

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

by

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Abstract

We consider a model in which banks face two moral hazard problems: 1) asset substitution by shareholders, which can occur when banks make risky, negative net-present-value loans; and 2) managerial rent-seeking, the result of bank owners investing in inefficient “pet” projects or shirking in effort. 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 rent-seeking 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. Leverage can be reduced via a minimum equity capital requirement, which can also 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 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

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The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of New York or the Federal Reserve System. For their helpful comments, the authors thank Shashwat Alok, Paolo Angelini (discussant), Mitch Berlin, Doug Diamond, Alex Edmans, Mark Flannery, Itay Goldstein, Beverly Hirtle, Yaron Leitner, Meg McConnell, Loretta Mester, Diego Rodriguez Palenzuela (discussant), Marc Saidenberg, Kevin Stiroh, Jean Tirole, Joseph Tracy, Lucy White (discussant), and participants at conferences held at the Federal Reserve Bank of New York (Conference on Contingent Capital, April 2010, and Conference on the Corporate Finance of Financial Intermediaries, September 2010), Gothenburg University (May 2010), Bank for International Settlements, Basel (June 2010), Federal Reserve Bank of Philadelphia (August 2010), National University of Singapore (September 2010), Board of Governors of the Federal Reserve System (October 2010), European Central Bank, Frankfurt (Conference on Liquidity, October 2010), the Riksbank, Stockholm (October 2010), and the Stockholm School of Economics (October 2010).

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“In many things, the middle have the best / Be mine a middle station.”

— Phocylides

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) managerial rent-seeking, which can take the form of managers pursuing private benefits via investments in “pet projects” (“tunneling” in extreme cases) or shirking in effort; and (ii) asset substitution or risk-

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. It has been proposed, for example, to use “contingent capital” (Flannery (2005)), which infuses capital into banks via conversion of debt into equity when banks get close to insolvency, individually and/or collectively. An alternative, stressed by Admati, DeMarzo, Hellwig and Pfleiderer (2010), is to simply increase levels of bank capital in good times. Acharya, Pedersen, Philippon and Richardson (2010a) have proposed tying capital requirements – or alternatively taxes (2010b) – to contributions of individual financial firms to capital shortages of the financial sector as a whole.

shifting, which is the shareholder-creditor conflict that bank equity value may be enhanced by engaging in excessively risky, negative net-present-value projects at the expense of creditors.

The first moral hazard problem—that of managerial rent-seeking—is well-recognized, and it has been proposed that (uninsured) debt can provide the necessary market discipline to 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., 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 rent-seeking 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 create systemic failures.

² Specifics of modeling differ across models. For instance, Diamond and Rajan (2001) model the managerial rent-seeking as a hold-up problem in the spirit of Hart and Moore (1994).

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.

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? Third, how does regulatory intervention in the form of ex post bank bailouts affect the bank's 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 – rent-seeking and risk-shifting – in a single model. We use this model to explicitly characterize the tension between the need to have enough bank leverage for market discipline and the need to have enough bank capital to attenuate asset-substitution incentives. We show that if leverage is too low, debt is essentially safe and creditors lack the incentive to monitor and discipline the rent-seeking behavior of bank managers. However, if leverage is too high, managers are inclined to choose risky assets and bet the bank with the creditors' money.

The privately-optimal capital structure of the bank is 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 in 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 project 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 choosing a rent-seeking project or the inefficiency of an excessively risky project, 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 project choices. 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 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.

In the absence of rules precluding forbearance or facilitating orderly low-cost resolution (which may be practically infeasible when there are wholesale failures) 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. As creditors anticipate being bailed out, increasing bank leverage is *not* met with a higher cost of debt financing, nor is there any credit rationing. In fact, somewhat perversely, banks' ability to raise leverage is enhanced when they take excessive risk. This is because riskier projects allow creditors to be promised a higher upside, but their downside risk is “socialized”. 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. Such looting arises purely through shareholder value maximization by banks. Indeed, because shareholders do not get bailed out ex post, excessively risky projects *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

⁶ Acharya and Yorulmazer (2007), Acharya (2009), and Farhi and Tirole (2009) build formal models of the regulator's time-consistency problem when banks fail together and of the induced herding behavior in banks. 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.

taxpayers. To the best of our knowledge, this perverse effect of government guarantees in *expanding* the debt capacity of projects more as risk *increases* 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 project 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, 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 keep 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 it is subject to contingent distribution rights. It belongs 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 unavailable to cover the claims of (uninsured) creditors. It belongs 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 monitoring incentives are not diluted and the managerial rent-seeking problem is dealt with adequately.

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.⁷ We 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 2010:⁸ “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 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 not available for creditor payments (in the event of non-systemic bank failures).

The rest of this paper is organized as follows. Section I discusses the related literature. Section II develops the single-bank model with managerial rent-seeking 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. Section V discusses the optimal capital requirement featuring the special capital account and its implications for current regulatory proposals. Section VI discusses several model extensions and

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.

⁸ 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>. 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.

robustness issues. Section VII concludes. All proofs not in the main body of the paper are in the Appendix.

I. RELATED LITERATURE

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.⁹ Our model shares some of their seminal insights, but focuses on the leverage distortions and correlated risk-taking induced by government guarantees and LOLR (see footnote 6).

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 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. Flannery (2005) makes a case for contingent capital certificates (CCC)¹⁰ 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 (debt to start with) should be converted into equity. Hart and Zingales (2009) and Duffie (2010) focus on forced equity issues by banks when performances 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

⁹ 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.

¹⁰ For a detailed discussion of contingent capital, see also Albul, Jaffee, and Tchisty (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.

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.

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. (2010b)), which raises counterparty risk issues.¹¹ 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

¹¹ 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.

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.

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 creditors on the bank’s project 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 a manager (to start with, same as the bank owners or shareholders, but in a model extension, by shareholders who appoint a manager). For simplicity, we will refer to the managers as “bank owners.” The bank possesses internal liquidity of E in the form of equity at $t = 0$ as a result of current earnings and retentions of past earnings or inside equity of bank owners. The bank needs D_0 units to meet a financing need at $t = 0$, where $D_0 \geq E$.¹² There are two ways to think about D_0 . One is that it is the amount the bank needs to invest in a new project. The other is to view it as the bank’s legacy debt, which must be rolled over at $t = 0$ before the bank can continue. In either case, if the bank is unable to finance D_0 , it ceases to exist at $t = 0$. We will refer to D_0 as the bank’s “investment need”. Thus, the bank needs a minimum external financing of $(D_0 - E)$. Bank owners decide how much new external financing to raise at $t = 0$, denoted as $D \geq D_0 - E$, provided that it is individually rational for outside financiers to provide such financing.

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 owners can meet their investment need at $t = 0$, which then allows them to choose a project at $t = 1$; no

¹² For example, consider Bear Stearns having to roll over its short-term paper every few days.

additional financing is required at $t = 1$. Raising external finance requires the bank to incur a transaction cost $T \geq 0$. For simplicity, we will set $T = 0$, but refer to the effect of a positive T when necessary. The time line to be explained below is summarized in Figure 1.

Figure 1 here

Note this specification limits *external* bank financing to debt. The bank's equity is all *inside* equity. We assume this to accommodate the popular view that bank equity is often prohibitively expensive to raise¹³. Thus whenever the bank is called (upon) to put additional equity in its capital structure, the assumption is that this will be achieved over time through earnings retentions.¹⁴

Project Attributes

There are three mutually-exclusive projects the bank owners can choose from at $t = 1$: a good project (G), a project (A) that may be preferred by bank owners owing to asset-substitution moral hazard, and a project (B) that maximizes the bank owners' private benefits and thus may also be preferred sometimes. Each project generates a stochastic cash flow at $t = 2$, denoted as Z_2 . The probability distribution of Z_2 depends on the project choice made by the bank and an interim signal about the state of the world that is publicly observable, denoted as Z_1 . The bank's project choice is made *after* the realized value of Z_1 is observed.

