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CAUGHT BETWEEN SCYLLA AND CHARYBDIS? REGULATING BANK LEVERAGE WHEN THERE IS RENT-SEEKING AND RISK-SHIFTING

Abstract

We consider a model in which banks face two moral hazard problems: 1) asset substitution by shareholders, which can occur when banks make socially-inefficient, risky loans; and 2) managerial under-provision of effort in loan monitoring. The privately-optimal level of bank leverage is neither too low nor too high: It efficiently balances the market discipline that owners of risky debt impose on managerial shirking in monitoring loans against the asset substitution induced at high levels of leverage. However, when correlated bank failures can impose significant social costs, regulators may bail out bank creditors. Anticipation of this action generates an equilibrium featuring systemic risk, in which all banks choose inefficiently high leverage to fund correlated, excessively risky assets. That is, regulatory forbearance itself becomes a source of systemic risk. Leverage can be reduced via a minimum equity capital requirement, which can rule out asset substitution. But this also compromises market discipline by making bank debt too safe. Optimal capital regulation requires that a part of bank capital be invested in safe assets and be attached with contingent distribution rights, in particular, be unavailable to creditors upon failure so as to retain market discipline and be made available to shareholders only contingent on good performance in order to contain risk-taking.

JEL: G21, G28, G32, G35, G38

Key words: market discipline, asset substitution, systemic risk, bailout, forbearance, moral hazard, capital requirements

"In many things, the middle have the best / Be mine a middle station." — *Phocylides*

I. INTRODUCTION

Financial crises have occurred for centuries, have been studied extensively (e.g. Allen and Gale (2000a, 2000b, 2007, 2008)), and are typically followed by calls for regulatory reform. In the wake of the recent financial crisis, the prudential regulation of banks has emerged once again as an issue of critical importance. The central question being asked is this: What is the socially optimal amount of capital that banks should be required to hold on their balance sheets?

Underlying this question is recognition that the private cost of bank equity capital may exceed its social cost—meaning that the amount of capital a bank will typically choose as its private optimum may diverge from the social optimum. This possibility creates the *raison d'être* for capital regulation. The exact form that such capital regulation should take is, however, still under debate.[1]

In this paper, we address this central question with a theoretical approach that recognizes the well-known frictions in banking and seeks to generate an implementable policy prescription for regulating bank capital. Broadly, our proposal is aimed at increasing bank capital in a way that does not compromise bank discipline by uninsured creditors, yet keeps in check bank incentives to take excessive leverage and risks that are correlated with those of other banks.

We begin with the observation that banks face two kinds of moral hazard problems: (i) rent-seeking by managers (indirectly, loan officers) in the form of shirking in the effort to monitor loans; and (ii) asset substitution or risk-shifting, which is the shareholder-creditor conflict that bank equity value may be enhanced by engaging in excessively risky, socially-inefficient portfolios at the expense of creditors.

The first moral hazard problem—that of managerial shirking in loan monitoring—is well-recognized, and it has been proposed that (uninsured) debt can provide the necessary market discipline to

[1] Numerous ideas have been put forth recently for how capital regulation—which has traditionally focused on tier-1 capital (common equity and some hybrid claims combining debt and equity features)—ought to be redone. We discuss these in the next section.

ameliorate this moral hazard (Calomiris and Kahn (1991) and Diamond and Rajan (2001)).[2] The second moral hazard problem—that of risk shifting—is also well recognized and is considered to be dealt with most effectively by ensuring that the bank has sufficient equity capital (see, e.g., Bhattacharya, Boot and Thakor (1998), and Merton (1977)).[3] A study of bank failures by the Office of the Comptroller of the Currency (1988) confirmed that these two moral hazard problems seem simultaneously relevant in understanding bank failures.[4] The emerging evidence from the financial crisis of 2007-09 appears to lead to a similar conclusion.[5]

We would ordinarily expect the privately optimal capital structure choices of banks to deal efficiently with these two forms of moral hazard. However, since there is an inherent conflict between how the two moral hazard problems can be addressed—risk-shifting by raising capital and managerial shirking by raising leverage—it is not clear what the private optimum would look like, particularly relative to bank capital structures observed in practice, since the observed capital structures are also affected by the ever-present possibility of government bailouts when poor lending practices, along with commonality of underlying risks, lead to systemic failures. Motivated by these observations, we attempt to answer the following questions. First, how do the disciplining roles of bank capital and leverage interact? Second, what does this interaction imply about the bank's privately optimal capital structure?

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[2] Specifics of modeling differ across models. For instance, Calomiris and Kahn (1991) model this as a problem of managerial fraud or private benefits, whereas Diamond and Rajan (2001) model the managerial rent-seeking as a hold-up problem in the spirit of Hart and Moore (1994). See also Acharya and Viswanathan (2011).

[3] While Jensen and Meckling (1976) proposed this as a problem for non-financial corporations, it is exacerbated in the case of financial firms by implicit and explicit guarantees such as deposit insurance (Bhattacharya and Thakor (1993)) and the ease with which financial risks can be altered (Myers and Rajan (1998)).

[4] The OCC's study was based on an analysis of banks that failed, that became problems and recovered, or that remained healthy during the period 1979-87. The study analyzed 171 failed banks to identify characteristics and conditions present when bank health deteriorated. The study concludes: "Management-driven weaknesses played a significant role in the decline of 90 percent of the failed and problem banks the OCC evaluated. Many of the difficulties the banks experienced resulted from inadequate loan policies, problem loan identification systems, and systems to ensure compliance with internal policies and banking law. In other cases, directors' or managements' overly aggressive behavior also resulted in imprudent lending practices and excessive loan growth that forced the banks to rely on volatile liabilities and to maintain inadequate liquid assets."

[5] For instance, on April 12, 2010, Senator Carl Levin, D-Mich., chair of the U.S. Senate Permanent Subcommittee on Investigations, issued a statement prior to beginning a series of hearings on the financial crisis. In the statement, he addressed some of the lending practices of Washington Mutual, the largest thrift in the United States until it was seized by the government and sold to J.P. Morgan Chase in 2008 (see U.S. Senate Press Release, "Senate Subcommittee Launches Series of Hearings on Wall Street and the Financial Crisis," April 12, 2010). The statement confirms evidence of poor lending, but also fraudulent documentation and lack of disclosure.

Third, how does regulatory intervention in the form of ex-post bank bailouts affect the bank's ex-ante capital structure? Does the possibility of bailouts justify regulatory capital requirements? And if so, what form should these requirements take?

We begin by combining both forms of moral hazard – shirking and risk-shifting – in a single model. In our model, the market discipline of debt works via creditors threatening to liquidate the bank if they observe that the bank has not monitored its loans. While shareholders could also use the same threat or fire the manager, we show that they lack the incentive to do so. We then show that if leverage is too low, debt becomes essentially safe and creditors also lack the incentive to threaten efficient liquidation and induce bank monitoring. At the other extreme, if leverage is too high, managers are inclined to choose inefficiently risky assets and bet the bank with the creditors' money. The privately-optimal capital structure of the bank is thus like a ship navigating carefully between the mythological sea monsters Scylla (rent-seeking) and Charybdis (asset substitution).

Formally, there are conditions under which the bank has a range of incentive-compatible leverage levels, and as long as bank leverage is within this range, both forms of moral hazard are well addressed (Case I). In this case, private contracting between the bank and its financiers leads to an optimal capital structure in which ex-ante bank liquidity is maximized by choosing the highest level of leverage that does not induce asset substitution, but is still sufficiently high to induce discipline by creditors. The result is the choice of the first-best asset (or loan) portfolio by the bank. However, there are other conditions (Case II) under which it is impossible to simultaneously choose leverage that is high enough to induce creditor discipline but low enough to deter asset substitution. In this case, the bank's (second-best) choice of capital structure must tolerate either the inefficiency of the manager shirking in loan monitoring or the inefficiency of an excessively risky loan portfolio, neither of which is first best.

This benchmark model can be viewed as capturing the problem of an individual bank that is one of arbitrarily many banks with uncorrelated loan portfolios. However, asset substitution at banks is often correlated across banks. Reinhart and Rogoff (2008) show, for instance, that most financial crises are preceded by a secular credit boom and asset-price inflation (often, but not restricted to, the real estate sector) fueled by inexpensive loans from the financial sector. We argue that this phenomenon is attributable to the presence of government guarantees and the lender of last resort (LOLR), which are triggered when banks (or financial firms in general) fail together; in this circumstance, it is time-inconsistent for regulators to refuse to bail out banks.[6]

In particular, when bank failures are correlated, there can be sufficiently high social costs associated with a systemic collapse of financial intermediation and markets, as witnessed in 2008 following the failures of Bear Stearns, Fannie Mae, Freddie Mac, Lehman Brothers, American International Group, and some of their global counterparts. Rules precluding forbearance or those facilitating orderly low-cost resolution may be useful in such circumstances, but are often practically infeasible if there are wholesale failures. Absent such rules, the regulator/government has a strong incentive to rescue banks by bailing out bank creditors but allowing bank equity to be wiped out. We take such forbearance as given and show that the anticipation of it generates multiple Nash equilibria in banks' leverage choices. In one equilibrium, systemic risk is inefficiently increased via two channels—banks over-lever and they also take on excessive levels of correlated asset risk. Thus, regulatory forbearance itself becomes a source of systemic risk. As creditors anticipate being bailed out, their downside risk is "socialized", so increasing bank leverage is *not* met with a higher cost of debt financing, nor is there any credit rationing. This situation enables banks to "loot" the taxpayer, in the sense of Akerlof and Romer (1993), by paying out dividends and eroding bank capital even as bank risk and leverage rise, looting that arises purely through shareholder value maximization by banks.

Somewhat perversely, banks' ability to raise leverage and loot the taxpayer is enhanced as loan monitoring becomes more valuable. This is because shareholders do not get bailed out ex post, and thus,

[6] Acharya and Yorulmazer (2007), Acharya (2009), and Farhi and Tirole (forthcoming) build formal models of the regulator's time-consistency problem when banks fail together and of the induced herding behavior in banks. Besides herding, joint failure risk can also be created by banks through the use of short-term debt and credit-risk transfer mechanisms, as studied by Allen, Babus and Carletti (forthcoming) and Allen and Carletti (2006). The point that excessive systemic risk may ultimately be rooted in government safety nets and time inconsistency of regulation was recognized as early as Kindleberger (1978) and has been reinforced recently by Kane (2010), among others. The issue is further complicated when regulatory intervention pertains to multinational banks with cross-border deposit insurance (e.g. Calzolari and Loranth (2011)).

excessively risky portfolios *cannot* be funded through equity, but they can be funded through debt that is *de facto* government-backed due to an implicit bailout assurance. Since debt is fairly priced, it becomes the conduit through which shareholders transfer risks onto taxpayers. To the best of our knowledge, this perverse effect of government guarantees in *expanding* to a greater extent the debt capacity of banks that are more effective in monitoring loans has not been recognized explicitly before.

A regulatory capital requirement can potentially address the systemic risk in this inefficient equilibrium. Under conditions guaranteeing that the privately-optimal capital structure in the absence of regulatory forbearance can fully resolve different forms of moral hazard (Case I), a simple minimum equity capital requirement does the job of restoring the first-best asset choice and eliminating correlated risk taking and excessive leverage. But under conditions that make it impossible for private contracting to simultaneously resolve different moral hazards (Case II), a minimum equity capital requirement is not efficient: The amount of equity capital that renders asset substitution unattractive makes debt so safe that it provides little market discipline inducing bankers to reduce monitoring of loans, and bank efficiency is sacrificed as a result. Instead, the optimal capital requirement features a two-tiered structure that has the following features.

First, the bank should be required to fund itself with a minimum amount of equity capital, which may be viewed as being similar to a leverage-ratio restriction or a tier-1 capital requirement. This capital faces no restrictions regarding assets in which it is invested.

Second, the bank must also be required to keep an additional "special capital account." This capital is special in the sense that (i) it must be kept in the form of relatively safe assets; [7] and, (ii) it is subject to contingent distribution rights. It accrues to the bank's shareholders when the bank is solvent, like any other form of capital. But in the event of an idiosyncratic failure of a bank, this capital is

[7] In particular, if there is a governance problem between shareholders and managers that is not adequately addressed through private forces, then free cash-flow diversion or perquisite consumption (Jensen (1986)) can also erode bank capital. To address this, we show that, though the first tier of capital can be used to fund any assets permissible for the bank, the special capital must be invested by the bank in pre-designated securities such as risk-free government bonds. This investment restriction makes the special capital account look like a cash-asset reserve requirement, but it goes beyond that because (as explained above) it stipulates a particular form of ownership or contingent distribution rights.

unavailable to cover the claims of (uninsured) creditors; it accrues instead to the regulator, who can employ it, for instance, to reduce its operational costs or make transfers either to solvent institutions or directly to taxpayers. The purpose of making the special capital account unavailable to creditors is to ensure that even when the bank has sufficiently high capital for shareholders not to substitute assets, creditors view the bank as having sufficiently low capital. Hence, there is sufficiently high "skin in the game" for creditors so that their incentives to liquidate inefficiently-run banks are not diluted and in turn the managerial incentives to monitor loans are adequately preserved. We discuss several details relating to the implementation of such an account by employing dividend restrictions and earning retentions in order to reduce the costs of raising external equity.

