

## **OPTIMAL DESIGN OF BANK BAILOUTS: THE CASE OF PROMPT CORRECTIVE ACTION\***

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*The paper investigates the optimal design of bank bailouts in economies where banks can hide loan losses, and focuses on banking regulation via two Prompt Corrective Action instruments: prohibition of dividends and early closure policy. The first has a mitigating effort on moral hazard and regulator's costs but the second instrument has a damaging impact. As to bad debts and the cleaning of banks' balance sheets, asset insurance for the bank's loan portfolio, bank capital and prohibition of dividends motivate banks to disclose loan losses. (JEL: G21, G28 )*

### **1. Introduction**

Beck (2009) reports that the problem of hidden bad loans is topical in the USA:<sup>1</sup>

Japan's economy was paralyzed for a decade as banks failed to deal with their troubled loans. That's why it's nothing

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<sup>1</sup> *The problem of hidden bad loans is common, recurrent and worldwide. It is also reported, for example, in Chile (Sheng, 1996), China (Heffernan, 2005), India (Heffernan, 2005), Japan (Cargill, Hutchison and Takatoshi., 1998; Caballero, Hoshi and Kashyap, 2008; Hoshi and Kashyap, 2010), Korea (Lindgren et al., 1999) and Thailand (Lindgren et al., 1999). For loan loss information, see also Anandaraman, Hasan and Lozano-Vivas (2003), and Hasan and Wall (2004).*

short of stunning to discover some U.S banks are doing the same thing now. Despite all the tough talk out of Washington and Wall Street about how the U.S can't repeat what happened in Japan, the reality is that banks are granting extensions to borrowers in one key category, commercial real-estate loans, so that they don't default. It's a bet that economic conditions will improve before the loans come due... The maneuvering is being called "extend and pretend" in financial circles, reflecting banks' willingness to extend loan maturities because they believe – or hope – rental rates and building values could come back to levels seen during the peak of the real-estate market in 2007.

Almost identical problem is documented in Britain by Thomas (2009):

...85 per cent of UK loans made in the past five years are in breach of lending agreements. But banks are ignoring such problems. Instead they are rolling over loans as these near maturity, in the hope that capital value and loan-to-value (LTV) ratios will rise once again to refinancing level. (p. 10)

This paper intends to construct a model of banking that can reproduce the facts of the incident portrayed above and, more commonly, to offer a model that can be used to investigate loan rollovers and alternative instruments to rescue banks. The paper poses questions such as, do banks have different disclosure/roll-over strategies. Why? What kind of regulatory instruments are effective to handle loan rollovers? Disclosed loan losses cause costs for a bank. This raises the fundamental question of “Why does a bank disclose loan losses at all?”

Banking theory stresses *ex ante* moral hazard. A bank either invests in excessively risky assets, e.g. Merton (1977), or, neglects monitoring, e.g. Holmström and Tirole (1997). This paper focuses on the less-well understood problem of *ex post* moral hazard; a bank that has already been hit by a shock and is saddled with bad loans. As reported above, the bank may react to the bad loans by hiding them via loan rollovers. The paper explores the problem by adopting a dynamic model with a stochastic value of loan collateral. A bank hides loan losses for a short-term profit. The non-disclosing bank is officially solvent and profitable and can pay out dividends, even when it possesses a large burden of hidden bad loans and is de facto insolvent. An *ex post risk shifting* problem is also present. The bank rolls over bad loans, in anticipation that their future value (the value of loan collateral) appreciates. This may represent a gamble for resurrection. The paper identifies that a healthy bank with few bad loans rolls over them only if it expects the collateral value to appreciate sufficiently. In contrast, a distressed bank with plenty of bad loans optimally rolls over them also when the expected value of collateral is fixed or depreciates.

With respect to the third example de Juan (1996), the former head of the inspection services at the central bank of Spain, in his conclusions on the causes of banking crises crystallizes his long-term experience in the following recommendation: “When questionable loans are converted into evergreens, they are almost never classified as doubtful or bad; they are classified as current. Supervisors should therefore focus their attention on the good loan portfolio rather than the bad one” (p. 91).

The recommendation may be surprising; one is likely to presume that a bank without disclosed bad loans is healthier than a bank with disclosed bad loans. We find that this presumption is correct under perfect information but under asymmetric information the findings are opposite: hiding incentives increases with the burden of bad loans in line with de Juan’s recommendation. Thus, the credibility of loan loss information is weak.<sup>2</sup>

The huge number of bank failures during the Savings and Loan crises in the 1980s triggered a strong reform process in U.S banking regulation.<sup>3</sup> *Prompt Corrective Action (PCA)* legislation was launched in 1991. PCA rests on the insight of timely and active intervention to early warning signals. Banks are classified into 5 categories depending on capital ratios. Banks with high levels of capital are subject to minimum restrictions. A bank becomes subject to restrictions which become more demanding the lower the capital ratio: (i) prohibition of dividends, (ii) limits on compensation to managers, (iii) early closure policy for weakly capitalized banks (capital ratio 2%), (iv) requirements to attract additional capital, (v) constraints on investments and (vi) frequent regulatory supervision. PCA proved to be revolutionary and successful (Benson and Kaufman, 1997; Freixas and Parigi, 2007). This has given rise to proposals that oth-

<sup>2</sup> Kim, Kristiansen and Vale (2005) find that the bank’s ability to avoid loan losses may act as a strategic variable. Borrowers use high-quality low-loss banks to signal their credit-worthiness to other stakeholders. For optimal bank transparency, see also Hyttinen and Takalo (2004).

<sup>3</sup> Between 1980s and 1994 there were 1295 thrift failures in the USA. Over the same period, 1617 banks “failed” in the sense that they were either closed or received FDIC assistance (Heffernan, 2005).

er countries ought to modernize their regulation by implementing PCA –type of legislation (e.g. Freixas and Parigi, 2007). Therefore, it is important to investigate the benefits and drawbacks of PCA instruments – e.g. prohibition of dividends – carefully.

PCA has stimulated little previous research. Freixas and Parigi (2007) advance pioneering findings. The optimal regulation a) allows well capitalized banks to invest freely, b) precludes banks with intermediate levels of capital from investing in the most opaque risky assets, and c) prevents undercapitalized banks from investing in any asset. Our paper extends research on PCA emphasizing the prohibition of dividends method (i). The *prohibition policy (PP)* is a very common instrument in bank rescue operations (e.g. Panetta et al., 2009; Lindgren et al., 1999; Hoshi and Kashyap, 2010) but, as far as we know, has not been investigated before. The paper fulfills this gap in the literature by studying the pros and cons of PP. It mitigates (with some parameter values eliminates) ex post risk shifting. In some cases, PP makes a bank risk-free or diminishes the probability of bank failures. PP reduces both regulator’s costs and banker’s moral hazard profits. It supplements other regulatory instruments by strengthening the advantages of capital requirements and asset insurance but it is less effective if the bank is already insolvent. With respect to the other elements of Prompt Corrective Action, Early closure method (iii) proves to be powerless. It induces banks to hide more bad loans to avoid early closure.

According to several researchers (e.g. Caballero, Hoshi and Kashyap, 2008; Hoshi and Kashyap, 2010), the main factor contributing to the deep slowdown in real GDP growth in Japan since the early 1990s is that Japanese banks possessed heavy portfolios of bad loans, thereby continuing to finance insolvent companies. Bad loans must be rapidly cleaned from banks (Hoshi and Kashyap, 2010; Borio, Vale and von Peter, 2010). It is crucial to develop instruments which help clean bad loans from banks. This paper suggests that the following instruments motivate banks to disclose bad loans truthfully: asset insurance for the bank’s loan portfolio, high capital ratio and prohibition of dividends. This suggestion extends the hallmark findings of

Aghion, Bolton and Fries (1999). They advocate that recapitalization should be achieved by buying out bad loans from banks rather than through capital injections. The novelty of our paper is to demonstrate how asset insurance, prohibition of dividends and capital ratios can be used to clean bad loans from banks. Furthermore, in Aghion et al. (1999), the value of bad loans is non-stochastic. In our paper it is stochastic. As seen above, this extension is realistic. It makes the optimal design of bailouts more demanding, because a bank can gamble with the future value of bad loans. If the value of bad loans is non-stochastic, prohibition of dividends eliminates hiding incentives efficiently.

