Playing Hardball: Relationship Banking in the Age of Credit Derivatives *

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Abstract

This paper shows how credit derivatives can facilitate banks' quest for more effective lending relationships. Credit protection improves banks' exit option, thereby making it less costly for banks to take a tough stance against misbehaving corporate borrowers and let them fail. This has positive implications for managerial incentives *ex ante*. Yet, while credit protection helps to resolve existing conflicts of interest it can also introduce new ones: when the "insiders" (bank and borrower) are insured against fluctuations in long term firm value then their *joint* incentive to maximize value will be seriously impaired. We show that well–capitalized banks fully mitigate this dilution effect by taking *temporary* protection that expires before project maturity. Poorly capitalized banks' hedging demand impedes full value maximization. We also argue that credit derivatives can have ambiguous effects on financial stability, and that disclosure requirements can strengthen the efficacy of the credit derivatives market.

Keywords: Credit Risk Transfer, Credit Derivatives, Bank Oversight, Conflicts of Interest, Bank Capital, Disclosure Requirements
JEL–Classification: G2, G3

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"Although the benefits and costs of derivatives remain the subject of spirited debate, the performance of the economy and the financial system in recent years suggests that those benefits have materially exceeded the costs."

Alan Greenspan

1 Introduction

The rapid growth of the credit risk transfer market during the past decade led to a paradigm shift in banking. Increasingly, the traditional "buy–and–hold" model of banking is transformed into a model where banks take an active approach to managing and trading credit risk exposures. A major driving force behind this process seems to stem from the development of sophisticated credit risk transfer instruments that allow banks to manage credit risk exposures in a more versatile manner. The growth of the credit derivatives market is particularly striking.[1] In the US, for example, commercial banks' credit derivative positions increased 15–fold over the period 1997 to 2003 (Office of the Comptroller of the Currency 2003). Table 1 documents global credit derivative positions as of September 2003 (survey among 181 market participants).[2]

USDb (sales)	Banks	Insurance & other non–bank companies	Total
Gross positions	1324 (77.7%)	381 (22.3%)	1705 (100%)
Net positions	-229	303	

Source: Fitch Ratings 2003

Table 1: Global Credit Derivative Positions

According to this survey, the global banking industry used the credit derivatives market to transfer USD 229 billion of credit risk out of the banking sector. Insurance and other non–bank companies sold USD 303 billion of net credit protection. Thus, banks are net protection buyers in the credit derivatives market, and insurance and other non–bank companies are net protection sellers.

[1]The most widely used credit derivative — the credit default swap — resembles an insurance contract under which a protection seller (e.g. an insurance company) commits to compensate a protection buyer (e.g. a bank) for losses upon occurrence of a pre–specified *credit event* (e.g. a loan defaulting). See Tavokoli (2001) for an in–depth description of various credit derivatives. Other useful references from the practitioners' literature include Bank for International Settlements (2003), Financial Services Authority (2002), Kiff and Morrow (2000), Scott–Quinn and Walmsley (1998), and Tolk (2001).

[2]The global credit derivatives market has been estimated to have reached USD 2 trillion by 2002 (British Bankers' Association 2002), which suggests that the survey is representative.

The surge of the credit derivatives market constitutes a challenge to the banking literature (see Gorton and Winton 2002 for a recent survey).[3] Central to this literature is the notion that banks have a unique advantage in building relationships with their borrowers, thereby facilitating monitoring (Diamond 1984) and promoting long–term value creation (von Thadden 1995). It is widely believed that credit risk transfers would impair these value–added functions of relationship lenders. The idea is that if a bank reduces its exposure to a borrower it will care only about the retained credit risk, thereby dampening its incentive to enhance the value of the loan. This reasoning seems to support the view that credit derivatives can impose a threat to the viability of relationship banking.

This paper provides a novel and more optimistic view. Specifically, we develop a model of credit protection and bank oversight/monitoring in the corporate loan market that demonstrates the *virtues* of credit derivatives for effective relationship lending. We start from the observation that, in many contexts, bank–borrower relationships are characterized by a functional separation of duties that arises naturally from the mismatch between managerial skills and financial resources: corporate borrowers/managers have specific skills in managing their projects that the banker does not have. The mismatch between skills and financial resources (and the resulting task separation) gives rise to agency conflicts between banks and corporate borrowers. The main insight of our paper is that properly devised credit protection allows banks to fulfill *their* core duties (viz. oversight) in a more effective manner. The basic argument is simple: credit protection improves banks' *exit option*, thereby making it less costly to penalize misbehaving borrowers by letting them fail.[4] Credit protection thus strengthens banks' commitment to engage in timely intervention, which has positive implications for borrower managerial incentives *ex ante*.

Yet, while credit protection helps to resolve existing conflicts of interests it can also *introduce* new ones: when the "insiders" (bank and borrower) are insured against fluctuations in long term firm value then their *joint* incentive to maximize value will be seriously impaired. We argue that credit derivatives are useful devices in mitigating this dilution cost. As has been emphasized by Duffee and Zhou (2001), among others, a key characteristic that distinguishes credit derivatives from first generation risk transfer instruments (such as loan sales) is that

[3]As eloquently put by Gorton and Winton (2002, p. 27): "[...] the basic paradox of loan sales remains unexplained. Indeed, the paradox is somewhat deepened to the extent that banks can transfer the credit risk of their loans to third parties via credit default swaps. Market participants seem to rely on banks' incentives to maintain their reputations for monitoring, but the efficacy of this mechanism remains largely unexplored."

[4]Within the context of the model, we consider that bank exit triggers project termination (which for obvious reasons is costly for the owner–manager running the firm). One could also imagine that bankruptcy per se is costly for the firm. For example, as has been pointed out by Titman (1984) and Opler and Timan (1994), bankruptcy can make customers reluctant to engage in further transactions with the firm, thereby threatening the firm's post bankruptcy survival. In such circumstance, managers will have an increased incentive to enhance the continuation value of banks' claims in order to prevent them from forcing default (and collecting protection).

they can be structured in terms of maturity. Notably, credit derivatives facilitate *temporary* transfers of credit risk. As such, credit derivatives allow banks to protect themselves at interim intervention stages, thereby improving their exit option and restoring the credibility of intervention threats. Prior to project maturity, however, first best credit protection policies should expire. This ensures that the surplus gains from taking value–maximizing decisions fully accrue to the insiders, which provides them with a proper incentive to maximize value.

The extent to which banks let credit derivatives "expire" before project maturity depends on their *own* capital constraints and hedging needs. Well–capitalized banks fully mitigate the dilution effect (and thereby fully resolve managerial incentive distortions) by taking credit derivatives that expire before loan maturity. Poorly–capitalized banks hedging demand impedes full value maximization. As bank capital constraints become less binding, banks take less "long term" protection. This entails a positive spill–over effect on managerial incentives in the corporate loan market.

Ranking in 2002	Application
1.	Trading/Market making
2.	Active portfolio management
3.	Management of individual credit lines
4.	Management of economic capital
5.	Management of regulatory capital
6.	Product restructuring

Source: British Bankers' Association 2002 (survey among market participants)

Table 2: Applications of Credit Derivatives

Our analysis generates novel insights into the use, design, and effects of credit derivatives. To our knowledge, the present paper is first in explaining why banks use credit derivatives for reasons other than capital relief (and/or reducing financial distress costs at the bank level). In our setting, the introduction of a viable credit derivatives market can create value on purely incentive–related relationship management grounds that are unrelated to capital or financial constraints at the bank level. Table 2 documents applications of credit derivatives. Among these are the traditional capital relief motives (rank 4 and 5), but also the management of individual credit lines (rank 3), the focus of the present paper. Our analysis also explains why credit derivatives often have maturities shorter than those of the underlying loans (see also Duffee and Zhou 2001, and the references mentioned there for evidence). The model allows to relate this maturity mismatch to observable characteristics both at the borrower and the bank level, notably the degree to which bank capital constraints are binding. Our analysis also yields insights into the effects of credit derivatives on financial stability, and into the role of disclosure requirements in strengthening the efficacy of the credit derivatives market.

This paper adds to several strands of the literature. A number of papers have examined the costs and benefits of diverse risk management and/or credit risk transfer instruments in banking (see, among others, James 1988, Pennacchi 1988, Carlstrom and Samolyk 1995, Gorton and Pennachi 1995, Froot and Stein 1998, Duffee and Zhou 2001, and Morrison 2003). For example, Gorton and Pennacchi (1995) have a model in which optimal credit risk transfers (in the form of loan sales) emerge from a tradeoff between bank capital relief and maintaining banks' monitoring (loan value enhancement) incentive. Duffee and Zhou (2001) also highlight the virtues of credit derivatives in facilitating temporary hedge outs of credit risk exposure. They develop a setting in which a capital–constrained bank has time–contingent private information about the value of a loan. In their model, credit derivatives facilitate the transfer of those "time portions" of credit risk about which the bank is not privately informed, thereby alleviating adverse selection costs. Morrison (2003) shows that when entrepreneurs rely upon the certification value of bank debt to obtain cheap bond finance, the existence of a credit derivatives market may cause them to tap the junk bond market and to engage in second–best behavior. In these papers, the value–added of credit risk transfers stems from capital relief (and/or reducing financial distress costs at the bank level). Thus, none of these papers can explain why banks engage in credit risk transfers for reasons other than capital relief.

The notion that "tough" financiers are willing to give more (more credit/liquidity, lower interest rates) as borrowers expropriate them less often has been stressed extensively in the corporate finance literature (see, among others, Aghion and Bolton 1992, Berglöf and von Thadden 1994, Dewatripont and Tirole 1994, Dewatripont and Maskin 1995, Bolton and Scharfstein 1996, Hart and Moore 1998, and Repullo and Suarez 1998). We build in particular on the framework introduced by Repullo and Suarez (1998). They consider a model in which multiple investor financing allows to reduce an active lender's long term claim, thereby making it less costly for lender to penalize the manager for shirking by terminating the project. Credit derivatives that provide banks with protection against losses when forcing pre–mature default and liquidation play a similar (albeit more effective) role in our setting. Lastly, our paper also complements the literature on relationship banking and on lender monitoring (see, among others, Diamond 1984, Rajan 1992, von Thadden 1995, Rajan and Winton 1995, Winton 1995, Holmström and Tirole 1997, Boot and Thakor 2000, Laux 2000, Park 2000, Diamond and Rajan 2000, 2001, Manove et al. 2001, and Carletti 2003).

