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

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1 Introduction

Commercial banks increasingly rely on credit derivatives to protect themselves against default risk. The British Bankers' Association estimates that by the end of 1999 the global market for credit derivatives reached USD 568bn (BBA 2000). The Office of the Comptroller of the Currency reports that in the third quarter of 2001, US commercial banks held credit derivatives with a notional amount of USD 360bn, representing a more than 6–fold increase since 1997 (OCC 2001). To put these numbers into perspective, the overall market for derivative contracts in the US amounted to USD 51 trillion. Credit derivatives thus represent less than one percent of the overall market for derivative contracts. However, the market for derivatives increased only 2–fold from 1997 to 2001. Thus, relative to other derivative products, the market for credit derivatives is still at its infancy but growing at rapid pace.[1]

There is substantial debate among both practitioners and academics about the economic consequences of banks' ever increasing reliance on credit derivatives (see, among others, Kiff and Morrow 2000, Scott–Quinn and Walmsley 1998, Tavakoli 2001, and Euromoney 2002).[2] The debate is centered around three issues: (i) How does the use of credit derivatives affect banks' incentives to monitor loans? In particular, does credit insurance undermine banks' monitoring incentives? (ii) Conversely, do banks enjoying default protection have excessive incentives to push their borrowers into default and liquidation?[3] That is, will the growth of the credit derivative market lead to an increased number of bankruptcies and worsening firm performance? (iii) What is the appropriate definition of an event triggering a payment from the protection seller to a protection buyer? Should a protection buyer be able to collect a payment only if the reference entity defaults? Or should a payment already be triggered when the reference entity does not default but enters restructuring? Would the former option induce banks to forego restructuring options and thus foster asset destruction?

This paper develops a formal framework to explore these issues and to assess the value contribution of credit derivatives. The framework elaborates on the interaction between a firm in need of outside funding, a bank, and an arm's length third party credit insurer.[4] The bank's role is to provide funding and to monitor the firm's man-

[1] During 2000–2002, there were a number of instances where restructuring or default of reference entities triggered credit protection payments. Examples include Conseco, SAirGroup, Railtrack, Edison, Comdisco, K–Mart, Armstrong, and Enron.

[2] Other useful references include credit derivatives specials in CreditRisk, March 2001, and Derivatives Strategy, January 2001.

[3] For example, Scott–Quinn and Walmsley 1998 argue that "*a situation could be envisaged where a bank which has credit protection might choose to 'play hard–ball' to maximize its recovery, secure in the knowledge that if it does tip the borrower into bankruptcy it is covered by its credit protection. One possibility might be a bank which has covenants in a loan which normally it might consider waiving. It might decide not to waive them, in order to trigger a default and collect on its protection.*" (p. 46)

[4] One reason why credit derivatives differ from credit insurance is that under credit insurance

agement. Monitoring enables the bank to obtain information about management's decision making and external influences affecting the firm's prospects. By expending effort (working hard, choosing the right project, etc.), management enhances the long term success prospects of the firm. The role of the credit insurer is to provide the bank with short term and/or long term credit protection (for example, by offering the bank a *credit–default swap*, which promises the bank a payment should the borrower default in exchange for a fixed premium).[5] Within this framework, we will analyze the effects of credit derivatives on (i) the bank's incentives to *monitor* the firm, i.e. to gather information about management's decision making and external influences affecting loan performance; (ii) its incentives to eventually *intervene* and liquidate the firm; and, ultimately, (iii) managerial incentives to *perform*.

Our central finding is that credit derivatives (or credit insurance) can *enhance* banks' incentives to monitor, their incentives to intervene, and managerial incentives to perform. While counterintuitive at first sight, the intuition behind this result is straightforward when noting that credit derivatives can have shorter maturities than the maturities of the underlying assets. As such, credit derivatives can be targeted to improve the bank's payoff at the interim liquidation stage. In particular, credit derivatives with short term maturity shift the balance between what the bank has to lose and what it has to gain from intervening and liquidating the borrower towards the benefit side. Short term credit insurance thus strengthens the credibility of a threat to liquidate the firm should management show poor performance. This enhances the bank's ability to incentivize management to choose value maximizing decisions, rather than behaving opportunistically. In contrast, if the bank did not source short term credit insurance, its incentives to respond to poor performance with intervention would be limited, as it would have too much to lose (its long term claim in the firm) but too little to gain (the assets' collateral value) from liquidating the firm and seizing its assets. While short term credit insurance strengthens intervention incentives, the credit insurer's break even constraint ensures that the bank won't have *excessive* incentives to liquidate. Credit derivatives with short term maturity thus introduce an additional degree of freedom, which allows to optimize the balance between too soft and excessive incentives to intervene.

Credit derivatives with long term maturity weaken incentives to intervene, ceteris paribus. This is because they shift the balance between what the bank has to lose and what is has to gain from terminating the firm towards the cost side. However, intervention incentives can be maintained by sourcing more short term credit insurance. Nevertheless, long term credit insurance worsens managerial incentives to perform, stemming from a *dilution* effect. In particular, while management is full residual claimant with respect to the bank as long as liquidation threats are credi-

the protection buyer has to own the underlying asset (in particular, the protection buyer must prove loss before making a claim). This is not the case with a credit derivative, which may be held for purely speculative reasons. This difference plays no role in our setting.

[5] See e.g. Tavakoli 2001 and Euromoney 2002 for descriptions of different credit derivative instruments used in practice.

ble, management does not internalize the negative externalities shirking impose on the (arm's length) credit insurance counterparties. Long term credit insurance thus distorts managerial incentives by diluting management's claim.

Credit derivatives with short term (long term) maturity strengthen (weaken) incentives to engage in costly monitoring, i.e. to gather information about the firm's prospects. In our setting, monitoring *incentives* stem from preventing management to continue the firm in bad states of the world. Short term credit insurance strengthens monitoring incentives as it improves the bank's payoff from liquidating the firm. Conversely, long term credit insurance worsens monitoring incentives as it protects the bank against long term credit risk. Yet, while these features explain why the bank would engage in costly monitoring (if it cannot a priori commit to monitor), it does not explain why the parties would envision a mechanism that commits the bank to monitor. Sourcing short term credit insurance or altering the bank's financial claim on the firm's cash flows in order to commit the bank to monitor is justified only if monitoring and intervention threats strengthen managerial incentives to perform. The analysis thus points to a *complementarity* between enhancing bank incentives to monitor and strengthening managerial performance incentives. Monitoring incentives can be further strengthened by increasing the riskiness of the bank's *long term* financial claim. This can be achieved through equity financing or reverse credit insurance (i.e. the bank making a payment to the counterparty should the borrower default on a *long term* claim).

Our research adds to several strands of the literature. In a seminal contribution, Diamond (1984) points to the role of loan portfolio diversification in financial intermediation and delegated monitoring. Diversification allows to minimize bank insolvency risk and hence to avoid deadweight bankruptcy costs. Yet, monitoring incentives are maintained as banks are fully exposed to individual credit risks. Efficiency gains stemming from loan portfolio diversification and delegated monitoring are passed on to the originators of real investment projects, thus fostering value creation.

Building on Diamond's insight, a large literature explores the costs and benefits of diverse risk management techniques in banking when diversification is subject to limits or costly and banks face financing constraints (see, among others, Carlstrom and Samolyk 1995, Duffee and Zhou 2001, Froot and Stein 1998, Gorton and Pennachi 1995, and James 1988). For example, Gorton and Pennacchi (1995) show that a capital constrained bank, which seeks to transfer loan portfolio risk to outside parties through loan sales, may want to retain part of its loan portfolio in order preserve its monitoring incentives. Duffee and Zhou (2001) demonstrate that a capital constrained bank may want to use credit derivatives in risk transfers, rather than relying on loan sales. They show that credit derivatives make it easier for a bank to circumvent the "lemons" problem caused by banks' superior information about the credit quality of their loans. Our framework deliberately abstracts from financing constraints at the bank level. This is not to dispute that financing constraints and bankruptcy deadweight costs provide important motivations for banks to source insurance against credit risk.[6] Rather, the objective of our paper is to show that credit insurance has important effects on bank–borrower relationships for reasons other than financing constraints at the bank level and bankruptcy deadweight costs.

We depart from much of the bank monitoring literature in that our framework opens up the monitoring "black box".[7] In particular, we distinguish between monitoring and intervention incentives. In our setting, monitoring refers to gathering information about a firm's decision making and external influences affecting the firm's prospects. The question how investors use this information is different from the question how to incentivize investors to acquire information in the first place. Intervention refers to using information obtained through monitoring in order to discipline management. By distinguishing between monitoring and intervention incentives (and endogenizing both of them), we are able to derive novel insights about the merits of credit derivatives in relationship banking.

