

# Impact of Credit Derivatives on Bank Monitoring

by

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A dissertation submitted to the Graduate Faculty in Business in partial fulfillment of the requirements for the degree of the Doctor of Philosophy, The City University of New York

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## ABSTRACT

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The development of new financial markets is often viewed as unambiguously beneficial, because market efficiency is improved by the offering of new financial securities that span all possible state space opportunities. In this paper, I show that this may not be the case if the introduction of a new market undermines the operation of an existing one. I examine the bank loan market in a world with fairly priced credit derivatives. I show that in a single period setting, the introduction of credit derivatives markets undermines the monitoring equilibrium in the bank loan market and induces banks to shirk. Subsequently, I show that banks' incentives to monitor loans are restored in a multi-period setting, where banks extract high rents by developing reputations as active monitors. However, since bank monitoring is unobservable, the resulting reputation equilibrium is not stable as banks build and burn their reputations over time.

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## Chapter 1                    INTRODUCTION AND MOTIVATION

It has long been said that banks are special. By providing monitoring activities to opaque and informationally challenged borrowers, banks create relationships that generate economic rents. Bank portfolios are therefore comprised of relationship loans that maybe imperfectly diversified. The resulting impact of which on bank risk and systemic risk has required a complex system of regulations and market discipline that imposes capital costs on banks that are exposed to excessive risks. One way banks reduce these costs is by diligently monitoring their borrowers' risk taking activities.

What if banks could avoid their capital costs without incurring the costs of monitoring, will they continue to monitor the activities of their borrowers and produce monitoring information that makes them special? Moreover, if banks shirk on their monitoring duties, will they earn economic rents from their opaque borrowers? This is the subject of this paper. We examine a substitute mechanism available to banks to control their capital costs – the credit derivatives markets.

Indeed, we find in a single period setting, that the credit derivatives market cannot co-exist with relationship lending. In a world without credit derivatives, banks traditionally choose their optimal monitoring intensity by weighing the costs of monitoring against the risk to both capital and relationship rents if they shirk on their monitoring responsibilities. The introduction of credit derivatives blurs this

trade-off. Banks may rationally choose not to monitor their loans if premiums on credit derivatives are lower than their monitoring and capital costs. Furthermore, banks can offset default risk on their illiquid loans, at little or no cost to their bank relationships, because they can structure these risk-sharing instruments without seeking permission from their borrowers. Hence, credit derivatives market may induce banks to shirk on monitoring without jeopardizing either their capital positions or their banking relationships, which could result in a lower production of information, especially for smaller firms most exposed to information asymmetries. However, this will undermine the viability of the bank loan market as extreme moral hazard and risk shifting among the opaque borrowers undermines shirking banks.

The LBO (leveraged buy-outs) craze of the 1980s illustrates the consequences of the single period bank-shirking problem we study in this paper. One of the reasons that bank financing was extensively used to finance LBO activity was the ability of banks to monitor the actions of LBO firms subject to free cash flow problems (Jensen, 1986). Bank financing was preferred to capital market debt because of its potential to better align manager-shareholder agency costs and prevent risk-shifting problems associated with high levels of debt at LBO firms. However, rather than monitor the activities of their risky borrowers, many banks chose to sell their leveraged loans and save on their costs of monitoring when they realized that they were unlikely to earn further economic rents from these debt-ridden firms, as much of their payoff was in the form of upfront fees and

loan commissions.<sup>1</sup> This contributed to the large level of loan losses in the LBO debt market of the late 1980s, which is analogous to the predicted result of our single period model with credit derivatives.

The unraveling of the bank loan market with credit derivatives can be mitigated in a multi-period setting, wherein repeated interaction between banks and credit protection sellers may create incentives for banks to build reputations as monitors. While reputation as a means for aligning monitoring incentives for banks has been studied in the parallel loan sales and syndication markets, its efficacy is largely unexplored in credit derivative markets.<sup>2</sup> We find that the unobservability of monitoring activities causes the resulting reputation equilibrium to be unstable and we examine its consequences for both the bank loan and credit derivatives markets.

Our theoretical model is similar to Holmstrom and Tirole (1997). Bank monitoring minimizes moral hazard by inducing firm managers to expend costly effort to improve the overall quality of projects. Banks earn relationship rents from credit-rated firms and protect their franchise value by purchasing credit derivatives. We show that with positive reputation effects, banks may continue to monitor

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<sup>1</sup> Trading activity in the secondary loan market increased dramatically in the early 1990s, funded in part by the sale of LBO loans by banks. Increase in bank capital requirements, with the implementation of the Basel Accord in 1992, also contributed to the process.

<sup>2</sup> Sharpe (1990) and Chemmanur and Fulghieri (1994) study reputation effects for banks in the context of implicit loan commitments and bank liquidation decisions, respectively.

their hedged loans to build reputation in the credit derivatives market in order to lower their hedging costs.

Our proposed reputation equilibrium is welfare enhancing as it strengthens banks capability to eliminate their costs of capital adjustments without incurring the agency costs associated with size, which they would incur, if they alternatively minimized their capital costs through internal diversification. Consequently, banks compete more aggressively by using their given capital base and transfer gains from better credit risk sharing to their borrowers by reducing systemic credit shocks in the banking industry. Under the reputation equilibrium, the competitive nature of the banking industry moves towards greater specialization than posited by traditional theories of diversification. The equilibrium tradeoff between bank capital and monitoring ability hypothesized by Alzaman (2002) also leans towards more concentrated, but monitored lending activity as banks access additional “synthetic capital” in the credit derivatives markets without incurring convex costs of capital.

## Chapter 2

## THEORETICAL MODEL

### 2.1 SINGLE PERIOD MODEL

We present an economy where firms are subject to severe moral hazard and capital markets are ineffective in meeting their financing needs. Capital-rationed firms can only secure financing from banks, which in turn, invest in costly monitoring to preserve their own capital and eliminate firm moral hazard.

In our single period model, we show that the emergence of a fairly priced credit derivatives market undermines the incentives of rational, opportunistic banks to monitor their loans. While opportunistic banks always monitored their loans in the absence of credit derivatives, we show that after purchasing credit protection these banks choose to shirk on their monitoring obligation to save on their monitoring costs. As monitoring is publicly unobservable and therefore non-contractible, the hedging of credit risk, ex-post, induces opportunistic banks to shirk on their monitoring commitment.

When opportunistic banks shirk on monitoring, then both the loan and credit protection markets are undermined. The loan markets become unviable because unmonitored projects revert to negative NPV choices, whereas credit protection markets collapse because the cost of the hedge does not accurately reflect the credit risk of the hedged loans. The break down of an opportunistic bank's

incentive to monitor its loans is hence a negative externality of credit derivatives markets. We describe this as the bank-shirking problem.

Described below is our formal model, starting first with the players: banks (Opportunistic and Monitors) and the credit derivative sellers. We also present the timeline of actions in the game, as well as, equilibrium conditions for the single period model, with and without credit derivatives.

## **Banks**

We model banks as risk neutral players endowed with funds that maybe either invested in a constant return technology to earn  $R$  or lent out to firms.  $R$  is the one-period future value of \$1 invested at the risk-free rate  $r$ ,  $R=1(1+r)$ . Without loss of generality, we assume that the risk-free interest rate  $r$  is zero, so that  $R=1$ .

Banks can lend to financially constrained firms having a single risky project. The project requires an initial investment of  $I$ , normalized to \$1, and generates an end of the period verifiable cash flow  $\$X$  with probability  $p$  and  $\$0$  with probability  $1-p$ . The probability of success  $p$  determines the quality of the risky project, with  $p=\{P_B, P_G\}$  and  $0 < P_B < P_G < 1$ , such  $P_G X > 1 > P_B X$ .<sup>3</sup> We assume that information about  $p$  is publicly available so that public capital markets screen out firms with observably bad projects  $P_B$  because their entrepreneurs, unless monitored, do

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<sup>3</sup> We assume a two-point distribution for  $p$  in the interest of maintaining the model's simplicity. Our results will not be affected if  $p$  is continuous over a support of  $(0, 1)$ .

not expend their private non-pecuniary benefits  $\varphi_B$  to improve the quality of their projects to  $P_G$ .<sup>4</sup> We can think of  $\varphi_B$  as the cost of entrepreneurs' effort. Bad projects remain negative NPV despite these non-pecuniary benefits, i.e.  $P_B X + \varphi_B < I$ .

Unlike capital markets, banks are willing to finance bad projects because of their ability to monitor the actions of their borrowing firms. The monitoring technology endowed to banks enables them to access private or soft information about their borrowers, which otherwise is not publicly available to arm-length lenders (public debt and equity markets).<sup>5</sup> As a result, banks are able to acquire soft information about their borrowers in a timely manner and use that information to effectively monitor firm moral hazard and enforce loan covenants. We assume that bank monitoring fully resolves the inside managers' incentives to shirk on effort.<sup>6</sup> Thus, monitoring can force managers to expend their private benefits  $\varphi_B$  and transform bad projects into good projects with a positive NPV of  $P_G X > I$ . However, monitoring does not make the loans risk-free because monitored loans can still default with probability  $1 - P_G$ .

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<sup>4</sup> We assume that these firms are rationed by public equity markets because public investors lack the ability to monitor the entrepreneurs from appropriating  $\varphi_B$  and expending more effort.

<sup>5</sup> Banks gather soft information by maintaining a close relationship with their borrowers which includes among other things, frequent client visits, regular inspection of cash flow statements and contact with the firm's major suppliers and customers.

<sup>6</sup> We could allow for imperfect monitoring (such as Park (2000)), but there will be no change in our conclusions.

The endowed bank monitoring technology is finite in time and resources. When banks monitor they incur a fixed monitoring cost  $m$ .<sup>7</sup> Banks seeking to lower their monitoring costs focus their lending activity to a few industries, regions and/or borrowers. However, this specialized lending exposes bank loan portfolios to high levels of concentration risk, which adversely raises the likelihood of their own failure. Imperfectly diversified banks are, therefore, vulnerable to a large proportion of their positively correlated or concentrated loans collectively defaulting.<sup>8</sup> High levels of concentration risk (or idiosyncratic risk) make it more expensive for banks to raise additional equity capital to cover their unexpected loan losses, and therefore, imperfectly diversified banks face positive marginal costs of capital adjustments.<sup>9</sup>

Thus, banks face a trade-off between portfolio loan diversification and monitoring costs. While greater loan diversification minimizes their delegated monitoring costs (Diamond (1984)), it also adversely affects their ability to monitor with the same level of efficiency. Hence, in our single-period model, we segment banks

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<sup>7</sup> For now, we assume that fixed monitoring costs are constant for all banks. However, we later relax this assumption when modeling bank types. Difference in monitoring cost functions capture the competitive advantage of banks in the loan market (Alzaman (2002)).

<sup>8</sup> Collective default may be triggered by either an industry or region wide default or default by only a few large borrowers. The Asian currency crisis of 1997 is a good example of a region wide default, where large-scale bank defaults occurred because of collective defaults by borrowers over-exposed to foreign currency price risk.

<sup>9</sup> As regulated institutions, banks are required to maintain a minimum level of capital as a percentage of their assets to protect the bank's depositors from losses. Proposals to include a capital change for portfolio concentration have been dropped from the June 2004 proposals for the New Capital Accord put out by the Basel Committee on Banking Supervision of the BIS.

into two types. Those endowed with a superior monitoring technology compete as specialist monitors, *Monitors* (Mon), while others endowed with a costlier monitoring technology compete by lowering their costs of capital adjustment through increased loan diversification, *Opportunists* (Opp). Mon and Opp banks are observationally identical. Thus, the players (borrowers, credit protection sellers and other banks) cannot distinguish a Mon bank from an Opp bank.

Before we describe the strategies and payoffs for Mon and Opp banks, we define below the functional form for marginal cost of capital adjustments and feasibility constraint for monitoring, common to both types of banks.

### **Marginal Cost of Capital Adjustment for Banks**

$C(x, \rho)$  represents a bank's ex-ante marginal cost for raising additional capital in the event of a loan default.<sup>10</sup>  $C(x, \rho)$  is a function of loan cash flow  $x \in \{0, X\}$  and level of concentration risk  $\rho$  of the bank's overall loan portfolio, with  $\rho \in (\tilde{\rho}, 1)$  and  $\tilde{\rho} > 0$ . We assume when  $\rho = 0$  the loan portfolio is well diversified, while  $\rho = 1$  indicates that the bank's loan portfolio is concentrated in a particular region or sector such that its loan portfolio behaves as if the bank had lent to a single large

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<sup>10</sup> We could also view  $C(x, \rho)$  as the loss of franchise or charter value when banks become insolvent. Empirical evidence by Berger, Klapper and Udell (2001) show that bank failures result in both direct and indirect costs to the economy. These costs are magnified; the more relationship oriented banking is done at the defunct banks, indicating that banks' lending relationships are unique. Bank failures, therefore, lead to loss of value to both banks and their informationally opaque borrowers.

borrower.<sup>11</sup> When banks lend to firms that are highly correlated in default, their resulting loan portfolios also exhibit high concentration risk; a result, independent of the number of borrowers in the bank's loan portfolio.<sup>12</sup>

Defined below is the functional form for  $C(x, \rho)$ :

$$\text{No default on loan } (x=X) \quad C(x, \rho) = 0 \quad \text{for all } \rho \quad (1)$$

$$\text{Default on loan } (x=0) \quad C(x, \rho) > C(x, \tilde{\rho}) > 0 \quad 0 < \tilde{\rho} < \rho \leq 1.$$

According to equation (1), banks incur marginal capital costs only when their loans default. A positive relationship between  $\rho$  and  $C(0, \rho)$  suggests that banks holding more concentrated loan portfolios, due to smaller balance sheet sizes or greater specialized lending, incur higher marginal cost of capital adjustments than do banks that are better diversified across a wider range of industries, regions and customers.<sup>13</sup> We assume that banks cannot fully eliminate their marginal capital costs through diversification because they do not have access to an infinite supply of capital needed to maintain a perfectly diversified loan

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<sup>11</sup> The result of this assumption is that when that single borrower defaults the bank also fails.

<sup>12</sup> Concentration risk  $\rho$  of the bank loan portfolio is more sensitive to industry and regional factors than the number of borrowers. Since loans within a sector/region tend to be highly correlated in default,  $\rho \rightarrow 1$ , if new loans also have high default correlations with the existing loans in the portfolio it does not lower the concentration risk. Thus, merely increasing borrowers does not significantly lower the bank's overall concentration risk.

<sup>13</sup> Comparable financing obtained by accessing the capital debt markets are hence less expensive than bank financing for observationally identifiable good borrowers, because capital debt markets are well diversified by assumption, i.e.  $\rho=0$ , and therefore, face no convex cost of capital adjustments, i.e.  $C(0, 0)=0$ .

portfolio.<sup>14</sup> As such, unless banks protect their capital with credit derivatives, they always incur positive marginal costs in raising fresh capital. Henceforth, we denote  $C(0, \rho)$  by  $C$  to keep our notation simple.

### **Monitoring Feasibility**

Banks price their loans to extract full relationship rents on their lending relationships.<sup>15</sup> Capital rationed firms that borrow from banks pay relationship rents since they have no other financing options available. The firms' managers earn their reservation utility, which in the absence of bank financing, is zero. Banks therefore set the face value of their loans ( $F$ ) to

$$F=X. \tag{2}$$

Assumption (A1) states that delegated monitoring is a positive NPV activity for banks

$$P_G X - (1 - P_G) C - l - m \geq 0. \tag{A1}$$

---

<sup>14</sup> We assume that banks' total costs of delegated monitoring, i.e. monitoring costs and marginal cost of capital, are lower than the free rider costs borne by individual bondholders in capital markets. We, therefore, maintain Diamond's (1984) classical justification for banks as delegated monitors.

<sup>15</sup> Peterson and Rajan (1994) show that banks do exert market power to extract monopoly rents from small firms who are unable to borrow from capital markets due to asymmetry of information. In our model, for simplicity, all of the firms approaching banks are credit-rationed firms that cannot access capital markets.

## Bank Types

We now define the characteristics, strategies and payoffs of Mon and Opp banks commonly known to all players, including the credit derivatives market.

### **Monitor (Mon) Banks**

Mon banks are smaller, less-capitalized, regional banks that compete as specialist monitors. They are endowed with an efficient monitoring technology that allows them to monitor firms at little cost. For notational simplicity, we assume  $m^{Mon} = 0$ .

Mon banks develop their specialized monitoring ability by focusing their lending activity on a few sectors and regions. This causes their loan portfolios to become less diversified and exposed to concentration risk. Since Mon types are smaller banks they are more likely to be denied the “too-big-too-fail” privilege available to their larger counterparts, and thus face greater liquidity constraints and loss of franchise value in the event of insolvency. Thus, Mon banks, due to their concentrated loan portfolios bear positive marginal capital costs when they extend additional loans, i.e.  $C^{Mom} > 0$ .<sup>16</sup>

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<sup>16</sup> Under-capitalized banks tend to be more risk-averse towards investing in assets that have a larger component of non-tradable risk. The greater the contribution of non-tradable risk by the new asset to the variance of the bank’s overall portfolio of non-tradable risk, the more pronounced is the bank’s conservatism, because it is costlier for under-capitalized banks to raise new external capital to cover their unexpected portfolio losses (Froot & Stein (1998)). Loans to small and medium sized companies have been, until recently, largely non-tradable in financial markets due to their information sensitivity.

Since monitoring costs are zero for Mon banks, they always monitor their loans. Monitoring is a positive NPV activity for Mon banks by assumption (A2)

$$P_G X - (1 - P_G) C^{Mon} - I \geq 0. \quad (\text{A2})$$

However, due to their high  $C^{Mon}$ , Mon banks prefer to hedge their portfolio's marginal concentration risk in the credit derivatives markets. We assume that payoff from their hedged monitoring strategy  $M\_CDS$  (where they monitor and buy credit derivatives) exceeds payoff from their un-hedged monitoring strategy  $M\_NoCDS$  (where they monitor and do not purchase credit derivatives), such that  $M\_CDS$  is a dominant strategy for Mon banks, as stated in (A3)

$$X - 1 - q(\mu) \geq P_G X - (1 - P_G) C^{Mon} - I. \quad (\text{A3})$$

where  $q(\mu)$  is the single period equilibrium price of CDS, which is a function of  $\mu$ , the proportion of Mon banks seeking credit protection. We develop a closed form solution for  $q(\mu)$  in equation (3) below. (A3) imposes the following necessary restriction on  $C^{Mon}$  for Mon banks to enter the credit derivatives market in the single period model

$$C^{Mon} \geq \frac{q^*(\mu) - X}{(1 - P_G)}. \quad (\text{A3.1})$$

Under these conditions, Mon banks always monitor their loans and hedge their concentration risk in the credit derivatives market. These types are not subject to bank shirking and therefore their behavior is uninteresting and not analyzed any further.

### **Opportunistic (Opp) Banks**

Opp banks are larger money center banks with wider operations and more diverse industry scope. As a result, the cost of monitoring is higher for Opp banks than Mon banks, i.e.  $m^{Opp} > 0$ . However, because of their larger balance sheet size and broader geographic/product focus, Opp banks hold more diversified loan portfolios and therefore bear lower marginal concentration risk, than Mon banks,  $\rho^{Opp} < \rho^{Mon}$ . Accordingly, for a given monitoring level, marginal costs of capital are lower for Opp banks than for Mon banks, i.e.  $C^{Mon} > C^{Opp} > 0$ . We henceforth represent  $C^{Opp} = C$ .

Opp banks independently choose their monitoring and hedging strategy at the start of the single period. Defined below are Opp bank's three pure strategies and their respective payoffs:

<u>Strategies</u>	<u>Payoffs</u>
$S1: M\_CDS$	$X - I - q(\mu) - m^{Opp}$
$S2: M\_NoCDS$	$Z \equiv P_G X - (1 - P_G) C - I - m^{Opp} \geq 0$
$S3: M\_NoCDS$	$Y(\mu) = X - I - q(\mu)$

where:

$M\_CDS$  = Monitor and buy credit derivatives

$M\_NoCDS$  = Monitor and do not buy credit derivatives

$M\_NoCDS$  = Do not monitor and buy credit derivatives.

We also allow for mixed strategies,  $\sigma^{Si}$ , and define a probability distribution  $\Sigma = \{\sigma^{M\_CDS}, \sigma^{M\_NoCDS}, \sigma^{NM\_CDS}\}$  over the three pure strategies,  $Si$ , with  $0 \leq \sigma^{Si} \leq 1$  and  $\sum_i \sigma^{Si} = 1$ .

Unlike Mon banks that always choose the socially optimal strategy  $M\_CDS$ , Opp banks are subject to bank shirking because  $M\_CDS$  is a dominated strategy for them in a single period horizon. Payoffs under  $M\_CDS$  are strictly lower than  $NM\_CDS$  for all values of  $q(\mu)$ , indicating that Opp bank's positive monitoring costs induce them to, ex-post, shirk on monitoring after they purchase credit protection. Thus, the existence of a fairly priced credit derivative market undermines the monitoring incentives for Opp banks. The monitoring of unhedged loans, strategy  $S2$ , remains a positive NPV activity for Opp banks by assumption (A1).

### **Credit Derivatives Markets**

Credit derivatives are contingent claims contracts, which for an upfront fee, pay out a pre-agreed cash flow contingent on the occurrence of a pre-specified

default event. The credit derivative instrument we consider is a single period Credit Default Swap (CDS), which makes a payment ( $\$X$  in our case) in the event of a loan default. Sellers of CDS pay out the pre-specified cash flow  $\$X$  to CDS buyers after a credit event occurs, in return for an upfront CDS premium,  $q(\mu)$ . The underlying obligation in the CDS contract may be either an individual loan or a portfolio of bank loans (Das (2002)). We assume Mon and Opp banks hedge their portfolio concentration risk by buying CDS on loan portfolios.<sup>17</sup>

CDS sellers are risk-neutral, competitive and well diversified, such that, CDS premiums  $q(\mu)$  earn zero rents on expected loan losses.<sup>18</sup> CDS sellers determine premiums based on expected loan losses to each type of bank in the event of a loan default. To fairly-price CDS premiums at the start of the period, CDS sellers only have to predict equilibrium actions of Opp banks since Mon banks always monitor their loans when they buy CDS, as stated in equation (3)

$$q^*(\mu) = \mu(1-P_G)X + (1-\mu)(\sigma^{M-CDS^*}(1-P_G) + \sigma^{NM-CDS^*}(1-P_B))X. \quad (3)$$

---

<sup>17</sup> Mon banks enter the credit derivatives market to hedge against their high portfolio concentration risk. Therefore, CDS structured on loan portfolios are better suited to meet their hedging objectives than those designed on individual loans. Mimicking the actions of Mon banks, Opp banks also trade in portfolio credit derivatives to hedge their entire loans. The market share of credit default swaps on portfolio products has grown to a sizeable 22 percent of the \$1.2 trillion global credit derivatives market in 2001 (British Banking Association 2001/2002 Survey Report).

<sup>18</sup> CDS sellers, similar to capital market investors, hold well-diversified portfolios with  $\rho=0$  and therefore face no convex cost of capital adjustments, i.e.  $C=0$ , by assumption.

Equilibrium pricing of  $q^*(\mu)$  in equation (3) thus depends upon  $\mu$ , the proportion of Mon banks buying credit protection, and equilibrium beliefs of the CDS sellers about Opp banks monitoring action under credit protection, denoted by  $\sigma^{M\_CDS^*}$  and  $\sigma^{NM\_CDS^*}$ . Mon banks by assumption always choose  $M\_CDS$ , that is,  $\sigma^{M\_CDS^*} = 1$ .

### **Equilibrium for the Single Period Game without Credit Derivatives**

In a world without credit derivatives, Opp banks always monitor their loans because monitoring generates positive relationship rents ( $Z > 0$ ) and protects bank capital. Opp banks do not shirk on monitoring because unmonitored loans are strictly negative NPV transactions. Mon banks also monitor their loans.

#### ***Proposition 1***

***In a world without credit derivatives, Opp banks always monitor their loans when they lend to firms.***

### **Equilibrium for the Single Period Game with Credit Derivatives**

We use the concept of Bayesian Nash Equilibrium to define equilibrium for the single period model with credit derivatives. Described below is the timeline for the single period game, followed by description of the equilibrium strategies for Opp

banks and CDS sellers. Equilibrium strategy for Mon banks is  $M\_CDS$  by assumption (A3).

### Time Line with Credit Derivatives

$t=0$

$t=1$



-Mon and Opp banks operate in the loan market .

-Firms approach banks to borrow \$1.

-Mon Banks monitor and buy CDS.

-Opp banks choose their monitoring and hedging decisions.

-CDS market sets premiums for CDS.

-Loan is repaid if project is successful.

-CDS contract is settled in the event of a loan default.

-Bank capital is adjusted to reflect unhedged loan defaults, if any.

At  $t=0$ :

- Banks are privately informed about their type, while CDS sellers only know the proportion of Mon and Opp banks operating in the economy, denoted by  $\mu$  (Mon banks) and  $1-\mu$  (Opp banks), where  $0 \leq \mu \leq 1$  .
- Firms borrow \$1 from banks.
- Mon banks always monitor loans and buy CDS to hedge their high marginal cost of capital.

- Opp banks choose their monitoring and hedging decision conditional on  $q^*(\mu)$ .
- CDS sellers set the price of  $q^*(\mu)$  based on  $\mu$  and beliefs about equilibrium actions of Opp banks.

*At t=1:*

- If the project succeeds, cash flows are realized and the loan is repaid. The probability of success of the financed projects is conditional on the bank's monitoring decision. If loans are monitored, banks receive  $\$X$  with probability  $P_G$ ; 0 otherwise.
- If the loan defaults and CDS were purchased at  $t=0$ , then banks collect the pre-specified amount  $\$X$  from CDS sellers, otherwise banks receive  $\$0$  under the CDS contract. Bank capital levels are reduced accordingly.