This paper is organized as follows. The next section develops our main argument within the context of a simple model of credit protection and bank oversight. Section 3 considers the effects of credit protection on banks' relationship building and information acquisition ("monitoring") incentive. Section 4 looks into the role of reporting requirements. Section 5 provides a discussion of the model's empirical implications. Section 6 concludes. Proofs are relegated to the appendix.

2 A Model of Credit Protection and Bank Oversight

In this section, we develop our main argument within the context of a simple model of credit protection and bank oversight in the corporate loan market. Subsection 2.1 presents the setup. Subsection 2.2 shows how credit derivatives can facilitate the management of client relationships in banks' core loan business. Subsection 2.3 introduces capital constraints at the bank level, and illustrates how the relationship management aspect of credit protection interacts with the standard hedging motive.

2.1 Setup

An owner–manager run firm needs outside funding for a project. Funding is to provided by a relationship lender, referred to as bank. The bank can take credit protection from a credit protection seller (e.g. an insurance company). For the moment, we abstract from the standard capital relief motive of credit protection, and assume that the bank does not face capital constraints. Bank capital constraints will be introduced in subsection 2.3. There is perfect competition in the financial sector. All parties are risk–neutral and there is no discounting.

Model Structure.— There are three dates, $t = 0, 1, 2$. At date $t = 0$ there is a fixed investment outlay $I > 0$. The firm has neither existing assets in place nor internal funds; it thus needs to raise I from a bank. Once the project is undertaken, the manager exerts effort $e \in [0, 1]$ at private cost $\psi(e) = \beta e^2$, where $\beta > 0$. It is assumed that effort is non–contractible but privately observable to the bank by virtue of its relationship with the borrower.

Project returns (which realize at date $t = 2$) depend on managerial effort and exogenous market influences. At date $t = 1$ a non–contractible signal about these market influences realizes. This signal is observed by the manager and the bank. (The credit insurer is an uninformed outsider who does neither observe effort nor the realization of the signal.) The signal is good with probability θ and bad with probability $1-\theta$. We will frequently refer to the realization of the good (bad) signal as the good (bad) state. In the good state (and provided the project is continued until date $t = 2$), final and verifiable cash flows are given by $\Pi > 0$ with probability e and zero with probability $1 - e$. In the bad state, cash flows are zero with probability one.

After the realization of the signal the project may be terminated. Assets in place have a salvage value $\mathcal{L} > 0$ at date $t = 1$ (and zero salvage value at date $t = 2$). There is some depreciation, $\mathcal{L} < I$.

First Best Allocation.— As a point of reference consider the first best allocation that would result if the manager could contractually commit to the efficient course of action. In the bad state project termination at date $t = 1$ is efficient, and hence the project is liquidated

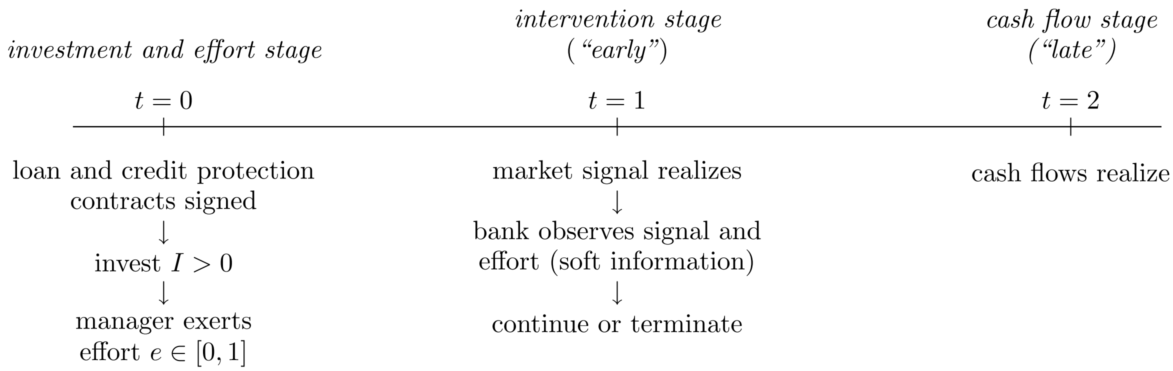

Figure 1: Timing

at salvage value $\mathcal{L}$. In the good state project termination must be inefficient in equilibrium (otherwise the parties would not have invested in the first place, since $\mathcal{L} < I$). Let e^{FB} denote the firm value maximizing effort level,

$$e^{FB} = \arg\max_{e\in[0,1]} \theta e \Pi + (1-\theta)\mathcal{L} - \psi(e)$$

Assuming interior solutions (i.e. β not too small), e^{FB} is uniquely characterized by the first order condition $\theta\Pi = \psi'(e)$. To make the analysis interesting, we assume that the net present value of the project is strictly positive under the first best,

$$\theta e^{FB}\Pi + (1-\theta)\mathcal{L} - \psi(e^{FB}) > I$$

For later reference, let I^{FB} denote the largest investment outlay such that investment is efficient under the first best (i.e. $I^{FB} = \theta e^{FB}\Pi + (1-\theta)\mathcal{L} - \psi(e^{FB})$).

Bank Oversight.— As in Repullo and Suarez (1998), observability of effort has the major advantage that the bank can impose a threat on the manager to *intervene* (specifically, terminate her project at date $t = 1$) should she deviate from the efficient course of action.[5] This can have positive implications for the manager's incentive to exert efficient effort. To allow for the possibility of intervention threats, we consider loan contracts under which the bank is pledged the contractual right to terminate the project at date $t = 1$ and seize the liquidation proceeds.[6] (It will become immediate below that it is optimal to pledge the bank these rights.)

[5]More generally, as has been emphasized by Dewatripont and Tirole (1994), one can think of a variety of possible intervention options, such as forcing downsizing, cutting continuation credit, stipulating costly changes in strategy, etc. To the extent that corporate managers dislike outside creditors intervening (as it threatens their private and/or monetary benefits) the threat of intervention can serve as an incentive device for managers to work harder.

[6]A natural interpretation of these income and control rights is that the bank retains the right to accelerate long–term debt and demand pre–mature repayment at date $t = 1$. Since the borrower cannot satisfy her payment obligation at this stage, the bank can force bankruptcy by calling the loan, which in turn equips the

Loan and Credit Protection Contracts.— At date $t = 0$ loan and credit protection contracts are signed. Throughout this and the next section, we adopt the convention that the level of credit protection is *contractible* between the bank and the borrower. In practical terms this means that the loan contract contains a covenant that limits the bank's discretion in taking credit protection. Section 4 provides a detailed analysis of the case of non–contractible and/or non–observable credit protection.

A loan contract specifies a repayment R due at date $t = 2$, conditional on project continuation and the realization of the high cash flow state,[7] and the previously mentioned liquidation control and income rights. Credit protection policies are designed to compensate protection buyers for losses upon the occurrence of pre–specified *credit events*. Formally, in our context, a credit protection contract specifies an initial insurance premium $P \geq 0$ and payments (C_1, C_2), where C_1 is a payment from the credit insurer to the bank in the event of pre–mature project termination (viz. the bank exercising its liquidation right), and C_2 is a payment conditional on the realization of the low cash flow state at date $t = 2$. We refer to C_1 as "early" credit protection and to C_2 as "late" credit protection. Below we will provide a more detailed discussion of how to interpret these contracts.

It is noteworthy that in our setting the transfer of credit risk is not hampered by the threat adverse selection. This is because the credit protection policy is agreed upon at the initial date $t = 0$ contracting stage. At this very early stage of the loan's life–cycle the bank did not yet acquire inside information, and hence the counterparties are symmetrically informed about the value of the loan (when signing the credit protection contract).

Debt Renegotiation.— The bank and the borrower are free to restructure debt. (Debt restructuring should be viewed as a private workout that does not constitute a credit event entitling the bank to collect protection.) This comes into consideration at the intervention stage when the bank prefers project termination but termination is inefficient. In this circumstance, the parties have an incentive to renegotiate the loan contract as to effectively avoid project termination. It is inessential whether the bank or the borrower has the bargaining power in renegotiation; we consider that the borrower makes take–it–or–leave–it renegotiation offers. We assume that the credit insurer does not interfere with this process. This can motivated by noting that the credit insurer is at arm's length and uninformed. We restrict without loss of generality attention to contracts that are renegotiation–proof in equilibrium.

bank with the right to seize collateral under standard bankruptcy rules [supposing that the borrower cannot tap the credit market at date $t = 1$ and refinance herself, e.g. because of asymmetric information (Rajan 1992)]. This approach captures the notion that relationship lenders typically have substantial discretion in *forcing* credit events. See Tolk (2001) for an interesting practitioner's discussion of this aspect and its potential implications for the use and design of credit derivatives.

[7] As is standard, the firm is protected by limited liability, and hence in the low cash flow state it pays out zero.

2.2 Optimal Credit Default Swaps in the Absence of Bank Capital Constraints

This subsection characterizes optimal credit protection policies in the absence of bank capital constraints. Our main aim is to demonstrate how properly devised credit protection strengthens banks' commitment to engage in timely intervention, thereby facilitating the resolution of managerial incentive problems in the corporate loan market.