We describe next the formal structure of the signal and the cash flow of the three projects. Informally, the good project (G) efficiently balances risk and return, the asset-substitution project (A) is excessively risky, and the private-benefit project (B) lacks efficient innovation and therefore achieves too low a return for the bank.

Signal at $t = 1$:

¹³ See Admati, DeMarzo, Hellwig and Pfleiderer (2010) for a criticism of this "popular" viewpoint.

¹⁴ Given our informational environment, debt is a more efficient contract than equity for raising external finance. The policy implications of our analysis do not preclude outside equity, however. So, if restoring appropriate decision-making incentives calls for an equity issue and such an issuance is feasible, then our analysis suggests outside equity should be issued.

$$Z_1 = \begin{cases} x & \text{with probability (w.p.) } \theta \in (0,1) \\ y & \text{w.p. } 1-\theta \end{cases}$$

Cash flows at $t = 2$:

For project $i \in \{A, B, G\}$:

$$Z_2^i = \begin{cases} H_i Z_1 & \text{w.p. } p_i \in (0,1) \\ 0 & \text{w.p. } 1-p_i \end{cases}$$

For now, assume that for each bank the date-1 signal, Z_1 , as well as the date-2 cash flow, Z_2^i , which is conditional on Z_1 , are independently and identically distributed (i.i.d.) in the cross section of banks for each of the three projects.

We assume the following: (i) $x > y > 0$, so state x is the more favorable signal about all the projects; (ii) in terms of the likelihood of success in date-2 cash flow, the good project, G , dominates the asset-substitution project A , which in turn dominates the private-benefit project B , i.e., $p_G > p_A > p_B$; (iii) in terms of the level of date-2 cash flow, project A dominates project G , which in turn dominates project B : $H_A > H_G > H_B$; and (iv) in terms of expected cash flow at date 2, project G dominates project A and by a sufficient margin: $p_G H_G - p_A H_A > p_G - p_A$. The “sufficient margin” between the good project G and the asset-substitution project A in (iv) is easily met as the left-hand side captures the difference in expected cash flows of projects, whereas the right-hand side captures the difference in probabilities that is bounded from above by 1. We also assume that:

$$p_G H_G y > p_A H_A y > D_0. \tag{1}$$

While the first inequality is already implied by (iv) above, the second inequality implies that the expected date-2 payoffs from the good- and asset-substitution projects both exceed the bank’s legacy debt to be rolled over, which is the starting investment to be made by the bank.

Note that (ii) and (iii) above imply that projects G and A dominate project B in terms of date-2 expected cash flows and, hence, overall project value at date 0. However, the private-benefit project is

still relevant to bank decision-making since the bank owners derive a private benefit of $\beta > 0$ from investing in project B , where

$$\beta < [p_G H_G - p_B H_B] y \quad (2)$$

Combined with (i), the restriction in (2) ensures that B is socially inefficient relative to G , regardless of the date-1 signal Z_1 .

First Best

Given the project cash flows above, it is clear that, absent any agency problems, the first-best outcome is for the bank to choose the project G at $t = 1$. This maximizes the bank's expected cash flows and, as G is a positive net-present-value project, it should be funded by external financing markets absent agency problems. In what follows, our model development will focus on deriving the second-best solution and characterizing when this solution coincides with the first best.

Bank Owners' Objective

The bank owners' objective is to maximize a weighted average of the equity of the bank and the private benefits derived from project choices. The bank owners maximize

$$E(U) = \sum_{t=0}^2 E(v_t) + \beta \cdot 1_B, \quad (3)$$

where $E(U)$ is the bank owners' date-0 expected utility, and $E(v_t)$ is the expected value of the date- t residual cash flows available to the bank owners, for $t = 0, 1, 2$, where "residual" implies the amount of cash flow left over after any payments are made to external financiers. 1_B is an indicator function for the bank owners choosing project B at date 1 (in which case the derived private benefit is β).

The Contract between the External Financiers and the Bank

Project cash flows are not verifiable by any party other than the initial owners of the bank. Hence, external financiers need certain contractual rights in order to be able to extract repayments from bank owners. We assume that creditors can liquidate the bank's assets if, at $t = 2$, bank owners do not repay

their obligations in full and do so before the cash flows are diverted by bank owners. The liquidation value is zero in case the actual cash flow is zero, but is a positive value L if the cash flow is in fact positive. For simplicity, we assume that the liquidation value is the same regardless of the project chosen by the bank owners¹⁵ and regardless of the interim signal.¹⁶ Then, it can be shown that the external finance contract is a debt contract (see, for example, Townsend (1979)) with a promised cash flow at $t = 2$ of $F > 0$. We assume that $L \in (0, p_B H_B y)$, which implies, in particular, that $L < H_B y$. So under our assumptions about the cash flows of different projects, bank owners will always (weakly) find it optimal to repay creditors their promised amount F whenever the cash flow is positive rather than attempt to divert cash flows and invite liquidation of the bank by the creditors.

We assume that external financiers (as argued above, they are creditors) possess a monitoring technology that allows them, at a cost $c > 0$, to imperfectly discover the bank's project choice at $t = 1$ and force a change. In particular, incurring the monitoring cost c permits creditors to detect whether the bank has chosen B or some other project, but it does not allow them to distinguish between projects A and G .¹⁷ That is, even conditional on monitoring-based intervention by creditors at $t = 1$, project A remains a feasible choice for the bank owners.

Consistent with the previous literature (e.g., Calomiris and Kahn (1991)), we will show that the optimal debt contract for raising financing at $t = 0$ is an "intervention contingent" contract that matures at $t = 2$ but requires explicit renewal by creditors at $t = 1$. These creditors could demand repayment in full at $t = 1$ ("accelerated default") and force liquidation if full repayment is not forthcoming. This situation resembles demandable debt (see also Diamond and Rajan (2001), and Acharya and Viswanathan (2010)). For simplicity, we assume that the bank's liquidation value at $t = 1$ is also L .

¹⁵ This may be justified by assuming that creditors would sell the bank upon liquidation to a buyer who would be unable to determine which project was chosen by the bank and who would thus offer a price for the assets that is independent of the project chosen by the bank.

¹⁶ Making the liquidation value contingent upon the interim signal does not qualitatively change the analysis.

¹⁷ In a model in which the presence of debt creates asset-substitution moral hazard, it must be the case that creditors cannot monitor so effectively as to observe the borrower's project choice perfectly and thereby control it perfectly; otherwise, the shareholder-bondholder conflict is trivialized "by fiat."

The Project Choice at $t=1$

We will assume that the bank owners prefer the private-benefit project B to the good project G if the interim signal is $Z_1 = y$, even if the financing for rolling over debt at $t = 0$ were funded entirely using existing equity (as would be possible if $D_0 = E$). That is:

$$y[p_G H_G - p_B H_B] < \beta. \quad (4)$$

Further, we assume that the bank owners prefer project G to project B if $Z_1 = x$, even when the entire investment D_0 is externally financed with debt:

$$\left[x p_G H_G - \frac{D_0 [p_G - p_B]}{p_G} - p_B H_B x \right] > \beta. \quad (5)$$

In that case, the repayment promised to the creditors, conditional on project G being chosen, is D_0 / p_G , so the value of the bank owners' equity with project G is $p_G [x H_G - \{D_0 / p_G\}]$. Given that promised repayment, the value of bank owners' equity with project B is $p_B [x H_B - \{D_0 / p_G\}]$, all in the absence of creditor intervention. This makes it clear that bank owners will prefer project G to project B in case of the signal Z_1 being x as long as (5) is satisfied (this is a sufficient condition, as creditor intervention would reduce the attractiveness only of project B).