**Proposition 2**

**In the single period equilibrium with credit derivatives, the socially optimal strategy  $M\_CDS$  is never chosen by Opp banks because it is strictly dominated by  $NM\_CDS$ , due to Opp banks' positive monitoring costs. Stated below are the equilibrium strategies for Opp banks and CDS sellers with respect to  $\mu$  :**

<b>Region</b>	<b>Equilibrium Strategies</b>	<b>Payoff</b>
<b>1. <math>\mu \geq \check{\mu}</math></b>	<b>Opp Banks:</b> $\sigma^{NM\_CDS^*} = 1$  <b>CDS Seller:</b> $q^*(\mu) = \mu(1-P_G)X + (1-\mu)(1-P_B)X$	$Y(\mu) \geq Z$
<b>2. <math>0 &lt; \mu &lt; \check{\mu}</math></b>	<b>Opp Banks:</b> $\sigma^{NM\_CDS^*} = \tilde{\sigma}$ , $\sigma^{M\_NoCDS^*} = 1 - \tilde{\sigma}$  <b>CDS Seller:</b> $q^*(\mu) = m^{Opp} + (1-P_G)(X + C)$	$Z$
<b>3. <math>\mu = 0</math></b>	<b>Opp Banks:</b> $\sigma^{M\_NoCDS^*} = 1$  <b>CDS Seller:</b> $q^*(\mu) = (1-P_B)X$	$Z$

**where:**

$$\check{\mu} \equiv \frac{\Delta X - ((1-P_G)C + m^{Opp})}{\Delta X} \quad \text{and} \quad \Delta \equiv P_G - P_B$$

$$\tilde{\sigma} \equiv \frac{X(1-P_G)(1-\mu) + (1-P_G)C + m^{Opp}}{(1-\mu)(1-P_B)X}$$

To protect their bank capital, Opp banks either monitor or hedge their loans in the single-period equilibrium characterized in Proposition (2). They never monitor

and hedge at the same time because once they purchase credit protection, monitoring costs only lowers their current period profits without protecting their bank capital or creating any future returns. Monitoring and hedging are thus mutually exclusive strategies for Opp banks in the single period model, for all values of  $\mu$ .

Proposition (2) shows that when  $\mu \geq \tilde{u}$ , a pure strategy shirking equilibrium exists with Opp banks choosing  $\sigma^{NM\_CDS^*} = 1$ . In this region, as the proportion of Mon banks increases to one, equilibrium prices for CDS decline towards their lower bound of  $q^*(\mu) = (1-P_G)X$  and Opp banks earn higher profits  $Y(\mu)$  from shirking than monitoring  $Z$ . Thus, in the single period equilibrium, when  $\mu$  is high, Opp banks always shirk on monitoring after buying credit protection.

In the second region, where  $0 < \mu < \tilde{u}$  the lower proportion of Mon banks makes it suboptimal for Opp banks to choose  $\sigma^{NM\_CDS^*} = 1$  because of the costlier equilibrium prices for CDS. Thus, the pure strategy shirking equilibrium of the first region is dominated by the mixed strategy equilibrium, wherein Opp banks randomize their action between bank-shirking and monitoring with probabilities  $\sigma^{NM\_CDS^*}$  and  $\sigma^{M\_NoCDS^*}$  respectively.<sup>19</sup> In equilibrium, Opp banks choose  $\sigma^{NM\_CDS^*}$  and  $\sigma^{M\_NoCDS^*}$  such that they are indifferent between their strategy payoffs, i.e.  $Y(\mu) = Z$ . Equilibrium prices of CDS stay constant at  $q^*(\mu) = m^{Opp} + (1-P_G)(X + C)$ , due

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<sup>19</sup> With uncertainty in the single period model about bank type, i.e.  $\mu > 0$ , the pure strategy equilibrium  $M\_NoCDS$ , is implausible because when  $\sigma^{M\_NoCDS^*}$ ,  $q^*(\mu) = (1-P_G)X$  and Opp banks, ex-post, will invariably switch to  $NM\_CDS$  and break the equilibrium.

to Opp banks' profit indifference; a condition necessary for the existence of a mixed strategy equilibrium.<sup>20</sup>

Finally, when  $\mu=0$  and the approaching bank is a known Opp type, CDS sellers price  $q^*(\mu)$  to  $(1-P_B)X$ . At these high CDS prices, shirking profits  $Y(\mu)$  become negative and Opp banks find it feasible to monitor loans and stay out of the CDS market altogether, therefore,  $\sigma^{M\_NoCDS^*} = 1$ .

### Social Welfare Analysis of Single Period Bank-Shirking Equilibrium

Bank monitoring is welfare enhancing as it increases society's aggregate wealth by financing projects that otherwise would have remained unfunded by capital markets owing to firm moral hazard, i.e. (similar to Stiglitz and Weiss (1981)), as stated in equation (4)

$$P_G X - I > P_B X - I . \quad (4)$$

The social gain of delegated bank monitoring is quantified below in equation (5) and simplified in equation (5a)

$$P_G X - (1 - P_G) C - I - m^{Opp} > P_B X - I \quad (5)$$

$$(P_G - P_B) X - (1 - P_G) C - m^{Opp} > 0. \quad (5a)$$

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<sup>20</sup> For  $0 < \mu < \check{\mu}$ ,  $q(\mu, \sigma^{M\_NoCDS}=1) > q^*(\mu, \sigma^{M\_NoCDS}<1)$ .

If markets are incomplete, the introduction of a liquid credit derivatives market will improve overall social welfare by allowing banks the option to hedge their marginal portfolio concentration risks. Credit derivatives markets offer banks that monitor an effective means to trade their illiquid portfolio credit risk and minimize the impact of credit and liquidity shocks to the banking system by spreading these macro risks more broadly over financial markets. Furthermore, these hedging markets also allow banks to manage their equity capital without causing any negative fallout affecting their bank-client relationships. Therefore, credit derivatives offer greater flexibility to banks in managing their capital resources, than their rival loan sales, which run the risk of jeopardizing bank's lucrative bank-client relationships.

Concurrent to the aforementioned social gains, credit derivatives are not without their social costs as they induce Opp banks to shirk on their monitoring activity. Opp banks who always monitored their loans in the absence of a credit derivatives market, no longer find it feasible to select the socially desirable strategy  $M\_CDS$  in the single period equilibrium because monitoring in conjunction with hedging becomes redundant in preserving bank capital. Creation of the credit derivatives market thus undermines the incentives of Opp banks to monitor loans, which results in the financing of negative NPV projects. Financing of bad projects by Opp banks is a negative externality of credit derivatives markets, that in a single period model, may completely wipe out any social gains accruing from the hedging of the marginal convex capital cost for all

banks.<sup>21</sup> In equation (6),  $\delta w^s$ , quantifies the net change in social welfare with the introduction of credit derivatives for the bank-shirking equilibrium described in Proposition 2:

$$\delta w^s = E(\delta \Pi^B) - (1-\mu)\sigma^{NM\_CDS^*}(\Delta X), \quad (6)$$

where:

$$E(\delta \Pi^B) = \mu(\Pi^{Mon}) + (1-\mu)(\delta \Pi^{Opp})$$

$$\delta \Pi^{Mon} = [(1-P_G)(X + C^{Mon}) - q(\mu)]$$

$$\delta \Pi^{Opp} = (\sigma^{M\_CDS^*} + \sigma^{NM\_CDS^*}) [(1-P_G)(X + C) - q(\mu)] + \sigma^{NM\_CDS^*}(m^{Mon})$$

$$\Delta = P_G - P_B.$$

In equation (6),  $E(\delta \Pi)$  represents net change in expected bank profits due to introduction of the credit derivatives markets, while  $(1-\mu)\sigma^{NM\_CDS^*}(\Delta X)$  captures the destruction of aggregate social wealth by Opp banks due to their failure to improve the quality of their hedged loans when they shirk on their monitoring function. In the single period shirking equilibrium, Opp banks increase their current profits by saving on their high monitoring costs. However, profits for Mon banks appreciate because they hedge their high marginal cost of capital adjustments in the credit derivatives market.

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<sup>21</sup> Mon banks will hedge only their marginal capital cost adjustments whereas Opp banks will hedge their entire loans. Thus, in equilibrium, while the incidence of hedging will be higher for Mon banks, than for Opp banks, their intensity will be lower.

In a first best world,  $\delta w^s$  increases to  $\mu(1-G)C^{Mon} + (1-\mu)(1-P_G)C$ , as Opp banks hedge their marginal capital costs in the credit derivatives market and continue monitoring their loans,  $\sigma^{M\_CDS^*} = 1$ , and Opp banks also ensure a steady flow of financing of opaque, but positive NPV projects. Small and opaque firms benefit the most from this uninterrupted flow of bank capital, as these firms are the first to endure the impact of an adverse credit crunch caused by a systemic banking shock (Repullo and Suarez (2000) and Holmstrom and Tirole (1997)). However, Opp banks commitment to monitor with credit protection is not credible in the single period setting because, ex-post, they will shirk on their hedged loans to save on their high monitoring costs, i.e.  $\sigma^{M\_CDS^*} = 0$ . This shirking will not be detected in the one period model because Mon and Opp banks are observationally identical.

## 2.2 DYNAMIC GAME (REPUTATION EFFECTS TO RESOLVE THE BANK-SHIRKING PROBLEM)

Having shown in the single period model that Opp banks never have the incentive to monitor loans in conjunction with credit protection, we now evaluate whether reputation concerns over a multi-period setting are sufficient to resolve the bank-shirking problem faced by Opp banks.<sup>22</sup> In other words, if the model were to last for more than one period, would Opp banks choose their dominated action  $M\_CDS$  to build reputations mimicking as Mon banks? If so, then reputation effects will be sufficient to establish the socially desired equilibrium  $M\_CDS$  over a multi period setting. Opp banks will choose the socially optimal action, at least in the earlier periods of a multi-period game, because gains on future credit-hedged loans will be higher than the current monitoring costs incurred in building their reputation capital.

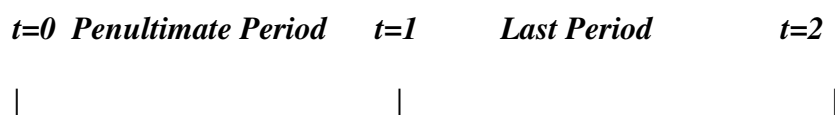
To illustrate reputation effects we use a two period model for ease of exposition and without loss of generality. Our predictions on reputation building for Opp banks in a two-period model maybe generalized over a multi-period model with more than two periods. We repeat the single period game in our two-period model. Therefore, strategies and payoffs for Mon/Opp banks and CDS sellers are carried over from the single period model.

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<sup>22</sup> Partial credit hedging will not be an equilibrium outcome because banks can go to multiple credit protection sellers and hedge their risk, secretly with each. Hence, partial hedging of only capital adjustments costs is not a credible signal to credit protection sellers that the bank will indeed monitor its loans.

In our two-period model, CDS sellers are short-lived players; with a new set entering the CDS market at the start of each of the two periods. Banks on the other hand are long-lived players who operate in both the periods. Similar to the single period model, we continue to assume that banks are privately informed about their types. CDS sellers only know the proportion of Mon banks  $\mu_t$  operating in each time period  $t$ , with  $\mu_0$  being the common prior for Mon types at  $t=0$ , and  $\tilde{\mu}_t$  being the posterior probability on Mon types, updated according to Bayes rules and equilibrium beliefs of CDS sellers about the action profile of Opp banks at  $t=0$ .

### **TimeLine for the Two-Period Game**



Our dynamic model consists of two periods and three dates,  $t=(0, 1, \text{ and } 2)$ . Banks and CDS sellers choose their actions at the beginning of each period while project cash flows and CDS settlements occur at the end. We represent end of period cash flows by their beginning period dates to synchronize actions with payoffs. Cash flows realized at  $t=1$  and  $t=2$  are thus represented by  $t=0$  and  $t=1$  respectively. This exposition makes the model easier to read as it reduces the number of dates from three to two without detracting from the model's main

results and implications. Besides, as the risk free interest rate is assumed as zero, timing of the cash flow in each period, whether at the beginning or end, is inconsequential.

*Penultimate Period  $t=0$ :*

1. Mon and Opp banks operate in the bank loan market with probability  $\mu_0$  and  $1-\mu_0$  respectively. Banks are privately informed about their type, while CDS sellers know the proportion of Mon and Opp banks.
2. Opp Banks choose their hedging and monitoring actions, while Mon banks always monitor and hedge their loans.
3. CDS sellers determine  $q_0^*(\mu_0)$  based on their priors on  $\mu_0$  and beliefs about equilibrium actions of Opp banks in the penultimate period.
4. Payoffs from the loan and CDS contract are realized at the end of the penultimate period at  $t=1$ .

*Last Period  $t=1$ :*

1. Opp Banks choose their hedging and monitoring actions, while Mon banks always monitor and hedge their loans.
2. CDS sellers determine  $q_1^*(\tilde{\mu}_1^i)$  based on  $\tilde{\mu}_1^i$  and beliefs about equilibrium action for Opp banks in the last period.  $\tilde{\mu}_1^i$  is updated on the outcome of the CDS contract (Default, No default) and equilibrium actions of Opp banks in the penultimate period.

3. Payoffs from the loan and CDS contract are realized at the end of the last period at  $t=2$ .
4. Game ends.

We describe below the action space, profit function and information set available to Opp and Mon banks in each of the two periods.

### Opportunistic (Opp) Banks

**Action space for Opp banks:**  $A_t^{Opp} = \{M\_CDS_t, M\_NoCDS_t, NM\_CDS_t\}$ .

$A_t^{Opp}$  represents feasible action space for Opp banks in each period. We define a probability distribution  $\Sigma_t = \{\sigma_t^{M\_CDS}, \sigma_t^{M\_NoCDS}, \sigma_t^{NM\_CDS}\}$  over  $A_t^{Opp}$  to allow for mixed strategies  $\sigma_t^{Si}$ , where  $Si$  represents the three actions for Opp banks, with  $0 \leq \sigma_t^{Si} \leq 1$  and  $\sum_i \sigma_t^{Si} = 1$ , for  $t=0, 1$ .

### Payoff function at time $t$ :

<u>Actions</u>	<u>Payoffs</u>
$S1_t: M\_CDS_t$	$X-1- q_t(\tilde{\mu}_t^i) - m^{Opp}$
$S2_t: M\_NoCDS_t$	$Z \equiv P_G X - (1-P_G) C - 1 - m^{Opp} \geq 0$
$S3_t: NM\_CDS_t$	$Y(\mu) = X-1- q_t(\tilde{\mu}_t^i)$

where  $q_t(\tilde{\mu}_t^i)$  represents the price of CDS at time  $t$ . In period  $t=0$ ,  $q_t(\tilde{\mu}_t^i) = q_0(\tilde{\mu}_0)$ .

Opp banks choose their equilibrium actions at  $t=0$  to maximize their total discounted profits, described below in equation (7)

$$E(\Pi_0^{Opp}) = \sum_i \sigma_0^{Si} \{ \pi_0(Si_0) + P_{si,1} ( \max [Y(\tilde{\mu}_1^{ND}), Z] ) + (1 - P_{si,1})(\max[Y(\tilde{\mu}_1^D), Z]) \} \quad (7)$$

where:

$Si_0$  = pure action chosen at  $t=0$ , with  $i = 1, 2, 3$

$\sigma_0^{Si}$  = probability distribution over  $Si_0$  at  $t=0$

$\pi_0(Si_0)$  = payoff for the first period under  $Si_0$  at  $t=0$

$P_{si,1}$  = probability of no default under  $Si_0$  at  $t=1$

$\max [.]$  = max operator defines profits for the last period

$E [.]$  = expectation operator.

**Information Available at the start of each period:**  $H_t^{Opp} (\sigma_t^{Si}, q_t^*(\tilde{\mu}_t^i); i_t)$ .

At the start of each period, Opp banks know their current and past period actions  $\sigma_t^{Si}$ , current and past CDS prices,  $q_t^*(\tilde{\mu}_t^i)$  and loan outcomes  $i_t$  for all preceding CDS contracts. The variable  $i_t$  represents the CDS loan outcome at time  $t$  for loans hedged at time  $t=t-1$ , with  $i_t = \{\text{Default (D), No Default (ND)}\}$ . At  $t=0$ ,  $i_0=0$ .

### Monitor (Mon) Banks

As described in the single period model, we assume Mon banks monitor their loans and buy CDS to hedge their high marginal cost of capital adjustments.  $M\_CDS_t$  remains a dominant strategy for Mon banks in each of the two periods.

**Action space for Mon banks:**  $A_t^{Mon} = \{M\_CDS_t\}$  for  $t = (0,1)$ .

**Payoff function (Mon Banks):**  $M\_CDS_t: Y(\mu) = X - I - q_t(\tilde{\mu}_t^i)$ , as  $m^{Mon} = 0$ .

**Information Available at the start of each period:**  $H_t^{Mon}(M\_CDS_t, q_t^*(\tilde{\mu}_t^i); i_t)$ .

Similar to Mon types, Opp banks also know their current and past period actions  $M\_CDS_t$ , current prices of CDS  $q_t^*(\tilde{\mu}_t^i)$  and the loan outcomes  $i_t$  for all the preceding CDS contracts.

### Credit Derivatives Market

Sellers of credit derivatives competitively price CDS in each period to earn zero profits. CDS prices at time  $t$  are set as follows in equation (8)

$$q_t^*(\tilde{\mu}_t^i) = \tilde{\mu}_t^i(1 - P_G)X + (1 - \tilde{\mu}_t^i)(\sigma_t^{M\_CDS^*}(1 - P_G) + \sigma_t^{NM\_CDS^*}(1 - P_B)), \quad (8)$$

where  $\tilde{\mu}_t^i$  is CDS seller's updated belief about Mon types at time  $t$  and  $\sigma_t^{M\_CDS^*}$  and  $\sigma_t^{NM\_CDS^*}$  are equilibrium probabilities for Opp banks for their monitoring actions,  $M\_CDS_t$  and  $NM\_CDS_t$ , respectively. At  $t=0$ ,  $\tilde{\mu}_t^i = \mu_0$ .

**Action Space for CDS Sellers:**  $Q_t = q_t(\tilde{\mu}_t^i) \in [(1-P_G)X, (1-P_B)X]$ .

**Payoff for CDS Sellers:**  $q_t^*(\tilde{\mu}_t^i) - (1-\tilde{p}_t)X=0$ ,

where  $(1-\tilde{p}_t) = \tilde{\mu}_t^i(1-P_G) + (1-\tilde{\mu}_t^i)(\sigma_t^{M\_CDS^*}(1-P_G) + \sigma_t^{NM\_CDS^*}(1-P_B))$ , is the expected probability of loss upon default on the underlying loan contract.

**Information Available at the start of each period:**  $H_t^{CDS} (q_t^*(\tilde{\mu}_t^i); i_t, d_t)$ .

CDS sellers have no private information about bank types and they cannot see monitoring action chosen by banks at the start of each period. However, they can observe loan outcomes  $i_t$  on all prior period CDS contracts. Additionally, CDS sellers can also identify if banks purchased credit protection in the preceding period, represented by a dummy variable  $d_t$  of values 0 and 1. At  $t=1$ ,  $d_1 = 1$  indicates credit protection was bought at  $t=0$  and  $d_1=0$  states that credit protection was not bought at  $t=0$ .<sup>23</sup> At  $t=0$ ,  $d_0$  is null and  $i_0=0$ .

Given that monitoring is not observable, CDS sellers update  $\tilde{\mu}_t^i$  according to Bayes rule, their equilibrium beliefs on the action profile of Opp banks and loan

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<sup>23</sup> We assume that banks fully disclose information about their off balance sheet credit hedging activity in their year-end financial statements. Our reputation results should go through even under the more realistic assumption of imperfect reporting. However, the reputation building process would have more noise and would therefore be more costly.

outcomes on the preceding period CDS contracts. Defined below are the updated probabilities for  $\mu_0$ ,  $\tilde{\mu}_1^D$  and  $\tilde{\mu}_1^{ND}$  where:

$$\tilde{\mu}_0 \equiv Pr(Mon_{t=0}) = \frac{\mu_0}{\mu_0 + (1 - \mu_0)(\sigma_0^{M\_CDS^*} + \sigma_0^{NM\_CDS^*})}$$

$$\tilde{\mu}_1^D \equiv Pr(Mon_{t=1} | d_1 = 1, i_1 = D) = \frac{\mu_0(1 - P_G)}{\mu_0(1 - P_G) + (1 - \mu_0)(\sigma_0^{M\_CDS^*}(1 - P_G) + \sigma_0^{NM\_CDS}(1 - P_B))}$$

$$\tilde{\mu}_1^{ND} \equiv Pr(Mon_{t=1} | d_1 = 1, i_1 = ND) = \frac{\mu_0 P_G}{\mu_0 P_G + (1 - \mu_0)(\sigma_0^{M\_CDS^*} P_G + \sigma_0^{NM\_CDS} P_B)}$$

### Lemma (1)

**At  $t=1$ , when  $d_1 = 0$ ,  $\tilde{\mu}_1^D = \tilde{\mu}_1^{ND} = 0$  and  $q_t(\tilde{\mu}_t^i = 0) = (1 - P_B)X$ .**

### Proof:

When a bank does not enter the CDS market at  $t=0$ , then  $d_1$  is zero and CDS sellers immediately identify that bank to be an Opp type because hedging is a dominating action for Mon banks. Consequently, at  $t=1$ , CDS premiums for an identified Opp bank are set at  $(1 - P_B)X$  to reflect their dominant shirking strategy under credit protection.

To describe equilibrium actions for Opp banks in the penultimate period, we describe below two lemmas and Proposition 3.

**Lemma (2)**

***In the penultimate period, Opp banks choose  $M\_CDS_0$  with probability less than one for all  $0 \leq \mu_0 \leq 1$ . This result is true regardless of the number of periods remaining before the last  $T$  period, in a multi-period model of more than two periods.***

***Proof:*** See Appendix A.

Lemma (2) stipulates an important result of our dynamic model. It states that reputation alone cannot resolve Opp banks' incentives to shirk on monitoring in any stage of a multi-period game because  $\sigma_0^{M\_CDS^*} < 1$ . Lemma (2) derives from the fact that CDS sellers cannot observe bank monitoring activity and must, therefore, update their beliefs about bank type based on a noisy signal (realized outcomes on the preceding period's loan contract) and not on the observed actions of Opp banks. In our dynamic model, the noisy loan signal  $i_t$  becomes completely uninformative when Opp banks choose the socially optimal monitoring strategy with probability one, i.e.  $\sigma_0^{M\_CDS^*} = 1$ . Thus, some level of shirking by Opp banks is necessary to keep the noisy signal meaningful. This result is independent of the number of periods remaining in the game (finite or infinite).

**Lemma (3)**

If  $\sigma_0^{M\_CDS^*} = 0$ , then  $\sigma_0^{NM\_CDS^*} > 0$  for  $\mu_0 \in (0, 1)$ .

**.Proof:** See Appendix A.

According to Lemma (3), Opp banks shirk with positive probability when  $\sigma_0^{M\_CDS^*} = 0$ . If this were not true, then the resulting equilibrium of  $\sigma_0^{M\_NoCDS^*} = 1$  would be implausible, because under CDS prices would equal  $(1 - P_G)X$  and Opp banks will surely switch to their shirking strategy,  $\sigma_I^{NM\_CDS} = 1$ , to earn higher profits. Hence, in the penultimate period, CDS sellers believe that Opp banks select  $\sigma_0^{NM\_CDS^*} > 0$ , whenever  $\sigma_0^{M\_CDS} = 0$ .

**Proposition 3**

**By virtue of lemmas (2) and (3), the pure strategy equilibria of  $\sigma_0^{M\_CDS^*} = 1$  and  $\sigma_0^{M\_NoCDS^*} = 1$  are implausible in the penultimate period of a two period game.**

**Our reputation function  $\sigma_0^{M\_CDS}$  ranges in value between  $0 \leq \sigma_0^{M\_CDS^*} < 1$ .**

**Furthermore, since  $\sigma_0^{M\_CDS} < 1$  and  $\sigma_0^{NM\_CDS^*} > 0$ , the Opp bank's incentives to shirk on monitoring after purchasing credit protection can never be fully resolved with reputation in the penultimate period of a two period game.**

### Equilibrium for the Two-Period Model

We use the concept of Perfect Bayesian Equilibrium to characterize equilibrium for our two-period model. Consequently, equilibrium actions of Opp banks and CDS sellers are optimal given the beliefs of CDS sellers about Opp banks' chosen actions.<sup>24</sup> We solve the two-period model using backward induction.

Propositions (2) and (3) characterize the equilibrium for the two-period model. Since there are no reputation effects to consider in the last period, equilibrium actions for Opp banks are simply those defined in Proposition (2). Accordingly, Opp banks always shirk on their hedged loans in the last period and destroy their reputation capital by choosing  $\sigma_I^{M\_CDS^*}$  with strictly positive probability. Reputation building takes place only in the penultimate period.

Figure (1) illustrates the equilibrium actions of Opp banks over the two periods with respect to their reputation capital, i.e.  $\mu_0$  and  $\tilde{\mu}_I^i$ . The difference between shirking profits  $Y(\tilde{\mu}_I^i)$  and monitoring profits  $Z$  represents reputation rents for Opp banks. These rents increase with respect to  $\tilde{\mu}_I^i$ , because lower prices of  $q_I^*(\tilde{\mu}_I^i)$ , as  $\tilde{\mu}_I^i$  increases, make hedging and shirking a more attractive strategy for Opp bank's than simply monitoring loans.

In the last period in Figure (1), reputation rents are positive in region VI because  $\tilde{\mu}_I^i \geq \check{\mu}_I$ . However, this is not the case in region V, where reputation capital is low

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<sup>24</sup> Hence we assume that in equilibrium, CDS sellers form correct (self-fulfilling) beliefs about the chosen actions of Opp banks when they price their CDS at  $t=(0,1)$ .

and reputation rents are zero because Opp banks randomize between  $NM\_CDS_I$  and  $M\_NoCDS_I$ , thereby setting  $Y(\tilde{\mu}_I^i)=Z$ . In region V, we see some level of monitoring by Opp banks on their partially hedged loan portfolios, unlike in region VI, where they always shirk on their fully hedged loan portfolios.

Opp banks monitor their hedged loans in the penultimate period because they may use their reputation as monitors to earn positive rents in the last period. However, in the penultimate period also, Opp banks may refrain from investing in their reputation if the likelihood of earning reputation rents in the last period is close to zero or one (due to extremely low or very high reputation capital). Opp banks endowed with low reputation capital,  $\mu_0$ , would not find it feasible to invest in reputation building, because even after monitoring, their next period reputation capital does not improve significantly for them to generate positive future reputation rents. Thus, in region I, where  $\mu_0$  is low and  $\check{y}_I > \tilde{\mu}_I^{ND} > \tilde{\mu}_I^D$ , Opp banks optimally randomize between strategies  $NM\_CDS_0$  and  $M\_NoCDS_0$  and do not invest in reputation building. Alternatively, when endowed reputation capital is extremely high, Opp banks do not monitor their hedged loans because they earn positive reputation rents, regardless of their monitoring action. This is equivalent to region IV where  $\mu_0$  is so high and  $\check{y}_I < \tilde{\mu}_I^{ND} < \tilde{\mu}_I^D$  that Opp banks shirk with probability one in both the penultimate and last periods. This region corresponds to the “reputation burning” stage in which Opp banks exploitation of reputation rents leads to behavior that eventually will destroy their reputation.

