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Kose John, Anthony Saunders, and Lemma W. Senbet

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*The authors are, respectively, Charles William Gerstenberg Professor of Banking and Finance, John M. Schiff Professor of Finance, New York University and William E. Mayer Professor of Finance, University of Maryland. Kose John acknowledges support from a Bank and Financial Analysts Faculty Fellowship. We are also grateful for helpful comments from David Beim, Allen Berger, Jaime Dermody, Teresa John, Ed Kane, Rita Maldonado-Bear, Marti Subrahmanyam, David Yermack and participants in the Wharton Financial Institutions Center Conference, March 1994, and seminars at Columbia University, New York University, Rutgers University, and the London School of Economics.

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Abstract

This paper examines the incentive structure underlying the current features of bank regulation, particularly the role of prompt corrective action, capital requirements and mandatory restrictions on asset choice as primary tools to control risk-shifting incentives of depository institutions. We propose instead a more direct and effective mechanism of influencing incentives through the role of top-management compensation, whereby a fair and revenue-neutral FDIC premium incorporates incentive features of top-management compensation as well as the level of bank capitalization. With this pricing scheme (for FDIC insurance) we show that bank owners choose an optimal management compensation structure which induces first-best value-maximizing investment choices by a bank's management. We also characterize the parameters of the optimal managerial compensation structure and the FDIC premium schedule explicitly.

1. Introduction

Capital requirements and mandatory restrictions on asset choice have been central features of recent U.S. bank regulation. For example, a central feature of the FDIC Improvement Act (FDICIA), passed in 1991, is a system of capital-based regulations based on prompt corrective action (PCA). In this regulatory framework five capital zones for banks are specified ranging from well capitalized to critically undercapitalized. Importantly, as a bank's capital adequacy ratio declines -- moving from well capitalized to undercapitalized -- regulators are required to take (or consider) a number of mandatory and discretionary actions restricting the asset and liability activities of weakly capitalized banks as well as imposing constraints on their payment of fees, dividends and management compensation.

In this paper, we examine the incentive structure underlying the existing PCA regime -- especially the potential role of capital rules, asset restrictions, and mandatory interventions by regulators in controlling the risk-shifting incentives of banks. We argue that bank regulation, through capital requirements and asset restrictions, has limited effectiveness, given the high leverage ratios of banks. Instead, we propose a more direct and effective mechanism for curbing risk-shifting incentives through exploiting the incentive features inherent in bank management compensation structures. Specifically, we propose an actuarially fair, revenue-neutral, scheme for pricing FDIC insurance by explicitly incorporating features of a bank's management compensation schedule (along with its level of capitalization) in the risk-based pricing of deposit insurance. Such a pricing scheme is shown to provide bank-owners with appropriate incentives to put in place optimal management compensation structures which induce the best, or most efficient, bank investment policies. In fact, for any level of deposit financing (or leverage) for the bank, we can characterize the optimal management compensation structure that bank-owners will choose (in their own self-interest) as well as the appropriate actuarially fair revenue-neutral FDIC insurance premium. In particular, the investment policy implemented by a bank is shown to be Pareto-optimal.

As is well known, stockholders of limited-liability banks financed by deposits (whether insured or uninsured) have incentives to take risk beyond that which is optimal for an "all equity" bank (see, for example, John, John and Senbet (1991)). This risk-shifting behavior by banks has been widely viewed as a major culprit in the recent S&L crisis. Capital regulation, prompt corrective action, asset restrictions and FDIC premiums -- based on the level of capitalization and supervisory characterization of bank risk -- have been major policy initiatives by regulators since the 1991 passage of the FDICIA. In the first part of the paper we examine the risk-shifting incentives of banks in a simple model of asset choice in the presence of moral hazard and incomplete contracting. We then analyze the effectiveness of FDICIA type capital regulations and asset choice restrictions in that framework.

