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Banks face two moral hazard problems: asset substitution by shareholders (e.g., making risky, negative net present value loans) and managerial rent seeking (e.g., investing in inefficient "pet" projects or simply being lazy and uninnovative). The privately-optimal level of bank leverage is neither too low nor too high: It balances efficiently the market discipline imposed by owners of risky debt 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 generates an equilibrium featuring systemic risk in which all banks choose inefficiently high leverage to fund correlated assets. A minimum equity capital requirement can rule out asset substitution but also compromises market discipline by making bank debt too safe. The optimal capital regulation requires that a part of bank capital be unavailable to creditors upon failure, and be available to shareholders only contingent on good performance.

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

"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 come to the fore once again as an issue of critical importance. The central question being asked is: what is the socially-optimal amount of capital that banks should be required to hold on their balance sheets? Underlying this question is the recognition that the private cost of bank equity capital may exceed its social cost, so that the amount of capital a bank will typically choose as its private optimum may diverge from the social optimum. This creates the *raison d'etre* 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 speaking, our proposal is aimed at increasing bank capital in a way that does not compromise bank discipline by uninsured creditors and yet keeps in check bank incentives to take excessive leverage and risks that are correlated with those of other banks.

We begin with the simple observation that banks face two kinds of moral hazard problems (both outlined in Jensen and Meckling, 1976)): (i) managerial rent-seeking, which can take the form of the pursuit of private benefits by managers via investments in "pet projects" or managers being lazy and un-innovative; and, (ii) asset-substitution or risk-shifting, which is the shareholder-creditor conflict that bank equity value may be enhanced by engaging in excessively risky, negative net present value projects. The problem of managerial inefficiency via various forms of rent-seeking (in extreme cases, amounting to fraud or "tunneling") is a well-recognized problem, and it has been proposed that (uninsured) debt can

[1] Numerous creative 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, without overburdening them with excessively onerous capital regulation in good times.

provide the necessary market discipline to ameliorate this moral hazard (Calomiris and Kahn (1991) and Diamond and Rajan (2001)).[2] Absent such discipline, bankers produce inadequately rich forms of financial intermediation that can ultimately hinder economic growth. The second moral hazard problem that bank managers can pursue excessive asset risks to transfer wealth from the creditors of the bank to its shareholders is also well recognized and is considered to be most effectively dealt with by ensuring that the bank has sufficient equity capital (e.g. Merton (1977)).[3] A study of bank failure by the Office of the Comptroller of the Currency (OCC (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 also 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, due to inherent conflict between how the two moral hazard problems can be addressed – risk-shifting by raising capital and rent-seeking by raising leverage – banks may in practice have leverage that is sometimes "too low" and sometimes "too high". The issue is further complicated by the ever-present possibility of government bailouts when poor lending practices create systemic failures. The possibility of such intervention may also influence bank behavior and the interaction between the disciplining roles of leverage and capital. We are thus led to confront the

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[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 the problem can apply to corporations also as pointed out by Jensen and Meckling (1976), 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, became problems and recovered, or remained healthy during the period 1979-1987. 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 U.S. 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.

following questions. First, how do the disciplining roles of bank capital and leverage interact? Second, what does this interaction imply about the bank's optimal leverage choice? Third, how does regulatory intervention in the form of ex post bank bailouts affect the bank's capital structure? Do the bailouts justify regulatory capital requirements, and if so, what form should these requirements take?

To address these questions we begin by combining both forms of moral hazard 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; whereas if leverage is too high, managers are inclined to choose risky assets and bet the bank with the creditors' money. The optimal capital structure of the bank navigates tightly between this Scylla (rent-seeking) and Charybdis (asset-substitution). Formally, there are conditions under which there is a range of incentive-compatible leverage levels for the bank, and as long as bank leverage is in this range, both forms of moral hazard are well addressed. 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 that is sufficiently high to induce discipline by creditors, resulting in the choice of the first-best project by the bank. However, there are also other conditions 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 failure of Bear Stearns, Fannie Mae, Freddie Mac, Lehman Brothers, American International Group (AIG), and some of their global counterparts.

In the absence of rules precluding forbearance or facilitating orderly low-cost resolution (which to an extent may be practically infeasible when there are wholesale failures, if not theoretically impossible), the regulator -- but more broadly the government -- has a strong incentive to exercise discretion and step in to rescue banks by bailing out bank creditors (we assume bank equity is entirely wiped out even in case of bailouts). We take such forbearance as given and show that the anticipation of such regulatory response generates multiple Nash equilibria in bank leverage choices. In one equilibrium, there is inefficient systemic risk in that banks over-lever and take on excessive levels of correlated asset risk. As creditors anticipate to be bailed out, increasing bank leverage is not met with a higher cost nor is there any credit rationing. In fact, somewhat perversely, banks' ability to raise leverage is enhanced when they take excessive risk: with riskier projects, creditors can be promised a higher upside but their downside risk is socialized. This 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 and it is possible only if risky projects are funded through debt. Indeed, because shareholders do not get bailed out ex post, excessively risky projects can *not* be funded through equity, but they can be funded through debt that is *de facto* government-backed due to an implicit bailout assurance. Since debt is fairly priced, it becomes the conduit through which shareholders transfer risks onto taxpayers. To the best of our knowledge, this

[6] Acharya and Yorulmazer (2007), Acharya (2009), and Farhi and Tirole (2009) build formal models of the regulator's time-inconsistency when banks fail together and of the induced herding behavior in bank risk choices.