With regard to previous theoretical research on bank bailouts, Mailath and Mester (1994) divulge how the regulator’s policy on bank closure affects a bank’s portfolio choice and its failure risk. In Gorton and Huang (2004), it is shown that it is costly for private agents to be prepared to purchase plenty of assets on short notice. The government can provide liquidity and boost welfare. Too many to fail problem inspires Acharya and Yorulmazer (2007a, 2007b), whereas Rochet (1992) analyzes bank capital with ex ante moral hazard. There exists some captive evidence on bank bailouts. Hoshi and Kashyap (2010) report lessons from Japan and Lindgren et al. (1999) from Asia. Panetta et al. (2009) review the last crisis and Borio et al. (2010) focus on Finland, Norway and Sweden. See also Freixas and Rochet (2008).

The paper proceeds as follows. Section 2 presents the model. Section 3 is devoted to ex post moral hazard, whereas Section 4 concentrates on early closure policy. Section 5 sheds light on asset insurance and Section 6 draws conclusions.

## 2. Economy

Consider a risk-neutral economy with entrepreneurs (=borrowers), depositors, banks, bankers and a bank regulator. An entrepreneur maximizes his income. A bank maximizes the income of its owner (the banker). Entrepreneurs and bankers enjoy limited liability. The regulator runs a deposit insurance scheme. Its costs are covered from taxes and from the liquidation proceeds of

insolvent banks. There are two periods. Period 1 begins at time point 0 and ends at time point 1. Period 2 begins at time point 1 and ends at time point 2.

### 2.1. Project types

There is a continuum of entrepreneurs. At the start of period 1 each of them can undertake an investment project, which requires a unit of capital input. Since he lacks capital, he must seek a bank loan. The upcoming type of a new project is uncertain at the time of the investment but the type realizes during period 1. There are three alternative types:

\* A *quick project* lasts for a period. It produces  $1+Y$  units of output at the end of period 1.

\* A *slow project* lasts for two periods. It produces interim output  $Y$  at the end of period 1 and final output  $1+Y$  at the end of period 2. Its liquidation value is  $L, L < 1$ , at the end of period 1.

\* A *bad project* produces output  $Y$  and it has liquidation value  $L$  at the end of period 1. If it is not liquidated after period 1, its value after period 2 is stochastic. This is detailed later.

For both slow projects and bad projects we have  $L+Y < 1+r$ ; the sum of the liquidation value and the interim output does not cover the risk-free interest rate of the economy,  $1+r$ ,  $r < Y$ .

Since an upcoming type is unknown when a project begins, a bank lends a unit of capital for a period at interest rate  $R_1$ . During period 1 the entrepreneur and the bank recognize the realized project type, which is private information and unobservable to outsiders. Suppose that the project proves to be slow. Given the low liquidation value and the great long-term output, it is optimal to reschedule the loan repayment. Therefore, at the start of period 1 the bank promises that it will roll over the original loan if the underlying project proves to be slow. The roll over process is detailed below. We define following labels. A loan is slow (quick or bad), if the underlying project is slow (quick or bad). A borrower is slow (quick or bad) if his project is slow (quick or bad).

### 2.2. Loan portfolio

In period 1 the amount of loans is 1. The regulator imposes capital requirement  $K_1$  for period 1. A bank funds its operations with equity capital,  $K_1$ , and insured deposits,  $1-K_1$ . The interest rate of the economy,  $r$ , represents the cost of capital and deposits. The bank pays interest on deposits at the end of each period. Thereafter, the bank profit is paid out as dividends to the banker.

Let  $q$ ,  $s$  and  $u$  indicate the realized shares of quick, slow and bad projects during period 1. Each of them is random. Slow projects have support  $[\underline{s}, 1]$ , and quick and bad projects  $[0, 1-\underline{s}]$ . Three assumptions follow.

**Assumption 1.** *The expected NPV of a project is positive*

$$(1) \quad E(q)(1+Y) + E(s)[Y + \delta(1+Y)] + E(u)(Y+L) > 1+r.$$

Here  $E(q)$ ,  $E(s)$  and  $E(u)$  denote the expected shares of quick, slow and bad projects. Besides,  $\delta = 1/1+r$  marks the discount factor. Assumption 1 ensures that it is optimal to start a project and Assumption 2 simplifies the model.

**Assumption 2.** *The interim output covers the expected costs of a project in period 1: interest rate and expected loan losses.*

$$(2) \quad Y \geq r + E(u)(1-L).$$

It is possible to price the project risk in the loan interest of period 1,  $R_1$ . Since each project type produces interim output,  $Y$ , an entrepreneur can pay interest  $R_1$  in period 1. Since projects are risk-free in period 2, the loan interest then satisfies  $R_2 = r^4$ .

Assumption 3 makes the bank illiquid. The liquidation value of assets at the end of period 1 is insufficient to cover the payback of deposits.

<sup>4</sup> In the following, we use symbol  $R_2$  to clarify the presentation even if  $R_2 = r$ .

**Assumption 3.**

$$Y + \underline{S}L + (1 - \underline{S}) < (1 + r)(1 - K_1).$$

On the LHS, the first term indicates the interim project output, the second term shows the liquidation proceeds from slow loans, and the third term expresses the principal repayments from quick loans. In total, the LHS gives the maximal proceeds from bank liquidation after period 1. It represents the maximum for three reasons: the bank has no bad loans, the volume of slow projects is minimal and  $Y \geq R_1$  (in reality, a borrower repays  $R_1$  not  $Y$ ). Assumption 3 states that even the maximum liquidation proceeds are deficient to cover the payback of deposits. The bank fails if it is liquidated after period 1, because a notable share of loans is tied in slow projects with a low liquidation value. This restricts the regulator's alternatives. Now it is possible to define the rolling over contract:

**Definition 1 (roll-over).** *A bank and a borrower commit to the following contract at the start of period 1. The borrower promises to repay loan interest ( $R_1$ ) and principal ( $1$ ) at the end of period 1. In reality, the borrower can always pay  $R_1$ , but if the loan becomes slow, he cannot repay the principal. Then, according to the contract, the bank can roll over the loan, which delays the repayment of the principal for a period. During period 2 the size of the rolled over loan is  $1$  and the loan interest rate is  $R_2$ . Thus, the borrower promises to repay  $1 + R_2$  after period 2.*

The roll-over option offers a method for avoiding the costly liquidation of slow projects. Given Assumption 3, the probability of a slow project is so high that it is unprofitable to begin a project at all if it is liquidated after period 1. Unfortunately, the roll-over option can be misused. Only the borrower and his bank observe the realized project type. The regulator does not know whether the bank rolls over a loan, because the underlying project is slow (the loan rollover is socially profitable), or to hide a bad loan (socially harmful). Since slow projects are common, the regulator cannot ignore loan rollovers (Assumption 3).

The regulator's key instrument to control banks is the *prohibition of dividends* at the end of period 1. The profit of period 1 is added to the bank capital for period 2. If the return from period 1 is negative, the prohibition policy (PP) has no effect, because there are no dividends. One may think of a situation where the regulator recognizes that problems are developing in the banking sector. He does not observe the true financial condition of a bank, but he can prohibit dividend payouts. Thereafter, the bank decides on the magnitude of disclosed bad loans,  $u_p$ . It can disclose bad loans in period 1, or hide some of them by rolling over these loans. The true value of the rolled over loans surfaces at the end of period 2.<sup>5</sup>

If a bank discloses bad loans in period 1 and is insolvent, the regulator closes it. We take as granted that deposits must be insured and that the regulator can commit to close insolvent banks. The latter assumption is usual (e.g. Marcus, 1984). This scenario is quite theoretical in our model, because the optimal strategy of an insolvent bank is to hide bad loans.

Again, the initial amount of bank capital is  $K_1$ . Obviously,  $0 \leq u_p \leq u$ ; the magnitude of disclosed bad loans cannot exceed the true magnitude of bad loans. If  $u_p$  is large, the return from period 1,  $\pi_1(u_p)$ , is negative to such a degree that the bank becomes insolvent after period 1,  $\pi_1 + K_1 < 0$ . More precisely, solvency/insolvency is defined as follows:

**Definition 2 (solvency).** *A bank is truly solvent (truly insolvent) in period 1 if it is solvent (insolvent) according to the true magnitude of bad loans,  $u$ , that is,  $\pi_1(u) + K_1 > 0$  ( $\pi_1(u) + K_1 < 0$ ). The bank is officially solvent (officially insolvent) in period 1, if it is solvent (insolvent) according to the disclosed magnitude of bad loans,  $u_p$ , that is,  $\pi_1(u_p) + K_1 > 0$  ( $\pi_1(u_p) + K_1 < 0$ ).*

<sup>5</sup> Sheng (1996) gives an example of effective hiding in Chile: "Auditors for Banco Espanol qualified their report for 1979 by stating that 37% of loans could not be evaluated because of lack of information on the debtors' ability to pay – even though the loans had been rolled over repeatedly" (p. 151). Consequently, when the hidden bad loans surface and the true financial condition of the bank finally becomes public, the bank is insolvent.