Suppose the project is undertaken and let e^* denote the (candidate) equilibrium effort level of the manager. Competition in the financial sector implies that the surplus gains from investment and credit protection accrue to the real sector. Optimal loan and credit protection contracts thus maximize ex ante firm value (i.e. project NPV),[8]

$$\max_{(e^* \in [0,1], R, P, C_1, C_2)} \quad \theta e^* \Pi + (1-\theta)\mathcal{L} - \psi(e^*) - I$$

subject to

- efficient continuation decisions at date $t = 1$,

$$\text{(continue in good state)} \qquad \underbrace{e^* R + (1-e^*)C_2}_{\text{continuation payoff}} \geq \underbrace{\mathcal{L} + C_1}_{\text{termination payoff}} \tag{1}$$

$$\text{(terminate in bad state)} \qquad \mathcal{L} + C_1 \geq C_2 \tag{2}$$

- the bank's and the credit insurer's zero profit constraints,

$$\theta\Big[\underbrace{e^* R + (1-e^*)C_2}_{\text{good state}}\Big] + (1-\theta)\Big[\underbrace{\mathcal{L} + C_1}_{\text{bad state}}\Big] = I + P \tag{3}$$

$$\underbrace{\theta\Big[(1-e^*)C_2\Big] + (1-\theta)C_1}_{\text{expected credit protection payment}} = P \tag{4}$$

- and the managerial incentive constraint,

$$e^* \text{ maximizes residual firm value.} \tag{5}$$

To obtain the managerial incentive constraint in operational form we need to know how the bank's continuation incentive is altered by the manager's choice of effort (which, recall, is observed by the bank). The bank's continuation incentive is in turn affected by credit protection. It will be this channel through which credit protection influences value creation in the real sector.

The continuation incentive constraint (1) says that in equilibrium (i.e. the manager exerting effort e^*) the bank has an appropriate incentive to continue the project in the good state. This

[8] For later reference notice that if credit protection were not contractible between the bank and the borrower then one would have to add an additional constraint to the program, namely the bank's incentive constraint to not deviate from a desired credit protection policy.

ensures that the bank does not *abuse* its discretion in forcing the credit event at date $t = 1$ (more specifically, (1) ensures that in equilibrium the contract is renegotiation–proof). The termination incentive constraint (2) says that in the bad state the bank takes the efficient termination decision. (3) is the bank's break even constraint. The left hand side is the bank's expected equilibrium payoff and the right hand side is the initial cash outflow, namely the sum of the investment outlay I and the insurance premium P. (4) is the credit insurer's break even constraint: the expected credit protection payment just equals the insurance premium. The break even constraints (3) and (4) pin down the face value of debt to

$$R = \frac{I - (1-\theta)\mathcal{L}}{\theta e^*}$$

Notice that credit protection does not enter the the bank's claim (holding the effort level fixed). This is because the expected credit protection payment just equals the insurance premium P, and hence credit protection does not alter the bank's break even constraint, *ceteris paribus.*

We now introduce the concept of a *credible* termination threat. We say the threat of termination is credible if following any downwards deviation from the (candidate) equilibrium effort level the bank strictly prefers to terminate the project in the good state (it will become immediate below why we define credible termination threats in this way). Formally, for any $e < e^*$,

$$\underbrace{eR + (1-e)C_2}_{\text{actual continuation payoff}} \quad < \quad \underbrace{\mathcal{L} + C_1}_{\text{termination payoff}}$$

(Notice that (1) and (2) imply $R \geq C_2$; we will see shortly below that this inequality is strict.) Thus, by the continuation incentive constraint (1) and continuity, the termination threat is credible if and only if (1) holds with equality. Substituting the bank's claim into (1) and re–arranging terms we can express this condition as follows

$$C_1 = \underbrace{(1-e^*)C_2}_{\text{value late protection}} + \frac{\overbrace{I - \mathcal{L}}^{\text{collateral gap}}}{\theta} \equiv C_1^* \tag{6}$$

The second term on the right hand side is the difference between the equilibrium continuation value of the bank's claim and the asset salvage value, $e^*R - \mathcal{L}$. We refer to this term as the collateral gap. The collateral gap measures the degree to which the bank's investment cost is sunk at the interim stage. Notice that the collateral gap is strictly positive. This implies that if the bank did not take credit protection ($C_1 = C_2 = 0$) the threat of termination would lack credibility.

The analysis proceeds as follows. We first characterize the loan market equilibrium *conditional* on the bank taking credit protection such that the threat of termination lacks credibility (lemma 1). We then show what can be implemented when the bank adopts a credit protection policy that restores the credibility of the termination threat (lemma 2). Subsequently, we characterize the optimal credit protection policy.

Fix a credit protection policy (C_1, C_2) and suppose the threat of termination lacks credibility (i.e. the continuation incentive constraint (1) holds with strict inequality). Since the bank strictly prefers project continuation in equilibrium it still prefers continuation when the manager's actual effort level is slightly below the equilibrium effort level. Thus the bank is willing to tolerate some shirking on the side of the manager: as long as the manager exerts effort $e \geq e^* - \epsilon$, where $\epsilon > 0$ but small, the project is continued without renegotiation (in the good state). The manager's payoff from exerting effort $e \geq e^* - \epsilon$ thus reads

$$\theta e(\Pi - R) - \psi(e)$$

Therefore, e^* is incentive–compatible only if $\theta(\Pi - R) = \psi'(e^*)$. In view of this observation, the following result is immediate.

Lemma 1 *Suppose the threat of termination lacks credibility ($C_1 < C_1^*$). Then,*

(i) *Credit protection is neither harmful nor benign for managerial incentives / value creation in the real sector.*

(ii) *If outside financing is feasible the equilibrium effort level $e^{\text{no cds}}$ is given by the (largest) solution of the reduced form incentive constraint*

$$\theta \left(\Pi - \frac{I - (1-\theta)\mathcal{L}}{\theta e^{\text{no cds}}} \right) = \psi'(e^{\text{no cds}}) \tag{7}$$

Managerial incentives are distorted: $e^{\text{no cds}} < e^{FB}$.

(iii) *Credit may be rationed: there is a threshold $I^{\text{no cds}} < I^{FB}$ such that the project is undertaken if and only if $I \leq I^{\text{no cds}}$.* ■

The lemma delivers a key insight. *When the threat of termination lacks credibility (respectively, the agency conflict between the bank and the borrower is unresolved) there is a wedge between the bank's hedging activities in the credit risk transfer market and loan performance.* This can be understood as follows. When the threat of termination lacks credibility the bank finds it too costly to resolve the agency problem and align the manager's incentive to exert effort with its own interests (because it would require leaving the manager a too high rent, as a result of which the bank would not break even). In this circumstance, what matters for the magnitude of the effort distortion is the *aggregate* externality that the manager exerts on financial stakeholders (viz. the bank *and* the credit insurer). This externality is given by the bank's claim against the project's cash flows, R (late protection C_2 is instead a transfer payment from the credit insurer to the bank which does not enter the joint payoff of financial stakeholders). Consequently, credit protection does not influence the aggregate externality that the manager exerts on financial stakeholders. This explains why credit protection is irrelevant when oversight is ineffective. The bank–borrower relationship is subject to a standard agency conflict, which gives rise to an incentive distortion and, potentially, credit rationing.

Next, suppose the bank takes credit protection such that the threat of termination is credible (i.e. $C_1 = C_1^*$). The following lemma shows what can be implemented in this case.

Lemma 2 *Suppose the threat of termination is credible. Then the manager exerts effort as to maximize the joint surplus of the "insiders" (bank and borrower),*

$$e^* = \arg\max_{e\in[0,1]} \theta(e\Pi + (1-e)C_2) + (1-\theta)(\mathcal{L} + C_1) - \psi(e)$$

Consequently, the agency conflict between the bank and the borrower is resolved and transformed into a conflict of interest between the insiders and the credit protection seller. ■

This can be explained as follows. If in equilibrium the bank is indifferent between project continuation and termination then it can always reap its equilibrium continuation payoff by terminating the project. Thus the bank is fully protected against moral hazard on the side of the borrower: if the manager shirked and did not pay for the cost then the bank would reap its "no–shirking" continuation payoff by terminating the project. The agency conflict between the bank and the borrower is resolved and, by implication, transformed into a conflict of interest between the insiders and the credit protection seller. Obviously, this new conflict of interest entails a distortion if and only if $C_2 > 0$. This leads to our main result.

Proposition 1 *Suppose the bank does not face capital constraints. Then,*

(i) *Under an optimal credit protection policy the bank takes early credit protection*

$$C_1 = \frac{I - \mathcal{L}}{\theta} > 0$$

but no late credit protection, $C_2 = 0$.

(ii) *Managerial incentives in the corporate loan market are first best, $e^* = e^{FB}$.*

(iii) *All positive NPV projects are undertaken.* ■

This demonstrates the *virtues* of credit protection for effective bank oversight. The intuition behind this result is the following. Early credit protection improves the bank's exit option at the interim intervention stage, thereby strengthening the bank's commitment to penalize the manager for shirking by "abandoning" her. This resolves the standard agency problem between the bank and the borrower, and transforms it into a conflict of interest between the bank–borrower coalition and the credit insurer. This new conflict of interest entails a distortion if and only if part of the benefit from maximizing firm value accrues to the credit insurer. Thus, by letting credit protection expire after the intervention stage the bank effectively ensures that the value–added from exerting efficient effort fully accrues to the bank–borrower coalition. This provides the insiders with a proper incentive to maximize value. Intuitively, the bank takes back credit exposure to commit itself to "care" about what the manager is doing. At the same time, the bank reduces its exposure at the interim stage in order to not "care too much", which enables the bank to align the manager's private incentive to exert effort with its own interests.

It is important to stress that in the good state project termination is an *out–of–equilibrium* event. While the bank has unlimited discretion in forcing the credit event at the interim stage, it has no incentive to abuse this discretion. The reason is very simple: the loan and credit protection contracts are designed so that the bank has no interest in exercising the termination threat when the manager behaves diligently. The bank should "cheat" and exercise the exit option if and only if the manager deviates from the efficient course of action (and refrains from paying for the cost of shirking). Early protection provides the bank with such an incentive, thereby inducing the borrower to behave diligently. This, in turn, ensures that in equilibrium the bank has no interest in exercising the exit threat. The bank neither has an interest in holding up the borrower and demanding additional repayment for not terminating. This is because the bank would hurt itself if it exercised the exit option in equilibrium.[9] In the bad state, the bank of course exercises the exit option (which is efficient) and collects protection. The insurance premium fully compensates the credit insurer for the cost.

