Internal Reporting Systems, Compensation Contracts, and Bank Regulation*

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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. 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 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 organizational form of the banks within which they work, and by the level of direct control that the central headquarters exercises 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 & 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. Berger, Miller, Petersen, Rajan & Stein (2005) find evidence 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 & 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 & 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] Agarwal & Wang (2008) find using data from a large US commercial bank that a switch from fixed salary compensation to payment via origination fees increases the probability that loans will be booked, and reduces the credit worthiness of loans. In contrast to Baker's work, 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. These incentives cause loan officers to uncover more loans and, in line with Agarwal and Wang, we find that they result in more lending to lower-quality borrowers. However, in our model this lending has positive expected NPV and hence is welfare-enhancing.

Under the constrained-optimal 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 & 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 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 & 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. Hence, as in Crémer (1995), the decision-maker in this paper achieves valuable commitment by managing the quality of information that he receives. In our model, however, this commitment comes at a cost: 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 & Carey (2000) and Grunert, Norden & 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

[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."

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 from 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.

Although we study the choice between advanced and basic reporting systems even in the absence of targeted regulatory support for either approach, the choice is of particular interest in light of the introduction of the Basel II capital adequacy Accord (see Basel Committee, 2006). 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 are 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 is sensitive to risk, advanced IRB capital requirements are 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 lowers the cost of advancing funds, and hence increases loan volumes to high quality borrowers: see for example Repullo & Suarez (2004).

Our analysis highlights an additional effect of the new Basel Accord which has not been recognized 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 is important in institutions that cater to markets characterized by high 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 headquarters equilibrium investment policies with risk-insensitive and risk-sensitive capital requirements, respectively. Section 6 discusses the policy implications of our work, and Section 7 draws empirical implications. Section 8 considers the robustness of our model and discusses some possible extensions. Section 9 concludes.

2. Model Description

We analyze the choice of internal reporting system within a bank, and the impact that regulation has upon this choice. 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 specialized 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*, $\mu \in \{0, M\}$, where $M > 0$. A project with monitoring cost 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 project with monitoring cost μ is $\Pi R - \mu - 1$ if it is monitored, and is $\frac{1}{2}R - 1$ if it is not. Clearly, a project with zero monitoring cost generates a higher social surplus than does a project whose monitoring cost is M. We think of projects with monitoring cost M as *marginal investments*, and of those with zero monitoring costs as *strong investments*. A fraction $\frac{1}{2}$ of all projects is marginal. We assume that

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

so that unmonitored projects are not viable, and monitored projects have a positive NPV after search costs have been sunk.[3] Note that ex ante, before search occurs, a project with high enough ζ can have a negative NPV.

The cost M of monitoring marginal projects is 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 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 characterized by a higher reliance upon loan officer skills, and so by higher monitoring costs. Second, high monitoring costs arise in relationship lending that is characterized 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 monitoring costs, by contrast, are associated with well-developed formal legal systems, and with lending to mature businesses and to businesses with easily redeployable 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 is neither observable nor contractible.*

[3] The first inequality in equation (1) is not essential for most of the model; it allows us to exclude a large number of uninteresting cases from our welfare analysis.

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.

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.*

Assumption 2 captures the intuition outlined in the Introduction that, in chosing an IRS, banks are deciding how much of the information collected by a loan officer should be codified for transmission up the management hierarchy. The first part of the Assumption, which states that every type of IRS reveals whether the project has a positive NPV, allows us to present our results in the most focussed way possible, but it is not critical; we discuss its relaxation in Section 8.1.

We assume that the information that the bank's headquarters derives from its IRS 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 & 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.[4] 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,[5] 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 represents direct costs borne by the bank shareholders; it therefore appears in the their objective function. However, the cost is purely a transfer of wealth and hence has no direct effect upon welfare; γC therefore does not feature in welfare expressions although, because it affects incentives and behavior in banks, it has an indirect effect upon social welfare.

We assume that depositors are protected by deposit insurance with a risk-insensitive cost to the bank, which we normalize to zero. A large literature justifies the existence of deposit insurance,[6] but we do not

[4] In particular, even though project search is always successful, the absence of a project cannot be used as the basis for a contractual penalty.

[5] For evidence of equity issuance costs, see for example Chen & Ritter (2000).

[6] See for example Bryant (1980), Diamond & Dybvig (1983), Freeman (1988), and Morrison & White (2004).

attempt to derive its existence from more primitive assumptions in this paper. In any event, the experience of the 2007-2009 financial crisis indicates that deposit insurance is a fact of life: Feyen & Vittas (2009) identify ten developed countries that extended blanket deposit guarantees during the crisis, and report that, amongst countries without a blanket guarantee, deposit insurance coverage as a multiple of GDP per capita increased from 1.5 to 5.[7] Moreover, evidence presented by Laeven (2002) and Demirgüç-Kunt & Kane (2002) indicates that deposit insurance pricing is at best only weakly related to loan portfolio riskiness.

As a result of deposit insurance, 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 sets 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.*

Capital regulation in our model is a necessary consequence of deposit insurance. We adopt Assumption 5, that capital requirements are as low as is consistent with monitoring, for the sake of analytic tractability. The assumption appears reasonable, however. First, by Assumption 4, high capital requirements act as a direct disincentive to investment, and hence may reduce welfare. Second, 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.[8]

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 1 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.

At time 2 the loan officer decides whether to search for a project. At this time neither the headquarters nor the loan officer knows whether a strong or a marginal project will be discovered.

[7] See Financial Stability Board (2009, Appendix) for details of deposit insurance schemes in 46 countries.

[8] This is a standard invocation of the Theory of the Second Best: see Lipsey & 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 1: Time line for the investment game.

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.