The present paper is related to Rajan and Winton (1995), who discuss the impact of *covenants* and *collateral* on a bank's incentives to engage in monitoring. They show that covenants and collateral can be motivated as contractual devices that increase a lender's incentives to monitor in order to prevent inefficient continuation. This differs from our setting where preventing inefficient continuation alone is not sufficient as to justify providing the bank with additional collateral (through sourcing short term credit insurance). Rather, the benefits of short term credit insurance stem from improving managerial incentives to perform through enhancing the bank's incentives to monitor and to intervene. Manove et al. (2001) point to the downside of collateral protection. They show that strong creditor protection may lead to circumstances in which cheap credit is inappropriately emphasized over project screening. Restrictions on collateral requirements can redress this imbalance and increase credit–market efficiency.[8]

This paper also draws on the corporate finance literature on hardening firms' budget constraints (Berglöf and von Thadden 1994, Bolton and Scharfstein 1996, Dewatripont and Tirole 1994, Hart and Moore 1995, 1998, Repullo and Suarez

[6]Our framework also abstracts from regulatory capital arbitrage issues. Under current capital adequacy regulation, banks have to put aside regulatory capital for individual credit risks, even if individual credit risks reduce aggregate loan portfolio risk (i.e. banks are penalized for diversifying their loan portfolios). Thus, banks may want to get rid of individual credit risks in order to relieve their regulatory capital constraints. See, for example, Tavakoli 2001 for further discussion of regulatory capital arbitrage issues arising in practice.

[7]For example, in Diamond 1984 and Besanko and Kanatas 1993, "monitoring" refers to committing management to first best actions. In Gorton and Pennachi 1995, "monitoring" refers to enhancing the long term value of a loan. In Holmström and Tirole 1997, "monitoring", if taken literally, refers to reducing management's private benefits from shirking. This may be best interpreted as providing management with advice or interfering with managerial decision making. Our approach is more in line with e.g. von Thadden 1995, Rajan 1992, and Repullo and Suarez 1998, where monitoring refers to gathering "soft" information.

[8]Their argument mirrors ours that long term credit insurance may undermine monitoring and intervention incentives (we show, however, that this problem can be addressed through the bank sourcing more short term credit insurance).

1998). For example, Berglöf and von Thadden (1994) show that separating short–term and long–term claims and allocating these claims to different classes of investors allows to commit management not to hold up investors ex post. Dewatripont and Tirole (1994) point to the role of debt and equity in balancing outside investors' intervention incentives. Hart and Moore (1995) also point to the merits of "hard claims" (e.g. senior debt) in committing outsiders to intervene and in constraining management. Closest related to our framework, Repullo and Suarez (1998) demonstrate that multiple source financing and collateral help to improve the disciplinary power of liquidation threats and thus to strengthen managerial performance incentives. Our analysis suggests that short term credit insurance can effectively serve as a substitute for collateral.

The paper proceeds as follows. Section 2 outlines the formal framework and the main assumptions. Section 3 explore the effects of credit derivatives with short term and long term maturity on incentives to *intervene*. Section 4 explores a bank's incentives to *monitor* when sourcing credit insurance. Section 5 concludes. Proofs are relegated to the appendix.

2 Model

2.1 Informal Overview

The framework elaborates on the financing relationship between a firm in need of outside funding and a bank which may source short or long term credit insurance from a third party. The firm's investment project generates long term returns; at an interim stage the project might be liquidated. Long term credit insurance reduces the bank's exposure to *long term* credit risk, while short term credit insurance is meant to improve the bank's payoff from *liquidating* the firm at the interim stage (this feature will be discussed in detail below). The firm is run by a management team whose role is to work hard and ensure that the project is successful. By *monitoring* the firm, the bank *observes* management's decision making and external influences affecting the firm's prospects. Within this framework, we explore how short and long term credit insurance affects (i) the bank's incentives to *monitor*, (ii) its incentives to *intervene* at the interim stage, and ultimately, (iii) managerial incentives to perform.

2.2 Agents, Timing, and Information

There are three agents: a *firm* with zero internal funds, a *bank* with deep pockets, and a third party, referred to as the *credit insurer*. The firm is in need of outside funding, which is to be provided by the bank. The credit insurer's role is to offer the bank protection against default risk. All parties are risk neutral and there is no discounting. There are four dates, $t = 0, 1, 2, 3$. The timing of events is summarized in figure 1.

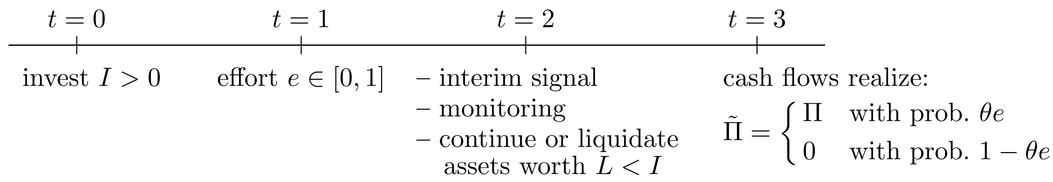

Figure 1: Timing

At $t = 0$, the firm has to finance a fixed investment outlay I. At $t = 1$, the firm's management/owner expends privately costly effort $e \in [0, 1]$ (examples include working hard, choosing the right project, finding out what customers want, etc.). The effort cost function $\psi(e)$ is twice continuously differentiable, strictly increasing and convex, and satisfies the following standard regularity conditions: $\psi(0) = 0$, $\psi'(0) = 0$, and $\lim_{e \to 1} \psi'(e) = \infty$. The more effort management expends at this stage, the larger will be the likelihood that the firm will be successful when final and verifiable cash flows realize at $t = 3$. From an *ex ante* perspective, the firm is successful with probability θe in which case it generates cash flows $\Pi > I$. With probability $1 - \theta e$, the firm fails and cash flows are zero.

Apart from providing financing, a key role of the bank is to *monitor* the firm. This involves visiting the firm, inspecting management's decision making, and evaluating external influences affecting the firm's prospects. The bank's ability to *commit* to such monitoring activities will be discussed in more detail below. Monitoring enables the bank to obtain two critical pieces of information, (i) management's decision making (i.e. its effort expended at $t = 1$), and (ii) external influences affecting the firm's prospects. Formally, with probability $1 - \theta$, management and the bank (if it monitors) receive a *bad* signal at $t = 2$, indicating that cash flows will be zero with probability one. For example, the firm's innovation may leak to a competitor, a competitor may come up with a superior product, or potential customers may turn out to be no longer interested in the firm's product. These events would severely undermine the firm's prospects. With probability θ, the parties receive a good signal, indicating that the firm will be successful with probability e and fail with probability $1 - e$. In what follows, we will frequently refer to the realization of the good signal as the good state and the realization of the bad signal as the bade state. While both management and the bank can observe effort and the interim signal, neither effort nor the interim signal are verifiable in court (in other words, information obtained through monitoring is soft). This precludes conditioning financial contracts on either effort or the signal.

The firm's assets have a liquidation value L at $t = 2$, where $0 < L < I$, and zero liquidation value at $t = 3$. Hence, conditional on the parties receiving the bad signal, it is efficient to liquidate the firm's assets and deploy them elsewhere. Conditional on the good signal, the firm's going concern value is given by $e\Pi$, while its liquidation value is given by L. Hence, liquidation is inefficient if and only if $e \geq L/\Pi$. The *first best* effort level e^{FB} is given by the solution of $\theta\Pi - \psi'(e) = 0$.

In order to make the analysis interesting, we assume that liquidation is inefficient, conditional on the good signal and first best effort, $e^{FB}\Pi > L$. Furthermore, the firm's net present value under the first best is strictly positive,

$$\theta e^{FB}\Pi + (1-\theta)L - I - \psi(e^{FB}) > 0 \tag{1}$$

While effort and the interim signal are observable by the "insiders", i.e. management and the bank, the credit insurer observes *neither* piece of information. In other words, there is asymmetric information between the credit insurer and the insiders. Finally, there is perfect competition in the banking and credit insurance markets. Hence, in equilibrium, both the bank and the credit insurer just break even.