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 the conditions that guarantee that the privately-optimal capital structure in the absence of regulatory forbearance can resolve different forms of moral hazard fully, 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 the conditions that make it impossible for private contracting to simultaneously resolve different moral hazards, the formal analysis reveals that the 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 as a result bank efficiency is sacrificed. Instead, the optimal capital requirement in general features a two-tiered structure that has the following two 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 on assets it is invested in.

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 bank has sufficiently high capital for shareholders not to substitute assets, creditors view the bank as having sufficiently low capital -- and 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 adequately dealt with.

We discuss several practical 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] Finally, we note that the specific capital regulation proposal based on our theory is close to a new model for capital regulation proposed by the 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. 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, however, from this proposal by the 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, the associated externality costs and induced regulatory forbearance. Section V discusses optimal intervention in the form of capital requirement with the special capital account and its implications for current regulatory proposals. Section

[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 like 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] Secretary of Treasury Timothy F. Geithner Speech at New York University's Stern School of Business "Rebuilding the American Financial System", August 2, 2010: 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" by the Basel Committee on Banking Supervision of the Bank for International Settlements, 12 September 2010.

VI discusses several model extensions and 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 for the related literature on this point). The point that excessive systemic risk may ultimately be rooted in government safety nets and time-inconsistency of regulation has been recognized as early as by Kindeberger (1978) and reinforced recently by Kane (2010). 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 induce ex post regulatory bailouts of banks and ultimately reduce market discipline ex ante. They refer to this as the "dark side" of leverage-based liquidity creation, but also highlight that addressing it through a lender-of-last-resort or regulatory forbearance runs the risk of eliminating *all* market discipline role 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) should be converted into equity. Hart and Zingales (2009) and Duffie (2010) focus on forced equity issues by banks when their performance is

[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 Dewatripont and Tirole (1994) style model in which monitoring by different claimholders of the firm is endogenized.

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

deteriorating. Hart and Zingales (2009) argue that banks should be required to issue equity if the prices of their Credit Default Swaps indicate that they are very risky; refusal to issue equity would result in the bank's shareholders losing control to regulators. Recognizing adverse selection problems associated with equity issues, Duffie (2010) advocates forced deep-discount rights offers. To provide incentives for banks to issue equity and overcome the problem of risk-shifting, Admati and Pfleiderer (2009) propose the idea of expanding the limited liability of equity, thereby transferring more risk to bank shareholders than at present, but question the usefulness of leverage in general as a device to provide discipline of banks. Kashyap, Rajan and Stein (KRS, 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, 2010b) propose taxing the systemic risk of financial institutions. This is a tax based on the expected loss of a financial firm, conditional on the occurrence of a systemic crisis. They advocate 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 compared to 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 equity to improve bank-level incentives as this can compromise the market discipline role of debt and make banks "lazy" (un-innovative). 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] In our theoretical framework, banks are compelled to internalize the consequences of all their decisions, including inadequate capital. Rather than investing in

[11] In the limit, for there to be no counterparty risk, the insurer must hold 100% of risk-free government securities against insurance sold. The insurer would pass on the costs of holding this liquidity to the insured, but then the insured might as well as keep the liquidity itself (unless it is better to designate liquidity management to an insurance firm to avoid free-cash-flow problem). 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.

insurance, in practice banks can build up the capital they need in good times through accumulation of retained earnings (and savings) in a capital 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 of capital. Overall, the feature of our proposed capital requirement that capital be high enough from shareholder standpoint to deter excessive risk-taking but low enough from creditor standpoint to induce monitoring and discipline is both unique and 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 discipline imposed by creditors on the bank's project choices. In turn, the model 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 (or alternately 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 at $t = 0$ due to current earnings and retentions of past earnings or inside equity of bank owners. The bank needs D_0 units to make an investment, where $D_0 > E$.[12] 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 $D \geq D_0 - E$, providing 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 bank's securities is zero. If the bank can raise this financing, bank owners make an investment at $t=0$ but can alter the risk-return characteristics of the investment at t = 1; no additional financing is however required at t = 1. This choice can be interpreted as possible portfolio adjustments

[12] Alternately, the bank has some legacy debt which needs to be repaid, failing which the bank is liquidated and bank owners get nothing. For example, consider Bear Stearns having to roll over its (short-term) paper every 30 days.

that the bank can make. As noted by Myers and Rajan (1998), it is relatively easy for financial institutions to make such adjustments. 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

Project Attributes

There are three mutually exclusive project alterations the bank owners can make at t = 1: a good project (G), a project (A) that may be preferred by bank owners due 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 which is publicly observable, denoted as Z_1. The project choice made by the bank is itself contingent upon the realized value of signal Z_1.