Only in regions II and III of the penultimate period do we see positive reputation effects in our two-period analysis. These are the “reputation building” stages. In region II, Opp banks endowed with slightly higher reputation capital than those in region I, find it optimal to monitor and build their reputation capital by choosing  $M\_CDS_0$  with positive probability. Monitoring becomes viable as  $\tilde{\mu}_1^{ND} > \check{u}_1 > \tilde{\mu}_1^D$  indicating that Opp banks earn positive reputation rents in the no default state. Investment in reputation building also continues to occur into region III, with Opp banks choosing  $M\_CDS_0$  with increasing probability because incremental rents from monitoring are higher than incremental costs of monitoring. However, in region III, once  $\mu_0$  is high enough such that  $\tilde{\mu}_1^{ND} > \tilde{\mu}_1^D > \check{u}_1$  and marginal costs of monitoring outweigh marginal benefit from reputation, reputation effects start to weaken and Opp banks choose  $M\_CDS_0$  with decreasing probability. Since our reputation function  $\sigma_0^{M\_CDS^*}$  is less than one by Proposition (3), mixed strategy equilibrium exists in regions II and III, wherein Opp banks first randomize among all three strategies and then select between  $M\_CDS_0$  and  $NM\_CDS_0$  respectively. Thus, shirking on hedged loans by Opp banks remains a negative externality of credit derivatives markets in the penultimate period also as  $\sigma_0^{NM\_CDS^*} > 0$ .

Summarizing the characterization of our two-period equilibrium, reputation effects occur only in the penultimate period. Further, a non-monotonic relationship exists for  $\sigma_0^{M\_CDS^*}$  with respect to  $\mu_0$ , indicating that Opp banks first build and then burn their reputation capital in the two-period model. Since our reputation function  $\sigma_0^{M\_CDS^*}$  does not have a closed form solution, we present simulations in section V

to capture its non-monotonic form. Defined below are the bounds on  $\mu_0$  where reputation is ineffective in controlling shirking incentives for Opp banks in the penultimate period:

$\sigma_0^{M\_CDS^*} = 0$  when  $0 \leq \mu_0 < \check{\mu}_1 \{ P_B / (P_G - \check{\mu}_1(P_G - P_B)) \}$  banks do not invest in building a reputation in the credit derivatives markets because monitoring costs are higher than the consequent reputation rents.

$\sigma_0^{M\_CDS^*} = 0$  when  $A \leq \mu_0 \leq I$ , Opp banks shirk on monitoring as their high reputation capital assures them reputation rents in the last period, independent of their chosen monitoring action in the penultimate period. Opp banks thus save on monitoring costs in both the periods. A is defined below as:

$$A \equiv (\Delta^2 X - m(1 - 2P_B) + ((\Delta^2 X (P_B^2 - 2P_B P_G + P_G^2) - 2\Delta X m (P_G + P_B) + m^2 + 4P_G \Delta X m P_B)^{1/2}) / 2(\Delta X - m).$$

### 2.3 SIMULATIONS OF REPUTATION EFFECT IN THE PENULTIMATE PERIOD

We use simulations to illustrate the non-monotonic relationship of  $\sigma_0^{M\_CDS^*}$  over  $\mu_0$  in the penultimate period of our two-period model.<sup>25</sup> Simulation results for the two-period model are general and maybe extrapolated to represent reputation effects at any time period  $t$ , other than the last period  $T$ , of a multi-period game, where  $T$  approaches infinity. In a model with more than two periods, the non-monotonic relationship of  $\sigma_0^{M\_CDS^*}$  with respect to  $\mu_0$  would indicate self-generating monitoring cycles in a time series context, as Opp banks would gradually build and burn their reputation over time. Because the monitoring actions of banks are unobservable, time varying oscillations in the reputation function are the result of the noisy loan signal, i.e. default and no default outcomes on loans. In contrast, in standard reputation models, the resulting reputation equilibrium is stable because the long run player, in each period, chooses his sub-optimal action in such a manner so that his reputation capital does not vary with time.<sup>26</sup>

Figure (2) presents base case simulation results for our reputation function in the penultimate period. Figure (2), shows the two sub regions of  $\mu_0$  wherein  $\sigma_0^{M\_CDS^*}=0$ , and reputation is ineffective in resolving Opp banks incentive to shirk, i.e.  $0 < \mu_0 < 0.1$  and  $0.95 < \mu_0 < 1$ . In the first region where  $0 < \mu_0 < 0.1$ , Opp banks do not build reputation because reputation rents  $Y(\tilde{\mu}_1^i) - Z$  are lower than current period monitoring costs. This region is akin to region I of Figure (1) where Opp

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<sup>25</sup> The parameter values chosen are not pathological and we get similar non-monotonic functions for  $\sigma_0^{M\_CDS^*}$  with different parameter values.

<sup>26</sup> See Kreps and Wilson (1982) and Milgrom and Robert (1983).

banks randomize between  $\sigma_0^{NM\_CDS^*}$  and  $\sigma_0^{M\_NoCDS^*}$ . In a multi-period model with more than two periods, this region would be much smaller and almost non-existent because Opp banks with extremely low reputations  $\tilde{\mu}_t^i$  would also find it optimal to monitor due to larger reputation rents.

In the second region where  $0.95 < \mu_0 < 1$ , Opp banks shirk on their hedged loans in both the periods as the gain in their future reputation rents is lower than their current monitoring costs. High values of  $\tilde{\mu}_t^i$  in a multi period setting of more than two periods would be equivalent to high reputation capital accumulated by Opp banks by monitoring hedged loans in the prior periods.

The reputation function  $\sigma_0^{M\_CDS^*}$  becomes positive over  $0.95 < \mu_0 < 1$  but non-monotonic with respect to  $\mu_0$ . Figure (2) shows that first the function increases over the range  $0.1 < \mu_0 < 0.55$ , this is the reputation building stage. Subsequently, the function's value decreases over the range  $0.55 < \mu_0 < 0.95$ , this is the reputation burning stage. As  $\sigma_0^{M\_CDS^*}$  increases over  $0.1 < \mu_0 < 0.55$ , Opp banks monitor their hedged loans with greater intensity to reap higher reputation rents  $Y(\tilde{\mu}_1^i) - Z$  in the last period. However, over  $0.55 < \mu_0 < 0.95$  Opp banks do not invest as aggressively in monitoring because the proportion of Mon banks is so high or the level of reputation capital so large that they can afford to shirk with increasing probability. Thus, in this region, Opp banks reap the rewards of their monitoring capital by burning their reputation and shirking, because their invested reputation capital is large enough to ensure them high future reputation rents.

## 2.4 COMPARATIVE STATICS

In this section, we present comparative analysis of the reputation function  $\sigma_0^{M\_CDS^*}$  with respect to changes in the bank's monitoring costs and marginal costs of capital adjustments.

### Change in Monitoring Costs

Holding all else constant, increase in monitoring costs dampen the effect of reputation because rising monitoring costs make reputation building more costly. As can be seen in Figure (3), the  $\sigma_0^{M\_CDS^*}$  associated with increased monitoring costs lies beneath our base case,  $\sigma_0^{M\_CDS^*}$ , for all values of  $\mu_0$ , indicating the adverse impact of rising monitoring costs on Opp banks incentive to monitor hedged loans. Hence, the region where reputation effects are positive shrinks from  $0.1 < \mu_0 < 0.95$  in Figure (2) to  $0.15 < \mu_0 < 0.89$  in Figure (3). As can be seen from Figure (3), under rising monitoring costs, Opp banks consume their reputation capital more quickly because it is costlier for them to maintain their reputation capital. Moreover, incentives to build reputation weaken as rising monitoring costs lower monopolist rents ( $Z=0$ ) for Opp banks.

### Change in Marginal Costs of Capital Adjustments

Holding all else constant, increase in marginal cost of capital adjustments reinforces Opp banks' incentive to build reputation. In Figure (4), an increase in Opp banks' cost of capital strengthens the reputation effect by shifting  $\sigma_0^{M\_CDS^*}$  associated with increased marginal capital costs to the left of our base case

$\sigma_0^{M\_CDS^*}$ . Thus, showing that investment in reputation building becomes attractive for a larger initial region of  $\mu_0$  values. This is because, with monitoring costs remaining unchanged, when concentration costs increase, Opp banks with lower-endowed reputation capital also find it feasible to build their reputation by monitoring their hedged loans.<sup>27</sup>

As can be seen in Figure (4), increase in the marginal cost of capital affects Opp banks' decision to monitor only in the reputation-building phase. This is because Opp banks endowed with low reputation capital protect their capital positions by either shirking on hedged loans (due to high CDS prices) or monitoring their unhedged loans. As reputation capital increases, Opp banks with higher reputation capital are not affected by increase in the marginal cost of capital because they are already hedged in the credit derivatives market. Therefore, capital adjustment costs do not influence Opp bank's decision to monitor in the reputation burning stage.

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<sup>27</sup> This effect is similar to Furlong and Keeley's (1989) finding that a bank's risk taking incentives decline as its charter value, equivalent to our marginal cost of capital costs, increases.

#### 4.5 SOCIAL WELFARE ANALYSIS OF TWO PERIOD REPUTATION EQUILIBRIUM

In a first best world, introduction of credit derivatives improves social welfare because banks gain the opportunity to hedge their cost of capital in the financial markets, while they continue to monitor credit-rationed borrowers subject to firm moral hazard. Hence, banks monitor to generate positive NPV projects and the credit derivative markets allow banks to hedge their cost of capital, thereby increasing their total profits.

However, given that monitoring is unobservable, credit derivatives markets may also induce banks to shirk on their monitoring responsibility. Bank shirking creates negative NPV projects that otherwise are monitored by banks. Severe levels of bank shirking could cause shut down of the credit derivative markets making us revert to the equilibrium where banks bear the full cost of their costs of capital. In our two-period equilibrium, reputation incentives can align bank's shirking incentives and cause bank profits to increase to the first best level as reputation capital grows. Net change in social welfare for the two-period reputation equilibrium,  $\delta w^R$ , is described below in equation (9)

$$\Delta w^R = \sum_{t=0,1} E(\delta \Pi_t^B) - E((1 - \tilde{\mu}_t^i) \sigma_t^{NM\_CDS*} (\Delta X)), \quad (9)$$

where:

$$E(\delta \Pi_t^B) = \tilde{\mu}_t^i (\Pi_t^{Mon}) + (1 - \tilde{\mu}_t^i) (\delta \Pi_t^{Opp})$$

$$\delta\Pi_t^{Mon} = [(1-P_G)(X + C^{Mon}) - q_t(\tilde{\mu}_t^i)]$$

$$\delta\Pi_t^{Opp} = (\sigma_t^{M\_CDS^*} + \sigma_t^{NM\_CDS^*}) [(1-P_G)(X + C) - q_t(\tilde{\mu}_t^i)] + \sigma_t^{NM\_CDS^*}(m^{Mon})$$

$$\Delta = P_G - P_B$$

$E(.)$ = Expectation Operator.

Equation (9) is the two-period counterpart for the net social welfare of the single period described in equation (6). Figure (5) depicts  $\Delta w^R$  for our base case simulation. In Figure (5), for smaller values of  $\tilde{\mu}_t^i$ ,  $\Delta w^R$  is negative because shirking losses from financing negative NPV projects by Opp banks dominates positive gains realized from hedging marginal cost of capital adjustments by Mon banks. However, as  $\tilde{\mu}_t^i$  increases and Opp banks increase their monitoring intensity, these shirking losses decline. Thus,  $\Delta w^R$  becomes positive and rises towards the first best level.

In the reputation equilibrium, failure rates decline for Opp banks sharply when they invest in building reputation, and subsequently, increase as they consume their reputation in the reputation-burning phase. Figure (6) shows Opp banks' default rates for the base case simulation and compares them to the default rates of Mon banks. As can be seen in Figure (6), for all values of  $\mu_0$ , default rates for Opp banks are higher than those of Mon banks, which are following the first best strategy of monitoring their hedged loans, because in the second best reputation equilibrium  $\sigma_0^{NM\_CDS^*} > 0$ . Thus, in a world with credit derivatives, reputation alone cannot completely align Opp banks incentive to shirk on monitoring and,

therefore, cannot eliminate sub-optimal allocation of bank capital to finance negative NPV projects.

### Chapter 3

### LITERATURE REVIEW

Credit derivatives are financial instruments that allow transference of credit risk from one party to another for hedging or trading purposes. Batten & Hogan (2002) provide detail description of the many types of credit derivative instruments available in the market today; we, however, focus only on credit default swaps.<sup>28</sup> Credit default swaps are similar to put options on credit sensitive assets. Under these instruments, buyers are protected against losses in the value of their referenced credit assets in case of future default.<sup>29</sup> In return, buyers of the credit default swaps pay a fixed fees or premium to protection sellers. There are no standard maturities for these instruments, nor are there any minimum quality requirements for referenced assets; which range from investment grade corporate or government bonds to non-rated bank loans to medium and small sized firms.<sup>30</sup>

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<sup>28</sup> Batten & Hogan (2002) classify credit derivative instruments into two classes those which (1) synthetically replicate a loan and (2) emulate the behavior of a put option on credit sensitive assets. Total Return Swaps and Credit Spread Options are examples of the first category, while Credit Default Swaps, Credit Linked Notes, and Credit Debt Obligations are examples of the second.

<sup>29</sup> The pre-specified credit event is generally default. However, International Swaps and Derivatives Association (ISDA) in its 2003 ISDA Credit Derivatives Definitions, has defined eight possible credit events, including bankruptcy, downgrades, mergers, restructuring. The 2003 Definitions update the 1999 ISDA Credit Derivatives Definitions offers the basic framework for documentation of privately negotiated credit derivative transactions and global standard documentation for the rapidly growing credit default swap product.

<sup>30</sup> Adverse selection and moral hazard concerns restrict the market to public companies for which ratings on credit quality and other public information are readily available. However, growth in the bank loan portfolios has occurred in the last couple of years as the market has developed new credit risk models to price credit risk on these portfolios. See Allen and Saunders (2002).

The market for credit derivatives started in mid nineties and its development is still in its embryonic stages. As per the British Banking Association 2001/2002 Survey Report, the size of the global market for credit derivatives in 2001 was an estimated \$1.2 trillion (excluding asset swaps), which in 2004, is projected to exponentially grow to \$4.8 trillion (See Table A). There are an estimated 400 financial institutions using credit derivatives for trading and hedging activity (Batten and Hogan (2002)).

Financial innovation in credit derivatives markets has resulted from several factors. Firstly, these markets have seen growth from the creation of collateralized loan obligations. Secondly, there has been an increased demand for loans by non-bank financial institutions such as mutual funds and insurance companies. Insurance companies have increasingly found the provision of credit risk shifting services as a profit center. Consequently, they have become major net sellers of credit protection to banks and non-bank financial firms with credit risk exposures. Finally, increases in bank capital requirements have drawn banks to credit derivatives markets. Banks use credit default swaps to shift credit risk off their balance sheets and manage their capital more efficiently. Unlike loan sales markets, credit derivatives markets are opaque as they allow banks to maintain secrecy of their borrowers' identity.<sup>31</sup> Banks value this secrecy, as it allows them to protect their relationship rents while gaining from hedging portfolio

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<sup>31</sup> Under, credit default swaps banks are not required to inform their borrowers of their hedging activity because the hedged loans remain on the banks balance sheets. Further, banks also do not have to disclose information about their borrowers to providers of credit protection. Underlying loans in the referenced portfolio are identified by internal credit ratings assigned by protection seeking banks (Das (2000)).

risk. Banks, therefore, are net buyers in the credit derivatives market (as seen in Table B).

Introduction of credit derivatives have thus expanded the scope of bank risk management. However, they have also brought to the forefront, incentive of banks to shirk on monitoring loans. When banks do not actively monitor their borrowers, bank debt loses its certification value. Destruction of a bank's certification value adversely affects its borrowers, especially, small and medium sized firms, which bear the highest information costs in accessing direct capital markets (Berger and Udell (1998)). Slovin, Sushka, and Polonchek (1993) find that firms lose value when their banks fail because of the loss of accumulated bank information. Hence, in light of Slovin et al. (1993) findings, credit derivatives markets allow banks to become safer, but at the cost of possibly undermining their information production and monitoring functions.

In the world of Miller and Modigliani (1958, 1963), financial intermediaries are irrelevant because capital markets are perfect. In frictionless markets, financing decisions bear no consequence in increasing shareholder wealth, and firms only care about identifying real growth opportunities. However, as capital markets are neither perfect nor complete, informational asymmetries and moral hazard impede direct transfer of information between capital market participants.<sup>32</sup>

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<sup>32</sup> Moral hazard impairs direct transfer of information between market participants, as firms are likely to not speak the truth about their projects and characteristics when there may be substantial gains to be made by exaggerating positive qualities.

Commercial banks enjoy a comparative advantage over capital markets in producing information under asymmetric conditions and controlling risk shifting incentives of firms under debt finance (Jensen and Meckling (1976), Black and Scholes (1973)). Diamond (1984) explains that banks' comparative advantage lies in their ability to lend across to many non-correlated firms, which lowers their cost of delegated monitoring (or portfolio concentration risk).<sup>33</sup> Also, unlike bondholders banks are not subject to free rider problems.<sup>34</sup> Besides, Yosha (1995) posit that banks have a special advantage in becoming privy to sensitive and confidential information about their borrowers, which if became public, could be used against them by their competitors. Banks use the soft and private information gathered from their monitoring role to influence managerial decision-making; therefore, bank loans carry lower information costs (Fama (1985)) and have smaller price reactions on default dates than bonds (Altman, Gande, and Saunders (2003)).

Banks maintain close contact with their borrowers at all stages of the loan process. Banks use their soft information to enforce loan covenants. Mester, Nakamura and Renault (2001) report information from checking accounts is used by banks to ascertain whether operating loans are used for the stated purposes, rather than to finance excessively risky projects. They find evidence that

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<sup>33</sup> Hughes and Mester (1998) find that larger asset based take on more risk than smaller banks because of their ability to achieve higher levels of portfolio diversification.

<sup>34</sup> Bondholders do not invest in costly monitoring because their individual claims in the overall debt issue are small, and all the other bondholders enjoy their monitoring gains. Hence, if all bondholders can free ride on other bondholders' effort, monitoring does not take place.

borrowings not accounted for by inventory and accounts receivable in the checking accounts are good predictors of credit downgrades and loan write downs. Strahan (1999) report that firms control risk shifting incentives of borrowers by enforcing tighter price (interest rates) and non-price (collateral, seniority, maturity etc) terms in loan covenants, suggesting that banks as inside lenders use loan features to control borrower moral hazard costs. Finally, Altman et al. (2003) find higher recovery rates for loans than bonds, indicating that banks continue to monitor even after default.

Bank relationship lending creates value for borrowers by offering better pricing, greater protection against credit crunches and better liquidation decisions.<sup>35</sup> Berger and Udell (1995) report that after successful loan repayments, banks lower loan rates and collateral levels for their borrowers. Repullo and Suarez (2000) and Holmstrom and Tirole (1997) find bank financing feasible over a wider range of net worth ratios (proxy for severity of firm moral hazard) than capital markets. Hence, supporting the claim that relationship lending reduces credit crunches for firms. As specialist monitors, Berlin and Loeys (1988) show that liquidation decisions made by banks are far more efficient than loan liquidation

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<sup>35</sup> Relationship lending is not exactly innocuous. Exclusive access to borrower specific information gives single bank relationships market power over their borrowers. Rajan (1992) argue that banks use their superior information to extract hold up rents from borrowers at the time of loan renewals, especially if the projects are good, as they realize outside borrowers will be reluctant to extend them financing because of winner's curse problems. Peterson and Rajan (1994) show that banks exert market power to extract monopoly rents from small firms who are unable to borrow from capital markets due to asymmetry of information. In monopoly markets, bank's powerful position may distort borrower's incentives to select first best projects causing them to make inefficient investment choices and inducing better quality borrowers to move to capital markets.

decisions made by capital markets on noisy public indicators. Consequently, capital markets tend to be either too harsh (good projects are liquidated) or too lenient (bad projects fail to be liquidated) in their liquidation decisions.

As informed monitors, banks also signal firm value to uninformed investors by certifying management actions. Diamond (1991) postulate that bank certification value critically assists new and opaque firms the opportunity to build credit histories to signal higher quality to capital markets. James (1987) and Billet, Flannery and Garfinkel (1995) find that borrowers experience positive equity returns following the announcement of a loan transaction. Lummer and McConnell (1989) state this announcement effect more significant on renewal of old loans. Dahiya, Puri and Saunders (2003) report negative abnormal returns on bank loan sales, giving support to the claim that bank financing has a positive effect on firm value. Low, Gorfeld, Hearth and Rimbey (2001), studying the impact of dividend omissions on stock returns, discover that firms who maintained bank relationships were not as severely affected by dividend omissions as firms that did not maintain such relationships. Thus, bank monitoring creates social value by signaling firm quality and mitigating agency costs.

However, monitoring is costly for banks, as it requires investment of time, effort and money. Besanko and Kanatas (1993) show that when banks maximize their own profit functions rather than the NPV of their financed projects they provide

sub-optimal levels of monitoring. Historically, banks have reinstated their commitment to monitor by observably holding their loans to maturity. By risking their equity capital and deliberately not participating in external credit hedging activity, such as loan sale markets, banks have successfully managed to commit to their borrowers that they indeed will monitor their loans. Retention of loans on bank balance sheets made monitoring incentive-compatible, as monitoring protected bank capital and also preserved the bank's lucrative client relationship. However, possibility of secretly hedging in credit derivatives markets unravels the bank's monitoring commitment device.

As regulated institutions, banks are required to hold sufficient capital to cover their unexpected loan losses.<sup>36</sup> Froot and Stein (1998) show that capital costs for banks are convex because banks bear non-tradable risks, such as illiquid loan portfolio risks. Bank capital structure decisions are, thus, tradeoffs between the costs of holding capital slack today against the cost of raising higher cost capital tomorrow. Monitoring lowers the likelihood of imperfectly diversified banks experiencing a capital shock that requires them to access capital markets. Hence, banks that face high costs of capital adjustments have a stronger incentive to monitor their illiquid loans compared to banks that do not face convex cost of capital functions. Therefore, less diversified banks are more likely to be over capitalized and have stronger incentives to monitor than well-diversified banks, which operate on a lower capital base. Demsetz and Strahan

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<sup>36</sup> A technical definition of bank *capital* is the bank's net worth, that cushion's its depositors against possible losses due to market, credit, and operational risks.

(1995) find strong empirical that large banks operate on lower capital than smaller banks because they hold more diversified portfolios and activities. Alzaman (2002) find that monitoring decisions of banks are tradeoffs between capital levels and monitoring expertise. Banks endowed with weak capital base compete by developing superior monitoring expertise to minimize the likelihood of their failure. Meyer and Yeager (2001) corroborate this trade-off and find that performance of smaller rural banks is less susceptible to local, than regional, downturns because of their better local monitoring expertise.

Hence, bank monitoring has remained the first and foremost line of defense in protecting bank capital, followed by internal portfolio diversification.<sup>37</sup> However, despite risk minimizing benefits identified by Diamond (1984), banks seldom hold perfectly diversified loan portfolios. Cerasi and Daltung (2004) attribute sub-optimal loan diversification to increasing marginal cost of bank monitoring. Cerasi and Daltung (2000) posit a trade-off between the number of loans a bank can efficiently monitor against diversification gains associated with increased lending. Thus, according to Cerasi and Daltung (2000), optimal bank monitoring levels are not determined by the borrower's information opacity or agency problems but rather by resource constraints. Alternatively, Das (2000) cite *increased specialization* (owing to limited resources and/or inadequate knowledge of new industries / regions) and *intense competitive forces* (pressurizing banks to

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<sup>37</sup> Concepts of loan diversification are rooted in the notion of standard portfolio theory. By lending to borrowers whose default correlations are imperfectly related to the bank's other loans, lower overall concentration risk for the bank's loan portfolio. Concentration risk captures the risk of unexpected loan losses caused due to increase in default correlations of loan assets.

increase exposure on individual borrowers to maximize relationship rents) as reasons preventing banks from achieving optimum levels of internal diversification. Furthermore, Winton (1999) and Acharya, Hasan and Saunders (2003) attribute lack of diversification to a winner's curse problem faced by banks seeking to diversify into newer and heavily banked industries. Insufficient internal loan diversification raises the cost of delegated monitoring for banks, reinstating the significance of bank monitoring in protecting bank capital.

Additionally, incentives to align bank monitoring incentives have been explained through bank seniority and information rents. Longhoffer and Santos (1998) realign monitoring incentives of banks by awarding them senior lending positions to other creditors. If banks are junior to other creditors, their incentives to monitor are weakened because senior creditors enjoy the rewards of bank monitoring free of cost. Cook, Schellhorn and Spellman (2003) and Elsas (2002) find that banks are more inclined to monitor when they have the potential to earn relationship rents on loans, holding constant for borrower risk and information costs.

External management of credit risk through loan sales, and until recently, credit derivatives have a negative impact on banks' incentive to monitor loans. Cebenoyon and Strahan (2004) find empirical evidence that banks that manage their credit portfolios through loan sales lower their capital levels and hold riskier loans. Of course once loans are sold, banks no longer have an incentive to

monitor the sold loans. Dahiya et al. (2003) report that borrowers paying relationship rents do not view loan sales favorably because premature loan sales by informed banks serves as a negative signal with respect to borrower's quality. Since banks extract monitoring rents from opaque borrowers, they do not use loan sales very aggressively to manage their portfolio risk for fear of jeopardizing their relationship rents and certification premiums. Consequently, banks whose loan portfolios are skewed towards relationship loans generally refrain from actively managing credit exposure with loan sales because the gains realized from better capital management are often outstripped by the losses in their relationship rents. Gorton and Pennacchi (1995) find empirical evidence that banks sell larger portions of those loans, which do not require active bank monitoring services, and therefore generate low information rents.

Unlike loan sales, credit derivatives do not cause negative fallout on the bank-client relationships. Moreover, establishment of credit derivatives market induces banks to shirk on monitoring because they alter the trade-off between monitoring intensity and capital levels. If banks can reduce their capital risk exposure with credit derivatives they may also reduce the level of their monitoring. Morrison (2005) finds that credit derivatives markets weaken incentive of banks to monitor loans, particularly of intermediate quality firms for which bank certification is most valuable. As a result, break down of the bank certification role causes disintermediation. In Morrison (2005) financing and investment decisions of entrepreneurs are based on the private benefits of their second best projects.

Firms with low private benefits select good projects and issue investment grade bonds, while those with high private benefits invest in bad projects and issue junk bonds. Intermediary quality firms, whose private benefits can be aligned with bank monitoring, select good projects by partly financing their projects with costly bank debt. Mixed financing (bonds and bank loans) hence serves as a pre-commitment device by intermediary quality firms to abstain from risk shifting incentives. Introduction of a fairly priced credit derivatives market, however, destroys this bank monitoring equilibrium.