2.3 Monitoring vs Intervention Incentives

In our framework, there will be an important difference between *incentives to monitor* (i.e. to gather information) and *incentives to intervene* (i.e. to use information obtained through monitoring). In order to elaborate on this feature we will first assume that the bank can *commit* to monitor the firm and subsequently drop this assumption. If the bank can commit to monitor, it expends some (small) cost $c > 0$ at $t = 0$, after having funded the firm. This can be interpreted as an investment into the bank's monitoring ability. Once the monitoring expense is sunk, the bank is able to monitor at zero cost (and management knows that it will be monitored). Under the no–commitment regime, the bank is unable to commit to monitor. Formally, after management has made its effort decision and after the realization of the interim signal, the bank has to decide whether to inspect the firm at a cost $c > 0$ or whether to leave the firm unmonitored. In our framework, monitoring will be worthwhile for two reasons:

1. Provided the bank is granted the *right* to liquidate the firm, it can condition its decision whether to "pull the plug" and terminate the firm on management's effort choice. In particular, the bank may use the right to liquidate as a threat point in renegotiation in order to extract a higher payment from the firm should it observe that management shirked. As a result, management will internalize the cost of shirking imposed on the bank and, consequently, will be less inclined to shirk. We assume that the firm has the entire bargaining power in renegotiation. This assumption allows to abstract from a hold up problem à la Rajan (1992) and thus to focus on the merits of liquidation threats as a disciplinary device. Crucially, however, termination threats may lack credibility. A key novelty of the paper is to analyze how the use credit derivatives affects the credibility of termination threats.

2. Monitoring also enables the bank to prevent management from continuing the firm in the bad state. We assume that if management is left unmonitored, it would never self–liquidate the firm.[9] Hence, as will be shown below, monitoring ensures efficient liquidation decisions.

[9]This may or may not stem from managerial private benefits. In particular, in our setting, the

2.4 Contracts

Rather than imposing specific classes of contracts, we adopt the strategy to derive the optimal contracts and to match these contracts with financial contracts used in practice. Liquidation at $t = 2$ and final cash flows at $t = 3$ are verifiable. Hence, contracts will condition on these variables. A credit contract between the bank and the firm specifies *long term* payments R_H and R_L from the bank to the firm, conditional on the high and the low cash flow state, respectively.[10] Without loss of generality, suppose the bank does not invest more than I and is granted the *option* to liquidate the firm at $t = 2$ and to seize its assets.[11]

A credit insurance contract between the bank and the credit insurer specifies a premium P to be paid by the bank at $t = 0$, *long term* credit insurance payments C_H and C_L from the credit insurer to the bank (conditional on $t = 3$ cash flow realizations), and a *short term* insurance payment C_0 if the bank *liquidates* at $t = 2$. The bank's total expense at $t = 0$ is thus given by $I+P$. It is relatively unimportant for the analysis whether short term credit insurance payments condition on liquidation or on default, as long as the bank does not lose its credit insurance claims if it liquidates the firm after default.[12] If short term credit insurance contracts conditioned on default, one would have to specify an additional short term debt repayment such that the borrower must default if credit terms are not renegotiated prior to $t = 2$ (and after the bank monitored). The bank has then the option to induce default, collect the credit insurance payment (in which case it must transfer its cash flow rights to the credit insurer), and liquidate the firm. Alternatively, the bank can either renegotiate credit terms with the borrower as to avoid default or renegotiate after default, forego the credit insurance payment, and keep its claim on the firm. For the rest of the paper, we adopt the convention that short term

parties may want to manipulate the financial contract such that management has incentives to continue in the bad state, if left unmonitored. This will be beneficial in order to commit the bank to monitor.

[10] In addition, one could specify a *short term* payment R_0 if the firm is liquidated at $t = 2$. From the firm's wealth constraint such a payment would have to be non–positive, and, hence, it would only put a burden on the bank's incentives to intervene. Thus, $R_0 = 0$ will be optimal. A different question is how to *interpret* the class of contracts under consideration. As in Rajan (1992), one may want to specify some short term credit payment in order to *induce* default at $t = 2$. Standard short term debt would then give the bank the right to intervene and to liquidate.

[11] This will be optimal in our framework. We exclude partial liquidation or the parties committing to a randomization device. Extending the model along those lines would not alter its qualitative insights.

[12] If bankruptcy were costly for management, the bank could very well transfer cash flow and liquidation rights to the credit insurer after default and collection of the credit insurance payment (furthermore, the bank could lose its claim on the credit insurer if it liquidated). Bankruptcy frequently imposes deadweight costs on firms as customers and suppliers are typically reluctant to engage in further transactions with a firm once the firm filed for bankruptcy (Opler and Titman 1994, Titman 1984). Hence, once the firm declared bankruptcy, it might be most efficient to proceed with liquidation. It is then up to the bank to waive its short term debt claims in order to avoid this adverse event. Short term credit insurance enhances the bank's bargaining power in short term debt renegotiations.

credit insurance contracts condition on liquidation, rather than on default.

The firm is protected by limited liability (it cannot pay out more than it has). In contrast, the bank is not protected by limited liability (it has deep pockets). In particular, we allow for negative payments from the credit insurer to the bank (e.g. $C_L < 0$). We restrict, however, attention to credit insurance contracts with a non–negative premium, i.e. $P \geq 0$. As is standard in models with multiple investors, we exclude renegotiation between the bank and the third party credit insurer. In particular, the bank cannot impose a threat on the credit insurer to liquidate the firm, extract a payment from the credit insurer, and subsequently let the firm continue (and keep its claim on the firm). This can be motivated on several grounds: (i) since the credit insurer is at arm's length, renegotiation between the credit insurer and the bank will be impeded by asymmetric information; (ii) without loss of generality, one could allow the bank to source default protection from *many* credit insurers. Presumably, renegotiation with all of those credit insurers would be very cumbersome and costly for the bank. Hence, sourcing credit insurance from many parties would commit the bank not to hold up credit insurers ex post;[13] (iii) the credit insurer could have the bargaining power over the bank, in which case the hold up problem would not arise in the first place.

3 Incentives to Intervene

This section elaborates on how credit derivatives (or credit insurance) affect the bank's incentives to *intervene* when it can *commit* to monitor. First, the optimal credit contract between the bank and the firm in the absence of credit derivatives is derived. We will show then how credit derivatives allow to *improve* the bank's intervention incentives.

3.1 Contracting in the absence of credit insurance

Suppose the bank does not source credit insurance and commits to monitor by incurring the monitoring cost c. Since the bank has the choice between liquidating the firm's assets or letting the firm continue, the bank has to decide what to do after having observed management's effort and the interim signal. If the bank liquidates, its payoff will be given by L. If the bank does not liquidate after having received the good signal, its payoff will amount to $eR_H + (1-e)R_L$. After the bad signal, if the bank does not liquidate, its payoff will be given by R_L. Thus, to ensure that the bank liquidates in the bad state we must have $L \geq R_L$. To ensure that the bank does not liquidate in the good state, given management's equilibrium effort level e^{**}, we need

$$e^{**}R_H + (1-e^{**})R_L \geq L \tag{2}$$

[13] An arm's length relationship between the credit insurer and the bank is equally important as to avoid collusion at the expense of the firm. Credit derivatives constitute such arm's length financial instruments.

Suppose that in equilibrium the liquidation policy is efficient. Then, for the bank to break even, we must have

$$\theta(e^{**}R_H + (1-e^{**})R_L) + (1-\theta)L \geq I + c \tag{3}$$

We will now show that a threat to terminate following a small deviation from the equilibrium effort level cannot be credible when the bank does not source credit insurance. Suppose, to the contrary, that a threat to terminate is credible. Hence, for any $e < e^{**}$, the bank's payoff from continuation must not be larger than its payoff from liquidation. Formally, for any $e < e^{**}$,

$$eR_H + (1-e)R_L \leq L \tag{4}$$

Thus, from (2) and by continuity,

$$e^{**}R_H + (1-e^{**})R_L = L \tag{5}$$

and $R_H \geq R_L$. From (3), $L \geq I + c$, which contradicts $L < I$. Therefore, a threat to liquidate following a small deviation from the equilibrium effort level cannot be credible.

Lemma 1 *Suppose the bank does not source credit insurance. Then, as long as the bank breaks even in equilibrium, a threat to intervene and liquidate the firm following a small deviation from the equilibrium effort level lacks credibility.* ■

Intuitively, the bank has *too much to lose* and *too little to gain* from liquidating the firm following a small deviation from the equilibrium effort level. If it decided to liquidate, the bank would lose its stake in the firm, which in equilibrium is just sufficient to compensate the bank for its initial investment. It would gain the liquidation proceeds but these are not sufficient for the bank to be willing to forego its stake in the firm.

