DISCUSSION PAPER SERIES

No. 7155

INTERNAL REPORTING SYSTEMS, COMPENSATION CONTRACTS, AND BANK REGULATION

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FINANCIAL ECONOMICS

Centre for Economic Policy Research

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Available online at: www.cepr.org/pubs/dps/DP7155.asp

ISSN 0265-8003

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Discussion Paper No. 7155
February 2009

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ABSTRACT

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JEL Classification:
Keywords:

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Submitted January 2009

We are grateful to Alexander Guembel and Tom Noe for helpful comments and discussions, and to seminar participants at the Saïd Business School, the University of Valencia, and at the 2008 EEA meetings in Milan.

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Abstract

We examine the interdependency between loan officer compensation contracts and commercial bank internal reporting systems (IRSs). The optimal incentive contract for bank loan officers may require the bank headquarters to commit not to act on certain types of information. The headquarters can achieve this by running a basic reporting system that restricts information flow within the bank. We show that origination fees for loan officers emerge naturally as part of the optimal contract in our set-up. We examine the likely effect of the new Basel Accord upon IRS choice, loan officer compensation, and bank investment strategies. We argue that the new Accord reduces the value of commitment, and hence that it may reduce the number of marginal projects financed by banks.

1. Introduction

A substantial literature argues that commercial banks specialize in information production. However, only recently have we started to understand how this information is created, and how banks process it. An emerging literature examines the incentives of the specialist loan officers who form close relationships with the firms to whom commercial banks lend. Loan officer incentives are affected by the organisational form of the banks within which they work, and by the level of direct control that the central headquarters exercised over lending decisions.

This paper contributes to the literature on bank organizational form and loan officer incentives by addressing three questions. First, how can banks best use internal reporting systems to structure information flows between loan officers and the central headquarters? Second, how does the optimal loan officer compensation contract use information generated by the internal reporting system? Third, what is the relationship between internal reporting systems, loan officer compensation contracts, and bank capital regulation? We are able to explain the existence of "origination fees" in loan officer contracts, and we make testable predictions about the likely effect of the use in the second Basel Accord of risk-sensitive capital requirements that are based upon internal reporting systems.

In discussing information flows within a large organization like a commercial bank, we distinguish between "hard" and "soft" data. The former are facts that can be transmitted at arm's length using formal reporting systems, for example using accounting data, engineering specifications, and market research: that is, they can be *codified*. Soft data are not easily susceptible to codification: they include information born of a long relationship about such intangibles as trustworthiness, managerial competence, and credibility. Soft information of this type is hard to separate from the person who generates it: it is analyzed by Polanyi (1966), who refers to it as *tacit knowledge*.

Soft information may be very important for assessing loans, but, when it cannot be codified, it cannot be communicated by the originating loan officer to the central headquarters, and hence cannot feature in its decision-making process. Consequently, Berger and Udell (2002) argue that organizations with deep hierarchies are not well-suited to relationship lending. Stein (2002) presents a formal analysis of this problem. He argues that loan officers in decentralized bureaucratic banks will exert less effort to find loans in situations where soft information is particularly important. Hence, in soft information environments, Stein concludes that lending decisions should be delegated. In contrast, Stein argues that large bureaucracies are better able to channel resources to loans concerning which they have plenty of hard information; he concludes that large institutions have a comparative advantage for this type of loan. Berger, Miller, Petersen, Rajan, and Stein (2005) find evidence consistent with this hypothesis, stating that "large banks are less willing to lend to informationally 'difficult' credits, such as firms with no financial records."

Stein's work takes the distinction between hard and soft loan information as exogenous. In practice, however, it is possible at least to some extent to codify soft information. Petersen (2004) notes that credit ratings emerged in the nineteenth century as a way of hardening previously soft information about commercial borrowers. He argues that the computerization of price return data has enabled the codification of at least some knowledge of stock markets. More generally, the advent of low-cost distributed microcomputers has enabled the codification of much information that previously was entirely tacit. Morrison and Wilhelm (2007, 2008) use this observation to explain the recent shift in the investment banking industry from the partnership to the joint stock form, and also a simultaneous change in the scale and scope of investment banks; Murphy and Zábonjník (2004) argue that increased standardization and codification of managerial knowledge has increased job mobility and pay amongst American CEOs. Liberti (2005) presents evidence that soft information can be codified for transmission up a bank's decision-making hierarchy.

In this paper, we explicitly model the decision to codify information within commercial banks. We assume that loan-making decisions are made hierarchically, with local loan officers feeding possible investments to a headquarters that sanctions lending. This type of arrangement is commonplace: Liberti (2003) gives a detailed account of its use in a specific bank, and Eggenberger (2006) presents survey evidence from 120 German bankers of hierarchical lending practices. Fama and Jensen (1983) suggest that formal hierarchies of this type may be a response to governance problems that arise in large corporations when decision-making is separated from the ownership of residual cash flows. In this case, they argue, it may be optimal to separate the decision execution activities of line managers from the decision control that headquarters performs. Hence, using Fama and Jensen's terminology, we would expect large commercial banks to assign the *initiation* of lending decisions separately from their *ratification*. We take this separation as given, and analyze the optimal design of the internal reporting systems that the loan officers use to communicate with the headquarters.

Project discovery and the subsequent monitoring of loans are both performed by loan officers. Each gives rise to an agency problem between loan officers and the bank headquarters. First, loan officers have to be incentivized to find valuable projects. It is impossible to reward loan officers on the basis of the effort that they make to find a project; we assume that it is also impossible to verify that a worthwhile project has been found, and hence that even this cannot be the basis of a compensation contract. However, it is possible to contract upon project *investment*. Second, loan officers require incentives to monitor projects actively and, since monitoring effort is once again non-verifiable, incentives must be based upon project *outcomes*. We demonstrate that the constrained optimal contract in this situation has two components: first, an *origination fee* that is paid to the loan officer when loans are approved by headquarters, and a *performance fee* that is paid upon project success. The former serves to incentivize project discovery, and the latter to incentivize monitoring.

The constrained optimal contracts that we derive closely resemble those that are observed in practice. The US Department of Labor states on its website[1] that most loan officers are paid a commission that is based on the number of loans that they originate. Baker (2000) suggests that this type of contract over-incentivizes origination at the expense of adequate screening, and argues that it reflects the high costs of forcing loan officers to bear the risk associated with a longer-term, more-informative, contract.[2] In contrast, origination fees emerge in our model as part of the solution to a contracting problem: provided a minimal degree of screening is possible at the level of the headquarters, origination fees are the most efficient way to provide loan officers with search incentives.

With this type of contract, the headquarters faces a commitment problem: if the loan officer identifies a marginal project then the headquarters can avoid compensating the loan officer for his search efforts by refusing to sanction investment, so that the origination fee is not paid. This action is anticipated by the loan officer, who demands a higher origination fee to compensate him for discarded investment projects. This higher fee may render further projects undesirable and so raise the fee further: indeed, as noted in a similar set-up by Rotemberg and Saloner (1994), the commitment problem may *in extremis* preclude investment altogether.

In some situations, the headquarters would prefer to minimize the origination fee paid to the

[1] See http://www.bls.gov/oco/ocos018.htm#earnings

[2] Similar sentiments have been forcefully expressed by some industry commentators. For example, Nadler (2000) states that "As for rewarding loan officers for placing new loans on the book, this is like buying a deck chair on the Titanic. It is easy to make a loan; the job is to get your money back on time and with interest."

loan officer by committing to invest in every positive NPV project that the loan officer turns up. This requires the devolution of some *de facto* lending power to the loan officer: as in Aghion and Tirole (1997), this can be accomplished by designing information flow restrictions into the organization. If the headquarters is unable to distinguish between marginal and highly profitable projects, it will accept either all or none of them. When the former action dominates the latter, restricting information flow between the headquarters and the loan officer achieves the desired commitment. It does so at a cost, however: when the headquarters cannot distinguish between marginal and strong projects, it has to promise the same *ex post* performance fee to both; this promise is an additional source of information rent for the loan officer.

The information flows upon which the above trade-off rests are designed into the bank's internal reporting system (IRS). There is evidence that banks use a wide range of systems to report information about borrowers: see for example Treacy and Mark Carey (2000) and Grunert, Norden, and Weber (2005). In this paper, we distinguish between two types of reporting system. A *basic IRS* allows headquarters to distinguish positive from negative NPV projects, but not between marginal and strong projects. Such a system deliberately restricts the quantity of soft information that is codified and sent up the hierarchy to the headquarters. Doing so leaves information rent to loan officers, but it allows the bank to commit to lend to both marginal and strong projects. An *advanced IRS* codifies sufficient of the loan officer's personal knowledge of potential borrowers to allow headquarters to distinguish marginal and strong investment opportunities. This reduces the information rent that is left to the loan officer, and in the absence of commitment problems will therefore be preferred; when it is impossible *ex ante* to commit to lend to marginal projects, the bank faces a choice between using only a basic IRS and investing in every project, and using a sophisticated IRS to cherry-pick the most attractive projects.

The choice between sophisticated and basic internal reporting systems is of particular interest in light of the introduction of the Basel II capital adequacy Accord (see Basel Committee, 2006).[3] Under Basel II, banks are able to choose between standardized capital adequacy requirements, which are largely insensitive to the risk of the bank's assets, and risk-sensitive capital requirements, which are based upon sophisticated internal risk management systems: the so-called "Advanced Internal Ratings-Based," or "Advanced IRB" approach.

The one-size-fits-all capital requirements of the standardized approach will be sufficient to provide against the most marginal bank loans; in contrast, because the regulatory contract of banks that are regulated under the Advanced IRB approach will be sensitive to risk, advanced IRB capital requirements will be lower on average than standardized approach requirements. One of the arguments advanced in favor of the new Accord is that this reduction in average capital requirements will lower the cost of advancing funds, and hence increase loan volumes to high quality borrowers:

[3]The implementation time line for the new Accord is outlined by the Basel Committee on Banking Supervision (2007). Japan implemented the new Accord in 2007, EU countries are set to do so in 2008, and the US will do so in 2009.

see for example Repullo and Suarez (2004). Our model captures this effect.

Our analysis highlights an additional effect of the new Basel Accord which has not been recognised in previous discussions of the Basel II Accord. When capital is costly, the possibility of Advanced IRB capital regulation will raise the opportunity cost of using a basic IRS as a commitment device, and hence will reduce the number of banks that choose commitment over cherry-picking. As a result, the introduction of risk-sensitive capital requirements will reduce the number of marginal investments that are undertaken. We argue that this previously unexamined effect will be important in institutions that cater to markets characterised by high search and monitoring costs.

The remainder of the paper is laid out as follows. Section 2 describes our basic model. Section 3 derives general results concerning its solution. Sections 4 and 5 derive the headquarter's equilibrium investment policies with risk-insensitive and risk-sensitive capital requirements, respectively. Section 7 considers the robustness of our model and discusses some possible extensions. Section 8 concludes.

2. Model Description

We analyze the regulation of a bank. Banks in our model consist of a *headquarters*, which works to maximize shareholder value, and a number of *loan officers*, who are responsible for originating and managing the bank's assets. Loan officers have two special skills: first, they have a search technology, which gives them monopolistic access to investment opportunities; and second, they are able to monitor investments actively, and so to increase their expected return. We restrict our analysis to the simplest case, where the bank has only one loan officer. For the effects that we analyze in this paper, this assumption is without loss of generality.

2.1. Banking Technology

The loan officer's decision to deploy his search technology is non-observable; if he does so, he experiences a private disutility of $\zeta > 0$, and with probability 1, he finds a project whose NPV excluding the sunk search cost ζ is positive. Loan officers who make no search effort do not find a positive NPV project. It is important to note that our analysis rests upon the assumption that the loan officer's search effort could not be substituted by activity at the headquarters. We therefore think of ζ as capturing the importance of the loan officer's special skill in discovering new investments. Hence, for example, ζ could represent the costs of deploying specialised knowledge of industries, markets, or countries.

A bank project requires an initial investment of 1, and it returns either $R > 0$ (success) or 0 (failure). Bank projects can be of two types, which are distinguished by their *monitoring cost*, $\mu \in \{m, M\}$, where $0 \leq m < M$. A project of type μ succeeds with probability $\Pi > \frac{1}{2}$ if the loan officer incurs a private expense μ on monitoring, and succeeds with probability $\frac{1}{2}$ if he does not monitor.