Morrison (2005) shows that if banks are sufficiently risk-averse, utility gain from purchasing complete insurance in the credit derivatives market and not monitoring is correspondingly higher than the benefit derived from continued monitoring of loans. As a consequence, bank debt loses its certification value with bond investors, which causes disintermediation, because intermediary quality firms substitute junk bonds for mixed financing and invest in the second best projects.

Destruction of wealth, described in Morrison (2005), occurs because banks are unable to pre-commit to monitor loans, when ex-post, it is incentive incompatible for them to do so. In our theoretical model, we show that lack of ex post incentives for bank monitoring can be restored with reputation rents. Morrison (2005) differs from ours in the sense that it only addresses bank moral hazard over a single period model and does not take into consideration that banks, as

long run players, consider the effect of reputation on their monitoring decision. Further, the paper states that opacity in the credit derivatives markets can be removed through better public disclosure of banks credit derivative activity, as banks could then be held accountable for their monitoring actions or lack thereof. While public disclosure will help mitigate the bank-shirking problem, we propose that the information will not be voluntarily forthcoming from banks unless this information can help establish their good conduct with sellers of credit protection. This provides an important foundation for our model. In a multi-period setting, we show that banks have incentive to build their reputation capital to lower their premiums on future credit derivatives trades. Hence, reputation acquisition can reinstate the bank monitoring equilibrium destroyed in Morrison (2005) and minimize the loss of bank certification value.

While credit derivatives may allow optimal risk sharing of credit risk across capital markets, they may simultaneously destabilize the banking sector by inducing banks to acquire risk more aggressively. Instefjord (2005) investigate the impact of credit derivatives on bank risk. Instefjord (2005) postulate that the level of extra risk retained by banks, as a result of financial innovation in the credit derivatives market, depends upon the price elasticity in the underlying credit markets. If the underlying credit markets are elastic, banks operate more aggressively following a financial innovation process, with the result that a destabilizing effect is caused on the banking sector. Alternatively, a stabilizing effect is induced when the underlying credit markets are price inelastic.

Instefjord (2005) show that it is not lack of risk sharing in the credit derivatives markets that could cause an increase in bank risk, but rather, the direction of the financial innovations process. Social welfare is realized when credit derivatives innovation occurs in inelastic segment of the loan markets to reduce concentration risk of banks that lend to opaque borrowers. Prevalence of bank shirking incentives mentioned by Morrison (2005), however, restrain financial innovators from venturing into inelastic credit markets. Instefjord (2005) states that financial innovation is likely to destabilize the banking system because innovators place more weight on trading liquidity, than reducing the risk of bank failures. As a result, Instefjord (2005) predicts a likely over supply of credit derivatives that span the most elastic credit markets and an under supply in credit derivatives that span the least elastic credit markets.

Instefjord (2005) propose regulation of credit derivative markets to promote financial innovation in less elastic credit markets. In our opinion, effectiveness of any such regulation will be limited in controlling bank moral hazard, since bank monitoring is unobservable, and therefore, non-contractible. Credit derivatives trade in over-the-counter markets, which internalize the cost of bank moral hazard, and price according to the perceived monitoring reputation of the protection buying banks. In negotiated credit derivatives markets, it makes economic sense for banks, especially those operating in inelastic credit markets, to signal their higher quality through their reputation and access a richer set of

derivatives to manage their credit risk. Monitoring costs incurred by banks in building their reputation capital will be offset by the gains realized in hedging portfolio concentration risk at cheaper rates, thereby maximizing consumer surplus and improving the stability of the banking system. In our opinion, self regulation through reputation will prove to be far more effective to stimulate financial innovation in less elastic segments of the credit derivatives markets than could be achieved through any level of external regulation.

Masso, Antonio and Pelizzon (2004) suggest a contractual solution to minimize the agency problems impeding financial innovation in opaque loan markets. Their contractual solution, in spirit, is similar to our reputation response. Masso et al. (2004) propose a separating equilibrium in the credit derivatives markets with first-to-default (FTD) basket swaps. FTD basket swaps have a rescission clause that terminates the hedge on the first default of any of the underlying loan in the basket. High quality (high reputation) banks credibly signal by hedging with FTD basket swaps, while low quality banks either stay out of the credit derivatives markets and if they do enter, they purchase plain vanilla credit default swaps. Thus, FTD basket swaps minimize agency costs for credit buyers.

Credit derivatives sellers are uninformed about bank types and price FTD basket swaps at average loan quality. However, with the passage of time, these protection sellers become fully informed about the quality of the underlying loans basket, and subsequently price all derivatives contracts (basket or vanilla) on the

revealed loan quality of the subject bank. Consequently, high quality banks use the rescission clause of the FTD swaps to effectively signal their high type by committing to purchase future credit protection at fair price. For low quality banks, the rescission clause makes it costly to hedge with FTD swaps, as it increases the incidence of termination of the FTD hedge and also increases the premiums paid on the subsequent hedge. As a result, only high quality banks use FTD swaps to hedge their concentration risk, while low quality banks do not find it optimal to mimic the actions of the high type and hedge with plain vanilla credit default swaps.

Masso et al.'s (2004) separating equilibrium hinges on the assumption that private information about bank type is completely revealed to credit derivative sellers on the termination of the FTD swap. Perfect revelation of bank private information on termination of the FTD hedge makes it costly for low quality banks to mimic the actions of the high quality banks. The separating equilibrium with FTD swaps becomes implausible if the assumed information revelation process is imperfect and bank monitoring costs are positive. In this case, for certain parameter values, low type banks may find it optimal to mimic the actions of high type banks by hedging with FTD swaps, thereby unraveling the proposed separating equilibrium. Moreover, acceptance of the rescission clause under FTD swaps is no different from the high type bank creating a maturity mismatch between the credit hedge and the underlying loan contract to commit to a truthful strategy. Such a structure is similar in nature to a FTD contract, because banks

exposed to mismatch will have to renegotiate the credit derivatives contract at the time of rollover. Arping (2004) shows that maturities mismatch on the hedge resolves the moral hazard problem only if the level of short-term credit hedge is contractible between banks and borrowers. Bank commitment to monitor loans is incentive compatible only at optimal level of short-term credit protection, and is violated, if banks can purchase additional short term or long term credit protection.

Arping (2004) demonstrate that credit derivatives strengthen bank monitoring because they align managerial incentives by increasing the value of banks exit option. Arping (2004) shows that in the absence of credit derivatives, banks do not liquidate firms because liquidation values are lower than banks' expected claim in the terminal cash flows of firms. Anticipating lack of incentive of banks to intervene and liquidate shirking firms causes managers to expend sub-optimal levels of costly effort. Thus, in equilibrium without credit derivatives, banks willingly tolerate sub-optimal levels of managerial effort and allow firms to continue. Purchase of short-term credit protection, however, corrects this anomaly. Short-term credit substitutes for borrower collateral and enhances banks liquidation cash flows, making it less costly for banks to take a tough stance against misbehaving corporate borrowers. In equilibrium with credit derivatives, firms expend first best level of effort to ward off liquidation, and banks purchase short term credit protection to reinforce their liquidation incentives. Short-term credit protection thus improves bank monitoring

effectiveness by aligning managerial incentives (by increasing liquidation cash flows), whereas long-term credit protection distorts managerial incentives by weakening bank intervention incentives (by increasing terminal cash flows).

The socially optimal equilibrium of Arping (2004) is based on the assumption that banks purchase sufficient levels of short-term credit protection to make their liquidation threat credible. If banks buy additional short-term credit protection, the equilibrium breaks down and credit markets collapse, because firms expend zero effort as they anticipate banks' intention to extract hold up rents in liquidation. Thus, a necessary condition for the equilibrium to hold is that firms can observe or contract the optimal level of credit protection needed by banks. In practice, it may be impossible to enforce this condition, as credit derivatives are traded over the counter and borrowers rarely have the ability to observe their banks credit derivative positions. Furthermore, it may be difficult for borrowing firms to specify as a covenant in the loan contract the bank's discretion in seeking short and long term credit protection.

However, if we assume that banks are willing to contract their credit derivative positions with their borrowers, then also, their incentive to monitor loans with credit hedging are aligned only if liquidation proceeds of firms are contingent on bank monitoring. If realized liquidation values are unaffected by bank monitoring levels or are close to zero, banks incentive to monitor break down at the proposed level of short term credit protection. This shows that as banks hedge

their full credit risk they will always have an incentive to save on their monitoring costs, a result similar to our one-period model, wherein we show that opportunistic banks shirk on monitoring loans after they purchase credit protection. In our single period model, we show that credits hedging and monitoring are not complements but substitutes.

Finally, Duffie and Zhou (2001) show that introduction of the credit derivatives markets may cause welfare reduction if they disrupt the functioning of an existing loan sales market. However, Duffie and Zhou (2001) assume that asymmetric information occurs in the longer maturity loan sales market and not over the shorter end. If pooling equilibrium in the loan sales market is destroyed by the existence of a credit derivative market, banks only sell their bad loans and retain good loans on their balance sheets for hedging in the credit derivative markets. Alternatively, if the loan sales market operates under a separating equilibrium, then the introduction of credit derivative markets is wealth maximizing, as they allow hedging of high quality loans previously not available. Duffie and Zhou (2001) fail to take into account the adverse effect of loan sales on banks' propensity to extract relationship rents. Furthermore, this paper suggests that credit derivative instruments will be used when bank agency costs are minimal, thereby undermining the value of reputation building as an effective avenue to align agency problems of banks in credit derivatives markets. In contrast, our consider as extreme case of firm moral hazard and takes into consideration relationship rents earned by banks when they hold their loans to maturity.

**Chapter 4****EMPIRICAL ANALYSIS**

Credit derivatives are instruments for hedging and re-allocating credit risk. Their importance in managing credit exposures is evident by the exponential growth witnessed in the global credit derivatives markets, which in 2004, was expected to reach a notional value of \$4 trillion compared to \$350 Billion in 1998.<sup>38</sup> Banks and insurance companies are the major players in global credit-hedging markets. Banks, who are net buyers, use credit derivatives to diversify their loan portfolios and manage their individual borrower exposures. While, insurance companies use credit derivatives to improve their portfolio risk-return trade-off by selling credit protection on bank loans. Insurance companies have come to view credit derivatives favorably because of their low correlation with commercial and life insurance risks, traditionally, underwritten by them.

Besides re-allocating credit risks, credit derivatives markets also have the potential to destabilize the underlying loan markets. Morrison (2005) shows that credit derivatives worsen agency problems, in a single period model, by destroying incentives of banks to monitor their loans. Morrison (2005) explains that monitoring, in conjunction with credit protection, becomes redundant in protecting bank capital in the event of loan default. Similarly, Instefjord (2005) demonstrate that banks acquire risk more aggressively as they gain access to a richer set of credit management derivatives. Instefjord (2005) show that when the

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<sup>38</sup>Source: British Banking Association 2001/2002 Survey Report.

underlying loan markets are elastic, banks acquire risk more aggressive and credit derivatives markets have a destabilizing effect on the banking sector, whereas a stabilizing effect is caused when the underlying loan markets are inelastic. Thus, according to Instefjord (2005), in order for credit derivatives markets to have a stabilizing effect on the banking sector it is important that their financial innovation be encouraged into inelastic loan markets.

Our reputation model builds on Morrison (2005) and Instefjord (2005) and shows that bank-monitoring incentives destroyed by financial innovation of credit derivatives may be partially restored with reputation rents. We show that, in a multi-period setting, banks monitor their hedged loans to lower their future hedging costs in the credit derivatives markets. However, since bank monitoring is unobservable, our reputation equilibrium oscillates over time because credit derivatives markets update their beliefs on a noisy loan signal (default, no default). In our empirical paper, we test for periodic fluctuations in the level of default rates for opportunistic banks as evidence supporting oscillations in our reputation equilibrium across time.

The extent to which credit derivatives destroy the monitoring equilibrium in the loans market, is an empirical one, and depends upon the proportion of opportunistic banks operating in the economy and their relative strength to burn or build their reputation capital. If accumulated reputation capital for opportunistic banks is high then overall shirking incentives in the banking system will be weak,

and welfare losses caused by financing sub-optimal projects will be minimal. However, if shirking incentives in the banking sector are strong, owing to low reputation concerns, then credit derivatives activity will increase loan default rates because of increased financing of sub-optimal projects. Thus, aggregate failure rates of loans in the banking sector are a decreasing function of reputation capital, as shown in Figure (7) of our theoretical paper.

We therefore also wish to test the impact of credit derivatives on loan markets. If our empirical results show that loan default rates in the banking sector have not increased significantly, then credit derivatives markets are welfare enhancing because they allow banks to re-allocate their loan concentration risks. However, if failure rates in the banking sector significantly increase with credit derivatives, then the resulting welfare effect may be negative, if increased financing of sub-optimal projects offsets the gains realized from optimal risk sharing of bank concentration risks.

We identify a methodology, consistent with our reputation model, to group banks into opportunistic and monitoring banks. We use these bank classifications to test for structural differences between monitoring and opportunistic banks with respect to monitoring activity, relationship profitability and costs of capital adjustments. Creation of a classifying criterion, however, does not break our reputation equilibrium's assumption of incomplete information on bank types, because it only identifies banks probabilistically. Existence of incomplete

information on bank types is a necessary condition for reputation building to take effect, else credit derivatives markets price on true revealed quality and banks have no incentives to invest in monitoring to build their reputations.

Finally, the paper also addresses the industry's concerns about moral hazard issues relating to the inclusion of restructuring as a settlement-triggering event in credit default swaps, since banks decide on the timing and incidence of such loan restructuring events. In the absence of credit derivatives, the decision of banks to restructure non-performing loans is a trade off between their capital costs and potential rents extracted from the restructured loans. However, when banks buy credit protection, they may find it more attractive to restructure their loans because their capital costs are covered by the credit default swap. Conversely, our reputation model predicts the opposite, because Opp banks as weak monitors will have less of an incentive to restructure their loans because of their higher monitoring costs and lower hold up rents. The empirical question that we wish to test in this paper is whether Opp banks renegotiate their loans more frequently with credit protection, given that they are weaker monitors than Mon banks.

The chapter proceeds as follows: Section 4.1 describes our data and variables. Section 4.2 lays out our criterion for classifying banks into Mon and Opp types in our sample. Section 4.3 describes our Logit model to model the characteristics of

Mon type banks. Section 4.4 outlines our empirical models and presents our results.

#### 4.1 DATA AND VARIABLE DESCRIPTION

Our sample consists of US commercial banks, from the calendar period, 1997 to 2003.<sup>39</sup> The financial data is obtained from the Consolidated Reports of Condition and Income (“Call Reports”) filed quarterly by banks with the Federal Reserve. FDIC’s demographic data files are used to obtain information on interstate, domestic and foreign branches. All observations are end year values, with the exception of ROA and ROE, which are annualized quarterly returns. We scale all financial variables by Total Assets and clean the data for outliers in Liquid Assets (*LIQUID*), Trading Assets (*TRAD\_ASSETS*), Loans (*LOANS*), Non Performing Loans (*NPL*) and Tier One Capital (*RBC*). We define all our variables in Annexure1.

Table 1 contains descriptive statistics for the entire sample form 1997-2003. It shows mean, median, standard deviations, minimum and maximum statistics for all our variables. During our sample period, we find that *LIQUID* assets and *LOANS* were 30.55% and 60.15% of average bank assets. *C\_I* accounted for 10.376% of Total Assets, while real estate secured loans (*RE\_LOANS*) accounted 36.492% of Total Assets. The average value of *LLR* was 0.89% of assets,

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<sup>39</sup>Banks in the US were required to report their credit derivatives buying and selling activity to the Federal Reserve, in the first calendar quarter of 1997.

indicating that banks during the period held sufficient reserves to cover their *NPL* of 0.59% of assets, but which just barely covered their troubled loans (*TrobLoan*).

As seen in Table 1, approximately 16% of our sample observations are classified as opportunistic (Opp) banks, as indicated by the dummy variable, *DUM\_OPP*. Banks classified as Opp banks held about 83.24% of the total banking assets during our respective sample period. Mean value of 28.60% on *MBHC\_DUM*, an indicator variable for multi bank holding company, shows that about 70% of the observations in our sample were of banks, which were held by single bank holding companies or operated independently. Within multi-bank holding companies, about 48% of the observations were of banks that are owned by a multi-state holding company.

### ***Variable Description***

Banks incur expected and unexpected loan losses when they lend to risky firms. Their expected and unexpected loan losses are directly proportional to their monitoring ability and level of concentration risk on their loan portfolios. In our reputation model we segmented the loan market into two types; Monitors or relationship lenders (Mon) and Opportunistic or transaction oriented lenders (Opp). Since Mon types are specialist monitors, their expected loan losses are lower than Opp banks. However, their convex cost of capital adjustments or unexpected loan losses are higher than Opp banks because their loan portfolios are less diversified across sectors / regions due to their specialized monitoring

technology. Both types of banks buy credit protection, but of course, for different reasons. Mon banks enter the credit derivatives market to hedge their high convex cost of capital, while Opp banks, with their lower convex cost of capital, enter the credit derivatives market to save on monitoring costs. Reputation effects are more likely to align shirking incentives of Opp banks than Mon banks, as Mon banks have a higher probability of monitoring their loans due to their cheaper monitoring technology.

We describe below our proxy variables for bank monitoring and convex cost of capital.

***Monitoring / Reputation Measure: Loan Loss Reserves Levels (LLR)***

The level of Loan Loss Reserves (*LLR*) held by a bank directly measures its monitoring ability and also proxies for its monitoring reputation. Banks who are efficient monitors are expected to have lower *LLR* than banks who are costly monitors. Thus, Mon banks are likely to have lower levels of *LLR* than Opp banks. The difference in the level of *LLR* between Mon and Opp banks thus measures difference in their monitoring technology and also captures Opp banks' residual reputation effects. When reputation effects are strong and Opp banks are monitoring their hedged loans, *LLR* levels for Opp banks also decline when they purchase credit protection.

To measure monitoring ability, we use aggregate *LLR* levels, as opposed to periodic loan loss amounts (Bad Debt Expense), because periodic provisioning amounts are more susceptible to income smoothing than aggregate *LLR* levels (Hasan and Wall, 2003).<sup>40</sup> Bikker and Metzmakers (2004) find weaker procyclicity effects in *LLR*, than annual additions, suggesting that income-smoothing effects are less likely to cumulate over time in *LLR* levels than annual additions.

### ***Convex Cost of Capital Adjustments***

#### ***(i) DUM\_TRAD and DUM\_HEDG***

Froot and Stein (1998) posit that banks that hold diversified loan portfolios and actively manage their market risk exposures face lower costs of capital adjustments. Banks active in risk management are more likely to use financial derivatives for trading and hedging purposes. Hence, we proxy convex cost of capital adjustments by the dummy variables, *DUM\_TRAD* and *DUM\_HEDG*, which indicate the use financial derivatives for trading and hedging by banks.

We expect Opp banks to be more active in managing risk than Mon banks because of their lower cost of capital adjustments. As a consequence, according to Froot and Stein (1998) we expect Opp banks to operate on lower capital levels than Mon banks, as measured by the variable, *RBC*, which represents Tier One capital levels, held by banks.

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<sup>40</sup>The timing and profit amounts provisioned towards *LLR* affects a bank's return on equity and capital adequacy levels and thus may be subject to income smoothing by the bank's management

**(ii) *LIQUID* and *DUM\_DEBT***

Liquid assets represent financial slack held by banks to cover unexpected loan losses. Billet and Garfinkel (2004) find that banks that face higher costs of capital adjustments in capital markets or insured deposits market carry more liquid assets than banks facing lower costs. The level of liquid assets, *LIQUID*, held by a bank also proxy's for its convex cost of capital adjustments. We expect Mon banks to carry higher levels of liquid assets than Opp banks because of their higher convex cost of capital adjustments.

Secondly, as suggested by Billet and Garfinkel (2004) we also use the dummy variable, *DUM\_DEBT*, which indicates if banks have issued subordinate debt, as another proxy variable to measure convex cost capital. Consistent with our reputation model we expect Mon banks to be less active in accessing capital markets for capital requirements, as indicated by the dummy variable, *DUM\_DEBT*, and therefore carry higher levels of *LIQUID* reserves.

**4.2 BANK CLASSIFICATION CRITERION**

Our classification criterion groups banks into Mon and Opp types based on the scope of their geographic operations and organizational form of ownership. Berger, Klapper and Udell (2001) find that as distance increases between a bank's headquarters and borrowers it becomes more difficult for banks to gather locally based soft information about their opaque firms for monitoring purposes. Berger, Miller, Peterson, Rajan and Stein (2005) also find similar evidence that

banks which are more distantly located from their borrowers are less likely to be engaged in relationship lending, and consequently, are more active in providing capital market products / services.

Hence, we expect relationship lending, Mon banks, to be located close to their borrowers to resolve their information asymmetry problems. Secondly, as Mon banks bear higher convex cost of capital because of their concentrated loan portfolios, we expect Mon banks to have more lending activity focused within a single region or state. Conversely, we expect lending activity of Opp banks to be more geographically dispersed to improve their loan diversification.

Hence, we classify as Mon types, those banks that do not possess interstate (*STMULT*) or international branches (*OFF\_FOR*) and are not owned by multi-bank holding companies, operating subsidiaries in more than one state (*MBHC\_MST*). Conversely, banks that have interstate or international branches or are held by multi bank holding companies, operating in more than one state, are classified as Opp banks. Variables *STMULT*, *OFF\_FOR* and *MBHC\_MST* are dummy variables, which take the value of one when banks operate interstate branches, foreign branches and are part of a multi-bank holding company operating in more than one state, respectively. We report our classified banks by a dummy variable, *DUM\_OPP*, which takes the value of one when a bank is classified as an Opp type and zero when it is classified as a Mon type.

It is important to note that our classification criterion does not perfectly identify banks into Mon and Opp types. It only predicts a bank's type probabilistically, which is what is required to uphold our reputation model's assumption of incomplete information to motivate monitoring by Opp banks to build their reputations as active monitors.

Table 1A presents quintiles for our bank classification. It is not surprising that most of the larger sized banks are grouped as Opp banks, as larger banks are also more likely to operate wide scale branch network, which includes foreign branches, and be owned by multi-bank holding companies. Thus, the median size of a bank classified as an Opp bank has an asset size of \$210 Million, while that of a Mon bank is only \$74 Million.

In Table 2, we present our difference of means test for Mon and Opp banks during our full sample period. As expected, Opp banks have larger branch networks because of their greater geographic reach, as indicated by the variable *BRANCH*. The difference in size of branch network between Mon and Opp banks that of nine times. On average, Opp banks operate about 38 branches, while Mon banks only managed a network of four.

As per our theoretical model, we find that Mon banks have lower levels of *LLR* than Opp banks because they are better monitors. The average *LLR* level for Mon banks is 0.8643% of Total Assets compared to 0.9973% for Opp banks, a

difference of 15.39%, which is significant at the 1% level. The higher level of real estate loans held by Opp banks, 38.327% compared to 36.159% for Mon banks, also give support to our hypothesis that Opp banks are costlier monitors, because real estate loans require less active bank monitoring as they are collateralized by tangible assets. A higher coefficient for Opp banks on the dummy variable, *DUM\_LHFS*, also suggests that Opp banks do not engage in relationship lending because loan sales have the potential to jeopardize the bank's lucrative borrower relationships. Banks earn relationship rents by lending to firms that require closer bank monitoring to minimize their agency problems. *DUM\_LHFS* is a dummy variable, which indicates if the bank held loans held for sale on its balance sheet.

Mon banks held 16.69% lower *C\_I* loans than Opp banks. This is consistent with our expectation that Mon banks carry less *C\_I* loans due to their higher concentrated loan portfolios. As Call Reports do not provide a breakdown of *C\_I* loans by industry or region, the percentage of *C\_I* loans held could proxy for *C\_I* concentration risk. Thus, since Opp banks are relatively better diversified than Mon banks and therefore can assume more *C\_I* loans.

Due to their concentrated loan portfolios, we find that Mon banks held more *LIQUID* and capital (*RBC*) reserves than Opp banks. Also, as predicted by Froot and Stein (1998), Mon banks faced higher convex cost of capital adjustments than Opp banks, because they do not actively manage their market risks and

rarely accessed capital markets for meeting capital requirements. Accordingly, Mon banks had lower coefficients than Opp banks on all three variables proxying for convex cost of capital adjustments, *DUM\_TRAD*, *DUM\_HEDG*, and *DUM\_DEBT*.

Consistent with our theoretical model, we also observe difference in credit derivatives activity of Mon and Opp banks. As expected, the intensity to buy and sell credit default swaps (CDS) is significantly higher for Opp banks than Mon banks. While the data does not provide us a break down of portfolio or single borrower CDS activity, the mean difference in usage alone is consistent with our theoretical hypothesis, which posits that Mon banks use the credit derivatives market to hedge their marginal costs of capital while Opp banks enter the market to lower their monitoring costs. Thus Opp banks hedge larger portions of *C/I* loans than Mon banks, as seen in Table 2.

To ensure that our difference of means results are not driven by banks that are performing market making function in credit derivatives markets, we conduct our difference of means test by dropping all banks from the sample that had ever sold credit derivatives. Selling of credit derivatives requires understanding of sophisticated pricing models and an active approach to credit risk management, which Mon type banks are most likely not to possess. Thus, by dropping banks that sell credit derivatives, we reduce our sample of Mon and Opp banks to only those banks that are not likely to be performing a market marking function, and

therefore enter the credit derivatives market to seek protection on their existing loan portfolios.

The difference of means results without sell trades are reported in Table 2A. The results in Table 2A are fairly similar to our main results in Table 2, which shows that our original Mon and Opp classifications are robust. In Table 2A, the intensity of Opp banks buying credit default swaps remains higher than Mon banks, though the difference is insignificant.

While our original classification criterion has a higher likelihood of grouping larger banks into Opp banks, it also classifies as Opp banks, small and regional banks acquired by *MBHC\_MST*. We expect these smaller banks to behave more like Opp than Mon banks, because (1) of the increased distance between them and their new headquarters (*MBHC\_MST*), and (2) pressures from their new headquarters to move away from relationship lending. To support our hypothesis in Table 2B we present difference of means tests for banks that operate in single states, but are owned by multi-state operating holding companies as opposed to a single state holding company (or being held independently). The results of Table 2B are consistent with our main results of Table 2. We find that regional banks owned by multi-state operating holding companies have lower convex cost of capital, as evident by the significant positive difference in mean values for *DUM\_DEBT*, *DUM\_TRAD* and *DUM\_HEDG*, and significant negative difference in mean values for *RBC* and *LIQUID* levels. Furthermore, *LLR* and *BRANCH* are

larger for regional banks held by a multi-state operating holding companies, supporting our claim that regional banks held by multi state operating parent companies tend to become costlier monitors and, therefore, deserve to be classified as Opp banks.