If a bank is truly solvent, it is officially solvent. If it sufficiently hides bad loans (= loan losses), it is considered officially solvent even if it is truly insolvent. If the official return for period 1 is negative,  $\pi_1(u_p) < 0$ , but the bank is still officially solvent, the regulator allows it to keep on operating in period 2.<sup>6</sup> Then, bank capital in period 2 amounts to  $K_2 = \pi_1(u_p) + K_1 < K_1$ , where  $K_2 \geq 0$ . The negative returns erode the capital. If  $\pi_1(u_p) > 0$ , we have  $K_2 = K_1$  and the bank can pay out the profit,  $\pi_1$ , as dividends after period-1. The bank size is not fixed. It is 1 during period 1 but in period 2 the size is equal to the magnitude of the rolled over loans.

### 2.3. The value of stochastic collateral

As mentioned above, after period 1 the value of a bad project is  $L$ , which consists of collateral. It is  $L$  after period 1, but if the project is not liquidated, it can appreciate or depreciate during period 2. There are several potential reasons for the fluctuation. First, collateral is likely to incorporate real estate: e.g. production factories, office buildings, etc. The value of real estate varies substantially.<sup>7</sup> Second,  $L$  involves outside collateral, which often includes firm stocks with wide price variance.<sup>8</sup> For simplicity, we model this as follows. During period 2 the value of an

bad project appreciates with probability  $h$  to  $1+r$ , and depreciates with probability  $1-h$  to  $\underline{L}$ ,  $\underline{L} < L$ . The expected value in period 2 is

$$(3) \quad E(L) = h(1+r) + (1-h)\underline{L}.$$

Since  $R_2 = r$ , the bank receives the promised repayment in the appreciation.

How is  $L$  related to the expected present value,  $\delta E(L)$ ? Should we assume  $\delta E(L) = L$ ,  $\delta E(L) < L$  or  $\delta E(L) > L$ ? Suppose  $\delta E(L) < L$ . This is realistic, if collateral value is fixed,  $E(L) = L$ . Moreover, the physical characteristics of collateral may erode during the delay in the liquidation process: factory buildings decompose, machines become obsolete or rusty, etc., and we have  $E(L) < L$ . Consider now  $\delta E(L) \geq L$ . Shleifer and Vishny (1992) conclude: “When a firm in financial distress needs to sell assets, its industry peers are likely to be experiencing problems themselves, leading to asset sales at prices below value in the best use. Such illiquidity makes assets cheap in bad times...” (p. 1343). Their findings are confirmed by Allen and Gale (1994):

In equilibrium, the price of the risky asset is equal to the lesser of two amounts. The first is the standard discounted value of future dividends; it applies when there is no shortage of liquidity in the market. The second is the amount of cash available from buyers divided by the number of shares being sold: it applies when there is a shortage of liquidity. In this case, assets are underpriced, and returns are excessive to the standard, discounted dividends formula. (p. 935)

If the risky asset of Allen and Gale (1994) is the same as  $L$  in our model, it is possible that  $\delta E(L) > L$ , because the asset is now underpriced. In bad times the price of assets,  $L$ , may sink to an excessively low level and the expected proceeds from assets are excessive,  $\delta E(L) > L$ . Thus, both cases,  $\delta E(L) < L$  and  $\delta E(L) \geq L$ , are realistic!

<sup>6</sup> Regulators must have precise hard evidence on insolvency before they can begin liquidation process. They cannot adopt illegal methods. The following example is from Argentina: “In Argentina, judges forced the central bank to compensate the shareholders on the grounds that a bank was solvent at the time of intervention, and that the insolvency actually resulted from mismanagement during the intervention (BIS, 1999, p. 62).”

<sup>7</sup> Real estate collateral plays a crucial role in lending. According to Borio (1996), the share of loans secured by real estate is 59% in Britain, 56% in Canada and 66% in U.S.A. The value of real estate collateral varies greatly. Hilbers, Lei and Zacho(2001) document that in Japan commercial property prices rose over 300% in the 1980s, but declined again to the initial level over the next 5 years. Lamm (1998) reports that in Iowa, farmland value per acre soared from \$319 in 1970 to \$1,694 in 1982, an increase of 431%, but then dropped 62% by 1987. See also Niinimäki (2009, 2011a).

<sup>8</sup> Collins and Senhadji (2002) offer an illuminating example. During the Asian crisis in the 1990s, stock prices appreciated sharply during the boom phase: 450% in Hong-Kong, 352% in Philippines, and over 155% in Malaysia. Depreciation was dramatic during the economic downturn:

–56% in Hong-Kong in a year, –53% in Philippines in 18 months and –76% in Malaysia in 18 months.

Importantly, the regulator does not know the realized value of  $E(L)$ , which is the same in the whole economy and observable only to entrepreneurs and their bank.

## 2.4. Time line

- 1.1. The regulator determines the equity capital requirement,  $K_1$ .
- 1.2. A bank is established. It maintains  $K_1$  units of capital and attracts  $1 - K_1$  units of deposits.
- 1.3. The bank grants loans.
- 1.4. The types of the financed projects (quick, slow, bad) are realized.
- 1.5. The end of period 1: quick projects mature and these loans are repaid.
- 1.6. The regulator decides whether or not he prohibits dividend payouts (step 1.9). He makes the decision public.
- 1.7. The bank rolls over slow loans. It may also roll over bad loans. The magnitude of disclosed bad loans determines whether or not the bank is officially profitable in period 1. If the bank is officially insolvent, the regulator closes it. Otherwise, the bank goes on to point 1.8.
- 1.8. The bank attracts deposits for period 2 and pays back the deposits of period 1.
- 1.9. If the regulator does not prohibit dividends, the bank pays them to the banker. Otherwise, the dividends are added to the bank capital. Negative returns in period 1 erode bank capital.
- 2.1. Period 2 begins.
- 2.2. At the end of period 2, all loans mature and the bank is closed down. It pays back deposits and the banker receives the remaining returns.

We adopt this model to study the optimal strategy of the bank. When does it hide bad loans? If the banker profits by hiding bad loans – under scenarios in which it is socially optimal to disclose them,  $\delta E(L) < L$  – we say that the banker earns moral hazard profits or that he makes excessive profits. When  $\delta E(L) > L$ , it is socially profitable to roll over bad loans and the roll-over decision does not represent moral hazard. The

regulator aims to eliminate moral hazard so that banks roll over loans only if it is socially profitable. The elimination of moral hazard reduces his costs. In some special cases the regulator's costs would be lower if a bank disclosed bad loans and bad projects were liquidated even when  $\delta E(L) > L$ . Yet, the regulator does not adopt this socially unprofitable liquidation strategy. His goal is to ensure that banks pursue the socially optimal strategy. This increases the regulator's costs from deposit insurance but he can recover the costs by taxing banks. In most cases below it is possible only to mitigate, not eliminate, moral hazard.

## 3. Ex post risk shifting

The section deals with the bank's optimal action at the end of period 1 when it learns the shares of different loan types. An *ex post risk shifting* problem appears: the bank may roll over a bad loan to gamble with the future value of collateral even when the roll-over decision is not socially optimal,  $\delta E(L) < L$ . If the collateral value appreciates, the returns from period 2 increase. If it depreciates, the returns decrease, the bank fails and the regulator bears the costs of the gamble. With regard to the gambling incentives, the magnitude of bad loans,  $u$ , proves to be crucial.

Consider a benchmark case with perfect information. The regulator discerns the magnitude of bad loans, instructs banks to disclose them, closes insolvent banks liquidating their bad loans and maintains slow loans during period 2. A conclusion follows:

**Lemma 1.** *With perfect information, the magnitude of disclosed bad loans declines with the financial condition of the bank.*

Healthy banks disclose less bad loans. Later we obtain the opposite result with asymmetric information.