Within the context of the formal analysis, we have considered that banks' exit option consists of abandoning borrowers and *terminating* their projects. In practice, one can imagine that financial distress *per se* (and/or exit of inside banks) is costly for corporate borrowers. For example, as has been pointed out by Titman (1984) and Opler and Timan (1994), bankruptcy can make customers reluctant to engage in further transactions with the firm, thereby threatening the firm's post bankruptcy survival. Likewise, bankruptcy survival typically necessitates financial and organizational restructuring, the success of which may rely on inside banks' restructuring skills and effort. Once protected inside banks took their exit option and transferred their claims to protection sellers, their incentive to provide such reorganization effort will be very limited.

In this circumstance, optimal interim credit protection may well condition on default (rather than on project termination). The bank is pledged the right to accelerate debt and demand pre–mature repayment at date $t = 1$. To the extent that informational asymmetries prevent the borrower from "opportunistically" refinancing her debt at the capital market (Rajan 1992), accelerating debt allows the bank to trigger pre–mature bankruptcy, thus entitling

[9]See von Thadden (1995) for a seminal paper on the role of long–term financial contracting in resolving hold up problems stemming from contractual or informational lock–in. One may argue that since in equilibrium the bank is indifferent between termination and continuation it may still hold up the borrower. However, this misses the point, for if the bank had a preference for exercising the termination threat conditional on being indifferent in monetary terms then, in practice, the borrower would simply exert a little bit more effort, thereby destroying the credibility of the bank's hold up threat.

the bank to collect protection. Upon collecting protection, the bank abandons the borrower and transfers its income and control rights to credit protection sellers. Given that bankruptcy hurts the firm's business prospects and the inside bank is no longer around, new creditors (viz. protection sellers) may well proceed with liquidation. Even if the new creditors did not proceed with liquidation the borrower would be hurt by deteriorated business conditions and the inside bank having abandoned her. In this context, the borrower will have an increased incentive to behave diligently in order to enhance the continuation value of the bank's claim, thereby making it less worthwhile for the bank to take the exit route and force costly bankruptcy.

2.3 Capital Constraints: The Costs and Benefits of Hedging

We now demonstrate how the relationship management aspect of credit protection interacts with the standard capital relief motive. To this end, we introduce capital constraints at the bank level. We adopt the simplest possible approach to modelling bank capital constraints: the bank must not make losses of more than $K > 0$, where K can be thought of as the bank's "capital" (per loan). Capital constraints thus impose a limit to the bank's risk–bearing capacity.

The bank's state–contingent losses are easily derived. In the event of project termination at date $t = 1$ the bank makes a loss of

$$V_1 = \underbrace{I + P}_{\text{initial investment}} - (\underbrace{\mathcal{L} + C_1}_{\text{cash inflow}})$$

Conditional on the realization of the low cash flow state at date $t = 2$ the bank makes a loss of $V_2 = I + P - C_2$. In the high cash flow state, the bank obviously does not make a loss. The bank's capital constraint thus reads $V_t \leq K$, $t \in \{1, 2\}$.

Suppose the bank takes credit protection (C_1^*, C_2) such that the threat of termination is effective (i.e. (1) holds with equality).[10] The bank's break even constraint implies $I + P = \mathcal{L} + C_1^*$. Thus, the capital constraint in the event of project termination is not binding. The relevant constraint is the capital constraint in the low cash flow state, which reduces to $\mathcal{L} + C_1^* - C_2 \leq K$. Substituting for early protection $C_1^* = (1 - e^*)C_2 + (I - \mathcal{L})/\theta$ this can be rewritten as

$$C_2 \geq \frac{I - (1 - \theta)\mathcal{L} - \theta K}{\theta e^*} \equiv C_2^*(K) \tag{8}$$

[10] It is straightforward to show that in the absence of credit protection the project would be undertaken if and only if $I \leq \min[K, I^{\text{no cds}}]$. Loan performance would be given by $e^{\text{no cds}}$. If the bank took credit protection to relieve its capital constraint but did not restore the credibility of the termination threat loan performance would be given by $e^{\text{no cds}}$, too. However, there would be less credit rationing (projects with $I \leq I^{\text{no cds}}$ would be undertaken).

Optimal credit protection maximizes total value subject to the capital constraint (8) and the managerial incentive constraint,

$$\begin{aligned}\max_{e^* \in [0,1], C_2} \quad & \theta e^* \Pi + (1-\theta)\mathcal{L} - \psi(e^*) \\ \text{s.t.} \quad & \\ & C_2 \geq C_2^*(K) \\ & \theta(\Pi - C_2) = \psi'(e^*)\end{aligned}$$

The solution to this problem is straightforward. For $C_2^*(K) \leq 0$ (K large) the capital constraint is not binding. In this case, the first best is implementable. For K small, some late protection is required. Since late protection stifles loan performance, the bank takes as little protection as is compatible with its risk–bearing capacity. The capital constraint is thus binding. Equilibrium loan performance, denoted by e^{cds}, is then given by the (largest) solution of the reduced form incentive constraint

$$\theta \left(\Pi - C_2^{\text{cds}}(K) \right) = \psi'(e^{\text{cds}})$$

where

$$C_2^{\text{cds}}(K) = \frac{I - (1-\theta)\mathcal{L} - \theta K}{\theta e^{\text{cds}}}$$

Since $C_2^*(K)$ is decreasing in K loan performance is increasing in bank capital. In sum,

Proposition 2 *There is a bank capital threshold* $\hat{K} = (I - (1-\theta)\mathcal{L})/\theta$ *such that*

(i) *for* $K \geq \hat{K}$ *(well–capitalized bank), capital constraints are not binding. The bank takes early protection but no late protection. The first best is implemented (proposition 1).*

(ii) *for* $K < \hat{K}$ *(poorly capitalized bank), the capital constraint in the low cash flow state is binding.*

  (a) *The bank takes early protection and some late protection.*

  (b) *Managerial incentives in the corporate loan market are distorted,* $e^{\text{cds}} < e^{FB}$. *A decrease in bank capital has a negative effect on loan performance. As the bank becomes unable to sustain losses, the incentive value–added of credit protection evaporates,* $\lim_{K\to 0} e^{\text{cds}} = e^{\text{no cds}}$.

  (c) *An increase in bank capital reduces credit rationing: there is an investment outlay threshold* $I^{\text{cds}}(K) \in (I^{\text{no cds}}, I^{FB})$, *increasing in* K *and satisfying* $I^{\text{cds}}(\hat{K}) = I^{FB}$ *and* $\lim_{K\to 0} I^{\text{cds}}(K) = I^{\text{no cds}}$, *such that the project is undertaken if and only if* $I \leq I^{\text{cds}}(K)$. ■

Well–capitalized banks have sufficient capital to sustain losses. These banks take a full hedge against losses at the interim stage, but no late protection. This ensures that the threat of termination is effective. At the same time, loan performance is not stifled by late protection. Poorly capitalized banks' capital constraint puts a binding limit to their risk–bearing capacity. As such, poorly capitalized banks take some late credit protection. They also fully hedge their position at the interim stage (which makes termination threats effective and relieves capital constraints). Late protection gives rise to an agency problem between the insiders and the credit insurer, which translates into an effort distortion. Loan performance is gradually decreasing in the severity of the capital constraint. As the bank becomes unable to sustain losses, loan performance with credit protection is no different from loan performance without credit protection (conditional on the project being undertaken). Intuitively, as the bank's risk–bearing capacity decreases, the credit insurer will have to absorb more and more credit risk. In the limit, as the bank becomes fully insured, the effort externality on the payoff of the credit insurer is given by $C_2 = R$. The incentive constraint is then given by "arm's length" lending incentive constraint (7).

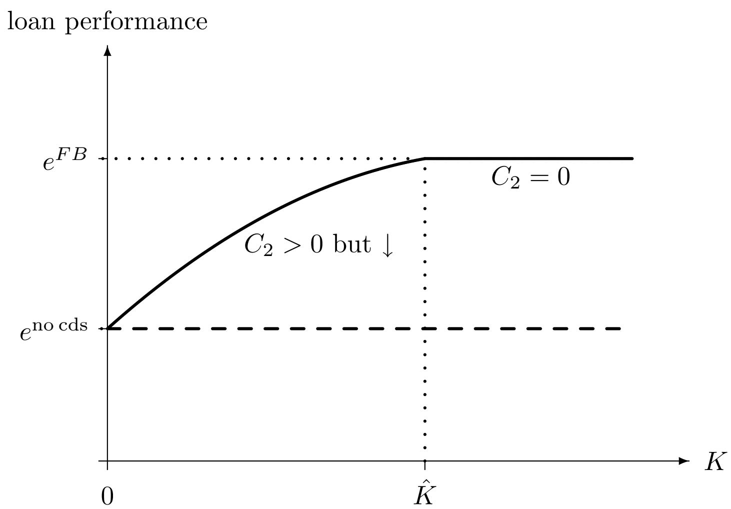

Figure 2: Bank Capital and Corporate Loan Performance

The figure relates bank capital K to loan performance (solid line). As capital increases from zero to the threshold $\hat{K}$, loan performance increases and late credit protection decreases. Once the threshold is reached, the first best is implementable. Loan performance is always above the no–protection benchmark $e^{\text{no cds}}$ (dashed line).

Figure 2 illustrates the link between bank capital and loan performance. The dashed line depicts loan performance in the absence of credit protection. In this case, there is no link between bank capital and loan performance (conditional on the project being undertaken). The introduction of a viable credit protection market has unambiguously positive implications for loan performance. It also introduces a link between bank capital and loan performance. As capital constraints become less binding banks take less credit protection. This entails a positive spillover effect on managerial incentives in the corporate loan market.