### 4.3 EMIRICAL CHARACTERISTICS OF MON AND OPP BANKS

We conduct a logit analysis to identify characteristics that influence the likelihood of a bank behaving like a Mon bank. Since we draw our characteristics from our theoretical model, these include measures on monitoring ability and convex cost of capital. We present our logit model below in equation (10).

$$\begin{aligned}
 DUM\_OPP = & \alpha_1 + \beta_1(BRANCH) + \beta_2(C\_I) + \beta_3(LIQUID) + \beta_4(RBC) + \beta_5(DUM\_DEBT) + \\
 & \beta_6(DUM\_LHFS) + \beta_7(LLR) + \beta_8(DUM\_TRAD) + \beta_9(DUM\_HEDG) + \varepsilon
 \end{aligned}
 \tag{10}$$

where:

<i>DUM_OPP</i>	=Dummy variable indicating that the bank is classified as an Opp bank
<i>BRANCH</i>	=Number of branches operated by banks
<i>LIQUID</i>	=(Cash+Marketable Securities) / Total Assets
<i>C_I</i>	= Commercial & Industrial Loans / Total Assets
<i>RBC</i>	= Tier One capital

<i>DUM_DEBT</i>	= Dummy variable indicating that the bank has issued subordinate debt, zero otherwise
<i>DUM_LHFS</i>	= Dummy variable indicating that the bank has Loans Held For Sale (LHFS), zero otherwise
<i>LLR</i>	= Loan Loss Reserve / Total Assets
<i>DUM_TRAD</i>	= Dummy variable indicating that the bank uses derivatives for trading purposes, zero otherwise
<i>DUM_HEDG</i>	=Dummy variable indicating that the bank uses derivatives for hedging purposes, zero otherwise.

The results of our cross sectional logit analysis for each year, during 1997-2003, are presented in Table 3. Overall, our logit results corroborate our theoretical model's hypothesized differences between Mon and Opp banks with respect to monitoring intensity and convex cost of capital. All the coefficients proxying for reputation (*LLR*) and convex cost of capital (*DUM\_TRAD*, *DUM\_HEDG*, *LIQUID*, *DUM\_DEBT*) carry the correct signs and are generally significant at the 1% and 5% levels.

Among our characteristic parameters, we find that *DUM\_TRAD* and *DUM\_HEDG* have a significant influence in determining whether a bank will behave like an Opp bank, as seen by the significant negative marginal effects of these variables on the probability of a Mon bank. Excluding 1997, we find that banks that use derivatives for trading and hedging purposes on average are about 20% and

14.75% respectively, more likely to be an Opp bank than a Mon bank. The marginal effect of *DUM\_HEDG* declines over the sample period while that of *DUM\_TRAD* remains fairly constant. Decline in the marginal influence of *DUM\_HEDG* indicates that as banks in general become more active in hedging their market risks, the effect of *DUM\_HEDG* on the probability of a Mon bank diminishes accordingly.

We also find that when banks issue subordinate debt, indicated by the dummy variable *DUM\_DEBT*, their probability of being a Mon bank reduces, because Mon banks find it costlier to access capital market because of their higher convex capital costs. The marginal effect of *DUM\_DEBT* has lowered the probability of a Mon bank from 3.81% in 1997 to 16.22% in 2003, indicating that access to capital markets has become more significant in predicting the probability a Mon bank, during our sample period.

As expected, we find that increase in *LLR* levels adversely affects the likelihood of being a Mon bank, as seen by its negative coefficient, significant at the 1% level in each of the seven years. Thus, banks that have more efficient monitoring technologies are more likely to be Mon banks. The characteristic variables of *BRANCH*, *C\_I*, *LIQUID*, and *RBC* do not influence market's expectation about a Mon type as significantly as *LLR*.

Thus, consistent with our theoretical model, our logit analysis also shows that the marginal affects of *DUM\_HEDG*, *DUM\_TRAD*, *DUM\_DEBT* and *LLR* are most significant in influencing the probability of a Mon bank.

#### **4.4 EMIPRICAL MODEL AND RESULTS**

In this section, we first test the impact of credit derivatives in lowering the convex cost of capital for banks, as evidenced by a decline in the levels of their risk based capital (*RBC*) levels. We also test whether Mon banks as relationship lenders earn higher rents on their lending activity as opposed to Opp banks. Next, we test the impact of credit derivatives on bank's incentives to monitor and restructure loans. We also test for periodic fluctuations in the level of *LLR* held by Opp banks as evidence supporting existence of our reputation equilibrium.

We estimate all our empirical models using maximum likelihood estimates on the pooled data set, and correct for serial correlation and hetroscedasticity in the errors caused by our cross sectional and time series observations. To capture oscillations in reputation capital for Opp banks, we also present cross sectional results for *LLR*, for each of the seven years in our sample.

##### **Convex Cost of Capital: *RBC***

In the logit analysis, shown in Tables 3, Opp banks held less capital and financial slack than Mon banks because of their lower convex costs of capital adjustments. We now test for the effectiveness of credit derivatives in managing

capital adequacy levels for Mon and Opp banks, given that they each have different incentives for entering the credit derivatives markets; - Mon banks looking to lower their high concentration costs, and Opp banks hoping to save on their high monitoring costs. Hence, we expect  $SELL_{it}$  and  $BUY_{it}$  trades to yield capital reduction benefits for Mon and Opp banks, as witnessed by a negative coefficient on both these variables in equation (11).

$$RBC_{it} = \alpha_1 + \beta_1(DUM\_OPP_{it}) + \beta_2(BUY_{it}) + \beta_3(SELL_{it}) + Year\ Dummies + \varepsilon_{it} \quad (11)$$

where:

$RBC_{it}$  = Tier One Capital for bank  $i$  in period  $t$

$DUM\_OPP_{it}$  = Dummy variable indicating bank  $i$  is classified as an Opp type in period  $t$ ; 0 otherwise

$BUY_{it}$  = Dummy variable indicating that bank  $i$  purchased CDS in period  $t$ ; 0 otherwise

$SELL_{it}$  = Dummy variable indicating that bank  $i$  sold CDS in period  $t$ ; 0 otherwise.

We present results for our  $RBC_{it}$  model in Table 4. As predicted under our theoretical model, Mon banks carry 5.59% more capital than Opp banks because of their sub-optimal loan allocations and higher cost of capital adjustments. The coefficient on  $DUM\_OPP_{it}$  is significantly negative at  $-0.5439$ , indicating that Opp

banks hold lower capital levels because of their better loan diversification and consequent lower convex cost of capital adjustments.

After controlling for differences in  $RBC_{it}$  levels between Mon and Opp banks, we find that purchasing of credit derivatives generally lowers capital levels for banks. The coefficient on  $BUY_{it}$  trades is significantly negative at  $-0.4025$ . We observe a similar reduction in capital levels when banks sell credit protection, however, the coefficient for  $SELL_{it}$  is insignificant. The insignificance of  $SELL_{it}$  trades suggests that selling of credit protection does not adversely increase capital levels either because these trades are executed from a market making perspective or else they allow banks to improve their portfolio diversification. As regulatory authorities give more weight to portfolio loan correlations, sell trades will also significantly reduce regulatory capital levels for banks.

In Table 4, we see evidence of a general reduction in  $RBC_{it}$  levels for all banks.  $RBC_{it}$  levels have declined consistently over the first four years, as seen by the positive and significant coefficient on the year dummies. This decline in capital levels is consistent with the change in regulatory capital requirements, which has moved towards more risk-based capital assessments.

### **Relationship Rents and Opp banks: *ROA* and *ROE***

Relationship lending banks are known to extract information rents from their small, informationally opaque borrowers (Rajan and Peterson (1998)). The

opportunity to extract information rents from borrowers is explained to be an important factor inducing banks to engage in relationship lending (Elsas (2002)). In the context of our reputation model, we expect Mon banks to earn more relationship rents than Opp banks.

To measure relationship profitability, we use net income because banks usually tie-in funded loan facilities with other non-funded products and services (guarantees, letters of credit, trust services etc) to maximize their relationship rents. As relationship loans are subject to greater asymmetric information problems than arm's length loans they also are subject to greater loan loss risk. Therefore, we adjust relationship rents for greater loan risk, by including the variable  $TrobLoan_{it}$  in equation (12) and (13). The variable  $TrobLoan_{it}$  is defined as non-performing loans and charge-offs divided by Total Assets.

$$ROA_{it} = \alpha_1 + \beta_1(C_{I_{it}}) + \beta_2(C \& I_{it} * DUM\_OPP_{it}) + \beta_3(TrobLoan_{it}) + \beta_4(TRAD\_ASSETS_{it}) + \beta_5(LIQUID_{it}) + Year\ Dummies + \varepsilon_{it} \quad (12)$$

$$ROE_{it} = \alpha_1 + \beta_1(C_{I_{it}}) + \beta_2(C \& I_{it} * DUM\_OPP_{it}) + \beta_3(TrobLoan_{it}) + \beta_4(TRAD\_ASSETS_{it}) + \beta_5(LIQUID_{it}) + Year\ Dummies + \xi_{it} \quad (13)$$

where:

$ROA_{it}$  = (Net Income) / (Total Assets) for bank  $i$  in period  $t$

$ROE_{it}$  = (Net Income) / Equity for bank  $i$  in period  $t$

$C_{I_{it}}$	= (Commercial and Industrial Loans)/ (Total Assets) for bank $i$ in period $t$
$LIQUID_{it}$	= (Cash and Marketable Securities) / (Total Assets) for bank $i$ in period $t$
$TRAD\_ASSETS_{it}$	= (Trading Assets) / (Total Assets) for bank $i$ in period $t$ .
$TrobLoan_{it}$	= (Non Performing Loans and Charge_offs) / (Total Assets) for bank $i$ in period $t$
$DUM\_OPP_{it}$	= Dummy variable indicating bank $i$ is classified as an Opp type in period $t$ ; 0 otherwise.

In the above risk adjusted profitability models of  $ROA_{it}$  and  $ROE_{it}$ , the intercept captures the returns earned by Mon banks after taking into consideration  $C_{I_{it}}$ , trading activity and liquid assets. The interaction variable  $Dum\_OPP_{it}$  and  $C_{I_{it}}$  captures the difference in rents earned by Opp banks on their loans. According to our theoretical model, we expect that the interaction variable between  $Dum\_OPP_{it}$  and  $C_{I_{it}}$  will be negative, because Opp banks will have less potential to extract relationship rents from their price sensitive borrowers, which do not require active bank monitoring facilities.

Table 5 presents the results for our profitability equations (12) and (13). In both  $ROA_{it}$  and  $ROE_{it}$  models we find that  $C_{I_{it}}$  generate positive returns for banks, after adjusting for risk,  $TrobLoan_{it}$ . The coefficient on interaction variable  $DUM\_OPP_{it}$  and  $C_{I_{it}}$  is significantly negative for both  $ROA_{it}$  and  $ROE_{it}$  showing that Opp banks indeed earn lower relationship rents than Mon banks because

their borrowers are more competitively priced. Thus, we find evidence supporting our claim that Opp banks are inefficient monitors and therefore earn lower relationship rents, after controlling for loan risk.

Further, in Table 5 we observe that *LIQUID* and *TRAD\_ASSETS* lower bank profitability. *LIQUID* assets, as financial slack, are a drag on a bank's profits and therefore are costly to hold (especially for our Mon types). A negative coefficient on trading activity may proxy for the overall decline in market conditions for our sample period, as seen by the positive and declining coefficient on all the year dummies.

### ***Reputation and Monitoring: Loan Loss Reserve (LLR)***

The empirical model stated in equation (14) below tests the main prediction of our theoretical model that reputation concerns induce Opp banks to monitor their loans after they have purchased credit protection. A decline in the level of *LLR* held by Opp banks would support our reputation hypothesis. However, our theoretical model predicts that because monitoring being unobservable, Opp banks randomize between monitoring and not monitoring their hedged loans, with positive probability. This randomization by Opp banks causes oscillation in our reputation equilibrium and causes Opp banks to shirk on monitoring despite building reputation in the credit derivatives market. A positive coefficient on the interaction variable  $DUM\_OPP_{it} * BUY_{it}$  in equation (14) will support our claim that Opp banks shirking along the equilibrium path as they build their reputation.

$$\begin{aligned}
LLR_{it} = & \alpha_1 + \beta_1(NPL_{it}) + \beta_2(LOANS_{it}) + \beta_3(Log\_Assets_{it}) + \beta_4(DUM\_OPP_{it}) + \beta_5(SELL_{it}) \\
& + \beta_6(DUM\_OPP_{it} * SELL_{it}) + \beta_7(BUY_{it}) + \beta_8(DUM\_OPP_{it} * BUY_{it}) + \varepsilon_{it}
\end{aligned}
\tag{14}.$$

where:

$LLR_{it}$  = (Loan Loss Reserve / Total Assets) for bank  $i$  in period  $t$ .

$LOANS_{it}$  = (Loans and Lease/Total Assets) for bank  $i$  in period  $t$ .

$NPL_{it}$  = ((Overdue loan 90 days)+ (Non-accrual Loans) /Total Assets for bank  $i$  in period  $t$ .

$Log\_Assets_{it}$  = Log of Total Assets for bank  $i$  in period  $t$ .

$DUM\_OPP_{it}$  = Dummy variable indicating if bank  $i$  is classified as an Opp type in period  $t$ ; 0 otherwise.

$BUY_{it}$  = Dummy variable indicating that bank  $i$  purchased CDS in period  $t$ ; 0 otherwise.

$SELL_{it}$  = Dummy variable indicating that bank  $i$  purchased CDS in period  $t$ ; 0 otherwise.

In equation (14),  $Log\_Assets_{it}$  control for provisioning levels for a diversified bank. We expect smaller banks, constrained by the size of their balance sheets, to have more concentrated loan portfolios and therefore have higher provisioning levels than well-diversified banks (Das (2000)).<sup>41</sup> Since our Opp banks also

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<sup>41</sup>As regulated institutions, growth in bank loan portfolios is constrained by the ability of banks to acquire additional external or internal capital.

include smaller, regional banks we control for the size effect needed to attain optimal portfolio loan diversification by  $Log\_Assets_{it}$ .

The variable  $LOANS_{it}$  in equation (14) controls for loan losses expected on the banks unqualified loan portfolio. Larger loan portfolios are expected to have higher potential loan losses, while  $NPL_{it}$  controls for provisioning levels required for qualified loans. We expect a positive coefficient for  $NPL_{it}$ , because banks with higher  $NPL_{it}$  will have larger levels of  $LLR_{it}$ .

Table 6 presents the results for our  $LLR_{it}$  model for the pooled sample. We find that all our year and bank specific control variables have the correct and significant effect on LLR, with the exception of  $SELL_{it}$  and its interaction variable  $DUM\_OPP_{it} * SELL_{it}$ .

The negative coefficient of  $-0.1371$  on  $BUY_{it}$  indicates that credit default swaps are effective instruments in lowering a bank's expected loan losses. When banks purchase credit protection, they significantly reduce their provisioning requirements by efficiently re-allocating their credit risk into the credit derivatives markets. Alternatively, we observe a positive, though insignificant coefficient on sell credit derivatives. The insignificance of  $SELL_{it}$  on  $LLR_{it}$  indicates that  $SELL_{it}$  trades are executed to either improve sub-optimal sector / regional allocations of loan portfolios or to make markets, and therefore have no impact on  $LLR_{it}$ . Thus,

$SELL_{it}$  trades do not significantly influence a bank's incentives to monitor and therefore have an insignificant effect on the banks expected loan losses.

Consistent with our theoretical model, we find a positive and significant coefficient of 0.1246 on  $DUM\_OPP_{it}$ , after controlling for  $NPL_{it}$ ,  $LOANS_{it}$  and  $Log\_Assets_{it}$ , indicating that Opp banks are weaker monitors than Mon banks. Opp banks, on average, maintained 25.11% higher  $LLR_{it}$  reserves than Mon banks during the sample period on the pooled data. Furthermore, provisioning levels of Opp banks when they purchased credit protection  $DUM\_OPP_{it}*BUY_{it}$  increased by a significant coefficient of 0.1450 or a level of 23%. Adverse impact of credit protection on the  $LLR_{it}$  for Opp banks supports our shirking hypothesis, which states that Opp banks will shirk with positive probability as they build their reputation in the credit derivatives markets. Thus, provisioning levels for Opp banks increase after they buy credit protection. Also, Opp bank's incentives to shirk on monitoring are evident only when they buy credit protection, and not when they sell it. The interaction coefficient on  $DUM\_OPP_{it}*SELL_{it}$  is insignificant, which strongly indicates that monitoring incentives for OPP banks are destroyed only when they buy credit protection.

To capture the time varying oscillations in Opp banks' reputation capital, we also present cross sectional results for our  $LLR$  model stated in equation (14). Table (6A) presents our results for each of the seven years. The rise in the intercept over time, from 0.2007 in 1997 to 0.4094 in 2003 indicates the general increase

in the risk level of loans in the US, during our sample period, which includes the end of the dot com boom in 2000 and filing of corporate bankruptcies which involved large bank loans, such as Enron and WorldCom, in 2001. The intercept, in Table (6A), captures the average loan loss reserves maintained by Mon banks. The positive coefficients on *NPL* and *LOANS* are significant and fairly constant across the years. *Log\_Assets* has the expected positive effect of lower *LLR* levels for five out of the seven years, however, excluding 2002, this effect is insignificant.

In each of the seven years, Opp banks reported higher loan losses than Mon banks, as seen by the positive coefficient on *DUM\_OPP<sub>it</sub>*, which ranged from 0.1101 in 1997 to 0.1191 in 2001 and 0.1000 in 2003, significant at the 1% level. Being costlier monitors, Opp banks were more active than Mon banks in buying credit protection. In fact, in 1999 and 2000, only Opp banks were buying credit insurance in the credit derivatives markets as the variables *DUM\_OPP\*BUY* and *DUM\_OPP* become perfectly collinear. The interaction variable *DUM\_OPP\*BUY* is positively significant in four out of the seven years, with its effect in 2000 reflected in the coefficient of the variable, *BUY*, as only OPP banks were buying credit protection that year.

We show the combined effect of *BUY* and *DUM\_OPP\*BUY* under *Incremental BUY effect for (Opp banks)* to capture the impact of credit derivatives on Opp banks incentives to monitor. The *incremental BUY effect for Opp banks* in Table (6A) clearly shows the reputation burning and building phases of our reputation

model, wherein Opp banks shirk with positive probability along the equilibrium path. In three out of the seven years we find that the *incremental BUY effect for Opp banks* was significantly positive, giving evidence that OPP banks in those years were most likely shirking on monitoring their hedged loans. Accordingly, in 1997, 2000 and 2001 we see that *LLR* for Opp banks increase by 0.0867, 0.1483 and 0.0927 when they purchase credit protection, and decrease in 1998, 1999, 2002 and 2003 (though the decreasing effect is significant only in 1998). This positive and negative impact of credit protection on *LLR* levels for Op banks is consistent with our reputation building and burning phases along the equilibrium path for our reputation model.

We estimate equation (14) in Table 6B but drop all banks that have ever sold credit derivatives. By restricting our sample to only banks that buy credit derivatives we control for market making function performed by banks in the credit derivatives markets. After controlling for market making trades in Table (6B), we find that reputation oscillation effects become more pronounced. Compared to Table 6A, more coefficients on *BUY* and *DUM\_OPP\*BUY* in Table (6B) are significant at the 1% level. Also, the level of Incremental Buy effect for Opp banks, which captures our reputation oscillation, is higher than in Table (6A).

Finally, we estimate equation (14) without the dummy variable *DUM\_OPP* because our reputation model assumes that Mon and Opp banks are not

observationally identifiable by outsiders. By describing a classification criterion, in a sense, we are declaring that we can observe Mon and Opp banks, even though imperfectly. Therefore, the only aspect of the reputation model that we can truly test is the net effect of reputation building on the average default rates in the banking sector. The level of aggregate default rates are a function of the proportion of Mon banks operating in the economy, which of course will also include Opp banks building their reputation by mimicking actions of Mon banks. As reputation effects become strong and proportion of Mon banks increase, aggregate default rates fall and an opposite effect occurs when the proportion of Mon banks decreases because Opp banks are burning their reputation capital, as shown in Figure (7).

In Table 6C we show the results of equation (14) without dummy variable *DUM\_OPP*, while in Table 6D we present the same results but drop all those banks from our sample which have had a positive *SELL* trade. In Table (6C), the coefficient for *BUY* changes its sign from positive to negative, indicating the incentives of unobservable Opp banks to burn and build reputation across time. When Opp banks build their reputation, aggregate *LLR* levels decline with *BUY* trades, and aggregate *LLR* level increase when Opp banks burn their reputation capital. In Table 6C, the coefficient for *BUY* trades are insignificant for all of the seven years. However, three of the seven *BUY* coefficients become significant in Table 6D, when we drop banks whose trades are more likely motivated by

market making than, hedging or reputation building. In Table 6C, the coefficient on SELL trades are positive for all the seven years but are also insignificant.

**Restructured Loans:  $RESTRUCT_{it}$**

The decision to restructure non-performing loans is the discretion of banks. Mon banks who are better monitors than Opp banks are expected to be more active in renegotiating loans since they can extract more rents from their restructured loans. Hence, we expect  $DUM\_OPP$  in equation (15) to have a negative coefficient.

Under credit default swaps loan restructurings may create potential moral hazard problems, given that banks choose the timing of these events. All else constant, if moral hazard concerns are valid, than Opp banks should restructure more often under credit protection in order to draw maximum value from their credit protection contracts, i.e. in equation (15), the coefficient on interaction variable  $DUM\_OPP_{it} * BUY_{it}$  should be positive.

$$\begin{aligned}
 RESTRUCT_{it} = & \alpha_1 + \beta_1(NPL_{it}) + \beta_2(DUM\_OPP_{it}) + \beta_3(DUM\_OPP_{it} * BUY_{it}) \\
 & + \beta_4(MON_{it} * BUY_{it}) + Year\ Dummies + \varepsilon_{it}
 \end{aligned}
 \tag{15}.$$

where:

$$RESTRUCT_{it} = (\text{Restructured Loans}) / (\text{Total Assets}) \text{ for bank } i \text{ in period } t$$

$NPL_{it}$  = (Overdue loan 90 days and Non-Accrual Loans) / Total Assets  
for bank  $i$  in period  $t$

$DUM\_OPP_{it}$  = Dummy variable indicating bank  $i$  is classified as an Opp type in period  $t$ ; 0 otherwise

$MON_{it}$  = Dummy variable indicating bank  $i$  is classified as a MON type in period  $t$ ; 0 otherwise

$BUY_{it}$  = Dummy variable indicating that bank  $i$  purchased CDS in period  $t$ ; 0 otherwise.

We expect coefficient on  $MON_{it} * BUY_{it}$  to be zero or insignificant, as Mon banks are assumed to be less affected by moral hazard issues, and therefore their decision to restructure should not be significantly altered or influenced by their credit hedging activity. The variable  $NPL_{it}$  controls for the level of loan restructuring, with higher levels of  $NPL_{it}$  indicating a higher potential for loan restructuring. Hence, we expect a positive coefficient on  $NPL_{it}$ .

Table 7 presents the results for our restructured loans model. After controlling for the level of  $NPL_{it}$ , we find that Opp banks restructure loans less often than Mon banks, as witnessed by the negative and significant coefficient of -0.0102 on  $DUM\_OPP_{it}$ . This is an expected result, as Opp banks are assumed to be non-specialist lenders. The positive coefficient on the intercept 0.0436, corroborates our expectation about Mon banks, in general, renegotiate their problem loans more often than Opp banks.

Consistent with our theoretical model, Opp banks do not restructure their loans more often under credit protection, as seen from the significantly negative coefficient of -0.0124 on the interaction variable  $DUM\_OPP_{it} * BUY_{it}$ . The results of Table 7 do not support the industry's moral hazard concerns about loan restructuring, in fact, to the contrary, we find that Opp banks write off their loans more often with credit protection, than without it, to recover their loan losses.

The negative coefficient on the interaction variable  $MON_{it} * BUY_{it}$  is however contrary to our expectation. This result corroborates our earlier assertion that Mon and Opp classification is really a proxy since Mon banks can act opportunistically.

**Chapter 5****CONCLUSION**

Banks enjoy a comparative advantage over capital markets as monitors in reducing firm moral hazard. To minimize their monitoring costs, banks tend to concentrate their lending activity to a few industries, regions and/or sectors. As a result, bank loan portfolios become overly concentrated and vulnerable to regional and economic downturns. Social cost of these heavily concentrated banks is high because these banks fail frequently and increase systemic risk to the banking system. To prevent occurrence of these systemic shocks, regulatory restrictions on capital are imposed which force banks to diversify internally and lose some of the economies of scale in monitoring concentrated loan portfolios.

The emergence of credit derivatives market is socially beneficial because these markets allow banks to exploit their comparative advantage by investing in concentrated monitoring technology and subsequently spreading their concentrated risk over global financial markets to reduce their capital costs and minimize the risk of systemic banking shocks. However, we show that introduction of these credit-hedging markets may concurrently induce banks to shirk on their monitoring responsibility. When banks shirk on their monitoring function, once they have bought credit protection in the credit derivatives market, they destroy social welfare by eliminating the bank-monitoring device that controls firm moral hazard. Thus, the introduction of credit derivatives market may destroy the monitoring equilibrium in the bank loan market.

However, the incentives of banks to shirk on monitoring may lead to market failure. High-realized losses on unmonitored bank loans may make the credit derivatives markets too expensive for banks to hedge their concentrated risks, thereby forcing regulatory authorities to re-impose restrictions on capital to prevent systemic shocks.

In our theoretical model, we show that reputation can prove to be a valuable means of bridging the gap between these two paradigms; the first best world where banks always monitor and simultaneously manage their capital positions using credit derivatives versus the sub-optimal equilibrium where banks always shirk. We show that reputation can increase social welfare and move us closer to the first best world by generating benefits associated with efficient bank monitoring technology and reducing systemic risk in the banking system, thereby enabling banks to economize on their capital costs. Thus, the introduction of a credit derivatives market permits banks to become more specialized and generate greater monitoring benefits, on a given capital base, without increasing systemic risk to the banking system. However, since Opp banks incentive to shirk on monitoring cannot be fully resolved under the reputation equilibrium; we predict that overall failure rates for the banking sector will increase with credit derivatives, but the same will be discounted in the equilibrium prices for CDS.

The empirical chapter investigates finds evidence in support of our oscillating reputation equilibrium. It also tests the impact of credit derivatives on expected bank loan losses, capital levels and risk management activity.