We describe next the formal structure of the signal and the cash flow of the three projects. Informally, the good project efficiently balances risk and return, the asset-substitution project is excessively aggressive on the risk dimension, whereas the private-benefit project lacks efficient innovation and therefore achieves too low a return for the bank.

Signal at t = 1:

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

Cash Flows at t = 2:

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

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

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.

It is assumed that: (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 difference in expected cash flows of projects, whereas the right-hand side captures the difference in probabilities which is bounded from above by one. 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 payoff from good and asset-substitution projects each exceeds 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

$$\beta < [p_G H_G - p_B H_B] y. \tag{2}$$

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 project 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 private benefits derived from project choices. The bank owners maximize

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

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, $t = 0,1,2,$ where "residual" implies after any payments to external financiers. $1_{B,t}$ is an indicator function for the bank owners choosing project B at date t (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 $t=2$ if 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 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 owners[13] and regardless of the interim signal[14]. Then, it is clear 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 $L \in (0, p_B H_B y)$. This implies in particular that $L < H_B y$, so that under our assumptions on 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 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[15]. 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 $t = 1$ who could demand repayment in full at $t = 1$ ("accelerated default") and force liquidation if full repayment is not forthcoming. That is, it looks like 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.

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 $t = 0$ is raised entirely from equity. That is:

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[13] 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 would thus offer a price for the assets that is independent of the project chosen by the bank.

[14] Making the liquidation value contingent upon the interim signal does not qualitatively change the analysis.

[15] 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 that they can observe the borrower's project choice perfectly and thereby control it perfectly, or else the shareholder-bondholder conflict is trivialized "by fiat".

$$y[p_G H_G - p_B H_B] < \beta. \tag{4}$$

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:

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

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

Summary of Assumptions:

At the cost of repeating some of the key assumptions of the model, we summarize them before analyzing the model's outcomes:

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 and there is 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 $c > 0,$ 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.

In the analysis that follows, we will show that whether bank owners prefer project G or project A depends crucially on the promised face value of debt F. Our goal will be to derive the capital structure F that achieves ex-ante efficiency. This requires that:

(i) The face value of debt F is large enough to ensure that creditors will wish to intervene and continue rather than unconditionally wish to liquidate the bank at $t = 1$; and,

(ii) The face value of debt F is small enough that when creditors intervene and force the manager to abandon project B, the manager will prefer project G to project A.

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, with the main result summarized in Proposition 2. We obtain conditions under which private contracting between the bank and its financiers results in leverage that resolves different agency problems fully and the first-best is attained. We will also indicate the conditions under which it is impossible for private contracting to simultaneously resolve both rent-seeking and asset-substitution moral hazards, so the constrained-efficient (second-best) solution represents a distortion away from the first-best.

Events at t = 1:

At this stage, the main issues of interest are whether the bank owners will switch project choice after observing Z_1 and what the creditors will decide to do. Suppose that at t = 0, the owners financed the bank with an amount D in debt. 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, and force either a change in project choice or liquidate 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 owner's 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 date-0 threats of intervention that are not time consistent. 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 switch to project B at $t = 1$ if they did not already choose it at t = 0, 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: $\mathbf{Z_1 = x}$. In this case, creditors need to be assured that the bank owners will not voluntarily wish to switch from project G to project A or project B when $Z_1 = x$ is realized (*Assumption 5*). These incentive compatibility (IC) conditions are:

$$p_G\{xH_G - F\} \geq p_A\{xH_A - F\} \tag{6}$$

$$p_G\{xH_G - F\} \geq p_B\{xH_B - F\} + \beta \tag{7}$$

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:

$$F^* = \frac{x\left[p_G H_G - p_A H_A\right]}{p_G - p_A} \tag{8}$$

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

Case 2: $\mathbf{Z_1 = y}$. To keep the problem interesting, we need to identify conditions such that the manager *will* switch to 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 entirely financed with internal equity. We now state the condition for this when the bank has debt with face value *F* outstanding. This condition is:

$$p_G\left\{yH_G - F\right\} < p_B\{yH_B - F\} + \beta \tag{9}$$

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:

$$p_G F - c \geq L \tag{10}$$

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.:

$$F > F^0 \equiv L \tag{11}$$

Then we see that satisfying (10) requires:

$$F \geq \hat{F} \equiv \left[c + L\right] p_G^{-1}. \tag{12}$$

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,

$$p_G\{yH_G - F\} \geq p_A\left\{yH_A - F\right\} \tag{13}$$

This requires:

$$F \leq \tilde{F} \equiv \frac{y\left[p_G H_G - p_A H_A\right]}{\left[p_G - p_A\right]} \tag{14}$$