Our analysis shows several limitations of capital and asset choice regulation. First, capital regulation still leaves a high degree of risk-shifting incentives even for the best-capitalized banks (given the high leverage of banking firms). Second, for any level of bank capitalization, the degree of risk-shifting incentives critically depends on the characteristics of its investment opportunity set (i.e., the asset technology for risk-taking available to the bank). Third, mandatory asset restrictions can result in a significant degree of investment inefficiency.

Our analysis also has good news and bad news for the FDICIA provisions regarding the risk-based pricing or premium setting of FDIC insurance premia. The good news is that there is a qualitative parallel between the 1993 implementation of FDIC insurance premia that utilizes a bank's capital ratio and supervisory classifications, on the one hand,[1] and our theoretical result which links fair insurance premia to leverage and the observable parameters of a bank's asset investment schedule. The bad news is that mandatory restrictions on asset choice, which induce a common type of risk-taking for banks, are distortionary from an investment efficiency point of view. Further, we show that capital regulation may only have limited effectiveness in curbing risk-shifting incentives. Indeed, it is particularly ineffective for certain types of investment schedules (and wholesale loan markets) facing the largest banks.

The principal message of our paper is to argue for a prominent role for managerial compensation structures in bank regulation.[2] Unlike capital and asset regulations, which have at best *indirect* effects on managerial incentives and thus on managerial decisions, top-management compensation is a direct and effective way of influencing managerial return and risk taking incentives. Indeed, not only is management compensation readily observable by regulators, but recent empirical studies by Houston and James (1993) and Saunders, Strock and Travlos (1991) have found that managerial compensation -- salary and bonus in the case of Houston and James

[1]The FDICIA required risk-based premiums to be fully implemented by 1994. The 1993 premium structure (viewed as a temporary scheme) allows for a 9bp spread in premiums between the best and worst banks. The premiums are set according to a bank's capital ratio and supervisory rating.

[2]The FDICIA of 1991 required regulators to restrict the compensation of managers in significantly undercapitalized banks. This implied a systematic regulation of compensation structures in undercapitalized banks. In 1992 Congress amended this regulation, allowing bankers to determine their own compensation structures, but giving regulators the discretion to impose restrictions on undercapitalized banks on a bank by bank basis.

and managerial equity stakes in the case of SST -- are significantly correlated with bank returns and risk.

In an environment of moral hazard, investment-risk choices made by management are not readily observable by depositors and regulators, and hence are not contractible. However, for a given compensation structure in place the risk choices which will be made by managers, in their own "self-interest," can be correctly anticipated by outsiders, such as depositors and regulators. This anticipated risk-taking can be incorporated in pricing all claims issued by the bank, including the pricing of deposit insurance premia. Therefore, for any level of bank capitalization, the incentive features in a bank's top-management compensation structure should be crucial inputs into deposit insurance pricing and other aspects of bank regulation. Thus, even though the setting may be one of moral hazard, and investment choices are unobservable, stockholders can be viewed as effectively precommitting to specific risk choices through the observable parameters of the compensation structure they put in place. Thus, incorporating the parameters of the compensation structure, as a determinant of FDIC insurance premia, indirectly prices the risk choices that will optimally be made by bank management.

Given such an FDIC pricing mechanism (which we characterize explicitly), we show that bank owners (stockholders) would directly choose -- and put in place -- an optimal management compensation structure. The compensation structure is optimal in that it would induce management to undertake Pareto-optimal (value-maximizing) investment policies, *with no risk-shifting*. That is, stockholders use the management's compensation structure to precommit to implementation of an optimal investment policy. We show that for any level of deposits (or debt), such an optimal compensation scheme can be structured, and the associated FDIC premium can be characterized in terms of the level of bank capitalization and the features of the bank's compensation structure. Moreover, the resulting investment policy is shown to be socially optimal. It should also be pointed out that the proposed scheme not only achieves an optimal bank investment policy and fair (revenue-neutral) pricing of FDIC insurance, but does so for any level of depository financing.[3] The rest of the paper is organized as follows: Section 2 characterizes a bank's risk shifting incentives and examines the efficiency of capital requirements and mandatory restrictions on asset choice. Section 3 provides a generalized analysis which incorporates the crucial role of a bank's management compensation structure on its asset choice and risk-taking. Section 4 is a summary and conclusion.