The social return to a type μ project is $\Pi R - \mu - 1$ if it is monitored, and is $\frac{1}{2}R - 1$ if it is not. Clearly, a type m project generates a higher social surplus when it is monitored than does a type M. We think of type M projects as being *marginal investments*, and type m projects as being *strong investments*. A fraction $\frac{1}{2}$ of all projects is marginal. We assume that

$$M < \left(\Pi - \frac{1}{2}\right) R, \tag{1}$$

so that monitoring is socially optimal for all projects. We also assume that

$$\frac{1}{2}R - 1 < 0 < \Pi R - M - 1, \tag{2}$$

so that unmonitored projects are not viable, and all monitored projects have a positive NPV after search costs have been sunk.[4]

The difference $M - m$ between the costs of monitoring strong and marginal projects will be critical for our analysis. It represents the effort that the loan officer has to exert to resolve borrower moral hazard. Once again, the loan officer's monitoring abilities cannot be replaced by activity in the headquarters. High values of $M - m$ can occur for one of two reasons. First, they could reflect the institutional environment within which the bank operates: a less-developed market with weaker property rights relies upon more informal and relationship-based modes of contract enforcement, and hence is characterised by a higher reliance upon loan officer skills, and so by a higher $M - m$. Second, high values of $M - m$ arise in relationship lending that is characterised by a high degree of informational opacity, as for example in early stage venture financing, and in commercial lending to small and medium sized enterprises (SMEs). Lower values of $M - m$, by contrast, are associated with well-developed formal legal systems, and with lending to mature businesses and to businesses with easily verified collateral and easily verified cash flows.

We assume that it is impossible to contract upon monitoring. Specifically:

ASSUMPTION 1. *The loan officer's monitoring expenditure μ is neither observable nor contractible.*

We make no further assumptions at this stage concerning the social and private value derived from investment in strong and marginal projects.

2.2. Information Structure

If the loan officer uncovers a positive NPV project then its type is always observable by the loan officer. The quality of project information available to any other agent is determined by the quality of the bank's *internal reporting system*, or *IRS*. There are two types of IRS: *basic* and *advanced*. Assumption 2 describes their properties.

[4] The first inequality in equation (2) is not essential for most of the model; it allows us to exclude a large number of uninteresting cases from our welfare analysis.

ASSUMPTION 2. *The information generated by a basic IRS is sufficient to distinguish between positive and negative NPV projects, but not between marginal and strong projects. In contrast, an advanced IRS reveals the project's type perfectly.*

The information partitions introduced by assumption 2 are illustrated in figure 1. The first line in the figure shows the elements of the state space, labelled with their prior probabilities. A basic IRS reveals no further information to the headquarters, and hence induces the partition $\mathscr{B}$ illustrated on the first line of the figure; an advanced IRS enables the headquarters to distinguish between marginal and strong projects, and therefore induces the information partition $\mathscr{A}$ illustrated in the figure.

	Strong project ($\mu = m$)	Marginal project ($\mu = M$)
Partition $\mathscr{B}$: *ex ante* and *ex post* with Basic IRS	• $1-\eta$	• η
Partition $\mathscr{A}$: *ex post* with Advanced IRS	• 1	• 1

Figure 1: Information partition induced by the bank's internal reporting system.

Figure 1 illustrates the information that the headquarters derives from the bank's IRS. However, we assume that this information is not verifiable in court:

ASSUMPTION 3. *It is impossible for the bank's headquarters to write a contract with the loan officer under which payments are contingent upon the information revealed by its IRS. In particular, contracts cannot be contingent upon project discovery.*

In line with Rotemberg and Saloner (1994), assumption 3 states that, while the existence and type of a positive NPV project may be observable by the headquarters, neither of these variables can be contracted upon. It *is* however possible to condition contracts upon whether or not investment occurs.

2.3. Regulation

If the bank invests in a project then its initial \$1 investment is composed of an equity piece C, which we will call the bank's *capital*, and of deposits $1-C$. It is costly to issue equity, and in most jurisdictions, it is at a tax disadvantage relative to debt. As a consequence, practitioners tend to regard equity capital as costly. We capture these observations in assumption 4:

ASSUMPTION 4. *In order to invest \$$C$ of equity capital, it is necessary to raise \$$C(1+\gamma)$.*

The cost γC appears in the bank shareholder's objective function but, because it represents a transfer of wealth, it will not appear in welfare calculations.

We assume that depositors are protected by deposit insurance with a risk-insensitive cost to the bank, which we normalize to zero. As a consequence, depositors fail to charge the bank for the risk that it incurs. The resultant moral hazard problem is addressed by the bank's regulator. The regulator's role is to maximize social welfare. However, it is unable to dictate investment policy to the bank: its only tool is a *regulatory capital adequacy requirement*, which is a lower bound for the bank's equity investment C. Since, by equation (1), monitoring is welfare-enhancing the regulator will set the capital requirement C at a high enough level to ensure that the bank elects to monitor. We assume that the regulator does not impose a higher capital requirement than is necessary:

ASSUMPTION 5. *Regulators set the minimum positive capital requirement consistent with monitoring.*

We do not attempt to derive assumption 5 from the primitives of our model. Clearly, by assumption 4, high capital requirements act as a direct disincentive to investment, and hence may reduce welfare. Even the standard counter-argument that higher capital requirements may resolve over-investment incentives introduced by deposit insurance does not obviously apply in our set-up: we demonstrate below that the deposit insurance put may correct for under-investment introduced by the agency problem between the headquarters and the loan officer.[5]

The regulator is able to observe the data generated by the bank's IRS. However, for legal reasons it may be unable to condition the regulatory capital requirement upon this data. Hence we consider two types of capital regulation: *risk-insensitive* capital requirements, which are not contingent upon IRS reports, and *risk-sensitive* capital requirements, which are contingent upon IRS reports. Note that risk-sensitive capital requirements can be fully contingent upon project type only if the bank has an advanced IRS.

2.4. Description of the Game

Figure 2 illustrates the time line for the game that we analyze.

At time 0, the regulator decides whether to adopt a risk-sensitive capital adequacy policy, under which bank capital requirements can be contingent upon IRS reports, or a risk-insensitive policy, under which capital adequacy requirements are fixed.

At time 1 the headquarters decides whether to install a basic or an advanced IRS. We assume that neither decision has a cost. By assumption 3, it is impossible to contract upon project discovery, but project investment is verifiable and hence the headquarters *can* commit at time 1 to pay the loan officer an *origination fee* F upon time 4 project *investment.* This fee is a bonus paid simply for originating loans.

[5]This is a standard invocation of the Theory of the Second Best: see Lipsey and Lancaster (1956).

time 0	*time* 1	*time* 2	*time* 3	*time* 4
Capital regulation policy is set: risk-insensitive or risk-sensitive.	Headquarters chooses between basic and advanced IRS, and agrees an "origination fee" F with the loan officer.	Project search decision.	Search results reported using IRS; HQ makes an investment decision and signs a wage contract with the loan officer.	Returns realize and are distributed.

Figure 2: Time line for the investment game.

At time 2 the loan officer decides whether to search for a project. At this time both the headquarters and the loan officer have the information partition $\mathscr{B}$ in figure 1.

The loan officer learns the results of his search at time 3 and they are communicated to the headquarters and to the regulator using the bank's IRS system. While the headquarters always learns whether the search was successful, assumption 2 implies that it learns the project type only if the bank has an advanced IRS. Hence, with a basic IRS the the headquarters has information partition $\mathscr{B}$, and with an advanced IRS it has information partition $\mathscr{A}$.

Once the headquarters has extracted information from the IRS it decides whether to invest. Recall from assumption 1 that the local bank's monitoring decision cannot be contracted upon. The project's success or failure is however contractible, so the headquarters can commit to pay a performance fee w conditional upon the project's success. Note that the payment w is independent of the origination fee F.

At time 4 returns realize and are distributed in accordance with the performance fee and deposit contract.

In the next section we solve our model using backward induction.

3. Model Solution

The information structure in this game differs for the headquarters and the loan officer, and is an endogenous consequence of the type of IRS that the bank has. It is therefore important that we are precise about the information structures that obtain when expectations are formed. Hence we denote by $\mathbb{E}\{\cdot\}$ the expectations operator prior to the realization of project search, when both headquarters and the loan officer have information partition $\mathscr{B}$; after search results the headquarters' information partition will be $\mathscr{B}$ or $\mathscr{A}$, according to whether the bank has adopted a basic or an advanced IRS, and we denote its expectations operator by $\mathbb{E}_H\{\cdot\}$.[6]

We start by considering the time 3 incentive contract between the headquarters and the loan officer. Under the (constrained) optimal compensation contract, the loan officer is paid a performance

[6] We will not need to consider expectations taken by the loan officer after search results realize and hence we do not define the corresponding operator.

fee w precisely when the project succeeds. He will elect to monitor a type μ project precisely when his expected returns from doing so exceed the costs: equivalently, when $w \geq \mu / \left(\Pi - \frac{1}{2}\right)$. The minimum performance fee that ensures that type μ projects are monitored is therefore given by

$$w(\mu) \equiv \frac{\mu}{\Pi - \frac{1}{2}}. \tag{3}$$

Since headquarters wishes to maximize the residual cash flows that accrue to shareholders, it pays the minimum performance fee consistent with monitoring: with an advanced IRS, when headquarters can distinguish between the two types of project, the performance fee will therefore be $w(m)$ for strong projects, and $w(M)$ for marginal ones. With a basic IRS, when headquarters has information partition $\mathscr{B}$ from figure 1, the performance fee for every project will be $w(M)$.

The headquarters will incorporate the above compensation decisions into its time 3 investment decision. With performance fee w and origination fee F, a project with monitoring cost μ will require an up-front investment by headquarters of $C(1+\gamma)+F$ and will return $R+C-1-w$ if successful. Hence investment will occur precisely when

$$\mathbb{E}_H \left\{\Pi(R+C-1-w) - C(1+\gamma) - F\right\} \geq 0. \tag{4}$$

Recall from our earlier discussion that the expectations operator $\mathbb{E}_H\{\cdot\}$ is non-trivial only for banks that have a basic IRS.

We define

$$I_\mu \equiv \begin{cases} 1, & \text{if condition (4) is satisfied for type } \mu \text{ projects;} \\ 0, & \text{otherwise.} \end{cases} \tag{5}$$

I_μ indicates whether the headquarters will undertake a type μ project. In equilibrium this indicator function will be known as soon as the IRS has been selected: in particular, it can be evaluated when the time 3 investment decision occurs. We call a bank with an advanced IRS a *selective bank* if condition (4) is satisfied only for strong projects: i.e., if $I_m = 1$ and $I_M = 0$, and we call it an *unselective bank* if condition (4) is satisfied for both marginal and strong projects: i.e., if $I_m = I_M = 1$. For consistency, we will sometimes refer to a bank with a basic IRS as a *basic bank*. Since the headquarters in a basic bank is unable to distinguish between strong and marginal projects, it will either accept every positive NPV investment, or it will select none of them.

We now turn to a discussion of the contract between the headquarters and the loan officer. First, we identify conditions under which the loan officer receives an origination fee when investment occurs.

LEMMA 1. *At time* 1*, the headquarters pays an origination fee F given by equation*

$$F \equiv \max\left(\frac{1}{\delta}(\zeta - r), 0\right), \tag{6}$$

where $\delta = \mathbb{E}\left\{I_\mu\right\}$ *is the probability assessed at time* 2 *that time* 3 *investment occurs, and*

$$r \equiv \mathbb{E}\left\{(w\Pi - \mu)\, I_\mu\right\}. \tag{7}$$

Proof: In the appendix. □

Lemma 1 has a simple explanation. If project investment occurs, the loan officer derives an expected informational rent of $w\Pi - \mu$ from his monitoring. Hence the loan officer anticipates at time 2 that a search effort will yield an expected monitoring rent of r; the headquarters knocks this expected loan officer rent off the search cost ζ when determining the origination fee F. But, because loan officers have limited liability, F cannot be negative: F is therefore given by equation (6).

We denote by ρ the loan officer's expected rent at time 1. The following corollary follows immediately from lemma 1:

COROLLARY 1. *The loan officer's expected time* 1 *rent* ρ *is positive precisely when the origination fee* F *is zero.*

With a (possibly state-dependent) capital requirement C, the expected surplus W that the shareholders derive from the bank, excluding the cost of any origination fee, is given by expression (8):

$$W = \mathbb{E}\left\{(\Pi\,(R + C - 1 - w) - C\,(1+\gamma))\, I_\mu\right\}. \tag{8}$$

The expected shareholder surplus S when the loan officer is promised an origination fee F is therefore given by expression (9):

$$S = W - \delta F. \tag{9}$$

In the welfare analysis of section 4.3 below, we define the welfare V of an equilibrium to be the total NPV of all allocation decisions made in the economy. Lemma 2 relates the value of the bank to its shareholders to the social surplus it generates, the value of the deposit insurance subsidy, and the loan officer's information rent.