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 $F \leq \tilde{F}$ and $F \geq \hat{F}$. That is, we need:

$$F \in \left[\hat{F}, \tilde{F}\right] \tag{15}$$

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:

$$c + L < \frac{yp_G\left[p_G H_G - p_A H_A\right]}{\left[p_G - p_A\right]} \tag{16}$$

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:

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 have sufficient "skin in the game" to induce them to monitor the bank owners and prevent them from choosing project *B* at $t=1$, rather than unconditionally liquidating the bank 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[16]. This leads to $F \geq \hat{F}$ as the condition necessary to prevent managerial rent-seeking. However, there also needs to be sufficient equity capital to ensure that, conditional upon the manager not opting for *B*, he will not prefer *A* over *G* and therefore not gamble at expense of bank creditors. This implies that the amount of debt financing can be no greater than $\tilde{F}$.

Thus far we have examined creditors' monitoring incentives taking as a given that this monitoring will be non-stochastic in states in which 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 one.*

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 optimal because reducing the auditing probability below one 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

[16] Note that the creditors' payoff is concave in the bank's total payoff, so there is induced risk aversion.

merely 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 $Z_1 = y$ holds *pointwise*, in any state (in a randomized monitoring scheme) in which creditors choose not to monitor when $Z_1 = y$, they are worse off relative to monitoring because the bank owners will indeed choose project *B* in that non-monitored state at $t = 1$.

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, the pricing of this debt, and the choice of project. We first examine the issue of creditors' intervention rights. In particular, we show that

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 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* $F \in \left[\hat{F}, \tilde{F}\right]$ *assuming (16) holds) and ensuring that any cash raised at t=0 in excess of that needed to roll over legacy debt is paid out to the owners at t=0.*

The intuition 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 both the initial choice of the value-maximizing project G at t = 0 and 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 shareholders to pay off legacy debt D_0 at t = 0 is *after* they have used retained earnings or internal liquidity to roll over existing debt:

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

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 $\left[\hat{F}, \tilde{F}\right]$.

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

Clearly, $D \in \left[\hat{D}, \tilde{D}\right]$ 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* $\hat{D} - \left[D_0 - E\right]$ *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 debt repayment using debt financing.*

The intuition is clear. The bank cannot raise more debt than that at which asset-substitution moral hazard is triggered. Interestingly, if the bank needs to raise less debt than the level at which the creditors have no incentive to monitor the owners to prevent choice of the private-benefit project—the bank has so much equity *E* that the amount of new debt raised falls below that needed for incentive compatibility for private-benefit moral hazard—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 pictorially this situation of being "caught between 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 socially-inefficient risks.

Figure 2 here

Thus far we have assumed that (16) holds, so 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 due 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 $D < \tilde{D}$. It is clear that it is impossible for both these inequalities to hold simultaneously. The bank will have to choose to either forgo 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 pr*o*ject *A* as 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 so that there is no 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 nothing more than another example of a second-best that deviates from the first-best because not all frictions can be costlessly resolved, and again is not a prescription for regulatory intervention. But even if (16) holds, in practice an efficient outcome is unlikely to arise due to limits on contracting and monitoring. We have, however, set up the benchmark model this way precisely to examine why even when such limits are not present, government forbearance can distort the private outcomes toward socially inefficient ones and how to address this distortion.

We now extend the model by assuming that there are 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 both the case in which (16) holds and 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 a negligibly small cost associated with failure of any individual bank[17]. 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 shareholders), and thereby avoids the cost Ψ. Indeed, if shareholders are bailed out too, then the distortions induced by regulatory forbearance would be even larger. Consider for sake of argument that *all* banks are bailed out if they fail together, e.g. due to "fairness" reasons. Consider first the case of Proposition 2 where the banks are able to roll over their existing debt by issuing new debt, i.e. (16) holds and the D that satisfies (18) does not exceed $\tilde{D}$.

Before proceeding further, let us specify the *regulatory objective function*. The regulator's objective is to avoid the social cost Ψ (since it is assumed to be sufficiently large), and among different regulatory policies that achieve this, choose the one that maximizes the value of the bank. The regulator faces the same informational constraints that the bank owners face 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

[17] Recall that we have assumed there is an arbitrarily large number of banks, so even a negligible social cost associated with an individual bank failing can add up to a significant social cost associated with all banks failing. But more likely, there are externalities from failures of many banks at the same time.

equity, etc.), but has the ability to restrict the bank's capital structure and its asset choices (as we will explain below), and potentially create ex ante "super-priority" claims on the bank's assets.[18]

We can then show that 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 pay off their legacy debt but does not trigger the asset-substitution incentives: $D \in \left[\hat{D}, \tilde{D}\right]$. 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 $D \in \left[\hat{D}, \tilde{D}\right]$.