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 D_0 that it can meet using inside equity and outside financing (debt) at $t = 0$. There is an arbitrarily large number of banks in the economy.

Assumption 2 (Project Choices): Each bank's owners can make a project choice at $t = 1$ from among three mutually exclusive projects, A , G , and B , where G is the efficient (highest expected value) or the good project, A is a "risk shifting" project, and B yields the bank owners private benefits.

Across all banks choosing the same project, the terminal project cash flows are *i.i.d.* random variables. Project cash flows across banks are independent also for different project choices.

Assumption 3 (Preferences and Pricing): There is universal risk neutrality as well as competitive pricing in the capital market with a zero riskless interest rate.

Assumption 4 (Bank Owner's Objective): The bank owners maximize the sum of bank equity value and private benefits. Consumption of private benefits is socially inefficient.

Assumption 5 (Project Preferences): Bank owners prefer project *B* to all others when the signal at $t = 1$ is y and project *G* to project *B* when the signal at $t = 1$ is x . (See (4) and (5)).

Assumption 6 (Creditor Monitoring): Creditors can incur a cost $c > 0$, can monitor the bank's project choice at $t = 1$, and can force a project choice from project *B* to another project, but they cannot distinguish between projects *A* and *G*.

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 provided 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 bank chooses its project and creditors choose whether to liquidate the bank or allow it to continue. We then move to $t = 0$, at which time the bank chooses the design of the debt contract for external finance and its capital structure (mix of inside equity and outside debt).

Events at $t = 1$

At this stage, the main issues of interest are the bank owners' project choice and the actions of creditors after observing Z_1 . Suppose that at $t = 0$, the owners financed the bank with debt D . For now, we will take it as given that the debt contract with which financing was raised at $t = 0$ was one that matures at $t = 2$ but gives creditors the right to intervene at $t = 1$ and demand full repayment at that time, forcing either a

change in project choice or liquidation if repayment is not forthcoming. We will endogenize this contract when we examine events at $t = 0$. The actions of the creditors depend on what they believe the bank owners will do at $t = 1$, conditional on Z_1 , and the owners' actions at $t = 0$ and $t = 1$ will depend on what actions they believe the creditors will take in their own best interest at $t = 1$.

Our interest is in actions that are sub-game perfect for creditors at $t = 1$, not those that merely represent ex ante efficient but time-inconsistent date-0 threats of intervention. A case of particular interest is that creditors investigate the bank and then decide to let it continue at $t = 1$, rather than liquidating it. For costly investigation and continuation to be preferred by the creditors, it must be true that: (i) conditional on Z_1 , the creditors know that, without their intervention, the bank owners will choose project B at $t = 1$, and (ii) the payoff from unconditional liquidation is lower than that from investigation and continuation; recall that creditors cannot distinguish between project G and project A .

Case 1: $Z_1 = x$. In this case, creditors need to be assured that the bank owners will not prefer project A or project B to project G when $Z_1 = x$ is realized (*Assumption 5*). These incentive compatibility (IC) conditions are:

$$p_G\{xH_G - F\} \geq p_A\{xH_A - F\} \quad (6)$$

$$p_G\{xH_G - F\} \geq p_B\{xH_B - F\} + \beta \quad (7)$$

In equilibrium, at least one of these two IC constraints must be binding, or else a Pareto superior outcome can be found. Note that (7) is guaranteed by (5), so the constraint (7) is not binding under our maintained assumptions. Thus, (6) must be binding. Solving (6) as an equality yields:

$$F^* = \frac{x[p_G H_G - p_A H_A]}{p_G - p_A} \quad (8)$$

so that if $F \leq F^*$, the bank owners prefer the efficient project G to the asset-substitution project A .

Case 2: $Z_1 = y$. To keep the problem interesting, we need to identify conditions such that the manager will prefer project B in the absence of creditor intervention, so creditors will find it sub-game perfect to

intervene. *Assumption 5* ensures that this will happen when D_0 is financed entirely with internal equity.

We now state the condition for this when the bank has debt with face value F outstanding. This condition is:

$$p_G \{yH_G - F\} < p_B \{yH_B - F\} + \beta \quad (9)$$

Note that this is guaranteed by (4). Thus, this constraint is also not binding.

Next, we verify that the creditors will indeed wish to intervene and continue with project G rather than liquidate it unconditionally. That is:

$$p_G F - c \geq L \quad (10)$$

where $p_G F - c$ is the net expected payoff of the creditors from intervening at a cost c and ensuring choice of project G (expected payoff of $p_G F$ for the creditors), and L is the creditors' payoff from liquidation.

Note that if F is sufficiently low so that $F < L$ it is impossible to satisfy (10) and creditors will always unconditionally liquidate. So, assume F is large enough to satisfy $F > L$ i.e.:

$$F > F^0 \equiv L \quad (11)$$

Then we see that satisfying (10) requires:

$$F \geq \hat{F} \equiv [c + L] p_G^{-1}. \quad (12)$$

It is easy to see that $\hat{F} > F^0$, so we just need to make sure that (12) is satisfied.

Moreover, we need to ensure that when creditors intervene and force the bank owners to drop the private-benefit project B , the owners will indeed prefer the efficient project G to the riskier project A .

That is,

$$p_G \{yH_G - F\} \geq p_A \{yH_A - F\} \quad (13)$$

This requires:

$$F \leq \tilde{F} \equiv \frac{y[p_G H_G - p_A H_A]}{[p_G - p_A]} \quad (14)$$

It is easy to verify that the feasibility condition for debt is met—that is, $\tilde{F} < yH_G$.

From (8) and (14), we have $\tilde{F} < F^*$, where F^* is defined in (8). Hence, our analysis implies that the binding constraints are that $F \leq \hat{F}$ and $F \geq \tilde{F}$. That is, we need:

$$F \in [\hat{F}, \tilde{F}] \quad (15)$$

where \hat{F} is defined in (12) and \tilde{F} is defined in (14). We also need to verify that $\tilde{F} > \hat{F}$. The restriction that guarantees this is:

$$c + L < \frac{yp_G [p_G H_G - p_A H_A]}{[p_G - p_A]} \quad (16)$$

It will be assumed for now that (16) holds. We will later examine the consequences of assuming (16) does not hold. Thus, so far we have the following.

Proposition 1: *Suppose (16) holds. Then, to ensure that in equilibrium at $t = 1$ the bank owners will choose the good project G in preference to both the private-benefit project B and the asset-substitution project A, it is necessary that the $t = 2$ repayment obligation on the new debt financing raised at $t = 0$ be at least as great as \hat{F} but no greater than \tilde{F} .*

The intuition is as follows. The bank needs enough debt financing to ensure that creditors, rather than unconditionally liquidating the bank at $t = 1$, have sufficient “skin in the game” to monitor the bank owners and prevent them from choosing project B at $t = 1$. If the amount of repayment owed to the creditors is too low, they prefer to take the sure liquidation payoff L at $t = 1$ without monitoring, rather than to gamble on the risky payoff at $t = 2$ and also incur the monitoring cost.¹⁸ This leads to $F \geq \hat{F}$ as the condition necessary to prevent managerial rent-seeking. However, there also needs to be sufficient residual value to equity to ensure that, conditional upon the bank owners not opting for B, they will not prefer A over G and therefore not gamble at the expense of bank creditors. This implies that the amount of debt financing can be no greater than \tilde{F} .