This analysis has implications for the *maturity design* of credit protection. Let us refer to the difference between early and late protection, $C_1 - C_2$, as the credit protection *maturity mismatch*. It is straightforward to show that the maturity mismatch amounts to

$$C_1 - C_2 = \begin{cases} K - \mathcal{L} & \text{for } K \leq \hat{K} \\ \hat{K} - \mathcal{L} & \text{for } K \geq \hat{K} \end{cases}$$

where

$$\hat{K} = \frac{I - (1-\theta)\mathcal{L}}{\theta} = e^* R > \mathcal{L}$$

Observe that $\hat{K} - \mathcal{L}$ just equals the collateral gap, $(I - \mathcal{L})/\theta > 0$. Thus, in case of a well–capitalized bank the maturity mismatch is strictly positive. Poorly capitalized banks' credit protection maturity mismatch is strictly increasing in bank capital, and positive as long as banks are not severely undercapitalized. For K very small the maturity mismatch may become negative. This feature stems from our convention that the bank is entitled to seize the asset salvage value upon collection of early protection. As a result, if a severely undercapitalized bank's maturity mismatch were positive the bank would have an excessive termination incentive. Alternatively, one could define early protection as the total amount received by the bank when it takes the exit option. This amount is given by $\hat{C}_1 = \mathcal{L} + C_1$. Thus, redefining the maturity mismatch as $\hat{C}_1 - C_2$ the maturity mismatch would be given by $\min[K, \hat{K}]$, which is always positive.

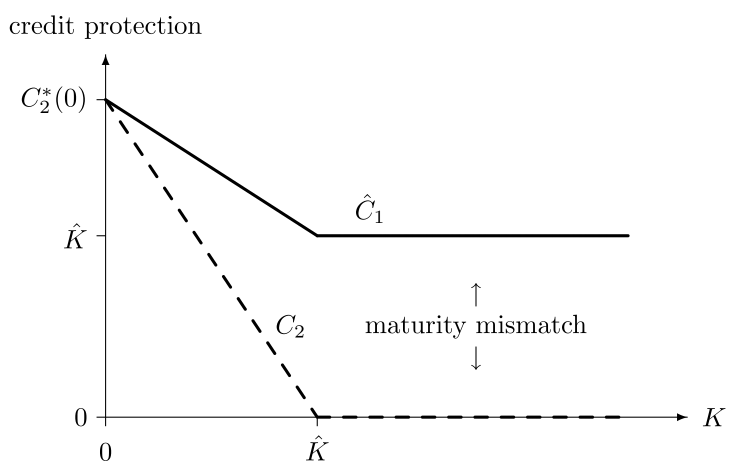

Figure 3: Bank Capital and Credit Protection Maturity Design

The figure relates bank capital K to early protection $\hat{C}_1 = \mathcal{L} + C_1$ and late protection C_2. As capital increases from zero to the threshold $\hat{K}$, early (solid line) and late (dashed line) protection decrease, but late protection decreases at a faster pace.

Figure 3 illustrates the link between bank capital, early protection $\hat{C}_1 = \mathcal{L} + C_1$ (solid line), and late protection C_2 (dashed line). As bank capital increases from zero to $\hat{K}$ both early and late protection decrease. Yet early protection decreases at a faster pace. The intuition is the following. As the bank's risk–bearing capacity increases it takes less late protection to relieve the managerial incentive constraint. The decrease in C_2 must then be matched with a decrease in C_1. Specifically, a decrease in C_2 by one unit triggers a decrease in C_1 by $1 - e^*$ units (because the bank receives late protection with probability $1 - e^*$, conditional on the realization of the good signal). This explains why late protection decreases faster than early protection, which in turn explains why the maturity mismatch in increasing in bank capital. Once the threshold $\hat{K}$ is reached, the maturity mismatch is no longer influenced by bank capital.

An importance difference between our approach and the existing theoretical literature on credit risk transfers (see the references mentioned in the introduction) stems from the way how bank–borrower relationships and bank monitoring are modelled. In Gorton and Pennacchi (1995), for example, bank monitoring is modelled as a loan value enhancement effort problem on the side of the bank. Credit risk transfers then facilitate capital relief but come at the expense of distorting banks' loan value enhancement incentive. This loan value enhancement moral hazard problem is analogous to the moral hazard problem at issue here, namely the conflict of interest between the bank–borrower coalition and the credit insurer. Yet, in our setting, this conflict of interest materializes if and only if bank oversight ("monitoring") is effective (i.e. the threat of termination is credible), which in turn *requires that the bank hedges out some credit risk*. As shown earlier (lemma 1), when the termination threat lacks credibility there is a wedge between the bank's hedging activities and corporate loan performance: neither bank capital nor credit protection have any effect on loan performance.

In essence, this is because of the functional separation of duties (and the resulting moral hazard problem) that arises naturally from the mismatch between skills and financial resources: the corporate borrower/manager has specific skills in running her project which the banker does not have. As a result, the banker is confined to her core business, viz. funding and oversight. It is this mismatch between skills and financial resources that gives rise to moral hazard in the corporate loan market. Properly devised credit protection makes bank oversight effective. This allows to resolve the agency problem between the bank and its borrower but comes at the expense of a new conflict of interest between the bank–borrower coalition and the credit insurer. However, this new conflict of interest is less costly than the original conflict of interest between the bank and the borrower. It is thus the very presence of agency conflicts between banks and their corporate borrowers (which bank monitoring is meant to resolve) that explains why, in our setting, credit protection creates value even when banks do not face binding capital constraints. In the absence of moral hazard in the corporate loan market, credit protection would stifle loan performance. In such a world, however, there would be no demand for bank monitoring services.

3 Further Complementarities Between Credit Risk Transfer and Relationship Lending

In this section, we endogenize banks' relationship building and information acquisition ("monitoring") incentive in order to gain further insights into the virtues of credit derivatives for relationship lending. We first show how credit protection can make it more worthwhile for banks to invest in costly relationships. Subsequently, we argue that credit protection can strengthen banks' monitoring incentive.

3.1 Credit Protection and Banks' Incentive to Invest in Relationships

The preceding analysis has shown that credit protection can make bank–borrower relationships more effective, *given* that such relationships are established. In this subsection, we analyze how credit protection influences banks' incentive to establish close relationships with their borrowers in the first place. Suppose that at date $t = 0$ the bank faces a choice between two alternative lending regimes: (i) arm's length lending and (ii) relationship lending. If the bank adopts the latter approach it incurs a relationship setup cost $c > 0$.[11] No such setup cost is incurred when the bank adopts the arm's length lending approach. To ease the exposition, let us redefine the bank's investment cost under relationship lending as $I = \mathcal{I} + c$, where $\mathcal{I}$ denotes the project investment outlay. The bank's investment cost under arm's length lending is thus given by $I - c$.

We emphasize two central aspects of relationship lending:[12]

(i) Following Repullo and Suarez (1998), we consider that by establishing a close lending relationship the bank can (at no additional cost) observe firm–specific soft information, namely, in our context, the manager's actual effort level and the realization of the market signal (as above). Under arm's length lending the bank remains ignorant about either piece of information (obviously, however, the bank will correctly conjecture the manager's equilibrium effort choice).

(ii) Following Diamond and Rajan (2000, 2001), we allow for the possibility that relationship financiers have an advantage in re–deploying assets and enhancing their salvage value. The idea is that relationship lenders acquire industry and market expertise over the

[11] For instance, this could refer to an investment into the banker's human capital in order to familiarize him with the borrower and her business, market conditions, etc. Alternatively, it could refer to an investment into information technology and/or expertise that facilitates the timely transmission of information from the borrower to the bank.

[12] For empirical evidence on relationship lending, see, among others, James (1987), Lummer and McConnell (1989), Petersen and Rajan (1994, 1995), Berger and Udell (1995), Ongena and Smith (2000, 2001), and Degryse and Ongena (2001).

course of lending relationships, which strengthens their asset re–deployment skills. Formally, if the bank adopts the arm's length lending approach it won't be able to re–deploy assets in a meaningful way. The date $t = 1$ asset salvage value is then given by zero. Conversely, if the bank establishes a close relationship with the borrower then it will be able to enhance the date $t = 1$ asset salvage value from zero to $\mathcal{L} < \mathcal{I}$. For simplicity, the date $t = 2$ asset salvage value is given by zero, no matter whether the bank adopts the arm's length or relationship lending approach.

For simplicity, we abstract from bank capital constraints. For the moment, we think of the choice between arm's length and relationship lending as a contractible investment choice. In other words, the bank incurs the relationship setup cost $c > 0$ if and only if relationship lending is efficient (i.e. improves project NPV).

Suppose the bank adopts the arm's length lending approach. Under arm's length lending the bank is not able to observe the manager's decision–making (and hence cannot possibly penalize the manager for not behaving diligently). Thus, credit protection is irrelevant (given that the bank does not face binding capital constraints). The loan contract specifies a payment $R = (I - c)/(\theta e^{**})$, where e^{**} is the largest solution of the reduced form incentive constraint,

$$\theta\Pi - (I - c)/e^{**} = \psi'(e^{**})$$

Under arm's length financing, borrower welfare (i.e. project NPV) is then given by

$$\theta e^{**}\Pi - \psi(e^{**}) - (I - c) \tag{9}$$

Next, suppose the bank adopts the relationship lending approach but does *not* have access to a viable credit protection market. Competition among banks implies that the efficiency gains from relationship lending accrue to the corporate sector. From the preceding section we know that borrower welfare reads

$$\theta e^{\text{no cds}}\Pi + (1 - \theta)\mathcal{L} - \psi(e^{\text{no cds}}) - I \tag{10}$$

where $e^{\text{no cds}}$ is the largest solution of the reduced form incentive constraint (7). Comparing (9) with (10) shows that in the absence of credit protection relationship lending is efficient if and only if

$$(1 - \theta)\mathcal{L} + \int_{e^{**}}^{e^{\text{no cds}}} \theta\Pi - \psi'(e)\, de \geq c$$

The first term on the left hand side is the surplus gain from the enhanced asset salvage value in the bad state. The second term stems from the manager's potentially improved incentive to exert effort. It is straightforward to show that the incentive value–added is positive (i.e. $e^{\text{no cds}} \geq e^{**}$) if and only if $(1 - \theta)\mathcal{L} \geq c$. In other words, the incentive value–added is of second order. This is because when the threat of termination lacks credibility relationship lending improves managerial incentives if and only if it relieves the outside funding burden. However, this requires $(1-\theta)\mathcal{L} \geq c$. In sum, in the absence of credit protection relationship lending is efficient if and only if $(1-\theta)\mathcal{L} \geq c$.