But there is also another 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 $F = F_A \equiv yH_A$[19]. We call this the "looting" equilibrium, as in Akerlof and Romer (1993). To see this, 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:

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

This expression recognizes that if creditors believe they will be bailed out contingent upon project failure, then they view their claim on the cash flow of project *A* as being of the same risk as their claim on the

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[18] 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 pre-determined level.

[19] 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.

cash flow of project *G*. We shall assume that $D_0 - D_A < H_A$. We will allow for the possibility that $D_A > D_0 - E$, that is, asset-substitution in presence of forbearance reduces the risk of debt enough and raises debt capacity to the point that banks can not only meet their legacy claims 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 may 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 legacy debt payments even by choosing the asset-substitution project, *A*.

Proposition 3 (Looting Equilibrium): *Suppose (16) holds and let the minimum debt financing necessary to meet the legacy debt payment D 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* $D^* \in \left[D, \tilde{D}\right]$ *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 legacy debt repayment.*

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 shareholders and taxpayers. That is, the only economic creditor of the banking sector is the taxpayer, and the formal creditors are *de facto* equivalent to shareholders too, at least from a cash flow perspective, even though not from a control rights perspective.[20] Hence, maximizing bank shareholder value amounts to behavior where the bank shareholders "loot" the regulator or effectively the taxpayer as much as possible by passing on risks to them and paying out to themselves the proceeds from the extra debt issued. The reason why the bank owners insist on the surplus debt issuance *S* being paid out as a dividend is that otherwise it would stay in the bank and increase the value of the creditors' claim beyond what they paid for it and thereby transfer wealth from the shareholders to the creditors.

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 debt rollover needs at t = 0. However, with correlated asset-substitution, the prospect of regulatory intervention enables banks to roll over existing debt even in this insolvency region. 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 creditors are the channel through which regulatory forbearance is transferred in value terms to bank shareholders through undertaking of excessively risky projects. Such "looting" arises purely through shareholder value maximization and it is possible *only if* risky projects are funded through debt. Recall that shareholders do not get bailed out ex

[20] Acharya, Gujral, Kulkarni and Shin (2009) show that while distressed depositories (such as Wachovia and Washington Mutual) subject to prompt corrective action of 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.

post (as is also typically the case 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 – but not through equity.

Somewhat perversely, making project A riskier may only serve to increase it debt capacity, as the following result shows.

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, so that banks' ability to raise debt does not erode due to a mean-preserving increase in the risk of the project being financed, but rather it perversely expands. Highlighting this intuitive – but somewhat surprising – effect of government guarantees in expanding debt capacity of projects by a *greater* amount as risk *increases* is a novel contribution of our model.

Incentive Compatible Regulatory Policy

From the standpoint of the regulator, the inefficient equilibrium with high leverage is problematic because banks are encouraged to engage in excessive and correlated risk taking, an incentive engendered by the very presence of the regulator (LOLR, resolution authority, government guarantees, etc.). How can the regulator design an ex-ante policy in order to eliminate the high-leverage Nash equilibrium and prevent the choice of the socially inefficient project? One way to do it would be to make a pre-commitment 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 banking crisis is sufficiently high (see related literature that has underscored this point in footnote 6) and hence a more attractive approach is to impose *ex ante* regulation, for example, in the form of a capital requirement.

In fact, if (16) holds, then all that the regulator needs to do is to impose a capital requirement that limits the bank's debt to be 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 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 with capital requirements that the papers that focus on the market discipline of risky (or 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 there exists a policy that eliminates the social cost Ψ and also ensures selection of project *G*, because such a policy would also maximize the value of the bank (recall that the regulator wishes to eliminate the social cost of correlated failures and also choose the value-maximizing policy from among policies that eliminate this cost).

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

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 $D \in \left[\hat{D}, \tilde{D}\right]$, 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 of which 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 roll over its legacy debt. If the bank finds it prohibitively expensive to provide new equity, it will be asked to seek forbearance from the creditors until the necessary equity can be raised through earnings retentions to permit legacy debt to be completely paid off. If such forbearance is unavailable, the bank is shut down and liquidated.*

(v) Suppose (16) does not hold. Then 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.*

In both cases, when banks are bailed out, the claims of the creditors are fully covered by the regulator, and when the banks fail but are not bailed out, the special capital account belongs to the regulator rather than the creditors.

Under the regulatory policy laid out in Proposition 4, the regulator demands that, in addition to the equity input E that permitted the bank to roll over its legacy debt 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 is 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[21]. 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, utilize the proceeds from the account to fund its administrative costs and potentially even transfer them to surviving banks and firms in the economy e.g., by lowering taxes.

Another interesting aspect of Proposition 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 is ΔE, the higher will be $\tilde{F}$, 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-one capital.