¹⁸ Note that the creditors’ payoff is concave in the bank’s total payoff, so there is induced risk aversion.

Thus far, we have examined creditors' monitoring incentives, taking as a given that this monitoring will be non-stochastic in states where creditors find it sub-game perfect to monitor. There is, however, a literature on monitoring in costly-state-verification settings, which finds that randomized auditing/monitoring is generally optimal (see, for example, Mookherjee and P'ng (1989)). We establish below that this result does not apply in our model.

Lemma 1: *The optimal (sub-game perfect) monitoring strategy for creditors at $t = 1$ is to incur the monitoring cost c to investigate the manager's project choice and force a change away from project B only when $Z_1 = y$ and not when $Z_1 = x$. And when $Z_1 = y$, creditors will monitor with probability 1.*

The reason why we encounter a different result from the usual one is as follows. In the standard model (e.g., Mookherjee and P'ng (1989)), randomized auditing is ex-ante efficient because reducing the auditing probability below 1 economizes on expected monitoring costs without adversely affecting the monitored agent's action choice. In our model, however, creditors' monitoring at $t = 1$ is not intended to provide the bank with the appropriate ex-ante incentives, but rather to make sure that the bank is prevented from choosing the "wrong" project at $t = 1$. Because the incentive compatibility constraint for creditors to wish to monitor at $t = 1$ when $Z_1 = y$ must hold *pointwise* ex post rather than in expectation ex ante (as in Mookherjee and P'ng (1989)). Thus, if creditors choose not to monitor when $Z_1 = y$, they are worse off (under a randomized monitoring scheme) relative to monitoring always.

Events at $t = 0$

Now we examine the bank's decisions at $t = 0$ about the intervention rights of creditors, the amount of debt to issue, and the pricing of this debt. We first examine the issue of creditors' intervention rights.

Lemma 2: *It is optimal for the bank owners at $t = 0$ to raise debt with a contract that requires repayment at $t = 2$ but gives the creditors intervention rights at $t = 1$ that include the ability to demand full repayment at $t = 1$ or demand a change in project choice that excludes project B.*

The intuition for this result is as follows. Because the bank's project pays off only at $t = 2$ and the liquidation value of the bank at $t = 1$ is below its value at $t = 2$, it is optimal for the bank to have a

debt contract that requires repayment at $t = 2$. However, when $Z_1 = y$, the bank owners have an incentive to invest in project B , and they would do so if creditors were powerless to stop them. But creditors would also rationally anticipate this action and reflect it in the pricing of the bank's debt at $t = 0$, thereby making the bank owners bear the full brunt of investing in the inefficient project B . By giving creditors the intervention rights stipulated in the lemma, the bank owners ensure that project B will not be chosen. Since the expected value of project G or A exceeds that of B , in equilibrium the incremental value gain from not investing in B accrues to the bank owners.

We turn next to the issue of how much debt the bank will issue at $t = 0$. Note that the amount of debt financing the bank can raise at $t = 0$ with a debt face value of F is:

$$D = p_G F . \tag{17}$$

We now note a straightforward result.

Lemma 3: *The shareholders of the bank will choose the amount of debt to raise at $t = 0$ so as to maximize the total value of the bank by ensuring an equilibrium choice of project G at $t = 0$ (i.e., debt repayment obligation $F \in [\hat{F}, \tilde{F}]$ assuming (16) holds) and ensuring that any cash raised at $t = 0$ in excess of that needed to meet the bank's date-0 investment need is paid out to the owners at $t = 0$.*

The intuition here is similar to that for Lemma 2. Put simply, since debt is fairly priced and the entire surplus from operating the bank goes to the owners, they wish to have the value of the bank maximized at $t = 0$. This involves making sure that no surplus cash is left over in the bank to reduce the creditors' risk, given that creditors have based the pricing of debt solely on the project payoff.

Given the costs of raising external debt financing (recall the transaction cost of external financing T even if arbitrarily small), it follows that the debt financing needed to be issued by bank owners to meet the $t = 0$ need of D_0 is determined *after* they have used retained earnings or internal liquidity:

$$D = D_0 - E . \tag{18}$$

We can now solve for how much debt the bank can issue at $t = 0$. Since the value of the bank is maximized with the choice of project G , the face value of the debt F must be in the interval $[\hat{F}, \tilde{F}]$.

Using (17), let \hat{D} and \tilde{D} be the corresponding amounts of debt raised at $t = 0$.

Then, $D \in [\hat{D}, \tilde{D}]$ is necessary to maximize bank value. We thus have the following result:

Proposition 2: *In equilibrium, the amount of privately optimal debt financing raised by a bank at $t = 0$, D^* , is as follows. If the D that satisfies (18):*

- (i) *is less than \hat{D} , the bank borrows $D^* = \hat{D}$ and pays out $\hat{D} - [D_0 - E]$ as a dividend to the owners at $t = 0$.*
- (ii) *exceeds \hat{D} , but is less than \tilde{D} , then the bank is indifferent across different values of borrowing as long as $D \in [\hat{D}, \tilde{D}]$, and $(\hat{D} - [D_0 - E])^+$ is paid out as a dividend to the owners at $t = 0$.*
- (iii) *exceeds \tilde{D} , then the bank cannot meet its date-0 or investment need.*

The intuition is as follows. The bank cannot raise more debt than the level at which asset-substitution moral hazard is triggered. But interestingly, it cannot raise too little debt either. If the bank has so much equity E that meeting its investment need requires raising less debt than the minimum level \hat{D} needed to induce the creditors to monitor and prevent choice of the private-benefit project, then some of the equity is paid out as a dividend to ensure that at least \hat{D} in new debt is raised. *Figure 2* depicts this situation of being caught between the threats posed by Scylla and Charybdis, i.e., the tension between needing sufficient debt to impose market discipline on the bank owners and not raising so much debt that the owners will be induced to invest in projects with inefficient risks.

Figure 2 here

Thus far, we have assumed that (16) holds, such that $\hat{D} < \tilde{D}$. This yields the convenient result that a leverage level can be found that exceeds the minimum level \hat{D} needed to ensure creditor discipline

and is less than the maximum level \tilde{D} above which asset-substitution moral hazard is triggered. But what if the inequality in (16) is reversed—say, because project A becomes more attractive to the owners of the levered bank owing to a shock that increases H_A , decreases p_A , and keeps $p_A H_A$ constant? Now $\hat{D} > \tilde{D}$, so the amount of leverage, D , that the bank needs to ensure the choice of project G should be such that $D > \hat{D}$ and $D < \tilde{D}$. Clearly, it is impossible for both these inequalities to hold simultaneously. The bank will have to choose to forgo either creditor monitoring or the ability to pre-commit to eschew project A , so some inefficiency with private contracting will have to be tolerated.

Which of the two inefficiencies will be tolerated in the second-best outcome will depend on specific parameter values. If the bank chooses $D > \hat{D} > \tilde{D}$, then it will end up with the asset-substitution project A because creditor monitoring will preclude the choice of project B . On the other hand, if the bank chooses $D < \tilde{D} < \hat{D}$, then creditor monitoring is lost and leverage loses all its benefit. The bank will end up with the rent-seeking project B . This situation is depicted in Figure 3.