Next, suppose the bank adopts the relationship lending approach, and takes credit protection such that oversight is effective. Thus the manager exerts first best effort. Borrower welfare is given by

$$\theta e^{FB}\Pi + (1-\theta)\mathcal{L} - \psi(e^{FB}) - I$$

Comparing this expression with (9) shows that with credit protection relationship banking is efficient if and only if

$$(1-\theta)\mathcal{L} + \underbrace{\int_{e^{**}}^{e^{FB}} \theta\Pi - \psi'(e)\, de}_{\text{incentive enhancement}} \geq c \qquad (11)$$

which may hold even when relationship banking is inefficient in the absence of credit protection (i.e. $(1-\theta)\mathcal{L} < c$). Hence,

Proposition 3 *Credit protection makes it more worthwhile for banks to invest in relationships.* ■

The intuition behind this result is straightforward. Credit protection improves the effectiveness of bank oversight. Yet, a prerequisite for effective oversight is that the bank adopts the relationship lending approach. Thus, credit protection — via its effect on bank oversight and managerial incentives — makes it more worthwhile to invest in relationships in the first place.

3.2 Credit Protection and Banks' Monitoring Incentive

Let us now relax the assumption that the bank can commit to build a relationship with borrower. Specifically, suppose that at date $t = 1$ (i.e. after the manager has sunk her effort choice) the bank needs to contemplate whether to "move closer" to the borrower at cost $c > 0$, thereby acquiring asset re–deployment expertise and observing the manager's actual effort choice (and the realization of the state). We refer to this activity as "monitoring". To make the analysis interesting we assume that the asset salvage value is unverifiable. (If the asset salvage value were verifiable then a date $t = 1$ asset salvage value of zero would reveal to the court that the bank did not monitor.) Notice that at date $t = 1$ the manager's effort choice is sunk, and hence the bank cannot influence effort with its monitoring activity. A commitment to monitor can be worthwhile, though, for the manager will have a stronger incentive to exert effort when the bank is committed to monitor. We now explore how credit protection alters the bank's monitoring commitment.

Suppose monitoring is ex ante efficient, i.e. (11) holds, and the bank takes credit protection such that the threat of termination is credible (we again abstract from bank capital constraints). Let us show under which circumstances there is a pure strategy equilibrium in which the bank monitors and the manager exerts efficient effort. To this end we need to explore whether monitoring is a best response for the bank, given that the manager exerts efficient effort (we already know that exerting efficient effort is the manager's best response to the bank monitoring).

Suppose the bank monitors (at cost c). In this case, the project is continued in the good state and terminated in the bad state. Monitoring is a best response for the bank if and only if the monitoring payoff is not smaller than the highest payoff from leaving the borrower uninspected. When leaving the borrower uninspected the bank may either continue or terminate her. If the bank prefers to continue an uninspected borrower the monitoring incentive constraint reads

$$\theta e^{FB} R + (1-\theta)(\mathcal{L} + C_1) - c \geq \theta e^{FB} R$$

The left hand side is the bank's payoff when it monitors, given that the borrower exerts efficient effort. The right hand side is the bank's payoff when it leaves the borrower uninspected and continues her. This inequality can be rewritten as

$$(1-\theta)(\mathcal{L} + C_1) \geq c \tag{12}$$

Conversely, if the bank prefers to terminate an uninspected borrower then the monitoring incentive constraint reads

$$\theta e^{FB} R + (1-\theta)(\mathcal{L} + C_1) - c \geq C_1 \tag{13}$$

Recall that the continuation incentive constraint holds with equality, $e^{FB} R = \mathcal{L} + C_1$. Condition (13) thus reduces to $\mathcal{L} + C_1 - c \geq C_1$, or $\mathcal{L} \geq c$.[13] In sum, monitoring is a best response for the bank if and only if (12) and $\mathcal{L} \geq c$ hold.

Next, consider the bank's monitoring incentive in the absence of credit protection. In this case, the bank has an incentive to monitor if and only if

$$\theta e^{\text{no cds}} R + (1-\theta)\mathcal{L} - c \geq \theta e^{\text{no cds}} R$$

or $(1-\theta)\mathcal{L} \geq c$. By inspection, this constraint is *tighter* than both (12) and $\mathcal{L} \geq c$. This shows that credit protection ($C_1 > 0$) *relaxes* the monitoring incentive constraint. Thus,

Proposition 4 *Credit protection can enhance banks' monitoring incentive.* ■

[13]By implication, if $\mathcal{L} < c$ a pure strategy equilibrium with monitoring fails to exist. In the absence of credit protection, monitoring is inefficient (since $(1-\theta)\mathcal{L} < c$). Hence there is no point to commit the bank to monitor. With credit protection, the bank cannot be made indifferent between project continuation and termination in the good state (conditional on having monitored) and at the same time be provided with an incentive to not terminate an uninspected borrower.

To see the intuition behind this result recall the principal role of credit protection in our setting: it *rewards* the bank for forcing the borrower into pre–mature liquidation. Now, suppose the bank has no interest in terminating an uninspected borrower. Credit protection then provides the bank with an additional payoff when terminating the borrower in the bad state. This additional reward improves the bank's incentive to resolve the uncertainty about the realization of the state. At the same time, when $\mathcal{L} \geq c$ forcing an uninspected borrower into liquidation is too costly for the bank. This is because terminating an uninspected borrower is dominated by inspecting the borrower (and thus enhancing the asset salvage value) and then terminating the borrower (formally, $\mathcal{L} + C_1 - c \geq C_1$). Once having inspected the borrower, however, the bank no longer has an incentive to terminate the borrower in the good state (provided, of course, that the manager exerted efficient effort). As a side effect, the bank can also penalize the manager for shirking, if necessary. Faced with this threat, the manager has an appropriate incentive to behave diligently. *It is this incentive value–added that makes the monitoring commitment worthwhile in the first place.*

4 The Role of Covenants and Disclosure Requirements

We have assumed that credit protection is contractible between the bank and the borrower (and hence observable to the borrower). In practice, credit derivatives are traded over the counter. As such, borrowers may not be able to observe their lenders' credit derivative positions. Loan contracts may not specify covenants that limit banks' discretion in taking credit protection. There is thus some interest in analyzing the loan market equilibrium when the bank is free to take as much credit protection as it likes and/or credit protection is unobservable to the borrower. In this section, we aim at addressing these issues.

The main difficulty of non–contractibility of credit protection is that it introduces a hold–up problem between the borrower and the bank. The bank may have an incentive to take *additional* early protection in order to improve its rent extraction power vis–à–vis the borrower. This may impose a threat to the efficacy of the incentive mechanism.[14] We will now demonstrate that (under a natural assumption) the rent extraction hold–up problem can be resolved at zero cost, *provided the bank discloses its derivative position to the borrower.* We discuss at a later stage how non–observability of credit protection would alter this result.

[14] It should be stressed that the rent extraction hold–up problem is of concern only if the bank can take *excessive* protection in the sense that protection payments exceed what the bank can possibly lose when abandoning the borrower (given the loan contract specified above). To see this notice that optimal interim credit protection keeps the bank indifferent between project termination and continuation in the good state. Notably, the credit protection payment equals $e^*R - \mathcal{L}$, precisely the amount that the bank would lose if it exercised the exit threat in equilibrium. Therefore, if credit protection were limited to "fair" losses (by convention or on legal grounds) then non–contractibility of credit protection would not cause harm. Our aim is to show that contractibility of credit protection is not crucial, even when banks can take excessive protection.

Consider the following setup. At $t = 0$, the loan contract is signed and the project is undertaken. The bank subsequently has the opportunity to buy credit protection (as much as it likes). This transaction is disclosed to the manager, who then makes her effort choice. We assume that once the manager made her effort choice (more precisely, the state at date $t = 1$ realized), the bank no longer has the opportunity to take credit protection.[15] The firm then evolves as specified above. We abstract from bank capital constraints and assume that the bank can commit to build a relationship.

We are interested in showing that there is an equilibrium in which the manager exerts efficient effort, the project is continued in the good state and terminated in the bad state, and investors just break even (i.e. the hold–up problem does not impose a binding constraint). To this end, it suffices to consider the following loan contract:

- an initial transfer,
$$T = \theta e^{FB}\Pi + (1-\theta)\mathcal{L} - \psi(e^{FB}) > I$$
out of which the borrower must finance the initial investment outlay
- and a claim (due at $t = 2$),
$$R = \Pi - \psi(e^{FB})/(\theta e^{FB}) \tag{14}$$

As above the bank has the right to terminate the project at $t = 1$ and capture the liquidation proceeds. The excess cash $T - I$ is immediately distributed to shareholders in form of a dividend. Let us show that this contract implements the first best.

Consider the continuation subgame once the project is underway. The following lemma simplifies the analysis.

Lemma 3 *Suppose the bank takes a credit protection policy such that in equilibrium the project is continued (terminated) in the good (bad) state, the borrower exerts effort e^{FB}, and the bank is paid R in the high cash flow state and nothing otherwise. Then the bank cannot do better by deviating from this credit protection policy.* ■

Proof: Notice that the borrower derives a continuation payoff of zero under this outcome,

$$\theta e^{FB}(\Pi - R) - \psi(e^{FB}) = \theta e^{FB}\Big(\Pi - \Big(\Pi - \psi/(\theta(e^{FB}\Big)\Big) - \psi(e^{FB}) = 0$$

The borrower's continuation rent is thus fully extracted (her outside option is to exert zero effort, which gives her a payoff of zero). The credit insurer just breaks even in equilibrium (and hence payments to and from the credit insurer do not alter the bank's equilibrium payoff). The bank thus derives a continuation payoff of

$$\theta e^{FB}R + (1-\theta)\mathcal{L} = \theta e^{FB}\Pi + (1-\theta)\mathcal{L} - \psi(e^{FB})$$

[15] To motivate, notice that at this stage there is asymmetric information between the bank and the credit insurer. The threat of adverse selection may deter the bank from taking additional protection.