Let us turn to asymmetric information. A bank learns the magnitude of bad loans,  $u$ , and chooses the magnitude of disclosed bad loans,  $u_p$ ,  $u_p \leq u$ , so that the banker's life-time income is maximal. The choice is easy, because no

more loan defaults take place in period 2. Given  $u_p$ , the bank hides  $u - u_p$  bad loans by rolling them over. It also rolls over slow loans. This yields the following return from period 1

$$(4) \quad \pi_1(u_p) = R_1 - u_p(1-L) - (1-K_1)r.$$

Here  $R_1$  is the loan interest from period 1, the second term shows costs from the disclosed bad loans (lost loan principal), and the third term indicates payments to depositors. If  $\pi_1 > 0$ , the bank is officially profitable and can pay out the profit as dividends. If  $\pi_1 < 0$ , the negative return erodes bank capital. The bank can keep on operating in period 2 only if it is officially solvent; otherwise the regulator closes it after period 1.

In period 2 two scenarios appears depending on the realized value of rolled over bad loans. First, suppose that it depreciates. The return from period 2 is

$$(5) \quad \pi_D = s(R_2 - r) + (u - u_p)[\underline{L} - (1+r)] + K_2(1+r).$$

Let  $\bar{u}_D(u_p)$  mark the maximal magnitude of surfacing bad loans in period 2 so that the bank is solvent if the liquidation value is  $\underline{L}$ . When  $u - u_p = \bar{u}_D$ ,  $\pi_D$  is zero. When more bad loans surface in period 2,  $u - u_p > \bar{u}_D$ ,  $\pi_D$  is negative and the bank fails. Recall that  $K_2 = \pi_1(u_p) + K_1 < K_1$  (where  $K_2 \geq 0$ ) when  $\pi_1(u_p) < 0$ . When  $\pi_1(u_p) \geq 0$  we have  $K_2 = K_1$ .

If the value of bad loans appreciates, the returns from period 2 are  $\pi_A = (u + s - u_p)(R_2 - r) + K_2(1+r)$ , that is,

$$(6) \quad \pi_A = K_2(1+r).$$

We can now sum the banker's life-time income. If profitable, the bank pays the profits as dividends to the banker after period 1. Since he enjoys limited liability, his income in period 1 is  $\text{Max}\{0, \pi_1\}$ . If officially solvent in period 1, the bank can keep on operating in period 2, the banker earns  $\text{Max}\{0, \pi_2\}$ , where  $\pi_2 \in \{\pi_A, \pi_D\}$ , and his life-time income totals  $\text{Max}\{0, \pi_1\} + \delta \text{Max}\{0, \pi_2\}$ . Three cases occur depending on the magnitude of bad loans.

### 3.1. Scenario $u \leq \bar{u}_D$

When  $u \leq \bar{u}_D$  ( $u_p = 0$ ), the magnitude of bad loans is so low that a bank is truly solvent in both periods. It does not fail in period 2 even with minimal returns: bad loans are rolled over and collateral value depreciates. We learn that the bank pursues the socially optimal liquidation policy with and without the prohibition policy (PP).

*Without PP:* The expected return in period 2 is  $h\pi_A + (1-h)\pi_D$ . Given  $\pi_A$  in (6) and  $\pi_D$  in (5) we can express the expected return as

$$(7) \quad \pi_2(u_p) = (u - u_p)[E(L) - (1+r)] + K_2(1+r).$$

The banker's expected life-time income totals  $\text{Max}\{\pi_1, 0\} + \delta\pi_2$  where  $\pi_1$  is given by (4) and  $\pi_2$  by (7). Given  $u \leq \bar{u}_D$  the bank is solvent in period 2. Two cases arise.

First, if  $\pi_1 > 0$ , we have  $K_1 = K_2$  in (7) and the expected life-time income is

$$(8) \quad R_1 - (1-K_1)r - (1-L)u_p + K_1(u - u_p)[\delta E(L) - 1].$$

Second, if  $\pi_1 < 0$ ,  $\text{Max}\{\pi_1, 0\} + \delta\pi_2$  simplifies to  $\delta\pi_2$  in which  $K_2 = K_1 + \pi_1$ . Again, (8) gives the expected life-time income. Whether  $\pi_1 > 0$  or  $\pi_1 < 0$ , the banker chooses  $u_p$  to maximize (8). The FOC is

$$(9) \quad L - \delta E(L).$$

Suppose  $L > \delta E(L)$ . Then  $u_p = u$ , and (8) gives  $R_1 - (1-K_1)r - (1-L)u + K_1$ . The fact that the collateral value is stochastic has no effect, since bad loans are liquidated in period 1. Only if  $L < \delta E(L)$ , is the roll-over decision profitable. The bank earns  $R_1 - (1-K_1)r$  in period 1, and in period 2 either  $\delta\pi_A = K_1$  with appreciation or  $\delta\pi_D = u(\delta\underline{L} - 1) + K_1$  with depreciation.

*With PP:* The bank pays no dividends after period 1. Instead, the returns from period 1 are added to the capital,  $K_2 = K_1 + \pi_1(u_p)$ . The banker's life-time income consists of dividends in period 2. Their present value is  $\delta\pi_2$  in which  $K_2 = K_1 + \pi_1(u_p)$ . The life-time income is the same as in (8) and the bank pursues the socially

optimal liquidation policy, which is given in (9). PP has no effect on the liquidation policy or life-time income. Conclusions follow.

**Proposition 1.** *When the magnitude of bad loans is so small that a bank is solvent in both periods with certainty, it discloses bad loans if  $L > \delta E(L)$  and rolls over them if  $L < \delta E(L)$ . PP has no impact on the disclosure decision, on the banker's life-time income or on the regulator's costs (which are zero) but it does postpone the banker's dividend income.*

Since the bank is risk free, there is no benefit from limited liability. It bears full costs from the loan liquidations. Hence, it rolls over bad loans only if it is socially optimal and the regulator has no reason to deny loan rollovers or adopt PP. However, since he cannot observe the magnitude of bad loans and the realized value of  $E(L)$ , he is unable to pursue this optimal policy.

### 3.2. Scenario $u > \bar{u}_D$ and truly solvent in period 1

#### 3.2.1. The choice of the bank

We turn to the next best group with regards to the share of bad loans,  $u > \bar{u}_D$ . A bank is truly solvent in period 1 but fails in period 2 if it rolls over bad loans and their value depreciates during the period. If the value appreciates, the bank is successful. Since the bank is truly solvent in period 1, it can avoid failure by disclosing bad loans. Yet, its profit maximizing policy may be to gamble with collateral. If successful, the returns are high. If unsuccessful, the bank fails and the regulator incurs the cost of the gamble. PP mitigates the problem and in some scenarios eliminates it.

*Without PP:* Consider a bank, which hides so few bad loans that it does not fail in period 2 even with depreciation,  $u - u_p \leq \bar{u}_D$  (again,  $\bar{u}_D$  marks the maximal magnitude of surfacing bad loans in period 2 so that the bank is solvent if their liquidation value is  $\underline{L}$ ). An extra rolled over bad loan increases returns by  $\delta[(1+R_2)-(1+r)]+(1-L)$  or  $1-L$  during apprecia-

tion and by  $\delta[\underline{L} - (1+r)]+(1-L)$  during depreciation with an expected value  $\delta E(L) - L$ .

If the bank diminishes the magnitude of disclosed bad loans in period 1 so that more bad loans surface in period 2,  $u - u_p > \bar{u}_D$ , the bank fails in period 2 with depreciation but its returns increase with appreciation. Each extra rolled over bad loan boosts the returns during appreciation but has no impact on the returns during depreciation because the bank fails. The expected returns from an extra rolled over bad loan are  $h(1-L)$ . Due to limited liability the *ex post risk shifting* problem is present. Lemma 2 is confirmed in Appendix A.

**Lemma 2.** *The optimal magnitude of the rolled over loans is either 0 or  $u$ .*

We will find out when a bank rolls over bad loans. Given Lemma 2, it is sufficient to investigate both ends,  $u_p = 0$  or  $u_p = u$ . Suppose, first, that the bank discloses bad loans,  $u_p = u$ . Lemma 3, which is proved in Appendix B, displays the banker's life-time income.