The lemma implies that the bank would not use the termination option as a threat point in renegotiation if management picked an effort level slightly lower than the equilibrium effort level e^{**}. Hence, around e^{**} management's payoff is given by

$$\theta(e(\Pi - R_H) - (1-e)R_L) - \psi(e) \tag{6}$$

The equilibrium effort level is thus characterized by the standard incentive constraint,

$$\theta(\Pi - R_H + R_L) - \psi'(e^{**}) = 0 \tag{7}$$

Suppose that $R_H > R_L$ at the optimum (i.e. the first best effort level is not achievable). Hence, an optimal contract will minimize $R_H - R_L$ subject to the bank's break even constraint and the two limited liability constraints, $R_H \leq \Pi$ and $R_L \leq 0$. The solution to this problem is $R_L = 0$ and

$$R_H = \frac{I + c - (1-\theta)L}{\theta e^{**}} > 0 \tag{8}$$

The following proposition characterizes the optimal contract and the equilibrium effort level when the bank does not source credit insurance:

Proposition 1 *Suppose the bank does not source credit insurance. Then, if outside funding is feasible, the firm is financed with debt, giving the bank a senior claim on the firm's cash flows,*

$$R = \frac{I + c - (1-\theta)L}{\theta e^{**}} \tag{9}$$

The bank has the right to call the loan and seize the firm's assets if the firm cannot fulfill its payment obligations. In equilibrium, management expends effort given by the largest solution of

$$\theta \Pi - \frac{I + c - (1-\theta)L}{e^{**}} - \psi'(e^{**}) = 0, \tag{10}$$

and the firm is liquidated in the bad state and continued in the good state. ■

Monitoring and the bank's liquidation rights' only role is to avoid inefficient continuation in the bad state. They play no role in terms of disciplining management. Under monitoring, the surplus is given by

$$\theta e^{**}\Pi + (1-\theta)L - I - c - \psi(e^{**}) \tag{11}$$

Conversely, if the bank did not monitor the firm, the surplus would be given by

$$\theta e^{**}(0)\Pi - I - \psi(e^{**}(0)) \tag{12}$$

where $e^{**}(0)$ denotes the equilibrium effort level if the bank does not monitor. Hence, the surplus gain from monitoring is given by $(1-\theta)L - c$, *and* the efficiency gains stemming from management's improved incentives due to the lower outside financing burden.[14] Monitoring is thus efficient as long as the monitoring cost c is sufficiently small. However, outside financing may not be feasible (in which case monitoring is obviously inefficient). While launching the project is efficient under the first best, it may well be inefficient to launch the project under the second best. In what follows, we will show how credit insurance allows to address this problem.

3.2 Credit insurance

Preliminaries: A credit insurance contract specifies a premium P, to be paid at $t = 0$, a payment C_0 from the credit insurer to the bank if the firm is liquidated, and payments C_L and C_H if the firm is continued, conditional on the low and high cash flow state, respectively. In order to ensure that the bank liquidates the firm in the bad state, we must have $L + C_0 \geq R_L + C_L$. In the good state, the bank must not liquidate in equilibrium. Letting e^* denote the equilibrium effort level, the corresponding incentive constraint amounts to

$$e^*(R_H + C_H) + (1-e^*)(R_L + C_L) \geq L + C_0 \tag{13}$$

[14]Conversely, when $(1-\theta)L < c$, the efficiency loss from monitoring is given by the direct loss $(1-\theta)L - c$ and the loss stemming from worse performance through the higher outside financing burden. This has an important implication for the role of credit insurance in terms of enhancing the bank's monitoring incentives, which will be discussed in detail in section 4.

Thus, for the bank just to break even,

$$\theta(e^*(R_H + C_H) + (1 - e^*)(R_L + C_L)) + (1 - \theta)(L + C_0) = I + P + c \tag{14}$$

Conversely, for the credit insurer just to break even,

$$\theta(e^* C_H + (1 - e^*)C_L) + (1 - \theta)C_0 = P \tag{15}$$

Suppose $e^* > e^{**}$, otherwise sourcing credit insurance would be pointless in our framework. Therefore, a threat to liquidate the firm must be credible for any "downwards" deviation from e^*. Formally, for *any* $e < e^*$,

$$e(R_H + C_H) + (1 - e)(R_L + C_L) \leq L + C_0 \tag{16}$$

Hence, from (13) and by continuity,

$$e^*(R_H + C_H) + (1 - e^*)(R_L + C_L) = L + C_0 \tag{17}$$

and $R_H + C_H \geq R_L + C_L$. Therefore, from (14), $L + C_0 = I + P + c$. Substituting P from the credit insurer's break even constraint (15), the *short term* credit insurance payment thus amounts to

$$C_0 = e^* C_H + (1 - e^*)C_L + \frac{I + c - L}{\theta} \tag{18}$$

This analysis yields two important insights: (i) *short term* credit insurance improves the bank's incentives to intervene, i.e. strenghtens the credibility of termination threats.[15] Intuitively, short term credit insurance is like providing additional collateral, and the more valuable is collateral, the more the bank has to gain from liquidating; (ii) in order to maintain the bank's incentives to intervene, *short term* credit insurance must be positively correlated with *long term* credit insurance. In particular, the short term credit insurance payment is increasing in the long term credit insurance payments C_L and C_H. Long term credit insurance ceteris paribus worsens the bank's incentives to intervene as it has more to lose from liquidating (namely the long term credit insurance payments). Hence, if the bank sources long term credit insurance, it has to source more short term credit insurance in order to preserve its intervention incentives.

Note too that short term credit insurance is increasing in $I + c$ but decreasing in L. This is because when $I + c$ is large, the bank must be promised a fairly large stake in the firm. This shifts the balance between the benefits and the costs of liquidation towards the cost side. Conversely, if L is large, the bank already has quite a bit to gain from liquidating. Hence, the additional short term credit insurance payment needed to close the credibility gap is rather small. Finally, short term credit insurance is increasing in the *cash flow riskiness* of the firm (the inverse of the likelihood of the good state). However, this does not stem from the bank's own financing constraints, but from the fact that when the likelihood of the good

[15] Note that $P \geq 0$ and $I + c > L$ imply that $C_0 > 0$.

state is small the bank must be promised a fairly large stake in the firm. Hence, the short term credit insurance payment has to be relatively large in order to maintain the bank's incentives to liquidate and to forego its stake in the firm.

Consider then management's decision problem. Since a termination threat is credible, the bank would not be willing to let the firm continue if management shirked. Hence, following a deviation from the equilibrium effort level, $e < e^*$, management would have to raise the bank's compensation to induce the bank to forego the termination option (in the good state). Management thus offers some feasible payments $R'_H \leq \Pi$ and $R'_L \leq 0$ such that the bank is just willing to let the firm continue,[16]

$$e(R'_H + C_H) + (1 - e)(R'_L + C_L) = L + C_0 \tag{19}$$

Consequently, for $e < e^*$, management's payoff (before taking effort) would be given by

$$\theta(e(\Pi + C_H) + (1 - e)C_L) - \theta(L + C_0) - \psi(e) \tag{20}$$

Conversely, for $e \geq e^*$, management's payoff amounts to

$$\theta(e(\Pi - R_H) - (1 - e)R_L) - \psi(e) \tag{21}$$

Note that from (17) management's payoff function is continuous in e. By concavity, the equilibrium effort level e^* is thus incentive compatible if and only if

$$\theta(\Pi + C_H - C_L) - \psi'(e^*) \geq 0 \tag{22}$$

and

$$\theta(\Pi - R_H + R_L) - \psi'(e^*) \leq 0 \tag{23}$$

The "downwards" incentive constraint (22) ensures $e \geq e^*$, while the "upwards" incentive constraint (23) ensures $e \leq e^*$. By inspection, the *long term* credit insurance payments feed into the "downwards" incentive constraint (22). This is because when using the termination option as a threat point in renegotiation, the bank's status quo payoff, $L + C_0$, does not depend on the long term credit insurance payments. Hence, the credit insurance payments will be captured by management. As a result, long term credit insurance may distort performance incentives. In particular, the first best can be implemented only if $C_H \geq C_L$. A large credit insurance payment in the low cash flow state indirectly *rewards* management for expending low effort. Intuitively, as long as the termination threat is credible, management fully internalizes the negative externality poor performance imposes on the *bank's* payoff. However, management does not internalize any negative externalities imposed on the credit insurer as the latter is at arm's length. Hence, as long as the firm is not full residual claimant with respect to the credit insurer ($C_H \geq C_L$), management's

[16] This holds true for small deviations from the equilibrium effort level. If management showed very poor performance, continuation would be inefficient in which case the bank would always liquidate. We show in the appendix that management's incentive constraint not to choose such very low effort levels is not binding.

claim is diluted. More importantly, as long as $C_H \geq C_L$ and $R_H \geq R_L$, neither incentive constraint is binding at the first best effort level e^{FB}. Hence, provided the bank does not source long term credit insurance and a termination threat is credible, the first best is achievable.