LEMMA 2. *The ex ante expected value of the bank to its shareholders is equal to the sum of the social surplus* V *that it generates and the value* D *of the deposit insurance put, less the expected loan officer rent* $\delta\rho$ *and the cost* γC *of raising equity capital:*

$$S = V - \delta\rho + D - \gamma C. \tag{10}$$

Proof: In the appendix. □

The value that the shareholders derive from the bank is equal to the social surplus that it generates, adjusted for any contractual imperfections. In our model the first of these arises because search and monitoring are delegated to a loan officer, but cannot be directly contracted upon. The resultant moral hazard problem may generate an information rent ρ for the loan officer, which will not be internalized by the shareholders. The second imperfection arises because deposit insurance is not fairly priced, and the third because it is expensive to raise capital.

The second best trade-off that we discussed when we introduced assumption 5 is apparent from lemma 2: the deposit insurance subsidy serves in our second best world to counter the investment disincentive caused by the loan officer's information rent. We argued that this effect undermined standard arguments justifying higher capital requirements as a way to curb excessive investment incentives flowing the deposit insurance put.

In lemma 3 we determine the regulator's time 0 choice of regulatory capital requirements.

LEMMA 3. *Let*

$$C(\mu) \equiv max\left\{\frac{\mu\Pi}{\left(\Pi-\frac{1}{2}\right)^2}-(R-1),0\right\}. \tag{11}$$

Then the capital requirement for basic banks and for banks with risk-insensitive capital requirements is $C(M)$; the capital requirement for advanced IRS banks with risk-sensitive capital requirements is $C(m)$ for strong projects, and $C(M)$ for marginal projects.

Proof: Shareholders will elect to incentivise loan officer monitoring precisely when the marginal return $(R-1+C)\left(\Pi-\frac{1}{2}\right)$ from doing so exceeds the cost $w(\mu)$: this is true precisely when

$$C \geq \frac{\mu\Pi}{\left(\Pi-\frac{1}{2}\right)^2}-(R-1).$$

Capital requirements can be contingent upon project type precisely when they are risk-sensitive and the bank has an advanced IRS, so that the regulator can observe μ. In this case, by assumption 5, capital requirements for strong and marginal projects respectively will be set equal to $C(m)$ and $C(M)$. If capital requirements are risk-insensitive or the bank has a basic IRS then capital requirements cannot be contingent upon μ. To ensure that the bank monitors every project that it selects the regulator must therefore set the capital requirement for both strong and marginal projects at least equal to $C(M) = \max\{C(m), C(M)\}$ and, by assumption 5, choose precisely this value. □

If $C(M)$ were greater than 1 then the bank would incentivise monitoring only if it stood to lose more than the initial outlay required by the project. While a contract of this nature is feasible, we do not observe it in practice, and we therefore adopt assumption 6:

ASSUMPTION 6. *The optimal capital requirement $C(M)$ for marginal projects is never greater than* 1*:*

$$M \leq M_{max} \equiv \frac{R}{\Pi}\left(\Pi-\frac{1}{2}\right)^2. \tag{12}$$

In the following sections we determine the bank's optimal choice of IRS in the case where the regulator sets risk-insensitive and risk-sensitive capital requirements.

4. Risk-Insensitive Capital Requirements

In this section, we consider the bank's choice of internal reporting system when the regulator sets a risk-insensitive capital requirement. We simplify the presentation for the remainder of the paper by making type m projects as strong as possible:

ASSUMPTION 7. *We assume that $m = 0$.*

Because strong projects require no active monitoring when assumption 7 holds, they are subject to no *ex post* agency problems. The assumption simplifies the analysis of this section and the next, but it is without significant loss of generality: we discuss its relaxation in section 7.

When capital requirements are risk-insensitive, they will not be affected by the bank's IRS. The only factor that headquarters considers when it chooses an IRS at time 1 is therefore the effect that it will have upon its time 3 behaviour. With an advanced IRS, headquarters is able perfectly to distinguish between strong and marginal projects, so that both the time 3 incentive contract and the time 3 investment strategy can be conditioned upon project type. Conditioning performance fees upon project type reduces the information rent that accrues to the loan officer; this increases the headquarter's incentives to invest and hence creates an unambiguous welfare increase.

The welfare consequences of conditioning investment decisions upon project type are no so clear-cut. If the headquarters can identify a marginal project at time 3, it may decide not to accept it, so as to avoid paying the origination fee. The ability to cherry-pick strong investment projects may enhance the headquarter's investment incentives and hence raise welfare. Cherry-picking may however damage the headquarters: it will be anticipated by the loan officer, who will therefore demand a higher origination fee F to cover in expectation the costs that he incurs performing project searches that do not result in investment. The effect of a increased origination fee is to attenuate the headquarter's investment incentives and so to lower welfare. Under some circumstances the disincentive effect of the higher origination fee may be sufficiently high to outweigh the benefits of being able to cherry-pick at time 1: in this case, possession of an advanced IRS may *lower* the headquarter's time 1 expected income relative to the basic IRS case. This problem arises because, by assumption 3, the headquarters is unable to commit not to use information from the advanced IRS. As a result the headquarters can raise welfare by electing for a basic IRS. In doing so, it commits to remain ignorant of project type, and hence is able to incentivize search with the lower fee.

The three strategies that emerge from this discussion were identified in section 3. *Unselective* banks have an advanced IRS, and accept both marginal and strong projects; *selective banks* have an advanced IRS, which they use to cherry-pick strong projects; and *basic* banks have a basic IRS, and hence either accept every investment project, or no investment project. The remainder of this section uses the analysis of section 3 to determine the equilibrium strategy that headquarters will adopt as a function of the cost M of monitoring a marginal project when it is subject to a

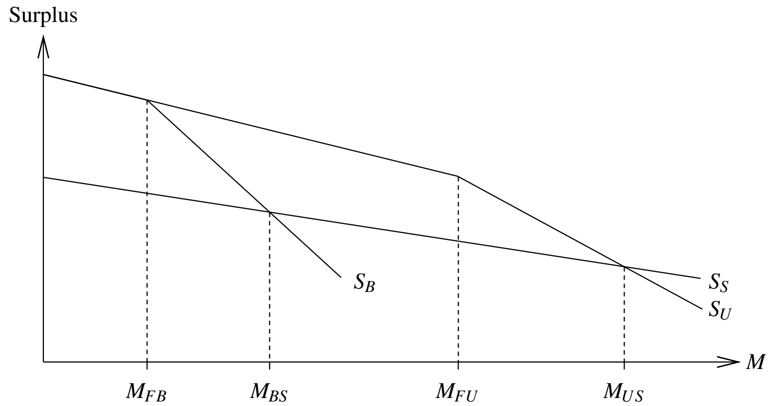

Figure 3: **Ex ante headquarter preferences.** S_S, S_U, and S_B are the respective expected shareholder surpluses in selective, unselective, and basic banks; they are illustrated as functions of the cost M of monitoring a marginal project.

risk-insensitive capital requirements regime. To do so, we firstly determine which strategy is *ex ante* most attractive to the headquarters, and we then identify conditions under which this strategy choice is time-consistent. In the following discussion, we denote by subscripts U, S, and B quantities that relate to unselective, selective, and basic banks, respectively.

4.1. Ex ante Preferred Headquarter Strategies

In this section we determine the strategy that yields the highest time 1 expected returns to the bank's shareholders. Throughout the section, we denote by S_S, S_U, and S_B the expected surplus that accrues to shareholders in selective, unselective, and basic banks, respectively. Our basic result is presented in lemma 4.

LEMMA 4. *For a given search cost ζ, there exist M_{FB}, M_{BS}, and M_{US}, with $M_{BS} \leq M_{US}$, such that:*

1. $S_U = S_B$ *for* $M \leq M_{FB}$ *and* $S_U > S_B$ *for* $M > M_{FB}$;
2. $S_B > S_S$ *for* $M < M_{BS}$, $S_B = S_S$ *for* $M = M_{BS}$, *and* $S_B < S_S$ *for* $M > M_{BS}$;
3. $S_U > S_S$ *for* $M < M_{US}$ *and* $S_U < S_S$ *for* $M > M_{US}$.

Proof: In appendix B. □

Lemma 4 is illustrated in figure 3, where, for fixed search cost ζ, the three surplus functions are graphed as functions of the cost M of monitoring marginal projects.

The intuition underlying figure 3 is straightforward. Raising the cost M of monitoring decreases the social surplus that a project generates, (weakly) increases the managerial rent extracted from the project, raises the capital requirement needed to incentivise monitoring, and hence also lowers the deposit insurance subsidy associated with the project. It follows immediately from lemma 2 that S_U, S_B, and S_S are all decreasing in M.

The rate at which the shareholder surplus decreases with M is greater when loan officers earn positive rent, and hence extract a benefit from increases in M; the kinks in S_B and S_U occur at the points M_{FB} and M_{FU} where managerial rent becomes positive in basic and unselective banks, respectively. All loan officers in basic banks are paid the higher performance fee that is needed to incentivise monitoring of marginal projects, and hence $M_{FB} < M_{FU}$. Basic and unselective banks differ only in the level of managerial rent: consequently, $S_B = S_U$ when $M < M_{FB}$, so that managers in neither type of bank earn any rent. Finally, managers in selective banks earn no rent, since they experience no disutility from monitoring, and hence there is no kink in the S_S line.

Lemma 4 has the following corollary:

COROLLARY 2. *Expected surplus is never maximized in a basic bank.*

Proof: Immediate from figure 3: expected bank shareholder surplus is greatest in an unselective bank for $M < M_{US}$ and in a selective bank for $M \geq M_{US}$. □

Unselective bank shareholders earn a greater surplus than the shareholders of basic banks for any M greater than M_{FB}, because of the higher rents extracted by basic bank loan officers. Hence basic banks are never preferred to unselective banks from an ex ante perspective. Whether unselective or selective banks are preferred depends upon the magnitude of the marginal project monitoring cost, M: when M is sufficiently high, the loan officer rent required to induce monitoring of marginal projects is so great that the shareholders prefer not to invest in them, and hence run a selective bank. This is the case for $M \geq M_{US}$, the point in figure 3 at which S_U crosses S_S from above.

Proposition 1 presents the dependence upon ζ of both M_{US} and the headquarters' participation constraint:

PROPOSITION 1. *Suppose that capital requirements are risk-insensitive. Then:*

1. *The maximum monitoring cost M_{US} for which unselective banks are ex ante preferred by the headquarters to selective banks is increasing in ζ for $\zeta \leq \zeta_{US} \equiv \left(\Pi - \frac{1}{2}\right)(R-1)$, and is ζ-invariant for $\zeta > \zeta_{US}$;*
2. *There exists $\bar{M}$ such that the headquarters participates precisely when $M \leq \bar{M}$. $\bar{M}$ is weakly decreasing in ζ.*

Proof: In the appendix. □

Proposition 1 is illustrated in figure 4. The effect of an increase in the search cost ζ upon the surplus that shareholders derive from selective and unselective banks can be understood with reference to lemma 2. An increased ζ has the same effect upon social surplus and upon deposit insurance payouts in both types of bank; loan officers earn no rent in selective banks, so the key question is how ζ affects loan officer rent in unselective banks. When $M > M_{FU}$, loan officer rent is positive and decreasing in ζ; in this case a higher ζ renders unselective banks relatively more

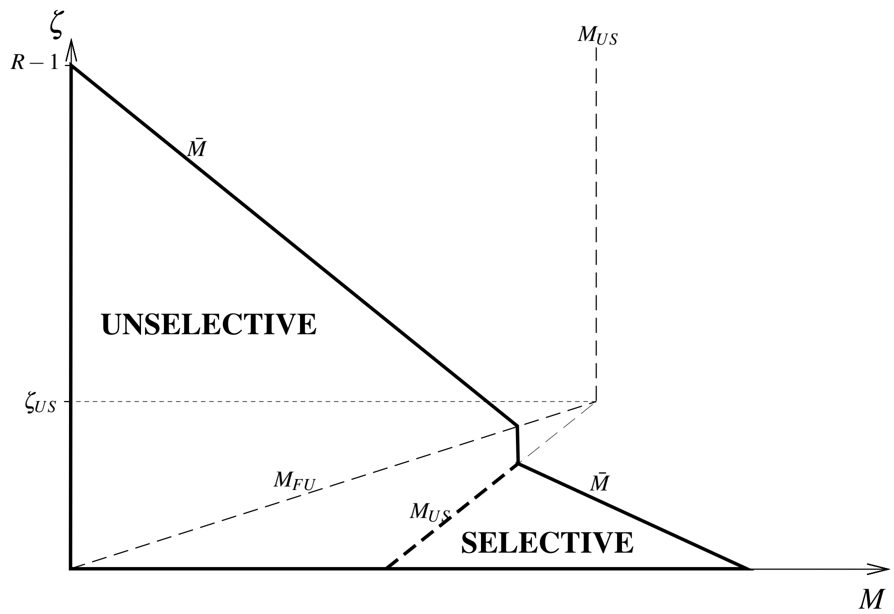

Figure 4: **Headquarters ex ante preferences with individual rationality constraints.** It is individually rational for the headquarters to run a bank in the region bordered by the bold $\bar{M}$ line and, from a ex ante perspective, the headquarters always prefers to run an unselective or a selective bank. Unselective banks are ex ante preferred to the left of the dashed M_{US} line; within the unselective bank region, loan officers earn a positive rent to the right of the M_{FU} line.

attractive to shareholders, and thus increases the maximum monitoring cost M_{US} below which unselective banks are preferred. For $\zeta \geq \zeta_{US}$, $M_{US} \geq M_{FU}$ so that loan officers earn no rent in unselective banks, and hence M_{US} is ζ-invariant.