An important feature of our analysis is that both bank leverage and bank capital discipline banker incentives. Some, notably Admati, DeMarzo, Hellwig and Pfleiderer (2010), have recently criticized models that stress the role of creditor discipline on banks on the grounds that they overstate the disciplining role of debt and understate the value of equity. They observe that creditor discipline was ineffective or non-existent in the recent crisis, as the banks that got into the most trouble were in fact the most highly levered. A similar observation has also been made about the Savings & Loans crisis of 1980's. Our overall thrust is not in conflict with these observations, except that we stress that such ineffectiveness of creditors is *in the presence of government safety nets*, which distort creditor incentives. In our model too, *creditor discipline works only when government safety nets are absent*. In the presence of safety nets, capital regulation of a special form is needed to restore creditor disciplining incentives, which we analyze and propose.

The rest of this paper is organized as follows. Section II develops the single-bank model with managerial shirking and risk-shifting problems. Section III contains the analysis of privately-optimal bank leverage in this benchmark model. Section IV examines the important extension when bank leverage is affected by correlated defaults and induced regulatory forbearance. This section also discusses the optimal capital requirement featuring the special capital account. Section VI discusses model extensions and robustness issues as well as the implications of our proposed scheme for current regulatory proposals. Section VII discusses the related literature. Section VIII concludes. All proofs not in the main text are in the Appendix A.

II. MODEL

We present a model that shows how the extent of leverage in a bank's financial structure determines the incentives provided and the discipline imposed by debt on the bank's portfolio choices. In doing so, the model also explains the economic role played by bank capital.

The Economy

Consider an economy in which all agents are risk-neutral and the risk-free rate of interest is zero. There are three dates: $t = 0$, 1, and 2. The economy has a large number of banks. At $t = 0$, each bank is owned by shareholders and operated by a manager. The bank has on its balance sheet E_0 in the form of equity liability at $t = 0$ as well as some debt that needs to be rolled over. On the asset side, the bank has assets in place (brick and mortar, computers, etc.) that have a non-stochastic value of $V_{AIP} > 0$. At $t = 0$, the bank needs I to invest in a new loan portfolio and to roll over legacy debt. This investment can be financed with any combination of debt (D) and equity (E), so that $D + E = I$ at $t = 0$. We will refer to $E + E_0$ as the bank's total equity capital.[8]

It is simplest to think of the bank as being 100% owned by the manager at the outset, with the owner-manager first choosing the bank's capital structure while raising external financing of I. Subsequent to this choice, the manager chooses the loan portfolio. The bank's owner-manager is wealth-constrained, which is why he needs external financing. An alternative to this interpretation is that the bank manager is distinct from the initial shareholders who are wealth-constrained, but the manager's incentives are aligned with maximizing the wealth of the initial shareholders (for example, due to the design of his compensation contract or some other unmodeled alignment mechanism), net of his own cost of monitoring loans. .

[8] E_0 is not available as liquidity to meet the bank's incremental financing need at $t = 0$. That is, it can be viewed as equity tied up in the assets in place.

We assume that the capital market is competitive so that the expected return that must be provided to investors purchasing the bank's securities is zero. If the bank can raise this financing, bank can meet its investment need at $t = 0$, which then allows it to choose a loan portfolio at $t = 1$; no additional financing is required at $t = 1$. The time line is explained in Figure 1.

Figure 1 here

Loan Portfolio Attributes

There are two mutually-exclusive loan portfolios the bank can choose from at $t = 1$: a "good" portfolio (G), and an "aggressive" portfolio (A) that may be preferred by bank shareholders owing to asset-substitution moral hazard. Each loan portfolio generates a stochastic cash flow at $t = 2$, denoted as Z_2, whose distribution depends on the monitoring effort of the bank's manager. Moreover, each portfolio also produces an interim signal, $\tilde{Z}_1$, which reveals whether the bank engaged in monitoring at $t = 0$. This signal is costlessly observable to all at $t = 1$, but it is *not* verifiable for contracting purposes, so contracts cannot be conditioned on it.

We describe next the formal structure of the probability distributions of the cash flows of the two portfolios. Informally, the good portfolio (G) efficiently balances risk and return, whereas the aggressive portfolio (A) is excessively risky.

Signal at t = 1 (for both A and G portfolio):

$$\tilde{Z}_1 = \begin{cases} x > 0 & \text{if the loan portfolio is monitored} \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

Cash flows at t = 2:

For portfolio $i \in \{\text{A, G}\}$, if the bank monitors, then:

$$Z_2^i = \begin{cases} H_i > 0 & w.p. \;\; p_i \in (0,1) \\ 0 & w.p. \;\; 1 - p_i \end{cases} \tag{2}$$

If the bank does not monitor its loans, then the portfolios are rendered indistinguishable:

$$Z_2^i = \begin{cases} H_\ell > 0 & w.p. \;\; p_\ell \in (0,1) \\ 0 & w.p. \;\; 1 - p_\ell \end{cases} \tag{3}$$

for $i \in \{A, G\}$. We assume the following: (i) in terms of the likelihood of success in date-2 cash flow, given monitoring, the good loan portfolio, *G*, dominates the aggressive portfolio *A*, i.e., $p_G > p_A$, and the aggressive portfolio *A* dominates the inefficiently monitored portfolio, i.e., $p_A > p_l$; (ii) in terms of the level of date-2 cash flow, given monitoring, portfolio *A* dominates portfolio *G* which in turn dominates the inefficiently monitored portfolio: $H_A > H_G > H_l$; and (iii) in terms of expected cash flow at date 2, given monitoring, *G* dominates *A* and by a sufficient margin: $\left[p_G/\left(p_G - p_A\right)\right]H_G - \left[p_A/\left(p_G - p_A\right)\right]H_A > 1$. The "sufficient margin" between the good loan portfolio *G* and the aggressive loan portfolio *A* in (iii) is easily met since we know that $p_G H_G - p_A H_A > 0$, implying that the condition above is satisfied if we were to simply assume $p_G H_G - P_A H_A > 1$, for instance.

The bank can be liquidated at *t = 1* or the bank manager can be fired at *t = 1* and replaced with a *de novo* manager. Both actions produce the same outcome: the value of the bank assets take on a value of $L > 0$. To capture opacity and asset-specificity of bank assets, we assume that that both actions are costly, and lead to a bank value that is lower than the continuation value of the bank without monitoring:

$$p_\ell H_\ell + V_{AIP} > L > V_{AIP}. \tag{4}$$

The idea is that the bank has made relationship loans for which the incumbent bank manager has developed relationship-specific monitoring expertise that cannot be replaced costlessly by liquidating loans to alternate bank managers. Nonetheless, liquidation fully recovers the value of assets in place $\left(V_{AIP}\right)$ as well as a portion of the loan portfolio value, so $L > V_{AIP}$.

The Bank Manager's Objective and the Rent-Seeking Problem

The bank manager seeks to maximize the wealth of the initial shareholders, net of his private monitoring cost, $M > 0$. Monitoring is a binary decision: either the manager monitors or not, and thus decision is made at *t = 0.* It is assumed that the bank manager's monitoring effort is unobservable. We will now make parametric assumptions which guarantee that the *G* loan portfolio when monitoring is socially efficient:

$$p_G H_G + V_{AIP} - I - M > 0; \tag{5a}$$

$$p_G H_G + V_{AIP} - M > p_\ell H_\ell + V_{AIP} > I. \tag{5b}$$

Since $p_G H_G > p_A H_A$, (5a) and (5b) imply that portfolio *G* with monitoring dominates any other choice from a social efficiency standpoint. Further, it is assumed that:

$$p_G H_G - p_\ell H_\ell - [p_G - p_\ell][p_G]^{-1}[I - V_{AIP}] < M. \tag{6}$$

This restriction means that if the bank manager raises all of the external financing *I* from debt and financiers assume that the manager will choose the *G* loan portfolio and monitor it, the manager will find it privately optimal *not* to monitor. This restriction merely ensures that the external financing that has to be raised at *t = 0* is large enough to precipitate moral hazard in bank monitoring (note that the left-hand side of (6) is strictly decreasing in *M*). It is this moral hazard that creates a potential role for disciplining of the bank by external financiers. We discuss this next.

Observability, Control Rights, and Contracts

All cash flows are observable ex post, but only the bank manager privately observes whether the chosen loan portfolio is *G* or *A* and whether there is monitoring of the loan portfolio. Thus, external financiers cannot observe which loan portfolio they financed, but financiers have the right to fire the incumbent manager or liquidate the bank. We consider (possibly a mix of) two forms of external financing contracts: *debt* and *equity*.[9] The debt contract is such that creditors cannot demand more repayment than what was promised to them contractually nor impose some other penalty on the bank if the bank is able to fully repay its debt obligation[10]. The debt contract stipulates that creditors can demand full repayment of the debt face value, D_R, at *t = 1*, and can force liquidation of the bank at *t = 1* and collect the proceeds if their demand of full repayment cannot be met at that time. Creditors could also decide not to demand full repayment of the debt at *t = 1* and simply agree to roll over the debt and be

[9] Numerous papers have provided the micro-foundations of debt and equity as optimal securities. See, among others, Boot and Thakor (1993).

[10] This is a ubiquitous feature of debt contracts that we take as a given. It rules out creditors writing debt contracts that would force the bank to repay creditors more if H_A, rather than H_G, was observed at *t = 2*.

repaid at $t = 2$. In contrast, equity is not promised a specific repayment, i.e., shareholders are residual claimants, but they can fire the incumbent manager at $t = 1$.

Finally, we will assume to start with that for each bank the date-1 signal, Z_1, as well as the date-2 cash flow, Z_2^i, are independently and identically distributed (i.i.d.) in the cross section of banks for each of the loan portfolios.

Summary of Assumptions

We now gather and reiterate the key assumptions of the model:

Assumption 1 (Financing Choices and Number of Banks): Each bank needs an investment of *I* that it can meet using an external financing mix of equity and debt at $t = 0$. There is an arbitrarily large number of banks in the economy.

Assumption 2 (Loan Portfolio Choices): Each bank's manager can make a loan portfolio choice at $t = 0$ from among two mutually exclusive portfolios, *A and G*, where *G* is the efficient (highest expected value) or the good portfolio, and *A* is an aggressive "risk shifting" portfolio. Across all banks choosing the same portfolio, conditional on monitoring the terminal portfolio cash flows are *i.i.d.* random variables. Portfolio cash flows across banks are independent also for different portfolio choices.

Assumption 3 (Loan Monitoring): The bank's manager can choose to monitor the loan portfolio at a private cost $M > 0$. Monitoring is not observable and cannot be directly contracted upon. If there is monitoring, the probability distributions of the date-2 cash flows for both loan portfolios stochastically dominate the probability distributions attainable without monitoring.

Assumption 4 (Preferences and Pricing): There is universal risk neutrality as well as competitive pricing in the capital market with a zero riskless interest rate.

Assumption 5 (Bank Manager's Objective): The bank's owner-manager ("manager" henceforth) maximizes the value of his initial equity in the bank net of his monitoring cost.

At this stage, there is no regulator in the model and our focus is on optimal private contracting. A rationale for regulatory intervention will be introduced in Section IV.

III. ANALYSIS OF THE BENCHMARK MODEL

In this section, we present the analysis of our base model. We solve the model by backward induction, starting with events at $t = 1$, at which time the financiers of the bank choose whether to liquidate the bank (or fire the manager), or allow it to continue (with the same manager). We then move to $t = 0$, at which time the bank manager chooses the bank's capital structure and its loan portfolio, and also makes his monitoring decision. We begin with a description of the first-best outcome.

The First Best

If the manager's monitoring effort is contractible, then given (5a), (5b) and the assumption that $p_G H_G > p_A H_A$, the loan portfolio *G* with bank monitoring is the first-best choice. In the first best, the bank's capital structure is irrelevant.

The Second Best

Events at *t* = 1

At this stage, the main issue of interest is the decision of the shareholders and the creditors of the bank about whether to let the bank continue with the incumbent manager or to liquidate the bank/fire the manager. Suppose the bank issued *D* in debt and *E* in equity to raise *I* at $t = 0$. Let D_R be the date-2 repayment obligation on the debt raised at $t = 0$. The relationship between *D* and D_R will be determined by the bank's equilibrium choice of loan portfolio and the bank manager's choice of monitoring made at $t = 0$.