Figure 3 here

IV. CORRELATED DEFAULTS AND EXTERNALITIES

In the analysis up to this point, if (16) 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 (16) does not hold, then private contracting does 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 extend the model by assuming two failure states for the asset-substitution 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, assume that:

$$1 - p_A - q_S = 1 - p_G \tag{19}$$

or, in other words, $q_i = 1 - p_G$. This condition implies that the probability of idiosyncratic state θ_i is the same as the failure probability of the good project 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 (19) would suffice for our purposes, but (19) effectively implies that the entire asset-substitution component of project A relative to project G is due to its systematic risk. Also note that having arbitrarily many banks and *i.i.d.* project cash flows for project G also guarantees that the probability that all banks will fail together if they choose project G is asymptotically zero. We will consider the case in which (16) holds and also the case in which (16) does not hold.

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.¹⁹ 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) 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 project

¹⁹ 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.

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 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.²⁰

Consider first the case of Proposition 2, where (16) holds and the D that satisfies (18) does not exceed \tilde{D} . 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 an amount of debt that is moderate and allows them to meet their date-0 investment need, but it does not trigger asset-substitution incentives: $D \in [\hat{D}, \tilde{D}]$. 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. Our previous analysis of Proposition 2 stands in this case, and it is privately optimal for each bank to raise $D \in [\hat{D}, \tilde{D}]$.

But there is also a Nash equilibrium in which all banks asset-substitute in favor of project A (even though condition (18) can be met by a level of debt that would not trigger asset substitution) and raise the maximum possible leverage by setting $F = F_A \equiv yH_A$,²¹ 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 $F = yH_A$ and creditors believe the bank will choose project 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:

²⁰ 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.

²¹ One could argue that the bank could even set F_A at $xH_A > yH_A$. Examining this case makes the algebra more cumbersome, but does not yield additional insights.

$$\begin{aligned}
D_A &= \{p_A + [1 - p_A - q_i]\} yH_A \\
&= [1 - q_i] yH_A \\
&= yP_G H_A
\end{aligned} \tag{20}$$

This expression recognizes that if creditors believe they will be bailed out contingent upon project failure, then they will view their claim on the cash flow of project A as being of the same risk as their claim on the cash flow of project G . Suppose that $D_0 - D_A < H_A$ and allow for the possibility that $D_A > D_0 - E$. This 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:

$$S \equiv \{D_A - (D_0 - E)\}^+ \tag{21}$$

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.

Finally, if the D that satisfies (18) exceeds \tilde{D} , then it can be shown that the looting equilibrium is in fact the unique equilibrium, and if D exceeds D_A , then banks cannot meet their investment need even by choosing the asset-substitution project, A .

Proposition 3 (Looting Equilibrium): *Suppose (16) holds and let the minimum debt financing, D , necessary to meet the date-0 investment need satisfies (18). In the extended model with multiple banks and correlated risk in the asset-substitution project A , assuming that the regulator bails out all banks (creditors take no haircuts but shareholders are wiped out) when they fail together and none otherwise, the following is true:*

- (i) *If D is less than \tilde{D} , then two Nash equilibria arise. In one (socially efficient) Nash equilibrium, all banks raise debt $D^* \in [\hat{D}, \tilde{D}]$ and also choose the good project G . In the other (socially inefficient) Nash equilibrium, all banks set the face value of debt at the highest possible level yH_A , raise D_A of debt (given by equation (20)), and choose the asset-*

- substitution project A. In the inefficient Nash equilibrium, the bank owners pay to themselves at $t = 0$ all of the surplus debt, S , raised by the bank (given by equation (21)).*
- (ii) If D is greater than \tilde{D} but less than D_A , then the inefficient Nash equilibrium stated in (i) arises as a unique equilibrium.*
- (iii) If D exceeds D_A , then banks cannot meet their date-0 investment need.*

In essence, the regulator's intervention in state θ_s "socializes" the bank's incremental risk in choosing project A relative to project G . This induces all banks to choose project A and also employ excessive leverage. The market discipline that would otherwise be provided by uninsured creditors is lost because creditors are now effectively insured and the relevant agency problem is the conflict of interest between bank owners and taxpayers. That is, the only "economic creditor" of the banking sector is the taxpayer, and the formal creditors are *de facto* equivalent to bank owners too, at least from a cash flow perspective, though not from a control rights perspective.²² Hence, maximizing bank equity value can lead to highly-levered capital structures and correlated risky asset choices by bank owners. 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 bank owners insist on the surplus debt issuance S being paid out as a dividend is that it would otherwise stay in the bank and limit creditor shortfalls when the banks fails, reducing the size of the ex-post bailout, and in turn, reducing the ex-ante transfer to bank owners.

Equally importantly, note from Proposition 2 that, in the absence of regulatory intervention, when banks are "insolvent" (i.e., the D that satisfies (18) is greater than \tilde{D}), they cannot meet their investment needs at $t = 0$. However, with correlated asset substitution, the prospect of regulatory intervention enables banks to meet their investment needs and roll over existing debt even in this insolvency region if

²² 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.

the investment need involves paying off legacy debt. Bank debt now only serves the purpose of curbing managerial rent-seeking, but loses all of its bite as far as pricing the debt to reflect the bank's risk-shifting problem is concerned. In fact, bank leverage is the conduit through which regulatory forbearance is transferred in value terms to bank owners through undertaking of excessively risky projects. Such "looting" arises purely through equity value maximization and it is possible *only if* risky projects are funded through debt. Recall that shareholders do not get bailed out ex post (as is also typical in practice), so, absent leverage, looting incentives do not exist. Hence, excessively risky projects can be funded through debt—that is, effectively or implicitly government-backed claims—but not through equity.

Somewhat perversely, as project A gets riskier, it increase banks' debt capacity, as shown below:

Corollary 1: *Suppose H_A increases and p_A decreases in such a way that $p_A H_A$ remains constant and q_S adjusts to satisfy (19). Then, absent regulatory intervention to explicitly prevent the bank from taking additional 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 the riskier the asset-substitution project, the worse is the regulator's problem. Banks can pledge the highest possible cash flow to creditors because their downside in the systematic-risk state is socialized. Therefore, banks' ability to raise debt does not erode because of a mean-preserving increase in the risk of the project being financed. Rather, it perversely expands, highlighting an intuitive—but somewhat surprising—effect of government guarantees in expanding debt capacity of projects by a *greater* amount as risk *increases*.

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 projects? 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 6). Hence, a more attractive approach is to consider ex-ante regulation—for example, a capital requirement.

In fact, if (16) holds, then all that the regulator needs to do is impose a capital requirement that limits the bank's debt to no more than \tilde{D} . Given that leverage, it becomes privately optimal for the bank to select project G since the incentive compatibility constraint for the choice of G holds. So a simple capital requirement takes care 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 (16) holds.

Now suppose (16) does not hold, so that $\hat{F} > \tilde{F}$ or $\hat{D} > \tilde{D}$. In this setting, the regulatory capital requirement such that $D \leq \tilde{D}$ continues to dissuade banks from investing in project A and hence eliminates the social cost Ψ . In that sense, this is a feasible regulatory policy. However, with this policy, creditors will have no incentive to monitor the bank and prevent the choice of the private-benefit project, B . This is the very problem that the papers analyzing the market discipline of uninsured demandable debt have articulated (e.g., Calomiris and Kahn (1991) and Diamond and Rajan (2001)). Thus, the feasible capital requirement outlined above can be improved upon if a policy exists that eliminates the social cost Ψ and also ensures selection of the value-maximizing project G .