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.[9]

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 the same information; after search, the headquarters' information depends upon whether the bank has adopted a basic or an advanced IRS, and we denote its expectations operator by $\mathbb{E}_H\{\cdot\}$.[10]

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 fee w upon project success. He will elect to monitor a project with monitoring cost μ 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 projects with monitoring cost μ are monitored is therefore given by

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

Since the 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 0 for strong projects,

[9] It would be possible to agree the wage contract at an earlier time. However, if the bank has an advanced IRS, the headquarters knows the project type when it writes the time 3 wage contract; if the contract were written before time 3, it would not be possible to use the information revealed by the IRS.

[10] 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.

and $w(M)$ for marginal ones. With a basic IRS, when headquarters cannot distinguish between strong and marginal projects, the performance fee for every project will be $w(M)$.

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

$$\mathbb{E}_H\{\Pi(R+C-1-w(\mu))-C(1+\gamma)-F\}\geq 0. \tag{3}$$

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

$$I_\mu \equiv \begin{cases} 1, & \text{if condition (3) is satisfied projects with monitoring cost } \mu; \\ 0, & \text{otherwise.} \end{cases} \tag{4}$$

I_μ indicates whether the headquarters will undertake a project with monitoring cost μ. 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 (3) is satisfied only for strong projects: i.e., if $I_0 = 1$ and $I_M = 0$, and we call it an *unselective bank* if condition (3) is satisfied for both marginal and strong projects: i.e., if $I_0 = I_M = 1$. 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*

$$F \equiv \max\left(\frac{1}{\delta}(\zeta - r), 0\right), \tag{5}$$

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

$$r \equiv \mathbb{E}\left\{(w(\mu)\Pi - \mu) I_\mu\right\}. \tag{6}$$

Proof. In the appendix.

Lemma 1 has a simple explanation. If project investment occurs, the loan officer derives an expected informational rent of $w(\mu)\Pi-\mu$ 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 (5).

We denote by ρ the loan officer's expected rent at time 1. The following corollaries follow 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.*

Corollary 2 *Loan officers earn no expected rent in selective banks.*

Corollary 2 follows because loan officers require no incentive payments in selective banks, and hence never receive a zero origination fee.

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 (7):

$$W = \mathbb{E}\left\{(\Pi(R+C-1-w(\mu)) - C(1+\gamma))I_{\mu}\right\}. \tag{7}$$

The expected shareholder surplus S when the loan officer is promised an origination fee F is therefore given by expression (8):

$$S = W - \delta F. \tag{8}$$

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:*

$$S = V - \delta\rho + D - \gamma C. \tag{9}$$

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. This effect undermines standard arguments justifying higher capital requirements as a way to curb excessive investment incentives flowing from the deposit insurance put.

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

Lemma 3 *Let*

$$C(\mu) \equiv max\left\{\frac{\mu\Pi}{\left(\Pi - \frac{1}{2}\right)^2} - (R-1), 0\right\}. \tag{10}$$

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 $C(0) = 0$ for strong projects, and $C(M)$ for marginal projects.

Proof. Shareholders will elect to incentivize 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 $C(0)$ 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 $C(M)=\max\{C(0),C(M)\}$ and, by Assumption 5, choose precisely this value.

If $C(M)$ were greater than 1 then the bank would incentivize 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*:*

$$M \leq M_{max} \equiv \frac{R}{\Pi}\left(\Pi-\frac{1}{2}\right)^2. \tag{11}$$

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. This case is extremely similar to the one in which the bank is not regulated; we discuss the unregulated case in Section 8.5.

When capital requirements are risk-insensitive, they are not affected by the bank's IRS. Hence, because the headquarter's time 1 IRS choice does not affect its regulation, the only factor that it considers is the impact that its IRS choice will have upon its time 3 behavior. With an advanced IRS, the 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 headquarters' incentives to invest and hence creates an unambiguous welfare increase.

The welfare consequences of conditioning investment decisions upon project type are not 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 headquarters' 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 he incurs performing project searches that do not result in investment. The effect of a increased origination fee is to attenuate the headquarters' 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 headquarters' 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 project, or no project. We impose a technical restriction on ζ to ensure that each of these types of bank can exist in equilibrium: this restriction appears in the Appendix as Assumption 8. Insofar as the banks to which our results refer exist, the results are robust to a relaxation of this assumption: the relevant calculations appear in the working paper version of this paper.

The remainder of this section uses the analysis of Section 3 to determine the equilibrium strategy that the headquarters adopts as a function of the cost M of monitoring a marginal project when it is subject to a risk-insensitive capital requirements regime. In Section 4.1 we identify the first best investment strategy; in Section 4.2, we determine which strategy is *ex ante* most attractive to the headquarters, and in Section 4.3 we 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. The First Best Investment Strategy

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 (12):

$$V_U \equiv R\Pi - 1 - \zeta - \frac{1}{2}M. \tag{12}$$

Equation (12) comprises the expected net income generated by basic and unselective banks, less the search cost and the expected monitoring cost. Selective banks incur the same search cost, but they invest only in strong projects, which do not require monitoring. Hence the social welfare derived from a selective bank is given by expression (13):

$$V_S \equiv \frac{1}{2}(R\Pi - 1) - \zeta. \tag{13}$$

It is convenient, and without significant loss of generality, to adopt Assumption 7:

Assumption 7 *The cost γ of capital is not so great as to overwhelm the social benefit of investment in selective banks:*

$$V_S > \frac{1}{2}\gamma. \tag{14}$$

As selective banks invest in strong projects, Assumption 7 is reasonable; it also reduces the number of cases that we have to consider in the welfare analysis.[11]

Selective banks are socially preferred to unselective banks precisely when $V_S > V_U$, which is impossible by the second inequality in equation (1). Hence the first best investment strategy is to run an unselective or a basic bank whenever doing so generates a positive expected surplus. Hence, we have Lemma 4:

Lemma 4 *Welfare is maximized by running an unselective or (equivalently) a basic bank when*

$$M \leq \bar{M}^* \equiv 2\left(R\Pi - 1 - \zeta\right), \tag{15}$$

and by running no bank if $M > \bar{M}^*$.

