Looting and Gambling in Banking Crises*

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Abstract

We construct a model of the banking firm and use it to study bank behavior and bank regulatory policy during crises. In our model, during a crisis a bank can increase the risk of its asset portfolio ("risk shift"), convert bank assets to the personal benefit of the bank manager ("loot"), or do both. Each action is socially costly. To mitigate such actions, a regulator has three policy tools: it can impose a penalty on risk-shifting; it can impose a penalty on looting; and it can force banks to hold more equity capital. All policies must be implemented before anyone knows if there will be a crisis.

Our paper contains three important policy lessons. *First*, enforcing property rights and punishing theft is the policy that works best and has the fewest side effects. *Second*, trying to prohibit the bank manager from taking risk may backfire, he may switch to even riskier strategies. *Third*, there is a conflict of interest between inside and outside equity; outside equity induces looting.

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1 Introduction

There is a large theory literature on banking crises and how banks respond when they are close to or in bankruptcy. Most of this work has focused on "risk shifting," also sometimes known in the literature as "gambling for redemption." The idea is that in a crisis and with its equity depleted, a bank may willingly take on large risks even if these risks are associated with low expected returns. If these low probability, high return gambles pay off, the bank may survive; if they do not, the bank was broke anyway. Thus, from the bank's perspective there may be little downside risk to such gambles. Anecdotal evidence suggests that many savings and loan associations did pursue this kind of strategy during the US savings and loan crisis. In the literature, such risk-seeking behavior is usually studied as an off-shoot of a more general moral hazard problem induced by deposit insurance and/or the Discount Window. There is also a very large literature on that topic, beginning with the seminal work of Kareken and Wallace (1978).[1]

An interesting and probably under-appreciated study by Akerlof and Romer (1993) argues that much of the theoretical work on banking crises has overlooked an important fact. They argue that bank managers in crisis are primarily interested in personally taking as much from the bank as the can (looting), and their risk-shifting actions are primarily intended to facilitate such looting. In such circumstances, there is often a fine line between activities that raise eyebrows, and those that are criminal. An example may help to clarify. Consider a savings and loan association in a crisis, which issues a large volume of fixed rate mortgages financed with short maturity liabilities having a much lower rate of interest. Now, this action produces an extreme maturity mismatch, is inherently risky, and might be interpreted as the risk-shifting action predicted by many theory models. Akerlof and Romer observe, however, that this portfolio allocation also substantially increases short run accounting profits which may allow bank owner-managers to pay themselves large salaries and bonuses, consume perkuisites, and so on, without violating regulation or attracting much shareholder attention. (Such self-dealing actions were also common during the US savings and loan crisis). The relaxation of the profits constraint on bank managers' self-dealing may not be effective for long, but they don't have a long time horizon under such circumstances.

[1] See (Gorton and Winton, 2002, section V) for a literature review.

In essence, the Akerlof-Romer argument is that risk-shifting need not be an end to itself, but rather may be a device that facilitates legal looting. Their study is thought-provoking and puts a new perspective on a large literature. However, it stops short of providing a fully-specified model of banks' actions when risk-shifting and looting are both possible. Nor could we find such a model elsewhere in the literature, and that led to our writing the present study. Next, we briefly discuss some case-study evidence that importantly influenced our modeling strategy.

Evidence There is not a large case-study literature on bank actions during crises, but there are a few useful papers including, of course, Akerlof and Romer.[2] Our review of this literature, and confidential conversations with World Bank officials, led us to several tentative conclusions. Risk-shifting and looting are frequently observed simultaneously, suggesting that the two activities are likely to be complementary. However, experience across countries has been highly varied in terms of the end-game strategies employed by banks.

In the developing world looting seems to have been the more usual strategy and in some instances was a spectacular element of the crisis. Such looting frequently occurred without any smoke-screen of artificially inflated short-run profits. Venezuela (1993) and Dominican Republic (2003) were high profile cases that involved the "diverted deposits" fraud wherein the bank managers kept part of the bank off the balance sheet so that the supervisors could not observe self-lending. (It is suspected that supervisor collusion may have been involved in one or both of these crises.) When they started to run out of cash, some banks requested liquidity loans from the central bank which they also exported (to themselves) through the capital account. The famous failure of BCCI in 1991 also involved the diverted deposits scheme.

Obviously, such tactics are little more than outright theft. One possible explanation for their frequency is that when legal protections of shareholders

[2] Johnson, Boone, Breach, and Friedman (2000) show that countries whose legal systems restrict looting of firms had milder financial crises in 1997–1998. Johnson, Porta, Lopez-de-Silanes, and Shleifer (2000) give some examples for looting (which they call tunneling) in Western European firms, and discuss forms of looting, such as self-dealing transactions, theft or fraud, asset sales and advantageous transfer pricing to the controlling shareholder, excessive executive compensation, loan guarantees, and so on.
Friedman, Johnson, and Mitton (2003), Myers (2000), Boyd and Smith (1999), Fluck (1998)

and creditors are weak, supervisors are corrupt(ible), and accounting standards are lax, the easiest course is to take the money and run. With a better institutional and legal environment, however, such blatant looting is likely to be more costly. In the United States, bank managers seem to have gone to more effort to stay within the confines of the law when possible, and employed risk shifting strategies either to pump up short run profits, gamble for redemption, or both. The Japanese banking crisis experience was quite different, but also instructive. In that case, there is scant evidence of either risk-shifting or looting, even though the Japanese crisis was one of the longest and most costly on record. Indeed, the Japanese banks mostly did nothing, even though they were clearly bankrupt in the sense that the value of their liabilities exceeded that of their assets. A plausible explanation is that in most cases Japan officials were not threatened with immediate bank closure or job loss. Thus they were not in a true end-game situation that called for highly risky strategies. They primarily relied on lobbying and the political process to attempt to keep their banks open and buy time.

Case studies clearly suggest that there are conflicts of interest not just with the regulatory authorities, but within the banks themselves, and that importantly guided our modeling strategy. In the absence of looting, the interests of bank owner-managers and outside equity investors are potentially well aligned. Both are shareholders, and both aim at maximizing the value of their shares. However, if a bank manager loots he damages outside equity investors. This in turn may influence the cost of equity, which in turn affects the bank manager's decision on risk taking and looting. In order to analyze these potential implications, we differentiate between inside owner-managers and outside equity holders in the theoretical analysis that follows. We begin first, however, with a simpler more standard model in which there is only one class of equity claimants.

2 Looting

2.1 Model Environment

Consider an economy with two dates, 0 and 1. There are two types of agents; a bank manager and depositors.

The Bank Owner-Manager There is a bank owner-manager who has access to a risky loan portfolio. The portfolio costs I and returns a stochastic Y which is distributed on $\mathbb{R}_+$ with a density function $f(Y)$. Later, for a parameterized example, we will make more specific assumptions on $f(Y)$. The bank's assets are financed with deposits d. If $d < I$, then the bank manager must put in some own resources $e_i = I - d$ as inside equity.[3] A unit of equity has an opportunity cost of r_i. We assume that this opportunity cost exceeds the expected return of the loans, $r_i > \mathrm{E}Y$, hence equity is rather expensive, and the bank manager will be reluctant to use it. The balance sheet of the bank thus contains three items: equity e_i and deposits d on the liability side, and the loan portfolio of size I on the asset side. We will treat the capital structure of the bank as exogenous, and potentially imposed by a regulator. Finally, let us assume that, if the bank remains solvent, the bank manager gets future profits that lead to a continuation value (or charter value) of V.

The Depositors The bank manager collects d deposits from the depositors. Depositors are covered by deposit insurance with a flat fee α, paid at date $t = 1$. Hence, depositors do not care about the bank's default risk. Depositors demand a return of r_d per deposit which is taken as exogenously given. The aggregate liability of the bank is thus $D := (r_d + \alpha)\, d$. Note that d, not D, is the position on the liability side of the bank manager's balance sheet.

The Looting Technology In most models, it is assumed that the return from the loan portfolio is public information and hence cannot be diverted. Other models explicitly model the hold-up problem and assume that bank managers can steal the return, at no cost.[4] We take an intermediate approach. Assume that the bank manager can loot L from the bank at date

[3] Hence the bank manager is also the owner/residual claimant or the bank. We will discuss the role of outside equity/outside ownership below. Note that, because bank managers are "endowed" with the bank, they are able to earn supernormal returns above r_i.