This is total value under the first best. Hence, the bank cannot do better by adopting another credit protection policy. ■

Therefore, we merely have to find a credit protection policy that implements the outcome stated in the lemma. Once we have found such a credit protection policy, we also know that the loan contract is optimal. This is because in *ex ante* terms (accounting for the initial transfer T), the bank just breaks even under this outcome, as is easily verified.

Consider the following credit protection policy: the bank takes early credit protection C_1 (but no late credit protection) such that under the status–quo contract it is just indifferent between continuation and termination in the good state, conditional on the borrower exerting effort e^{FB},

$$e^{FB}R = \mathcal{L} + C_1$$

Substituting for the bank's claim (14), this can be rewritten as

$$C_1 = e^{FB}\Pi - \mathcal{L} - \psi(e^{FB})/\theta \tag{15}$$

Consider then the manager's effort choice problem. If she exerts effort $e \geq e^{FB}$ then the bank won't terminate her project in the good state. If she shirks and takes effort $e < e^{FB}$, then termination may or may not be efficient for the insiders. In the former case ($e < e^{FB} - \psi(e^{FB})/(\theta\Pi) \equiv e'$), the bank terminates. In the latter case, the manager commits to pay $(\mathcal{L} + C_1)/e$ in the high cash flow state and the project is continued. The manager's payoff function thus reads

$$\mathcal{U}(e) = \begin{cases} -\psi(e) & \text{for } e < e' \\ \theta(e\Pi - (\mathcal{L} + C_1)) - \psi(e) & \text{for } e \in [e', e^{FB}) \\ \theta e(\Pi - R) - \psi(e) & \text{for } e \geq e^{FB} \end{cases}$$

This is maximized at e^{FB}.[16] Hence, e^{FB} is incentive–compatible, and the project is continued in the good state and terminated in the bad state. By lemma 3, we know that the bank cannot do better. Furthermore, the firm cannot do better in ex ante terms. This information can be summarized as follows.

Proposition 5 *Suppose the bank is bound to take credit protection before it acquires private information about the value of the loan, and credit protection is disclosed to the borrower. Then, the hold–up problem arising from non–contractibility of credit protection can be resolved at zero cost.* ■

[16]The manager's effort problem boils down to choosing between zero effort and effort e^{FB}, which both give her a payoff of zero (all other effort levels would result in a negative payoff). The manager is thus indifferent between zero effort and effort e^{FB}. However, in the second case her firm is continued. We assume that this breaks the manager's indifference.

Thus, non–contractibility of credit protection does not impose a binding constraint. The parties can design a simple mechanism that resolves the hold–up problem at zero cost. This mechanism effectively incorporates the hold–up rent directly into the contract by increasing the firm's leverage. The bank pays for the hold–up rent by making an additional upfront cash transfer. The threat of termination ensures that the leverage increase does not distort the manager's incentive to exert effort.

To conclude this section, let us briefly discuss the case of unobservable credit protection. In this case, if the bank had full discretion in taking credit protection (and in forcing project termination) the credit market would break down. The reasoning is the following. When the borrower cannot observe the bank's activities in the credit protection market she cannot possibly impose a threat on the bank to exert zero effort should the bank take excessive credit protection. The bank then has an incentive to take additional credit protection to further strengthen its rent extraction power vis–à–vis the borrower (provided, of course, that market convention or legal constraints do not prevent the bank from taking excessive protection). The borrower of course anticipates the bank's incentive to take additional protection, and exerts zero effort. Given that, however, credit is not available in the first place.

In this situation, a simple covenant that constrains the bank's discretion in taking credit protection allows to restore first best efficiency.[17] Formally, this covenant would take the following form: $C_1 \leq (I - \mathcal{L})/\theta \equiv C_1^*$. The covenant would be matched with the loan contract as considered in section 2. This contract implements the first best, *even when the bank's actual credit derivative position is unobservable to the borrower*. This is because taking credit protection C_1^* is a (weakly) dominant strategy for the bank.[18] Anticipating that the bank takes credit protection C_1^*, the borrower's best response is to stick to the efficient course of action.

This analysis suggests that reporting requirements or covenants that constrain lenders' discretion in taking credit protection can enhance the effectiveness of the credit derivatives market. A reporting requirement would force the bank to disclose its credit derivative position to the reference entity in question. As seen above, in this case, there may be no need to constrain the bank's discretion in taking protection. Alternatively, the loan contract may specify a simple covenant that prevents the bank from taking *excessive* protection, as illustrated above.

[17]Likewise, as mentioned earlier, if credit protection were limited to "fair" losses (by convention or on legal grounds) then the rent extraction problem would not be an issue in the first place.

[18]Given $e \geq e^{FB}$ (and e very small), the bank is indifferent between $C_1 \in [0, C_1^*]$. Given $e < e^{FB}$ (but not too small), the bank strictly prefers C_1^*.

5 Discussion and Implications

This section provides a discussion of the model's empirical implications. Implication 1 summarizes the effects of the introduction of a viable credit derivatives market on credit availability and value creation in the corporate sector.

Implication 1 *The introduction of a viable credit derivatives market should lead to*

- *better corporate managerial incentives*
- *lower interest rates*
- *additional NPV creation (enhanced firm value, less credit rationing)*
- *more effective bank–borrower relationships.* ■

Credit derivatives enhance the effectiveness of bank oversight, which has positive implications for corporate managerial incentives. This leads to lower interest rates and additional net present value creation. While these empirical implications are in line with the views put forward by advocates of derivatives, they still await systematic empirical testing. Our analysis also suggests that credit derivatives make relationships more (rather than less) effective.[19]

The next implication relates the use of credit derivatives to observable firm and bank characteristics.

Implication 2 *(comparative statics)*

- *lenders to safer firms take less protection*
- *lenders to firms with more tangible assets take less protection*
- *lenders to firms with little internal funding capacity take more protection*
- *less capitalized lenders take more protection.* ■

The prediction that lending to safer firms with more tangible assets and less dependence on external finance is accompanied by less credit protection is intuitive, but still awaits systematic empirical testing. We also relate credit protection to observable characteristics at the bank level. In particular, the extent to which banks use credit protection is decreasing in their capital.

The empirically predicted negative relation between credit protection and asset tangibility allows to shed light on the relatively recent surge of the credit derivatives market. Given the

[19]It is interesting to relate this implication to Boot and Thakor (2000), who argue that competitive pressure from the arm's length financing market can encourage banks to become more client–driven and to focus more on relationship banking. In light of this view, banks' recent embracement of the credit derivatives market may well be interpreted as a strategic move to enhance their relationship management core competencies.

alleged benefits of credit derivatives, why did banks embrace the credit derivatives market only relatively recently? One reason could stem from recent changes in the *nature of the firm*. As has been emphasized by Zingales (2000), modern value creation modes rely heavily on human capital and other intangible assets — assets that are not prime candidates for bank collateral. Yet, collateral arguably makes it easier for banks to mitigate conflicts of interest in the corporate loan market. In such a world, banks should have an incentive to seek external collateral enhancements in the market for credit protection. This suggests a major economic function of the credit derivatives market could stem from the supply of collateral substitutes.

Implication 3 *Credit derivatives should exhibit maturities shorter than those of the underlying loans. An increase in bank capital widens the maturity mismatch.* ■

Our analysis thus generates testable predictions about the relation between the severity of bank capital constraints and credit protection maturity mismatches. See Duffee and Zhou (2001) for a discussion of empirical evidence that credit derivatives have maturities shorter than those of the underlying loans.

Implication 4 *The introduction and deepening of a viable credit derivatives market should have positive implications for value creation in the real sector. Yet, once banks have access to a viable credit derivatives market, increases in credit derivatives volumes may be accompanied by deteriorating loan performance.* ■

We believe this implication is a main insight of our study. The difference between implications 1 and 4 is that implication 1 refers to the effects of credit derivatives relative to a situation in which banks do not have access to a credit derivatives market. Implication 4 instead describes the empirically predicted relation between credit derivatives volumes and loan performance, *once* banks have access to a viable credit derivatives market. As the market for credit derivatives evolves, more and more banks embrace credit derivatives as vehicles to transfer risk, which entails a *permanent* boost to economy–wide performance. However, once banks have access to a viable credit derivatives market, changes in credit derivative volumes reflect changes in bank capital and other exogenous variables, which in turn affect loan performance.

Credit derivative volumes are then negatively correlated with loan performance. To see this consider, for example, a decrease in bank capital. A decrease in bank capital requires additional hedging, which stifles loan performance. Thus, loan performance is negatively correlated with credit derivative volumes. A similar conclusion applies to a number of exogenous variables in our model. Yet, it would be premature to infer from an empirically observed negative relation between credit derivative volumes and loan performance that credit protection destroys value. To the contrary, it adds value, for if banks were forced to slash credit protection, loan performance would be even worse or credit would not have been available in the first place.

Lastly, our analysis also has implications for the impact of credit derivatives on financial (and economy–wide) stability.

Implication 5 *The introduction of a viable credit derivatives market has ambiguous implications for financial market and economy–wide turbulence.* ■

Several countervailing effects are at work. As seen above, the introduction of a credit derivatives market boosts real sector performance, which arguably reduces financial market volatility. Yet, it also mitigates credit rationing. Naturally, this comes to the benefit of relatively low quality (but positive NPV) and hence *riskier* projects, thus increasing volatility. Whether the former or the latter effect dominates depends on the distribution of project risk in the economy. Credit derivatives also introduce spillover effects between bank capital and loan performance. This implies an increase in volatility. In particular, once banks have access to a viable credit derivatives market, swings in bank capital are associated with swings in loan performance. Another important effect stems from the fact that, on a net basis, banks transfer credit risks out of the banking system into the insurance and other non–bank sectors. To the extent that these sectors are less fragile and less prone to systemic risk problems than the banking sector, transfers of credit risk out of the banking sector may well go in the direction of reducing financial market turbulence.