We now explain the shape of the participation constraint $\bar{M}$ in figure 4. Loan officers earn no rent for parameterizations to the left of the M_{FU} line and to the right of the M_{US} line in the figure. Hence, within these regions, all of the marginal effects of an increase in the search cost ζ accrue to the shareholders, so that $\bar{M}$ has a negative slope. In contrast, for parameterisations between the M_{FU} line and the M_{US} line, the loan officer earns a positive rent; the effect of an increased ζ upon this rent exactly offsets the associated social cost, so that shareholder income is unaffected. As a result, $\bar{M}$ is ζ-invariant in this region.

We have demonstrated in this section that, from an ex ante perspective, the headquarters always prefers to run an advanced IRS. However, by assumption 3, it is impossible for the headquarters to commit at time 1 to a time 3 investment policy. When the origination fee F is particularly high, the headquarters may elect at time 3 not to invest, even if committing to do so would have maximized its time 1 expected surplus. If this is the case, the headquarters commitment problem generates a cost, and the headquarters may be prepared to adopt a more expensive strategy to overcome it. In the next section we show how a basic risk management system can accomplish this.

4.2. Time Consistent Strategy

A headquarters with a basic IRS is unable to distinguish between marginal and strong projects. Hence it will either accept every project at time 3, or no project. When the former choice dominates the latter, a basic internal reporting system serves as a commitment device, which guarantees that investment will occur. Lemma 5 gives conditions under which this is the case.

LEMMA 5. *The headquarters will use a basic IRS to commit to time* 3 *investment when the following conditions are satisfied:*

1. *The headquarters would prefer with an advanced IRS to discard marginal projects at time* 3. *This is the case precisely when* (13) *is satisfied:*

$$M \quad \geq \quad M_c \equiv min\left(2\frac{(2\Pi-1)^2}{1+2\Pi+8\Pi\gamma}\left((R-1)(1+\gamma)-\zeta\right), \frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}(R-1)(1+\gamma)\right) \tag{13}$$

2. *The headquarters derives a higher time* 1 *expected surplus from running a basic bank than it derives from a selective bank. This is the case precisely when condition* (14) *is satisfied:*

$$M \leq M_{BS}; \tag{14}$$

Proof: In appendix B. □

The intutition for lemma 5 is straightforward. For the headquarters to value the commitment that a basic bank provides, it must first be unable to commit to accept projects that are revealed at time 3 to be marginal by an advanced IRS. This is the case if M is sufficiently high to render the time 3 value of marginal projects to be negative, net of the origination fee F, as in equation (13). The two values in this equation correspond to the respective cases where the headquarters pays, and does not pay, a fee to unselective bank loan officers.

Proposition 2 summarizes the headquarters' investment strategy when it is impossible at time 1 to commit to a given investment strategy:

PROPOSITION 2. *Suppose that capital requirements are risk-insensitive and that the headquarters is unable at time* 1 *to commit to a time* 3 *investment strategy.*

1. *Denote by* $\bar{M}'$ *the maximum monitoring cost at which investment is individually rational for the headquarters. Then:*
   (a) $\bar{M}' = \bar{M}$ *for* $M < M_{FB}$ *and* $M \geq M_{US}$, *and* $\bar{M}' < \bar{M}$ *for* $M_{FB} < M \leq M_{US}$;
   (b) $\bar{M}' > M_c$;
2. *The headquarters selects its internal reporting system and its investment strategy as follows:*
   (a) *If* $M \leq M_c$, *headquarters adopts an advanced IRS and follows an unselective investment strategy;*

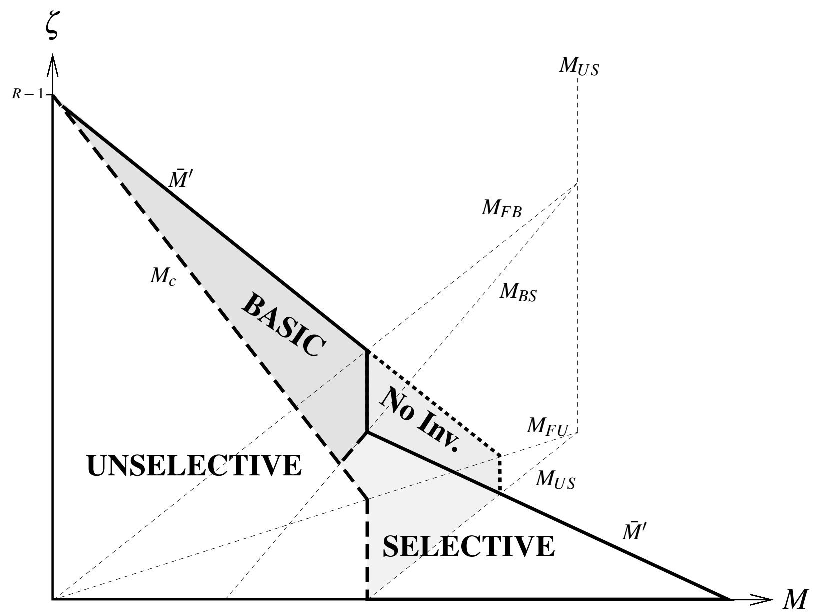

Figure 5: **Equilibrium headquarters strategies with risk-insensitive capital requirements.** The headquarters can commit to accept marginal projects only for parameterizations that lie to the left of M_c. To the right of this region, only basic or selective banks are possible. The former are preferred to the left of both M_{BS} and $\bar{M}'$; the latter are preferred to the left of $\bar{M}'$ and to the right of M_{BS}. The headquarters' commitment problem prevents valuable investment from occuring in the region labelled "No Inv.", and it results in credit rationing for marginal projects in the shaded part of the selective region.

(b) If $M_c < M \leq min(\bar{M}', M_{BS})$, headquarters adopts a basic IRS;

(c) If $max(M_c, M_{BS}) < M \leq \bar{M}'$, headquarters adopts an advanced IRS and follows a selective strategy.

Proof: In the appendix. □

Proposition 2 is illustrated in figure 5. M_c is illustrated in the figure as a bold dashed line. To the left of this line, the headquarters in an unselective bank will choose at time 3 to accept marginal projects; to its right, the headquarters will not do so, even if ex ante this is the preferred strategy. We refer to M_c in our discussion as the "commitment line."

Note that the M_c line passes to the left of the selective region of figure 4. This has two implications. First, it is impossible for a bank with an advanced IRS to commit to accept marginal projects if *ex ante* it prefers to run a selective bank. Second, there is a region, bordered by M_c, $\bar{M}$, and M_{US} within which the headquarters prefers to run an unselective bank, but within which it is unable to commit to accept marginal projects at time 3. Within this region three strategies are available to the headquarters: it can run a selective bank, a basic bank, or no bank at all.

The headquarters prefers a basic bank to a selective one to the left of the M_{BS} line; for $M > M_{FB}$, running the basic bank will be individually rational for a smaller parameter set than running an unselective bank, because loan officers in the former receive higher expected rents than those in the latter. Hence the maximum M for which investment occurs is reduced in this region from $\bar{M}$, represented by the bold dotted line on figure 5, to $\bar{M}'$, represented by a vertical bold line. The region in which basic banking occurs is shaded and labelled accordingly on the figure.

To the right of the M_{BS} line the headquarters prefers a selective bank to a basic one; selective bank investment is individually rational to the left of the $\bar{M}'$ line indicated on the figure. Hence selective bank investment occurs in the labelled region on the figure.

The real economic impact of the headquarter's commitment problem is apparent from figure 5. First, because the individual rationality constraint is tightened when $M_{FB} \leq M < M_{US}$, investment will not occur for some parameterizations that previously would have attracted investment. This occurs in the shaded region labelled "No Inv." in the figure. Second, when $M > M_{BS}$, the headquarters responds to the commitment problem that arises when $M > M_c$ by running a selective bank. Hence there is a parameter set, indicated in the selective region of figure 5 by shading, where marginal projects are discarded, even though, ex ante, they have a positive net present value.

4.3. Welfare

We now consider the welfare properties of the equilibrium that we discuss in section 4.2. Throughout the paper we adopt a standard utilitarian measure of welfare: that is, we define the welfare of an equilibrium to be the total NPV of all allocation decisions made in the economy. Hence, we regard wealth transfers between agents as welfare-neutral.

We start by describing the social first best outcome. Since wealth transfers have no impact upon welfare in our model, equilibria with basic and unselective banks are socially equivalent. The social welfare derived from either type of bank is given by expression (15):

$$V_U \equiv R\Pi - 1 - \zeta - \frac{1}{2}M. \tag{15}$$

The social welfare derived from a selective bank is given by expression (16):

$$V_S \equiv \frac{1}{2}(R\Pi - 1) - \zeta. \tag{16}$$

Lemma 6 describes the welfare-maximizing organizational form.

LEMMA 6. *Welfare is maximized by running an unselective or a basic bank when*

$$M \leq min\{R\Pi - 1, 2(R\Pi - 1 - \zeta)\}, \tag{17}$$

a selective bank when

$$M \geq R\Pi - 1 \geq 2\zeta, \tag{18}$$

and no bank at all otherwise.

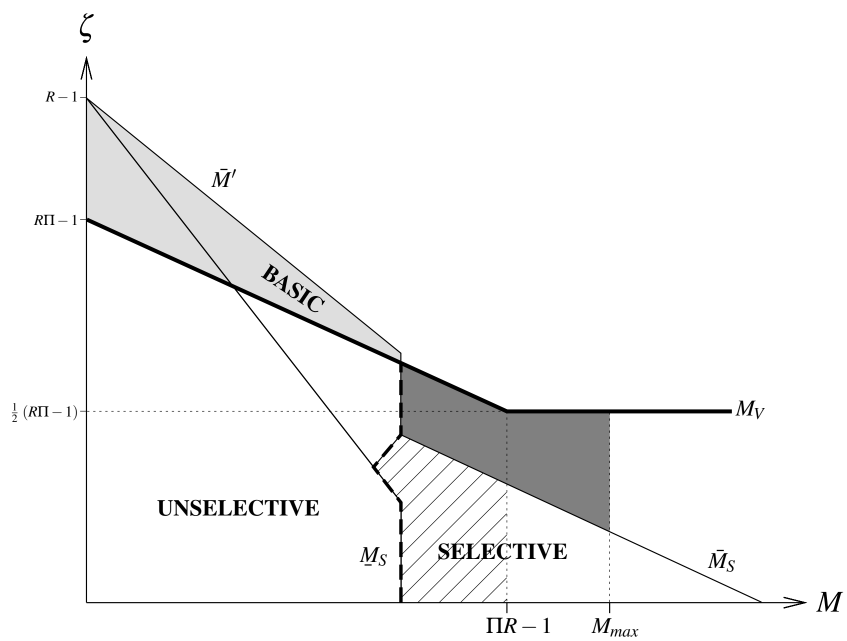

Figure 6: **Welfare with Risk-Insensitive Capital Requirements.** Banking is welfare-enhancing for precisely those parameterizations that lie below the solid line M_V, with unselective or basic banking optimal for $M \leq \Pi R - 1$, and selective banking optimal otherwize. Parameterizations in the light shaded region result in unselective or basic banking, even though it is socially better not to bank; although banking is welfare-enhancing for parameterizations in the darker shaded region, it does not occur. Finally, the cross-hatched region corresponds to parameterizations for which the banker elects to run a selective bank, although unselective banking is socially better.