An important point to note is what it means 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 (i.e., project *A* is chosen and the correlated-failure state is realized), then the regulator bails them all out and creditors take *no* haircut, so the treatment of the special capital account is a moot point in this state. That is, it does effectively pay off the creditors. However, in the state in which a particular bank fails when some other banks succeed – the bank's failure is an idiosyncratic event rather than part of a system-wide collapse – the special capital account of the failing bank goes to the regulator rather than the failing bank's creditors. In other words, creditors take *some* haircut even if there is capital

[21] The special capital account is in the spirit of cash-asset or 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% special capital requirement, every dollar of capital in this account allows the bank to put another $25 of assets on its books.

in the special account. Since credit remains risky, monitoring incentives are preserved and banks are prevented from becoming lazy or un-innovative.

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 it is essential to choose $F = \hat{F}$ 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 find a way 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 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 state of solvency 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.

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. The existing evidence points to a positive relationship in the cross-section between bank equity capital and bank value (e.g. Mehran and Thakor (forthcoming)). Nonetheless, we cannot overlook the possibility that there might be adverse-selection costs associated with bank owners attempting to raise outside equity by issuing claims against *other* assets may have that verifiable cash flows and therefore permit equity issuance.[22]

In practice, the regulator could avoid adverse-selection costs by simply imposing a dividend restriction on the bank and asking for the special capital account to be filled via earnings retentions. This would avoid any dissipative private (or social) costs of issuing new equity. Banks will not impose such dividend restrictions on their own because its benefit is primarily to avoid the systemic externality associated with *en masse* bank failures, which is not a private benefit to any bank, especially given a regulatory bailout expectation. The anticipation of dividend restrictions will provide the same incentives to bank shareholders as would issuing equity (backed by the dividends) and placing the proceeds in a special capital account. We will discuss later why it makes sense for the special capital account to be "locked up" in the form of Treasuries.

One may argue that introducing the special capital account means that we have given the regulator contracting possibilities that were unavailable to the bank and its financiers in the absence of the regulator. In particular, this account represents a kind of security that differs from debt and equity. This security achieves efficiency by breaking the "budget balancing constraint" which requires that the sum of the claims of the shareholders and bondholders must be equal to the total claims on the bank.[23] The reason why such a security was not permitted in the absence of the regulator is that we limited the set of securities available for contracting to debt and equity and did not address the problem of optimal mechanism/security design in the presence of a third party (such as the regulator) that is not a claimant of the firm[24]. We do not know of any existing securities that correspond exactly to the special capital

[22] This is, 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 out model because everybody is risk neutral.
[23] This is reminiscent of the resolution provided by relaxing the budget balancing constraint in the model of moral hazard in teams in Holmstrom (1982).
[24] Numerous papers have provided the microfoundations of debt and equity as optimal securities. See, among others, Boot and Thakor (1993).

account.[25] 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 may be more costly or difficult for the court than a bank regulator. Moreover, 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. But it appears almost impossible to achieve this with a private insurer. In essence, there would need to be a regulator of the private insurer with similar problems as we have analyzed for banks; see Kashyap, Rajan and Stein, 2008, and Acharya, Pedersen, Philippon and Richardson, 2010a, for a discussion of such private insurance.

Another point worth discussing 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, and not siphoned off by the bank owners. Mandating investment in Treasuries is one way to achieve this, but clearly any permissible

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[25] In this sense, the special capital account is also different from deposit insurance premium. One, creditors are not guaranteed in all instances of bank failures, but only in case of systemic failures. Due to this feature, contribution to the special capital account are not available to pay off creditors in idiosyncratic bank failures (effectively, the FDIC imposes a "haircut" on creditors in case of such failures), unlike a reserve fund which is in principle always available to pay off insured creditors, 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 hence, are not like once-and-for-all payments to the deposit insurance fund. That is, the contributions are more like a "deductible" than a "premium".

investment will do. We will discuss in the next section the conditions under which mandating investment of the special capital account in Treasuries becomes the *unique* efficient equilibrium.

Finally, we have assumed that when banks fail *en masse*, the regulator bails out *all* the banks. If the regulator were to bail out only a subset of banks, say only the largest banks in the spirit of Too Big to Fail (TBTF), or the systemically most important banks, then the looting problem that 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 moral hazard. However, in practice, there may be a third from of moral hazard, namely inefficient consumption of perquisites 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[26], 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 Treasuries, if we assume that any other kind of investment could be perquisites consumption in disguise[27]. Thus, we have:

Corollary 2: *Suppose the bank owners can consume perquisites, and this perquisites consumption is inefficient but not excessively so. Moreover, the owners can disguise such perquisites consumption as loans. Then it is a uniquely efficient equilibrium in Proposition 4 for the regulator to demand that the*

[26] 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 roll over legacy debt, when there is a lender of last resort.

[27] 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.

special capital account be invested in Treasuries (or a similar security whose authenticity can be costlessly verified).