Optimal credit insurance: Since the firm extracts the entire surplus, the optimal credit and credit insurance contracts maximize the joint surplus subject to the previously derived constraints. In particular, the *first best*, $e^* = e^{FB}$, can be implemented if and only if there exist payments (R_H, R_L) and (P, C_H, C_L, C_0) such that (i) the payments are feasible, $R_H \leq \Pi$ and $R_L \leq 0$, (ii) the liquidation policy is ex post efficient (at the equilibrium effort level) and incentive compatible, $L + C_0 \geq R_L + C_L$, $R_H + C_H \geq R_L + C_L$, and

$$C_0 = e^{FB} C_H + (1 - e^{FB}) C_L + \frac{I + c - L}{\theta}, \tag{24}$$

(iii) the bank and the credit insurer break even in equilibrium, and (iv) the incentive constraints (22) and (23) are satisfied at the first best, $C_H \geq C_L$ and $R_H \geq R_L$.

A particularly appealing contract that implements the *first best* is pure short term credit insurance, $C_L = C_H = 0$. From (18), the short term credit insurance payment amounts to

$$C_0 = \frac{I + c - L}{\theta} \tag{25}$$

The premium the bank pays to the credit insurer is thus given by

$$P = (1 - \theta) \frac{I + c - L}{\theta} \tag{26}$$

For the bank to break even (and to satisfy the other constraints), standard debt will be fine. Hence, $R_L = 0$ and, from the bank's break even constraint,

$$R_H = \frac{I + c - (1 - \theta) L}{\theta e^{FB}} \tag{27}$$

We are ready to claim the following

Proposition 2 *An optimal credit insurance contract stipulates that the bank receives short term credit insurance but no long term credit insurance. In the bad state, the bank liquidates, seizes the firm's assets and receives a payment* $C_0 = \frac{I+c-L}{\theta}$ *from the credit insurer. In the good state, the firm is continued. Management expends first best effort.* ■

Proposition 2 demonstrates that short term credit insurance enhances the bank's incentives to intervene which in turn strengthens management's incentives to perform. In contrast, long term credit insurance will impede managerial incentives as long as management is not full residual claimant with respect to the credit insurer, i.e. $C_H \geq C_L$. As was stressed earlier, the distortion long term credit insurance imposes on management's incentives does not stem from the bank's weakened incentives to intervene but from a *dilution* effect.

The optimal contracts are easily matched with securities used in practice. It suffices to specify a *short term* debt payment

$$R = \frac{I + c - (1-\theta)L}{\theta e^{FB}} \tag{28}$$

which matures at $t = 2$. As the firm cannot fulfill its payment obligation at this stage, it must default. This constitutes the *credit event*. The bank has then the choice between liquidating the firm (and collecting the short term credit insurance payment) or letting the firm continue (and not collecting the short term credit insurance payment). If the bank decides to liquidate it receives L from liquidation and a payment

$$C_0 = \frac{I + c - L}{\theta} \tag{29}$$

from the credit insurer. Hence, in total, the bank receives

$$L + C_0 = \frac{I + c - (1-\theta)L}{\theta} \tag{30}$$

if it liquidates. If the bank does not liquidate, it receives no payment from the credit insurer and short term debt is rolled over. Hence, the bank's payoff from not liquidating after having received the good signal is given by

$$eR = e\frac{I + c - (1-\theta)L}{\theta e^{FB}} \tag{31}$$

and 0 after having received the bad signal. The bank thus liquidates in the bad state. In the good state, it lets the firm continue if and only if

$$eR = e\frac{I + c - (1-\theta)L}{\theta e^{FB}} \geq \frac{I + c - (1-\theta)L}{\theta} = L + C_0 \tag{32}$$

or $e \geq e^{FB}$. For small deviations from e^{FB}, the bank uses the liquidation option as a threat point in order to extract a higher payment from the firm. Given this penalty, management is incentivized to expend the first best effort level. Summarizing, a financial structure with short term debt and short term credit insurance implements the first best. As was discussed earlier, long term credit insurance would undermine the incentive efficiency of this financial structure. This will be addressed in more detail next.

The costs of long term credit insurance: What is the *efficiency loss* stemming from long term credit insurance? Suppose the bank receives partial long term credit insurance. Formally, normalize C_H and R_L to zero and express C_L as a fraction of outstanding long term debt, $C_L = \phi R_H$, where $\phi \in (0, 1]$. In order to incentivize the bank to intervene, we must have

$$C_0 = (1 - e^*)\phi R_H + \frac{I + c - L}{\theta} \tag{33}$$

In other words, in order to maintain the bank's incentives to intervene, short term credit insurance has to be increased if long term credit insurance is granted too.

The bank's long term debt claim in the firm is affected by long term credit insurance only through its effects on management's incentives. Hence,

$$R_H = \frac{I + c - (1-\theta)L}{\theta e^*} \tag{34}$$

The long term credit insurance payment is thus given by

$$C_L = \phi \frac{I + c - (1-\theta)L}{\theta e^*} > 0 \tag{35}$$

Suppose the "upwards" incentive constraint (23) is not binding. Then, the "downwards" incentive constraint (22) must be binding.[17] Thus, the equilibrium effort level is given by the largest solution of

$$\theta\Pi - \phi \frac{I + c - (1-\theta)L}{e^*} - \psi'(e^*) = 0 \tag{36}$$

Note then that the "upwards" incentive constraint (23) is indeed not binding, as $\theta(\Pi - R_H) \leq \theta(\Pi - \phi R_H) = \psi'(e^*)$.

The incentive constraint (36) reveals that long term credit insurance distorts management's incentives by *diluting* its claim. In particular, management will be rewarded for expending low effort and consequently lacks commitment to work hard. In order to preserve the bank's incentives to intervene, the bank has to source more short term credit insurance. Preserving the bank's incentives to intervene is in turn worthwhile as management's distorted effort level is still above the effort level under the no credit insurance regime. Formally, comparing the incentive constraint under partial credit insurance (36) with the corresponding incentive constraint under no credit insurance (10), demonstrates that management has better incentives to perform under partial long term credit insurance than under the no credit insurance regime. In the limit, as the bank's long term claim becomes fully insured, the benefits of short term credit insurance evaporate, and we are back to the case of no credit insurance.

Proposition 3 *Suppose the bank sources long term credit insurance. Then, in order to maintain incentives to intervene the bank has to source more short term credit insurance. Even when intervention incentives are maintained, long term credit insurance will worsen the firm's performance. In the limit, as the bank's long term claim becomes fully insured, the incentive effects of short term credit insurance evaporate.* ■

If the bank sources long term credit insurance, it can preserve its incentives to intervene by sourcing more short term credit insurance. Long term credit insurance nevertheless distorts management's incentives to perform. In particular, the incentive effects of short term credit insurance vanish when the bank's long term claim becomes fully insured. It is important to stress that this efficiency loss does

[17] Formally, suppose the "downwards" incentive constraint is not binding. Then, $e^* = e^{FB}$, which from $C_H < C_L$ would violate the "downwards" incentive constraint.

not stem from the bank's reduced incentives to intervene (these are maintained by sourcing more short term credit insurance), but from diluting management's claim.

In our setting, long term credit insurance impedes efficiency. This would be different if default on long term debt or exposure to long term credit risk imposed deadweight costs on the bank, stemming, for example, from the bank's own financing constraints, bankruptcy deadweight costs, or regulatory capital constraints. One could easily extend the setting to allow for such deadweight costs. The parties would have to trade off the benefits of long term credit insurance with its costs. The benefits stem from reducing the deadweight costs that default or exposure to credit risk impose on the bank. These benefits are passed on to the borrower. The costs stem from diluting the borrower's claim. As soon as the deadweight costs of default become *very* large, the bank takes full insurance against long term default risk. The incentive effects of short term credit insurance would vanish in the limit.

4 Incentives to Monitor

Suppose the bank cannot commit to monitor. At $t = 2$, the bank thus needs to contemplate whether to inspect the firm at a cost c or whether to leave the firm unmonitored. If the bank expends c and monitors, it will be able to observe both the interim signal and management's prior decision making. If it does not monitor, it will not observe anything and the firm will be continued even in the bad state.[18] Thus, the bank has incentives to monitor if and only if continuation in the bad state is sufficiently costly for the bank.

No credit insurance: Suppose first that the bank does not source credit insurance. If the bank monitors, given management's equilibrium effort e^{**}, it derives a payoff of

$$\theta(e^{**}R_H + (1 - e^{**})R_L) + (1 - \theta)L - c \tag{37}$$

If the bank does not monitor, management continues the firm in the bad state. Hence, the bank's payoff is given by

$$\theta e^{**}R_H + (1 - e^{**})R_L + (1 - \theta)R_L \tag{38}$$

The *monitoring incentive constraint* thus reads

$$L \geq R_L + \frac{c}{1 - \theta} \tag{39}$$

By inspection, the monitoring incentive constraint is not binding at the optimum ($R_L = 0$) if and only if $L \geq \frac{c}{1-\theta}$, i.e. the likelihood of the bad state is sufficiently large, the monitoring cost is sufficiently small, and/or assets have sufficient collateral value. Note that $(1 - \theta)L - c$ is the direct (ex ante) surplus gain from monitoring.