Proof. Equation (15) is satisfied precisely when $V_U \geq 0$.

4.2. 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. Our main result is in Proposition 1.

Proposition 1 *When capital adequacy requirements are risk insensitive:*

1. *The time* 1 *expected shareholder surplus is maximized by investing in an unselective bank;*
2. *If*
$$\zeta < \zeta^* \equiv \frac{R}{8\Pi}\left(4\Pi^2 + 2\Pi - 1\right) - 1 \tag{16}$$
then $\bar{M}^* < M_{max}$: in this case, the time 1 *shareholder preferred strategy results in over-investment relative to the social optimum for $\bar{M}^* < M \leq M_{max}$;*
3. *If $\zeta \geq \zeta^*$ then the time* 1 *shareholder preferred strategy coincides with the social optimum for every M.*

Proposition 1 states that, at time 1, any bank prefers to run an advanced internal reporting system, and to accept every positive NPV project. The intuition for this result is as follows. First, note that basic banks accept all positive NPV projects but that, because they have insufficient information to condition the performance fee w on project type, their expected wage bill exceeds that incurred by unselective banks. Hence basic banks are always dominated by unselective banks from an ex ante perspective.

The trade-off between selective and unselective banks is slightly more involved. On the one hand, selective banks never invest in marginal projects, which have a positive NPV. On the other hand, by Corollary 2, loan officers in selective banks earn no rent, while those in unselective banks do. If the expected loan officer rent were sufficiently high in unselective banks, selective banks would generate a higher time 1 expected shareholder surplus, and so would be preferred. This case is ruled out by Assumption 8, which appears in the Appendix. Relaxing this assumption would greatly complicate our analysis, without altering any of our substantive qualitative conclusions.

[11] The working paper version of the paper considers every possible parametrization. Although the results are more complex, they are qualitatively unchanged by this generality.

When equation (16) is satisfied, the time 1 expected shareholder surplus is maximized by investing when $\bar{M}^* < M \leq M_{max}$, even though investment in this region has a negative NPV. The reason is that when M is high, capital requirements are also high, and hence so too is the deposit insurance subsidy. When ζ is low enough, the value of the deposit insurance subsidy to the headquarters is sufficient to outweigh the social costs of investment.

Proposition 1 states that, from an ex ante perspective, the headquarters always prefers to run an unselective bank, which has 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.

4.3. 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 *There exist M_c and M_{BS} with $M_c < M_{BS}$ such that the headquarters uses 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 condition* (17) *is satisfied:*

$$M \geq M_c. \tag{17}$$

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* (18) *is satisfied:*

$$M \leq M_{BS}; \tag{18}$$

Proof. In the appendix.

The intuition for Lemma 5 is straightforward. For the headquarters to value the commitment that a basic bank provides, it must be unable to commit to accept projects that are revealed at time 3 to be marginal by an advanced IRS, and it must be willing to incur the higher expected compensation costs associated with a basic bank. The first of these requirements is met if condition 1 of the Lemma is satisfied, so that M is sufficiently high to render the time 3 value of marginal projects to be negative, net of the origination fee F. The second requirement is met if condition 2 of the Lemma is satisfied, so that M is not so large that the loan officer rent exceeds the ex ante expected value that the headquarters derives from marginal projects.

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

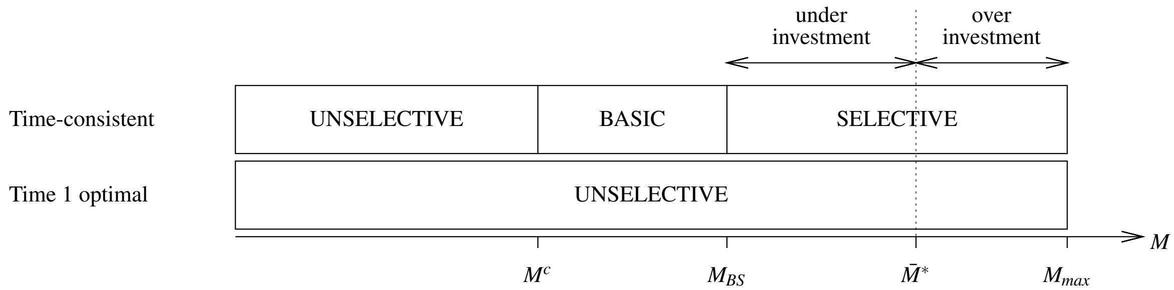

Figure 2: **Equilibrium headquarters strategies with risk-insensitive capital requirements.** From an ex ante perspective, the headquarters would prefer to adopt an advanced IRS and follow an unselective investment strategy, as indicated in the lower bar. However, as indicated in the upper bar, the headquarters is able to commit to accept marginal projects, and hence to run an unselective bank, only when $M \leq M^c$. For $M > M^c$, only basic or selective banks are possible. The former are preferred for $M \leq M_{BS}$, and the latter are preferred for $M > M_{BS}$. The figure illustrates the case where equation (16) is satisfied, so that $\bar{M}^* < M_{max}$. In this case, the headquarters runs a selective bank for $\bar{M}^* < M \leq M_{max}$, even though banking is welfare-reductive in this region. For $M_{BS} < M \leq \bar{M}^*$, there is under-investment relative to the social optimum.

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. *If $M \leq M^c$, the headquarters adopts an advanced IRS and follows an unselective investment strategy;*
2. *If $M^c < M \leq M_{BS}$, the headquarters adopts a basic IRS;*
3. *If $M_{BS} < M$, the headquarters adopts an advanced IRS and follows a selective investment strategy.*

For $M_{BS} < M \leq \min(\bar{M}^*, M_{max})$, there is under-investment relative to the social optimum; for $\min(\bar{M}^*, M_{max}) < M \leq M_{max}$, there is over-investment relative to the social optimum.