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

Proposition 4: *In the extended model with multiple banks and correlated risk in the asset-substitution project, assuming that ex post the regulator bails out all banks (creditors take no haircuts but shareholders are wiped out) when they fail together and none otherwise, we obtain the following ex ante ($t = 0$) optimal regulatory policy:*

(iv) *Suppose (16) holds. Let D be such that it satisfies (18). Then, if $D \in [\hat{D}, \tilde{D}]$, the regulator permits the bank to raise D in leverage and no restrictions are imposed. If $D < \hat{D}$, then the regulator permits the bank to raise \hat{D} in new debt and pay out $\hat{D} - D$ as a dividend to the shareholders; both actions are privately optimal for the bank. If $D > \tilde{D}$, the bank is limited to raising only \tilde{D} in leverage and providing equity for the remaining amount needed to meet its*

date-0 financing need. If the bank finds it prohibitively expensive to provide new equity, it will be asked to seek the forbearance necessary to delay meeting its investment need until the necessary equity can be raised through earnings retentions. If such forbearance is unavailable, the bank is shut down and liquidated.

(v) Suppose (16) does not hold. In that case, one efficient solution for the regulator is to allow the bank to raise \hat{D} in leverage and to provide additional equity (special capital account) that is invested in a risk-free and liquid security, whose payoff is available to the bank's shareholders in the solvency state, such that \tilde{F} increases enough to exceed \hat{F} and ensure (16) holds. The special capital account is not available to the bank's creditors in the insolvency state, but instead belongs to the regulator. If the bank finds it prohibitively expensive to raise new equity, then this additional equity must be provided through earnings retentions made possible by dividend restrictions on the bank.

Under the regulatory policy laid out in Proposition 4, the regulator demands that, in addition to the equity input E , which permits the bank to meet its investment need D_0 when combined with new borrowing D , the bank must raise an additional ΔE in equity. This ΔE 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.²³ Assuming that the contractual 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).

²³ 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.

Another interesting aspect of Proposition 4 is that the special capital account can be arbitrarily large (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 small in all of our algebra). Once $\tilde{F} > \hat{F}$, it does not matter by how much \tilde{F} exceeds \hat{F} . The bigger ΔE is, the higher \tilde{F} will be, but increases in \tilde{F} leave \hat{F} unaffected. 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. Note that the original equity E is viewed here as part of the “normal” (or tier 1) capital.

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. In other words, it does effectively pay off the creditors. However, if a particular bank experiences idiosyncratic failure when some others succeed, its special capital account goes 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 project-success state (the special capital account is an additional equity input that belongs to the bank’s shareholders) and the non-systemic failure state (the special capital account belongs 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 (16) is violated, $\hat{F} > \tilde{F}$. So $F = \hat{F}$ must be chosen to ensure that creditors will monitor the bank. Because this violates the IC constraint for the bank to prefer project G to A , we need to increase \tilde{F} without affecting \hat{F} such that $\tilde{F} > \hat{F}$ and (16) is honored once again. Providing an additional equity input—via the special capital account—helps raise \tilde{F} 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 \hat{F} 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 since they get paid in full with or without this account. Consequently, the special capital account is “invisible” to the creditors. Once \tilde{F} is raised sufficiently, it will eventually exceed \hat{F} and (16) will hold. All of our previous results (Section III, Proposition 1) will therefore apply.

Another point to note is that the proposition claims that when (16) 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 owners. 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.

We have assumed thus far that cash flow non-verifiability means that all external finance must be in the form of debt. So where would an additional equity input, if necessary, come from? Here our assumption is that the bank owners would be asked to provide the additional equity. Our analysis does not deal with the private costs the owners would incur/perceive in raising this equity, but the issue of the magnitude of these costs is somewhat debatable and worthy of further consideration.²⁴

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” requiring that the sum of the claims of the shareholders and bondholders must be equal to the total claims on the bank.²⁵ The reason why such a security was not permitted in the absence of the regulator is that we limited the set of

²⁴ Bank owners may possess assets other than the bank, and these may be such that equity claims can be issued against them. Alternatively, bank owners may have liquid wealth that could be used to provide an additional equity input to the bank, but this may impose non-diversification costs on bank owners. These costs are absent in our model because all parties are risk neutral.

²⁵ This is reminiscent of the resolution provided by relaxing the budget-balancing constraint in the model of moral hazard in teams in Holmstrom (1982).

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.²⁶ We do not know of any existing securities that correspond exactly to the special capital account.²⁷ But if such a security were to be designed, then the inefficiency associated with the second best (when (16) 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. Thus, private contracting would *de facto* give the bank's shareholders the expected value of the ex post state-contingent transfer, which may undermine their ex ante incentives to avoid the risky project A. Yet another issue is that it is important for the scheme described in Proposition 4 that there be *no* counterparty risk, i.e., no doubt about the ability of the insurer to bail out all banks. Thus, capital requirements would be necessary on a new set of agents – the private insurers.. In essence, there would need to be a regulator of the private insurer with problems similar to those we have analyzed for banks²⁸.

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

²⁶ Numerous papers have provided the micro-foundations of debt and equity as optimal securities. See, among others, Boot and Thakor (1993).

²⁷ 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.”

²⁸ See Kashyap, Rajan, and Stein (2008), and Acharya, Pedersen, Philippon, and Richardson (2010a).

TBTF—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 4.

V. INEFFICIENT PERQUISITES CONSUMPTION

In the model so far, we have considered two forms of moral hazard: managerial private benefits and asset-substitution. However, in practice, there may be a third form of moral hazard: inefficient consumption of perquisites or diversion of cash flows by bank managers. We sidestepped this issue in our formal analysis by assuming that the bank was run by its owners. However, even in this case, when there is a special capital account, there may be incentives for the owners to inefficiently consume perquisites out of excess cash,²⁹ 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 be perquisites consumption in disguise.³⁰ Thus, we have the following.

Corollary 2: *Suppose bank owners can consume perquisites, and this consumption is inefficient but not excessively so. Moreover, the owners can disguise such consumption as loans or risky assets. Then it is a uniquely efficient equilibrium in Proposition 4 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 owners do not merely take money from one pocket and inefficiently transfer it to another when they provide funds for the special capital account.

VI. REGULATORY IMPLICATIONS

²⁹ By excess cash, we mean that the bank has raised via security issuance more cash than it needs to roll over its legacy debt. This issue of excess cash is relevant because the bank has an incentive to issue more debt than needed to meet its investment need when there is a lender of last resort.

³⁰ 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.

Our analysis has several implications for regulatory capital requirements. We discuss below the implementation of the two-tiered capital requirement in Proposition 4 (when (16) 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.³¹ 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 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 ratio³².

Note that this approach can deal not only with the challenge of refurbishing 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—managerial rent-seeking, 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 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.

³¹ 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.

³² Using dividends to build up equity also avoids dissipative adverse-selection costs of issuing new equity. 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.

Second, 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.

Third, the high capital during normal times also leads to a reduction of asset substitution during such times. The fact that the shareholders/managers will lose this special capital in a bad state means the positive aspect of high capital is maintained. Thus, we avoid 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.

Fourth, the idea of building and preserving capital through retained earnings and dividend restrictions is relatively simple. In particular, 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, *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.

Sixth, 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.” 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).³³

VII. CONCLUSION

In this paper, we developed a theoretical model to examine the tension between the role of leverage in disciplining bank managers—preventing rent-seeking that takes the form of perks or the choice of inefficient “pet” projects—and the role of bank capital in diminishing the risk-shifting incentives of bank shareholders. These agency problems 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 pursuit of private benefits), explaining that, in typical models, managerial pursuit of private benefits does not alter project risk, whereas asset substitution does. This asymmetry prevents an analysis of optimal capital structure along a common continuum of project choices.