Proof: $V_U \geq V_S$ precisely when $M \leq R\Pi - 1$; unselective and selective banks increase social welfare precisely when V_U and V_S respectively are non-negative. These observations immediately yield conditions (17) and (18). □

Lemma 6 is illustrated in figure 6. The bold line labelled M_V in this figure[7] is the convex hull of the lines described by allowing equations (17) and (18) to bind. Investment in some sort of bank is socially optimal for (M, ζ) values that lie below M_V; within this region, unselective banking is socially preferred for $M \leq R\Pi - 1$, and selective banking is socially preferred otherwise. Investment decisions are made by the headquarters in accordance with proposition 2; the basic, unselective, and selective regions idenitified in that proposition are delineated in figure 6 by non-bold lines. For purposes of exposition, we define $\underline{M}_S$ to be the line that borders the selective region on the left,[8] denoted in figure 6 by a bold dashed line, and we write $\bar{M}_S$ for the right hand border

[7]Formally, $M_V(\zeta) = \max(0, 2(R\Pi - 1 - \zeta))$ for $\zeta > \frac{1}{2}(R\Pi - 1)$, and is infinite for $\zeta < \frac{1}{2}(R\Pi - 1)$.

[8]Formally, $\underline{M}_S = \max(M_c, M_{BS})$.

of the selective region.[9]

The figure illustrates a specific parameter constellation. However, it highlights some general effects. First, there is a set of M and ζ values, indicated by light shading, for which $M_V < M \leq \bar{M}'$. For these values, there is over-investment: unselective or basic bank investment occurs despite the fact that it would be socially better not to run a bank. Second, there are parameterizations, indicated by dark shading, for which $\max(\underline{M}_S, \bar{M}_S) < M \leq M_V$. With these parameterizations there is under-investment: banks are not opened, although they would enhance welfare. Third, for intermediate values of M there may be under- or over-investment. The figure illustrates the case for which $\underline{M}_S < \Pi R - 1$, so that throughout the cross-hatched region there is under-investment, in that selective banks are opened, even though unselective banks are preferable for a social point of view. In the alternative case where $\Pi R - 1 < \underline{M}_S$, over-investment occurs when $\Pi R - 1 < M \leq \underline{M}_S$, since in this case the headquarters opts for unselective banks, even though selective banks would be socially better.

Lemma 2 explains this divergence between private incentives and social optimality. Access to the deposit insurance fund encourages overinvestment, while both the loan officer's rent and the cost γ of capital reduce shareholder investment incentives relative to the social first best. The deposit insurance fund is most valuable when capital requirements are low; this is the case for low M, as in the light-shaded over-investment region of figure 6. With risk-insensitive capital regulation, every bank has a high capital adequacy ratio for M values in the dark shaded region; the headquarters therefore derives little value from deposit insurance, and incurs a high cost γC of capitalization, so that it prefers not to run a bank.[10]

Proposition 3 summarizes the intuitive discussion of this section.

PROPOSITION 3.

1. *For $M_V < M \leq \bar{M}'$, the headquarters runs a bank that invests in both strong and marginal projects, although it would be socially optimal not to run a bank at all;*

2. *For $\Pi R - 1 < M \leq \underline{M}_S$, the headquarters runs a bank that invests in strong and marginal projects, although it would be socially optimal to run a selective bank;*

3. *For $\underline{M}_S \leq M < \min(\Pi R - 1, \bar{M}_S)$, the headquarters runs a selective bank, although it would be socially optimal to invest in both strong and marginal projects;*

4. *For $\max(\underline{M}_S, \bar{M}_S) < M \leq M_V$, the headquarters does not run a bank, although it would be socially optimal to do so;*

5. *All other bank investment decisions are socially first best.*

As R increases, the set of parameter values for which part 1 or part 3 of the proposition applies expands, and the set for which part 2 or part 4 applies shrinks.

[9] A formal definition of $\bar{M}_S$ appears in the appendix.

[10] Note that the headquarters would always prefer to run a selective bank in this region, so that the loan officer would never earn an information rent.

Proof: In appendix B. □

Parts 1 and 4 of this proposition correspond to the light- and dark- shaded regions of figure 6, respectively. Part 3 corresponds to the cross-hatched region of the figure, and part 2 corresponds to the case where $\Pi R - 1 < M \leq \underline{M}_S$, so that over-investment occurs for intermediate values of M.

The proposition describes the effect of an increased R upon each of the regions illustrated in figure 6. The aggregate effect is simple: over-investment increases, and under-investment decreases. Over-investment occurs in regions 1 and 2 of the proposition. In region 1 there is excess banking, while in region 2 the level of banking is correct, but the banks run too many projects. Increasing R diminishes the size of region 2 and increases the size of region 1: intuitively, some of the over investment that occurs within banks is being replaced by more severe over-investment in the form of excess banking. The same intuition applies to the diminishing level of under-investment in regions 3 and 4 of the proposition.

To understand the comparative statics of parts 1 and 4 of the proposition, note that higher values of R reduce the capital requirement needed to induce the headquarters to monitor marginal projects, and hence, in a risk-insensitive capital regime, lower capital requirements for all banks. Higher R values therefore increase the value of the deposit insurance subsidy, and hence increase over-investment. Increasing R therefore increases the size of the light-shaded over-investment region and diminishes the size of the dark-shaded under-investment region.

The effect of higher R upon parts 2 and 3 of the proposition is slightly more complex. These parts are concerned with the difference between the maximum M for which headquarters will commit to invest in marginal projects, and the maximum M at which it is socially desirable to do so. Both of these quantities are increasing in R. However, because some of the social value of a marginal project accrues to the loan officer in the form of monitoring rent, the former increases less rapidly than the latter.

5. Risk-Sensitive Capital Requirements

In this section we consider the effect of risk-sensitive regulatory capital requirements upon the headquarter's time 1 choices. In this case, capital regulation can be predicated upon information revealed by the bank's IRS. Hence capital requirements for basic banks are unchanged, while capital requirements for strong projects undertaken by advanced IRS banks are reduced from $C(M)$ to $C(0)$. This is the situation created by the introduction of the new Basel Accord, under which banks can opt if they wish to use the output from their own sophisticated risk-management systems to compute capital requirements.

5.1. Investment Strategies with Risk-Sensitive Capital Requirements

PROPOSITION 4. *The introduction of risk-sensitive capital requirements has the following effects:*

1. *The individual rationality constraint for headquarters investment is as follows:*

$$M \leq \bar{M^{\sigma}} \equiv \begin{cases} \bar{M} = \bar{M},' & \text{if } \zeta > \frac{\Pi}{2}(R-1); \\ \infty, & \text{if } \zeta \leq \frac{\Pi}{2}(R-1). \end{cases} \tag{19}$$

2. *Investment strategies are altered from the case with risk-insensitive capital requirements as follows:*

   (a) *When investment occurs under risk-sensitive capital requirements that would not have occurred with risk-insensitive capital requirements, the headquarters runs a selective bank;*

   (b) *The monitoring cost at which the headquarters is indifferent between basic and selective banks is M_{BS}^{σ}, where $M_{BS}^{\sigma} < M_{BS}$ for $\zeta < \frac{1}{2}(R-1)$. When max $\left[M_{BS}^{\sigma}, M_c\right] < M \leq$ min $\left[M_{BS}, \bar{M}'\right]$, headquarters with risk-sensitive capital requirements run selective banks, while those with risk-insenstive capital requirements run unselective banks.*

Proof: In appendix B, including an explicit expression for M_{BS}^{σ}. □

Proposition 4 is illustrated in figure 7. The individual rationality constraint $\bar{M}'$ for risk-insensitive capital requirements (see proposition 2) is illustrated in the figure as a dotted bold line, and the individual rationality constraint $\bar{M^{\sigma}}$ with risk-sensitive capital requirements appears as a bold line. These lines coincide along the sloped upper bound of the basic region in the figure, and diverge to the right of the point at which this sloped bound intersects the selective region. When they diverge, the region between the lines contains the model parameterizations for which investment occurs via a selective bank with risk-sensitive capital requirements, but does not occur at all with risk-insensitive capital requirements.

The individual rationality constraint is relaxed with risk-sensitive capital requirements because risk-sensitive banks enjoy a lower capital requirement, which translates into a higher expected deposit insurance subsidy. At the same time, because this benefit is denied to basic banks, introducing risk-sensitive capital requirements makes basic banking relatively less attractive than selective banking, so the line M_{BS}^{σ} along which the headquarters is indifferent between basic and selective banking is to the left of M_{BS}, as in figure 7. Hence there is a set of model parameterizations for which basic banking is the optimal strategy with risk-insensitive capital requirements, but selective banking is preferred with risk-sensitive capital requirements. This set of parameterizations is indicated in figure 7 by cross-hatching.

A detailed discussion of the changes to investment incentives engendered by the introduction of risk-sensitive capital requirements appears in the following section, where it is combined with an analysis of their welfare consequences.

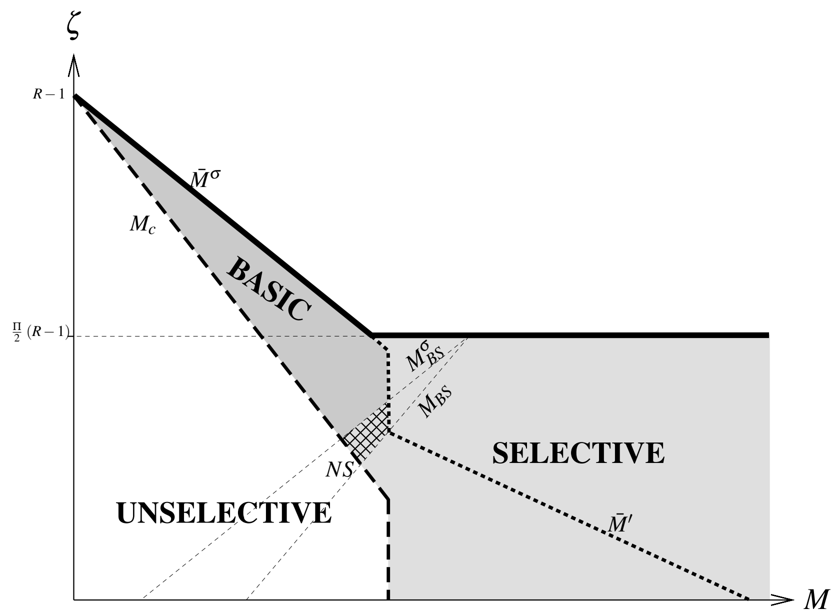

Figure 7: **Changes to Constraints with Risk-Sensitive Capital Requirements.** With risk-sensitive capital requirements, the headquarters runs a basic bank in the dark gray region, and an unselective bank in the light gray region. The dotted bold line is the headquarters' participation constraint with risk-insensitive capital requirements: for parameterizations above this line, the headquarters runs a selective bank with risk-sensitive capital requirements, but does not participate with risk-insensitive capital requirements. The cross-hatched region consists of parameterizations for which the headquarters runs a selective bank with risk-sensitive capital requirements, and runs a basic bank with risk-insensitive capital requirements.

5.2. Welfare With Risk-Sensitive Capital Requirements

The introduction of risk-sensitive capital requirements removes the under-investment problem identified in part 4 of proposition 3. The reason for this is that, with risk-sensitive capital requirements, selective banks attract a zero capital requirement, and hence are not subject to the capital costs that cause underinvestment in the risk-insensitive case. In fact, because the headquarters still earns a return from deposit insurance, it is excessively willing to invest from a social perspective, so that unselective banks overinvest relative to the social optimum. This effect is illustrated in figure 8. As in figure 6 of section 4.3, the border M_V of the socially optimal investment region is indicated with a bold line, and we refer to the left hand boundary of the selective region as $\underline{M}_S^{\sigma}$: $\underline{M}_S^{\sigma}$ is obtained by shifting $\underline{M}_S$ out to incorporate the cross-hatched region of figure 7. The basic, unselective, and selective regions of figure 7 are indicated on figure 8 with non-bold lines. The shaded region under the horizontal portion of the $\bar{M}^{\sigma}$ indicates the additional over-investment that occurs when risk-sensitive capital requirements are introduced.