If the manager chose *not* to monitor, then $\tilde{Z}_1 = 0$ is observed and creditors will infer that the bank manager chose not to monitor at $t = 0$. Given the assumption that all control transfers to creditors, they assess the expected vale of their claim *with continuation* as:

$$p_\ell\left[D_R \wedge \left(H_\ell + V_{AIP}\right)\right] + \left[1 - p_\ell\right]V_{AIP} \tag{6}$$

where " $\wedge$ " is the "min" operator. The liquidation value of their claim is

$$L. \tag{7}$$

If the bank manager chooses to monitor, then $\tilde{Z}_1 = x$ is observed. Now the creditors know that the bank monitored its loan portfolio at $t = 0$. *Assuming* that the bank chose the *G* loan portfolio at $t = 0$, the continuation value of the creditor' claims is

$$p_G D_R + \left[1 - p_G\right]V_{AIP} \tag{8}$$

which assumes that $D_R < H_G + V_{AIP}$. The following result can now be stated.

Lemma 1**:** *When the bank raises external financing of I, the bank manager will abstain from monitoring the loan portfolio regardless of the bank's capital structure (mix of debt and equity in I) as long as there is no threat of dismissal of the manager or liquidation of the bank.*

The intuition is quite simple. Recall that (5a) guarantees that the manager would monitor the *G* loan portfolio if the bank was completely internally financed and the manager owned all of the equity. However, the presence of external financing weakens the manager's incentive to monitor as the manager now has to share the benefits of monitoring (the enhancement in the portfolio value), but the cost of monitoring, *M*, is borne entirely by the manager. The higher is the external financing, *I*, the greater is the share of the monitoring-induced enhancement in portfolio value that the manager has to surrender to external financiers. Thus, for *I* large enough, the manager finds that it is better for him to shirk, as long as external financiers do not threaten him with liquidation or dismissal for shirking. This sets up our next result:

Lemma 2**:** *If creditors assume that the bank has chosen the G loan portfolio, then as long as the bank issues debt D at t = 0 such that* $D_R \in \left[\hat{D}, D^0\right)$*, the creditors will liquidate the bank at t = 1 if* $\tilde{Z}_1 = 0$ *at t = 1, and will allow it to continue if* $\tilde{Z}_1 = x$ *at t = 1, where:*

$$\hat{D} \equiv V_{AIP} + \frac{\left[L - V_{AIP}\right]}{p_G}, \tag{9}$$

$$D^0 \equiv V_{AIP} + \frac{\left[L - V_{AIP}\right]}{p_\ell}. \tag{10}$$

The intuition can be seen as follows. If the bank keeps too low a level of debt in its capital structure $\left(D_R < \hat{D}\right)$, then the creditors will unconditionally demand full repayment at *t = 1* even if $\tilde{Z}_1 = x$, recognizing that this will force liquidation of the bank at *t = 1*. This is because the net liquidation value is large enough relative to the expected value of their claim under continuation, so concavity of the creditor' claims ensures that they prefer to liquidate and take the sure liquidation payoff at *t = 1* rather than gamble on the risky continuation payoff. At the other extreme is when the amount of debt issued at *t = 0* is so large $\left(D > D^0\right)$ that the creditors have *de facto* ownership of most of the bank and behave very much like shareholders, unconditionally passing up the opportunity to liquidate in the hope of a risky continuation gamble paying off in the future. It is only when the bank's debt repayment is between these two extremes $\left(D \in \left[\hat{D}, D^0\right]\right)$ that creditors demand full repayment at *t = 1* and force liquidation *only* if $\tilde{Z}_1 = 0$ and *not* if $\tilde{Z}_1 = x$. We now turn to how the shareholders behave.

Lemma 3**:** *Even if* $\tilde{Z}_1 = 0$ *is observed at t = 1, the shareholders will not fire the incumbent manager at t = 1 and will choose to continue with him, for any debt repayment* $D_R \in \left[0, D^0\right]$.

The reason why the shareholders do not fire the manager is that gambling on risky continuation has a higher expected payoff for the shareholders than taking the sure liquidation payoff, given the non-concave payoff structure of the equity contract.

This difference in behavior between debt and equity, highlighted by Lemmas 2 and 3, stems entirely from the difference in the nature of these contractual claims on the bank's cash flows. The upshot of these two lemmas is that creditors will impose the necessary discipline on the bank manager, but shareholders will not.

Events at *t = 0*

The key events at *t = 0* are the initial shareholders' choice of capital and the bank manager's loan portfolio and monitoring choices. We begin with a simple result.

Lemma 4*: *The manager will choose the capital structure that maximizes the value of the bank at t = 0.

The result is transparent in its intuition. Since new securities are being issued to deliver for financiers a competitive expected return of zero, the beneficiaries of a value-maximizing loan portfolio choice at *t = 0* are the initial shareholders, represented by the bank manager.

Clearly, the value-maximizing loan portfolio is *G* with monitoring. Since neither the bank manager's loan portfolio choice nor his decision to monitor are observable ex ante, indirect incentives must be provided to achieve the appropriate choices when external financing creates moral hazard in the bank's provision of loan monitoring. Conditional on monitoring, the incentive compatibility constraint for the manager to prefer *G* over *A* (assuming $D_R \geq V_{AIP}$) is:

$$p_G\left[H_G + V_{AIP} - D_R\right] \geq p_A\left[H_A + V_{AIP} - D_R\right],$$

which can be written as:

$$D_R \leq \tilde{D} \equiv V_{AIP} + \frac{\left[p_G H_G - p_A H_A\right]}{p_G - p_A}. \tag{11}$$

We shall initially assume that:

$$\frac{\left[p_G H_G - p_A H_A\right]}{p_G - p_A} > \frac{\left[L - V_{AIP}\right]}{p_G} \tag{12}$$

which will ensure that $\tilde{D} > \hat{D}$ (see (9)). Now recall from Lemma 2 that if the debt repayment exceeds D^0 (given by (10)), then creditors unconditionally allow the bank to continue at *t = 1*. We will require that $\tilde{D}$ (given by (11)) is less than D^0. The following condition, obtained by comparing (10) and (11), guarantees that $\tilde{D} < D^0$, and we will assume that it holds:

$$\frac{[L - V_{AIP}]}{p_\ell} > \frac{[p_G H_G - p_A H_A]}{[p_G - p_A]}. \tag{13}$$

Condition (13) is easy to interpret. Recalling that D^0 is the upper bound such that for a debt repayment less than D^0, creditors are willing to liquidate the bank if $\tilde{Z}_1 = 0$. As p_ℓ becomes smaller, the expected continuation value of a bank that has not monitored its loans declines, so it becomes more attractive for creditors to liquidate the bank and collect L if $\tilde{Z}_1 = 0$, i.e., liquidation conditional on $\tilde{Z}_1 = 0$ occurs for a larger range of exogenous parameter values, which means D^0 goes up. Thus, a sufficient condition for $\tilde{D} < D^0$ is for D^0 to be large enough, for which a sufficient condition is that p_ℓ is small enough. Note that (13) holds if p_ℓ is small enough.

We now state a useful result for later use.

Lemma 5**:** *If the bank chooses loan portfolio G and monitors in equilibrium, then repayment,* D_R*, that the bank must promise creditors at t = 2, in order to raise an amount D at t = 0 is:*

$$D_R(D) = \frac{[D - V_{AIP}]}{p_G} + V_{AIP}. \tag{14}$$

We can now state our main result:

Proposition 1**:** *Suppose (12) holds. Then, the bank manager will choose D at t = 0 such that* $D_R^* \in [\hat{D}, \tilde{D}]$*, so* $D(D_R^*)$*, given this* D_R^**, will be given by the inverse function from (14), and new equity* $E = I - D(D_R^*)$*. With this capital structure, the manager will choose the loan portfolio G and also provide monitoring. If* $D(D_R^*) > I$ *, then no new equity is issued and* $D(D_R^*) - I > 0$ *is paid out as a dividend to the initial shareholders (manager).*

The intuition follows from the earlier results. When the debt repayment obligation, D_R^*, is set to be higher that $\hat{D}$, it ensures that the bank's creditors find it subgame-perfect to avoid unconditionally liquidating the bank at *t = 1*, and the fact that it is lower than D^0 (since $D_R^* < \tilde{D} < D^0$) ensures that the creditors will indeed find it subgame-perfect to liquidate the bank when the signal *t = 1* is zero. This is predicated on the assumption that the bank manager will choose the *G* loan portfolio. Since $D_R^* \leq \tilde{D}$, we guarantee that the manager prefers the *G* portfolio to the *A* portfolio. Further, since $\hat{D} \leq D_R^* < D^0$, we also guarantee that the manager prefers to monitor the loan portfolio, given a credible liquidation threat by the creditors. Thus, the beliefs of financiers about the manager's loan portfolio and monitoring decisions are validated in equilibrium. This situation is depicted in *Figure 2*.

Figure 2 here

In Proposition 1, we assumed that (12) holds. But what if it does not? In that case $\tilde{D} < \hat{D}$ (see *Figure 3*). The original shareholders are now between a rock and a hard place—if D_R^* is chosen to be less than $\tilde{D}$ to avoid asset-substitution moral hazard, then the creditors will unconditionally liquidate the bank at *t = 1*, and if D_R^* is set above $\hat{D}$ to avoid unconditional liquidation, then the manager will risk-shift and prefer the aggressive portfolio *A* over *G*.

Figure 3 here

It might appear that a straightforward resolution of this problem would be to issue long-maturity debt with a date-2 face value of $D_R^* \leq \tilde{D}$ and give creditors control rights to demand early repayment at $t = 1$ only when $\tilde{Z}_1 = 0$ is observed. This would take out of the hands of the creditors the power to unconditionally demand repayment and liquidate the bank at $t = 1$. However, this solution does not work here because $\tilde{Z}_1$ is not a verifiable signal for contracting purposes, so debt contracts cannot be written conditional on $\tilde{Z}_1$. But even if $\tilde{Z}_1$ were verifiable and contractible, we show in Appendix B that giving creditors only $\tilde{Z}_1$-conditional control rights may not work in a slightly modified setting for which our model can be viewed as a reduced-form representation. The basic idea in this more general setting is that as long as creditors have access to some non-contractible, payoff-relevant private information in addition to $\tilde{Z}_1$, giving creditors unconditional control rights to demand full repayment at $t=1$ may be desirable because it would enable them to use this private information to discipline the bank.

IV. CORRELATED DEFAULTS AND EXTERNALITIES

In the analysis up to this point, if (12) holds, then private contracting results in optimal leverage decisions that eliminate the problems created by managerial rent-seeking and risk-shifting and, as a result, eliminate the need for any sort of prudential regulation. If (12) does not hold, then private contracting may not lead to the first-best outcome, as discussed above. This, however, is still the second best that deviates from the first best because not all frictions can be resolved without cost and, again, it is not a prescription for regulatory intervention. We have set up the benchmark model in this way precisely to examine how government forbearance can distort the private outcomes toward socially inefficient ones and how to address this distortion.

We now consider the possibility of systemic risk. We deliberately make simplistic but tractable assumptions that are essential to illustrate our main points. We provide a discussion of robustness of our conclusions to relaxing these assumptions in Section VI.

We extend the model by assuming two failure states for the aggressive loan portfolio project *A*: an idiosyncratic state—say, θ_i—and a systematic state—say, θ_S. The probabilities of these states are q_i and q_s, respectively, such that $q_i + q_S = 1 - p_A$. Moreover, for simplicity, we assume that:

$$1 - p_A - q_S = 1 - p_G \qquad (15)$$

or, in other words, $q_i = 1 - p_G$. This condition implies that the probability of the idiosyncratic state θ_i is the same as the failure probability of the good loan portfolio *G*. We assume that in state θ_i bank failures are uncorrelated in the cross section of banks and that there are arbitrarily many banks, so that by the law of large numbers, in state θ_i, the probability that *all* banks will fail is zero in the limit. In state θ_S, however, these failures are perfectly correlated. Assumptions weaker than (15) would suffice for our purposes, but (15) effectively implies that the entire asset-substitution component of portfolio *A* relative to portfolio *G* is due to its systematic risk. Also note that having arbitrarily many banks and *i.i.d.* portfolio cash flows for portfolio *G* also guarantees that the probability that all banks will fail together if they choose portfolio *G* is asymptotically zero.

Rationale for Lender of Last Resort and "Looting" in the End Game

Assume that there is a sufficiently large social cost, Ψ, associated with *all* banks failing together and their creditors making losses, but no (or a negligibly small) cost associated with the failure of any individual bank.[11] Then, in the case where all banks fail together, and only in this case, the regulator (such as a LOLR or resolution authority) will find it ex post efficient to intervene and bail out some or all banks. We assume that in a bailout the forbearing regulator needs to pay off only the creditors fully (but can wipe out equity, replacing it for example with a government stake that is unwound in due course) and thereby avoids the cost Ψ. Indeed, if bank owners or shareholders are bailed out too, then the distortions induced by regulatory forbearance would be even larger. Assume also for the sake of argument that *all* banks are bailed out if they fail together, e.g., due to "fairness" reasons.