Our paper addresses exactly this issue in the context of bank leverage choices.³⁴ We show that the tension between private-benefits and asset-substitution moral hazard problems requires that bank

³³ 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).

³⁴ 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

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 monitor and deter managerial rent-seeking. 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.³⁵

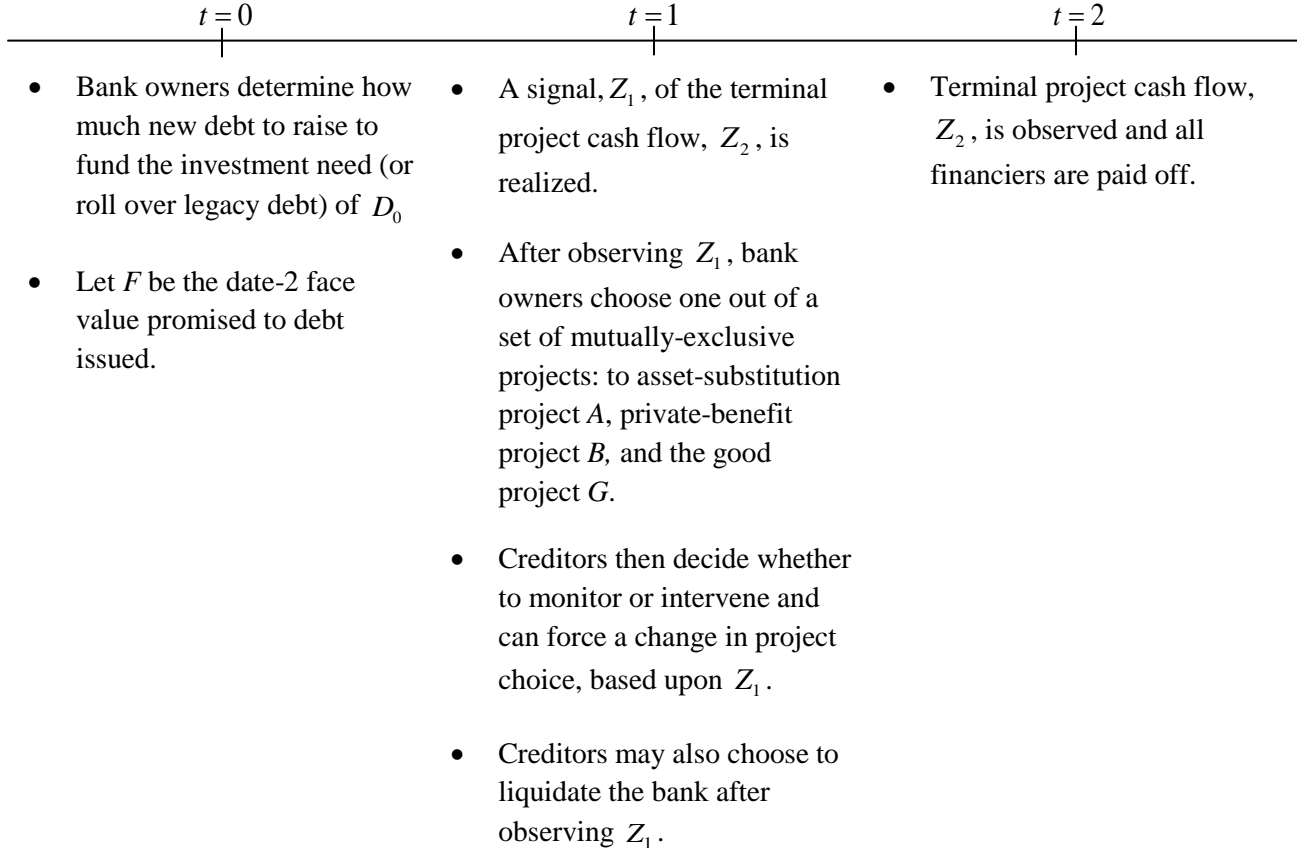
When we introduce correlated default risk, bank failures generate negative social externalities. This result creates a potential case for ex post regulatory intervention to bail out banks when they fail *en masse*. Such discretionary regulatory forbearance itself becomes a source of systemic risk. It 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 projects, and paying out surplus debt as dividends or other forms of cash distributions. Indeed, riskier projects may be funded only with debt and not equity, as it is the creditors that enjoy the ex post forbearance.

By funding risky projects, 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 an additional tier of capital requirements—a special capital account—that involves restrictions on dividend payments and on how the special capital may be invested in good times. That is, it prevents creditors from accessing it in the event of bank failures. Such capital regulation prevents erosion of capital in good times, avoids costly issuance of capital in bad times, and yet preserves the market discipline of debt.

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.

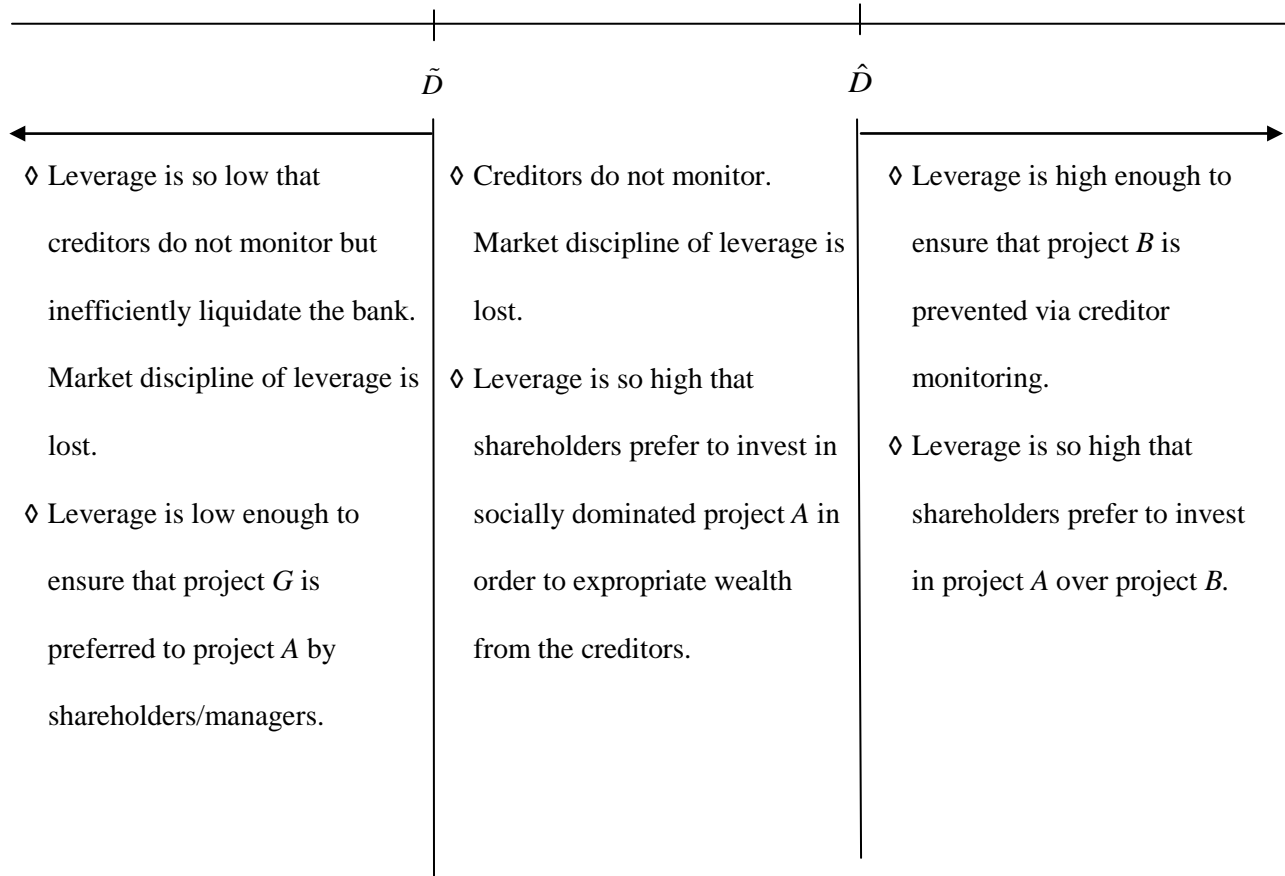
³⁵ Mehran and Thakor (forthcoming) provide a theory of bank capital structure that focuses on the monitoring benefits of bank capital and predicts that higher capital is correlated with higher bank values in the cross section. They also provide empirical evidence to support this view. By contrast, our theory here focuses on the role of bank capital in dealing with three forms of moral hazard and optimal capital-replenishment regulatory policy.