Overall, our empirical results support our theoretical findings that banks that are relationship lenders tend to be regionally based, operate smaller branch networks to keep their processing costs low, and keep a close watch on the actions of their informationally opaque borrowers. These banks are able to extract positive relationship rents on their loans, and use the credit derivatives market to lower their convex cost of capital by diversifying their concentration risk. We also find evidence that banks operating geographically diverse networks, tend to operate on lower cost of capital, and carry less financial slack in the shape of liquid assets and risk based capital than their regionally concentrated counterparts. As a result, Opp banks were found to be more active in hedging and trading their market risks, and were not overly concentrated in relationship lending.

Overall our empirical results finds strong evidence supporting our claim that Opp banks shirk on monitoring under credit protection; however, we also find evidence of their reputation building. We do not find evidence supporting the moral hazard concerns in relation to loan restructuring for credit derivatives.

**TABLE A**  
**CREDIT DERIVATIVES MARKET**  
(In billion of U.S. dollars)

	1998	1991	2000	2001	2002
<b>Credit Derivatives (NV)</b>	350	586	893	1,189	1,952
<b>Global**-Loans (Corp.)</b>	14,528	15,541	14,238	12,745	13,698
<b>-Corp. Bonds</b>	8,650	9,308	9,563	10,042	11,507
<b>As a %of Global loans and bonds</b>	1.5	2.4	3.8	5.2	7.7

**\*\*USA, UK, Euro Area, and Japan**

**Source: BBA, FRB, IMF, BOJ & UK**

**TABLE B**  
**CREDIT DERIVATIVES MARKET: PLAYERS**

		2001
<b>Protection Buyers</b>	<b>Banks</b>	<b>52%</b>
	<b>Sec. Houses</b>	<b>21%</b>
	<b>Hedge Funds</b>	<b>12%</b>
<b>Protection Sellers</b>	<b>Banks</b>	<b>39%</b>
	<b>Insurance Cos.</b>	<b>39%</b>
<b>Major Instruments</b>	<b>CDS-Single Borrower</b>	<b>45%</b>
	<b>CDS-Loan Portfolio</b>	<b>22%</b>
<b>Underlying assets</b>	<b>Sovereign.</b>	<b>22%</b>
	<b>Corporates</b>	<b>60%</b>

Source: BBA Survey Report 2001/2002

**TABLE 1**  
**DESCRIPTIVE STATISTICS**

The table shows descriptive statistics for the full sample from 1997-2003. *LIQUID* denotes Cash and Marketable Securities divided by Total Assets. *TRAD\_ASSETS* denotes Trading Assets divided by Total Assets. *C\_I* denote Commercial & Industrial Loans divided by Total Assets. *RE\_LOANS* denotes loans secured by real estate loans divided by Total Assets. *LLR* denotes Loan Loss Reserve divided by Total Assets. *RESTRUCT* denotes restructured loans divided by Total Assets. *NPL* denotes loans overdue for 90 days and Non-accruing loans divided by Total Assets. *TrobLoan* denotes NPL and Charge\_off divided by Total Assets. *BRANCH* represents the number of branches. *OFF\_FOR* indicates if the bank operates foreign branches. *STMULT* indicates if the bank operates interstate branches. *MBHC\_DUM* indicates if the bank is held by a multi-bank holding company. *MBHC\_MST* indicates if the bank is owned by a multi-state holding company. *ROA* denotes Return on Assets. *ROE* denotes Return on Equity. *CDS\_BUY* denotes notional amount of credit derivatives bought divided by Total Assets. *CDS\_SELL* denotes notional amount of credit derivatives sold divided by Total Assets. *LHFS* denotes Loans Held for Sale divided by Total Assets. *RBC* denotes Tier One capital. Financial variables are stated in percentage terms. Total Assets reported in million of dollars.

TABLE 1 continued

<b>Variable</b>	<b>N</b>	<b>Mean</b>	<b>Median</b>	<b>Std Dev.</b>	<b>Minimum</b>	<b>Maximum</b>
<i>LIQUID (%)</i>	58973	30.55	28.77	14.13	0	98.99
<i>TRAD_ASSETS (%)</i>	58973	0.03	0	0.82	0	59.27
<i>C_I (%)</i>	58973	10.38	8.61	7.66	0	88.84
<i>LOANS (%)</i>	58973	60.15	61.72	14.59	0.02	99.45
<i>RE_LOANS (%)</i>	58973	36.49	36.43	15.79	0	96.04
<i>TOTAL ASSETS (\$MLN)</i>	58973	759	83	10,544	1	628,662
<i>LLR (%)</i>	58973	0.89	0.81	0.48	0	14.90
<i>RESTRUCT (%)</i>	58973	0.03	0	0.22	0	16.62
<i>NPL (%)</i>	58973	0.59	0.35	0.79	0	26.83
<i>TrobLoan (%)</i>	58973	0.83	0.52	1.10	0	34.79
<i>BRANCH (#)</i>	57925	8.98	3.00	71.05	1	4767
<i>OFF_FOR (#)</i>	57933	0.11	0	3.95	0	283
<i>STMULT</i>	57933	0.03	0	0.18	0	1
<i>MBHC_DUM</i>	58981	0.29	0	0.45	0	1
<i>MBHC_MST</i>	58981	0.14	0	0.34	0	1
<i>DUM_OPP</i>	58512	0.16	0	0.37	0	1
<i>DUM_OPP (no of obs)</i>	9342					
<i>DUM_OPP (% of Assets)</i>		83.24				
<i>ROA (%)</i>	58981	4.01	3.96	1.24	-32.73	87.64
<i>ROE (%)</i>	58981	42.23	41.63	18.87	-294.29	1826.45
<i>CDS-BUY (%)</i>	58973	0.01	0.00	0.71	0	84.00
<i>CDS-SOLD (%)</i>	58973	0.01	0.00	0.50	0	62.55
<i>LHFS (%)</i>	58973	0.62	0.00	3.86	0	100.00
<i>RBC (%)</i>	58973	10.32	9.08	4.96	0.16	99.95

**TABLE 1A**  
**QUINTILES FOR TOTAL ASSETS**

This table shows the quintiles for Total Assets for banks classified as Mon and Opp banks. Total Assets in Million of dollars.

	<b>25Q</b>	<b>50Q</b>	<b>75Q</b>	<b>95Q</b>
<b>MON</b>	38.57	73.33	144.80	474.68
<b>OPP</b>	84.71	210.08	758.56	11,917.51
<b>Size Multiple</b>	2.20	2.87	5.24	25.11

**TABLE 2**  
**DIFFERENCE OF MEANS**

The table shows the difference in means for Mon and Opp banks. The criterion for classifying banks into Mon and Opp is:

<b>DUM_OPP=0 (MON)</b>	<b>if STMULT=0 and MBHC_MST=0 and OFF_FOR=0</b>
<b>DUM_OPP=1 (OPP)</b>	<b>if STMULT=1 or MBHC_MST=1 or OFF_FOR &gt; 0.</b>

*STMULT* indicates if the bank operates interstate branches. *MBHC\_MST* indicates if the bank is owned by a multi-state holding company. *OFF\_FOR* indicates if the bank operates foreign branches. *BRANCH* denotes the number of branches. *C\_I* denote Commercial & Industrial Loans divided by Total Assets. *RE\_LOANS* denotes Real Estate loans divided by Total Assets. *LIQUID* denotes Cash and Marketable Securities divided by Total Assets. *RBC* denotes Tier One capital. *DUM\_DEBT* indicates issuance of subordinate debt. *DUM\_LHFS* indicates Loans Held for Sale (LHFS). *LLR* denotes Loan Loss Reserve divided by Total Assets. *DUM\_TRAD* indicates usage of derivatives for trading purposes. *DUM\_HEDG* indicates usage of derivatives for hedging purposes. *CDS\_BUY* denotes notional amount of credit derivatives bought divided by Total Assets. *CDS\_SELL* denotes notional amount of credit derivatives sold divided by Total Assets. T values are based on unequal variances. \*\*\* indicate significance at 1%. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 2 Continued

	Mon	Opp	Difference	t Values
<i>BRANCH</i>	3.8755	37.601	(33.7300)	-17.59***
<i>C_I</i>	10.106	11.793	(1.6870)	-17.64***
<i>RE_LOANS</i>	36.159	38.327	(2.1690)	-11.81***
<i>LIQUID</i>	31.335	26.472	4.8635	32.46***
<i>RBC</i>	10.551	9.0197	1.5313	31.26***
<i>DUM_DEBT</i>	0.0115	0.1195	(0.1080)	-31.48***
<i>DUM_LHFS</i>	0.1574	0.3288	(0.1710)	-33.42***
<i>LLR</i>	0.8643	0.9973	(0.1330)	-20.86***
<i>DUM_TRAD</i>	0.0018	0.0673	(0.0650)	-25.19***
<i>DUM_HEDG</i>	0.0175	0.1415	(0.1240)	-33.94***
<i>CDS_BUY</i>	0.005	0.0635	(0.0590)	-3.97***
<i>CDS_SELL</i>	0.0015	0.0494	(0.0480)	-3.79***

## TABLE 2A

### DIFFERENCE OF MEANS (Without *CDS\_SELL*)

The table shows the difference in means for Mon and Opp banks after dropping all bank observations with positive *CDS\_SELL* trades. The criterion for classifying banks into Mon and Opp is:

**DUM\_OPP=0 (MON) if STMULT=0 and MBHC\_MST=0 and OFF\_FOR=0**

**DUM\_OPP=1 (OPP) if STMULT=1 or MBHC\_MST=1 or OFF\_FOR > 0.**

*STMULT* indicates if the bank operates interstate branches. *MBHC\_MST* indicates if the bank is owned by a multi-state holding company. *OFF\_FOR* indicates if the bank operates foreign branches. *BRANCH* denotes the number of branches. *C\_I* denote Commercial & Industrial Loans divided by Total Assets. *RE\_LOANS* denotes Real Estate loans divided by Total Assets. *LIQUID* denotes Cash and Marketable Securities divided by Total Assets. *RBC* denotes Tier One capital. *DUM\_DEBT* indicates issuance of subordinate debt. *DUM\_LHFS* indicates Loans Held for Sale (LHFS). *LLR* denotes Loan Loss Reserve divided by Total Assets. *DUM\_TRAD* indicates usage of derivatives for trading purposes. *DUM\_HEDG* indicates usage of derivatives for hedging purposes. *CDS\_BUY* denotes notional amount of credit derivatives bought divided by Total Assets. *CDS\_SELL* denotes notional amount of credit derivatives sold divided by Total Assets. T values are based on unequal variances. \*\*\* indicate significance at 1%. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 2A Continued

	Mon	Opp	Difference	t Values
<i>BRANCH</i>	3.8470	23.1530	(19.3060)	-24.84***
<i>C_I</i>	10.0960	11.5400	(1.4440)	-15.52***
<i>RE_LOANS</i>	36.1640	38.6850	(2.5210)	-13.68***
<i>LIQUID</i>	31.3350	26.5520	4.7830	31.64***
<i>RBC</i>	10.5520	9.0546	1.4974	30.24***
<i>DUM_DEBT</i>	0.0113	0.1012	(0.0899)	-28.27***
<i>DUM_LHFS</i>	0.1573	0.3179	(0.1606)	-31.24***
<i>LLR</i>	0.8640	0.9953	(0.1313)	-20.31***
<i>DUM_TRAD</i>	0.0018	0.0510	(0.0492)	-21.31***
<i>DUM_HEDG</i>	0.0173	0.1248	(0.1075)	-30.66***
<i>CDS_BUY</i>	0.0050	0.0025	0.0025	0.91
<i>CDS_SELL</i>	-	-	-	-

## TABLE 2B

### DIFFERENCE FOR MEANS FOR REGIONAL BANKS

The table shows the difference in means for Mon and Opp banks. The criterion for classifying banks into Mon and Opp is:

**DUM\_OPP=0 (MON) if STMULT=0 and MBHC\_MST=0 and OFF\_FOR=0**

**DUM\_OPP=1 (OPP) if STMULT=0 or MBHC\_MST=1 or OFF\_FOR=0.**

*STMULT* indicates if the bank operates interstate branches. *MBHC\_MST* indicates if the bank is owned by a multi-bank holding company operating in more than one state. *OFF\_FOR* indicates if the bank operates foreign branches. *BRANCH* denotes the number of branches. *C\_I* denote Commercial & Industrial Loans divided by Total Assets. *RE\_LOANS* denotes Real Estate loans divided by Total Assets. *LIQUID* denotes Cash and Marketable Securities divided by Total Assets. *RBC* denotes Tier One capital. *DUM\_DEBT* indicates issuance of subordinate debt. *DUM\_LHFS* indicates Loans Held for Sale (LHFS). *LLR* denotes Loan Loss Reserve divided by Total Assets. *DUM\_TRAD* indicates usage of derivatives for trading purposes. *DUM\_HEDG* indicates usage of derivatives for hedging purposes. *CDS\_BUY* denotes notional amount of credit derivatives bought divided by Total Assets. *CDS\_SELL* denotes notional amount of credit derivatives sold divided by Total Assets. T values are based on unequal variances. \*\*\* indicate significance at 1%. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC). Total Assets are reported in million of dollars.

TABLE 2B Continued

	MBHC -Single State (Mon Banks)	MBHC- Multi State (Opp Banks)	Difference	t Values
<i>BRANCH</i>	3.875	10.235	-6.36	-21.27 <sup>***</sup>
<i>C_I</i>	10.106	11.179	-1.07	-10.15 <sup>***</sup>
<i>LIQUID</i>	31.335	26.174	5.16	30.14 <sup>***</sup>
<i>RBC</i>	10.551	9.25	1.3	21.26 <sup>***</sup>
<i>DUM_DEBT</i>	0.012	0.0689	-0.06	-18.14 <sup>***</sup>
<i>DUM_LHFS</i>	0.157	0.266	-0.11	-19.00 <sup>***</sup>
<i>LLR</i>	0.8643	1.006	-0.14	-18.29 <sup>***</sup>
<i>DUM_TRAD</i>	0.0018	0.0159	-0.01	-9.02 <sup>***</sup>
<i>DUM_HEDG</i>	0.0175	0.0668	-0.05	-15.71 <sup>***</sup>
<i>TOTAL ASSETS</i>	151.061	666.756	-516	-20.24 <sup>***</sup>
<i>CDS_BUY</i>	0.005	0.0001	0	2.24 <sup>**</sup>
<i>CDS_SELL</i>	0.0015	0.0013	0	0.21

**TABLE 3**  
**LOGIT ANALYSIS**

This table shows the probability of a Mon bank ( $DUM\_OPP=0$ ) under Logit Analysis, during 1997 to 2003.

$$\begin{aligned}
 DUM\_OPP = & \alpha_1 + \beta_1(BRANCH) + \beta_2(C\_I) + \beta_3(LIQUID) + \beta_4(RBC) \\
 & + \beta_5(DUM\_DEBT) + \beta_6(DUM\_LHFS) + \beta_7(LLR) + \beta_8(DUM\_TRAD) \\
 & + \beta_9(DUM\_HEDG) + \varepsilon
 \end{aligned}$$

*DUM\_OPP* denotes that the bank is classified as an Opp type. *BRANCH* denotes the number of branches. *LIQUID* denotes Cash and Marketable Securities divided by Total Assets. *C\_I* denote Commercial & Industrial Loans divided by Total Assets. *RBC* denotes Tier One Capital. *DUM\_DEBT* indicates issuance of subordinate debt. *DUM\_LHFS* indicates Loans Held for Sale (LHFS). *LLR* denotes Loan Loss Reserve divided by Total Assets. *DUM\_TRAD* indicates usage of derivatives for trading purposes. *DUM\_HEDG* indicates usage of derivatives for hedging purposes. The marginal effects are stated in Italics and are calculated at mean values of the parameters, while the coefficients are reported in bold print. Standard errors are reported in parenthesis. \*\*\*, \*\*, \* indicate significance at 1%, 5% and 10% levels respectively. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 3 Continued

	1997	1998	1999	2000	2001	2002	2003
<i>Intercept</i>	<b>1.0086</b> <sup>***</sup> (0.1752)	<b>1.4483</b> <sup>***</sup> (0.1684)	<b>1.1607</b> <sup>***</sup> (1.1607)	<b>1.3060</b> <sup>***</sup> (0.1643)	<b>1.6185</b> <sup>***</sup> (0.1561)	<b>1.8353</b> <sup>***</sup> (0.1730)	<b>1.7280</b> <sup>***</sup> (0.1652)
<i>BRANCH</i>	<b>-0.0578</b> <sup>***</sup> 0.38% (0.0044)	<b>-0.0489</b> <sup>***</sup> -0.64% (0.0043)	<b>-0.0486</b> <sup>***</sup> -0.65% (0.0041)	<b>-0.0536</b> <sup>***</sup> -0.68% (0.0041)	<b>-0.0556</b> <sup>***</sup> -0.71% (0.0041)	<b>-0.0566</b> <sup>***</sup> -0.69% (0.0042)	<b>-0.0534</b> <sup>***</sup> -0.63% (0.0042)
<i>C_I</i>	<b>-0.0017</b> -0.01% (0.0045)	<b>-0.0077</b> <sup>*</sup> -0.10% (0.0044)	<b>-0.004</b> -0.05% (0.0042)	<b>-0.0033</b> -0.04% (0.0042)	<b>0.0039</b> 0.05% (0.0044)	<b>-0.0036</b> -0.04% (0.0046)	<b>-0.0043</b> -0.05% (0.0048)
<i>LIQUID</i>	<b>0.0143</b> <sup>***</sup> 0.09% (0.0029)	<b>0.0105</b> <sup>***</sup> 0.14% (0.0029)	<b>0.0173</b> <sup>***</sup> 0.23% (0.0028)	<b>0.0213</b> <sup>***</sup> 0.27% (0.0031)	<b>0.0288</b> <sup>***</sup> 0.37% (0.0030)	<b>0.0240</b> <sup>***</sup> 0.29% (0.0031)	<b>0.0216</b> <sup>***</sup> 0.26% (0.0029)
<i>RBC</i>	<b>0.1115</b> <sup>***</sup> 0.72% (0.0131)	<b>0.0861</b> <sup>***</sup> 1.13% (0.0117)	<b>0.0848</b> <sup>***</sup> 1.14% (0.0113)	<b>0.0646</b> <sup>**</sup> 0.83% (0.0112)	<b>0.0184</b> <sup>**</sup> 0.24% (0.0091)	<b>0.0249</b> <sup>**</sup> 0.30% (0.0107)	<b>0.0384</b> <sup>***</sup> 0.46% (0.0113)
<i>DUM_DEBT</i>	<b>-0.586</b> <sup>***</sup> -3.81% (0.1997)	<b>-0.7394</b> <sup>***</sup> -9.70% (0.1962)	<b>-0.8839</b> <sup>***</sup> -11.86% (0.1971)	<b>-0.9151</b> -11.69% (0.1941)	<b>-0.7369</b> <sup>***</sup> -9.47% (0.1962)	<b>-0.9987</b> <sup>***</sup> -12.17% (0.1827)	<b>-1.3646</b> <sup>***</sup> -16.22% (0.1614)
<i>DUM_LHFS</i>	<b>-0.2689</b> <sup>***</sup> -1.75% (0.0816)	<b>-0.3433</b> <sup>***</sup> -4.50% (0.0800)	<b>-0.2677</b> <sup>***</sup> -3.59% (0.0824)	<b>-0.0731</b> -0.93% (0.0893)	<b>-0.0973</b> -1.25% (0.0846)	<b>-0.0436</b> -0.53% (0.0870)	<b>-0.0013</b> -0.02% (0.0899)
<i>LLR</i>	<b>-0.3836</b> <sup>***</sup> -2.49% (0.0627)	<b>-0.4089</b> <sup>***</sup> -5.37% (0.0643)	<b>-0.4031</b> <sup>***</sup> -5.41% (0.0637)	<b>-0.3300</b> <sup>***</sup> -4.22% (0.0697)	<b>-0.3588</b> <sup>***</sup> -4.61% (0.0667)	<b>-0.3078</b> <sup>***</sup> -3.75% (0.0745)	<b>-0.2477</b> <sup>***</sup> -2.94% (0.0602)
<i>DUM_TRAD</i>	<b>-1.3987</b> <sup>***</sup> -9.09% (0.4218)	<b>-1.7085</b> <sup>***</sup> -22.42% (0.4224)	<b>-1.7443</b> <sup>***</sup> -23.41% (0.4404)	<b>-1.5053</b> <sup>***</sup> -19.23% (0.4132)	<b>-1.8162</b> <sup>***</sup> -23.34% (0.3735)	<b>-1.9578</b> <sup>***</sup> -23.85% (0.3835)	<b>-1.8867</b> <sup>***</sup> -22.43% (0.3426)
<i>DUM_HEDG</i>	<b>-1.4118</b> <sup>***</sup> -9.17% (0.2305)	<b>-1.4612</b> <sup>***</sup> -19.18% (0.2035)	<b>-1.2154</b> <sup>***</sup> -16.31% (0.1994)	<b>-1.2568</b> <sup>***</sup> -16.05% (0.1955)	<b>-1.082</b> <sup>***</sup> -13.91% (0.1477)	<b>-1.0327</b> <sup>***</sup> -12.58% (0.1343)	<b>-0.8896</b> <sup>***</sup> -10.57% (0.1233)
<i>-2 log L</i>	6561.17	6316.16	6523.28	5958.37	5750.64	5287.90	5154.68
<i>LR Test</i>	1179.48 <sup>***</sup>	1087.43 <sup>***</sup>	1133.52 <sup>***</sup>	1048.38 <sup>***</sup>	1055.20 <sup>***</sup>	1066.34 <sup>***</sup>	1067.745 <sup>***</sup>

**TABLE 4**  
**DEPENDENT VARIABLE: *RBC***

This table shows the effect of credit derivatives on managing the level of Risk Based Capital (*RBC*) of Mon and Opp banks, over the period 1997-2003

$$RBC_{it} = \alpha_1 + \beta_1(DUM\_OPP_{it}) + \beta_2(BUY_{it}) + \beta_3(SELL_{it}) + Year\ Dummies + \varepsilon_{it}$$

$RBC_{it}$  represents Tier One Capital for bank  $i$  in period  $t$ .  $DUM\_OPP_{it}$  indicates if bank  $i$  is classified as an Opp type in period  $t$ .  $BUY_{it}$  denotes that bank  $i$  purchased CDS in period  $t$ .  $SELL_{it}$  denotes that bank  $i$  sold CDS in period  $t$ . \*\*\*, \*\*, \* indicate significance at 1% , 5% and 10% LEVELS respectively. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC). White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis.

<i>Intercept</i>	<b>9.7300<sup>***</sup></b>	(0.0446)
<i>DUM_OPP</i>	<b>-0.5439<sup>***</sup></b>	(0.0673)
<i>SELL</i>	<b>-0.2613</b>	(0.2708)
<i>BUY</i>	<b>-0.4025<sup>*</sup></b>	(0.2469)
1997	<b>0.4978<sup>***</sup></b>	(0.0623)
1998	<b>0.1729<sup>***</sup></b>	(0.0426)
1999	<b>0.0942<sup>***</sup></b>	(0.0363)
2000	<b>0.0763<sup>***</sup></b>	(0.0310)
2001	<b>-0.1658<sup>***</sup></b>	(0.0253)
2002	<b>-0.1024<sup>***</sup></b>	(0.0183)
AR(1)		0.8746
# of obs		58,504
-2 Log L		268,447
LR Test		82,223 <sup>***</sup>

**TABLE 5**  
**DEPENDENT VARIABLE: *ROA* and *ROE***

This table shows the profitability of Mon and Opp banks with respect to commercial and industrial loans, over the period 1997-2003

$$ROA_{it} = \alpha_1 + \beta_1(C_{I_{it}}) + \beta_2(C_{I_{it}} * DUM\_OPP_{it}) + \beta_3(TrobLoan_{it}) + \beta_4(TRAD\_ASSETS_{it}) + \beta_5(LIQUID_{it}) + Year\ Dummies + \varepsilon_{it}$$

$$ROE_{it} = \alpha_1 + \beta_1(C_{I_{it}}) + \beta_2(C_{I_{it}} * DUM\_OPP_{it}) + \beta_3(TrobLoan_{it}) + \beta_4(TRAD\_ASSETS_{it}) + \beta_5(LIQUID_{it}) + Year\ Dummies + \varepsilon_{it}$$

*DUM\\_OPP<sub>it</sub>* indicates bank *i* is classified as an Opp type in period *t*. *ROA<sub>it</sub>* measures Net Income divided by Total Assets for bank *i* in period *t*. *ROE<sub>it</sub>* represents Net Income divided by Equity for bank *i* in period *t*. *C<sub>I<sub>it</sub></sub>* denotes Commercial & Industrial Loans divided by Total Assets for bank *i* in period *t*. *LIQUID<sub>it</sub>* denotes Cash and Marketable Securities divided by Total Assets for bank *i* in period *t*. *TRAD\\_ASSETS<sub>it</sub>* denotes Trading Assets divided by Total Assets for bank *i* in period *t*. *TrobLoan<sub>it</sub>* denotes NPL and Charge\_off divided by Total Assets for bank *i* in period *t*. White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis. All coefficients are significant at the 1% level. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 5 Continued

Dependent Variable	ROA		ROE	
<i>Intercept</i>	<b>4.1181</b> <sup>***</sup>	(0.0393) <sup>a</sup>	<b>40.7796</b> <sup>***</sup>	(0.8400) <sup>a</sup>
<i>C_I</i>	<b>0.0090</b> <sup>***</sup>	(0.0017)	<b>0.2432</b> <sup>***</sup>	(0.0479)
<i>TrobLoan</i>	<b>0.1038</b> <sup>***</sup>	(0.0154)	<b>1.2465</b> <sup>***</sup>	(0.4132)
<i>DUM_OPP*C_I</i>	<b>-0.0173</b> <sup>***</sup>	(0.0019)	<b>-0.2548</b> <sup>***</sup>	(0.0391)
<i>TRAD_ASSETS</i>	<b>-0.0583</b> <sup>***</sup>	(0.0081)	<b>-0.3565</b> <sup>***</sup>	(0.0774)
<i>LIQUID</i>	<b>-0.0164</b> <sup>***</sup>	(0.0008)	<b>-0.1616</b> <sup>***</sup>	(0.0107)
<b>1997</b>	<b>0.5210</b> <sup>***</sup>	(0.0186)	<b>5.009</b> <sup>***</sup>	(0.2774)
<b>1998</b>	<b>0.3029</b> <sup>***</sup>	(0.0154)	<b>3.3368</b> <sup>***</sup>	(0.2519)
<b>1999</b>	<b>0.3555</b> <sup>***</sup>	(0.0158)	<b>5.4061</b> <sup>***</sup>	(0.2300)
<b>2000</b>	<b>0.2432</b> <sup>***</sup>	(0.0148)	<b>2.6891</b> <sup>***</sup>	(0.2035)
<b>2001</b>	<b>0.0652</b> <sup>***</sup>	(0.0139)	<b>1.2438</b> <sup>***</sup>	(0.2179)
<b>2002</b>	<b>0.0952</b> <sup>***</sup>	(0.0102)	<b>0.6841</b> <sup>***</sup>	(0.1909)
DW		1.388		1.217
AR(1)		0.47		0.79
- 2 Log L		176,712		474,176
LR Test		9215 <sup>***</sup>		26057 <sup>***</sup>
# of Observations		58,504		58,504

<sup>a</sup>White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis.