The over- and under- investment problems described in parts 2 and 3 of proposition 5 continue

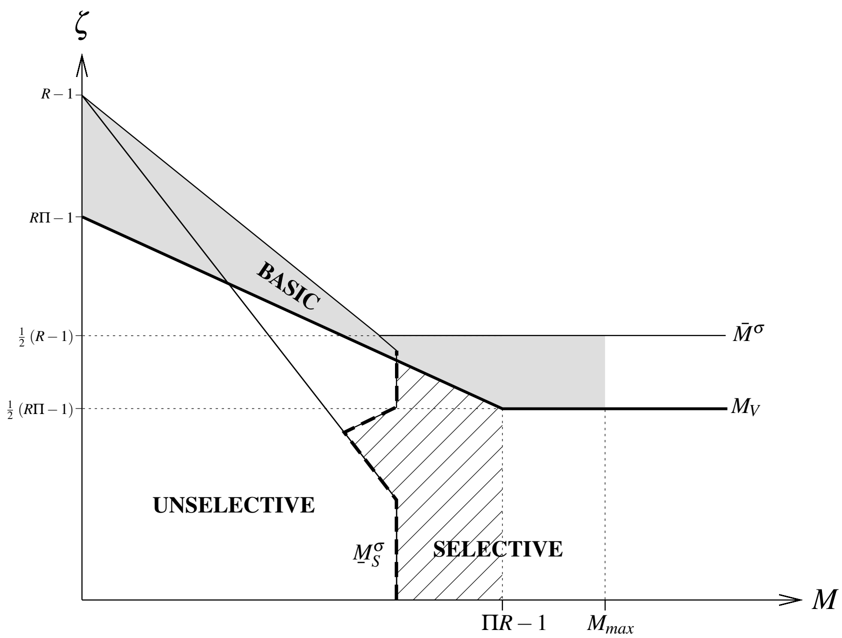

Figure 8: **Welfare with Risk-Sensitive Capital Requirements.** As in figure 6, banking is welfare-enhancing precisely for (M,ζ) values that lie below the bold M_V line; the whole of the shaded region in this figure therefore represents over-investment in the form of excessive banking. As in figure 6, the cross-hatched region corresponds to underinvestment that occurs when the bank elects to run a selective bank, even though unselective banking is socially better.

to occur with risk-sensitive capital requirements, for the same reasons. As in figure 6, the cross-hatched region in figure 8 indicates parameter values for which banks under-invest.

Proposition 5 provides a formal statement of these results, and outlines their comparative statics.

PROPOSITION 5.

1. *For $M_V < M \leq \bar{M}^{\sigma}$, the headquarters runs a bank that invests in both strong and marginal projects, although it would be socially optimal not to run a bank at all;*
2. *For $\Pi R - 1 < M \leq \underline{M}_S^{\sigma}$, the headquarters runs a bank that invests in strong and marginal projects, although it would be socially optimal to run a selective bank;*
3. *For $\underline{M}_S^{\sigma} < M \leq \Pi R - 1$, the headquarters runs a selective bank, although it would be socially optimal to invest in both strong and marginal projects;*
4. *All other bank investment decisions are socially optimal.*

As R increases, the set of parameter values for which part 1 or part 3 of the proposition applies expands, and the set for which part 2 applies shrinks.

Proof: Entirely analogous to the proof of proposition 3, and hence omitted. □

The intuition for the comparative statics relating to parts 2 and 3 of the proposition mirrors that for the corresponding parts of proposition 3; similarly, the over-investment region below the sloped portion of $\bar{M}^{\sigma}$ is identical to the corresponding region with risk-insensitive capital requirements and hence also expands for the reasons outlined in section 4.3. The over-investment region below the horizontal part of $\bar{M}^{\sigma}$ is R-invariant, because the capital requirement, and hence the deposit insurance benefit, is also R-invariant in selective banks.

Proposition 5 points to an effect that has been widely discussed elsewhere: namely, that risk-sensitive capital requirements reduce the costs of capitalising high-quality investments, and hence render them more attractive to banks. This effect manifests itself in figures 7 and 8 as an increase in the size of the selective region, to the extent that some over-investment occurs. The aggregate effect upon a universe of banks is therefore a portfolio shift from lower- to higher-quality assets.

A shift from risk-insensitive to risk-sensitive capital requirements will increase the value that bank shareholders derive from an advanced IRS. As a result, some banks will switch from a basic to advanced IRS: these banks are identified in figure 7 by the cross-hatched *NS* ("New System") region.[11] The welfare consequences of this switch from basic to advanced IRS have not been widely discussed, but we are able to analyze them within our model: proposition 6 shows that they are not always benign.

PROPOSITION 6. *Let NS be the set of M and ζ values for which banks respond to the introduction of risk-sensitive capital requirements by switching from a basic IRS to a new advanced IRS. The size of NS is increasing in R. For high enough Π and R, NS represents under-investment relative to the social optimum; for low enough Π and R, NS represents a reduction in over-investment relative to the social optimum.*

Proof: In appendix B. □

Higher values of R increase the value of the deposit insurance subsidy that is derived from risk-sensitive capital requirements and hence render selective banking relatively more attractive than basic banking. As a result, the size of the *NS* region is increasing in R. When the social value of investment is large enough, the failure in region *NS* to use the commitment value of the basic bank is welfare-reductive: this is the case for high enough R and Π; for lower R and Π there is excessive investment, which is reduced for parameter values within *NR*.

6. Policy Implications

Throughout the paper, we have used graphs of M against ζ to represent the effects of different parameterizations upon the headquarter investment strategies, and the welfare implications, that follow from our analysis. We can use the discussion in section 2.1 to interpret these parametriza-

[11] *NS* is the region bounded by M_{BS}, M_{BS}^{σ}, $\bar{M}_{B}^{nf}$, and M_{c}^{f}.

tions, and hence to draw some policy conclusions.[12]

There are obvious limitations to any policy analysis conducted in our set-up, because we do not assign a distribution function to (M,ζ) values: doing so would complicate our analysis so far as to render it intractable. However, we make some general statements here about the type of distributions that strike us as plausible.

As we discuss in section 2.1, high levels of M reflect either a market in which relationship-based modes of contract enforcement dominate, or a high degree of borrower opacity. In either case, the level of loan officer effort and expertise required to identify a positive NPV loan is also likely to be high. As a result, we believe that a reasonable distribution function for (M,ζ) values should assign much of the probability mass to parameter values near the leading diagonal: we anticipate that either M and ζ are both high, or that both are low.

6.1. Compulsory Adoption of Advanced IRS

Should banks be actively encouraged, or even compelled, to install an advanced IRS system? Our analysis indicates that, provided banks rationally choose between basic and advanced internal reporting systems, there is no *a priori* reason to believe that compelling them to adopt an advanced IRS would raise welfare. Indeed, it is apparent from figures 6 and 8 that while doing so would reduce the over-investment that occurs with basic banks, it would also reduce some socially desirable investment in the marginal projects for which bank finance is generally regarded as critical. While our analysis does not include a specific distribution function over parameter values, we argue above that the parameters for which basic banking is socially useful are more likely to arise in practice.

6.2. Pro-Cyclicality

A very substantial literature points to the danger that the Basel II Accord will amplify the economic cycle: for example, see Goodhart and Segoviano (2004), Danielsson, Keating, Goodhart, and Shin (2001), Kashyap and Stein (2004), Gordy and Howells (2006), Heid (2007). The usual argument is that, because banks treat capital as a costly resource, forcing them to hold more of it when their portfolios are weakened by an economic downturn will reduce lending, and do will worsen the downturn. Similarly, economic upturns that improve the bank's prospects will reduce its capital requirement and so engender more lending and hence more economic activity at the macro level.

We cannot address pro-cyclicality directly in our static model, but our analysis suggests two points. First, pro-cyclical bank lending may reflect inexact pricing of deposit insurance protection. When, as in an upturn, the return R to a successful investment increases, it becomes easier to incentivise loan officer monitoring, and hence bank capital requirements are reduced. This increases

[12]The discussion in section 2.1 relates to $M-m$; by assumption 7 this is equivalent to a discussion of the M axis in our figures.

the value of the deposit insurance put and hence, as we prove in propositions 3 and 5, results in an increase in bank over-investment, and a reduction in under-investment.

Second, pro-cyclical effects arise in our model with both risk-sensitive and risk-insensitive capital requirements. Indeed, pro-cyclical lending in our set-up has nothing to do with the introduction of risk-sensitive capital regulation: the deposit insurance effects of the previous paragraph occur only in the basic banking region of figures 6 and 8, where risk-sensitive capital requirements do not apply. As discussed in section 5.2, the over-investment in selective banks that occurs with risk-sensnitive capital requirements is independent of R, and hence of the economic cycle.

6.3. Multinational Banks

When banks expand to foreign countries, they use one of two organizational forms: they form wholly-owned *subsidiary* firms of the parent bank, or they open *branch* offices. Subsidiary firms are separately capitalized firms, while branches are legally part of the parent institution, and share its balance sheet. Because they have their own balance sheets, subsidiary firms tend to run their own risk management systems, and to report less information to their parent firms. Some distance between the foreign bank and its home institution is therefore built into a subsidiary structure. In the context of our model, we can think of them as having a similar relationship to their parent to that between the loan officer and the headquarters in a basic bank.

In contrast, branches share a balance sheet with the parent and tend to use a common reporting system with the parent; strong information flows between the two institutions are therefore designed into branch structures, and we can view branches as having an analogous relationship with their parent to that between the loan officer and the headquarters in a bank with an advanced IRS.

We can use our model with the analogies drawn above to derive conclusions about the organizational form of a multinational bank. Our analysis suggests that banks should expand into markets where project origination is costly via subsidiaries, and that expansion into markets where the gulf between the best and the worst projects is smaller should be via branch banks.

7. Robustness and Extensions

In this section we examine the robustness of our model's conclusions to some changes in its assumptions.

7.1. Delegation of Authority

In our model, every investment that the loan officer discovers has a positive net present value after the search cost ζ is sunk. Moreover, because he is rewarded only for his search efforts only if investment occurs, he will always prefer *ex post* that the investments he uncovers be accepted. Hence, in our set-up, the inefficiencies that arise because of the contracting problem between the loan officer and the headquarters could be avoided by delegating all authority for investment decisions to the loan officer.

In practice, however, this solution would be unlikely to work. In a simple modification of our model in which loan officers can easily find very low quality projects from which they derive a substantial private benefit, delegation of decision-making authority to the loan officer would result in a great many value-reductive investments. This modification would introduce additional complication to our analysis, but would have no substantive effect upon our intuitive results. Moreover, we believe that the modification would capture realistic feature of real world banks.

7.2. Entrepreneurial Banks

Related to the discussion in section 7.1, we now consider the effect upon our model of entrepreneurial banking under which the loan officer has a sufficiently large equity stake in the bank's future to be trusted to take investment decisions for himself. In this case, the agency problem between loan officers and headquarters that drives our model vanishes. However, for a number of reasons, we do not believe this to be a realistic model for much commercial banking.

First, the entrepreneurial story flies in the face of a great deal of empirical evidence. Banks are growing larger, not smaller. There are good technological reasons for this change, but the increase in scale results inevitably in dispersed loan officers under a centralized headquarters.

Second, there may be large fixed costs to an advanced IRS that are not captured by our model. If this is the case then the introduction of risk-sensitive capital requirements is meaningful only in institutions that suffer from the effects that we have modelled. Similarly, capital may be easier to raise for institutions that attain a scale at which the separation of the loan officer from the headquarters is inevitable.

Finally, it is possible that the difficulty of monitoring loans, M, and the cost ζ of finding them, depend upon bank size in ways that we do not model. If large banks have advantages in monitoring and loan origination that derive from their ability to bring more loan officers and more computing power to these tasks then they may derive sufficient efficiency gains from scale to render it worthwhile to introduce the agency effects that we model.

7.3. Regulatory Signals

When the regulator has access to information from the bank's IRS, it could force the headquarters to compensate loan officers for finding projects, even when no investment occurs. This would resolve the commitment problem that lies at the heart of our analysis. However, for a number of reasons, we believe that this solution would be highly unlikely to succeed. First, if the regulator were to attempt to enforce payments in this fashion then the bank would have greatly diminished incentives to provide it with access to its systems in the first place. Second, a regulator that actively intervened at an operational level in a bank would potentially be implicated if the bank experienced financial fragility as a result of a poor loan portfolio, or if it uncovered a significant failure of corporate governance. To the extent that these problems were likely to be revealed by regulatory actions, the regulator's incentive to intervene would be reduced and hence, because this effect would be anticipated by the bank, the regulator's ability to influence bank behaviour would similarly be reduced. For these reasons a policy of allowing the regulator to intervene to enforce employment contracts within the bank seems, to us, to be unrealistic.

7.4. Positive m

Assumption 7 guarantees that the cost m of monitoring a strong project is zero and hence simplifies the analysis considerably. In an earlier working paper version of this paper, we demonstrate, at the cost of a far greater degree of complexity of analysis and exposition, that relaxing this assumption does not materially alter our results. Banks face a commitment problem whenever they wish to run an unselective bank because doing so reduces the per-investment cost of project search sufficiently to compensate for the costs of accepting marginal projects. This commitment problem renders basic banking attractive when m is positive, and the remainder of our results then carry through.

7.5. Costly Deposit Insurance

Lemma 2 shows that when investment levels exceed the social optimum, they do so precisely because deposit insurance is incorrectly priced. In practice, we think that some inaccuracy in the pricing of deposit insurance is inevitable. Bank assets are opaque, and the deposit insurance fund relies upon bank self-reporting for its information about their investments. An attempt to force comprehensive reporting of asset quality might would therefore be unlikely to succeed. Indeed, Chan, Greenbaum, and Thakor (1992) demonstrate that it is not possible in general to design revelation mechanisms that induce banks to reveal the risk profiles of their investments, and Freixas and Rochet (1998) argue that fairly priced deposit insurance would in any case result in the socially undesirable cross-subsidization of inefficient bankers by efficient ones.