FIGURE 1: SEQUENCE OF EVENTS



**FIGURE 3:
OPTIMAL AMOUNT OF BANK DEBT AT $t = 0$ WHEN (16) DOES NOT HOLD**

There does not exist an optimal D that simultaneously ensures that creditors monitor ($D > \hat{D}$) and the bank prefers project G ($D < \tilde{D}$). Optimal value of D is \hat{D} or \tilde{D} .



APPENDIX

Proof of Proposition 1: Follows from the discussion preceding the statement of the proposition in the text. ■

Proof of Lemma 1: Note that satisfaction of (12) ensures that creditors will wish to monitor, intervene, and continue with project G . Since the bank owners can change project choice at $t = 1$, any case in which the creditors choose not to monitor will lead to the bank owners choosing project B if $Z_1 = y$. But given that (12) holds, it is never sub-game perfect for creditors to not monitor when $Z_1 = y$, so they monitor with probability 1. When $Z_1 = x$, creditors know that the bank owners prefer project G , so it is not optimal for them to incur the monitoring cost c . ■

Proof of Lemma 2: Since the external providers of capital simply earn their reservation return of zero, all remaining surplus goes to the initial owners of the bank, and this surplus is maximized by choosing project G . However, ensuring the choice of G depends on the creditors having intervention rights at $t = 1$ that give them the ability to either liquidate the bank or demand full repayment at $t = 1$. Without this, the bank owners would select project B , which then reduces their surplus ex ante at $t = 0$. Designing a debt contract with repayment at $t = 2$ is efficient because the project cash flow is realized at $t = 2$. ■

Proof of Lemma 3: The proof is similar to that of Lemma 2. To maximize the bank's ex ante surplus for the owners, project G must be chosen. This means that the amount of debt must have face value $F \in [\hat{F}, \tilde{F}]$ to ensure there is incentive compatibility (IC). Funds raised in excess of that needed to roll over legacy debt can be paid out to the owners without violating the IC constraint. ■

Proof of Proposition 2: To satisfy the IC constraints that $D \geq \hat{D}$, the bank needs to increase its borrowing until $D = \hat{D}$. Since $\hat{D} - [D_0 - E]$ is left over after meeting the date-0 investment need, this excess can be paid out as a dividend to the bank owners. If, on the other hand, $D_0 - E > \tilde{D}$, then satisfying the IC constraint requires that $D = \tilde{D}$ and the bank owners cannot meet the bank's investment need using debt financing. ■

Proof of Proposition 3: We have already established that $D = \tilde{D}$ is a Nash equilibrium. Our previous analysis also shows that, as long as $D \leq \tilde{D}$, the bank will choose project G . As for the second Nash equilibrium, note that if all other banks are choosing $D = D_A > \tilde{D}$, then from our previous analysis it follows that the IC constraint for the bank to choose project G is violated and the bank will consequently choose project A . If all other banks are raising $D = D_A$ and choosing project A , then it is privately optimal for a particular bank to also raise $D = D_A$ and choose project A . The reason is that, in state θ_S all banks choosing project A will fail together, causing the regulator to bail out all the banks by paying off creditors and thereby avoiding the social cost Ψ . This means that creditors will price the debt ex ante (at $t = 0$) to satisfy (20)—which assumes the probability of full repayment of debt is p_G —even though they know that the bank will choose project A . That is, even though the IC constraint $\left(D \in [\hat{D}, \tilde{D}] \right)$ is violated and banks are choosing project A , the pricing of debt is as if banks are choosing project G . And since the value of equity ex post is higher with project A than with project G , the bank owners prefer to choose project A at $t = 1$. The owners prefer to pay out the surplus debt raised as a dividend because keeping it in the bank increases the value of debt at the expense of equity. This proves part (i). Part (ii) follows immediately from the above arguments. Part (iii) follows from the fact that, when $D > D_A$, the amount of debt needed to roll over the legacy debt exceeds the maximum pledgeable debt. ■

Proof of Corollary 1: Differentiating D_A in (20), we see that

$$\partial D_A / \partial H_A > 0.$$

Moreover, since $p_A H_A$ is remaining constant, none of the other key inequalities (such as $p_G H_G > p_A H_A$) is affected. And since (19) is satisfied, the idiosyncratic failure probability of A remains equal to that of G . ■

Proof of Proposition 4: Proving (i) is straightforward, as the proof follows directly from arguments made earlier in the analysis. So consider (ii). Set $F = \hat{F} = \frac{c + L}{p_G}$, thereby satisfying (12). Note that (12) treats the project success

probability as p_G , so the assumption is that if banks select project A , the regulator will bail out all banks if they fail

together and none otherwise (which makes the probability of success from the creditors' standpoint exactly equal to p_G). By assumption, the \tilde{F} that satisfies (14) is such that $\tilde{F} < \hat{F}$. So introduce an equity input ΔE that is invested in a riskless asset like Treasury securities. Given the zero riskless-rate assumption that we have made, this investment will pay off ΔE . If ΔE is unavailable to creditors upon insolvency, then satisfaction of (12) is unaffected by ΔE . However, the IC constraint (13) now becomes

$$p_G \{yH_G + \Delta E - F\} \geq p_A \{yH_A + \Delta E - F\}$$

and this means the constraint is:

$$F \leq \tilde{F} \equiv \frac{\{y[p_G H_G - p_A H_A] + [p_G - p_A] \Delta E\}}{[p_G - p_A]} \quad (\text{A-1})$$

Comparing (A-1) to (14), we see that the \tilde{F} in (A-1) is bigger than the \tilde{F} in (14). Moreover, in (A-1), $\frac{\partial \tilde{F}}{\partial \Delta E} > 0$. Thus, $\exists \Delta E$ is large enough that $\tilde{F} > \hat{F}$. Once this is achieved, both the IC constraints will be satisfied and project G will be chosen. To the extent that issuing equity is prohibitively expensive, allowing the bank to raise ΔE through earnings retentions will be value maximizing. ■

Proof of Corollary 2: Suppose the bank owners can take the ΔE in the proof of Proposition 4 and consume perquisites that yield them a utility of $b\Delta E$, where the constant $b \in (0,1)$. Then their expected utility if they keep ΔE invested in the bank (at a zero rate of return) is:

$$p_G \{yH_G + \Delta E - F\} \text{ with project G,}$$

and if they consume ΔE as perquisites it is:

$$p_G \{yH_G + \Delta E - F\} + b\Delta E \text{ with project G.}$$

Thus, as long as $b > p_G$ (the perquisites consumption is not too inefficient), the owners will prefer to consume ΔE as perquisites by dressing up the perquisites consumption as a real project. ■

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