[4] Hart and Moore (1998) have an optimal contracting model, however they look at debt-contracts only. All variables are (or can be) stochastic, therefore things like inefficient liquidation can occur. In comparison to Bolton and Scharfstein (1990), there is no commitment from the investors to refinance in the second period. Povel and Raith (2004) analyze a contracting problem where the investment (effort/risk) is not contractible.

Figure 1: Basic Time Structure

$t = 0$	The bank manager collects deposits d, leading to liabilities of $D = (r_d + \alpha)\, d$.
·	The bank manager injects $e_i = I - d$ of inside equity.
·	The bank manager invests in the loan portfolio.
$t = 1$	The portfolio return a stochastic Y.
·	The bank manager decides how much to loot.
·	From the remaining return, the bank manager pays back deposits. If the bank remains solvent, the bank manager gets the continuation value V.

1, after the return Y is realized and observed. That is, he can steal L directly from the portfolio return, *before* deposits are repaid and dividends are distributed. However, the bank manager gets only $g(L) < L$. Assume that $g(0) = 0$; if the bank manager steals nothing, he has no benefits from stealing; $g'(0) = 1$; if the bank manager steals only very little, the distortions from stealing are negligible; $g''(L) < 0$ for all $L \geq 0$; the more the bank manager steals, the larger are the distortions. The justification for why the bank manager gets only $g(L)$ instead of L from looting is that looting is prohibited by law. Hence, the function $g(\cdot)$ is a policy variable.[5]

2.2 Equilibrium and Comparative Statics

Potentially, there are two kinds of looting. First, even if the bank is healthy, the bank manager might want to steal a little, which we call *pilfering*. From pilfering some $L > 0$, the bank manager ends up getting $g(L) < L$ directly. However, the bank's profits, and hence the bank manager's profits, decrease. If the bank remains solvent, the bank managers profits decrease by $L - g(L) > 0$. Hence in this first model with only one class of equity claimants the bank manager will never pilfer. That will change in Section 4. where we consider a model with outside equity as well as the owner-manager's claim.

If the loan portfolio yields a low return Y, the manager may want to just

[5]In effect, we are assuming the the authorities cannot absolutely deter looting, but can make it difficult and/or costly for the bank manager. This depends on the legal system, such as the conduct of law enforcement, or the magnitude of potential punishment.

steal everything, setting $L = Y$. We call this behavior *raiding*. In the case of a raid, the bank pays nothing to depositors or equity investors.[6] The bank manager's return is then $g(Y)$. Hence, the owner-manager will raid whenever

$$g(Y) > Y - D + V. \tag{1}$$

Let Y_{crit} be the critical yield Y such that the above holds with equality. Then the bank manager will raid the complete return if $Y < Y_{\text{crit}}$. Note that, because the owner-manager raids his bank if and only if $Y < Y_{\text{crit}}$, Y_{crit} can be interpreted as the manager's propensity to raid. If the probability distribution of the portfolio return remains unchanged, a higher Y_{crit} increases the probability of a raid.

The owner-manager's expected profit is

$$\begin{aligned} E\Pi &= \int_0^\infty \max\left\{g(Y), Y - D + V\right\} f(Y)\, dY \\ &= \int_0^{Y_{\text{crit}}} g(Y)\, f(Y)\, dY + \int_{Y_{\text{crit}}}^\infty (Y - D + V)\, f(Y)\, dY. \end{aligned} \tag{2}$$

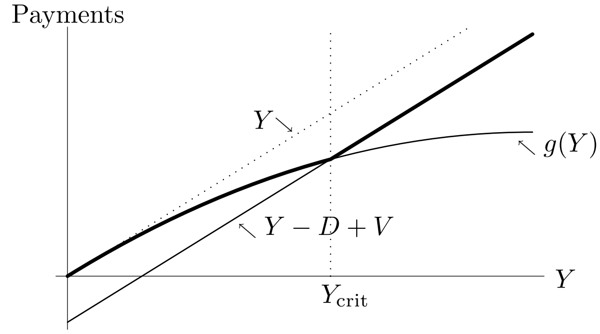
Let us discuss the endogenous variable, Y_{crit}, which is determined by (1), hence by the implicit equation $\bar{G} = g(Y_{\text{crit}}) - (Y_{\text{crit}} - D + V) = 0$. The implicit function theorem yields:

Proposition 1 (Propensity to Raid) *Ceteris paribus, a high leverage D increases the bank manager's propensity to raid,* $\mathrm{d}Y_{\text{crit}}/\mathrm{d}D > 0$. *A high continuation value decreases it,* $\mathrm{d}Y_{\text{crit}}/\mathrm{d}V < 0$.

For a fixed probability distribution, a high leverage increases the *probability* of a raid, a high continuation value decreases it. The intuition of the argument is straightforward. If the amount of deposits d is high, then the repayment to depositors D is high. Hence if the bank manager is honest and does not loot, he may keep rather little (only $Y - D + V$). If the bank manager loots, his profits are $g(Y)$, independent of the amount of deposits. As a result, for higher $D = (r_d + \alpha)\, d$, the bank manager will loot more often. A higher continuation value makes the bank manager loot less often: If he loots, he looses the continuation value. Hence, a higher continuation value V deters the bank manager from raiding.

[6] Because of the assumption that $g'(L) > 0$, a bank manager who raids will leave nothing to depositors. One could weaken this extreme result by assuming that $g(L)$ becomes maximal for some $\bar{L}$, in which case the bank manager would never raid more than $\bar{L}$ and leave the remaining $Y - \bar{L}$ to the depositors.

Figure 2: Decision on Raiding



The bank manager's actual profit function follows the bold curve. For small Y, the bank manager takes the complete return, hence he gets $g(Y)$. For larger Y, the bank manager does not loot, hence he gets the return net of repayments to depositors, plus the continuation value.

2.3 Deterring Banks from Looting

We have assumed that looting is unlawful, therefore it comes at a cost for the owner-manager. Instead of L, the manager gets only $g(L) \leq L$. The shape of the function $g(\cdot)$ is a policy variable. In the extreme case, the regulator can punish looting heavily (and hence set an extremely low $g(L) \ll L$), or he can *de facto* legalize looting by putting $g(L) = L$. To reduce the complexity of the regulators policy, assume that the regulator fixes a parameter c, and that the costs of looting are $g_c(L) = g(c\,L)/c$ for some concave monotonically increasing function $g(\cdot)$ with $g(0) = 0$, $g'(0) = 1$ and $g'(\infty) \to 0$. Then $g_c(0) = 0$ and $g_c'(0) = 1$. Furthermore, for the limit $c \to 0$, one gets $g_c(L) \to L$, hence the regulator is extremely mild, and looting is legal. For the limit $c \to \infty$, one gets $g_c(L) \to 0$; the regulator is extremely strict. The critical Y_{crit} is then given by the implicit equation $\bar{G} = g(c\,Y_{\text{crit}})/c - (Y_{\text{crit}} - D + V) = 0$.

Proposition 2 (Deterring Banks from Looting) *A strict looting policy c decreases the owner-manager's propensity to raid,* $\mathrm{d}Y_{\text{crit}}/\mathrm{d}c \leq 0$.

For a fixed return distribution, a strict looting policy decreases the probability of a raid. Note that the introduction of the parameter c leaves the comparative statics of Proposition 1 unchanged.

3 Risk Shifting (Gambling)

Up to now, we have considered only the bank manager's ability to loot. However, as we have argued in the introduction, we must also consider the possibility that the owner-manager may choose a high-risk investment, a strategy often observed when banks are (near) failing. In our model, we consider looting and risk shifting simultaneously. Now what is the interdependence of looting with gambling? And how does a policy that is designed to prevent looting influence a bank manager's attitude towards gambling? These are the questions we address in this section.

3.1 Model Environment

Typically, the owner-manager's propensity to gamble comes from his limited liability, and from the resulting convexity of the return function. From Figure 2, however, it becomes clear that with the possibility of looting, the bank manager's decision on gambling becomes more interesting; the profit function is concave for $Y < Y_{\text{crit}}$, convex around Y_{crit}, and linear above Y_{crit}. To simplify, assume that the owner-manager can choose between two return distributions with the same mean. Further, we assume that the good state occurs with probability $p(Y_1)$, in which case the loan portfolio returns Y_1, and that the bad state occurs with probability $1 - p(Y_1)$, in which case the portfolio returns Y_0. We further assume that $p'(Y_1) < 0$ and that $p''(Y_1) \leq 0$. By choosing Y_1, the bank manager can thus influence the risk-return structure of the loan portfolio. The expected return of the portfolio is maximized for $Y_1\, p(Y_1) + Y_0\,(1 - p(Y_1)) = \max$, hence $p(Y_1) + (Y_1 - Y_0)\, p'(Y_1) = 0$. This return distribution has been widely employed in the banking and corporate finance literature (see e. g. Allen and Gale (2000, 2004)).