Notwithstanding these observations, it is interesting to discuss the effect upon our results of more precise deposit insurance pricing. With completely accurate deposit insurance pricing, the overinvestment problems identified in propositions 3 and 5 would disappear. However, deposit insurance serves in our model as a counterweight to the disinvestment caused by loan officer information rent and costly capitalization. Accurately priced deposit insurance would accentuate these effects, and hence would exacerbate the underinvestment problems identified in these propositions.

7.6. Costly Advanced IRS

We have assumed, in the interest of simplifity and tractability, that it is costless to acquire an advanced IRS. In practice, of course, it is expensive to resolve the technological and organizational problems associated with advanced internal reporting systems.[13] Allowing for these costs would have no effect in our model upon the overinvestment preformed by basic banks in propositions 3 and 5, since these occur when banks strictly prefer to use a basic IRS. Similarly, because selective banks rely upon advanced IRS, they would invest less with costly advanced IRS: this would exacerbate the under-investment problem with risk-insensitive capital requirements, and would diminish the over-invesment problem under risk-sensitive capital requirements. Finally, with a costly advanced IRS, banks would be less likely to switch from basic systems when risk-sensitive capital requirements were introduced. The NS region of proposition 6, and hence the corresponding under-investment in marginal projects, would therefore be diminished.

7.7. Type-Contingent Origination Fee

Assumption 3 states that it is impossible to condition loan officer contracts upon information revealed by the internal reporting system. Quite apart from the problems inherent in proving this information in court, we believe that this assumption is reasonable if loan officers are able to manipulate the information that the system uses. Nevertheless, it is interesting to consider the consequences of relaxing this assumption, and allowing loan officer origination fees to be contingent upon project type.

Clearly, allowing loan officers to be paid a type-contingent origination fee would relax the commitment constraint M_c, since it would allow some of the burden of paying the loan officer for search to be shifted from states of the world in which he uncovered a marginal project to those in which he uncovered a strong one. It need not follow, though, that the commitment problem is completely resolved, as there is an upper bound to the fee that the headquarters can commit to pay even to a strong project.

Note that relaxing the commitment constraint would not result in investment levels in excess of those attained without a commitment problem. Moreover, except where $\bar{M}' < \bar{M}$, these levels are achieved in overinvestment equilibria. It follows that type-contingent origination fees would have little effect upon over-investment levels. They would however have two desirable consequences. First, they would diminish the social underinvestment that occurs with risk-insensitive capital requirements. Second, they would shrink the *NS* region within which the introduction of risk-sensitive capital requirements causes banks to stop investing in marginal projects.

[13] The Economist Intelligence Unit (October, p. 11) states that "Depending on the starting point, advanced approaches can run into the tens and even sometimes into the hundreds of millions of dollars."

8. Conclusion

The risk-insensitive capital requirements of the 1988 Basel Accord were criticized because they imposed capital requirements on high quality lending that were out of proportion to its riskiness, and hence reduced the average quality of the loans that banks chose to make. The introduction in the Basel II Accord of risk-sensitive capital requirements is intended to counter this effect. Our model demonstrates that the new model will certainly have this effect. However, it also points to an additional consequence: some banks that previously would have used basic IRS systems to commit to lend to marginal borrowers will now find it more cost-effective to invest in advanced IRS systems, and to use them to cherry-pick the highest quality firms. Hence, although the new Accord will likely increase the average quality of banking sector assets, it does not follow directly from this statement that it will also increase welfare. While more high quality borrowers are likely to acquire access to intermediated finance, more marginal borrowers may lose it. Arguably, while the former type of borrower can access alternative sources of funds, the marginal borrowers, who suffer from a informational frictions may not be able to so. Hence it is possible that the new Accord may amplify recent trends towards disintermediation and lending based upon formal, codifiable, reports.

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Appendix

Proof of Lemma 1

The loan officer earns rent $w\Pi - \mu$ from investment, so r is the expected informational rent that he assesses at time 2. He will search for a project provided his expected fee δF from doing so exceeds his search costs, net of the expected informational rent r. In other words, project search is incentive compatible precisely when $F \geq (\zeta - r)/\delta$. Since loan officers are protected by limited liability, the fee is set according to equation (6).

Proof of Lemma 2

Define

$$\kappa \equiv \frac{1}{\delta}(\zeta - r). \tag{20}$$

Then the origination fee F is equal to $\max(\kappa, 0)$. Recall that the loan officer's informational rent from monitoring is 0 when $F > 0$, and that it is $-\kappa$ when $F \leq 0$, so that we can write his expected rent per project undertaken as

$$\rho \equiv \max(-\kappa, 0). \tag{21}$$

Note that $F = \max(\kappa, 0)$ is zero precisely when ρ is positive, which immediately gives us corollary 1. The expected social surplus V that the bank generates is given by equation (22):

$$V = \mathbb{E}\left\{(R\Pi - \mu - 1) I_\mu\right\} - \zeta, \tag{22}$$

and the the ex ante expected value D to headquarters of the deposit insurance subsidy is given by expression (23):

$$D = \mathbb{E}\left\{(1 - \Pi)(1 - C) I_\mu\right\}. \tag{23}$$

Equation (24) follows immediately from equations (8), (20), (22), and (23):

$$W = V + \delta\kappa + D - \gamma C. \tag{24}$$

Equation (10) then follows immediately from equations (24) and (9), and the fact that $\kappa = F - \rho$.

Proof of Proposition 1

M_{US} is given by equation (52), which we can re-write as follows:

$$M_{US} \quad = \quad \begin{cases} M_{US}^{nf}, & \text{if } \zeta < \zeta_{US}; \\ M_{US}^{f}, & \text{if } \zeta \geq \zeta_{US}. \end{cases}$$

The first part of the proposition follows immediately from equation (25):

$$\frac{\partial M_{US}^{nf}}{\partial \zeta} = \frac{(2\Pi - 1)^2}{\Pi(1+2\gamma)} > 0 = \frac{\partial M_{US}^{f}}{\partial \zeta}. \tag{25}$$

Participation by the headquarters is individually rational precisely when the surplus S is positive. It follows from equation (42) that the headquarters derives a positive expected surplus from investment in unselective banks when condition (26) is satisfied:

$$\begin{gathered} \left\{ (M < M_{FU}) \text{ and } \left(M < \bar{M}_U^f \equiv \tfrac{2(2\Pi-1)^2}{4\Pi(1-\Pi+2\gamma)+1} \left((R-1)(1+\gamma) - \zeta \right) \right) \right\} \\ \text{or} \\ \left\{ (M \geq M_{FU}) \text{ and } \left(M < \bar{M}_U^{nf} \equiv \tfrac{(2\Pi-1)^2}{\Pi(3-2\Pi+4\gamma)} (R-1)(1+\gamma) \right) \right\} \end{gathered} \tag{26}$$

This expression can be re-written as follows:

$$\left\{ M < \min\left(M_{FU}, \bar{M}_U^f \right) \right\} \text{ or } \left\{ M_{FU} \leq M < \bar{M}_U^{nf} \right\}. \tag{27}$$

It is easy to check that

$$\frac{M_{FU} - \bar{M}_U^f}{M_{FU} - \bar{M}_U^{nf}} = \frac{2\Pi(3 - 2\Pi + 4\gamma)}{1 + 4\Pi(1 - \Pi + 2\gamma)} > 0,$$

so that

$$\left\{ \min\left(M_{FU}, \bar{M}_U^f \right) = \bar{M}_U^f \right\} \Longleftrightarrow \left\{ \bar{M}_U^{nf} < M_{FU} \right\}.$$

It follows immediately that condition (27) for the headquarters to derive a positive surplus from running a unselective bank can be written as follows:

$$M \leq \bar{M}_U \equiv \min\left(\bar{M}_U^f, \bar{M}_U^{nf} \right). \tag{28}$$

An entirely analogous argument gives us the following condition for headquarters to derive a positive surplus from running a basic bank:

$$M \leq \bar{M}_B \equiv \min\left(\bar{M}_B^f, \bar{M}_B^{nf} \right), \tag{29}$$

where

$$\bar{M}_B^f \equiv \bar{M}_U^f; \tag{30}$$

$$\bar{M}_B^{nf} \equiv \frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}(R-1)(1+\gamma). \tag{31}$$

It follows from equation (44) that the headquarters derives a positive surplus from a selective bank precisely when condition (32) is satisfied:

$$M \leq \bar{M}_S \equiv \frac{(2\Pi-1)^2}{4\Pi(1-\Pi+\gamma)}((R-1)(1+\gamma)-2\zeta). \tag{32}$$

Finally, it is individually rational for headquarters to invest in a bank precisely when it derives a positive expected surplus from an unselective, basic, or selective bank. This is the case precisely when equation (33) is satisfied:

$$M \leq \bar{M} \equiv \max(\bar{M}_U, \bar{M}_B, \bar{M}_S). \tag{33}$$

Since $\bar{M}_U$, $\bar{M}_B$, and $\bar{M}_S$ are all (weakly) decreasing in ζ, so is $\bar{M}$, as required.

Proof of Proposition 2

We start by considering the headquarters' individual rationality constraint. First, suppose that $M < M_{FB}$. Then, because $M_{FU} - M_{FB} = 4\Pi\zeta\frac{2\Pi-1}{2\Pi+1} > 0$, the ex ante expected loan officer rent ρ is zero in both basic and unselective banks. Investing in a basic bank for commitment purposes therefore does not result in a lower profit than the optimal ex ante investment with commitment considered in proposition (1), so that $\bar{M}' = \bar{M}$. Second, suppose that $M \geq M_{US}$. Then, because headquarters earns a greater ex ante expected surplus from a selective bank than from an unselective bank, it will certainly never run a basic bank for commitment purposes. Since its optimal strategy choice is the one considered in proposition (1), we again have $\bar{M}' = \bar{M}$. Finally, suppose that $M_{FB} \leq M < M_{US}$. Then loan officers in basic banks will always earn a positive ex ante expected rent, so that

$$\begin{aligned}
\bar{M}' &= \max\left(\min(\bar{M}_U, M_c), \bar{M}_B^{nf}, \bar{M}_S\right) \\
&= \begin{cases} \bar{M}_B^{nf}, & \text{if } M < M_{BS}; \\ \bar{M}_S, & \text{if } M \geq M_{BS}. \end{cases} \\
&< \bar{M}_U = \bar{M}.
\end{aligned}$$

For the second part of the proposition, note that the headquarters will select an unselective bank provided $M \leq \min(M_c, \bar{M}_U)$ and $M \leq M_{US}$. But $M_c < \min(\bar{M}_U, M_{US})$, so that unselective bank investment occurs precisely when $M \leq M_c$.

Headquarters will adopt a basic IRS when conditions (13) and (14) are satisfied, along with the individual rationality constraint $M \leq \bar{M}'$. These requirements reduce to the condition in the third part of the proposition.

The headquarters will adopt a selective investment strategy when the IR constraint $M \leq \bar{M}'$ is satisfied, and when both (i) selective banks are preferred to basic banks ($M \geq M_{BS}$) and (ii) either unselective bank investment is impossible ($M \geq M_c$), or it is possible but dominated by selective bank investment ($M_c > M \geq M_{US}$). Since $M_c < M_{US}$, condition (ii) reduces to $M \geq M_c$, so that selective bank investment is performed precisely when the condition in the fourth part of the proposition is satisfied.

Web Appendix: Not for Publication

Proof of Lemma 4

All investments attract a capital charge of $C(M)$ with risk insensitive capital requirements. Basic banks pay a performance fee $w(M)$ to all projects, and advanced IRS banks pay a performance fee $w(0)$ to strong projects, and a performance fee $w(M)$ to marginal projects. Inserting these values into equation (8), we obtain the following values for the strategy-dependent expected surplus W that accrues to the headquarters, excluding any origination fees:

$$W_U = (R-1)(1+\gamma) - M\Pi\frac{(3-2\Pi+4\gamma)}{(1-2\Pi)^2};$$
$$W_S = \frac{1}{2}\left((R-1)(1+\gamma) - M\frac{4\Pi(1-\Pi+\gamma)}{(1-2\Pi)^2}\right);$$
$$W_B = (R-1)(1+\gamma) - M\frac{2\Pi(1+2\gamma)}{(1-2\Pi)^2}.$$

Using equation (7), we obtain the following values for the monitoring rent r that accrues to the loan officer after investment:

$$r_U = \frac{M}{2(2\Pi-1)}; \tag{34}$$
$$r_S = 0; \tag{35}$$
$$r_B = \frac{M(1+2\Pi)}{2(2\Pi-1)}. \tag{36}$$

Basic and unselective banks accept every investment, so that the time 2 probability of investment in these banks is $\delta_B = \delta_U = 1$; selective banks select half of all investments, so $\delta_S = \frac{1}{2}$. Substituting for r and δ in equation (6) gives us the following:

$$F_B = \begin{cases} \zeta - r_B, & \text{if } M < M_{FB}; \\ 0, & \text{if } M \geq M_{FB}. \end{cases} \tag{37}$$
$$F_U = \begin{cases} \zeta - r_S, & \text{if } M < M_{FU}; \\ 0, & \text{if } M \geq M_{FU}. \end{cases} \tag{38}$$
$$F_S = 2\zeta, \tag{39}$$

where

$$M_{FB} = \frac{2\zeta(2\Pi - 1)}{2\Pi + 1}; \tag{40}$$

$$M_{FU} = 2\zeta(2\Pi - 1). \tag{41}$$

Note that $M_{FB} < M_{FU}$.