Formally, the regulator's objective is to avoid the ex-post social cost Ψ when banks fail together (since this cost is assumed to be sufficiently large) and, among different regulatory policies at t = 0, choose the one that maximizes the ex-ante value of the bank, that is, which leads to efficient portfolio choice at $t = 1$. The regulator faces the same informational constraints as the bank owners and must respect the contractual features of debt and equity claims that the bank uses (e.g., limited liability of equity, priority of debt over equity, etc.), but it has the ability to restrict the bank's capital structure and its

[11] If only an individual bank fails, it can be readily acquired in practice since other banks are healthy. Such re-intermediation is difficult when a large part of the banking sector fails. Equally likely are externalities from a full-scale run on the financial sector when many banks fail at the same time.

asset choices (only partly, that is, limit investments to storage technology or liquid government bonds, as will be explained below), and potentially create and enforce "super priority" claims on the bank's assets.[12]

Consider first the case of Proposition 1, where (12) holds and $D_R^* \in \left[\hat{D}, \tilde{D}\right]$ is the private equilibrium of leverage choices. We can then show that with anticipation of regulatory bailouts when banks fail together but not otherwise, there are (at least) two Nash equilibria in the game in which banks are choosing their optimal capital structures. In one Nash equilibrium, all banks continue to raise debt, *D*, such that: $D_R^* \in \left[\hat{D}, \tilde{D}\right]$ and choose i.i.d. portfolios. This is a Nash equilibrium because, conditional on all other banks choosing such a D, an individual bank knows that if it deviates and fails, it will not be bailed out since all the other banks will not fail at the same time. In effect, our previous analysis of Proposition 1 stands in this case, and it is privately optimal for each bank to raise debt with a date-2 repayment obligation of $D_R^* \in \left[\hat{D}, \tilde{D}\right]$.

But there is also a Nash equilibrium in which all banks asset-substitute in favor of the aggressive portfolio *A* (even though condition (12) can be met by a level of debt that would not trigger asset substitution) and raise the maximum possible leverage consistent with the creditors having the liquidation incentives to induce the manager to monitor loans. That is, $D_R^* = D^0$. We call this the "looting" equilibrium, as in Akerlof and Romer (1993). To see why, note that if the bank sets the face value of the debt it raises at *t = 0* at $D_R^* = D^0 > \tilde{D}$, and creditors believe the bank will choose portfolio *A* and be bailed out by the central bank or the government in state θ_S, then the amount of debt the bank can raise at *t = 0* is:

$$D_{\max} = p_G D^0 + \left[1 - p_G\right] V_{AIP} \tag{15}$$

[12] An analogy can be made with respect to the objective function of the Federal Deposit Insurance Corporation (FDIC) in the United States. Its explicit mandate is to provide deposit insurance, charge the insured depositories an ex ante risk-based premium for the insurance, pay off insured claims if the insured institutions fail, resolve (merge or liquidate) the failed institutions, and intervene in an early fashion ("prompt corrective action") with a variety of restrictions on activities in case the capitalization of the insured depository falls below a predetermined level.

where D^0 is given by (10). This expression recognizes that if creditors believe they will be bailed out contingent upon portfolio failure, then they will view their claim on the cash flow of portfolio *A* as being of the same risk as their claim on the cash flow of portfolio *G*. And if the face value *D* that satisfies (15) exceeds *I*, then it means that asset substitution in the presence of forbearance reduces the risk of debt enough and raises debt capacity to the point that banks not only can satisfy their date-0 investment need, but in fact have surplus funds at date 0. We define:

$$S \equiv (D - I)^{+} \tag{16}$$

as the "surplus debt" that is raised by the bank at $t = 0$. This surplus debt can simply be paid out to bank shareholders as a dividend.

Proposition 2 (Looting Equilibrium): *Suppose (12) holds. Then with multiple banks and correlated risk in the aggressive loan portfolio* A, *assuming that the regulator bails out all banks when they fail together (creditors take no haircuts but shareholders are wiped out) and none otherwise, then two Nash equilibria arise. In one (socially efficient) Nash equilibrium, all banks raise debt* $D_R^* \in \left[\hat{D}, \tilde{D}\right]$ *and also choose the good loan portfolio* G. *In the other (socially inefficient) Nash equilibrium, all banks set the face value of debt at the highest possible level consistent with loan monitoring,* D^0*, (given by equation (10)); raise* $D_{\max}$ *of debt (given by equation (15)); and, choose the aggressive loan portfolio* A. *In the inefficient Nash equilibrium, the bank's initial shareholders pay to themselves at t = 0 any and all of the surplus debt, S, raised by the bank (given by equation (16)).*

In essence, the regulator's intervention in state θ_S "socializes" the bank's incremental risk in choosing portfolio *A* relative to portfolio *G*. This induces all banks to choose portfolio *A* and also employ excessive leverage. Although creditors still provide some market discipline by ensuring that the bank manager monitors loans, the locus of the relevant agency problem shifts now to the conflict of interest between bank owners and taxpayers. That is, the taxpayers now become an "economic creditor" of the banking sector, and maximizing bank equity value can lead to highly-levered capital structures and correlated risky asset choices by bank owners.[13] These capital structure and asset choices “loot” the regulator (effectively the taxpayers) by passing on risks to the regulator as much as possible and paying out dividends from the proceeds of the extra debt issued at $t = 0$. The reason why the initial shareholders of the bank want the surplus debt issuance S to be paid out as a dividend is that it would otherwise stay in the bank and limit creditor shortfalls when banks fail, reducing the size of the ex-post bailout, and in turn, reducing the ex-ante transfer to the shareholders.

Equally importantly, bank debt now only serves the purpose of curbing managerial shirking in monitoring, but loses all of its bite as far as pricing the debt to reflect the bank’s risk-shifting problem is concerned. In effect, bank leverage is the conduit through which regulatory forbearance is transferred in value terms to the bank’s shareholders through undertaking of excessively risky portfolios. Such “looting” arises purely through equity value maximization and it is possible *only if* risky portfolios are funded through debt. Recall that shareholders do not get bailed out ex post so that absent leverage, looting incentives do not exist. Somewhat interesting is the observation that as the marginal value of bank monitoring of loans increases, it increases the amount of looting banks can do, as shown below:

Corollary 1: *Suppose p_ℓ decreases, but all other parameters remain the same. Then, absent regulatory intervention to explicitly prevent banks from taking excess leverage, there is an increase in the amount of debt the bank can issue in the looting equilibrium at t = 0.*

Thus, we see that somewhat ironically the greater the effect of bank loan monitoring (as measured by the spead $p_A - p_\ell$ or $p_G - p_\ell$), the worse is the regulator’s problem. Banks can pledge the high cash flows to creditors because their downside in the systematic-risk state is socialized. Therefore, as the value of monitoring increases, there is an increase D^0 , as explained in the discussion of the intuition underlying condition (13). This increase in D^0 enables the bank to raise more debt before it hits the upper bound of

[13] Acharya, Gujral, Kulkarni, and Shin (2009) show that while distressed depositories (such as Wachovia and Washington Mutual) subject to prompt corrective action by the FDIC cut their dividends a few quarters prior to their failure, similarly distressed investment banks (Lehman Brothers and Merrill Lynch) in fact raised their dividends in quarters prior to failure even as their leverage was rising. The latter evidence is consistent with anticipation of regulatory forbearance, especially following the rescue of Bear Stearns, providing incentives to the investment banks to *not* cut back on leverage and dividends even as their insolvency became imminent.

D^0 beyond which creditors lose the incentive to credible threaten full repayment and *conditional* liquidation at *t = 1* to ensure loan monitoring by the bank.

Incentive Compatible Regulatory Policy

How can the regulator design an ex-ante policy to eliminate the high-leverage Nash equilibrium and prevent the choice of the socially-inefficient portfolios? One way would be to pre-commit *not* to bail out banks ex post (at least not all the time) when they fail together. However, such a pre-commitment is not time-consistent when the cost of a full-blown crisis is sufficiently high (see footnote 7). Hence, a more attractive approach is to consider ex-ante regulation—for example, a capital requirement.

In fact, if (12) holds, then all that the regulator needs to do is impose a capital requirement that limits the bank's debt to so that its promised date-2 repayment, D_R, is not more than $\tilde{D}$. Given that leverage, it becomes privately optimal for the bank to select portfolio *G* since the incentive compatibility constraint for the choice of *G* holds. So a simple capital requirement eliminates of the problem of looting. Indeed, this reaffirms the well-known role of capital requirements in ameliorating asset-substitution moral hazard. However, this result is predicated on the assumption that (12) holds.

Now suppose (12) does not hold, so $\hat{D} > \tilde{D}$. In this setting, the regulatory capital requirement such that $D_R(D) \le \tilde{D}$ continues to dissuade banks from investing in loan portfolio *A* and hence eliminates the social cost Ψ. In that sense, this is a feasible regulatory policy. However, with this policy, creditors follow an inefficient unconditional liquidation policy, so the market discipline of debt is lost altogether as the manager prefers not to monitor the loan portfolio in this case. The trick is to uncover a feasible capital requirement that eliminates the social cost Ψ, ensures selection of the loan portfolio *G*, and ensures that the manager monitors.

It turns out that a regulatory policy that attains such an outcome exists:

Proposition 3: *With multiple banks and correlated risk in the asset-substitution portfolio, assuming that ex post the regulator bails out all banks when they fail together (creditors take no haircuts but* *shareholders are wiped out) and none otherwise, we obtain the following ex ante (t = 0) optimal regulatory policy:*

(i) Suppose (12) holds. Then, the regulator requires the bank to issue debt D such that the corresponding face value $D_R(D)$ *given by (14) satisfies* $D_R(D) \in [\hat{D}, \tilde{D}]$. *Any financing need in excess of D, defined as* $E = I - D$, *is met with equity.*

(ii) Suppose (12) does not hold. In that case, one efficient solution for the regulator is to allow the bank to raise D in debt such that its date-2 repayment obligation (given by (14)) is $D_R(D) = \hat{D}$. *The bank is then also required to raise equity of* $\hat{D} - \tilde{D}$ *that is in excess of what it needs to satisfy its investment need, i.e., it must raise equity of* $E_T = E + E_s$, *where* $E = I - D$ *and* $E_s \equiv \hat{D} - \tilde{D}$, *giving the bank total equity capital of* $E_T + E_0$. *The bank is then required to invest the "special capital"* E_s *in a risk-free and liquid security, whose payoff,* $\hat{D} - \tilde{D}$, *accrues to the bank's shareholders in the solvency state*[14]. *The special capital account is not available to the bank's creditors in the insolvency state, but instead accrues to the regulator.*

Under the regulatory policy laid out in Proposition 3, the regulator demands that, in addition to the equity input *E*, which permits the bank to meet its investment need *I* when combined with new borrowing D, the bank must raise an additional E_s in equity. This E_s is kept in a "special capital account" and invested in a liquid and riskless security like Treasuries. A key feature of this account is that, while it is available to enhance the bank's shareholders' payoff in the solvency state, it is not available to the bank's creditors in the event of idiosyncratic insolvency.[15] Assuming that the contractual

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[14] The riskless asset in our model has a zero return. If the return $r > 0$, then $E_S = [\hat{D} - \tilde{D}] / [1 + r]$.

[15] The special capital account is in the spirit of cash-asset reserve requirements. However, it goes well beyond reserve requirements, given the restriction on its distribution to creditors. Another key difference is that a reserve requirement simply locks up a fraction of deposits in the form of cash or deposits at the Federal Reserve. By contrast, the special capital account can be "leveraged" by the bank to add assets, just like regular tier-1 capital. That is, with a 4 percent special capital requirement, every dollar of capital in this account allows the bank to put another $25 of assets on its books.

constraint that shareholders cannot be paid anything if creditors are not paid in full is binding, the only resolution is for the capital account to go to the regulator in the event of insolvency. The regulator can, in turn, use the proceeds from the account to fund its administrative costs and potentially even transfer them to surviving banks and firms in the economy (e.g., by lowering taxes).

Another interesting aspect of Proposition 3 is that the special capital account can be arbitrarily large.[16] The bank must raise at least as much special capital as $\hat{D}-\tilde{D}$, but if it raises more, *none* of the relevant incentives are affected in the sense that the bank's preference for the *G* loan portfolio is unchanged. This reduces the calibration burden on the regulator, who can choose the minimum level of the special capital account to be quite large without worrying about diluting the monitoring incentives of creditors.

What does it mean for the creditors to *not* have access to the special capital account in the event of bankruptcy when we admit the possibility of a bailout by the regulator? If all banks fail together (by choosing and experiencing the correlated-default state), then the regulator bails them all out and creditors take *no* haircut, making the treatment of the special capital account a moot point in this state. However, if a particular bank experiences idiosyncratic failure when some others succeed, its special capital account accrues to the regulator rather than its creditors. This means that creditors take *some* haircut even if there is capital in the special account. Since credit remains risky, monitoring incentives are preserved.