[18] Recall that if the bank does not monitor, then the decision whether to terminate or to continue is up to management. Management would, however, never self liquidate the firm.

In other words, the monitoring incentive constraint is not binding if and only if the direct surplus gain from monitoring is non–negative.

If the monitoring incentive constraint is violated at $R_L = 0$, the parties have to contemplate which of following two options to adopt (all other options are obviously suboptimal, as long as the bank does not source credit insurance): (i) $R_L = 0$ and leave the firm unmonitored; (ii) fix R_L such that the bank just has sufficient incentives to monitor. Let $e^{**}(0)$ denote the equilibrium effort level if the bank does not monitor. Under the first option, management's equilibrium effort level is thus given by the largest solution of

$$\theta\Pi - \frac{I}{e^{**}(0)} - \psi'(e^{**}(0)) = 0 \tag{40}$$

The surplus (and, hence, the firm's payoff) amounts to

$$\theta e^{**}(0)\Pi - I - \psi(e^{**}(0)) \tag{41}$$

Let $e^{**}(1)$ denote the equilibrium effort level if the bank monitors. Under the second option, it is easily verified that the equilibrium effort level is given by the largest solution of

$$\theta\Pi - \frac{I + \frac{c-(1-\theta)L}{1-\theta}}{e^{**}(1)} - \psi'(e^{**}(1)) = 0 \tag{42}$$

Comparing (42) with the corresponding incentive constraint when the bank can commit to monitor,

$$\theta\Pi - \frac{I + c - (1-\theta)L}{e^{**}} - \psi'(e^{**}) = 0 \tag{43}$$

reveals that lack of commitment to monitor will distort management's incentives.[19] This stems from the distortion of the financial contract needed to incentivize the bank to monitor. The surplus is given by

$$\theta e^{**}(1)\Pi + (1-\theta)L - c - I - \psi(e^{**}(1)) \tag{44}$$

By inspection, when $(1-\theta)L < c$, fixing R_L in order to incentivize the bank to monitor results in a direct surplus *decrease*, and moreover, *weakens* management's incentives to work hard. Note that the same conclusion holds when the bank *can* commit to monitor. While in this case there is no need to distort the financial contract in order to commit the bank to monitor, monitoring is nevertheless inefficient if the direct surplus gain from monitoring is negative. We thus have the following

Proposition 4 *Suppose the bank does not source credit insurance. Then, no matter whether the bank can commit to monitor or not, under an optimal contract the bank will monitor if and only if the direct surplus increase from monitoring is non–negative,* $(1-\theta)L \geq c$. ■

[19] Formally, if $c - (1-\theta)L > 0$ we have $I + \frac{c-(1-\theta)L}{1-\theta} > I + c - (1-\theta)L$ and hence $e^{**}(1) < e^{**}$ by concavity.

When the bank does not source credit insurance, termination threats imposed on management lack disciplinary power. Hence, the benefits of monitoring stem solely from ensuring efficient liquidation decisions. In particular, the bank should monitor if and only if the direct surplus gain from monitoring, $(1-\theta)L-c$, is non–negative. If the direct surplus gain from monitoring is negative, monitoring will adversely affect management's incentives by increasing the outside financing burden. When the bank cannot commit to monitor, there will be an additional effect in that the parties have to distort the financial contract to incentivize the bank to monitor. This will distort management's incentives even further. On the other hand, if the direct surplus gain is positive, the monitoring incentive constraint is not binding. Hence, there is no need to distort the financial contract in order to induce the bank to monitor.

These observations have an important implication for the role of credit insurance in our framework: As long as restoring the bank's monitoring incentives does not allow to improve managerial *performance* incentives, sourcing credit insurance in order to affect the bank's monitoring incentives is pointless. Monitoring to prevent management from continuing in the bad state is either efficient or inefficient. In the former case, the monitoring incentive constraint is not binding in the absence of credit insurance. In the latter case, the bank should not expend the monitoring cost, as long as a threat to respond to shirking with liquidation lacks credibility. In other words, restoring monitoring incentives by sourcing credit insurance or altering the bank's financial claim is worthwhile only if monitoring allows to restore managerial incentives to perform.

Credit insurance: The previous discussion highlights that restoring the bank's incentives to monitor is worthwhile only if doing so allows to improve managerial performance incentives. Let e^* denote management's equilibrium effort level when the bank commits itself to monitor. The surplus under monitoring amounts to

$$\theta e^*\Pi + (1-\theta)L - I - c - \psi(e^*) \tag{45}$$

Under the no monitoring regime, the surplus is given by

$$\theta e^{**}(0)\Pi - I - \psi(e^{**}(0)) \tag{46}$$

where $e^{**}(0) < e^* \leq e^{FB}$. Hence, monitoring will be ex ante efficient if and only if

$$(1-\theta)L - c + \int_{e^{**}(0)}^{e^*} (\theta\Pi - \psi'(e)) \ de \geq 0 \tag{47}$$

which may hold even if $(1-\theta)L < c$ (i.e. when monitoring would be inefficient if the bank did not source credit insurance). We assume that (47) holds at the first best effort level, $e^* = e^{FB}$. Hence, if there exists a contract such that (i) the bank has sufficient incentives to monitor, given that management sticks to first best effort level, and (ii) management expends first best effort, given that the bank monitors, the contract is optimal. In what follows, we derive such a contract.

Fix management's equilibrium effort level e^*. If the bank monitors, it derives a payoff of

$$\theta(e^*(R_H + C_H) + (1 - e^*)(R_L + C_L)) + (1 - \theta)(L + C_0) - c \tag{48}$$

Conversely, if the bank does not monitor, its payoff amounts to

$$\theta(e^*(R_H + C_H) + (1 - e^*)(R_L + C_L)) + (1 - \theta)(R_L + C_L) \tag{49}$$

If the bank monitors, it captures $L + C_0$ in the bad state. If it does not monitor, the firm is continued and hence it obtains $R_L + C_L$ in the bad state. The *monitoring incentive constraint* thus amounts to

$$L + C_0 \geq R_L + C_L + \frac{c}{1 - \theta} \tag{50}$$

By inspection, the bank has an incentive to monitor if (i) assets have high collateral value, (ii) the short term credit insurance payment is large, (iii) the bank receives little (or even a negative amount) in the low cash flow state when the firm is continued, (iv) the monitoring cost is small, and/or (v) the likelihood of the bad state is not too small. In particular, as θ approaches one, a pure strategy equilibrium with monitoring no longer exists. This stems from the fact that the only reason that the bank would monitor at this stage is to prevent management from continuing in the bad state. In contrast, management's effort is already sunk. In particular, there is no reason to incur the monitoring cost to verify that management indeed exerted the equilibrium effort level.[20]

The monitoring incentive constraint suggests that smart contract design can improve the bank's incentives to monitor. In particular, increasing the left hand side ($L + C_0$) and decreasing the right hand side ($R_L + C_L$) relax the monitoring incentive constraint. This suggests that short term credit insurance *strengthens* the bank's incentives to monitor, while long term credit insurance *weakens* monitoring incentives.