Proof. The headquarters follows its ex ante optimal strategy provided that strategy is time-consistent; this is the case for $M \leq M^c$. For $M > M^c$, the headquarters adopts a basic bank provided this generates a higher surplus than a selective bank, which is the case when $M \leq M_{BS}$. If $M > M_{BS}$ the headquarters opts for a selective bank provided selective banking generates a non-negative expected surplus, which is the case for $M \leq M_{max}$. From Lemma 4, the first best strategy is to invest unselectively for $M \leq \bar{M}^*$; hence investment in selective banks represents under-investment relative to the social optimum for $M \leq \bar{M}^*$; for higher M, the first best strategy is not to run a bank, so selective investment represents over-investment relative to the social optimum for $M > \bar{M}^*$.

Proposition 2 identifies a role for basic internal reporting systems that has not featured in previous discussions of capital regulation. A basic IRS restricts information flows to the bank headquarters, where investment decisions are made. This enables the bank to commit to accept positive but marginal NPV projects. This commitment spreads the loan officer search costs across a greater number of projects and so increases the expected value of the bank, even though marginal projects are never ex post attractive.

The Proposition is illustrated in Figure 2. The lower bar in the figure indicates the headquarters' ex ante optimal investment strategy, which is to run an unselective bank irrespective of the cost M of monitoring marginal projects. The upper bar indicates the strategies that are adopted when the headquarters is unable to make a contractual ex ante commitment to accept marginal projects. A verbal promise to do so is time consistent only for $M \leq M^c$. For $M^c < M \leq M_{BS}$, the headquarters uses a basic IRS to commit to accept marginal projects, at the cost of a higher expected performance fee payment; for $M > M_{BS}$, the headquarters prefers use an advanced IRS to lower its performance fee costs for strong projects, even though in doing so it forgoes the marginal projects.

The welfare implications of the headquarters' commitment problem are also indicated in the Figure. For $M_{BS} < M \leq \min(M_{max}, \bar{M}^*)$, the headquarters runs a selective investment strategy, although it would be socially optimal to accept marginal and strong investments. The inability to commit to accept marginal projects therefore results in a lower level of credit extension than the first best, and so lowers welfare. On the other hand, if equation (16) is satisfied then there exist M with $\bar{M}^* < M \leq M_{max}$, for which the headquarters invests in strong projects, although it would be socially better not to invest at all. The headquarters invests in order to receive the deposit insurance subsidy; were it able to commit to invest in marginal projects, it would invest in those, and would extract a larger subsidy. The theory of the second best therefore applies: while there is over-investment for $\bar{M}^* < M \leq M_{max}$, it is reduced by the headquarters' commitment problem, which, for these M, therefore raises welfare.

5. Risk-Sensitive Capital Requirements

In this section we consider the effect of risk-sensitive regulatory capital requirements upon the headquarters' 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.

Proposition 3 *When capital requirements are risk-sensitive, there exists M_{BS}^{σ}, with $M^c < M_{BS}^{\sigma} < M_{BS}$, such that:*

1. *If $M \leq M^c$, the headquarters adopts an advanced IRS and follows an unselective investment strategy;*
2. *If $M^c < M \leq M_{BS}^{\sigma}$, the headquarters adopts a basic IRS;*
3. *If $M_{BS}^{\sigma} < M$, the headquarters adopts an advanced IRS and follows a selective investment strategy.*

Proof. In the Appendix.

Proposition 3 is illustrated in Figure 3. As in Figure 2, the lower bar represents the ex ante preferred strategy, and the upper bar represents the time-consistent strategy that the headquarters adopts. The figure illustrates a consequence of risk-sensitive capital requirements that has not featured in policy discussions to date. Shifting from risk-insensitive to risk-sensitive capital requirements increases the value that bank shareholders derive from an advanced IRS. As a result, some banks switch from a basic to an advanced IRS: these banks are identified in Figure 3 by the shaded region. Since it is socially optimal to invest in marginal projects, the shaded region represents a welfare loss relative to the case with risk-insensitive capital requirements. This observation is summarized in Proposition 4.

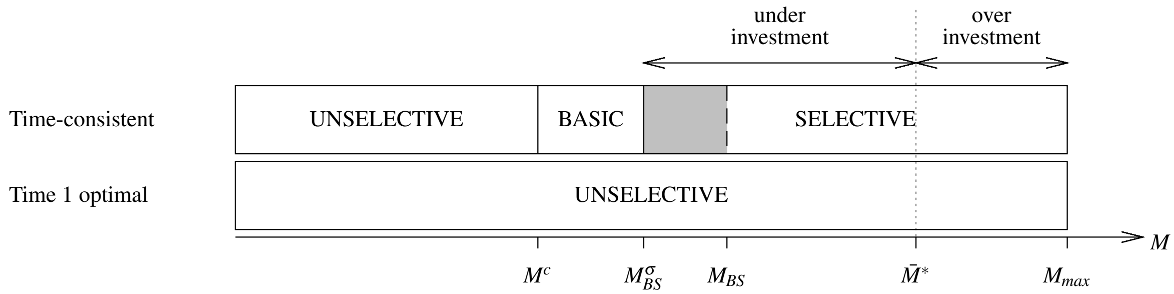

Figure 3: **Equilibrium headquarters strategies with risk-sensitive capital requirements.** The borderline monitoring cost M^c that separates the region where the headquarters runs an unselective bank from the region where it runs a basic bank is unchanged from Figure 2. The dividing line M^{σ}_{BS} between the basic bank region and the selective bank region when capital requirements are risk-sensitive is lower than the corresponding value M_{BS} when capital requirements are risk-insensitive. Hence, the under-investment region is increased by the shaded area in the Figure; this area represents a welfare loss caused by the introduction of risk-sensitive capital requirements.