Thus, it is the *combination* of what happens in the portfolio-success state (the special capital account is an additional equity input that accrues to the bank's shareholders) and the non-systemic failure state (the special capital account accrues to the regulator rather than the creditors) that allows asset-substitution moral hazard to be deterred without diluting creditors' monitoring incentives.

Formally, why this works is as follows. When (12) is violated, $\hat{D}>\tilde{D}$. So *the repayment* $D_R=\hat{D}$ must be chosen to ensure that creditors will only threaten conditional liquidation to induce the bank manager to monitor loans. Because this violates the IC constraint for the bank to prefer portfolio *G*

[16] Of course, it is constrained by future cash flows available for backing the issued equity and transaction costs involved in the issuance, which for simplicity we have assumed to be zero

to *A*, we need to somehow restore the incentives of shareholders to eschew the higher risk in A. Providing an additional equity input—via the special capital account—helps to do this since this amount is invested in the riskless asset. This action increases the bank shareholders' payoff in the solvency state and thus reduces asset-substitution moral hazard. But it does not affect creditors' incentives since it is not available to bank creditors in the event of insolvency; note that creditors do not care about this account in the solvency state or in case of correlated failures since they get paid in full with or without this account. Consequently, the special capital account is "invisible" to the creditors. All of our previous results (Section III, Proposition 1) will therefore apply.

Another point to note is that the proposition claims that when (12) does not hold, the proposed scheme is one, but not the only, efficient scheme. This is because all that is required is that the special capital account be invested in something within the bank, not siphoned off by the bank's shareholders. Mandating investment in Treasury securities is one way to achieve this, but clearly any permissible investment will do. We will discuss in the next section the conditions under which mandating investment of the special capital account in Treasury securities becomes the *unique* efficient equilibrium.

One may argue that introducing the special capital account means that we have given the regulator contracting possibilities that were unavailable to the bank and its financiers in the absence of the regulator. In particular, this account represents a kind of security that differs from debt and equity. This security achieves efficiency by breaking the "budget-balancing constraint" which requires that the sum of the claims of shareholders and bondholders must be equal to the total claims on the bank.[17] The reason why such a security was not permitted in the absence of the regulator is that we limited the set of securities available for contracting to debt and equity and did not address the problem of optimal mechanism/security design in the presence of a third party (such as the regulator) that is not a claimant of the firm. We do not know of any existing securities that correspond exactly to the special capital

[17] This is reminiscent of the resolution provided by relaxing the budget-balancing constraint in the model of moral hazard in teams in Holmstrom (1982).

account.[18] But if such a security were to be designed, then the inefficiency associated with the second best (when (12) does not hold) may be eliminated, and the regulator may be able to rely on this security instead of the special capital account.

We believe, however, that the regulator has the tools to do better on this front than is possible with private contracting. The reason is that if private contracting were to involve a security similar to the special capital account, it would require payment to a third party (not the bank, or its debt and equity financiers) in the event of an idiosyncratic failure, which would make it necessary for a court to verify whether a failure was idiosyncratic or systemic. This action may be more costly or difficult for the court than for a bank regulator, especially when banks may have failed and expediency may be a practical necessity. Finally, we have assumed that when banks fail *en masse*, the regulator bails out *all* the banks. If the regulator were to bail out only a subset of banks—say, only the largest banks in the spirit of too-big-to-fail or too-systemic-to-fail banks —or the systemically most important banks, then the looting problem we have discussed will be confined to that subset, as will be the application of the capital-requirement regime in Proposition 3.[19]

V. INEFFICIENT PERQUISITES CONSUMPTION

In the model so far, we considered two forms of moral hazard: shirking in managerial monitoring and asset-substitution. However, in practice, there may be a third from of moral hazard: inefficient consumption of perquisites or diversion of cash flows by bank managers. In particular, when there is a special capital account, there may be incentives for the bank managers (and even large shareholders) to

[18] The special capital account also differs from a deposit insurance premium. First, creditors are not guaranteed in all instances of bank failures, but only in case of systemic failures. Thus, the regulator imposes a "haircut" on creditors in case of such failures, whereas with deposit insurance, insured creditors are paid off regardless of whether bank failures are idiosyncratic or systemic. And second, contributions to the special capital account belong to bank shareholders in success states, and are therefore not like once-and-for-all payments to the deposit insurance fund. That is, the capital-account contributions are more like a "deductible" than a "premium."

[19] Moreover, it is also not necessary that the regulator know precisely when a bank failure is idiosyncratic and when it is systemic. As long as the regulator's (noisy) signal about this is informative, *ex ante* bank incentives with respect to leverage and project choice will be the same as in our main analysis, albeit with possibly additional conditions.

inefficiently consume perquisites out of excess cash,[20] since the cost of this consumption is shared with the regulator who takes possession of this account in the event of an idiosyncratic failure.

Once this possibility is recognized, it becomes uniquely efficient for the regulator to mandate investment of the special capital account in Treasury securities, if we assume that any other kind of investment could facilitate "regulatory arbitrage" or perquisites consumption in disguise. For example, a subsidized loan could be made to a company to build a fancy office at a below-market rate or provide a corporate jet at a below-market price, or the special capital could effectively consist of some variable interest in off-balance sheet entities and special purpose vehicles in the "shadow banking" sector.

Formally, suppose the bank manager can take the E_S in Proposition 3 and divert it to perquisites consumption that yields a utility of $b\Delta E_S$, where the constant $b \in (0,1)$. The inefficiency of perquisites consumption is measured by *b*. The assumption that $b < 1$ means that perquisites consumption is inefficient, and the smaller *b* is, the greater is the inefficiency. We now have:

Corollary 2: *Suppose the bank managers can (inefficiently) consume perquisites, but the perquisited consumption is not excessively inefficient in the sense that $b > p_G$. Moreover, the manager can disguise such consumption as loans or risky assets. Then it is a uniquely efficient equilibrium in Proposition 3 for the regulator to require the special capital account to be invested in Treasury or other securities whose authenticity can be costlessly verified.*

Thus, we see that adding this third form of moral hazard makes it necessary for the regulator to control how the special capital account is invested. In particular, the regulator needs to ensure that the bank manager does not inefficiently transfer to perquisites consumption the funds raised for the special capital account.

Note that this is not merely the usual shareholder-manager agency conflict. Even if the bank manager has 100% ownership of the bank at $t = 0$ before raising external financing, he will wish to

[20] By excess cash, we mean that the bank has raised via security issuance more cash than it needs to roll over its legacy debt and finance the new loan portfolio. This issue of excess cash is relevant because as we showed, the bank may have an incentive to issue more debt than needed to meet its investment need when there is the expectation of bailouts.

engage in this inefficient perquisites consumption since it provides him with a way to increase his expected utility at the expense of the regulator and taxpayers who end up losing the buffer provided by the special capital account in the event of an idiosyncratic failure of the bank.[21]

VI. ROBUSTNESS OF THE MODEL AND ITS REGULATORY IMPLICATIONS

The purpose of this section is to discuss the impact of some of the assumptions in our analysis, and then examine the regulatory policy implications, with a focus on implementation.

Model robustness. It is useful to consider some of the modeling features we adopted, especially in the context of the systemic risk state. We assumed that the risk-shifting project's entire incremental risk over and above the socially efficient project was due to correlated risk. As a result, when this risk materialized, banks all failed together. We also assumed that in such eventuality, the social cost of winding down the entire financial sector was substantially large, so that regulators adopted bailouts which wiped out shareholders but not the creditors. Finally, such forbearance of creditors was extended to all failing banks.

These assumptions are certainly stylized but aimed to capture the importance of *a* state in which there is the possibility of system-wide failures. Acharya and Yorulmazer (2008) consider a more general *n*-bank model in which only a part of bank risk-taking is correlated, so that not all banks fail together. The essence of their model (and related papers) is that as the number of bank failures becomes increasingly large, it becomes impossible to resolve bank failures in an orderly manner through the acquisition of failed banks' assets by surviving insiders (intuition is similar to that in Shleifer and Vishny, 1992). In such states, disorderly liquidations are necessary, or there is inefficient entry as banking assets are available at "fire-sale" prices. To avoid these, regulators find it desirable to intervene. Acharya and Yorulmazer (2007, 2008) also show that there is a time-inconsistency problem: regulators would ideally want to be tough and in fact liquidate all banks to discourage the ex-ante moral hazard of bank herding

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[21] The reason why $b > p_G$ is needed for this to happen is that p_G is the probability with which the manager and initial shareholders themselves get to enjoy E_S if it is not consumed as perquisites, so $b > p_G$ is merely a condition which says that the marginal benefit of perks to the manager exceeds its marginal cost.

and investments in correlated assets, but such a policy is not credible ex post given the costs of disorderly liquidations. Our model focuses simply on the extreme state in which all banks fail and systemic failures would lead to huge losses in continuation. This is for sake of simplicity and our qualitative insights would be preserved whenever expected losses (probability of the state times realized ex-post losses) from states with high enough bank failures are sufficiently large.

Acharya and Yorulmazer (2008) also show that depending upon the number of bank failures, the regulator may wish to liquidate some banks and bail out others, the tradeoffs being driven ex post by the fiscal costs of bailouts faced by banks. In a model such as their (and ours) where banks are all symmetric, such ex-post policies require randomization that involves bailing out some banks and letting others fail. In practice, such selective rules are somewhat difficult to implement due to reasons of equity among the failed banks. They also open the door for lobbying of the regulatory agencies and the government officials involved in making these bailout decisions. And put simply, even if such discrimination were possible based on other criteria, the uncertainty of the outcomes may itself lead to actions that amplify the initial risk and cause a full-fledged run on all banks. Therefore, our assumption that all banks are bailed out when the costs of a systemic failure are large is an admittedly simplistic but realistic description of regulatory behavior in truly systemic states of the world.

It is potentially also interesting to ask the question of how to optimally continue failed banks in systemic failure states. In a recent paper (among others), Philippon and Schnabl (2010) consider the optimal recapitalization problem of distressed banks in the context of the debt overhang problem faced by bankers in continuing intermediation activities. Note that under such considerations of the ex-post incentives of bankers, continuations would not necessarily involve bank shareholders – at least insiders – being entirely wiped out. While this may be reasonable in some circumstances, it would imply an even stronger ex-ante herding problem as forbearance extends not just to creditors, but also to bankers. At any rate, in most bank bailouts, the typical feature is that creditors – even unsecured creditors – are given blanket government guarantees.[22] Our model reflects such an assumption directly, capturing all costs of bank liquidations in a single parameter Ψ rather than modeling who are the bank creditors (depositors, money market funds, other banks, etc.) and why imposing losses on them would impair the flow of funds in the economy.

Finally, it might seem that the special capital account we propose can be quite costly since substantial levels of capital may be required to be set aside in Treasuries in order to counter bank-herding incentives; this then locks up capital that is not available for direct investments. Note first, however, that this special capital is still available to the bank for "leveraging" purposes, i.e., to acquire additional liabilities that can be productively invested in risky assets. It is only the direct investment of the special capital account that is in Treasuries. To what extent this direct investment restriction constrains the economy is ultimately an issue of calibration.[23] On the one hand, it seems from the evidence of Reinhart and Rogoff (2008) that costs of systemic banking crises are rather substantial and obliterate at least a decade of economic gains, if not more. On the other hand, the special capital account can be tied to a measure of banks' correlated exposures. Such measures are increasingly being used to assess the systemic risk of the financial sector (see Acharya, Pedersen, Philippon and Richardson, 2010a, 2010b, and references therein). While yet imperfect, such measures could nevertheless be used to vary the required levels of the special capital account. This way, the off-equilibrium levels of special capital account would be substantially large when bank correlations are high so that banks would be discouraged from herding and making correlated investments in the first place. In turn, the realized or equilibrium levels of the special capital accounts need not be substantially large. Our key point is that once suitably calibrated, a bank's special capital account should not be available to creditors in some states of the world when bank resolution is not so costly (e.g., in idiosyncratic states when banks can be sold to other banks), so that creditor incentives to monitor and discipline banks are preserved.

[22] See the empirical literature cited in Acharya and Yorulmazer (2008), as well as consider the evidence on bailouts such as those of A.I.G. and Citigroup following the failure of Lehman Brothers in the United States.
[23] See Acharya, Mehran, Thakor and Schuermann (2011) for a discussion of how to calibrate special capital accounts in a variety of ways using market data and regulatory stress tests in a manner that is robust to model errors.

Regulatory implications. Our analysis has several important implications for regulatory capital requirements. We discuss below the implementation of the two-tiered capital requirement in Proposition 3 (when (12) does not hold).