TABLE 6

**DEPENDENT VARIABLE:  $LLR_{it}$  (Pooled Sample)**

This table shows the effect of credit derivatives on the level of  $LLR_{it}$  of banks over the period 1997-2003. The intercept captures the  $LLR_{it}$  level for Mon banks and  $DUM\_OPP$  reflects the  $LLR_{it}$  level for Opp banks, without credit derivatives. The Incremental BUY effect (Opp) adds the coefficients of  $BUY_{it}$  and  $DUM\_OPP_{it} * BUY_{it}$ , and its positive value indicates shirking incentives of Opp banks when they buy credit protection.

$$LLR_{it} = \alpha_1 + \beta_1(NPL_{it}) + \beta_2(LOANS_{it}) + \beta_3(Log\_Assets_{it}) + \beta_4(DUM\_OPP_{it}) + \beta_5(SELL_{it}) + \beta_6(DUM\_OPP_{it} * SELL_{it}) + \beta_7(BUY_{it}) + \beta_8(DUM\_OPP_{it} * BUY_{it}) + Year\ Dummies + \varepsilon_{it}$$

$LLR_{it}$  denotes Loan Loss Reserves divided by Total Assets for bank  $i$  in period  $t$ .  $NPL_{it}$  denotes Loans overdue 90 days and non-accrual Loans divided by Total Assets for bank  $i$  in period  $t$ .  $LOANS_{it}$  denotes Loans and Lease divided by Total Assets for bank  $i$  in period  $t$ .  $Log\_Assets_{it}$  denotes Log of Total Assets for bank  $i$  in period  $t$ .  $DUM\_OPP_{it}$  denotes bank  $i$  classified as an Opp type in period  $t$ .  $BUY_{it}$  indicates that bank  $i$  purchased CDS in period  $t$ .  $SELL_{it}$  indicates that bank  $i$  sold CDS in period  $t$ . White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis. \*\*\*, \*\*, \* indicate significance at 1% , 5% and 10% levels respectively. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 6 Continued

<i>Intercept</i>	<b>0.4962<sup>**</sup></b>	(0.0563)
<i>NPL</i>	<b>0.1130<sup>***</sup></b>	(0.0073)
<i>LOANS</i>	<b>0.0072<sup>***</sup></b>	(0.0003)
<i>Log_Assets</i>	<b>-0.0089<sup>**</sup></b>	(0.0043)
<i>DUM_OPP</i>	<b>0.1246<sup>***</sup></b>	(0.0136)
<i>SELL</i>	<b>0.0717</b>	(0.1705)
<i>DUM_OPP*SELL</i>	<b>-0.0704</b>	(0.1603)
<i>BUY</i>	<b>-0.1371<sup>**</sup></b>	(0.0669)
<i>DUM_OPP*BUY</i>	<b>0.1450<sup>*</sup></b>	(0.0858)
<b>1997</b>	<b>-0.0258<sup>**</sup></b>	(0.0074)
<b>1998</b>	<b>-0.0301<sup>**</sup></b>	(0.0075)
<b>1999</b>	<b>-0.0286<sup>***</sup></b>	(0.0069)
<b>2000</b>	<b>-0.0308<sup>***</sup></b>	(0.0064)
<b>2001</b>	<b>-0.0274<sup>***</sup></b>	(0.0050)
<b>2002</b>	<b>-0.0075<sup>**</sup></b>	(0.0036)
<i>Incremental BUY effect (OPP)</i>	<b>0.0079</b>	
DW		0.809
AR(1) Estimate		0.822
# of obs		58,504
-2 Log L		20976.4
LR Test		45844 <sup>***</sup>

**TABLE 6A**  
**DEPENDENT VARIABLE: *LLR***

This table shows the effect of credit derivatives on the level of *LLR* of banks in each year, over the period 1997-2003. The intercept captures the *LLR* level for Mon banks and *DUM\_OPP* reflects the *LLR* level for Opp banks, without credit derivatives. The *Incremental BUY effect (Opp)* adds the coefficients of *BUY* and *DUM\_OPP\*BUY*, and its fluctuation indicates oscillation in Opp banks incentives to monitor loans as they burn and build their reputation in the credit derivatives markets.

$$LLR = \alpha_1 + \beta_1(NPL) + \beta_2(LOANS) + \beta_3(Log\_Assets) + \beta_4(DUM\_OPP) + \beta_5(SELL) + \beta_6(DUM\_OPP*SELL) + \beta_7(BUY) + \beta_8(DUM\_OPP*BUY) + \varepsilon$$

*LLR* denotes Loan Loss Reserves divided by Total Assets. *NPL* denotes Loans overdue 90 days and non-accrual Loans divided by Total Assets. *LOANS* denote loans and lease divided by Total Assets. *Log\_Assets* denotes Log of Total Assets. *DUM\_OPP* denotes if bank is classified as an Opp type. *BUY* indicates if a bank purchased CDS. *SELL* indicates if a bank sold CDS. White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis. \*\*\*, \*\*, \* indicate significance at 1%, 5% and 10% levels respectively. n/a indicates that *BUY* and *DUM\_OPP\*BUY* are perfectly collinear. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 6A Continued

	1997	1998	1999	2000	2001	2002	2003
<i>Intercept</i>	<b>0.2007**</b> (0.0643)	<b>0.2868***</b> (0.0615)	<b>0.2967***</b> (0.0663)	<b>0.3596***</b> (0.0636)	<b>0.3987***</b> (0.0590)	<b>0.3742***</b> (0.0591)	<b>0.4094***</b> (0.0683)
<i>NPL</i>	<b>0.2039***</b> (0.0182)	<b>0.2145***</b> (0.0141)	<b>0.2182***</b> (0.0152)	<b>0.1808***</b> (0.0130)	<b>0.1979***</b> (0.0129)	<b>0.1886***</b> (0.0204)	<b>0.2303***</b> (0.0193)
<i>LOANS</i>	<b>0.0081***</b> (0.0004)	<b>0.0081***</b> (0.0004)	<b>0.0072***</b> (0.0004)	<b>0.0074***</b> (0.0003)	<b>0.0073***</b> (0.0003)	<b>0.0081***</b> (0.0004)	<b>0.0075***</b> (0.0005)
<i>Log_Assets</i>	<b>0.0064</b> (0.0053)	<b>-0.0025</b> (0.0053)	<b>0.0013</b> (0.0054)	<b>-0.0041</b> (0.0051)	<b>-0.0087*</b> (0.0048)	<b>-0.0090*</b> (0.0048)	<b>-0.0101</b> (0.0062)
<i>DUM_OPP</i>	<b>0.1101***</b> (0.0142)	<b>0.1276***</b> (0.0150)	<b>0.1076***</b> (0.0153)	<b>0.0977***</b> (0.0155)	<b>0.1191***</b> (0.0160)	<b>0.1023***</b> (0.0162)	<b>0.1000***</b> (0.0196)
<i>SELL</i>	<b>0.0098***</b> (0.0167)	<b>-0.1302***</b> (0.0110)	<b>0.1881</b> (0.1636)	<b>1.3162***</b> (0.2341)	<b>0.8772***</b> (0.0219)	<b>0.6132*</b> (0.3675)	<b>1.7322***</b> (0.0327)
<i>DUM_OPP*SELL</i>	<b>-0.03939</b> (0.1246)	<b>0.2022*</b> (0.1060)	<b>-0.1096</b> (0.2164)	<b>-1.2885***</b> (0.2748)	<b>-0.8085***</b> -0.1481	<b>-0.4336</b> (0.3834)	<b>-1.5601***</b> (0.1465)
<i>BUY</i>	<b>-0.1793***</b> (0.0170)	<b>-0.2486***</b> (0.0160)	<b>-0.0861</b> (0.1392)	<b>0.1483</b> (0.1863)	<b>-0.786***</b> (0.0402)	<b>-0.1221</b> (0.1413)	<b>-0.1122</b> (0.2185)
<i>DUM_OPP*BUY</i>	<b>0.266**</b> (0.1242)	<b>0.1875*</b> (0.0972)	n/a	n/a	<b>0.8787***</b> (0.1533)	<b>0.0252</b> (0.1871)	<b>0.0289</b> (0.2614)
<i>Increm. BUY effect (Opp)</i>	<b>0.0867</b>	<b>(0.0611)</b>	<b>(0.0861)</b>	<b>0.1483</b>	<b>0.0927</b>	<b>(0.0969)</b>	<b>(0.0833)</b>
<b># of observations</b>	9162	8700	8581	8314	8110	7874	7763
<b>F Statistic</b>	244.84***	259.59***	279.18***	242.14***	279.1***	318.58***	250.72***
<b>Adj. R square</b>	0.1756	0.1921	0.1856	0.1688	0.2153	0.2447	0.2047

**TABLE 6B**  
**DEPENDENT VARIABLE: *LLR***  
**(Without *CDS\_SELL*)**

This table shows the effect of credit derivatives on the level of *LLR* of banks in each year, over the period 1997-2003, after dropping all bank observations that had a positive *SELL* trade. The intercept captures the *LLR* level for Mon banks and *DUM\_OPP* reflects the *LLR* level for Opp banks, without credit derivatives. The *Incremental BUY effect (Opp)* adds the coefficients of *BUY* and *DUM\_OPP\*BUY*, and its fluctuation indicates oscillation in Opp banks incentives to monitor loans as they burn and build their reputation in the credit derivatives markets.

$$LLR = a_1 + \beta_1(NPL) + \beta_2(LOANS) + \beta_3(Log\_Assets) + \beta_4(DUM\_OPP) + \beta_5(SELL) + \beta_6(DUM\_OPP*SELL) + \beta_7(BUY) + \beta_8(DUM\_OPP*BUY) + \varepsilon$$

*LLR* denotes Loan Loss Reserves divided by Total Assets. *NPL* denotes Loans overdue 90 days and non-accrual Loans divided by Total Assets. *LOANS* denote loans and lease divided by Total Assets. *Log\_Assets* denotes Log of Total Assets. *DUM\_OPP* denotes if bank is classified as an Opp type. *BUY* indicates if a bank purchased CDS. *SELL* indicates if a bank sold CDS. White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis. \*\*\*, \*\*, \* indicate significance at 1%, 5% and 10% levels respectively. n/a indicates that *BUY* and *DUM\_OPP\*BUY* are perfectly collinear. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 6B Continued

	1997	1998	1999	2000	2001	2002	2003
<i>Intercept</i>	<b>0.2014</b> <sup>***</sup> (0.0661)	<b>0.2890</b> <sup>***</sup> (0.0629)	<b>0.2945</b> <sup>***</sup> (0.0673)	<b>0.3536</b> <sup>***</sup> (0.0645)	<b>0.4202</b> <sup>***</sup> (0.0589)	<b>0.3909</b> <sup>***</sup> (0.0597)	<b>0.4101</b> <sup>***</sup> (0.0689)
<i>NPL</i>	<b>0.2037</b> <sup>***</sup> (0.0183)	<b>0.2141</b> <sup>***</sup> (0.0141)	<b>0.2182</b> <sup>***</sup> (0.0152)	<b>0.1804</b> <sup>***</sup> (0.0130)	<b>0.1941</b> <sup>***</sup> (0.0127)	<b>0.1849</b> <sup>***</sup> (0.0202)	<b>0.2301</b> <sup>***</sup> (0.0193)
<i>LOANS</i>	<b>0.0081</b> <sup>**</sup> (0.0004)	<b>0.0080</b> <sup>**</sup> (0.0004)	<b>0.0072</b> <sup>**</sup> (0.0004)	<b>0.0073</b> <sup>**</sup> (0.0003)	<b>0.0072</b> <sup>**</sup> (0.0003)	<b>0.0081</b> <sup>**</sup> (0.0004)	<b>0.0075</b> <sup>**</sup> (0.0005)
<i>Log_Assets</i>	<b>0.0064</b> (0.0054)	<b>-0.0026</b> (0.0054)	<b>0.0016</b> (0.0054)	<b>-0.0034</b> (0.0052)	<b>-0.0103</b> <sup>**</sup> (0.0048)	<b>-0.0105</b> <sup>**</sup> (0.0048)	<b>-0.0102</b> (0.0063)
<i>DUM_OPP</i>	<b>0.1095</b> <sup>***</sup> (0.0142)	<b>0.1267</b> <sup>***</sup> (0.0150)	<b>0.1061</b> <sup>***</sup> (0.0153)	<b>0.0967</b> <sup>***</sup> (0.0155)	<b>0.1182</b> <sup>***</sup> (0.0159)	<b>0.1017</b> <sup>***</sup> (0.0162)	<b>0.0988</b> <sup>**</sup> (0.0196)
<i>SELL</i>	- -	- -	- -	- -	- -	- -	- -
<i>DUM_OPP*SELL</i>	- -	- -	- -	- -	- -	- -	- -
<i>BUY</i>	<b>-0.1795</b> <sup>***</sup> (0.0175)	<b>-0.2483</b> <sup>***</sup> (0.0164)	<b>-0.3690</b> <sup>***</sup> (0.0338)	<b>0.4171</b> (0.6283)	<b>-0.7735</b> <sup>***</sup> (0.0395)	<b>-0.1195</b> (0.1411)	<b>-0.1122</b> (0.2185)
<i>DUM_OPP*BUY</i>	<b>0.3235</b> <sup>***</sup> (0.0166)	<b>-0.0950</b> <sup>***</sup> (0.0202)	n/a -	n/a -	<b>0.9274</b> <sup>***</sup> (0.3154)	<b>-0.2695</b> (0.1662)	<b>0.2177</b> (0.3567)
<b>Increment. BUY (effect)</b>	<b>0.1440</b>	<b>(0.3433)</b>	<b>(0.3690)</b>	<b>0.4171</b>	<b>0.1539</b>	<b>(0.3890)</b>	<b>0.1055</b>
<b># of obs.</b>	9,128	8,666	8,546	8,281	8,077	7,842	7,737
<b>F Statistic</b>	323.37 <sup>***</sup>	342.78 <sup>***</sup>	387.78 <sup>***</sup>	327.92 <sup>***</sup>	358.31 <sup>***</sup>	411.67 <sup>***</sup>	330.35 <sup>***</sup>
<b>Adj. R square</b>	0.1749	0.1914	0.1846	0.1649	0.2098	0.2391	0.2035

**TABLE 6C**  
**DEPENDENT VARIABLE: *LLR***  
**(Without *DUM\_OPP*)**

This table shows the effect of buying and selling of credit derivatives on the aggregate level of *LLR* for the banking sector, over the period 1997-2003.

$$LLR = \alpha_1 + \beta_1(NPL) + \beta_2(LOANS) + \beta_3(Log\_Assets) + \beta_4(SELL) + \beta_5(BUY) + \varepsilon$$

*LLR* denotes Loan Loss Reserves divided by Total Assets. *NPL* denotes Loans overdue 90 days and non-accrual Loans divided by Total Assets. *LOANS* denote Loans and Lease divided by Total Assets. *Log\_Assets* denotes Log of Total Assets. *BUY* indicates that banks purchased CDS. *SELL* indicates that banks sold CDS. White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis. \*\*\*, \*\*, \* indicate significance at 1% , 5% and 10% levels, respectively. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 6C Continued

	1997	1998	1999	2000	2001	2002	2003
<b>Intercept</b>	<b>0.0653</b> (0.0608)	<b>0.1370</b> (0.0628)	<b>0.1761</b> (0.0662)	<b>0.2634<sup>***</sup></b> (0.0612)	<b>0.2707<sup>***</sup></b> (0.0599)	<b>0.2675<sup>***</sup></b> (0.0595)	<b>0.3002<sup>***</sup></b> (0.0630)
<b>NPL</b>	<b>0.2039<sup>***</sup></b> (0.0178)	<b>0.2228<sup>***</sup></b> (0.0169)	<b>0.2176<sup>***</sup></b> (0.0152)	<b>0.1949<sup>***</sup></b> (0.0137)	<b>0.1977<sup>***</sup></b> (0.0128)	<b>0.1892<sup>***</sup></b> (0.0201)	<b>0.2495<sup>***</sup></b> (0.0239)
<b>LOANS</b>	<b>0.0083<sup>***</sup></b> (0.0004)	<b>0.0084<sup>***</sup></b> (0.0004)	<b>0.0074<sup>***</sup></b> (0.0004)	<b>0.0074<sup>***</sup></b> (0.0003)	<b>0.0074<sup>***</sup></b> (0.0003)	<b>0.0082<sup>***</sup></b> (0.0003)	<b>0.0074<sup>***</sup></b> (0.0005)
<b>Log_Assets</b>	<b>0.0196<sup>***</sup></b> (0.0490)	<b>0.0107<sup>**</sup></b> (0.0054)	<b>0.0125<sup>**</sup></b> (0.0053)	<b>0.0052</b> (0.0048)	<b>0.0033</b> (0.0048)	<b>0.0009</b> (0.0047)	<b>-0.0001</b> (0.0055)
<b>SELL</b>	<b>0.0049</b> (0.1038)	<b>0.0807</b> (0.0951)	<b>0.1064</b> (0.1215)	<b>0.2112</b> (0.1691)	<b>0.1893</b> (0.1472)	<b>0.2669<sup>**</sup></b> (0.1112)	<b>0.3570<sup>*</sup></b> (0.1865)
<b>BUY</b>	<b>0.0177</b> (0.1071)	<b>-0.0754</b> (0.0887)	<b>-0.0966</b> (0.1244)	<b>0.0505</b> (0.1926)	<b>0.0064</b> (0.1550)	<b>-0.1481</b> (0.1402)	<b>-0.1818</b> (0.1449)
<b># of obs.</b>	9,162	8,700	8,581	8,314	8,110	7,874	7,763
<b>F Statistic</b>	383.71 <sup>***</sup>	434.73 <sup>***</sup>	376.90 <sup>***</sup>	346.74 <sup>***</sup>	425.83 <sup>***</sup>	495.02 <sup>***</sup>	466.69 <sup>***</sup>
<b>Adj. R square</b>	0.1700	0.1966	0.1794	0.1711	0.2076	0.2388	0.2307

**TABLE 6D**

**DEPENDENT VARIABLE: *LLR***

**(Without *DUM\_OPP* and *CDS\_SELL*)**

This table shows the effect of buying and selling of credit derivatives on the aggregate level of *LLR* for the banking sector, after dropping all bank observations that had positive *SELL* trades, over the period 1997-2003.

$$LLR = \alpha_1 + \beta_1(NPL) + \beta_2(LOANS) + \beta_3(Log\_Assets) + \beta_4(SELL) + \beta_5(BUY) + \varepsilon$$

*LLR* denotes Loan Loss Reserves divided by Total Assets. *NPL* denotes Loans overdue 90 days and non-accrual Loans divided by Total Assets. *LOANS* denote Loans and Lease divided by Total Assets. *Log\_Assets* denotes Log of Total Assets. *BUY* indicates that banks purchased CDS. *SELL* indicates that banks sold CDS. White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis. \*\*\*, \*\*, \* indicate significance at 1% , 5% and 10% levels, respectively. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

TABLE 6D Continued

	1997	1998	1999	2000	2001	2002	2003
<b>Intercept</b>	<b>0.0673</b> (0.0628)	<b>0.1429</b> (0.0643)	<b>0.1764</b> (0.0672)	<b>0.2570</b> <sup>***</sup> (0.0622)	<b>0.2923</b> <sup>***</sup> (0.0601)	<b>0.2853</b> <sup>***</sup> (0.0603)	<b>0.2960</b> <sup>***</sup> (0.0636)
<b>NPL</b>	<b>0.2037</b> <sup>***</sup> (0.0178)	<b>0.2224</b> <sup>***</sup> (0.0169)	<b>0.2176</b> <sup>***</sup> (0.0151)	<b>0.1938</b> <sup>***</sup> (0.0137)	<b>0.1937</b> <sup>***</sup> (0.0127)	<b>0.1854</b> <sup>***</sup> (0.0200)	<b>0.2492</b> <sup>***</sup> (0.0239)
<b>LOANS</b>	<b>0.0082</b> <sup>***</sup> (0.0004)	<b>0.0083</b> <sup>***</sup> (0.0004)	<b>0.0074</b> <sup>***</sup> (0.0004)	<b>0.0073</b> <sup>***</sup> (0.0003)	<b>0.0074</b> <sup>***</sup> (0.0003)	<b>0.0082</b> <sup>***</sup> (0.0003)	<b>0.0074</b> <sup>***</sup> (0.0004)
<b>Log_Assets</b>	<b>0.0195</b> <sup>***</sup> (0.0510)	<b>0.0103</b> <sup>*</sup> (0.0055)	<b>0.0126</b> (0.0054)	<b>0.0060</b> (0.0050)	<b>0.0017</b> (0.0048)	<b>-0.0007</b> (0.0048)	<b>0.0017</b> (0.0056)
<b>SELL</b>	-	-	-	-	-	-	-
<b>BUY</b>	<b>-0.0387</b> (0.1424)	<b>-0.3147</b> <sup>***</sup> (0.0248)	<b>-0.3467</b> <sup>***</sup> (0.0331)	<b>0.4501</b> (0.6246)	<b>-0.0067</b> (0.3073)	<b>-0.2313</b> <sup>**</sup> (0.1073)	<b>-0.0453</b> (0.1786)
<b># of obs.</b>	9,310	8,871	8,566	8,341	8,077	7,842	7,739
<b>F Statistic</b>	475.31 <sup>***</sup>	539.09 <sup>***</sup>	467.94 <sup>***</sup>	424.56 <sup>***</sup>	512.86 <sup>***</sup>	599.73 <sup>***</sup>	580.36 <sup>***</sup>
<b>Adj. R square</b>	0.1693	0.1953	0.1790	0.1688	0.2022	0.2340	0.2305

TABLE 7

DEPENDENT VARIABLE: *RESTRUCT<sub>it</sub>*

This table shows the effect of credit derivatives on the amount of loans restructured by Mon and Opp banks, over the period 1997-2003

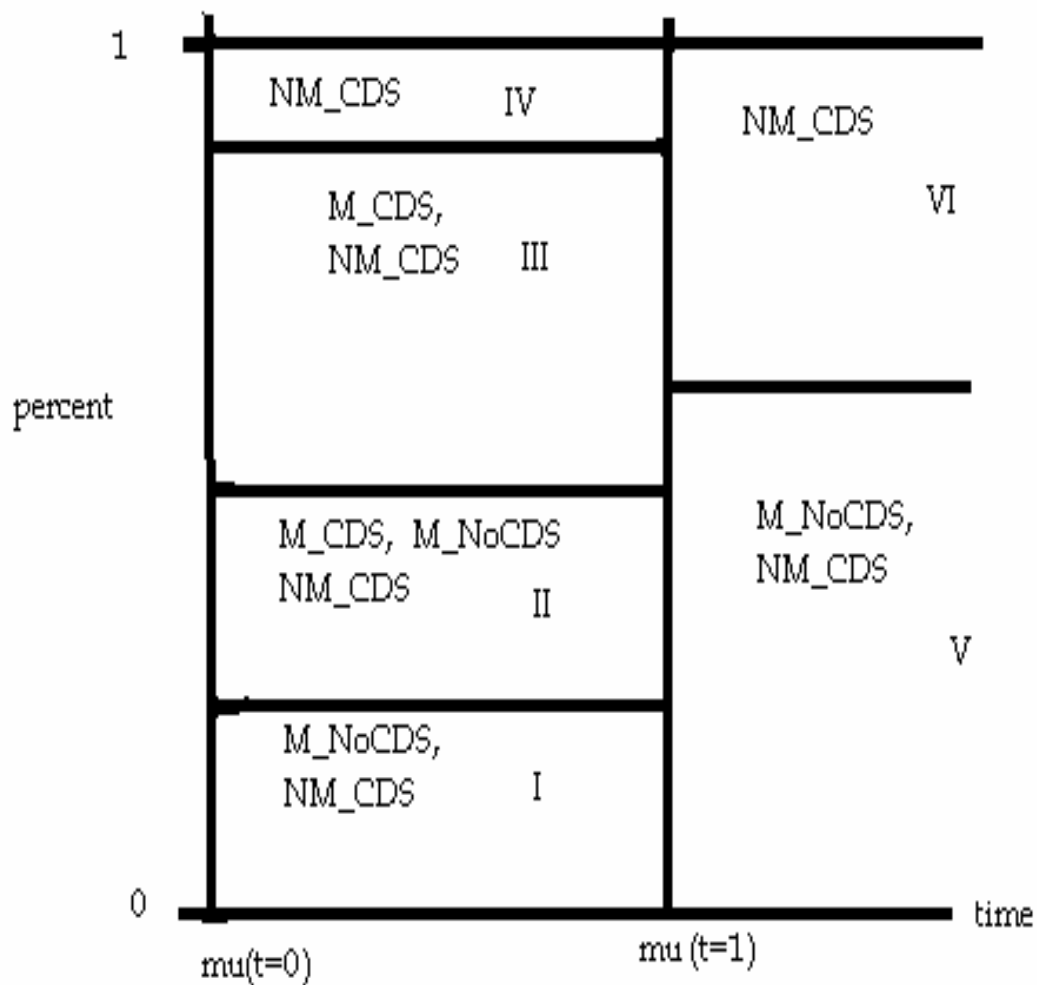
$$\begin{aligned} \mathit{RESTRUCT}_{it} = & \alpha_1 + \beta_1(\mathit{NPL}_{it}) + \beta_2(\mathit{DUM\_OPP}_{it}) + \beta_3(\mathit{DUM\_OPP}_{it} * \mathit{BUY}_{it}) \\ & + \beta_4(\mathit{MON}_{it} * \mathit{BUY}_{it}) + \text{Year Dummies} + \varepsilon_{it} \end{aligned}$$

*RESTRUCT<sub>it</sub>* represents restructured loans divided by Total Assets for bank *i* in period *t*. *NPL<sub>it</sub>* represents Loans Overdue 90 days and Non-Accrual Loans divided by Total Assets for bank *i* in period *t*. *DUM\_OPP<sub>it</sub>* indicates if bank *i* is classified as an Opp type in period *t*. *MON<sub>it</sub>* indicates if bank *i* is classified as a MON type in period *t*. *BUY<sub>it</sub>* denotes that bank *i* purchased CDS in period *t*. *SELL<sub>it</sub>* denotes that bank *i* sold CDS in period *t*; 0 otherwise. White's Heteroscedasticity Corrected Standard Errors are reported in parenthesis. \*\*\*, \*\*, \* indicate significance at 1% , 5% and 10% levels respectively. The data is obtained from Call Reports (Federal Reserve Bank) and Demographic data files (FDIC).