3.2 Equilibrium and Comparative Statics

We are interested in return distributions where the bank goes bankrupt in some states, and remains solvent in others. Hence, we restrict our attention to the cases where the bank manager loots if the outcome is low ($Y_0 < Y_{\text{crit}}$), and does not loot if the return is high ($Y_1 > Y_{\text{crit}}$). The bank manager chooses

Y_1 to maximize

$$\mathrm{E}\Pi = (1 - p(Y_1))\, g(Y_0) + p(Y_1)\,(Y_1 - D + V), \tag{3}$$

$$\frac{\mathrm{dE}\Pi}{\mathrm{d}Y_1} = p(Y_1) + p'(Y_1)\,(Y_1 - D + V - g(Y_0)) = 0. \tag{4}$$

We use (4) to derive comparative statics and (in the Appendix) prove the following proposition.

Proposition 3 (Gambling) *High leverage induces the the bank manager to take more risk,* $\mathrm{d}Y_1/\mathrm{d}D > 0$*. A high continuation value deters the bank manager from taking risk,* $\mathrm{d}Y_1/\mathrm{d}V < 0$*. The penalty on looting deters the bank manager not only from looting, but also from risk shifting,* $\mathrm{d}Y_1/\mathrm{dc} \leq 0$.

The first two parts of the proposition have a straightforward intuition. If the bank is highly leveraged, then the bank manager exploits the deposit insurance in the bad state. As a consequence, the higher the leverage, the more risk the bank manager wants to take. On the other hand, the bank manager looses the continuation value V in the bad state. Hence, the higher V, the less risk the bank manager wants to take.

The effect of c, the strictness of the regulator with respect to looting, is less obvious and more interesting. In the good state, the bank manager does not loot, hence c does not influence profits. In the bad state, the bank manager raids the bank and gets $g(c\,Y_1)/c$. If the regulator is strict and sets a high c, the bank manager gets less from the raid, hence the bankruptcy states of nature are less valuable to the bank manager. Consequently, for higher c, the bank manager takes less risk. This is an important result and we shall return to it. For now, note that a policy of deterring theft has a beneficial side-effect in also deterring risk-shifting. As we shall see, most other policies do not fare so well.

3.3 Deterring Banks from Gambling

There are two natural regulatory instruments that may deter the owner-manager from taking too much risk: capital regulation and legal restrictions. Let us start with *capital regulation*. The bank's capital ratio is simply $e_i/I = (I - d)/I$. Thus if the regulator forces the bank manager to hold more capital, e_i/I rises, and d drops, which according to Proposition 3 makes the bank manager want to take less risk. As a second beneficial effect, lowering leverage decreases Y-crit according to Proposition 1. This increases the range of returns in which raiding will occur. Thus capital regulation has twin benefits in that it reduces the incentive to risk-shift and also reduces the probability of looting.

There is a second policy that can influence the bank manager's risk taking behavior: similar to penalizing looting, the regulator can penalize risk taking directly. In reality, the policy maker can ban bank managers from certain actions, for example from certain off balance sheet transactions. However, the regulator cannot ban the bank manager from any kind of risk taking. Risk is an inherent component of the business, and only the (informed) manager can realistically specify the riskiness of a bank.

In the language of our model, the bank manager's possible investments are characterized by the set $\{Y_0, Y_1, p(Y_1)\}_{Y_1}$. In the bad state the portfolio yields Y_0 and the complete return is looted by the bank manager. To concentrate on the set of tuples $\{Y_1, p(Y_1)\}_{Y_1}$, we simply set $Y_0 = 0$. The regulator's ban on certain business is equivalent to influencing the set of possible investments. Without loss of generality, one can assume that the regulator can change the set of investments from $\{Y_1, p(Y_1)\}_{Y_1}$ to $\{Y_1 - t(Y_1), p(Y_1)\}_{Y_1}$, with $t(\cdot) \geq 0$.[7]

Proposition 4 (Deterring Banks from Gambling) *If*

$$\frac{t'(Y_1)}{t(Y_1)} > -\frac{p'(Y_1)}{p(Y_1)} \tag{5}$$

for all Y_1, then restricting the bank manager's set of possible investments (e. g. increasing t) induces the bank manager to take less risk.

Condition (5) implies that the elasticity of the "penalty" t with respect to the risk parameter Y_1 must exceed the elasticity of the success probability p. The limiting case would be the one in which the elasticities are equal, hence the factor $p(Y_1)\, t(Y_1)$ would be a constant. This constant would simply be deducted from the bank manager's profits and not influence his behavior at all.

[7]Note that from the viewpoint of a bank manager, $t(Y_1)$ has the same effect as a tax on revenues. However, it differs from a tax in two dimensions. First, from the viewpoint of the regulator, the revenues from taxation would flow to the state; if instead the regulator bans certain investments, there are no tax-like revenues at all. Second, taxing the return would mean that the return were observable and contractible—a contradiction to the model assumptions.

Note that t also influences Y_{crit}, the critical return below which the bank manager will loot. If the bank manager fixes Y_1, the return is in fact only $Y_1 - t(Y_1)$ in the good state. Hence Y_{crit} is now determined by the implicit equation $g(Y_{\text{crit}}) = Y_{\text{crit}} - t(Y_{\text{crit}}) - D + V$, instead of equation (1). The set $[0, Y_{\text{crit}})$ expands and the bank manager loots for more potential outcomes. Thus, restricting the possible set of investments will reduce risk-shifting if (4) holds, but will have the unwanted side effect of increasing the probability of looting.

An Aside on Penalizing Risk Shifting As we have seen, restricting the set of possible risky investments does not always induce the bank manager to take less risk, even when $t'(Y_1) > 0$. To give a specific example, continue to assume that $Y_0 = 0$, assume further that $t(Y_1) = \tau Y_1$, and neglect the possibility of looting for a moment. Then the higher τ, the more difficult it becomes to obtain high profits (for the same return Y, the bank manager needs to take into account a higher probability of default), still under these assumptions the bank manager takes more risk and chooses a higher Y_1. To see this formally, consider the bank manager's expected profits in the absence of looting, $E\Pi = p(Y_1)\,[Y_1 - \tau Y_1 - D] + V$, leading to the first order condition $p'(Y_1)\,[(1-\tau)\,Y - D] + (1-\tau)\,p(Y_1) = 0$, or equivalently $p'(Y_1)\,[Y - D/(1-\tau)] + p(Y_1) = 0$. A tax on risk taking τ has hence the same effect as higher leverage D, i. e. the bank manager will end up taking on more risk. The intuition for this result is straightforward. Regulatory attempts to directly control risk shifting can easily "backfire" when the owner-manager can respond to the policy. Unfortunately, the owner-manager may optimally respond to risk-constraining regulation by choosing a strategy that is even riskier, if one is available. This finding has interesting implications that are largely peripheral to the present study and will only be discussed briefly. We have not seen this "backfire" possibility discussed elsewhere in the literature. There is an interesting and useful sequence of papers on the ex-post taxation of bank returns as a tool to control risk-shifting (see Marshall and Prescott (2006)). However, these authors examine a narrow set of policies and in all their examples such perverse results are never obtained. Yet, the above example producing the perverse result is a linear tax on revenues. This is about as simple an ex-post penalty as can be imagined. The new Basel-2 regulatory initiatives call (in general terms) for ex-post penalties on high returns and also seem unaware of the possibility of perverse responses. It seems more work on this topic might be useful.

In the next section, we turn to a richer model that allows for two classes of equity holders. Before turning to that task, let us briefly summarize results so far. First, a strict looting policy (high c) results in less looting in equilibrium. As a side benefit, it also results in a lower risk-shifting. Second, strict capital regulation (high e/I) has a similar pair of beneficials; it results in less risk-shifting and lower looting in equilibrium. Third, a strict policy of prohibiting risky activities (high t) may backfire, inducing the bank to take even more risk. Even if the policy does succeed in reducing risk shifting, it will then increase the equilibrium probability of looting.