Suppose that banks are at their "regular" tier-1 capital requirement at the outset. The regulator could ask each bank to retain all earnings and not pay any dividends, have the bank put the retained earnings in a "special" capital account, and require a separate minimum capital ratio for this kind of capital.[24] Once the special capital ratio exceeds that particular level, the bank can resume dividend payments. The retained earnings can be invested only in predetermined securities such as Treasuries. When a negative shock hits (either bank-specific or systemic) and the bank's tier-1 capital diminishes, it would be allowed to sell these Treasury securities and transfer cash from the special capital account to the regular capital account; indeed, this would be a requirement if banks do not replenish tier-1 capital through other means, such as equity issuances. However, the dividends would be frozen until special capital is built back up to its required ratio[25].

Note that this approach can deal not only with the challenge of replenishing capital but also with potential liquidity shortages, since selling Treasuries provides liquidity. This proposal to preserve capital—or, in other words, to prevent capital erosion—has numerous advantages.

First, the two-tiered capital proposal deals simultaneously with the various forms of moral hazard most commonly studied in banking—shirking in managerial monitoring of loans, managerial perquisites consumption, and shareholders' risk-shifting—in an integrated way and incorporates both the market discipline of debt as well as the risk-attenuation benefit of equity. For instance, the proposal gets around the criticism that more capital makes bank managers lazy or reduces creditor-induced market discipline. This is because the special capital account is *additional* capital that would not exist otherwise (money

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[24] The idea of building up equity via divided retentions invokes dynamic contracting issues. A dynamic agency model of financial contracting appears in DeMarzo and Fishman (2007) and is beyond the scope of our paper. In the banking context, how banks adjust their ratios depends on their asset portfolio activities (see Memmel and Raupach (2010)).

[25] Banks will not choose to impose such dividend restrictions on their own because the associated benefit of avoiding the systemic externality of *en masse* bank failures is *not* a private benefit to any bank.

would have been paid out as dividends)—so it does *not* replace the debt that provides discipline. Moreover, the bank *cannot* invest the retentions as it pleases—the investments have to be in Treasury securities.

Second, the fact that the shareholders/managers will lose the special capital in bad states ensures that the positive aspect of high capital is maintained. This precludes the gradual pre-crisis erosion of bank capital during the good times (through dividend and cash distributions to shareholders and bank managers) that can convert an adverse asset-side shock into a crisis. More importantly, our scheme eliminates bank behavior that makes adverse asset shocks endogenously more likely owing to correlated choices of poor investments with other banks.

Third, the proposal has the advantage of *not* requiring shareholders to infuse additional cash capital at a time when confidence in bank management is at its nadir and liquidity is very low. Dividends can be retained at a time when the bank is doing well, or at least not in imminent danger of distress. Specifically, *no* adverse information is communicated by dividend restrictions kicking in when capital has to be moved from the special capital account into the regular capital account because a negative shock to earnings has depleted the regular capital account. This is because the "automatic" nature of the transfer involves *no* management/regulatory discretion and hence communicates no information beyond that already contained in the negative earnings shock. Hence, this idea of building and preserving capital through retained earnings and dividend restrictions is relatively simple.

Fourth, since capital is transferred from the special capital account into the regular capital account on a continuous and mechanical basis, the issue of designing "crisis triggers" does *not* arise. The bank's regular capital never gets depleted (absent unexpected shocks), nor is the bank required to raise additional equity by issuing stock.

Fifth, if this scheme is limited to only the systemically important banks, then the special capital account could be viewed as a "special surcharge" on those banks.

Finally, the scheme is relatively easy to harmonize internationally, or at least as easy as the current tier-1 capital requirements.

In the fall of 2009, regulators raised the issue of banks needing to have additional liquid capital in difficult financial times and recommended the idea of "capital conservation." Later in the year, the Bank for International Settlements (BIS) proposed "a framework to promote the conservation of capital and the build-up of adequate buffers above the minimum that can be drawn down in periods of distress."[26] The BIS Task Force also questioned the prudence of the continuation of dividend payments by banks in 2008-09, a period when they were supposed to cut dividends (see Acharya, Gujral, Kulkarni, and Shin (2009)). The model presented here generates a formal rationale for the BIS capital conservation proposal, and also provides a channel through which dividend restrictions can be used to gradually replenish bank capital levels and dissolve risk-shifting incentives without diminishing the market discipline of subordinated debt. Since dividend cuts are mechanically triggered when banks access their special capital account, dividend payments cannot resume unless the special capital account is replenished to meet the regulatory requirement (e.g., some percentage of assets).[27]

We also note that the specific capital regulation proposal based on our theory is close to a new model for capital regulation proposed by U.S. Treasury Secretary Timothy Geithner in his first public speech since the enactment of the Dodd-Frank Act of 2010:[28] "Under the framework now being built, firms will be subject to two tiers of capital requirements. All firms will need to hold a substantial minimum level of capital. And they will be required to hold an added buffer of capital set above the minimum. If a firm suffers losses that force it to eat into that buffer, it will have to raise capital, reduce dividends, or suspend share repurchases. The hope is that this will help make the system more stable over time, in part by forcing banks to move more quickly to strengthen their balance sheets as the risk of

[26] See also the press release "Group of Governors and Heads of Supervision Announces Higher Global Minimum Capital Standards," issued by the Basel Committee on Banking Supervision, Bank for International Settlements, September 12, 2010.

[27] The calibration issue of what this percentage should be is outside the scope of our model. By all accounts, however, current Basel risk weights might need to be revisited to take account of systematic or correlated risk of assets rather than their total or absolute risk. See Acharya (2009), and Acharya, Pedersen, Philippon, and Richardson (2010a, 2010b), among others who have proposed measurement of such correlated risks and tying capital requirements to such "systemic risk weights".

[28] See U.S. Treasury Secretary Timothy F. Geithner's speech "Rebuilding the American Financial System," delivered at New York University's Stern School of Business, August 2, 2010, and available at http://www.ustreas.gov/press/releases/tg808.htm.

potential losses increases." Our two-tiered capital scheme differs from this proposal, however, by virtue of its contingent distribution rights— notably, that a part of the capital in our scheme is maintained in safe assets and not available for creditor payments (in the event of non-systemic bank failures).

VII. RELATED LITERATURE

In this paper, we developed a theoretical model to examine the tension between the role of leverage in disciplining bank managers—preventing shirking by bank managers responsible for monitoring loans—and the role of bank capital in diminishing the risk-shifting incentives of bank shareholders. The agency problems we studied are at least as old as the research by Jensen and Meckling (1976). Recently, however, Hellwig (2009) has pointed out the "asymmetry" in Jensen and Meckling's modeling of the agency costs of debt (asset substitution) and equity (managerial effort shirking or pursuit of perquisites consumption), explaining that, in typical models, managerial effort shirking or perquisites consumption does not alter portfolio risk, whereas asset substitution does. This asymmetry prevents an analysis of optimal capital structure along a common continuum of portfolio choices.

Our paper addresses exactly this issue in the context of bank leverage choices by building a model in which both effort-shirking in loan monitoring and asset substitution have portfolio risk ramifications.[29] Dewatripont and Tirole (1994) consider optimal regulation of bank capital structure in a model where too much debt can lead to excessive creditor intervention, whereas too much equity can lead to managerial shirking.[30] Our model shares some of their seminal insights, but focuses on the leverage distortions and correlated risk-taking induced by government guarantees and LOLR (also see footnote 7).

Acharya and Thakor (2010) highlight that, while bank liquidity is enhanced by short-term debt, such debt can endanger financial stability by increasing the likelihood of contagious asset liquidations by creditors. These liquidations induce ex-post regulatory bailouts of banks and ultimately reduce market

[29] For other papers that combine the rent-seeking and risk-shifting moral hazard problems, see Biais and Casamatta (1999), and Edmans and Liu (2010). In particular, Biais and Casamatta also argue that effort investment requires more leverage ,whereas risk-shifting containment requires less leverage. These papers do not, however, consider the correlated risk-taking across banks and the related regulatory distortions that we analyze in this paper.

[30] Stulz (1990) also models rent-seeking moral hazard in a corporate-finance setting in which financing policies are used to reduce the costs of investment distortions. Guembel and White (2007) build a model styled on Dewatripont and Tirole (1994) in which monitoring by different claimholders of the firm is endogenized.

discipline ex ante. Acharya and Thakor refer to this as the "dark side" of leverage-based liquidity creation, but also highlight that diminishing it through a LOLR or regulatory forbearance runs the risk of eliminating *all* of the market discipline of debt. While they model the micro-foundations of contagious creditor liquidations, we focus instead on the design of capital regulation that can ameliorate the distortions induced by correlated risk-taking and bailouts.

We also briefly discuss the relationship of our work to the many capital regulation proposals currently on the table. Perhaps the most direct approach to dealing with perceived capital shortages in banking is to require banks to keep more equity capital (e.g., Bhattacharya, Boot and Thakor (1998), and Admati, DeMarzo, Hellwig and Pfleiderer (2010)). This is a familiar argument in bank capital regulation, and a formal justification for it can be traced back to as early as Merton (1977), who showed that the value of the deposit insurance put option can be enhanced by banks keeping lower capital, which then necessitates minimum regulatory capital requirements. The higher-capital-requirement proposal was a recurring theme in the literature prior to the occurrence of the Savings & Loans crisis and in its aftermath (see, e.g. the discussion in Bhattacharya and Thakor (1993)). While this earlier work did not consider complications like correlated leverage and correlated risk taking, we have shown formally in this paper that the higher equity-capital-requirement proposal is similar to our Case I where a simple minimum equity capital requirement suffices to eliminate correlated risk taking and excessive leverage. However, an important part of our analysis is to point out that there is a limitation of this proposal in that it does not work when we are in Case II, where the two-tiered capital requirement structure we have proposed is needed to restore efficiency.

An alternative to simply increasing capital requirements is suggested by Flannery (2005) who makes a case for contingent capital certificates (CCC)[31] as part of bank regulatory capital. He argues that when a bank's stock price drops and the bank's viability becomes questionable, then its contingent capital

[31] For a detailed discussion of contingent capital, see also Albul, Jaffee, and Tchistyi (2010), Basel Committee on Bank Supervision (2009), Dudley (2009), McDonald (2010), Squam Lake Working Group on Financial Regulation (2009), Pennacchi (2010), Sundaresan and Wang (2010), and Vermaelen and Wolff (2010). Admati, DeMarzo, Hellwig, and Pfleiderer (2010) provide a critique of contingent capital proposals.

(debt to start with) should be converted into equity. Hart and Zingales (2009) and Duffie (2010) focus on forced equity issues by banks when bank performance is deteriorating. To provide incentives for banks to issue equity and overcome the problem of risk-shifting, Admati and Pfleiderer (2009) propose the idea of expanding the limited liability of equity, thereby transferring more risk to bank shareholders than at present, but they question the usefulness of leverage in general as a device to provide discipline of banks.

In another strand of recent proposals, Kashyap, Rajan, and Stein (2008) discuss the concept of "capital insurance," where a bank can purchase insurance against the risk of system-wide defaults. They argue that this approach would make banks more willing to issue equity and would create a priced mechanism for regulatory capital infusion during a crisis. Acharya, Pedersen, Philippon, and Richardson (2010a) propose taxing the systemic risk of financial institutions. This tax would be based on the expected loss of a financial firm, conditional on the occurrence of a systemic crisis. Acharya et al (2010b) recommend that a bank be required to purchase private capital insurance against its *own* losses contingent upon market or system-wide crisis.[32]

Our approach has similarities and differences with these proposals. Our proposal of the special capital account expands the shareholders' capital at risk and, on this dimension, is similar to Admati and Pfleiderer's (2009) idea of increasing bank shareholder liability. However, our proposal does not rely purely on increasing equity capital to improve bank-level incentives, as we argue that this can compromise the market discipline role of debt. Our focus is also not on security issues and reliance on capital markets (unlike Flannery (2005), Hart and Zingales (2009), and Duffie (2010)). In addition, we do not rely on private insurance protection (unlike Kashyap, Rajan, and Stein (2008), and Acharya et al.

[32] It is intuitive to think of bank capital as a hedge against (relatively continuous) profitability shocks, and insurance as protection against large (discontinuous) shocks. This intuition is related to the analysis of a firm's choice between hedging through derivatives and purchasing insurance provided by Rochet and Villeneuve (2011). Note, however, that the empirical evidence provided by Berger and Bouwman (2011) shows that capital improves the survival probability of a bank even during a crisis. Mehran and Thakor (2011) provide a theory and empirical evidence that higher capital is correlated with higher bank values in the cross section. See also Allen, Carletti and Marquez (2011) who analyze the monitoring-related benefits of bank capital, its effects in the context of credit market competition, and the implications for capital regulation.