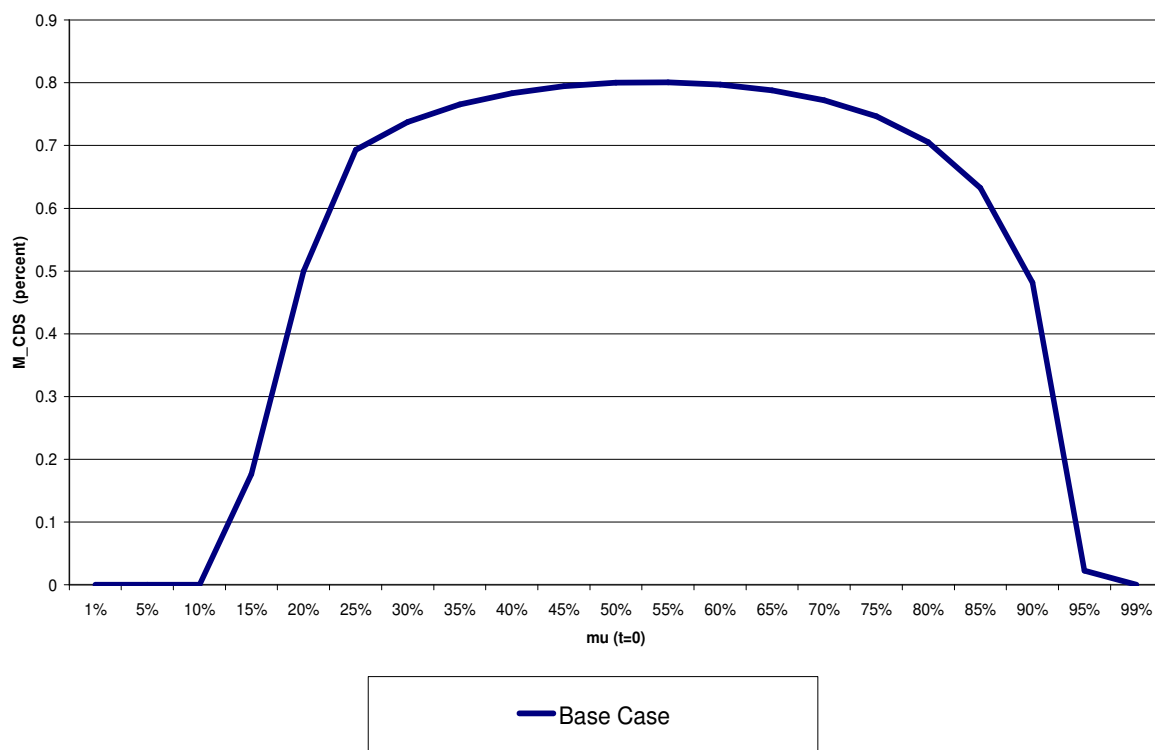
Table 7 Continued

<i>Intercept</i>	<b>0.0436<sup>***</sup></b>	(0.0038)
<i>NPL</i>	<b>0.0104<sup>***</sup></b>	(0.0020)
<i>DUM_OPP</i>	<b>-0.0102<sup>**</sup></b>	(0.0032)
<i>DUM_OPP *BUY</i>	<b>-0.0124<sup>**</sup></b>	(0.0055)
<i>MON*BUY</i>	<b>-0.0371<sup>***</sup></b>	(0.0040)
<b>1997</b>	<b>-0.0201<sup>***</sup></b>	(0.0039)
<b>1998</b>	<b>-0.0249<sup>***</sup></b>	(0.0038)
<b>1999</b>	<b>-0.0271<sup>***</sup></b>	(0.0037)
<b>2000</b>	<b>-0.0296<sup>***</sup></b>	(0.0036)
<b>2001</b>	<b>-0.0040</b>	(0.0037)
<b>2002</b>	<b>0.0025</b>	(0.0045)
<b>DW</b>		1.38
<b>AR(1)</b>		0.4171
<b># of observations.</b>		58504
<b>-2 Log L</b>		20189
<b>LR Test</b>		8107.59 <sup>***</sup>

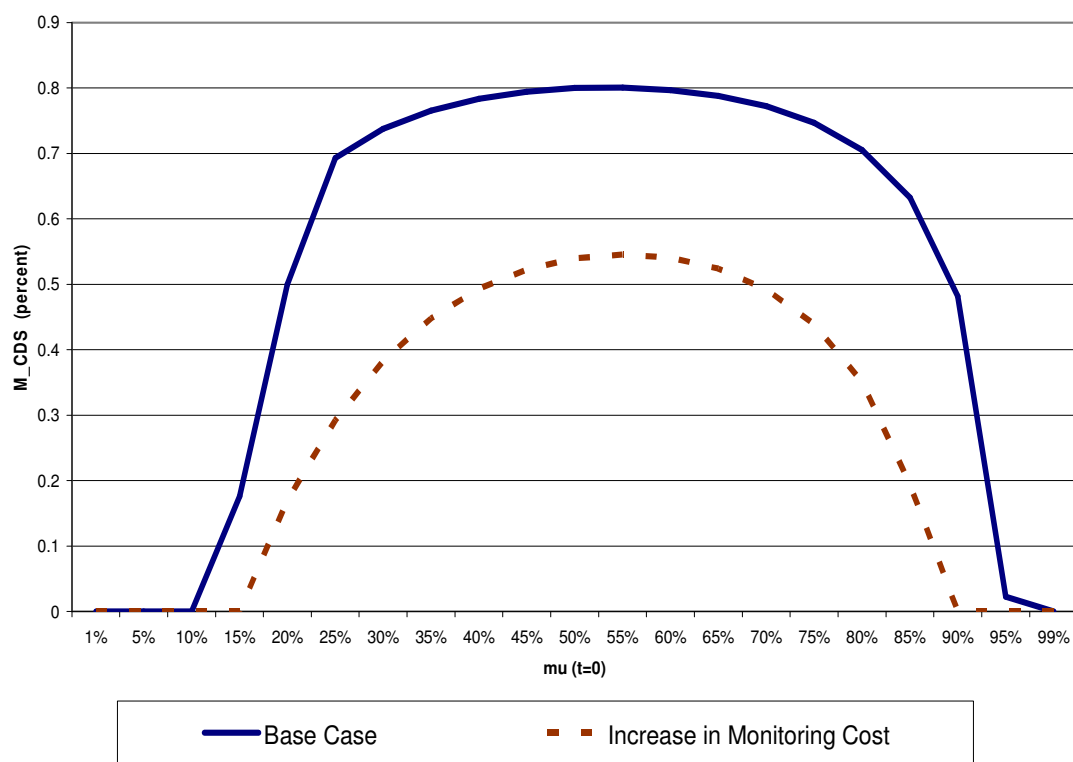
Figure 1: Characterization of Equilibrium Strategies for Opp Banks in the Two-Period Model.



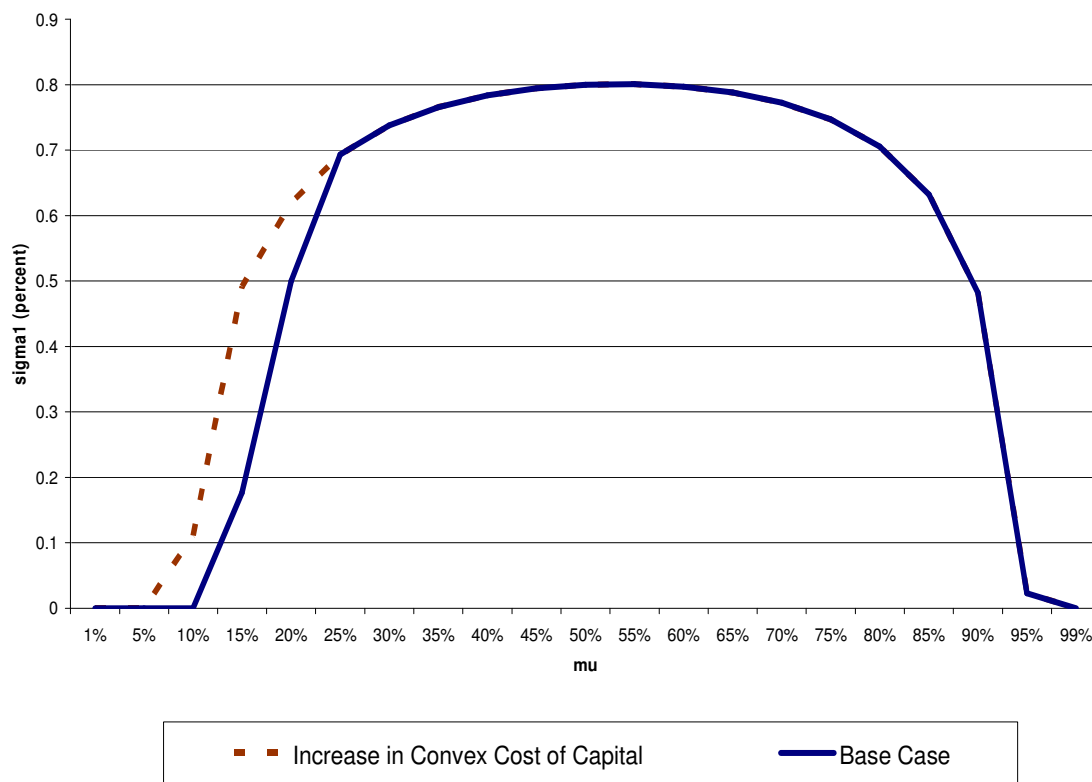
**Figure 2: Penultimate Period Equilibrium Strategies for Opp Banks**  
Base Case:  $P_g = 0.8$ ,  $P_{bar} = 0.3$ ,  $m = 0.1$ ,  $C = 6.0$ ,  $Z = 0.1$



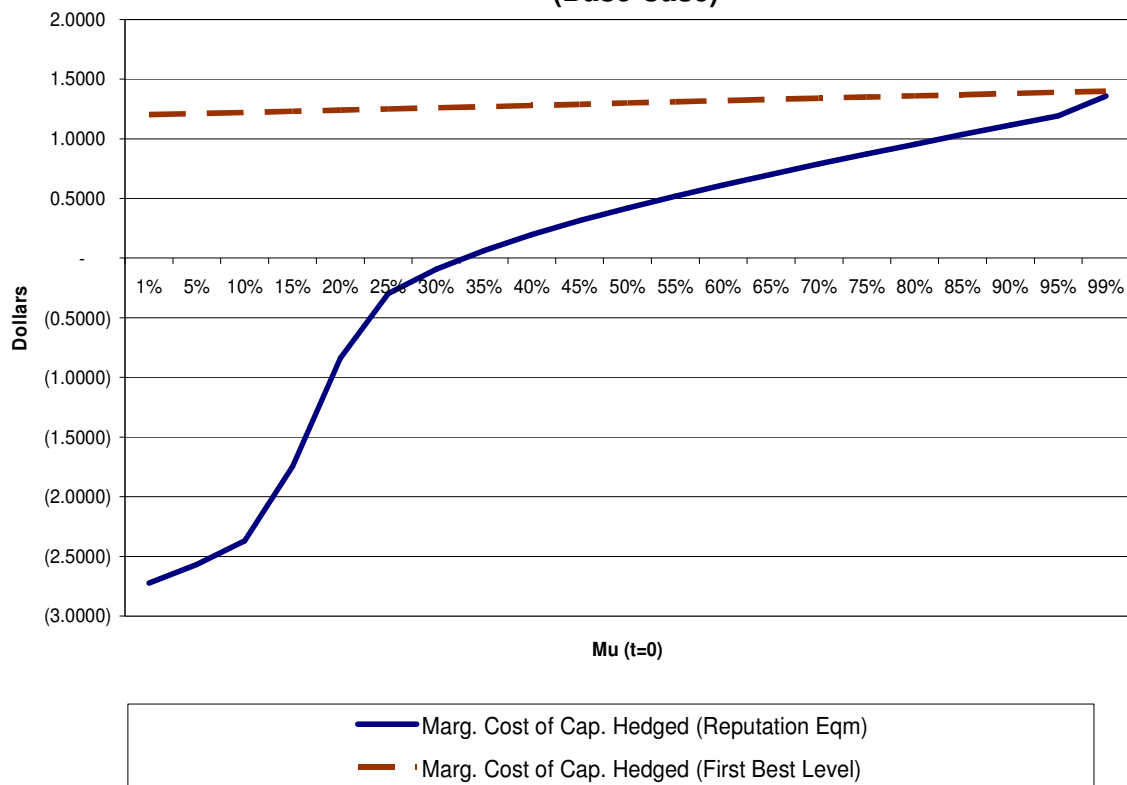
**Figure 3: Increase in Monitoring Costs, holding all else constant  
 $m = 0.2$ ,  $Z = 0.0$**



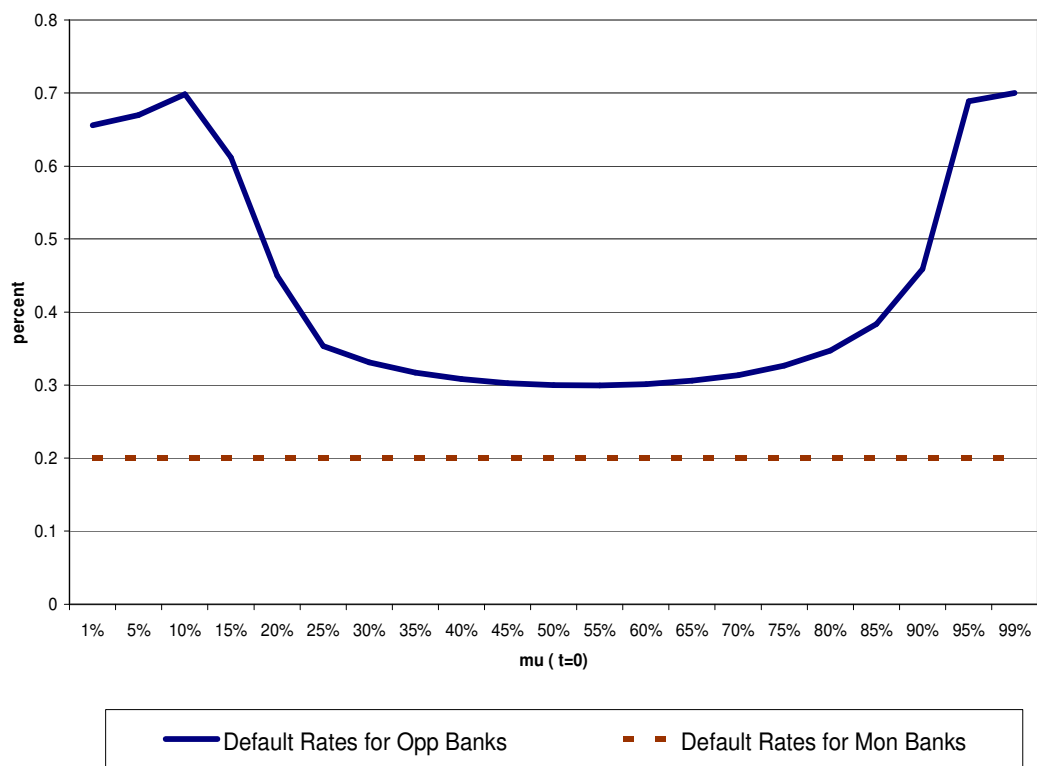
**Figure 4: Increase in Convex Costs, holding all else constant  
 $C = 6.5$ ,  $Z = 0.0$**



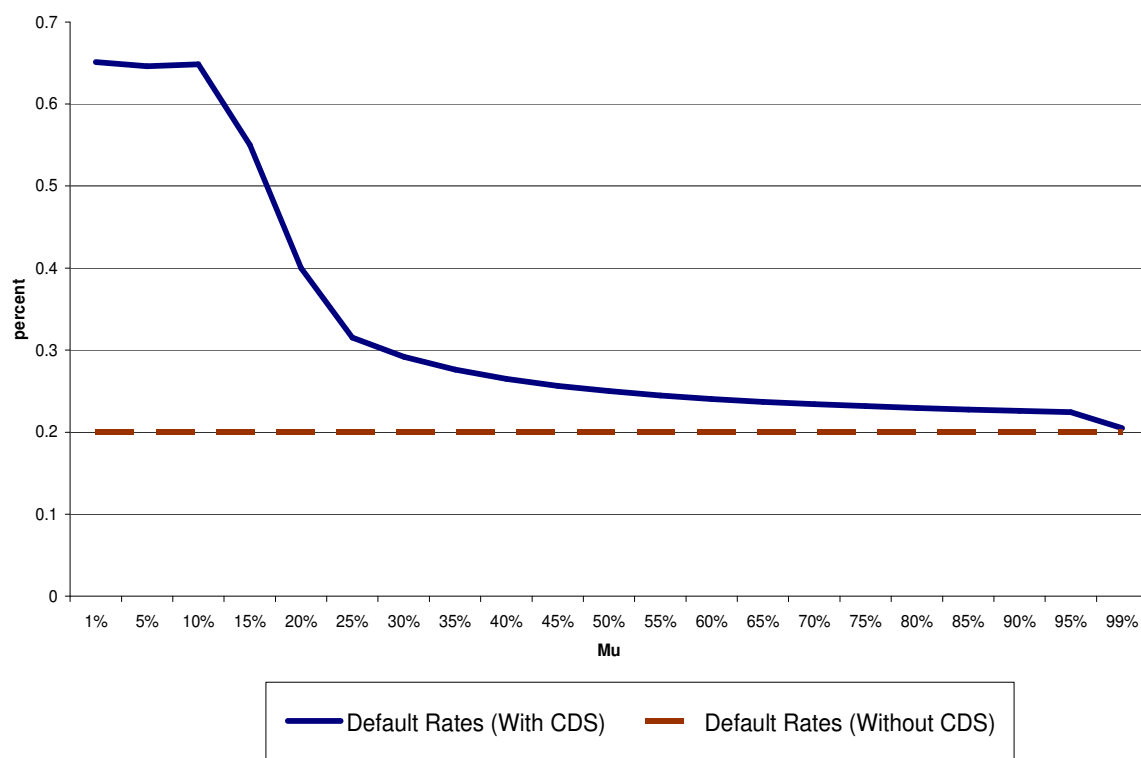
**Figure 5: Net Change in Social Welfare for the Reputation Equilibrium (Base Case)**



**Figure 6: Failure Rates for Mon and Opp Banks  
in the Penultimate Period**



**Figure 7: Aggregate Default Rates  
(Reputation Equilibrium)**



## Appendix A

## PROOFS

### Proof for Lemma (2)

We prove Lemma (2) by contradiction. If  $\sigma_0^{M\_CDS^*} = 1$ , then  $\tilde{\mu}_1^{ND} = \mu_0 = \tilde{\mu}_1^D$  and credit derivatives market no longer updates its beliefs,  $\tilde{\mu}_1^i$ , based on the outcomes of the CDS contract  $i_1 = (D, ND)$ . Thus, loan outcomes do not convey information about the monitoring action chosen by Opp banks, because when  $\sigma_0^{M\_CDS^*} = 1$ , a default (no default) outcome indicates an unlucky (lucky) realization on the risky, monitored loan and not that the bank shirked (not shirked) on its monitoring responsibility, as shown below:

$$\tilde{\mu}_1^D \equiv \Pr(\text{Mon}_{t=1} | d_1 = 1, i_1 = D) = \frac{\mu_0(1-P_G)}{\mu_0(1-P_G) + (1-\mu_0)(1-P_G)} = \mu_0$$

$$\tilde{\mu}_1^{ND} \equiv \Pr(\text{Mon}_{t=1} | d_1 = 1, i_1 = ND) = \frac{\mu_0 P_G}{\mu_0 P_G + (1-\mu_0) P_G} = \mu_0$$

With  $\tilde{\mu}_1^{ND} = \mu_0 = \tilde{\mu}_1^D$ , CDS sellers updated beliefs for the last period are unaffected by Opp banks' actions in the penultimate period. As a result, Opp banks, ex-post, shirk on monitoring in the penultimate period. Profits under their deviating strategy  $NM\_CDS_0$  are higher than those proposed under the conjectured equilibrium  $M\_CDS_0$ , with  $q_0(\mu_0) = (1-P_G)X$ , as shown below:

$$P_G X - 1 + (\max [Y(\tilde{\mu}_1^i), Z]) > P_G X - 1 - m^{Opp} + (\max [Y(\tilde{\mu}_1^i), Z]),$$

where the max operator ( $\cdot$ ) defines the last period equilibrium profits.

Thus,  $\sigma_0^{M\_CDS^*} = 1$ , cannot be a Perfect Bayesian Equilibrium (PBE) for the two period game because Opp banks will always deviate to the shirking option in the penultimate period, as doing so, has no adverse consequences on their last period profits. This result is true not only for the penultimate period of our two-period game but also for any other prior period  $t < T$  of a multi-period game of more than two periods, finite or infinite.<sup>42</sup>

### Proof for Lemma (3)

We prove Lemma (3) by contradiction. If  $\sigma_0^{M\_CDS^*} = 0$  and  $\sigma_0^{NM\_CDS^*} = 0$ , then  $\sigma_0^{M\_NoCDS^*} = 1$ , which causes  $\mu_0 = 1$  and  $q_0 = (1 - P_G)X$ .<sup>43</sup>

When the conjectured equilibrium is  $\sigma_0^{M\_NoCDS^*} = 1$ , CDS sellers believe that Opp banks never enter the credit derivatives markets. Any bank that approaches a credit derivatives seller under the conjectured beliefs has to be a Mon bank. Thus, CDS premiums are set at  $q_0 = (1 - P_G)X$ , which, ex-post, induce Opp banks to enter the credit derivatives market and deviate to their shirking strategy  $NM\_CDS_0$  to earn higher profits, thereby unraveling the conjectured equilibrium

$$\sigma_0^{M\_NoCDS^*} = 1.$$

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<sup>42</sup>  $T$  is the last period of a finite multi period model.

<sup>43</sup> As  $\mu_0 = 1$ .

Thus, whenever  $\sigma_0^{M\_CDS^*} = 0$ , Opp banks will shirk with positive probability, i.e.  $\sigma_0^{NM\_CDS^*} > 0$ , because  $\sigma_0^{M\_NoCDS^*} = 1$  is not a PBE for the two period game.

## Appendix B      VARIABLE DEFINITIONS AND CONSTRUCTION

We define all our variables below, and show their construction from the Call Reports. All balance sheet variables are reported on the Call Reports, with the prefix, RCON or RCFD, to indicate whether the reporting bank has only domestic or both domestic and foreign operations, respectively. For ease of exposition, we define all our balance sheet variables below using prefix, RCFD. In the data construction, we used RCON as applicable.

### Variable Definitions

<i>LIQUID</i>	(Cash + Marketable Securities) / Total Assets
<i>TRAD_ASSETS</i>	(Trading Assets) / Total Assets
<i>C_I</i>	(Commercial & Industrial Loans / Total Assets)
<i>RE_LOANS</i>	(Real Estate Loans / Total Assets)
<i>LOANS</i>	(Loans and Lease / Total Assets)
<i>LLR</i>	(Loan Loss Reserve / Total Assets)
<i>RESTRUCT</i>	(Restructured Loans / Total Assets)
<i>NPL</i>	(Overdue 90 days+ Non-accrual Loans) / Total Assets;
<i>Charge_off</i>	Loans written off as uncollectible.
<i>TrobLoans</i>	(NPL and Charge_off) / Total Assets
<i>DUM_OPP</i>	Dummy variable taking the value of one to indicate that the bank is classified as an Opp bank, zero otherwise.

<i>MON</i>	Dummy variable taking the value of one to indicate that the bank is classified as a Mon bank, zero otherwise.
<i>Dum_DEBT</i>	Dummy variable taking the value of one to indicate that the bank has issued subordinate debt, zero otherwise.
<i>DUM_LHFS</i>	Dummy variable taking the value of one to indicate that the bank has loans held for sale (LHFS), zero otherwise.
<i>DUM_TRAD</i>	Dummy variable taking the value of one to indicate that the bank uses derivatives (DERIV_TRAD) for trading purposes, zero otherwise.
<i>DUM_HEDG</i>	Dummy variable taking the value of one to indicate that the bank uses derivatives (DERIV_HEDG) for hedging purposes, and zero otherwise.
<i>BUY</i>	Dummy variable taking the value of one to indicate that the bank bought credit derivatives (CDS_BUY), zero otherwise.
<i>SELL</i>	Dummy variable taking the value of one to indicate that the bank sold credit derivatives (CDS_SELL), zero otherwise.
<i>ROA</i>	(Net Income/Total Assets)
<i>ROE</i>	(Net Income/Equity)

### Variable Construction from Call Reports

Total Assets	RCFD2170
<i>LIQUID</i>	(RCFD0081+RCFD0071+RCFD1754+ RCFD1773)/RCFD2170
<i>TRAD_ASSETS</i>	(RCFD3545/ RCFD2170)
<i>C_I</i>	(RCFD1600/RCFD2170)
<i>RE_LOANS</i>	(RCFD1410/ RCFD2170)
<i>LOANS</i>	(RCFD2122-RCFD3128)/RCFD2170 in 1997-2000. (RCFD2122/RCFD2170) in 2001-2003.
<i>LLR</i>	(RCFD3123/RCFD2170)
<i>RESTRUCT</i>	(RCFD8691/RCFD2170)
<i>NPL</i>	(RCFD1407+RCFD1403)/RCFD2170
<i>Charge_off</i>	RIAD4635
<i>TrobLoan</i>	(RCFD1407+RCFD1403+RIAD4635)/ RCFD2170
<i>Subord_Debt</i>	RCFD3200
<i>Loans Held for Sale</i>	RCFD5369
<i>CDS_BUY</i>	RCFDA535
<i>CDS_SELL</i>	RCFDA534
<i>RBC</i>	RCFD8274 / RCFDA224 in 1997-2000, and RCFD7204 in 2001-2003
<i>DERIV_TRAD</i>	(RCONA126+RCONA127+RCON8723+RCON8724)
<i>DERIV_HEDG</i>	(RCON8725+ RCON8726+ RCON8727+ RCON8728)
<i>ROA</i>	(RIAD4074/RCFD2170)

*ROE*

(RIAD4074/ RCFD3210)

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