4 Allowing for Two Classes of Equity

Often, and especially with larger banks, equity capital does not come primarily from owner-managers. Rather it comes from outside equity investors. In this section, we present a richer model in which both classes of equity investors are present and owner-managers. This generalization will have several important implications. First, two kinds of looting may now be observed in equilibrium. One kind is as we had before in which the bank manager steals everything from depositors (*raiding*). Now, there may be another kind of looting in which the manager steals a lesser amount without causing bankruptcy (*perks*). To keep the analysis as simple as possible, we assume that the same policy variable c represents a regulatory penalty on both raiding and on perks consumption by managers. We find that raising c not only deters the owner-manager from raiding, but also from perks consumption. However, increasing capital requirements increases the amount of perks consumption since, in effect, the owner-managers are stealing from outside equity investors. As will become apparent, this model is much richer than the previous one. The incentives of owner-managers are sometimes aligned with those of outside equity holders, and sometimes not. Such issues are invisible in any model that allows for only one class of shareholders.

4.1 Model Environment

(Equity) Investors Consider now a third type of agents, a continuum of outside equity investors. As an alternative source of financing, an owner-manager can collect e_o from outside equity investors by selling a fraction η of the bank's shares and keeping a fraction $1-\eta$ of the shares for himself. If the return from the loan portfolio is Y, the bank manager must pay $D = d\,(r_d + \alpha)$ to depositors and deposit insurance, leaving $\max\{0,\, Y - D\}$ for both classes of shareholders. The outside equity investor gets $\eta \max\{0,\, Y - D\}$, and the bank manager keeps $(1-\eta) \max\{0,\, Y - D\}$. By assumption, outside equity investors demand an expected rate of return of r_o. Therefore, the expected return from the equity investors' shares must be at least $e_o\, r_o$ and we assume that $r_o > \mathrm{E}Y$ so that the owner-manager will not raise outside equity unless he is forced. For convenience, set $E_o := e_o\, r_o$. In this new environment,

we can think of owner-managers endowed with bank charters which are in short supply. Thus, we fix the amount of inside equity e_i and assume that, if regulation forces banks to hold capital exceeding e_i this will be strictly in the form of outside equity, e_o. Importantly, we assume that if either raiding or perks consumption occurs it is done by the owner-manager and none of the proceeds go to outside shareholders. Finally, a new balance sheet identity must hold, $d + e_i + e_o = I$.

4.2 Equilibrium and Comparative Statics

As we have seen, without outside equity, the bank manager loots only in the case of default. In the presence of outside equity investors, however, the bank manager may want to take some smaller amount, allowing the bank to remain solvent. Define L the amount that the bank manager takes in the form of perks consumption, leaving the bank solvent. Then bank profits drop by L. The bank manager gains $g(L)$ from looting, but he looses $(1-\eta)\,L$ because bank profits drop. Hence the bank manager will consume perks such that the marginal benefits equal the marginal loss,

$$g'^{(L^*}) = 1 - \eta. \tag{6}$$

Without perks consumption, in non-default states the profits for a bank manager would be $(1-\eta)(Y - D)$. With perks consumption, the bank manager's profits are adjusted to

$$g(L^*) + (1-\eta)\,(Y - L^* - D) + V \tag{7}$$

Now let us analyze how the bank manager's attitude towards raiding changes in the presence of outside equity. Just as before, if the bank manager's investment yields a low return Y, the bank manager may want to just raid everything. In the case of a raid, the bank pays nothing to depositors or outside equity investors. The bank manager's profit is then simply $g(Y)$. Hence, the bank manager will raid whenever

$$g(Y) > g(L^*) + (1-\eta)(Y - L^* - D) + V. \tag{8}$$

As earlier, let Y_{crit} be the critical value of Y such that the above holds with equality. Then the bank manager will consume some amount of perks if $Y \geq Y_{\text{crit}}$, and will raid the bank if $Y < Y_{\text{crit}}$. Now the outside equity investors' aggregate expected profit is

$$\Pi_{\text{Eq Inv}} = \int_{Y_{\text{crit}}}^{\infty} \eta\,(Y - L^* - D)\,f(Y)\,dY - E_o = 0. \tag{9}$$

where $E_o = e_o\, r_o$ is the opportunity cost of investing in bank shares. If $\Pi_{\text{Eq Inv}} = 0$, as we will assume, the equity investors' participation constraint is just binding. We assume that the bank manager has the necessary bargaining power to drive the outside equity investor's expected surplus to zero. This gives us a function η, depending most importantly on e_o, but not on Y.

The bank manager's expected profit is then

$$\begin{aligned} E\Pi = &\int_0^{Y_{\text{crit}}} g(Y)\,f(Y)\,dY \\ &+ \int_{Y_{\text{crit}}}^{\infty} \Big(g(L^*) + (1-\eta)(Y - L^* - D) + V\Big)\,f(Y)\,dY. \end{aligned} \tag{10}$$

For a given return distribution $f(Y)$, the equilibrium is determined by the endogenous variables η, L^*, and Y_{crit} and the equilibrium conditions are (6), (8) (at equality), and (9). In order to define an equilibrium, let us return to the two-point-distribution of Section 3.3 and set $Y_0 = 0$ for convenience. We arrive at the following proposition.[8]

Proposition 5 (Capital Requirements) *In equilibrium, if an increase in capital requirements raises the fraction of outside equity ($d\eta/de_o > 0$), then it also mitigates risk shifting, $dY_1/de_o < 0$, and it increases pilfering, $dL^*/de_o > 0$. The effect on raiding, dY_{crit}/de_o, is ambiguous.*

[8] As proved in the Appendix, Proposition 5 still holds under the much weaker condition $g(Y_0) < V + g(L^*)$. So does Proposition 6. Here, we assume $Y_0 = 0$ because it greatly simplifies presentation and does not affect the intuition.

Proposition 5 is illustrated in the left column of Figure 1, which is based on a numerical simulation (solid curve for high charter value V, dashed curve for low charter value). Note that as capital requirements increase and the amount of outside equity e_o rises, the bank manager needs to sell more shares η. Consequently, the amount of pilfering L^* increases. Risk-shifting Y_1 is unambiguously reduced. Proposition 5. states that the effect of capital regulation on the propensity to raid Y_{crit} is ambiguous, and this is visible in the example. The propensity to raid is first decreasing in e_o, and then increasing. For sufficiently low e_o, more equity decreases the bank manager's propensity to raid. In this range, more equity reduces the leverage D of the bank, which decreases Y_{crit} as the dominant effect. For higher e_o, the bank manager needs to sell disproportionately many shares (cf. the function $L^*(e_o)$ is convex), the bank manager's stake shrivels, thus the bank manager becomes more prone to raiding.

What is producing these interesting results is the somewhat differing interests of inside owner-managers and outside shareholders. With respect to the shares' payments, interests of the two are perfectly aligned. However, the owner-manager also gets the continuation value V plus his perks consumption $g(L^*)$ in the good state. Consequently, the owner-manager manager is less willing to take risk than is the outside equity investor. These conflicting incentives are affected by capital regulation since it affects the relative magnitudes of the different kinds of returns. In turn, this results in a non-monotonic relation between capital regulation and risk of failure. There is an important implication. The risk effects of capital regulation can be quite different, depending on the ownership structure of the bank. If the bank has a single class of owner-managers (smaller bank?), tighter capital regulation will result in less risk-shifting. If the bank has both owner-managers and outside equity investors (large bank?), the effect of capital regulation on risk-shifting is uncertain.

4.3 Deterring Banks from Pilfering

We have assumed that looting is unlawful, and comes at a cost for the bank manager. Instead of L, the bank manager gets only $g(L) \leq L$. The penalty function itself is a policy variable of the regulator; the regulator can fix a high or low c to make looting more or less costly. One may now want to know the direct and indirect effects of the regulator's policy on the model's endogenous parameters.