(2010b)), which raises counterparty risk issues.[33] Rather than investing in insurance, banks can, in practice, build up the capital they need in good times by accumulating retained earnings (and savings) in an account to be used in difficult times when capital is needed. These dynamics could be mechanical so that there is no news or stigma associated with drawing down or building up capital. The key distinguishing feature of our theoretical framework, however, is that banks are compelled to internalize the consequences also of having inadequate capital. Overall, the feature of our proposed capital requirement—that capital be high enough from a shareholder standpoint to deter excessive risk taking, but low enough from a creditor standpoint to induce monitoring and discipline—is novel.

VIII. CONCLUSION

Introducing the disciplining roles of both bank debt and equity in a model of bank capital structure, we have shown that the tension between effort shirking and asset-substitution moral hazard problems requires that bank leverage not be too low or too high. The key to the result that leverage not be too low is the need to create strong enough incentives for creditors to threaten efficient liquidation and deter managerial shirking. And the key to the result that leverage not be too high is based on the need to have enough capital in the bank to eliminate the shareholders' propensity to take excessive risk at the creditors' expense. This leads to a theory of optimal bank capital structure with private contracting.

When we introduce correlated default risk, bank failures generate negative social externalities. This result creates a potential case for ex post regulatory intervention to bail out banks when they fail *en masse*. But such discretionary regulatory forbearance itself counterproductively becomes a source of systemic risk. It leads to multiple Nash equilibria for ex ante bank capital structures, one of which involves banks over-levering themselves; selecting socially inefficient, excessively risky and cross-sectionally correlated portfolios; and, paying out surplus debt as dividends or other forms of cash

[33] In the limit, for there to be no counterparty risk, the insurer must hold 100 percent of risk-free government securities against insurance sold. The insurer would pass the costs of holding this liquidity on to the insured, but then the insured might as well keep the liquidity itself (unless it is better to designate liquidity management to an insurance firm to avoid free cash-flow problems). We prefer that banks (the insured) keep liquidity with a regulator (rather than a private insurance firm) in the form of designated securities such as government bonds.

distributions. Indeed, riskier portfolios may be funded only with debt and not equity, as it is the creditors that enjoy the ex-post forbearance.

By funding excessively correlated risky portfolios, however, bank owners effectively extract rents from regulators and taxpayers. Under some conditions, a simple minimum equity capital requirement solves the problem and eliminates the bad Nash equilibrium. But in general, this approach can make bank debt too safe and erode market discipline, necessitating that a part of the capital requirement be in the form of a special capital account that does not accrue to creditors except in the case of *en masse* bank failures. Such capital regulation ensures that bank shareholders have enough skin in the game not to take aggressive risks, and also ensures that bank creditors have enough skin in the game too, which preserves the market discipline of debt even in the presence of the regulatory safety net.

APPENDIX A

Proof of Lemma 1**:** If the bank raises all of I from debt financing (i.e., $D=I$), then with a repayment obligation of D_R, the bank manager's expected payoff with loan portfolio G and monitoring is:

$$p_G\left[H_G + V_{AIP} - D_R\right] - M\ .$$

Competitive capital market pricing means that D_R is given by

$$I = p_G D_R + \left[1 - p_R\right] V_{AIP} \qquad \text{(A–1)}$$

Substituting for D_R, we can write the bank manager's expected payoff as:

$$p_G H_G + V_{AIP} - I - M.$$

The bank manager's expected payoff without monitoring (when creditors price the bank's debt assuming G will be chosen and monitored), absent any threat of liquidation at $t = 1$, is:

$$p_\ell\left[H_\ell + V_{AIP} - D_R\right].$$

The condition for the manager to not wish to monitor is

$$p_G\left[H_G + V_{AIP} - D_R\right] - M < p_\ell\left[H_\ell + V_{AIP} - D_R\right].$$

Upon substitution for D_R from (A-1) and rearranging the above inequality can be written as:

$$p_G H_G - p_\ell H_\ell - \left[p_G - p_\ell\right]\left[I - V_{AIP}\right]\left[p_G\right]^{-1} < M \tag{A–2}$$

Since (A-2) is the same as (6), it holds.

Now assume that all of *I* is raised from outside equity. Then, the condition for the manager to prefer *not* to monitor can be written as:

$$[1-\alpha]\left[p_G H_G + V_{AIP}\right] - M < [1-\alpha]\left[p_\ell H_\ell + V_{AIP}\right] \tag{A–3}$$

where α satisfies the competitive pricing condition:

$$\alpha = I\left[p_G H_G + V_{AIP}\right]^{-1} \tag{A–4}$$

Substituting (A–4) in (A–3) and rearranging yields:

$$p_G H_G - p_\ell H_\ell - I\left[p_G H_G + V_{AIP}\right]^{-1}\left[p_G H_G - p_\ell H_\ell\right] < M \tag{A–5}$$

It can be verified that, given (A–2), the inequality in (A–5) holds since

$$I\left[p_G H_G + V_{AIP}\right]^{-1}\left[p_G H_G - p_\ell H_\ell\right] > \left[p_G - p_\ell\right]\left[I + V_{AIP}\right]\left[p_G\right]^{-1}.$$

We have shown therefore that the manager will not monitor the loan portfolio regardless of whether the bank raises all of its external financing with debt or equity. It can also be verified that this is true for any convex combination of these two extremes, i.e. for any capital structure. Thus, as long as there is no threat of liquidation or dismissal at $t = 1$, the manager will not monitor when the investors price the debt or equity believing he will choose portfolio *G* and monitor. It is easy to verify that the manager will also not monitor in the absence of a liquidation threat for any capital structure even if investors believe that he will not monitor and hence price the debt and equity accordingly. Thus, the only

Nash equilibrium in the absence of a liquidation or dismissal threat at $t=1$ is for the manager to not monitor. ■

***Proof of Lemma 2*:** Creditors assume that the bank has chosen the *G* loan portfolio. If the creditors observe $\tilde{Z}_1 = 0$, then they can infer that the manager did not monitor at *t = 0*. With a date-2 repayment obligation of D_R, the expected value of the creditors' loan if they continue at *t = 1* is

$$p_\ell\left[D_R \wedge \left\{H_\ell + V_{AIP}\right\}\right] + \left[1 - p_\ell\right]V_{AIP} \tag{A–6}$$

where "$\wedge$" is the "min" operator. The value of the creditors' claims if there is liquidation is:

$$L \tag{A–7}$$

For the creditors to find it subgame prefect to liquidate to *t = 1* upon observing $\tilde{Z}_1 = 0$, the incentive comparability (IC) constraint is (A–6) $\leq$ (A–7). Suppose first that $D_R \geq H_\ell + V_{AIP}$. Then (A–6) becomes

$$p_\ell H_\ell + V_{AIP},$$

and we know by (4) that

$$p_\ell H_\ell + V_{AIP} > L,$$

so the IC constraint will not hold in this case. So choose $D_R < H_\ell + V_{AIP}$, so the IC constraint becomes

$$p_\ell D_R + \left[1 - p_\ell\right]V_{AIP} \leq L$$

which can be written as

$$D_R \leq D^0 \equiv V_{AIP} + \frac{\left[L - V_{AIP}\right]}{p_\ell} \tag{A–8}$$

It is easy to verify that $D^0 < H_\ell + V_{AIP}$, which validates the assumption that $D_R < H_\ell + V_{AIP}$.

Now suppose $\tilde{Z}_1 = x$ is observed at *t = 1*. Then the creditors' expected payoff from continuation is

$$p_G D_R + [1 - p_G] V_{AIP} . \tag{A–9}$$

Thus, the IC constraint for the creditors to find it subgame perfect to let the bank continue is

$$p_G D_R + [1 - p_G] V_{AIP} \geq L ,$$

which becomes

$$D_R \geq \hat{D} \equiv V_{AIP} + \frac{[L - V_{AIP}]}{p_G} \tag{A–10}$$

This completes the proof. ■

Proof of Lemma 3: Suppose shareholders observe $\tilde{Z}_1 = 0$ at *t = 1*. For any D_R, their expected payoff from liquidation is $\{L - D_R\} \wedge 0$. Their expected payoff from continuation is:

$$p_\ell [H_\ell + V_{AIP} - D_R] \tag{A–11}$$

which we know is strictly positive for any $D_R \leq D^0$.

Two cases will be considered. In the first case, suppose $D_R \in [\hat{D}, D^0]$, as per Lemma 2. Then it follows that $D_R = p_G D_R + [1 - p_G] D_R > p_G D_R + [1 - p_G] V_{AIP} \geq L$. Hence, $\{L - D_R\} \wedge 0 = 0$ and the IC constraint simply becomes

$$p_\ell [H_\ell + V_{AIP} - D_R] \geq 0$$

which clearly holds.

Now, in the second case, assume that the bank is all-equity financed. Then, the IC constraint for the shareholders to find it subgame perfect to continue becomes:

$$p_\ell\left[H_\ell + V_{AIP}\right] + \left[1 - p_\ell\right]V_{AIP} \geq L \qquad \text{(A–12)}$$

which clearly holds given (4). Thus, the shareholders will always avoid firing the bank manager. ■

Proof of Lemma 4: Follows immediately from the observation that since all debt and equity securities issued by the bank at $t = 0$ are fairly priced to give investors an expected return of zero, all the surplus from the initial capital structure choice goes to the initial shareholders. Hence, they will instruct the manager to choose the capital structure that is value maximizing. ■

Proof of Lemma 5: The proof follows immediately by showing that the initial amount D raised from debt must equal the expected value of the creditors' claims conditional on loan portfolio G being chosen and monitoring by the manager. That is,

$$D = p_G D_R + \left[1 - p_G\right]V_{AIP}$$

which yields (14) upon rearranging. ■

Proof of Proposition 1: If (12) holds, then $\hat{D} < \tilde{D}$. By asking the manager to choose $D_R^* \in \left[\hat{D}, \tilde{D}\right]$, the initial shareholders ensure that the creditors will liquidate at $t = 1$ if $\tilde{Z}_1 = 0$ and permit continuation if $\tilde{Z}_1 = x$. By choosing to monitor the loan portfolio, the manager guarantees $\tilde{Z}_1 = x$ at $t = 1$. Moreover, as long as $D_R^* \leq \tilde{D}$, the value of the equity of the bank is maximized by choosing loan portfolio G. Thus, with $D_R^* \in \left[\hat{D}, \tilde{D}\right]$ the manager chooses G and monitors the loan portfolio. If $D\left(D_R^*\right) < I$, then the rest of the bank's investment need, $I - D\left(D_R^*\right)$, is covered by issuing equity. If $D\left(D_R^*\right) > I$, then $D\left(D_R^*\right)$ is raised as debt, no equity is issued, and initial shareholders are paid a dividend of $D\left(D_R^*\right) - I$. It is then an equilibrium for creditors to infer that the bank will choose loan portfolio G and monitor it, so D_R^* is given by (14). ■

Proof of Proposition 2: We have $D_R^* \in [\hat{D}, \tilde{D}]$. To prove that it is a Nash equilibrium for all bank's to choose G and monitor their portfolios, suppose all banks except bank i choose G. If bank i chooses G, their all failures are i.i.d. and as long as $D_R^* \in [\hat{D}, \tilde{D}]$, the bank manager will prefer monitoring over no monitoring. The expected payoff for the bank manager with portfolio G is (denoting D^G as the amount of debt raised at $t = 0$ and α as the share of ownership sold to raise equity $I - D^G$):

$$[1-\alpha]\, p_G \left[H_G + V_{AIP} - D_R^* \right] - M$$

$$= p_G \left[H_G + V_{AIP} - D_R^* \right] - [I - D^G] - M \tag{A–13}$$

since $\alpha p_G \left[H_G + V_{AIP} - D_R^* \right] = I - D^G$. If the manager chooses portfolio A with $D_R^* \in [\hat{D}, \tilde{D}]$ and the creditors believe that he has chosen G, his expected payoff is

$$p_A \left[H_A + V_{AIP} - D_R^* \right] - [I - D^G] - M \tag{A–14}$$

Given that the IC constraint (11) holds with $D_R^* \in [\hat{D}, \tilde{D}]$, we know that (A–13) exceeds (A–14). So, as long as the manager of bank i chooses $D_R^* \in [\hat{D}, \tilde{D}]$, he will indeed choose portfolio G when all other banks are choosing G. To complete the proof, we need to show that he will indeed chose $D_R^* \in [\hat{D}, \tilde{D}]$. Suppose not. Let $D_R > \tilde{D}$. Now, in the single-bank case, the manager prefers A over G. Given that all the other banks are choosing G, the failure of bank i will be uncorrelated with the failures of other banks. Thus, the manager's expected payoff from choosing $D_R \in [\tilde{D}, D^0]$ can be written as:

$$p_A \left[H_A + V_{AIP} - D_R^A \right] - [I - D^A] - M \tag{A–15}$$

where $D_R^A > \tilde{D}$ designates the repayment obligation and D^A the amount of debt raised. Then, using (14), we can write (A–15) as:

$$p_A H_A + p_A D_R^A - \left\{ I - p_A D_R^A - [1 - p_A] V_{AIP} \right\} - M$$

$$= p_A H_A + V_{AIP} - I - M \tag{A–16}$$

Similarly, (A–13) can be written as:

$$p_G H_G + V_{AIP} - I - M \tag{A–17}$$

Clearly, (A–17) exceeds (A–16). hence, it is a Nash-equilibrium for all banks to issue debt such that $D_R^* \in \left[\hat{D}, \tilde{D}\right]$ and then choose portfolio *G* and monitor it.