Thus, we see that adding this third form of moral hazard makes it necessary for the regulator 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

Our analysis has several important implications for regulatory capital requirements. We discuss below how the prescription in Proposition 4 for a two-tiered capital requirement (when (16) does not hold) can be implemented.

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, putting the retained earnings in a "special" capital account, and requiring a separate minimum capital ratio for this kind of capital.[28] Once the special capital ratio exceeds that particular level, the bank can resume dividend payments. The retained earnings can only be invested in pre-determined securities like Treasuries. When a negative shock hits (either bank-specific or systemic) and bank's tier-1 capital diminishes, banks would be allowed to sell these securities and transfer cash from the special capital account to the regular capital account; this would indeed be a requirement if banks do not replenish tier-1 capital through other means such as equity issuances. However, the dividends would be frozen until special capital is built back up to its required ratio. Note that this can deal not only with the challenge of refurbishing capital but also potential liquidity shortages since selling Treasuries provides liquidity. Also, we stress that the special capital account is unavailable to creditors should they choose to liquidate the bank, unless, of course, the regulator intervenes with a bailout of all banks. The special capital account belongs to the regulator in the states in which the bank is insolvent, as we have stressed.

[28] 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.

This proposal to preserve capital, or in other words, 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 special capital account is *additional* capital that would not exist otherwise (money would have been paid out as dividends otherwise)—so that it does *not* replace the debt that provides discipline or liquidity creation. At the cost of reiterating, the key point is that the bank *cannot* invest the retentions as it wishes—the investments have to be in Treasuries.

Second, the proposal has the advantage of *not* requiring shareholders to infuse additional cash capital at a time when confidence in bank management is the lowest 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 these times. The fact that the shareholders/manager 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 converts an adverse asset-side shock into a crisis. More importantly, our scheme eliminates bank behavior that makes adverse asset shocks endogenously more likely due 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, and the bank's regular capital never gets depleted (absent unexpected shocks), nor is the bank required to raise additional equity by issuing stock.

Fifth, there is *no* adverse information 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 the need for banks 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 2008-2009, a period when they were supposed to cut their dividends (see Acharya, Gujral, Kulkarni and Shin, 2009). The model we presented generates a formal rationale for the BIS "Capital Conservation" proposal and furthermore provides a channel through which dividend restrictions can be judiciously deployed to gradually replenish bank capital levels to dissolve risk-shifting incentives without diminishing the market discipline provided by subordinated debt. As we stated, dividend cuts become mechanical when banks access their special capital account as they cannot resume dividend payouts unless the special capital account is replenished to meet the regulatory requirement e.g. some percentage of risk-weighted assets.[29]

[29] 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

VII. CONCLUSION

In this paper we developed a theoretical model to examine the tension between the role of leverage in disciplining bank managers—preventing the diversion of free cash flows in perks and dissuading rent-seeking 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 Jensen and Meckling (1976). Recently however, Hellwig (2010) has pointed out the "asymmetry" in Jensen and Meckling's (1976) 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.[30] We show that the tension between private-benefits and asset-substitution moral hazard problems requires that bank leverage not be too low or too high. The key to the result that leverage not be too low is the need to create strong enough incentives for creditors to 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.[31]

When we introduce correlated default risk, bank failures generate negative social externalities. This 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

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assets rather than their total or absolute risk (see Acharya (2009), and Acharya, Pedersen, Philippon and Richardson (2010a, b)).

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

[31] Recently, 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 in support. By contrast, our theory focuses on the role of bank capital in dealing with three forms of moral hazard and optimal capital-replenishment regulatory policy.

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 creditors that enjoy the ex-post forbearance, but by funding risky projects, bank owners to effectively extract rents from regulators and taxpayers. Under some conditions, a simple minimum equity (e.g., tier-1) capital requirement solves the problem and eliminates the bad Nash equilibrium. But in general, this can make bank debt too safe and erode market discipline. This necessitates an additional tier to capital requirement – a special capital account – that involves dividend payment restrictions as well as restrictions on how the special capital may be invested in good times and prevents creditors from accessing it in case 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 role of debt.

FIGURE 1: SEQUENCE OF EVENTS

$t = 0$

- Bank owners determine how much new debt to raise to roll over the old debt.
- Let *F* be the date-2 face value promised to debt issued to help rollover D_0 of legacy debt.
- Bank owners choose a project from asset-substitution project *A*, private benefit project *B* and the good project *G*.

$t = 1$

- Interim signal of project cash flow Z_1 is realized.
- Manager can change project choice after observing Z_1.
- Creditors decide whether to monitor, intervene and can force a change in project choice, based upon Z_1.
- Creditors may also choose to liquidate the bank after observing Z_1.

$t = 2$

- All terminal project payoffs are observed and all financiers are paid off.