**Lemma 3.** *Consider a solvent bank, which discloses bad loans. Whether  $\pi_1 < 0$  or  $\pi_1 > 0$ , the banker's life-time income is*

$$(10) \quad R_1 - u(1-L) - (1-K_1)r + K_1.$$

If the bank hides bad loans, the expected life-time income is (here  $h \delta \pi_A(u_p = 0) = hK_1$ )

$$(11) \quad R_1 - (1-K_1)r + h \delta \pi_A(u_p = 0).$$

Here  $R_1 - (1-K_1)r$  is the income from period 1 and  $h \delta \pi_A(u_p = 0)$  is the present value of the expected income from period 2. Due to hiding, no bad loans appear in period 1. If the collateral value appreciates, no bad loans appear in period 2 either. If the collateral value depreciates, the bank fails. Disclosure is optimal if (10) exceeds (11)

$$(12) \quad K_1 - u(1-L) - h \delta \pi_A \geq 0.$$

The hiding incentives are increasing in the magnitude of bad loans,  $u$ , in the costs from a

loan loss,  $1 - L$ , and in the expected returns from the gamble,  $h\delta\pi_A$ . On the contrary, bank capital,  $K_1$ , reduces risk taking. The following lemma is derived in Appendix C.

**Lemma 4.** *When  $u > \bar{u}_D$  and the bank is truly solvent in period 1, it rolls over bad loans if  $\delta E(L) - L + (1-h)\delta[-\underline{L} - K_1(1+r)/u + (1+r)] > 0$ , where the term in the brackets is positive. The bank is more eager to roll over bad loans than in subsection 3.1., where it is solvent and does not profit from limited liability.*

Recall that it is socially optimal to roll over bad loans if  $\delta E(L) > L$ . Even when this inequality is not satisfied, the bank rolls over loans if the term  $-\underline{L} - K_1(1+r)/u + (1+r)$  is sufficient. The bank takes excessive risks. It is solvent but its financial condition is so bad (the true amount of bank capital is low due to a large burden of bad loans) that the bank is willing to roll over bad loans and gamble with collateral. A conclusion follows.

**Proposition 2.** *Two conditions are satisfied. First, the magnitude of bad loans is so small that a bank is truly solvent in period 1 if it discloses bad loans. Second, if they surface in period 2, the bank fails if their value depreciates. The bank discloses bad loans if  $K_1 - u(1-L) - h\delta\pi_A > 0$ . Even if the disclosure is socially optimal, limited liability tempts the bank to delay disclosure so that the bank can gamble with the future value of collateral.*

### 3.2.2. The regulator's costs

Suppose  $L < \delta E(L)$ . It is socially optimal to roll over bad loans. Unfortunately, the returns from the loan rollover are split unequally between the bank and the regulator. If the collateral value appreciates, the bank can reap the proceeds but if it depreciates, the bank fails and the regulator must indemnify deposits. Since the expected returns from the loan rollover are positive, it is not optimal to deny the rollover. Instead, deposit insurance should be priced correctly so that the bank incurs a fair part of the expected losses.

Suppose, now, that  $L > \delta E(L)$ . It is socially optimal to disclose bad loans. Yet, the ex post risk-shifting problem appears. The correct pricing of deposit insurance would eliminate the gamble. Unfortunately, the regulator cannot price deposit insurance accurately, because he cannot detect the difference between slow projects and bad projects. In addition, he cannot detect  $E(L)$ .<sup>9</sup>

### 3.2.3. The effects of the prohibition policy (PP)

PP adds bank capital by  $\pi_1$  when  $\pi_1 > 0$ . If the collateral value appreciates, the additional capital is unimportant, since the bank is successful even without it. Assume next that the collateral value depreciates. With PP, the returns from period 2 are

$$(13) \quad \pi_D^{PP}(u_p) = -(u - u_p)[1 + r - \underline{L}] + K_1(1+r) + (1+r)\pi_1(u_p).$$

Given (5), the last term represents the effects of PP. The returns decrease with  $u$  and increase with  $u_p$ . If the returns are non-negative with each  $u_p$ , PP adds so much capital that the bank is risk-free in period 2. As observed above, a risk-free bank discloses bad loans if  $L > \delta E(L)$ .

Suppose that PP does not add enough capital to make the bank risk free. There is a critical volume of rolled over bad loans,  $\bar{u}_{DD}(u_p)$ , such that (13) is zero when  $u - u_p = \bar{u}_{DD}$ . When  $u - u_p > \bar{u}_{DD}$  the volume of rolled over bad loans exceeds the critical level and the bank fails

<sup>9</sup> Lindgren et al. (1999) discover captivating evidence from Thailand:

*Thus, the reported capital adequacy ratios were grossly misleading since loans were not appropriately classified and provisioned for. For example, financial institutions had built up large loan portfolios of increasingly questionable quality, secured by generally overvalued asset collateral. These loans were often simply restructured ("evergreened") when payment problems arose and not reclassified. Interest on non-performing loans continued to accrue and, hence, significantly overstated financial sector earnings. This had made it possible to pay dividends, bonuses and taxes on nonexisting profits effectively decapitalizing these institutions. (p. 94)*

in period 2 under depreciation. Does the bank disclose bad loans? With the disclosure strategy, the NPV of the returns from period 2 is  $K_1 + \pi_1(u_p = u)$  or

$$(14) \quad R_1 - u(1-L) - (1-K_1)r + K_1.$$

With the hiding strategy, the NPV of the expected returns from period 2 is

$$(15) \quad h \delta \left\{ (1+r)K_1 + (1+r)\pi_1(u_p = 0) \right\},$$

or  $h[R_1 - (1-K_1)r] + \delta h \pi_A(u_p = 0)$ . The bank avoids failure only if the collateral value appreciates. Whether or not it discloses bad loans, it pays dividends after period 2 due to PP. It is optimal to disclose bad loans if (14) exceeds (15), or

$$(16) \quad K_1 - u(1-L) + (1-h)[R_1 - (1-K_1)r] \geq \delta h \pi_A,$$

or  $-u(1-L)h + (1-h)[R_1 - (1-K_1)r + K_1 - u(1-L)] \geq 0$ .

Here (16) is almost the same as in (12). The effect of PP is given by  $(1-h)[R_1 - (1-K_1)r]$ . PP makes hiding less profitable by eliminating a dividend payout after period 1. Without PP, the banker receives the profits from period 1 as dividends after period 1. With PP, the banker receives the profits from period 1 only after period 2 if the collateral value appreciates, that is, with probability  $h$ . Obviously, this makes hiding less profitable. Put differently, PP adds to the bank capital, thereby lessening limited liability benefits and eroding profits that accrue from risk taking. Importantly, the addition of bank capital is based on official bank returns in period 1,  $R_1 - (1-K_1)r$ . Using Appendix C, it is possible to restate (16); the bank discloses bad loans if

$$(17) \quad u[L - \delta E(L)] + \delta \pi_D^{PP}(u_p = 0) \geq 0.$$

Here  $\pi_D^{PP}(u_p = 0)$  is negative (recall (13)). Hence, (17) reveals that the bank is willing to roll over bad loans. The ex post risk shifting problem is present and PP can only mitigate, not eliminate, it.

How does PP influence the regulator's costs? As observed above, sometimes PP adds so much

capital that the bank becomes risk free. Even if the amount of capital is lower, PP may change the optimal strategy from hiding to disclosure (compare (12) and (16)). Alternatively, moral hazard may be concern with PP. Under the hiding strategy, the regulator's expected costs amount to  $-\delta(1-h)(\pi_D^{PP}(u_p = 0) - (1+r)\pi_1(u_p = 0))$  without PP, and  $-\delta(1-h)(\pi_D^{PP}(u_p = 0))$  with PP. These costs are lower with PP. The difference is  $(1-h)\pi_1$ . The profit from period 1 is maintained in the bank and it adds to the bank capital, reducing the volume of deposits and thereby the costs of deposit insurance. A conclusion follows.

**Proposition 3.** *PP alleviates moral hazard. First, it is not possible to pay dividends after period 1. Second, by adding capital it may make the bank risk free, thereby eliminating incentives for ex post risk shifting. Third, even when the additional bank capital is insufficient to make the bank risk free, it lessens the limited liability benefits, thereby reducing moral hazard profits. This may eliminate moral hazard. Since PP eliminates moral hazard in a few cases, it also reduces the regulator's costs and limits bank failures. Even when the moral hazard problem is present, PP reduces the regulator's costs and the banker's excessive profits.*

### 3.3. The case of $u > \bar{u}_D$ and truly insolvent in period 1

Next, we turn to the third bank group. The burden of bad loans is so large that a bank is insolvent after period 1 at the given liquidation value  $L$ .