Proposition 6 (Deterring Banks from Pilfering) *Increasing the penalty c on looting induces the bank manager to pilfer less in equilibrium, $\partial L^*/\partial c < 0$. Furthermore, Proposition 2 holds true, $\partial Y_{\text{crit}}/\partial c < 0$: the manager is less likely to raid. Finally, the last statement of Proposition 3 is reversed, $\partial Y_1/\partial c > 0$.*

Let us first discuss the effect of c on η. The effect of an increase of c on η through L^* is negative: If the costs of looting are higher, the bank manager pilfers less; the equity investor anticipates less pilfering and hence gets fewer shares for his stake. Also the effect on η through Y_{crit} are negative: If the costs of looting c are higher, the bank manager raids less; the equity investor anticipates less raiding and hence gets a return in more states of nature, and hence demands fewer shares for his investment. Summing up, the effect on η is negative. As a consequence, there is an additional, indirect negative effect on pilfering L^*: Because the equity investors likes looting to be costly, he reduces η if c is high; hence the bank manager pilfers less because he can keep more shares to himself. For the same reason, the bank manager raids less. However, an increase in η also aggravates the bank manager's incentives to loot. He will pilfer more, and the range of outcomes $[0, Y_{\text{crit}}]$ in which he raids the bank increases. Hence we have the result that capital regulation mitigates the bank manager's incentives to gamble, but it exacerbates his incentives to loot.

We can now motivate why the sign of $\partial Y_1/\partial c > 0$ is reversed in comparison to Proposition 3. There are two reasons. First, in Proposition 3, a higher c makes the bank manager take less risk because $g(cY_0)$ drops and the bad state becomes less attractive. For $Y_0 = 0$, the risk level Y_1 remains unchanged if c increases. Second, in Proposition 3, the manager sells no shares to outside investors, $\eta = 0$. Here, as argued above, a higher c makes the manager sell less shares η. This implies that the share's payoff become more decisive to the manager, whereas the continuation value V becomes less important. Hence, the manager moves towards higher risk taking Y_1.

Proposition 6 is illustrated by the middle column of Figure 1. We know the effects of a stricter looting policy (higher c): the bank manager will gamble more (higher Y_1), he will raid and pilfer less (lower Y_{crit} and L^*), and he will have to sell less shares (lower η). All these predictions are confirmed by the numerical simulation in Figure 1.

Finally, let us also discuss the aggregate effect of a tax t on the bank manager's choice parameters. We parameterize the function $t(Y)$, choosing $t(Y) = \tau Y^2$ and using τ for a comparative static. Hence a high τ means that the regulator heavily restricts the set of possible investments for the bank manager. One can conjecture that a higher τ should make the bank manager gamble less (lower Y_1). As a consequence, the bank manager should sell more shares η, and hence he should gamble and pilfer more (higher Y_{crit} and L^*). Again, these predictions are confirmed by the numerical simulation in Figure 1.

5 Conclusion

The implications of this study are several. At the theoretical level, we have modeled the problem both in the conventional way with one class of equity, and with an augmented model allowing for both bank managers (inside equity holders), and outside equity holders. We have seen that providing for two classes of shareholders provides interesting insights which are invisible with the more conventional one-class-of-equity models. In particular, the interests of bank managers are in some ways aligned with those of outside equity holders, and in other ways not. Both groups share when returns are high, and this tends to make both groups like "gambling." On the other hand, in bad states of the world bank managers can loot and outside equity holders can't, rendering the latter group less eager to take high risks if looting is easy.

From a policy perspective, our work has a number of interesting implications. Of the three policies we have considered, penalizing crime (looting) may seem the most promising. However, penalizing crime simultaneously reduces incentives to pilfer and raid, but increases incentives to gamble. By contrast, capital requirements may deter gambling, but they actually tend to encourage looting. Similarly, if the regulator tries to reduce gambling by banning too risky loan portfolio choices, gambling may be reduced. But even then, pilfering and raiding will be encouraged.

Finally, we have shown that the policy of penalizing or taxing high risk strategies, may "backfire," causing the bank to take more, as opposed to less, risk. This does not happen in all cases, but it is easy to produce examples in which it does. The real world implications are clear: when certain risky activities are prohibited, the bank manager may simply resort to other strategies that are even riskier. Arguably, the regulator cannot identify and prohibit every sort of high risk activity a bank can undertake.[9]

A Proofs

Proof of Proposition 1: The implicit function theorem yields

$$\frac{\mathrm{d}Y_{\mathrm{crit}}}{\mathrm{d}D} = \frac{\partial Y_{\mathrm{crit}}}{\partial D} = -\frac{\partial \bar{G}/\partial D}{\partial \bar{G}/\partial Y_{\mathrm{crit}}} = -\frac{1}{g'(Y_{\mathrm{crit}})-1}. \tag{11}$$

We have assumed that $g'(0) = 1$ and $g''(\cdot) < 0$ everywhere, hence $g'(\cdot) \leq 1$ everywhere. As a consequence, the denominator is negative, and the whole term is positive.[10] Now the probability of a raid is given by $F(Y_{\mathrm{crit}})$, hence the reaction of this probability with respect to a change in D is $\partial F(Y_{\mathrm{crit}})/\partial D = f(Y_{\mathrm{crit}})\,\partial Y_{\mathrm{crit}}/\partial d$. So whenever $f(Y_{\mathrm{crit}}) > 0$, this derivative is strictly positive. When there is no probability mass at the point Y_{crit}, then the derivative is zero.

Along the same line,

$$\frac{\mathrm{d}Y_{\mathrm{crit}}}{\mathrm{d}V} = \frac{\partial Y_{\mathrm{crit}}}{\partial V} = -\frac{\partial \bar{G}/\partial D}{\partial \bar{G}/\partial Y_{\mathrm{crit}}} = -\frac{-1}{g'(Y_{\mathrm{crit}})-1} \tag{12}$$

which is negative. ■

Proof of Proposition 2: The implicit function theorem now yields

$$\frac{\mathrm{d}Y_{\mathrm{crit}}}{\mathrm{d}c} = \frac{\partial Y_{\mathrm{crit}}}{\partial c} = -\frac{1}{c^2}\,\frac{-[g(c\,Y_{\mathrm{crit}}) - c\,Y_{\mathrm{crit}}\,g'(c\,Y_{\mathrm{crit}})]}{g'(c\,Y_{\mathrm{crit}})-1}. \tag{13}$$

From Proposition 1, we already know that the denominator is negative. Furthermore, $g''(\cdot) < 0$ implies $Y\,g'(Y) < g(Y)$ for all $Y > 0$, hence the numerator is also negative. Consequently, the whole term is negative. ■

[9] The new Basel 2 capital requirements heavily depend on ex-post identification of excessive risk-taking exposures through backtesting, and then penalizing the cheaters. Although it is peripheral to the present study, our results might suggest that the success of the program will depend on the exact form of the ex-post taxation.

[10] Note that $\mathrm{d}Y_{\mathrm{crit}}/\mathrm{d}d = (r_d + \alpha)\,\mathrm{d}Y_{\mathrm{crit}}/\mathrm{d}D$ has identical sign, and so have $\mathrm{d}Y_{\mathrm{crit}}/\mathrm{d}r_d$ and $\mathrm{d}Y_{\mathrm{crit}}/\mathrm{d}\alpha$.

Proof of Proposition 3: The implicit function theorem now yields

$$\frac{\mathrm{d}Y_1}{\mathrm{d}D} = -\frac{-p'(Y_1)}{\partial^2 E\Pi/\partial Y^2}. \tag{14}$$

The denominator must be negative, otherwise Y_1 would not maximize, but minimize the bank manager's expected profits. The numerator is positive because $p'(\cdot) < 0$. Hence the whole derivative is positive. Next,

$$\frac{\partial Y_1}{\partial V} = -\frac{p'(Y_1)}{\partial^2 E\Pi/\partial Y_1^2}, \tag{15}$$

which is negative for analogous reasons. Finally,

$$\frac{\partial Y_1}{\partial c} = -\frac{p'(Y_1)}{c^2}\,\frac{g(c\,Y_0) - c\,Y_0\,g'(cY_0)}{\partial^2 E\Pi/\partial Y_1^2} \tag{16}$$

We have argued for Proposition 2 that $g(Y) > Y\,g'(Y)$, hence the denominator of the second fraction is positive (and zero for $Y_0 = 0$). Consequently, the whole term is negative. ■

Proof of Proposition 4: Note that (5) defines a differential inequality for $t(\cdot)$. If the inequality is strict, we obtain a first order differential equation, $t'(Y_1) = -t(Y_1)\,p'(Y_1)/p(Y_1)$. The solution to this equation is $t(Y_1) = C/p(Y_1)$, where C is an integration constant. This solution is not surprising; if the product of $t(Y_1)$ and $p(Y_1)$ is a constant, then the sum of the relative changes of both must add up to zero; this is exactly the differential equality. Now if indeed $t(Y_1) = C/p(Y_1)$, then the bank manager's profit function (see (3)) becomes

$$\begin{aligned} E\Pi &= (1 - p(Y_1))\,g(Y_0) + p(Y_1)\,\big(Y_1 - C/p(Y_1) - D + V\big) \\ &= (1 - p(Y_1))\,g(Y_0) + p(Y_1)\,\big(Y_1 - D + V\big) - C. \end{aligned} \tag{17}$$

Thus, the bank manager's expected profits do depend on the reduction of the set of possible investments. However, the bank manager's decision on risk, which is determined by the first order condition $\partial E\Pi/\partial Y_1 = 0$, does not. Hence, if inequality (5) holds, then taking risk becomes more costly for the bank manager in comparison to the above differential equation; the bank manager will take less risk in equilibrium. If the reverse of (5) holds true for all Y_1, then the bank manager will take more risk. If (5) holds only for some Y_1, then the effect on the regulation on the bank manager's risk choice is ambiguous. ■

Proof of Proposition 5: In order to derive the absolute derivatives of the endogenous variables, we first prove two lemmata that consider the direct influences of variables on one another.