Proposition 4 *Introducing risk-sensitive capital requirements increases under-investment from the level that obtains with risk-insensitive capital requirements.*

Risk-sensitive capital requirements increase the value of the deposit insurance subsidy that is derived form risk-sensitive capital requirements, and hence increase the opportunity cost of using a basic bank to commit to invest in marginal projects. As a result, the headquarters is excessively willing from a social point of view to adopt an advanced IRS.

6. Policy Implications

Our model's implications may be of interest to policy makers for two reasons. First, the model generates fresh insights about the Basel II Accord, which allows banks to use data generated by an advanced IRS to set capital requirements.[12] European Union countries implemented the most advanced model-based approaches of the Basel II Accord on January 1, 2008,[13] and the US is scheduled to do so in January 2010. Second, risk management and risk reporting models have been the subject of intense legislatory scrutiny since the start of the 2007/08 financial crisis.[14] If policy-makers are to make the right legislative decisions in the coming years, it is critical that legislators appreciate all of the implications of using advanced internal reporting systems in financial regulations.

Our model generates fresh insights about the welfare effects of Basel II, more generally about the adoption of advanced IRS in banks, and about pro-cyclicality in financial regulation.

[12] See Basle Committee on Banking Supervision (2006).

[13] The Accord allows for "standardized," "intermediate," and "advanced" approaches to capital adequacy calculation. Standard and intermediate approaches were implemented in the EU on January 1, 2007, and advanced approaches on January 1, 2008.

[14] For example, risk reporting systems were discussed at length in the British House of Lords' Select Committee on Economic Affairs (2009) report on the crisis.

6.1. Welfare Effects of Basel II

One welfare consequence of Basel II has been discussed elsewhere: ceteris paribus, Basel II should lower the cost of lending. As a result, it should increase banks' willingness to lend to credit worthy borrowers that generate a low return on capital employed. This may serve to increase lending and so to raise welfare. Our model points to a different effect: the benefits conferred by Basel II can only be realized by banks with an advanced IRS. The introduction of the new Accord therefore increases the opportunity cost of using a basic IRS. Hence, as noted in Corollary 4, fewer banks choose to use a basic IRS to commit to invest in marginal projects. As a result, the average profitability of bank loans increases, but credit rationing for marginal borrowers also increases, and so welfare is reduced.

We are not able in our model formally to model the trade-off between the potential benefits derived from lowering capital requirements for strong projects and the welfare loss associated with lower commitment value. A detailed analysis of this trade-off would require an enhanced model in which M was a random variable. This extension would render the model intractible; moreover, it is not obvious a priori which distributional assumptions would be most appropriate. However, our model does suggest that Basel II could reduce welfare if it causes banks to shift from a basic to an advanced IRS. Most medium and large banks have already implemented an advanced IRS,[15] so this effect is most likely to affect the willingness of smaller banks to invest in an advanced IRS. To the extent that smaller banks are more likely to lend to small and marginal borrowers (Berger et al. (2005), Haynes, Ou & Berney (1999)); our argument suggests that the new Accord may affect their lending incentives disproportionately.

6.2. Compulsory Adoption of Advanced IRS

Should banks be actively encouraged, or even compelled, to install an advanced IRS system? Sufficiently large institutions in the United States will be forced under the Basel II implementation to use an advanced IRS to set capital requirements. Hakenes & Schnabel (2005) argue that compulsion is desirable for all banks, because, when banks are free to choose between advanced and basic reporting systems, smaller banks will elect not to incur the high fixed cost of an advanced IRS; as a result, they will be placed at a competitive disadvantage, so that they are less able to extend loans to the smaller borrowers that rely upon them for funding.

Berger (2006) argues that the competitive effects to which Hakenes and Schnabel point are likely to be muted, because smaller banks have different loan clients than do large ones. Our model goes further: in contrast to Hakenes and Schnabel, we show that banks may opt for a basic IRS in order to commit to invest in marginal projects. Taking away their right to choose their risk management system would prevent banks from making this commitment, and so would *reduce* welfare. Our analysis therefore implies that banks should not be forced to adopt advanced IRSs.

6.3. Pro-Cyclicality

A very substantial literature points to the danger that the Basel II Accord will amplify the economic cycle: for example, see Goodhart & Segoviano (2004), Danielsson, Keating, Goodhart & Shin (2001), Kashyap &

[15] See for example the European Central Bank (2005).

Stein (2004), Gordy & 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 that 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 incentivize loan officer monitoring, and hence bank capital requirements are reduced. This increases the value of the deposit insurance put and hence raises both M_{BS} and M_{BS}^{σ}: this causes a reduction in bank under-investment. This effect occurs under both advanced and basic IRS.

7. Empirical Implications

This section highlights the positive implications of our work.

7.1. Loan Portfolio Quality

In our model, risk-sensitive capital requirements shrink the parameter set for which basic banking is used to commit to make marginal loans: the reduction is indicated by the shaded region in Figure 3. Banks in this region make fewer marginal loans, but continue to advance loans to strong projects. This gives us the following hypothesis:

Hypothesis 1 *The introduction of the Basel II Accord should raise the profitability of bank loan portfolios.*

Note that, as discussed in Section 6.1, Hypothesis 1 reflects increased credit rationing, and not improved lending procedures.

7.2. Loan Officer Compensation

In our model, loan officers in banks with an advanced IRS receive lower incentive payments for high quality loans, which require less monitoring. In contrast, banks with a basic IRS make risk-insensitive payments to loan officers, at the high level required to incentivize monitoring for lower quality loans. Moreover, because Basel II lowers the opportunity cost of an advanced IRS, it should lead to wider adoption of advanced IRSs. This yields the following hypotheses:

Hypothesis 2 *Loan officer compensation per loan is higher in banks with a basic IRS than in banks with an advanced IRS.*

Hypothesis 3 *Loan officer compensation should be more sensitive to loan profitability in banks with an advanced IRS than in banks with a basic IRS.*

Hypothesis 4 *The implementation of Basel II should result in lower per-loan loan officer compensation, and in higher loan officer compensation risk sensitivity.*

7.3. 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.