#### 3.3.1. The bank's choice

Since the bank is insolvent in period 1, it is insolvent when the liquidation value of bad loans is  $L$ . The bank fails after period 2 under depreciation.

*Without PP:* The bank maximizes the total returns from period 1 and period 2 during appreciation (because it fails during depreciation). Consider the banker's life-time income,  $Max\{0, \pi_1\} + \delta h \pi_A$ . Two cases occur. First, if

$Max\{0, \pi_1\} = 0$  (that is,  $\pi_1 \leq 0$ ) the life-time income simplifies to  $\delta h \pi_A$ . Given  $\pi_A = K_2(1+r)$  and  $K_2 = K_1 + \pi_1(u_p)$ ,  $\delta h \pi_A$  can be expressed as

$$(18) \quad h[K_1 + \pi_1(u_p)], \quad \bar{u}_1 \leq u_p \leq \bar{u}_1.$$

Here  $\bar{u}_1$  ( $\bar{u}_1$ ) is the upper limit of  $u_p$  so that the bank is officially solvent (profitable) in period 1. Since  $\pi_1 \leq 0$ , the maximal income in (18) is achieved when  $\pi_1(u_p) = 0$ , that is,  $u_p = \bar{u}_1$ . Then, the life-time income is  $hK_1$ . Second, if  $Max\{0, \pi_1\} = \pi_1 \geq 0$ , the life-time income is  $\pi_1 + \delta h \pi_A$ , or

$$(19) \quad R_1 - u_p(1-L) - (1-K_1)r + \delta h \left\{ (s + u - u_p) [1 + R_2 - (1+r)] + K_1(1+r) \right\}$$

The optimal level of disclosed bad loans can be solved from (19). The FOC provides

$$(20) \quad -(1-L) < 0, \quad \text{when } u_p \leq \bar{u}_1.$$

Here  $u_p \leq \bar{u}_1$  stems from  $\pi_1 \geq 0$ . The bank hides bad loans, earns  $R_1 - (1-K_1)r$  in period 1 and gambles in period 2. If the gamble is successful, the bank is profitable in period 2. Given (19), this strategy yields the expected returns  $R_1 - (1-K_1)r + hK_1$ . This is more than in the first case,  $hK_1$ . Thus, without PP the bank hides bad loans and makes expected returns  $R_1 - (1-K_1)r + hK_1$ .

*With PP:* The banker's life-time income consists of bank returns in period 2. The bank capital in period 2 is  $K_1 + \pi_1(u_p)$ . Two cases appear. First, if the collateral value depreciates, the returns of period 2 are given by (13),  $\pi_D^{PP}(u_p)$ , or

$$(21) \quad (1+r) \left\{ -(u - u_p)(L - \delta L) + [K_1 + R_1 - (1-K_1)r - u(1-L)] \right\}, \quad u_p \leq \bar{u}_1.$$

The term in brackets is negative, because the bank is initially insolvent. Thus, (21) is negative; the bank fails with depreciation. Second, suppose that the collateral value appreciates. Given  $K_2 = K_1 + \pi_1$ , the present value of the expected returns,  $h\delta\pi_A$ , that is,  $hK_2$ , can be restated as

$$(22) \quad hK_1 + h[R_1 - (1-K_1)r - u_p(1-L)].$$

This is decreasing in  $u_p$ . The bank optimally hides bad loans,  $u_p = 0$ . It is truly insolvent after period 1 and it can be resurrected only if the collateral value appreciates. To maximize the expected returns from the gamble, the bank rolls over bad loans in total. Their expected value in period 2,  $E(L)$ , is inefficient. Neither has PP affected the hiding incentives. Given  $u_p = 0$  in (22), the expected returns from period 2 are

$$(23) \quad hK_1 + h[R_1 - (1-K_1)r].$$

How does PP work? Without PP, the returns are  $R_1 - (1-K_1)r + hK_1$  (recall (19) with  $u_p = 0$ ). Now (19) and (23) together reveal that the returns are higher without PP. The difference is  $[R_1 - (1-K_1)r](1-h)$ . With PP, the bank cannot pay out the returns from period 1 from the bank until after period 2. The banker obtains the returns from period 1 only if the collateral value appreciates in period 2, that is, with probability  $h$ . Without PP, the banker receives the returns from period 1 at once. Put differently, without PP the bank can operate with a lower capital ratio in period 2. PP also reduces the regulator's costs when the bank fails. Since failure happens with probability  $1-h$ , the regulator's expected benefit is  $[R_1 - (1-K_1)r](1-h)$ . This is equal to the banker's expected loss due to PP.<sup>10</sup>

**Proposition 4.** *When a bank is truly insolvent and  $u > \bar{u}_D$ , it always hides bad loans. If the bank disclosed bad loans, it would fail. By hid-*

<sup>10</sup> Cargill, Hutchison and Takatoshi (1998) shed light on hiding in Japan: "banks made additional loans to enable borrowers to pay interest on previous loans, so the nonperforming loan amount is understated" (p. 183). On p. 188 they detail *Usen banks*:

...Ministry of Finance made the first on-site examinations of *Usen* in 1991–1992. Those examinations revealed that 67 percent of loans made to the largest 50 borrowers were already nonperforming; however, the ministry allowed the *Usen* companies to operate on the assumption that land prices would rise in the future. Instead land prices continued to decline and the *Usen* problem increased in magnitude: in the subsequent four years nonperforming loans in the *Usen* increased by 75 percent.

Hence, regulators anticipated that the collateral value would appreciate but it did not.

ing bad loans, it profits in period 1. If the collateral value later appreciates, the profits from period 2 are also positive. PP cannot eliminate hiding, but it reduces the regulator's costs and the banker's excessive income.

In sum: The materialized magnitude of bad loans proves to have a crucial impact on the optimal strategy. Three scenarios appear. If the bank is solvent, PP has no effect on the bank's liquidation decision, the banker's life-time income, the regulator's costs (which are zero) or the likelihood of bank failure (zero). If the bank is insolvent, it hides bad loans. PP has no effect on the likelihood of bank failure but PP does reduce both the regulator's costs and the banker's moral hazard profits. In the intermediate scenario, PP may make the bank risk free or change its optimal strategy from hiding to disclosure. With certainty, PP reduces the regulator's costs and the banker's moral hazard profits. With symmetric information, a solvent bank discloses less bad loans than an insolvent one (Lemma 1). Under asymmetric information the scenario is more complex.

**Corollary 1.** *The larger the magnitude of bad loans, the more willing the bank is to hide them.*

**Proof.** Section 3 has three bank types in the following order of financial condition: a solvent bank with  $u \leq u_D$ , a solvent one with  $u > u_D$  and an insolvent bank with  $u > u_D$ . Without PP, the first bank rolls over loans if  $\delta E(L) > L$ , the second bank rolls over them if  $\delta E(L) - L + (1-h)\delta[-\underline{L} - K_1(1+r)/u + (1+r)] > 0$  (the term in the brackets is positive and increases with  $u$ ) and the third bank always rolls over bad loans. With PP, the first bank rolls over loans if  $\delta E(L) > L$ , the second bank rolls over them if,  $\delta E(L) - L - \delta\pi_D^{PP}(u_p = 0)/u > 0$  that is,  $\delta E(L) - L + \{(1-\delta L) - [K_1 + R_1 - (1-K_1)r]/u\} > 0$ . The term in the parenthesis is positive and increases with  $u$ . The incentives to hide increase with  $u$ . The third bank rolls over bad loans. *Q.E.D.*

Intuitively, the larger the burden of bad loans, the lower the true level of bank capital. The lower the true level of capital, the more profitable it is to gamble with collateral. If  $\delta E(L) > L$ , each bank in the banking sector rolls over bad loans.

The official amount of loan losses is zero. If  $\delta E(L) < L$ , a few banks disclose bad loans while the others make no loan losses public. The latter group consists of the worst banks.