In order for the bank to use the termination option as a threat point in renegotiation if and only if management shirks, we must have

$$C_0 = e^* C_H + (1 - e^*) C_L + \frac{I + c - L}{\theta}, \tag{51}$$

$R_H + C_H \geq R_L + C_L$, and $L + C_0 \geq R_L + C_L$. We will first determine under which condition the monitoring incentive constraint is not binding when employing

[20]Since management by definition sticks to the equilibrium effort level in equilibrium and monitoring is costly, it is a best response for the bank not to monitor (if the likelihood of the bad state is zero). Hence, in a pure strategy equilibrium, the bank would not monitor. However, as has been suggested by the auditing literature (see e.g. Choe 1998, Khalil 1998, and Mookherjee and Png 1989, for details.), a mixed strategy equilibrium with monitoring might exist (more precisely, an optimal contract might exist that implements a mixed strategy equilibrium with monitoring). We restrict attention to pure strategy equilibria for two reasons. First, the additional economic insights of mixed strategy equilibria will be limited. Second, as will be shown below, in our framework there almost always exists a pure strategy equilibrium with monitoring.

a standard debt contract and sourcing the optimal amount of short term credit insurance (but no long term credit insurance).[21] Thus, let $R_L = 0$ and

$$C_0 = \frac{I + c - L}{\theta} \tag{52}$$

Substituting $R_L = 0$, $C_H = C_L = 0$, and C_0 into (50) and rearranging terms, the monitoring incentive constraint reduces to

$$I - (1-\theta)L \geq \frac{2\theta - 1}{1-\theta}\ c \tag{53}$$

As the left hand side is strictly positive, the monitoring incentive constraint is not binding as long as the monitoring cost c is sufficiently small or the likelihood of the bad state is sufficient large, $\theta \leq 1/2$. In the latter case, the likelihood of the bad state is sufficiently large for the bank having incentives to prevent management from continuing in the bad state, no matter how large the monitoring cost. The intuition is that while the bank expends c when monitoring, the monitoring cost also shows up in the short term credit insurance payment through the bank's claim on the firm.[22] If the bank monitors, it expends c but recaptures c/θ with probability $1-\theta$. Hence, for $c \leq (1-\theta) \times c/\theta$ or $\theta \leq 1/2$, the monitoring constraint is not binding. We have the following

Proposition 5 *Suppose that monitoring and investment are efficient. Then, for any $\theta < 1$, there exists a critical threshold $c' > 0$ such that for any monitoring cost $c \leq c'$ the bank monitors and management expends the first best effort level under standard debt and short term credit insurance.* ■

As long as (53) holds, there is no need to give the bank further incentives to monitor by raising the bank's cost of not preventing management from continuing in the bad state. However, if (53) is violated, standard short term debt and short term credit insurance are no longer sufficient to guarantee monitoring incentive compatibility. In this case, the parties have two options: they can either reduce R_L (and increase R_H) or reduce C_L (and increase C_H or reduce P). Both options will *increase* the riskiness of the bank's claim. The intuition is that in order to maintain the bank's incentives to monitor, the bank has to incur a substantial loss in the low cash flow state if it leaves the firm ummonitored. Hence, the bank's payoff in the low cash flow state, $R_L + C_L$, should be as small a possible. Most generally, an optimal contract maximizes the surplus

$$\theta e^* \Pi + (1-\theta)L - \psi(e^*) - I - c \tag{54}$$

[21] Thus, the incentive compatibility constraints under the first best, $R_H + C_H \geq R_L + C_L$, $L + C_0 \geq R_L + C_L$, $\Pi - \psi'(e^{FB}) \geq 0$, and $\Pi - R_H - \psi'(e^{FB}) \leq 0$ are satisfied.

[22] A similar intuition explains why an increase in the collateral value L tightens the monitoring incentive constraint. This stems from the fact that in order to satisfy the intervention incentive compatibility constraint the bank must be indifferent between exercising the liquidation option (and capturing $L + C_0$) and the continuation option (and capturing eR_H) at the equilibrium effort level. Since in equilibrium the bank captures L in the bad state, R_H will be decreasing in the collateral value, and hence $L + C_0$ must be decreasing in L.

with respect to e^*, C_H, C_L, R_H, and R_L, subject to the monitoring incentive constraint (50), $R_H + C_H \geq R_L + C_L$, and $L + C_0 \geq R_L + C_L$ (where C_0 is given by (51)), the managerial incentive constraints,

$$\theta(\Pi + C_H - C_L) - \psi'(e^*) \geq 0 \tag{55}$$

and

$$\theta(\Pi - R_H + R_L) - \psi'(e^*) \leq 0 \tag{56}$$

the limited liability constraints $R_H \leq \Pi$ and $R_L \leq 0$, and the bank's (binding) break even constraint,

$$\theta(e^* R_H + (1 - e^*) R_L) + (1 - \theta)L = I + c \tag{57}$$

(the payments from and to the credit insurer cancel out). By inspection, an increase in R_H and C_H and a decrease in C_L relax the managerial incentive constraints, the monitoring incentive constraint, $R_H + C_H \geq R_L + C_L$, and $L + C_0 \geq R_L + C_L$. We can thus claim the following

Proposition 6 *For any monitoring cost c and $\theta < 1$ such that monitoring and investment are efficient, there exist optimal credit and credit insurance contracts with finite payments that implement a subgame perfect equilibrium in pure strategies in which management expends the first best effort level, the bank monitors, and the firm is continued in the good state and liquidated in the bad state.* ■

The proposition demonstrates that the bank's potential lack of monitoring incentives can be addressed with an appropriate credit contract and an appropriate "credit insurance" policy. In particular, the bank receives full short term credit *insurance* in order to maintain its incentives to intervene should it monitor and should management shirk. However, as soon as θ becomes large, the bank will *pay* an amount to the credit insurer in the low cash flow state and the credit insurer will pay an amount to the bank in the high cash flow state (see below). Hence, in order to commit itself to monitor, the bank has to sell "credit insurance" to the third party: it has to increase the risk of its stake in the firm. In particular, the bank has to be penalized for not monitoring by incurring a large loss in the low cash flow state. This makes leaving the firm unmonitored costly for the bank, and hence it will monitor in order to prevent management from continuing in the bad state. As a side effect, the bank is also able to punish management should it observe that management shirked. This latter effect does *not* explain why the bank expends the monitoring cost. This is because effort is sunk at the monitoring stage and, by definition, management sticks to the equilibrium effort level in equilibrium. Rather, it explains why the parties envision a mechanism that *commits* the bank to monitor.

In practice, the optimal contracts can be implemented with short term debt to be rolled over if the firm defaults at $t = 2$, short term credit insurance, and the bank committing to make a payment to the credit insurer should the firm at $t = 3$ default on its debt. In exchange, the credit insurer would commit to make a payment to the bank should the firm not default. For example, let

$$C_L = -\frac{e^{FB}}{1-e^{FB}} C_H \equiv C_L^*, \tag{58}$$

$$C_0 = \frac{I+c-L}{\theta}, \tag{59}$$

$R_L = 0$, and consider a short term debt claim

$$R = \frac{I+c-(1-\theta)L}{\theta e^{FB}} \tag{60}$$

to be rolled over if the firm defaults at $t = 2$ and is not liquidated (in which case the bank must forego the short term credit insurance payment). The monitoring incentive constraint reduces to[23]

$$C_H \geq \frac{1-e^{FB}}{e^{FB}} \left[\frac{(1-\theta)L - I - c}{\theta} + \frac{c}{1-\theta} \right] \equiv C_H^* \tag{61}$$

As long as (53) holds, the monitoring incentive constraint won't be binding at $C_H = C_L = 0$. Suppose instead that (53) is violated. Let then $C_H = C_H^* > 0$ and $C_L = C_L^* < 0$. The bank thus commits itself to monitor by promising the credit insurer a payment in the low cash flow state (and the credit insurer promising a payment to the bank in the high cash flow state). In other words, incentives to monitor are restored by *reverse* credit insurance. Such an arrangement can actually be interpreted as a *balance–sheet securitization* in which the bank sells (all or part of) its long term claim to third party investors, provides *loss protection*, and is paid a fee for its monitoring and credit enhancement services, provided the firm does not default at $t = 3$. In exchange for this fee, the bank would sell its claim at a discount. This structure resembles small business loan securitization arrangements used in practice (see Beshouri and Nigro 1994).

Alternatively, one could alter the bank's financial claim on the firm's cash flows in order to restore monitoring incentives. For the bank to have incentives to monitor, it should have a small (or even negative) claim in the low cash flow state (and, consequently, a large claim in the high cash flow state). Thus, the bank would receive less in the low cash flow state and more in the high cash flow state. This is to be interpreted as *equity financing*.[24] As long as a termination threat is credible, altering the bank's claim in this way has no impact on management's incentives.

Two caveats are in order. First, note that as soon as the likelihood of the bad state becomes small, the riskiness of the bank's and the credit insurer's respective claims becomes very large. In particular, as θ approaches one, C_L approaches minus infinity while C_H approaches plus infinity. For obvious reasons, such large payments

[23]It is easily verified that $R_H + C_H \geq R_L + C_L$ and $L + C_0 \geq R_L + C_L$ are implied by the monitoring incentive constraint. Hence, neither constraint is binding.

[24]Note that equity financing is feasible (and meaningful) in our setting, despite the fact that income in the low cash flow state is zero. It suffices that the bank makes an initial cash transfer larger than the initial investment outlay. Under debt financing, the bank would extract the firm's cash balance in the low cash flow state, but not under equity financing.

may not be feasible in practice. Capital constraints and each parties' risk taking capacity and willingness may thus put an upper bound on the feasible transfer payments. As a result, the first best may not be achievable. Second, if volatility imposes deadweight costs on the bank, the mechanism may well be too costly. While increasing the riskiness of the bank's long term claim allows to restore the bank's incentives to monitor, the burden put on the surplus might be too high.