If subsidiary bank expansion limits information flow to the multinational bank's headquarters, then our work suggests it should be preferred when the headquarters will be unable to commit to accept the investments uncovered by its local country offices. This will be the case when monitoring is difficult, and when it relies upon tacit and hard to communicate information. The following hypothesis therefore emerges from our discussion:

Hypothesis 5 *Multinational banks expand into countries where borrower information is hard-to-codify and local knowledge is particularly important in loan origination via subsidiaries; when local knowledge is less important and loan origination is easier expansion is via branches.*

8. Robustness and Extensions

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

8.1. Negative NPV Projects

The formal analysis of this paper relies upon Assumption 2, which states that the bank's headquarters is able to distinguish between positive and negative projects even when it relies upon a basic IRS. We believe that this Assumption is sufficiently close to reality to be reasonable. However, it is possible to extend our model to incorporate the case under which the bank has access to negative NPV projects, which are uncovered by advanced but not basic internal reporting systems. Precisely as in the analysis of this paper, the more general model reveals a parametrization under which banks that adopt an advanced IRS sacrifice positive NPV investments. But the analysis reveals a second set of parameters for which banks are willing to assume negative NPV projects so as to profit from the deposit insurance safety net. The compulsory adoption of an advanced IRS for regulatory purposes enables the regulator to prevent this type of gaming from occurring.

Hence, in a more general setting the decision to compel the adoption of advanced IRSs for regulatory purposes involves a trade-off between, on the one hand, the loss of commitment level and the concomitant reduction in investment and, on the other hand, the resolution of adverse selection between the regulator and the bank, and, hence, reduced demands upon the deposit insurance fund. There is no compelling reason to believe that the second effect outweighs the first. The loss of investment that follows from adopting an advanced IRS relates to the marginal projects for which bank finance is usually regarded as critical.

8.2. Type-Contingent Origination Fee

Assumption 3 states that it is impossible to condition loan officer contracts upon information revealed by the internal reporting system. We believe that this assumption is reasonable for two reasons. First, proving information about internal reporting systems in court would be very difficult; second, loan officers would have strong incentives to manipulate the information used by the IRS, and would be likely to do so. Nevertheless, it is interesting to weigh these effects against the possible benefits that type-contingent origination fees could generate.

Type-contingent origination fees would have two desirable consequences. First, they would diminish the social underinvestment that occurs with risk-insensitive capital requirements. Second, they would shrink the shaded region of Figure 3 within which the introduction of risk-sensitive capital requirements causes banks to stop investing in marginal projects.

8.3. Costly Advanced IRS

We have assumed, in the interest of simplicity 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.[16] Allowing for these costs would have two consequences. First, it would increase the range of M values for which basic IRS are preferred, and so would diminish the under-investment problem identified in Propositions 2 and 3. Second, it would introduce a new under-investment region, where neither basic banking nor selective banking with a costly advanced IRS was individually rational.

8.4. Costly Deposit Insurance

We assume that deposit insurance is not 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 & 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 & 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. 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 Propositions 2 and 3.

[16]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."

8.5. Unregulated Economy

Banking systems all over the world are regulated, and our formal analysis relates to regulated banks. However, many of our insights would apply in an unregulated economy; the analysis in this case would be very similar to Section 4, where we analyse a model with fixed capital requirements and deposit insurance with risk-insensitive pricing. In this context, we demonstrate that the choice between a basic and an advanced IRS trades off the benefits of commitment to invest against the concomitant costs of loan officer information rent. An analysis of an unregulated economy would generate the same trade-off, for two reasons. First, as in Section 4, IRS choice would not affect the choice of capital requirements. Second, provided that depositors cannot observe for themselves the investment choices that banks make, the value of the bank's limited liability option would be unaffected by the IRS choice. Given IRS-invariant depositor expectations, the headquarters would therefore have similar risk-shifting incentives to those provided by risk-insensitive deposit insurance in Section 4. The basic trade-off between commitment and information rent analysed in Section 4 would therefore obtain in a world without bank regulation.

8.6. 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 a realistic feature of real world banks.

8.7. Entrepreneurial Banks

Related to the discussion in section 8.6, 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 modeled. 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.

8.8. 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 behavior 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.

9. 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 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

We adopt the following assumption throughout this Appendix:

Assumption 8 *The cost ζ of search satisfies:*

$$\max\left\{\frac{(R-1)(1+\gamma)(1+4\gamma)(2\Pi-1)}{2+4\Pi(1+6\gamma+2\Pi)},\frac{(R-1)(1+\gamma)(2\Pi-1)}{4(1-\Pi+\gamma)}\right\}\leq\zeta\leq$$
$$\min\left\{\frac{(R-1)(1+\gamma)(2\Pi-1)}{2(2\gamma+1)},\frac{(R-1)[\Pi(1+2\Pi+8\Pi\gamma)-2(1+\gamma)(1-2\Pi)]}{2(1+4\Pi+12\Pi\gamma)}\right\}$$

Assumption 8 guarantees that basic, selective, and unselective banks can all exist in equilibrium. Insofar as the banks to which they refer exist, our qualitative results are robust to this assumption. Details for other ζ values appear in the earlier working paper version of this paper.

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 (5).