It follows immediately from equation (9) that

$$S_U = \begin{cases} S_U^f \equiv (R-1)(1+\gamma) - \zeta - M\frac{1+4\Pi(1-\Pi)+8\Pi\gamma}{2(2\Pi-1)^2}, & \text{if } M < M_{FU}; \\ S_U^{nf} \equiv W_U, & \text{if } M \geq M_{FU}. \end{cases} \tag{42}$$

$$S_B = \begin{cases} S_B^f \equiv (R-1)(1+\gamma) - \zeta - M\frac{1+4\Pi(1-\Pi)+8\Pi\gamma}{2(2\Pi-1)^2}, & \text{if } M < M_{FB}; \\ S_B^{nf} \equiv W_B, & \text{if } M \geq M_{FB}. \end{cases} \tag{43}$$

$$S_S = S_S^f \equiv \frac{1}{2}\left((R-1)(1+\gamma) - 2\zeta - 4M\frac{\Pi(1-\Pi+\gamma)}{(2\Pi-1)^2}\right), \tag{44}$$

where the f and nf superscripts indicate the shareholder surplus when loan officers receive and do not receive a fee, respectively. It will be convenient later in the proof to express equations (42) and (43) as follows:

$$S_U = \min\left(S_U^f, S_U^{nf}\right); \tag{45}$$

$$S_B = \min\left(S_B^f, S_B^{nf}\right). \tag{46}$$

Now note that

$$S_U - S_B = \begin{cases} 0, & \text{if } M < M_{FB}; \\ (M - M_{FB})\frac{(2\Pi+1)}{2(2\Pi-1)} > 0, & \text{if } M_{FB} \leq M < M_{FU}; \\ M\frac{\Pi}{2\Pi-1} > 0, & \text{if } M \geq M_{FU}, \end{cases}$$

which proves part 1 of the lemma.

To prove the second and third parts of the lemma, we define

$$M_{BS}^f = M_{US}^f = (R-1)(1+\gamma)\frac{(2\Pi-1)^2}{1+4\gamma\Pi};$$

$$M_{BS}^{nf} = ((R-1)(1+\gamma)+2\zeta)\frac{(2\Pi-1)^2}{4\Pi(\gamma+\Pi)};$$

$$M_{US}^{nf} = ((R-1)(1+\gamma)+2\zeta)\frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}.$$

Then it is easy to check that

$$S_B^f > S_S^f \quad \text{iff} \quad M < M_{BS}^f; \tag{47}$$

$$S_U^f > S_S^f \quad \text{iff} \quad M < M_{US}^f; \tag{48}$$

$$S_B^{nf} > S_S^f \quad \text{iff} \quad M < M_{BS}^{nf}; \tag{49}$$

$$S_U^{nf} > S_S^f \quad \text{iff} \quad M < M_{US}^{nf}. \tag{50}$$

For the second part of the lemma, note that shareholders prefer basic to selective banks precisely when $S_B > S_S$; we can use equations (47) and (49) to write this condition as follows:

$$\begin{aligned} S_B > S_S \text{ iff } & \min\left(S_B^f, S_B^{nf}\right) > S_S^f \\ \text{iff } & \left(M < M_B^f \text{ and } M < M_B^{nf}\right) \\ \text{iff } & M < M_{BS} \equiv \min\left(M_{BS}^f, M_{BS}^{nf}\right) \end{aligned} \tag{51}$$

Similarly,

$$S_U > S_S \text{ iff } M < M_{US} \equiv \min\left(M_{US}^f, M_{US}^{nf}\right), \tag{52}$$

which gives us the third part of the lemma.

Proof of Lemma 5

The headquarters will use a basic bank to commit to time 3 investment only when it is unable to commit ex ante to run an unselective bank with an advanced IRS system. This will be the case precisely when the time 3 value to a headquarters of investing in marginal projects, net of the origination fee F_U for unselective banks, is negative. We use equations (7)–(6) to compute F_U. Equation (7) gives us

$$r_U = \frac{M}{2\,(2\Pi - 1)},$$

from which, using equation (6), we get

$$F_U = \max\left(\zeta - \frac{M}{2\,(2\Pi - 1)}, 0\right).$$

The headquarters of an unselective IRS bank will not honor a time 1 commitment to accept marginal projects precisely when

$$\Pi\,(R + C\,(M) - 1 - w\,(M)) - C\,(M)\,(1+\gamma) - F_U < 0.$$

This is the case precisely when condition (53) is satisfied:

$$M \geq \begin{cases} 2\frac{(2\Pi-1)^2}{1+2\Pi+8\Pi\gamma}\left((R-1)\,(1+\gamma) - \zeta\right), & \text{if } M \leq M_{FU}; \\ \frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}\,(R-1)\,(1+\gamma), & \text{otherwize.} \end{cases} \tag{53}$$

It is easy to show that

$$\frac{M_{FU}-\frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}(R-1)(1+\gamma)}{\frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}(R-1)(1+\gamma)-2\frac{(2\Pi-1)^2}{1+2\Pi+8\Pi\gamma}((R-1)(1+\gamma)-\zeta)}=\frac{1+2\Pi+8\Pi\gamma}{2\Pi-1}>0,$$

from which it follows that

$$\left\{\frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}(R-1)(1+\gamma)<2\frac{(2\Pi-1)^2}{1+2\Pi+8\Pi\gamma}((R-1)(1+\gamma)-\zeta)\right\}\Longleftrightarrow M_{FU}<\frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}(R-1)(1+\gamma),$$

which implies that condition (53) is equivalent to condition (13), as required.

If condition (13) is satisfied then the headquarters is unable to commit to accept marginal projects at time 3 if it has an advanced IRS. It will use a basic IRS to do so if the resultant expected surplus exceeds the one it would earn by running a selective bank. This is the case precisely when condition (14) is satisfied.

Proof of Proposition 3

Parts 1-5 of the proposition are tautologies. For example, if $M > M_V$ then by definition banking is socially undesirable, and, if $M \leq \bar{M}$ then, again by definition, banking will occur. Combining these observations gives us part 1 of the proposition. Parts 2-5 follow similarly.

Only the comparative statics of the proposition require proof. For part 1, it is sufficient to prove that both the vertical difference between $\bar{M}$ and M_V and the vertical part of $\bar{M}$ are increasing in R. The vertical difference is equal to the difference between the corresponding ζ values: this can be shown to be equal to

$$R(1+\gamma-\Pi)-\frac{\gamma+4\Pi((M-\gamma)(1-\Pi)+M\gamma)}{(1-2\Pi)^2},$$

which is clearly increasing in R. The vertical part of $\bar{M}$ is $\bar{M}_B^{nf}$ (see equation (31)), and has R-derivative $\frac{(1+\gamma)(2\Pi-1)^2}{2\Pi(1+2\gamma)}>0$.

For part 2, since $\bar{M}_B^{nf}$ is increasing in R it is sufficient to prove that the vertical distance between the horizontal part of M_V and $\bar{M}$ is decreasing in R. It can be shown that the corresponding R derivative is $-\frac{1}{2}(1+\gamma-\Pi)<0$.

Finally, it can be shown that

$$\frac{\partial}{\partial R}\left(\Pi R-1-\bar{M}_B^{nf}\right)=\frac{\gamma(4\Pi-1)+(2\Pi-1)+2\Pi(1-\Pi)}{2\Pi(1+2\gamma)}>0,$$

from which the comparative statics for parts 2 and 3 of the proposition follow immediately.

Proof of Proposition 4

As in the statement of the proposition, we denote quantities under risk-sensitive capital requirements with a σ subscript. Since risk-sensitive capital requirements do not affect the operation of basic banks, we must have $S^f_{B,\sigma} = S^f_B$ and $S^{nf}_{B,\sigma} = S^{nf}_B$, so that neither M_{FB} nor $\bar{M}_B$ is altered. The respective ex ante expected surplus for selective and unselective banks is computed from equation (8), using state-contingent capital requirements, as follows:

$$S^f_{S,\sigma} = \frac{1}{2}\left(\Pi(R-1) - 2\zeta\right) = S^f_S + \frac{1}{2}C(M)(1-\Pi+\gamma); \tag{54}$$

$$S^f_{U,\sigma} = \frac{1}{2}\left((R-1)(1+\gamma+\Pi) - 2\zeta\right) - \frac{M(1+4\Pi\gamma)}{2(2\Pi-1)^2} = S^f_U + \frac{1}{2}C(M)(1-\Pi+\gamma); \tag{55}$$

$$S^{nf}_{U,\sigma} = \frac{1}{2}(R-1)(1+\gamma+\Pi) - \frac{M\Pi(1+2\gamma)}{(2\Pi-1)^2} = S^{nf}_U + \frac{1}{2}C(M)(1-\Pi+\gamma). \tag{56}$$

Note that, by assumption 6, equations (54) – (56) imply that the surplus that shareholders derive from running a selective or an unselective bank is greater with risk-sensitive capital requirements than with risk-insensitive capital requirements. The reason for this is that the value of the deposit insurance subsidy is decreasing in the size of the capital requirement.

As in section 4.1, the boundary M^σ_{BS} along which the headquarters is indifferent between selective and basic banks is at the intersection of $S^f_{S,\sigma}$ and $S^{nf}_{B,\sigma}$:

$$\begin{aligned}
M^\sigma_{BS} &= \frac{(2\Pi-1)^2}{4\Pi(1+2\gamma)}\left((R-1)(2+2\gamma-\Pi)+2\zeta\right) \\
&= M_{BS} - \frac{(1-\Pi+\gamma)(1-2\Pi)^2}{4\Pi(\Pi+\gamma)(1+2\gamma)}\left((R-1)(1-\Pi)+2\zeta\right) \\
&< M_{BS}, \text{ as required.}
\end{aligned}$$

$S^f_{S,\sigma}$ is positive, and hence headquarters will derive a positive surplus from investment in selective banks, precisely when condition (57) is satisfied:

$$\zeta \leq \frac{1}{2}\Pi(R-1). \tag{57}$$

In this case, because selective banks do not accept marginal projects, bank investment is individually rational irrespective of the value of M; when condition (57) is not satisfied, investment is only individually rational in basic or selective banks. Since basic bank investment dominates unselective bank investment for large enough M, investment is individually rational when condition (57) is violated precisely when $M \leq \bar{M}'$, as in proposition 2. Equation (19) follows immediately.

Proof of Proposition 6

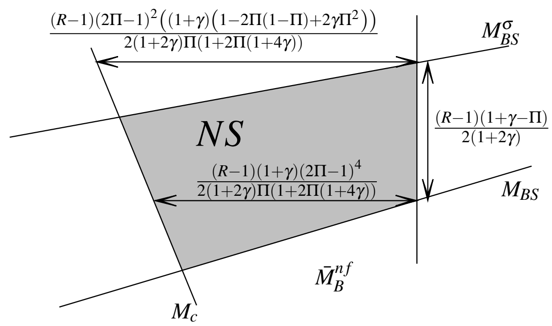

Figure 9: **Dimensions of the NS Region.**

Figure 9 illustrates the *NS* region, with some of its dimensions. Each of these dimensions is increasing in R and hence so is the size of the region.

The proof of the second part of the proposition is similarly algebraically involved, and we do not report our calculations. We first examine the vertical distance between the intersection of M_V with $\bar{M}_B^{nf}$, and the intersection of M_{BS}^{σ} with $\bar{M}_B^{nf}$; this distance is positive for large enough Π and R. We second examine the vertical distance between the intersection of M_V with $\bar{M}_B^{nf}$, and the intersection of M_{BS} with $\bar{M}_B^{nf}$; for small enough Π and R this distance is negative. The calculations are available upon request from the authors.