FIGURE 2:
OPTIMAL AMOUNT OF DEBT RAISED BY THE BANK AT t = 0 WHEN (16) HOLDS

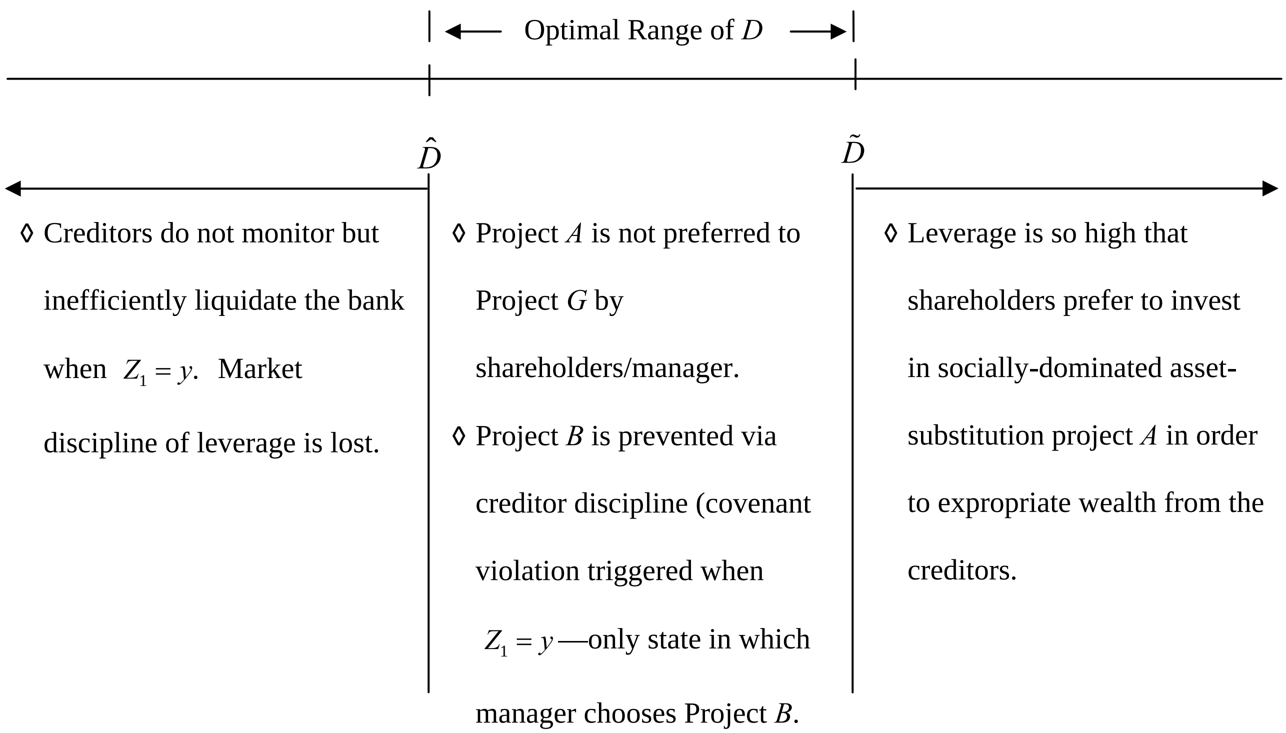

FIGURE 3:
OPTIMAL AMOUNT OF BANK DEBT AT t = 0 WHEN (16) DOES NOT HOLD

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 $\tilde{D}$.

← $\tilde{D}$	$\tilde{D}$ – $\hat{D}$	$\hat{D}$ →
◊ Leverage is so low that creditors do not monitor but inefficiently liquidate the bank. Market discipline of leverage is lost. ◊ Leverage is low enough to ensure that project G is preferred to project A by shareholders/managers.	◊ Creditors do not monitor. Market discipline of leverage is lost. ◊ Leverage is so high that shareholders prefer to invest in socially-dominated project A in order to expropriate wealth from the creditors.	◊ Leverage is high enough to ensure that project B is prevented via creditor monitoring. ◊ Leverage is so high that shareholders prefer to invest in project A over project B.

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 subgame 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 $F \in \left[\hat{F}, \tilde{F}\right]$ to ensure that 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 $\hat{D} - \left[D_0 - E\right]$ is left over after rolling over its legacy debt, 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 legacy debt repayment 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 $D \le \tilde{D}$ 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 $\left(D \in \left[\hat{D}, \tilde{D}\right]\right)$ 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 payout 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 $p_G H_G > p_A H_A$) are 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 $F = \hat{F} = \dfrac{c + L}{p_G}$, 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 Treasuries. 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

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

and this means the constraint is:

$$F \leq \tilde{F} \equiv \frac{\left\{ y\left[p_G H_G - p_A H_A \right] + \left[p_G - p_A \right] \Delta E \right\}}{\left[p_G - p_A \right]} \tag{A-1}$$

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, $\exists\, \Delta E$ 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:

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

and if they consume ΔE as perquisites, it is:

$p_G \left\{ yH_G + \Delta E - F \right\} + b\Delta E$ 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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