Proof of Lemma 2. Define

$$\kappa\equiv\frac{1}{\delta}(\zeta-r). \tag{19}$$

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

$$\rho\equiv\max(-\kappa,0). \tag{20}$$

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 (21):

$$V=\mathbb{E}\left\{(R\Pi-\mu-1)I_{\mu}\right\}-\zeta, \tag{21}$$

and the the ex ante expected value D to headquarters of the deposit insurance subsidy is given by expression (22):

$$D = \mathbb{E}\left\{(1-\Pi)(1-C)I_{\mu}\right\}. \tag{22}$$

Equation (23) follows immediately from equations (7), (19), (21), and (22):

$$W = V + \delta\kappa + D - \gamma C. \tag{23}$$

Equation (9) then follows immediately from equations (23) and (8), and the fact that $\kappa = F - \rho$.

Proof of Proposition 1. Note first that the time 1 expected shareholder surplus from a basic bank can never exceed that derived from an unselective bank. The reason is that, although both types of bank make the same investments, only the selective bank's headquarters knows the project type. As a result, basic banks pay a performance fee $w(M)$ to all projects, while the unselective bank pays performance fee $w(0)$ to strong projects, and $w(M)$ to marginal projects. As a result, selective banks makes lower expected success payments to loan officers than basic banks.

Shareholder surplus calculations. The critical comparison is between the unselective bank and the selective bank. To make this comparison, we first determine the expected shareholder surplus that each type of bank generates. All investments attract a capital charge of $C(M)$ with risk insensitive capital requirements. Inserting this and the type-contingent performance fee into equation (7) yields the following values for the expected surplus W that accrues to the headquarters in unselective and selective banks respectively, excluding any origination fees:

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

Using equation (6), we obtain the following values for the monitoring rent r that accrues to the loan officer after investment:

$$r_U = \frac{M}{2(2\Pi-1)}; \tag{24}$$

$$r_S = 0. \tag{25}$$

The time 2 probability of investment δ_U in unselective banks is 1; the corresponding probability in selective banks is $\delta_S = \frac{1}{2}$.Substituting for r and δ in equation (5) gives us the following:

$$F_U = \begin{cases} \zeta - r_U, & \text{if } M < M_{FU}; \\ 0, & \text{if } M \geq M_{FU}. \end{cases} \tag{26}$$

$$F_S = 2\zeta, \tag{27}$$

where

$$M_{FU} = 2\zeta(2\Pi-1). \tag{28}$$

It follows immediately from equation (8) that

$$S_U = \begin{cases} S_U^f \equiv (R-1)(1+\gamma) - \zeta - M\frac{1+4\Pi(1-\Pi)+8\Pi\gamma}{2(2\Pi-1)^2}, & \text{if } M < M_{FU}; \\ S_U^{nf} \equiv W_U, & \text{if } M \geq M_{FU}. \end{cases} \tag{29}$$

$$S_S = S_S^f \equiv \frac{1}{2}\left((R-1)(1+\gamma) - 2\zeta - 4M\frac{\Pi(1-\Pi+\gamma)}{(2\Pi-1)^2}\right), \tag{30}$$

where the f and nf superscripts indicate the shareholder surplus when loan officers receive and do not receive a fee, respectively. Note that equation (29) can be expressed as follows:

$$S_U = \min\left(S_U^f, S_U^{nf}\right). \tag{31}$$

Now define

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

Then it is easy to check that

$$S_U^f > S_S^f \quad \text{iff} \quad M < M_{US}^f; \tag{32}$$
$$S_U^{nf} > S_S^f \quad \text{iff} \quad M < M_{US}^{nf}. \tag{33}$$

Shareholders prefer unselective to selective banks precisely when $S_U > S_S$; we can use equations (32) and (33) to write this condition as follows:

$$\begin{aligned} S_U > S_S \text{ iff } & \min\left(S_U^f, S_U^{nf}\right) > S_S^f \\ \text{iff } & \left(M < M_U^f \text{ and } M < M_U^{nf}\right) \\ \text{iff } & M < M_{US} \equiv \min\left(M_{US}^f, M_{US}^{nf}\right). \end{aligned}$$

$M_{US}^{nf} < M_{US}^f$ precisely when $\zeta < \left(\Pi - \frac{1}{2}\right)(R-1)$, which is guaranteed by Assumption 8. Hence,

$$M_{US} = M_{US}^{nf} = ((R-1)(1+\gamma)+2\zeta)\frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}. \tag{34}$$

Individual Rationality Calculations. We now determine under what circumstances the headquarters generates a positive expected profit from running a selective and an unselective bank.

It follows from equation (29) that the headquarters derives a positive expected surplus from investment in unselective banks when condition (35) is satisfied:

$$\begin{gathered} \left\{(M < M_{FU}) \text{ and } \left(M < \bar{M}_U^f \equiv \tfrac{2(2\Pi-1)^2}{4\Pi(1-\Pi+2\gamma)+1}((R-1)(1+\gamma)-\zeta)\right)\right\} \\ \text{or} \\ \left\{(M \geq M_{FU}) \text{ and } \left(M < \bar{M}_U^{nf} \equiv \tfrac{(2\Pi-1)^2}{\Pi(3-2\Pi+4\gamma)}(R-1)(1+\gamma)\right)\right\} \end{gathered} \tag{35}$$

This expression can be re-written as follows:

$$\left\{M < \min\left(M_{FU}, \bar{M}_U^f\right)\right\} \text{ or } \left\{M_{FU} \leq M < \bar{M}_U^{nf}\right\}. \tag{36}$$

It is easy to check that
$$\frac{M_{FU}-\bar{M}_U^f}{M_{FU}-\bar{M}_U^{nf}}=\frac{2\Pi\left(3-2\Pi+4\gamma\right)}{1+4\Pi\left(1-\Pi+2\gamma\right)}>0,$$
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 (36) for the headquarters to derive a positive surplus from running a unselective bank can be written as follows:

$$M\leq\bar{M}_U\equiv\min\left(\bar{M}_U^f,\bar{M}_U^{nf}\right). \tag{37}$$

It follows from equation (30) that the headquarters derives a positive surplus from a selective bank precisely when condition (38) is satisfied:

$$M\leq\bar{M}_S\equiv\frac{\left(2\Pi-1\right)^2}{4\Pi\left(1-\Pi+\gamma\right)}\left(\left(R-1\right)\left(1+\gamma\right)-2\zeta\right). \tag{38}$$

Preferences over bank type. To determine what type of bank will be selected it is sufficient to observe that $\bar{M}_S<\bar{M}_U<M_{US}$ when $\zeta>\frac{(R-1)(1+\gamma)(2\Pi-1)}{4(1-\Pi+\gamma)}$. This condition is satisfied by Assumption 8. Hence unselective banks generate a higher ex ante profit than selective banks whenever either type of bank generates a positive profit.