Nevertheless, the analysis put forward in this section has important implications for the merits of short term and long term credit insurance: (i) short term credit insurance *strengthens* incentives to monitor, incentives to intervene, and managerial incentives to perform; (ii) long term credit insurance *weakens* incentives to monitor and managerial incentives to perform; (iii) increasing the riskiness of the bank's long term claims, through equity financing or reverse credit insurance, allows to *restore* monitoring incentives if needed.

5 Discussion and Conclusions

This paper demonstrates that credit derivatives can *strengthen* banks' incentives to monitor and to intervene. In particular, credit derivatives with short term maturity tend to enhance a bank's incentives to "pull the plug" by shifting the balance between what the bank has to lose and what it has to gain from doing so towards the benefit side. This is beneficial in order to harden a borrower's budget constraint and improve managerial performance incentives. While the bank's intervention incentives are strengthened, the credit insurer's break even constraint ensures that the bank won't have excessive incentives to liquidate the borrower. Credit derivatives with short term maturity thus introduce an additional degree of freedom, which allows to optimize the balance between too soft and excessive incentives to intervene.

Long term credit insurance worsens monitoring and intervention incentives, ceteris paribus. However, intervention incentives can be maintained by sourcing more short term credit insurance. Nevertheless, long term credit insurance worsens managerial incentives by diluting management's claim on the firm. Thus, as long as default on long term financial claims does not impose deadweight costs on the bank, long term credit insurance only tends to impede efficiency.

Our analysis departs from much of the bank monitoring literature in that monitoring refers to gathering information about a firm's decision making and external influences affecting the firm's prospects (rather than enhancing long term firm value). Monitoring thus differs from intervention, which refers to *using* the information obtained through monitoring. Opening up the monitoring "black box" in this way is essential to our findings that short term credit insurance improves monitoring and intervention incentives. The bank's role in terms of enhancing firm value through providing management with advice or interfering with management's decision making is limited in our setting. The role of running the firm is left to management. Still, in practice, banks sometimes provide managerial advice and interfere with decision making. Long term credit insurance would impede banks' incentives to engage in such actions, as it reduces the bank's risk exposure to long term value. Conversely, short term credit insurance would have little impact on the bank's incentives to enhance long term value.[25]

The analysis relies crucially on the absence of renegotiation between the bank and parties providing credit insurance. Credit derivatives constitute a financial instrument that enhances the parties' commitment not to engage in renegotiation. This is because counterparties in credit derivatives transactions are typically at arm's length and banks may acquire credit derivatives from a large number of counterparties.[26] Both features tend to render renegotiation prohibitively costly. Credit derivatives differ from other risk transfer instruments, such as loan sales, in another important respect. Credit derivatives can be structured in terms of maturity. As a result, banks can protect themselves against short term credit risk, while still being exposed to long term credit risk.[27] This is different from e.g. a loan sale, where the bank reduces its long term risk exposure. It is thus interesting to note that credit derivatives typically exhibit shorter maturities than the maturities of the underlying assets (see Duffee and Zhou 2001 and the references mentioned there).

This paper brings together two elements of the policy debate about the economic effects of credit derivatives. On the one hand, it is commonly alleged that insurance against credit risk worsens banks' incentives to monitor loans. On the other hand, many market observers express fears that banks that enjoy credit protection are unwilling to engage in restructuring. Rather, they prefer driving their borrowers into default and liquidation, and collecting the credit insurance payments. Our analysis demonstrates that strengthening banks' incentives to be tough in restructuring is beneficial in order to commit borrowers to perform better. Moreover, enhancing banks' bargaining position in restructurings is a *prerequisite* for banks to have incentives to monitor loans and to play a meaningful role in restructurings. Our findings suggest that banks' increased incentive to "pull the plug" does not result in an increased number of defaults, to the contrary, it improves firm performance and hence reduces default risk.

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[25] Short term credit insurance would strengthen bank's incentives to enhance long term value if bank advice and decision making and managerial decision making were strategic complements.

[26] As such, credit derivatives differ crucially from single–party credit insurance.

[27] Interestingly, Duffee and Zhou's 2001 finding that credit derivatives have advantages in risk transfers when bank have inside information about credit risk relies on the same argument. In their setting, the bank's informational advantage is not constant over the life of a loan. Credit derivatives that temporarily transfer loan risk to outsiders promote better risk sharing, reducing deadweight costs associated with bank insolvency.

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Appendix

Proof of lemma 1: See the discussion in the text. ■

Proof of proposition 1: In order to complete the proof, we have to show that the first best effort level and the equilibrium effort level exist and are unique and interior. Consider the first best effort level e^{FB}, given by the solution of $\theta\Pi - \psi'(e) = 0$. Since $\psi(0) = \psi'(0) = 0$, $\lim_{e\to 1} \psi'(e) = \infty$, $\theta\Pi > 0$, and $\psi'(e)$ is strictly increasing and continuous, e^{FB} exists, is unique and interior. Next, consider the equilibrium effort level, characterized by the following incentive constraint,

$$\varphi(e) = \theta\Pi - \frac{I + c - (1-\theta)L}{e} - \psi'(e) = 0 \tag{62}$$

Note that $\lim_{e\to 0} \varphi(e) = \lim_{e\to 1} \varphi(e) \to -\infty$. Moreover, if outside financing is feasible, $\varphi(e) = 0$ must have a generic solution, i.e. $\max \varphi(e) > 0$. Since $I + c - (1-\theta)L > 0$ and $\psi'(e)$ is increasing, any such solution will be inferior to the first best effort level. Hence, the optimal solution e^{**} is given by the largest interior solution of $\varphi(e) = 0$. ■

Proof of proposition 2: Note first that the limited liability constraints $R_H \leq \Pi$ and $R_L \leq 0$ and the liquidation incentive compatibility constraints $L + C_0 \geq R_L + C_L$ and $R_H + C_H \geq R_L + C_L$ are not binding. We have shown in the text that e^{FB} maximizes management's payoff function around e^{FB}. In order to complete the proof, we will have to show that e^{FB} is the global maximizer of management's payoff function. Consider an upwards deviation $e \geq e^{FB}$. Management's payoff would be given by

$$\theta e(\Pi - R_H) - \psi(e) \tag{63}$$

which from $R_H > 0$, $\theta(\Pi - R_H) < \psi'(e^{FB})$, and $e \geq e^{FB}$ is maximized at e^{FB}. Next, consider a downwards deviation $e \leq e^{FB}$. The bank will be willing to forego the termination option in exchange for raising its compensation as long as the limited liability constraint in renegotiation ($R'_H \leq \Pi$) is not binding. Hence, for

$$e < \frac{L + C_0}{\Pi} = \frac{I + c - (1-\theta)L}{\theta\Pi} \equiv e' \tag{64}$$

the bank would liquidate even in the good state in which case management would end up with a payoff of $-\psi(e)$. Hence, for $e < e'$, management optimally expends zero effort and thus achieves a payoff of zero. For $e \in [e', e^{FB}]$ (note that $e^{FB} > e'$ since investing is efficient), management derives a payoff of

$$\theta e\Pi - (I + c - (1-\theta)L) - \psi(e) \tag{65}$$

which is maximized at e^{FB} since $\theta\Pi - \psi'(e^{FB}) = 0$. Hence, for $e \leq e^{FB}$, management's payoff is maximized at e^{FB}, since

$$\theta e^{FB}\Pi + (1-\theta)L - (I + c) - \psi(e^{FB}) > 0 \tag{66}$$

Thus, e^{FB} is the global maximizer of management's payoff. ■

Proof of proposition 3: In order to complete the proof, we will have show that the optimal effort level is indeed the largest solution of

$$\varphi(e) = \theta\Pi - \phi\frac{I + c - (1-\theta)L}{e} - \psi'(e) = 0 \tag{67}$$

For this, a similar argument as made in the proof of proposition 1 suffices. Then, since e^* is the largest solution of $\varphi(e) = 0$, $\varphi(e)$ is continuous, and $\lim_{e\to 1}\varphi(e) = -\infty$, we must have $\varphi'(e^*) < 0$. Furthermore, $\varphi_\phi(e^*) < 0$. Thus, from the implicit function theorem, e^* is strictly decreasing in ϕ. Moreover, as $\phi \to 1$, we have

$$\theta\Pi - \frac{I + c - (1-\theta)L}{e^*} - \psi'(e^*) = 0 \tag{68}$$

Hence, $\lim_{\phi\to 1} e^* = e^{**}$, namely, the equilibrium effort level under the no credit insurance regime. ■

Proof of proposition 4: See the discussion in the text. ■

Proof of proposition 5: Follows from (53) and the discussion in the text. ■

Proof of proposition 6: See the discussion in the text for an example. ■