**Corollary 2.** *Moral hazard can be eliminated by setting a sufficient capital requirement for banks.*

**Proof:** Consider (5). Let  $\bar{u}$  denote the upper limit of bad loans. When  $K_1 = \bar{u}(1-\delta\underline{L})$ , the limited liability option ceases to exist and the bank pursues the socially optimal liquidation strategy. With PP, an equal level of bank capital can be solved from (13),  $K_1 = \bar{u}\delta(1-\delta\underline{L}) - \delta(R_1 - r)$ , that is,  $K_1 = \bar{u}(1-\delta\underline{L}) - \delta(R_1 - r) - \bar{u}(1-\delta)(1-\delta\underline{L})$ . PP reduces the need for bank capital. *Q.E.D.*

If collateral value is *non-stochastic* or it depreciates with certainty, it is possible to show that a bank hides bad loans if  $K_1 < u(1-L)$ . Given (12), the hiding incentives are larger with stochastic collateral. Consider non-stochastic collateral and  $K_1 < u(1-L)$ . The bank optimally hides bad loans in period 1 so that it makes high profits and can pay out good dividends after the period. In period 2 the bank fails with certainty when the loan losses surface. With non-stochastic collateral PP is an effective instrument. Since the value of bad loans cannot appreciate, the hiding incentives are based entirely on good dividends after period 1. PP eliminates these dividends and thus it also eliminates the hiding incentives. Each bank discloses loan losses in period 1, which is socially optimal. For a detailed analysis on non-stochastic collateral see Niinimäki (2011b).

#### 4. Early closure method (ECM)

Up to now the regulator closes a bank after period 1 only when the capital level is negative. An interesting novelty of the Prompt corrective action policy is *early closure method* (ECM): the regulator can close a bank with a low capital level (2%). It is illuminating to investigate the effects of ECM in the model. ECM determines the lower limit for bank capital for period 2,  $\underline{K}_2$ . The regulator closes a bank after period 1 when the capital level is lower than  $\underline{K}_2$ ,  $K_1 \geq \underline{K}_2 > 0$ .

In this model a bank cannot pay out initial equity capital. It can pay out only profits. Thus,  $\underline{K}_2$  can be binding only if the official return is negative or zero,  $\pi_1 \leq 0$ . Suppose  $\pi_1 \leq 0$ . In detail,  $\underline{K}_2^*$  is binding only if  $\underline{K}_2 > K_1 + \pi_1(u_p^*)$  where  $u_p^*$  represents the optimal magnitude of disclosed loan losses without ECM. As observed above, with asymmetric information the worst banks hide bad loans and the best ones disclose them. Hence, ECM is insignificant for the worst banks which officially have no bad loans,  $u_p^* = 0$ . To determine if ECM has any impact, we need to focus on the credible good banks which would disclose bad loans even without it. Suppose that a good bank is very good so that  $\underline{K}_2 < K_1 + \pi_1(u_p = u)$ . Whatever the share of disclosed bad loans,  $\underline{K}_2$  is not binding. It is binding only if a good bank possesses more bad loans. Consider this type of a bank with  $\underline{K}_2 > K_1 + \pi_1(u_p^*)$ . ECM prompts it to roll over a few unsuccessful loans so that it meets the capital requirement,  $\underline{K}_2 = K_1 + \pi_1(u_p^{**})$ , where  $u_p^{**}$  marks the magnitude of disclosed bad loans with ECM. Hence, ECM forces the bank to hide more loan losses than it wishes to do,  $u_p^* > u_p^{**}$ .

The effect of ECM is negative. From the social point of view, the bank rolls over bad loans too frequently even without ECM. ECM worsens the problem by postponing the disclosure of bad loans and thereby increasing their related costs. The increased costs may result in the bank changing the optimal strategy from disclosure to hiding. Excessive rollovers drive the bank to gamble with collateral, thereby making it risk-prone.<sup>11</sup>

### 5. Revelation principle: Asset insurance motivates to disclose loan losses

Due to disadvantages resulting from hidden bad loans (e.g. Caballero et al., 2008; Hoshi and Kashyap, 2010; Borio et al. 2010), it is important to clean them from banks' balance sheets. Above we explored three instruments. A bank

discloses bad loans in the socially optimal way if its capital ratio is sufficient. Sometimes the prohibition of dividends generates the same outcome. In contrast, early closure policy worsens the hiding problem. Next we introduce a novel instrument.

Panetta et al. (2009) and Borio et al. (2010) review recent asset insurance schemes, in which the regulator bears a share of the losses on a bank assets portfolio after the first loss – deductible – is absorbed by the bank. That is, asset insurance sets an upper limit to the bank regarding its costs from bad loans. Let  $D$  label the deductible. Since a bad loan causes a loss  $1-L$ , the bank must absorb losses from the first  $\bar{U} = D/(1-L)$  bad loans. Next, we assume that the banker has paid an insurance premium at the start of period 1 and thus it does not appear in the formulas. The bank can use asset insurance in either period. If the magnitude of bad loans,  $u$ , is smaller than  $\bar{U}$ , the regulator has no need to indemnify anything. The bank alone bears the costs of the bad loans. Suppose next  $u \geq \bar{U}$ . If the bank utilizes the asset insurance, it discloses bad loans (or a part of them) to the regulator. They are liquidated at once. The bank bears losses from the first  $\bar{U}$  bad loans. Thereafter, the regulator pays full indemnity, 1, for each liquidated bad loan to the bank. The bank's costs from the bad loans total  $\bar{U}(1-L)$ . Even if the magnitude of bad loans exceeds  $\bar{U}$ , the bank may decide to hide them instead of utilizing the asset insurance.

As above, we attempt to find a solution in which a bank pursues the socially optimal liquidation rule. To begin, suppose that the magnitude of bad loans is at the intermediate level and the bank operates without PP. Lemma 4 shows that the banker pursues the socially optimal rollover rule if the term in the brackets is zero

$$(24) \quad -\underline{L} - K_1(1+r)/u + (1+r) = 0.$$

The regulator sets  $\bar{U}$  so that (24) is zero:  $-\underline{L} - K_1(1+r)/\bar{U} + (1+r) = 0$ . This implies  $\bar{U} = K_1 / (1 - \delta\underline{L})$ . At the end of period 1 the bank decides whether or not to use asset insurance.

Suppose that the bank uses asset insurance in period 2. It hides bad loans in period 1 by rolling over them. If the collateral value later appreci-

<sup>11</sup> For brevity, we have omitted proofs, which are rather self evident.

ates, the bank does not need asset insurance. Suppose that it depreciates. E.g. (5) indicates the returns during depression without asset insurance. With asset insurance, (5) can be restated as

$$(25) \quad \bar{U}[\underline{L}-(1+r)] + K_1(1+r).$$

Substituting  $\bar{U} = K_1 / (1 - \delta\underline{L})$  into (25) gives 0. With asset insurance the returns during depression are zero. This is no surprise. The bank pursues the socially optimal roll-over policy only if it does not benefit from limited liability. Therefore, the deductible is such that the bank never fails.

Consider period 1 and the intermediate scenario. The returns from the disclosure strategy with deductible can be solved from (10) as

$$(26) \quad R_1 - \bar{U}(1-L) - (1-K_1)r + K_1.$$

The asset insurance does not alter the returns from the hiding strategy (11),  $R_1 - (1-K_1)r + h\delta\pi_A$ . Comparing this to (26) shows that the disclosure strategy is more profitable than the hiding strategy if  $(1-h)K_1 - \bar{U}(1-L) \geq 0$ . Inserting  $\bar{U} = K_1 / (1 - \delta\underline{L})$  to this implies that the bank discloses bad loans if  $-\delta E(L) + L \geq 0$ . The bank pursues the socially optimal liquidation rule in the intermediate scenario.

Consider the second scenario in period 1. The magnitude of bad loans is so small that the bank is solvent in period 2 with certainty. This means that  $\pi_D(u_p = 0) \geq 0$  in (5) or  $(1+r)[u(\delta\underline{L}-1) + K_1] \geq 0$ . Thus, the maximal magnitude of bad loans meets  $u(\delta\underline{L}-1) + K_1 = 0$ . Hence,  $u$  is at most equal to  $\bar{U}$ . The deductible is so large that the bank, which is solvent in both periods with certainty, obtains no indemnity from asset insurance. Given Proposition 1, a solvent bank pursues the socially optimal liquidation rule.

Finally, consider the third scenario in period 1: an insolvent bank. Now (26) displays the returns with asset insurance. If the bank hides bad loans, its expected returns are  $R_1 - (1-K_1)r + h\delta\pi_A$ . The scenario is identical to the intermediate case. Owing to asset insurance the fact that an insolvent bank has more bad loans than an intermediate bank is insignificant.