Bus suppose all other banks are choosing $D_R^* \in \left[\hat{D}, D^0\right]$. Now if the manager of bank *i* chooses *A*, with some probability the failure of bank *i* will be perfectly correlated with the failures of all the other banks. However, creditors will price the debt *as if* the repayment probability is p_G, not p_A, due to the systemic bailout in the state of correlated defaults. Thus, the manager's expected payoff from choosing $D_R^* \in \left[\hat{D}, D^0\right]$ and therefore being expected to choose portfolio *A* is:

$$p_A\left[H_A + V_{AIP} - D_R\right] - [I - D] - M$$

$$= p_A H_A + p_A V_{AIP} - p_A D_R - \left[I - p_G D_R - [1 - p_G]V_{AIP}\right] - M$$

$$= p_A H_A + V_{AIP} - \left[p_G - p_A\right]V_{AIP} + \left[p_G - p_A\right]D_R - I - M \tag{A–18}$$

We want to show that the expression in (A–18) is greater than $p_G H_G + V_{AIP} - I - M$. That is, we want to show

$$p_G H_G + V_{AIP} < p_A H_A + V_{AIP} - \left[p_G - p_A\right]V_{AIP} + \left[p_G - p_A\right]D_R$$

or

$$\left[p_G H_G - p_A H_A\right] < \left[p_G - p_A\right]\left[D_R - V_{AIP}\right] \tag{A–19}$$

Now, by (11), we have $\left[p_G - p_A\right]\left[\tilde{D} - V_{AIP}\right] = \left[p_G H_G - p_A H_A\right]$, which means

$$\begin{aligned}[p_G H_G - p_A H_A] &= [p_G - p_A][\tilde{D} - V_{AIP}] \\ &< [p_G - p_A][D_R - V_{AIP}]\end{aligned}$$

since $D_R > \tilde{D}$.

Thus, it is also a Nash equilibrium for every bank to issue debt such that $D_R \in [\tilde{D}, D^0]$ and choose portfolio A and monitor it. ■

Proof of Corollary 1: The upper bound on the amount of debt the bank issues in the looting equilibrium is D^0, given by (10). Clearly, $\partial D^0 / \partial p_\ell < 0$. So, a decrease in p_ℓ increases D^0. ■

Proof of Proposition 3: The proof of part (i) is straightforward. Since the regulator's objective is to maximize the ex ante value of each bank and avoid the social cost Ψ, the regulator will want each bank to choose portfolio G and monitor it. If (12) holds, this is clearly achieved by requiring the bank to issue enough debt to ensure $D_R \in [\hat{D}, \tilde{D}]$, as shown in the earlier results.

Now suppose (12) does not hold. Then $\hat{D} > \tilde{D}$. Suppose the regulator asks the bank to issue debt such that $D_R > \hat{D}$, and also issue equity $E_T = E + E_s$, where $E = I - D(\hat{D})$ and $E_S = \hat{D} - \tilde{D}$, with E_S being kept in a special capital account. The bank manager's expended payoff with portfolio *G* and monitoring now becomes:

$$[1-\alpha] p_G [H_G + V_{AIP} - \hat{D} + E_S] - M$$

where $\alpha p_G [H_G + V_{AIP} - \hat{D} + E_S] = I - D(\hat{D}) + E_S$.

So, this expression can be written as:

$$[1-\alpha] p_G [H_G + V_{AIP} - \hat{D} + \hat{D} - \tilde{D}] - M$$

$$=[1-\alpha]\, p_G \left[H_G + V_{AIP} - \tilde{D} \right] - M \tag{A–20}$$

If the manager chooses portfolio A instead, his expected payoff is:

$$[1-\alpha]\, p_A \left[H_A + V_{AIP} - \tilde{D} \right] - M \tag{A–21}$$

From our previous analysis (see (11)) we know that for $D_R = \tilde{D}$, (A–20) and (A–21) are equal.

Hence, the manager will choose portfolio *G*. ■

Proof of Corollary 2: Then manager's expected utility from keeping E_S invested in the bank (at a zero rate of return) is:

$$p_G \left\{ \hat{D} - \tilde{D} \right\} \text{ with portfolio G,} \tag{A–22}$$

and if he consumes E_S as perquisites, it is:

$$b\left[\hat{D} - \tilde{D} \right] \text{ with portfolio G.} \tag{A–23}$$

Comparing (A–22) and (A–23), we see that, as long as $b > p_G$ (the perquisites consumption is not too inefficient), the manager will prefer to consume E_S as perquisites by dressing up the perquisites consumption as a real portfolio. ■

APPENDIX B

Imagine that, $\tilde{Z}_1$ is publicly verifiable for contracting purposes and has the following probability distribution:

$$\tilde{Z}_1 = \begin{cases} x > 0 & w.p. \quad 1 \text{ if } M > 0 \\ x & w.p. \quad m \in (0,1) \text{ if } M = 0 \\ 0 & w.p. \quad 1 - m \text{ if } M = 0 \end{cases}$$

The effect of monitoring on $\tilde{Z}_2$ is unchanged. Moreover, after $\tilde{Z}_1$, is observed, any group of financiers—either shareholders or creditors—can incur a cost of $c_0 > 0$ to discover whether the manager indeed monitored the loan portfolio at $t = 0$. This discovery is possible only after $\tilde{Z}_1$ is realized. The result of this discovery is privately observed only by the group of financiers that invested in the discovery, and cannot be credibly communicated to another group of financiers.

The following becomes immediately apparent:

(1) No financiers will invest c_0 in finding out whether the manager monitored at $t = 0$ of $\tilde{Z}_1 = 0$ is observed. If they have the control rights to do so, creditors will liquidate the bank after observing $\tilde{Z}_1 = 0$.

(2) If $\tilde{Z}_1 = x$ is observed, then as long as c_0 is small enough, creditors will wish to investigate at a cost and find out if the manager monitored, and then liquidate the bank only if they discover monitoring was not done.

(3) If $\tilde{Z}_1 = x$ is observed, shareholders will not wish to either investigate at a cost c_0 or liquidate the bank.

Thus, in this setting, depending on parameter values, it may be efficient to give the bank's creditors *unconditional* (not contingent upon the realized $\tilde{Z}_1$) liquidation rights and rely on the incentives provided by the bank's capital structure to guarantee that only efficient liquidation occurs.

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FIGURE 1: SEQUENCE OF EVENTS

$t = 0$

- Initial bank shareholders determine the mix of equity and debt to raise to fund the investment need of *I*.
- Let $D_R(D)$ be the date-2 face value promised to creditors to raise *D* in debt.
- Bank manager chooses one out of two mutually-exclusive loan portfolios: an aggressive portfolio *A* and a good portfolio *G*.
- The manager makes a privately-observable choice of whether to monitor the loan portfolio at a private cost *M*.

$t = 1$

- An interim signal, Z_1, is realized, which reveals whether the manager has monitored loans.
- Creditors then decide whether to liquidate the bank or let it continue.
- Shareholders decide whether to fire the manager or let him continue.

$t = 2$

- Terminal portfolio cash flow, Z_2, is observed and all financiers are paid off.

FIGURE 2:
OPTIMAL AMOUNT OF DEBT RAISED BY THE BANK AT t = 0 WHEN (12) HOLDS

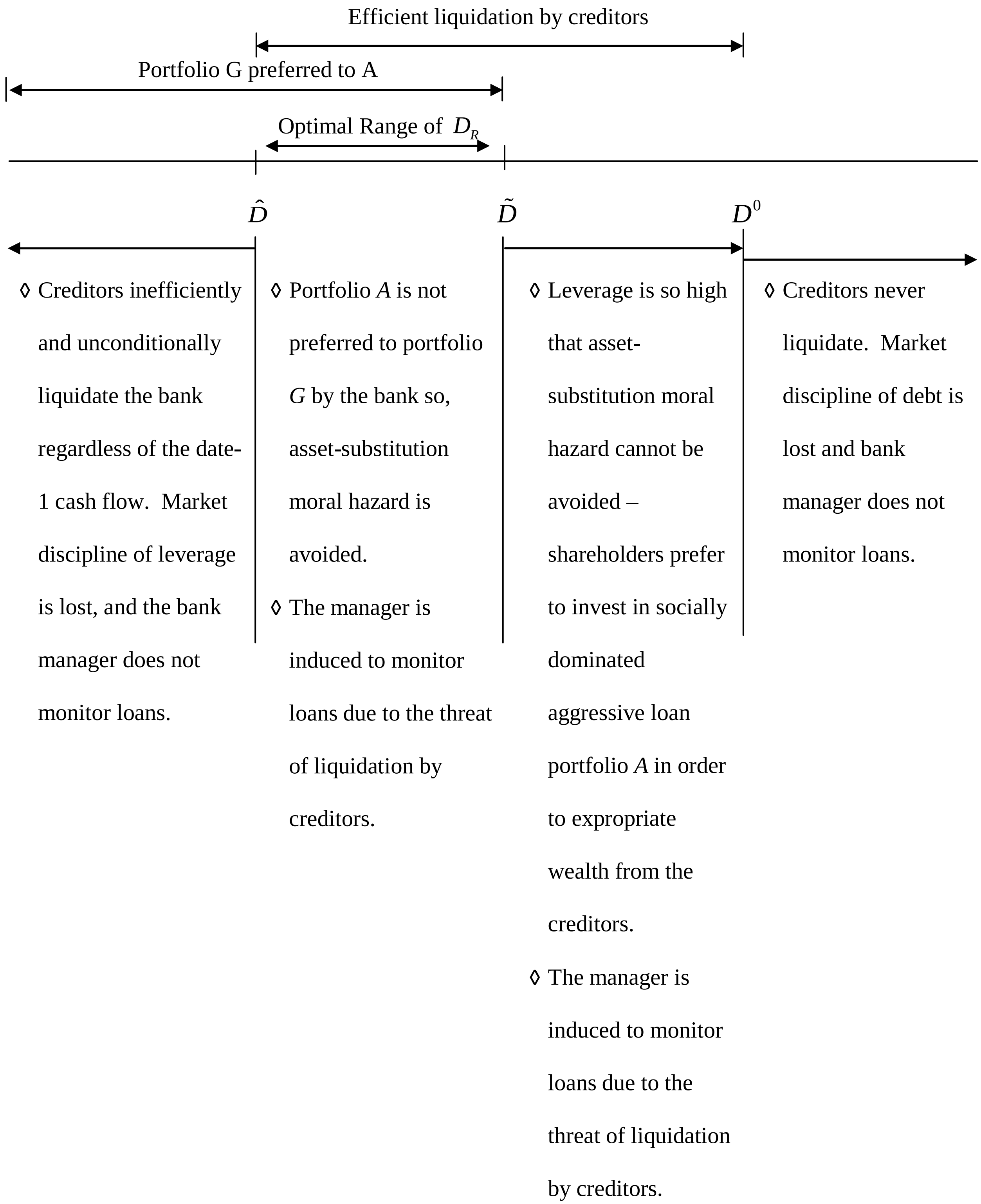

FIGURE 3:
OPTIMAL AMOUNT OF BANK DEBT AT t = 0 WHEN (12) DOES NOT HOLD

There does not exist an optimal D that simultaneously ensures that creditors monitor $(D_R(D) > \hat{D})$ and the bank prefers the G loan portfolio $(D_R(D) < \tilde{D})$.

$\tilde{D}$ $\hat{D}$ D^0

◊ Leverage is so low that creditors unconditionally and inefficiently liquidate the bank. Market discipline of leverage is lost and bank manager does not monitor loans. ◊ Leverage is low enough to ensure that portfolio *G* is preferred to portfolio *A* by the bank manager, so asset-substitution moral hazard is avoided.	◊ Creditors unconditionally and inefficiently liquidate the bank. So market discipline of leverage is lost and bank manager does not monitor loans. ◊ Leverage is so high that asset-substitution moral hazard cannot be avoided – bank manager prefers to invest in socially dominated portfolio *A* in order to expropriate wealth from the creditors.	◊ Leverage is high enough to ensure that creditors liquidate the bank conditionally and efficiently so the manager is induced to monitor due to creditor discipline. ◊ Leverage is so high that asset substitution moral hazard cannot be avoided – shareholders prefer to invest in portfolio *A* over portfolio *G*.	◊ Creditors never liquidate. Market discipline of debt is lost and bank manager does not monitor loans.