Parameter restrictions. Assumption 6 states that $M<M_{max}$. It is easy to check that $M_{max}<\bar{M}_S$ if and only if $V_S>\frac{1}{2}\gamma$, which is guaranteed to be true by equation (14). Since investment in unselective banks generates a time 1 expected surplus for $M<\bar{M}_U$ and $\bar{M}_U>\bar{M}_S>M_{max}$, investment in unselective banks generates a surplus for every feasible M-value.

This concludes the proof of Proposition 1.

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. That is, when condition (39) is satisfied:

$$\Pi\left(R+C\left(M\right)-1-w\left(M\right)\right)-C\left(M\right)\left(1+\gamma\right)-F_U<0, \tag{39}$$

where F_U is given by equation (26). Condition (39) is equivalent to condition (40):

$$M\geq\begin{cases}2\frac{(2\Pi-1)^2}{1+2\Pi+8\Pi\gamma}\left(\left(R-1\right)\left(1+\gamma\right)-\zeta\right), & \text{if } M\leq M_{FU};\\ \frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}\left(R-1\right)\left(1+\gamma\right), & \text{otherwize.}\end{cases} \tag{40}$$

It is easy to show that

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

from which it follows that

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

. That is, condition (40) is equivalent to

$$\begin{aligned} M \geq M_c &\equiv \min\left(2\frac{(2\Pi-1)^2}{1+2\Pi+8\Pi\gamma}((R-1)(1+\gamma)-\zeta), \frac{(2\Pi-1)^2}{2\Pi(1+2\gamma)}(R-1)(1+\gamma)\right) \\ &= 2\frac{(2\Pi-1)^2}{1+2\Pi+8\Pi\gamma}((R-1)(1+\gamma)-\zeta), \end{aligned}$$

where the final equality follows from the fact that, by Assumption 7, $\zeta \geq \frac{(R-1)(1+\gamma)(2\Pi-1)}{4(1-\Pi+\gamma)} > \frac{(R-1)(1+\gamma)(R-1)}{4\Pi(1+2\gamma)}$.

If condition (17) 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. The expected surplus S_S from running a selective bank is given by equation (30).

To determine the expected surplus from a basic bank, we follow the proof of Proposition 1. Excluding any origination fees, the surplus W_B that accrues to the headquarters of a basic bank is

$$W_B = (R-1)(1+\gamma) - M\frac{2\Pi(1+2\gamma)}{(1-2\Pi)^2}.$$

The monitoring rent r_B that accrues to the basic bank loan officer is

$$r_B = \frac{M(1+2\Pi)}{2(2\Pi-1)};$$

substituting r_B and $\delta_B = 1$ into equation (5) gives us

$$F_B = \begin{cases} \zeta - r_B, & \text{if } M < M_{FB}; \\ 0, & \text{if } M \geq M_{FB}, \end{cases}$$

where

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

Equation (8) now gives us the following expression for S_B:

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

The headquarters will use a basic bank to commit to accept marginal projects at time 3 if $S_B \geq S_S$. To express this condition in terms of the monitoring cost M, we define

$$\begin{aligned} M_{BS}^f &= M_{US}^f; \\ M_{BS}^{nf} &= M_{BS}^{nf} = ((R-1)(1+\gamma)+2\zeta)\frac{(2\Pi-1)^2}{4\Pi(\gamma+\Pi)}. \end{aligned}$$

Then straightforward manipulations give us

$$S_B^f > S_S^f \quad \text{iff} \quad M < M_{BS}^f; \tag{41}$$
$$S_B^{nf} > S_S^f \quad \text{iff} \quad M < M_{BS}^{nf}. \tag{42}$$

We can use equations (41) and (42) to write:

$$\begin{aligned} S_B > S_S \text{ iff } & \min\left(S_B^f, S_B^{nf}\right) > S_S^f \\ \text{iff } & \left(M < M_B^f \text{ and } M < M_B^{nf}\right) \\ \text{iff } & M < M_{BS} \equiv \min\left(M_{BS}^f, M_{BS}^{nf}\right) = M_{BS}^f. \end{aligned} \tag{43}$$

The final equality on the last line of equation (43) follows from Assumption 8.

Proof of Proposition 3. The monitoring cost M^c above which promises to invest in marginal projects are time-inconsistent is unaffected by the introduction of risk-sensitive capital requirements.

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 $S_{B,\sigma}^f = S_B^f$ and $S_{B,\sigma}^{nf} = S_B^{nf}$. The ex ante expected surplus for selective banks is computed from equation (7), using state-contingent capital requirements, as follows:

$$S_{S,\sigma}^f = \frac{1}{2}\left(\Pi(R-1) - 2\zeta\right) = S_S^f + \frac{1}{2}C(M)(1-\Pi+\gamma). \tag{44}$$

Since the headquarters derives a greater surplus from sensitive banks when capital requirements are risk-sensitive than when they are not, investment in these banks is incentive compatible for any $M \leq M_{max}$, as in Proposition 2.

The monitoring cost M_{BS}^σ at which the headquarters is indifferent between selective and basic banks, is the M-value for which $S_{S,\sigma}^f = S_{B,\sigma}^{nf}$:

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