Hence, asset insurance with  $\bar{U} = K_1 / (1 - \delta\underline{L})$  ensures that an insolvent bank pursues the socially optimal liquidation rule.

In sum, with  $\bar{U} = K_1 / (1 - \delta\underline{L})$  asset insurance guarantees that each bank type (solvent, intermediate, insolvent) pursues the socially optimal liquidation rule. When a bank uses asset insurance in period 1, it is risk free. When it does not use asset insurance, it hides bad loans. If their value appreciates during period 2, the bank is profitable. If it depreciates, the bank needs asset insurance in period 2 and earns zero returns. Regardless of whether the bank uses asset insurance in period 1 or in period 2, it is risk-free. A conclusion follows.

**Proposition 5.** *Consider stochastic collateral without PP. Asset insurance and deductible  $D = \bar{U}(1-L)$ , where  $\bar{U} = K_1 / (1 - \delta\underline{L})$  make the bank risk-free. It pursues the socially optimal liquidation rule.*

With PP: Recall (13) and (17). The bank follows the optimal liquidation rule if (13) is zero,  $(1-\delta\underline{L}) + [K_1 + R_1 - (1-K_1)r]/u = 0$ , when  $u = \bar{U}$ . This implies

$$(27) \quad \bar{U} = K_1 / (1 - \delta\underline{L}) + [R_1 - (1-K_1)r] / (1 - \delta\underline{L}).$$

Recall that without PP,  $\bar{U} = K_1 / (1 - \delta\underline{L})$ . PP strengthens asset insurance so that the hiding strategy becomes unprofitable with smaller insurance coverage. Using (14) and (15) it is possible to check that the bank pursues the socially optimal liquidation rule. It is also easy to check that the bank never pursues a strategy in which it discloses a few bad loans.

**Proposition 6.** *Consider stochastic collateral with PP. Asset insurance and deductible  $D = \bar{U}(1-L)$ , in which  $\bar{U} = K_1 / (1 - \delta\underline{L}) + [R_1 - (1-K_1)r] / (1 - \delta\underline{L})$  make the bank risk-free ensuring that it pursues the socially optimal liquidation rule. PP reduces insurance coverage.*

Asset insurance makes the bank risk free and the pricing problem of deposit insurance disappears. The size of the deductible depends on bank capital. The regulator can offer alternative

deductible/capital ratio combinations. A bank has an option of either a large deductible together with a high capital ratio or a combination consisting of a small deductible and a low capital ratio.

## *6. Conclusions*

Krahen (1999) notes that "...theoretical literature on financial intermediation and regulation, on the other hand, is surprisingly silent on the bank management's incentives *after* distress has occurred" (p. 77). His conclusions are confirmed by Aghion et al. (1999): "...few rules have been devised to deal with bank failures when they occur" (p. 51). This paper aims to fill these gaps in the literature by exploring a distressed bank and analyzing the ex post incentives. In this context, the paper examines the usefulness of the following regulatory instruments: prohibition of dividends, early closure policy, asset insurance and capital requirement.

With regard to incentives, the predictions of the model are consistent with earlier reported evidence on hidden loan losses. This is encouraging. With respect to regulatory instruments, prohibition of dividends reduces regulator's costs and banker's moral hazard profits. In few scenarios it changes the optimal strategy from hiding to disclosure or even makes the bank risk free. The prohibition policy is most effective if the collateral value is non-stochastic. With stochastic collateral the most insolvent banks always select the hiding strategy.

With asymmetric information, early closure policy is powerless. It compels the banks to hide more loan losses. In contrast, equity capital motivates the disclosure of loan losses. Unfortunately, the incentive compatible capital ratio may be high even if the prohibition of dividends policy reduces it.

Consequently, with non-stochastic collateral the problem of hidden loan losses can be eliminated by prohibiting dividends. With stochastic collateral, resolving the hiding problem is more demanding. The prohibition of dividends mitigates, but does not eliminate, the problem and thus regulators need to introduce complemen-

tary instruments. Asset insurance for the bank's loan portfolio may prove to be useful.

We wish to point out some limitations of our modeling that deserve particular attention. First, the paper ignores the signaling role of dividends. Thus, the findings on the prohibition of dividends may be a bit too optimistic. Second, we rule out ex ante moral hazard. Asset insurance might cause this type of problem. Third, we neglect different forms of capital injections and asset management companies, which are commonly used in bank bailouts. These subjects can also be investigated in this model framework.

*Appendix A. The proof of Lemma 2*

The optimal magnitude of the rolled over loans is either 0 or  $u$ . Consider first  $u - u_p \leq \bar{u}_D$ , that is,  $u_p \in [u - \bar{u}_D, u]$ . The magnitude of the disclosed bad loans in period 1 is so large that the bank is solvent in period 2. Put differently, so few bad loans surface in period 2 that the bank is then solvent even in depreciation. If  $L > \delta E(L)$ , the bank discloses bad loans in period 1,  $u_p = u$ , and if  $L < \delta E(L)$ , it rolls them over,  $u_p = u - \bar{u}_D$ . Consider now  $u_p \in [0, u - \bar{u}_D]$ . The magnitude of the disclosed bad loans is small. Since an extra rolled over bad loan increases expected returns by  $h(1-L) > 0$ , it is optimal to minimize  $u_p$  by choosing  $u_p = 0$ . We have three equilibrium candidates  $u_p = 0, u - \bar{u}_D$ , or  $u$ . Yet, it is easy to see that  $u_p = u - \bar{u}_D$  cannot be the equilibrium. Since  $h(1-L) > 0$  it is optimal to move from  $u_p = u - \bar{u}_D$  to  $u_p = 0$ . In sum, the marginal benefit from non-disclosure rises with the magnitude of rolled over loans from  $\delta E(L) - L$  to  $h(1-L)$ . If it is optimal to roll over at least one loan,  $\delta E(L) > L$ , it is optimal to roll over the rest of loans. Q.E.D.

*Appendix B. The proof of Lemma 3*

Suppose  $\pi_1(u_p = u) < 0$ . Since  $\pi_1$  is negative, the banker earns no income in period 1, and  $\pi_1$  erodes bank capital,  $K_2 = K_1 + \pi_1(u_p = u) < K_1$ . Since  $u_p = u$  and  $R_2 = r$ ,  $\delta\pi_2$  simplifies to  $K_2$  or  $K_1 + \pi_1(u_p = u)$ . Suppose  $\pi_1(u_p = u) > 0$ . The bank pays this as dividends to the banker. Since  $\pi_1$  is positive, there is no erosion in bank capital,  $K_2 = K_1$ . Since  $u_p = u$  and  $R_2 = r$ ,  $\delta\pi_2$  simplifies to  $K_2 (= K_1)$ . In period 1 the banker receives  $\pi_1$  and the NPV of his expected return from period 2 is  $K_1, K_1 + \pi_1(u_p = u)$  in total. Given  $\pi_1(u_p = u) = R_1 - (1 - K_1)r - u(1 - L)$ , the banker's life-time income is  $R_1 - (1 - K_1)r - u(1 - L) + K_1$  in both cases Q.E.D.

### Appendix C. Proof of Lemma 4

It is optimal to disclose bad loans if  $K_1 - (1-u)L - \delta h \pi_1(u_p = 0) > 0$ . This can be rewritten as

$$(C.1) \quad K_1 - u(1-L) - \delta h[u(1+R_2) - u(1+r) + K_1(1+r)] > 0,$$

or

$$(1-h)K_1 - u(1-L-h) - \delta hu(1+R_2) > 0. \text{ This can be restated as}$$

$$(C.2) \quad (1-h)K_1 - u(1-L-h) - \delta u[E(L) - (1-h)L] > 0,$$

or

$$(1-h)K_1 - u(1-L-h) - u[\delta E(L) - L] - uL + \delta u(1-h)L > 0. \text{ This implies}$$

$$(C.3) \quad (1-h)K_1 - u(1-h) - u[\delta E(L) - L] + \delta u(1-h)L > 0,$$

or

$$(C.4) \quad -u[\delta E(L) - L] + (1-h)\delta[uL + K_1(1+r) - u(1+r)] > 0.$$

Hence, it is optimal to roll over loans if

$$(C.5) \quad u[\delta E(L) - L] + (1-h)\delta[-uL - K_1(1+r) + u(1+r)] > 0.$$

The term in the latter brackets is positive, because the bank fails in depression. Q.E.D.

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