Lemma 1 (Outside Equity) *Ceteris paribus, more outside equity makes the bank manager pilfer more, $\partial L^*/\partial\eta > 0$, and it increases the range of possible returns in which the bank manager wants to raid the bank, $\partial Y_{\text{crit}}/\partial\eta > 0$. The statements of Proposition 1 hold true in the presence of outside equity ($\partial Y_{\text{crit}}/\partial D > 0$ and $\partial Y_{\text{crit}}/\partial V < 0$). Pilfering does not influence the bank manager's raiding decision, $\partial Y_{\text{crit}}/\partial L^* = 0$. Finally, the fraction of outside equity increases if the bank manager pilfers more, $\partial\eta/\partial L^* > 0$, and it weakly increases if the bank manager raids more often, $\partial\eta/\partial Y_{\text{crit}} \geq 0$.*

Proof of Lemma 1: Start with the discussion of L^*, which is determined by (6), hence by the implicit equation $G = g'(L^*) - (1-\eta) = 0$. The implicit function theorem yields

$$\frac{\partial L^*}{\partial\eta} = -\frac{\partial G/\partial\eta}{\partial G/\partial L^*} = -\frac{1}{g''(L^*)} > 0. \tag{18}$$

We obtain the very natural result that the higher the participation of the equity investor, the more the bank manager will pilfer. The higher the bank manager's own participation in profits $(1-\eta)$, the less he will pilfer.

Now come to the discussion of Y_{crit}, which is determined by (8), hence by the implicit equation $\bar{G} = g(Y_{\text{crit}}) - g(L^*) - (1-\eta)\,(Y_{\text{crit}} - L^* - D) - V = 0$. The implicit function theorem yields

$$\frac{\partial Y_{\text{crit}}}{\partial\eta} = -\frac{\partial\bar{G}/\partial\eta}{\partial\bar{G}/\partial Y_{\text{crit}}} = -\frac{Y_{\text{crit}} - L^* - D}{g'(Y_{\text{crit}}) - (1-\eta)} > 0. \tag{19}$$

The numerator is positive: If the portfolio returns only $D + L^*$, hence debt plus the amount that the bank manager would pilfer anyway, he would clearly prefer to steal the complete return, hence $Y_{\text{crit}} > L^* + D$. The denominator is negative because $Y_{\text{crit}} > L^*$, and $g'(L^*) = 1-\eta$, and $g'' < 0$. As a consequence, the whole derivative is positive. If the equity investor gets a higher fraction of the cake, the bank manager raids the bank already at a rather high Y_{crit}. Ceteris paribus, with a higher η, the probability of a raid increases. Along the same line,

$$\frac{\partial Y_{\text{crit}}}{\partial D} = -\frac{\partial\bar{G}/\partial D}{\partial\bar{G}/\partial Y_{\text{crit}}} = -\frac{1-\eta}{g'(Y_{\text{crit}}) - (1-\eta)} > 0. \tag{20}$$

The more deposits, the higher the debt of the bank manager, the more likely he is to raid the bank.

$$\frac{\partial Y_{\text{crit}}}{\partial V} = -\frac{\partial \bar{G}/\partial V}{\partial \bar{G}/\partial Y_{\text{crit}}} = -\frac{-1}{g'(Y_{\text{crit}}) - (1-\eta)} < 0. \tag{21}$$

The bank manager is not very likely to raid the bank if its continuation value is high.

$$\frac{\partial Y_{\text{crit}}}{\partial L^*} = -\frac{\partial \bar{G}/\partial L^*}{\partial \bar{G}/\partial Y_{\text{crit}}} = -\frac{-g'(L^*) + (1-\eta)}{g'(Y_{\text{crit}}) - (1-\eta)} = 0. \tag{22}$$

The numerator is zero because of (6). A marginal change in the amount of pilfering L^* does not make the bank manager want to raid more or less often.

Finally, let us come to the discussion of η, which is determined by the equity investors' participation constraint, hence $\hat{G} = \Pi_{\text{Eq Inv}} = 0$ with $\Pi_{\text{Eq Inv}}$ as in (9). C. p., we get the comparative statics

$$\frac{\partial \eta}{\partial L^*} = -\frac{\partial \hat{G}/\partial L^*}{\partial \hat{G}/\partial \eta} = -\frac{-\int_{Y_{\text{crit}}}^{\infty} \eta\, f(Y)\, dY}{\int_{Y_{\text{crit}}}^{\infty} (Y - L^* - D)\, f(Y)\, dY} > 0. \tag{23}$$

If the bank manager pilfers more, the equity investor wants a higher fraction η of profits, in order to still get the same expected return. The derivative $\partial\eta/\partial D$ is exactly the same; the equity investor does not care whether he gets less money because the bank manager pilfers more, or if he gets less money because the bank manager must repay more to depositors. Next,

$$\frac{\partial \eta}{\partial Y_{\text{crit}}} = -\frac{\partial \hat{G}/\partial Y_{\text{crit}}}{\partial \hat{G}/\partial \eta} = -\frac{-\eta\,(Y_{\text{crit}} - L^* - D)\, f(Y_{\text{crit}})}{\int_{Y_{\text{crit}}}^{\infty} (Y - L^* - D)\, f(Y)\, dY} \geq 0. \tag{24}$$

The numerator is negative because $Y_{\text{crit}} > L^* + D$ (as discussed above), it is zero if $f(Y_{\text{crit}}) = 0$ (which would typically be the case in a model with discrete outcomes. The denominator is positive, hence the complete fraction is positive: If the probability of a raid increases (hence if the critical Y_{crit} below which the bank manager will raid the bank) increases, the equity investor expects a lower repayment from the bank manager, hence he needs a higher η in order to be compensated. Finally, and quite trivially so, $\partial\eta/\partial E_o > 0$. □

From this lemma, it becomes already apparent that equity regulation (leading to a higher η) can backfire with respect to pilfering and raiding;

a high capitalization ratio is not necessarily a good thing. This reality is invisible in models with only one class of equity.

Interestingly, the bank manager's decision on gambling does not influence pilfering. Consider again a two-state distribution function, the portfolio yields Y_1 with probability $p(Y_1)$, and otherwise Y_0, with $Y_1 > Y_{\text{crit}} > Y_0$. Then if the return is low (Y_0), the bank manager will raid the bank, if the return is high (Y_1), he will just pilfer, independent of the size of returns (Y_1) and of the probability of success ($p(Y_1)$).

On the other hand, if the bank manager has the option to pilfer, he will get more out of the good state of nature, hence he will choose to take less risk Y_1. However, because L^* is chosen optimally in equilibrium, a marginal change in L does not affect the bank manager's profits in the high state. As a consequence, a marginal change in L would not change the bank manager's risk taking decision Y_1.

