bar{B}(1 - 4\kappa)}{2(1 + \kappa)}; \tag{A.9}$$

$$R_D > r_{>M}(R_M) \equiv -\frac{1}{3}(1 - R_M) - \frac{\zeta}{2}\left(\frac{1 + 2\kappa}{1 + \kappa}\right) + \rho + \frac{B(1 + 4\kappa)}{6(1 + \kappa)}; \tag{A.10}$$

$$R_D \geq r_{>0}(R_M) \equiv 1 + \rho - R_M - \zeta + \frac{B(1 + 4\kappa) + 3\zeta}{6(1 + \kappa)}. \tag{A.11}$$

Note constraint (A.3) is always slack:

$$\bar{r}(R_M) - r_{>SS}(R_M) = 4(\rho - 1) + \frac{2\bar{B} - \zeta(1 - \kappa)}{1 + \kappa} > 0,$$

because $\bar{B} > \zeta$.

To prove our result, it is sufficient to demonstrate that there exist parameters (R_M, R_D) that satisfy the remaining constraints (A.2), (A.8)–(A.11). Figure A.1 illustrates these constraints in the case where $r_{>0}(R_M) > \underline{r}(R_M)$; all constraints are satisfied in the shaded region. We therefore determine sufficient conditions for this region to be non-empty.

When $r_{>0}(R_M) > \underline{r}(R_M)$, as in the figure, the shaded region is non-empty if and only if $r_{>SS}(1) - r_{>0}(1) \geq 0$, or

$$4(1 - \rho) + \frac{2}{1 + \kappa} \left(\frac{\bar{B}}{3}(2\kappa - 1) + \zeta \right) \geq 0. \tag{A.12}$$

Note that, by Lemma 1, we must have $\rho \leq \frac{4}{3}(1 - \frac{1}{2}C_S^*)$. Substituting into Eq. (A.12) therefore yields the following sufficient condition for the shaded region in Fig. A.1 to be non-empty:

$$\frac{2}{3} \left(-2 + 2\bar{B} + \frac{\bar{B} - \zeta}{1 + \kappa} \right) \geq 0.$$

This condition is satisfied precisely when

$$\bar{B} \geq \frac{\zeta + 2(1 + \kappa)}{3 + 2\kappa}.$$

In the case where $r_{>0}(R_M) \leq \underline{r}(R_M)$, the shaded region is non-empty if and only if $r_{>SS}(1) - \underline{r}(1) \geq 0$, or

$$4(1 - \rho) + \frac{\zeta(1 - \kappa) + 2\bar{B}\kappa}{1 + \kappa} \geq 0. \tag{A.13}$$

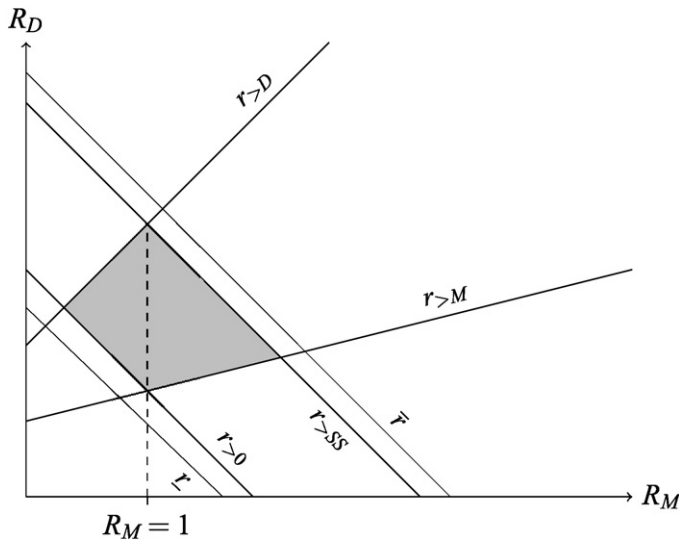


Fig. A.1. Parameter region within which an integrated conglomerate with total capital requirement C_S^* is fragile.

Once again, $\rho \leq \frac{4}{3}(1 - \frac{1}{2}C_S^*)$. Substituting into Eq. (A.13) gives us the following sufficient condition for the shaded region to be non-empty:

$$\frac{1}{3} \left(6\bar{B} - 4 - 3\zeta + \frac{2(\bar{B} - \zeta)}{1 + \kappa} \right) \geq 0.$$

This condition is satisfied precisely when

$$\bar{B} \geq \frac{4(1 + \kappa) + \zeta(5 + 3\kappa)}{2(4 + 3\kappa)}.$$

This concludes the proof.

Proof of Corollary 1. Suppose that the shaded region in Fig. A.1 is non-empty. The dashed vertical line through the figure illustrates parameters for which the MFI project has zero net present value. Any points within the shaded region and to the left of this line represent negative NPV MFI projects, which are accepted simply to generate a deposit insurance fund subsidy.

Lemma 3. *Provided*

$$R_l < \min \left\{ \frac{3 + 2\zeta\kappa}{3 + 2\kappa}, \frac{8 + \kappa(2 + 3\zeta)}{8 + 6\kappa} \right\}$$

conditions (15) and (16) can both be satisfied.

Proof. Equation (15) gives an upper bound for \bar{B} which is consistent with Eq. (16) precisely when firstly $\frac{\zeta + 2(1 + \kappa)}{3 + 2\kappa} < (1 - R_l)\frac{(1 + \kappa)}{\kappa} + \zeta$, which is true iff $R_l < \frac{3 + 2\zeta\kappa}{3 + 2\kappa}$, and secondly $\frac{4(1 + \kappa) + \zeta(5 + 3\kappa)}{2(4 + 3\kappa)} < (1 - R_l)\frac{(1 + \kappa)}{\kappa} + \zeta$, which is true iff $\frac{8 + \kappa(2 + 3\zeta)}{8 + 6\kappa}$. \square

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