6 Conclusion

Effective relationships are characterized by a healthy mix of "intimacy" and "distance". This paper has argued that the introduction of a viable credit derivatives market can *facilitate banks' quest for more effective relationships*. Credit protection makes it less costly for banks to let poorly performing borrowers fail, thereby enhancing banks' commitment to engage in timely intervention. Yet, while lenders' increased toughness facilitates the resolution of conflicts of interest between lenders and their corporate borrowers, full value maximization can be hampered by new conflicts of interests between bank–borrower coalitions and credit protection sellers: when the "insiders" are insured against fluctuations in long term firm value then their joint incentive to maximize value will be impaired. In contrast to first generation risk transfer instruments, such as loan sales, credit derivatives can be designed to mitigate these residual obstacles to firm value maximization. In this context, credit derivatives emerge as vehicles that facilitate the optimal *dynamic* management of client relationships in banks' core loan business, thereby promoting value creation in the real sector.

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Proofs

Proof of Lemma 1

Suppose outside financing is feasible and the termination incentive constraint (2) is not binding. We first demonstrate that in in equilibrium continuation in the good state is strictly efficient for the bank–borrower coalition. Let e^* denote the candidate equilibrium effort level. Since outside financing is feasible the equilibrium net present value must be non–negative,

$$\theta e^* \Pi + (1-\theta)\mathcal{L} - \psi(e^*) \geq I \tag{16}$$

which can be rewritten as

$$e^* \Pi - \mathcal{L} - \psi(e^*)/\theta \geq \frac{I - \mathcal{L}}{\theta} \tag{17}$$

Inequality (17), the continuation incentive constraint (1), and $\psi(e^*) > 0$ imply

$$e^* \Pi - \mathcal{L} > C_1 - (1-e^*) C_2 \tag{18}$$

or

$$e^*\Pi + (1-e^*)C_2 > \mathcal{L} + C_1 \tag{19}$$

Thus, in equilibrium, continuation in the good state is strictly efficient for the bank–borrower coalition.

Next, for a given effort level e, continuation in the good state is efficient for the insiders if and only if

$$e\Pi + (1-e)C_2 \geq \mathcal{L} + C_1 \tag{20}$$

Notice that the continuation and termination incentive constraints imply $R \geq C_2$. Since $\Pi > R$ we must have $\Pi > C_2$. There thus exists a threshold

$$e' = \frac{\mathcal{L} + C_1 - C_2}{\Pi - C_2} < e^* \tag{21}$$

such that continuation in the good state is jointly efficient for the insiders if and only if $e \geq e'$.

Now, suppose the continuation incentive constraint (1) holds with strict inequality, which implies $R > C_2$. For a given effort level e, the status–quo contract induces the bank to continue in the good state if and only if

$$eR + (1-e)C_2 \geq \mathcal{L} + C_1 \tag{22}$$

There thus exists a threshold

$$e'' = \frac{\mathcal{L} + C_1 - C_2}{R - C_2} \in (e', e^*) \tag{23}$$

such that under the status–quo contract the bank has no incentive to terminate in the good state if and only if $e \geq e''$.

We now construct the manager's payoff function. Suppose the manager exerts effort $e < e'$. In this case termination in the good state is efficient. Since the status–quo contract provides the bank with an incentive to terminate the project is terminated without renegotiation. Exerting effort $e < e'$ thus gives the manager a payoff of $-\psi(e)$. Next, suppose the manager takes effort $e \geq e''$. In this case continuation in the good state is efficient and the bank has an incentive to continue. Hence, the project is continued without renegotiation. Exerting effort $e \geq e''$ thus gives the manager an expected payoff of $\theta e(\Pi - R) - \psi(e)$. Lastly, suppose the manager exerts effort $e \in [e', e'')$. In this case the bank strictly prefers termination in the good state but termination is inefficient. In renegotiation, the manager offers the bank a new claim R' such that the bank is just willing to continue in the good state,

$$eR' + (1-e)C_2 = \mathcal{L} + C_1 \tag{24}$$

The manager's expected payoff from taking effort $e \in [e', e'')$ thus amounts to $\theta(e\Pi + (1-e)C_2 - \mathcal{L} - C_1) - \psi(e)$. The manager's payoff function thus reads

$$\mathcal{U}(e) = \begin{cases} -\psi(e) & \text{for } e < e' \\ \theta(e\Pi + (1-e)C_2 - \mathcal{L} - C_1) - \psi(e) & \text{for } e \in [e', e'') \\ \theta e(\Pi - R) - \psi(e) & \text{for } e \geq e'' \end{cases} \tag{25}$$

Notice that if the manager planned to exert effort $e < e'$ she would exert zero effort, which would give her a payoff of zero. Next, consider the range $e \geq e''$. Since $e^* > e''$ the effort level that maximizes the manager's payoff within this range (namely e^*) is characterized by the first order condition

$$\theta(\Pi - R) = \psi'(e^*) \tag{26}$$

Lastly, consider the range $e \in [e', e'')$. Within this range the derivative of the manager's payoff function is given by

$$\mathcal{U}'(e) = \theta(\Pi - C_2) - \psi'(e) \tag{27}$$

Since $e^* > e''$ and $C_2 < R$, we must have $\mathcal{U}'(e) > 0$ for all $e \in [e', e'']$ by concavity. Lastly, notice that $\mathcal{U}(e)$ is continuous in e and that $\mathcal{U}(e^*) \geq 0$ (by (16)). Thus, by concavity, e^* is incentive–compatible if and only if

$$\theta(\Pi - R) = \psi'(e^*) \tag{28}$$

Substituting for the bank's claim R, this reduces to

$$\varphi(e^*) = \theta\Pi - \frac{I - (1-\theta)\mathcal{L}}{e^*} - \psi'(e^*) = 0 \tag{29}$$

Since outside financing is feasible $\varphi(e^*) = 0$ must have a solution. By concavity any such solution is inferior to the first best effort level. Thus the optimal solution is given by the largest solution.

To complete the argument, let us show that if (29) has a solution then investment is efficient. Notice that (29) can be rewritten as

$$\theta e^*\Pi + (1-\theta)\mathcal{L} - I = e^*\psi'(e^*) \tag{30}$$

where the left hand side is project NPV gross of the effort cost. Thus investment is efficient if and only if $\xi(e^*) = e^*\psi'(e^*) - \psi(e^*) \geq 0$. Note that $\xi(0) = 0$ and $\xi'(e^*) = e^*\psi''(e^*) > 0$ for $e^* > 0$. Since $e^* > 0$ we must have $\xi(e^*) > 0$. Hence, if (29) has a solution, then investment is strictly efficient. Lastly, it is straightforward to show that (29) has a solution (i.e. outside financing is feasible) if and only if

$$\theta\tilde{e}\Pi + (1-\theta)\mathcal{L} - I \geq \tilde{e}\psi'(\tilde{e}) \tag{31}$$

where $\tilde{e}$ is the unique and interior solution of $e\psi''(e) = \theta\Pi - \psi'(e)$. The threshold $I^{\text{no cds}}$ follows straightforwardly. ■

Proof of Lemma 2

Fix a credit protection policy (C_1, C_2) such that the continuation incentive constraint (1) holds with equality. Hence, $e'' = e^*$, where e'' is given by (23). The manager's payoff function is then given by (see the proof of lemma 1):

$$U(e) = \begin{cases} -\psi(e) & \text{for } e < e' \\ \theta(e\Pi + (1-e)C_2 - \mathcal{L} - C_1) - \psi(e) & \text{for } e \in [e', e^*) \\ \theta e(\Pi - R) - \psi(e) & \text{for } e \geq e^* \end{cases} \tag{32}$$

Notice that $\mathcal{U}(e)$ is continuous in e. By concavity, e^* is incentive compatible only if

$$\theta(\Pi - C_2) - \psi'(e^*) \geq 0 \tag{33}$$

$$\theta(\Pi - R) - \psi'(e^*) \leq 0 \tag{34}$$

By $R > C_2$, (34) is not binding. (33) is binding if and only if $C_2 > 0$. Moreover, the manager must have no incentive to render continuation in the good state inefficient. If she had such an incentive she would exert zero effort which gives her a payoff of zero. By contrast, if she exerts effort e^* she derives a positive payoff. Thus, the equilibrium effort level is given by the solution of (33), which maximizes the surplus of the bank–borrower coalition. ■

Proof of Proposition 1

Follows immediately from lemma 2 and the observation that at $C_2 = 0$ the incentive constraint is not binding. ■

Proof of Proposition 2

For $K \geq \hat{K}$ neither the capital constraint nor the incentive constraint are binding, and hence the first is implementable. For $K < \hat{K}$ the reduced form incentive constraint reads

$$\varphi(e^*) = \theta\Pi - \frac{I - (1-\theta)\mathcal{L} - \theta K}{e^*} - \psi'(e^*) = 0 \tag{35}$$

The equilibrium effort level is then given by the largest solution of (35), denoted by e^{cds}. By concavity we must have $\varphi'(e^{\text{cds}}) < 0$ (generically). By the implicit function theorem,

$$\frac{d\,e^{\text{cds}}}{d\,K} = -\frac{\theta/e^{\text{cds}}}{\varphi'(e^{\text{cds}})} > 0 \tag{36}$$

As $K \to 0$, (35) converges to the reduced form incentive constraint in the absence of credit protection, (29), and hence $\lim_{K\to 0} e^{\text{cds}} = e^{\text{no cds}}$. The credit rationing threshold $I^{\text{cds}}(K)$ follows straightforwardly. ■

Proofs of Propositions 3 to 5

See the discussion in the text. ■