Lemma 2 (Outside Equity and Gambling) *If (5) holds, then in equilibrium, a larger fraction of outside equity η makes the bank manager gamble less, $\partial Y_1/\partial\eta < 0$, and more gambling makes equity investors demand a smaller fraction of the shares, $\partial\eta/\partial Y_1 < 0$. If $V < g(Y_0) - g(L^*)$, then both inequalities are reversed.*

Proof of Lemma 2: First, look at the reaction of risk Y_1 to an increase in the fraction of outsider shares η. The bank manager's expected profit is given by

$$E\Pi = (1 - p(Y_1))\, g(Y_0) + p(Y_1)\, \big(g(L^*) + (1-\eta)\,(Y_1 - L^* - D) + V\big). \quad (25)$$

The first order condition $\partial E\Pi/\partial Y_1 = 0$ determines the bank manager's risk choice Y_1, and especially defines an implicit function $Y_1(\eta)$. The implicit function theorem yields

$$\frac{\partial Y_1}{\partial \eta} = -\frac{p'(Y_1)\,\big(g(L^*) - g(Y_0) + V\big)/(1-\eta)}{\partial^2 E\Pi/\partial Y_1^2} \quad (26)$$

The denominator must be negative. If $g(Y_0) < g(L^*)+V$, then the numerator is negative, and the whole fraction is negative: if investors hold a larger fraction η of shares, the bank manager wants to take less risk. However, if $g(Y_0) > g(L^*) + V$, then the numerator is positive, hence the whole fraction becomes positive; the bank manager takes more risk if investors hold more shares.

In the other direction, Y_1 also influences η. Equity investors may or may not appreciate that the bank manager takes more risk; in reaction, they may demand a higher or smaller share η of the bank's profits. η is determined by the equation

$$\Pi_{\text{Eq Inv}} = p(Y_1)\,\eta\,(Y_1 - L^* - D) - e_o\,r_o, \tag{27}$$

which defines an implicit function $\eta(Y_1)$. The implicit function theorem yields

$$\begin{aligned} \frac{\partial \eta}{\partial Y_1} &= -\eta\,\frac{p'(Y_1)\,(Y_1 - L^* - D) + p(Y_1)}{p(Y_1)\,(Y_1 - L^* - D)} \\ &= -\eta\,\frac{-p'(Y_1)\,\big(g(L^*) - g(Y_0) + V\big)/(1-\eta)}{p(Y_1)\,(Y_1 - L^* - D)}. \end{aligned} \tag{28}$$

If $g(Y_0) < g(L^*) + V$, the bank manager takes less risk than the equity investor would like him to, hence $\partial\Pi_{\text{Eq Inv}}/\partial Y_1 > 0$. As a consequence, the complete derivative is negative, more risk makes the equity investor demand a lower compensation η. If $g(Y_0) > g(L^*) + V$, the bank manager is too prudent from the eyes of the equity investor, hence an increase in risk Y_1 increases η. □

According to Lemma 2, a high V implies that the bank manager likes risk taking less than outside equity investors. Hence, if for some reason the bank manager is anticipated to take marginally more risk, then the price of shares increases, and the bank needs to issue fewer shares in order to get the same amount of outside equity, $\partial\eta/\partial Y_1 < 0$.

Equation (5) is equivalent to $g(L^*) + V > g(Y_0)$. These are the hypothetical profits of a bank manager, net of compensation through shares. Under failure, the bank manager raids and hence gets $g(Y_0)$. Under success, he gets $g(L^*)$ from pilfering, plus he keeps the charter value V. Hence reformulating Lemma 2, if the bank manager prefers to be successful even without taking the profits from his inside equity shares into account, then the fact that he does hold inside equity makes him gamble more (because it increases the attractiveness of the successful states). Furthermore, outside equity investors dislike this risk shifting behavior, so the bank manager will have to issue more shares if investors anticipate him to take on more risk.

Note that there is always an amplifying multiplier between η and Y_1. If $g(Y_0) < g(L^*) + V$, then a larger fraction of outside equity η induces less risk taking Y_1, which in turn increases η. If on the other hand $g(Y_0) > g(L^*) + V$, then a larger fraction of outside equity η induces *more* risk taking Y_1, which in turn increases η. Hence the answer to the question whether capital regulation is effective depends on whether the bank manager gains a lot from looting in the bad state of the world, $g(Y_0)$. If the proceeds from looting $g(Y_0)$ are very high, then capital regulation is detrimental for risk taking. Especially when the regulator does not know the exact V, or if V itself is a stochastic variable, capital regulation may be a risky strategy for the regulator as it may increase the bank's risk choice.

Now let us come back to the proof of Proposition 5. The equilibrium is defined by four equations. (4) defines Y_1, (6) defines L^*, (8) defines Y_{crit}, and (9) defines η. For simplicity, consider $Y_0 = 0$ as an extreme example for the condition $g(Y_0) < g(L^*) + V$. We have hence four implicit equations that define the equilibrium,

$$\mathcal{E}_{Y_1} = (1-\eta)\, p(Y_1) + p'(Y_1)\big(g(L^*) + (1-\eta)(Y_1 - L^* - D) + V\big) = 0, \quad (29)$$

$$\mathcal{E}_{L^*} = g'(L^*) - (1-\eta) = 0, \quad (30)$$

$$\mathcal{E}_{Y_c} = g(L^*) + (1-\eta)\,(Y_c - L^* - D) + V - g(Y_c) = 0, \quad \text{and} \quad (31)$$

$$\mathcal{E}_{\eta} = \eta\, p(Y_1)(Y_1 - L^* - D) - E_o = 0. \quad (32)$$

We already know that η influences L^* positively, and vice versa L^* increases η. Neither Y_1 nor Y_c have a direct influence on L^*. As a consequence, we can (temporarily) ignore L^* in our discussion, and bear in mind that any effect on η will have to multiplied due to repercussions through L^*. We are left with three implicit equations for three variables.

Because E_o is defined as $E_o = r_o\, e_o$, we have to look at the comparative statics with respect to E_o. Furthermore, note that $I = d + e_i + e_o = D/(r_d + \alpha) + e_i + E_o/r_o$, and hence $D = (r_d + \alpha)\,(I - e_i - E_o/r_o)$. Hence through D, also (29) and (31) depend immediately on E_o. Substitute D through E_o and apply the implicit function theorem to get

$$\frac{d\eta}{dE_o} = \left(\frac{\partial \mathcal{E}_{Y_1}}{\partial Y_1}\cdot\frac{\partial \mathcal{E}_{\eta}}{\partial E_o} - \frac{\partial \mathcal{E}_{Y_1}}{\partial E_o}\cdot\frac{\partial \mathcal{E}_{\eta}}{\partial Y_1}\right) \Big/ \left(\frac{\partial \mathcal{E}_{Y_1}}{\partial \eta}\cdot\frac{\partial \mathcal{E}_{\eta}}{\partial Y_1} - \frac{\partial \mathcal{E}_{\eta}}{\partial \eta}\cdot\frac{\partial \mathcal{E}_{Y_1}}{\partial Y_1}\right), \quad (33)$$

$$\frac{dY_1}{dE_o} = \left(\frac{\partial \mathcal{E}_{Y_1}}{\partial \eta}\cdot\frac{\partial \mathcal{E}_{\eta}}{\partial E_o} - \frac{\partial \mathcal{E}_{Y_1}}{\partial E_o}\cdot\frac{\partial \mathcal{E}_{\eta}}{\partial \eta}\right) \Big/ \left(\frac{\partial \mathcal{E}_{\eta}}{\partial \eta}\cdot\frac{\partial \mathcal{E}_{Y_1}}{\partial Y_1} - \frac{\partial \mathcal{E}_{Y_1}}{\partial \eta}\cdot\frac{\partial \mathcal{E}_{\eta}}{\partial Y_1}\right), \quad (34)$$

$$\frac{dY_c}{dE_o} = -\left(\frac{\partial \mathcal{E}_{Y_c}}{\partial E_o} + \frac{\partial \mathcal{E}_{Y_c}}{\partial \eta}\cdot\frac{d\eta}{dE_o}\right) \Big/ \frac{\partial \mathcal{E}_{Y_c}}{\partial Y_c}. \quad (35)$$

The sign of $d\eta/dE_o$ must be positive. More outside equity means that the bank manager must sell more shares to outsiders. If the bank manager could increase the raised outside equity by selling fewer shares, then the capital regulation rules could not be binding because equity would be cheap (in fact, it would even bear a negative cost). As a direct consequence, due to (30), the derivative $dL^*/de_o > 0$.

Taking derivatives of (29), $\partial\mathcal{E}_{Y_1}/\partial Y_1 < 0$, $\partial\mathcal{E}_{Y_1}/\partial\eta < 0$, and $\partial\mathcal{E}_{Y_1}/\partial E_o < 0$. Taking derivatives of (32), $\partial\mathcal{E}_\eta/\partial\eta > 0$, $\partial\mathcal{E}_\eta/\partial E_o < 0$, and

$$\partial\mathcal{E}_\eta/\partial Y_1 = \eta\, p(Y_1) + \eta\, p'(Y_1)\,(Y_1 - L^* - D),$$

which is equal to $-p'(Y_1)\,(V + g(L^*))\,\eta/(1-\eta)$ due to (29), which is positive. (For large positive Y_0, the term might turn negative.) As a consequence, the numerator of (33) is negative. As argued above, the whole fraction must be positive, hence also the denominator must be negative. Now the denominator of (34) is exactly the negative of the denominator of (33), hence it is positive. The numerator of (34) is positive, hence the aggregate fraction of (34) is negative. Hence stricter capital requirements induce the bank manager to take less risk in equilibrium.

Now let us discuss (35). Taking derivatives of (31), $\partial\mathcal{E}_{Y_c}/\partial E_o > 0$ and $\partial\mathcal{E}_{Y_c}/\partial\eta < 0$, furthermore $\partial\mathcal{E}_{Y_c}/\partial Y_c > 0$. As a consequence, the sign of (35) is indeterminate. However, we can conjecture that for large E_o, as the problem of pilfering becomes more pronounced, $d\eta/dE_o$ increases. Hence the sign of $\partial\mathcal{E}_{Y_c}/\partial\eta < 0$ will be dominant, and hence $dY_c/dE_o > 0$. ■

Proof of Proposition 6: The level of pilfering is now given by a modification of (6), by $g'(c\,L^*) - (1-\eta) = 0$. As a consequence,

$$\frac{\partial L^*}{\partial c} = -\frac{c\,g'(c\,L^*)}{L^*\,g'(c\,L^*)} = -\frac{c}{L^*} < 0. \tag{36}$$

Quite naturally, a higher penalty on looting (of any kind) makes the bank manager want to pilfer less. The critical Y_{crit} is now given by $g(c\,Y_{\text{crit}})/c - g(c\,L^*)/c - (1-\eta)\,(Y_{\text{crit}} - L^* - D) = 0$. As a consequence,

$$\frac{\partial Y_{\text{crit}}}{\partial c} = -\frac{1}{c^2}\,\frac{[g(c\,L^*) - c\,L^*\,g'(c\,L^*)] - [g(c\,Y_{\text{crit}}) - c\,Y_{\text{crit}}\,g'(c\,Y_{\text{crit}})]}{g'(c\,Y_{\text{crit}}) - (1-\eta)}. \tag{37}$$

Now $Y_{\text{crit}} > L^*$, and $g(c\,Y) - c\,Y\,g'(c\,Y)$ is a strictly increasing function in Y, hence the numerator is negative. The denominator is also negative, because the derivative of g equals $1-\eta$ already at L^*, and g' is a decreasing function. Summing up, the whole derivative is negative. The higher the costs of looting c, the smaller the critical Y_{crit} below the bank manager will raid; the smaller the probability of a raid. Finally, there is no direct effect on η, the fraction of shares that the equity investor buys.

Finally, let us show that $\partial Y_1/\partial c < 0$ if and only if $Y_0 > L^*$. Using the implicit function theorem, we know that the sign of $\partial Y_1/\partial c$ is identical to that of

$$\frac{\partial^2 E\Pi}{\partial Y_1 \partial c} = \frac{p'(Y_1)}{c^2}\big(g(c\,Y_0) - g(c\,L^*) - c\,Y_0\,g'(c\,Y_0) + c\,L^*\,g'(c\,L^*)\big). \tag{38}$$

Because $g(c\,Y) - c\,Y\,g'(c\,Y)$ is a strictly increasing function in Y, the whole term is negative if and only if $Y_0 > L^*$.

If not (5), then the effect of an increase in c on Y_1, Y_{crit} and L^* is negative. The decrease of each of these variables makes η fall, which in a multiplier process leads to a further drop of Y_1, Y_{crit}. Note that, even if (5) does hold, the total derivatives can all be negative. If however $Y_0 < L^*$, then the direct effect of an rising c on Y_1 will be negative; the aggregate effect (through η) can still be positive. If $Y_0 \ll L^*$ (like in the numerical example for Figure 1 where $Y_0 = 0$), then the total derivative $\mathrm{d}Y_1/\mathrm{d}c$ will be negative. ■

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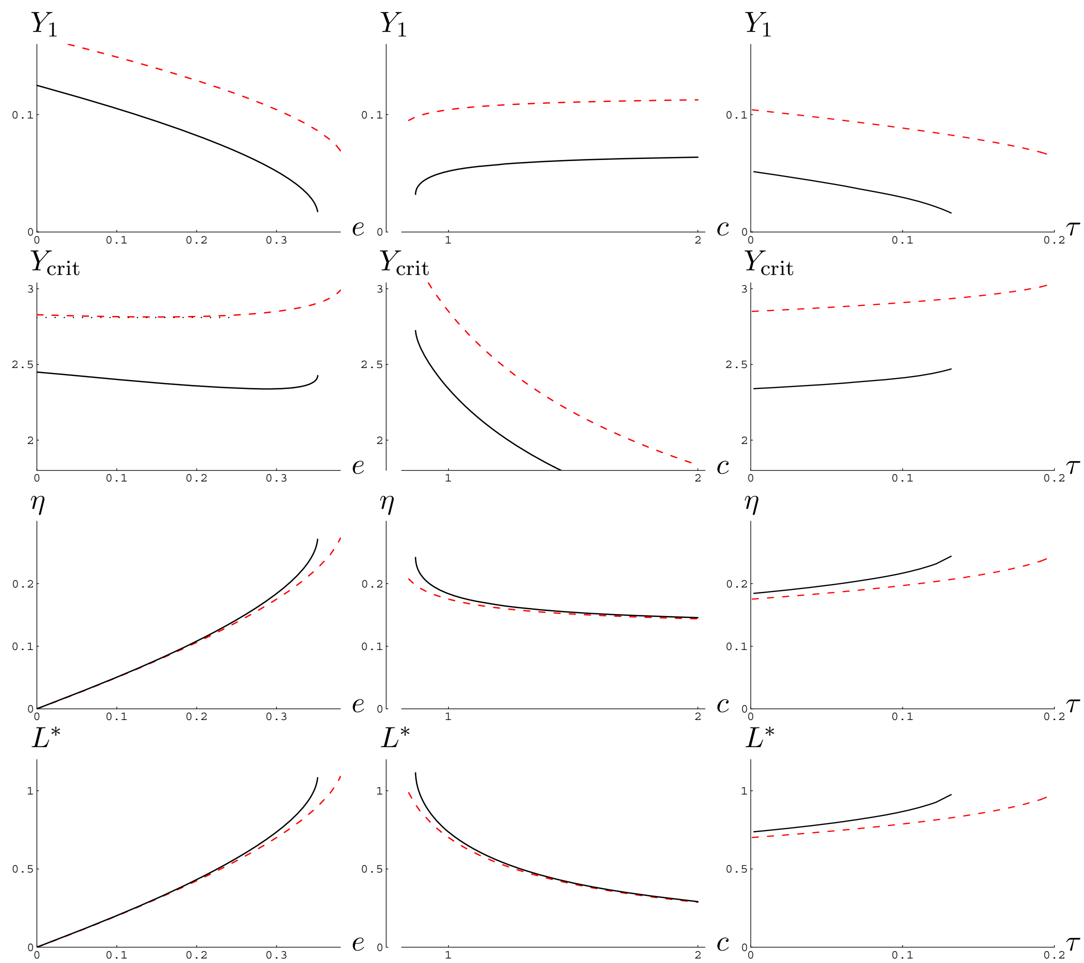
Table 1: Numerical Example



We have plotted endogenous variables (Y_1, Y_{crit}, η and λ) for changing policy parameters (capital requirements e, penalty on looting c, and penalty on risk shifting t). The numerical examples have $p(Y_1) = 2 - Y_1/3$, $g(L) = L - L^2/8$, $t(Y) = \tau Y^2$, $\alpha = 0$, $r_E = 1$, $r_d = 1$, $Y_0 = 0$, and $V = 0$ (dashed curves) or $V = .25$ (solid curves). Furthermore, $e = 0.3$ (except in the left column where it varies), $c = 1$ (except in the middle column) and $t = 0$ (except in the right column). The scales of three adjacent plots are identical and hence directly comparable. Hence reading the functions at $e = 0.3$, $c = 1$ and $t = 0$ yields identical values.

Hence if V drops, gambling increases, and so does raiding. Surprisingly, the amount of outsider shares η can decrease (because the outside investor likes the fact that the bank manager takes more risk in a crisis). As a consequence, also pilfering can decrease if the crisis is anticipated.