2. Capital Regulation and Risk-Shifting Incentives

In this section we study the effectiveness of capital adequacy requirements and the risk-shifting incentives of a bank as a function of its asset or investment opportunity set. The model developed in this section provides the setting for an analysis of the potential role of bank management compensation structures in bank regulation (and the setting of FDIC insurance premia) in section 3.

We show that the effectiveness of capital regulation depends on the shape of the investment schedule facing a bank. Different investment schedules imply different optimal levels of bank risk-taking, in the sense of the efficient allocation of bank funds. Mandatory provisions, that attempt to force banks into adopting a common pool or level of risk, induce allocational inefficiencies. Likewise, deposit insurance premia should, at a minimum, recognize differences in bank investment schedules as well as bank leverage.

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[3]This is important if there is perceived to be some socially optimal level of bank deposits (debt) say F*, associated with the provision of liquidity services to the economy.

2.1 Graphical Illustration

Before we study the detailed model of bank asset choice under moral hazard it would be useful to illustrate the role of capital requirements in the context of a simple "reduced form" characterization of the investment opportunity set of a bank.

Consider a representative bank which has monopoly access to a portfolio of risky assets (loans). These investment opportunities can most simply be characterized as a schedule of means and volatilities of the terminal cash flows from the loan.[4] The graph of this investment opportunity set $\{(V(\sigma),\sigma),\sigma \in \Omega\}$ is shown in Figure 1 for three different types of bank investment opportunity set.

Insert Figure 1 Here

The investment, and the associated risk, choices of σ made by a bank (as embodied in the loans extended or assets selected) are modeled as "private actions". That is, there is less-than-perfect external monitoring of a bank's risk choices by outsiders (depositors and regulators). However, at this stage, no agency problem is assumed to exist between bank stockholders (owners) and managers. This assumption is relaxed in Section 3, and management compensation structures are shown to play a crucial role. Given "incomplete contracting", *vis a vis* asset risk choices, insiders exercise discretion over asset choice so as to maximize the value of bank stockholders claims. If $E(\sigma)$ is the value of equity claims of insiders, then insiders (managers) acting on the behalf of stockholders will make investment and risk choices to maximize $E(\sigma)$,

[4]Here we assume that variance (or standard deviation) is a sufficient statistic to capture investment risk.

instead of those which maximize the total value of the bank, $V(\sigma)$. For convenience, we use σ^* to denote the bank's value-maximizing risk choice, *i.e.*, σ^* maximizes $V(\sigma)$. For a given level of deposit financing, with promised payment F, let $\sigma(F)$ be the level which maximizes the corresponding value of $E(\sigma)$.

We examine three examples of a bank's investment opportunity set, $V_i(\sigma)$, $\sigma \varepsilon \Omega \equiv [0,\bar{\sigma}]$, which are displayed in Figure 1. The value-maximizing level of risk for the investment opportunity i is σ_i^*, i = 1,2,3. For unimodal structures, such as V_1 and V_2, there is a unique value-maximizing level of risk, represented by σ_1^* and σ_2^*, respectively. To the extent that the bank is financed by a high level of deposits (debt), the investment implemented will be affected by the amount of capital in place and its complement, the level of debt financing. It is well-known that insiders will invest up to an asset risk choice level of $\sigma_i(F)$, which is higher than σ_i^*, such that $E(\sigma)$ is maximized for the level of debt financing in place. The deviation $\sigma_i(F) - \sigma_i^*$ will depend on the level of stockholders equity capital in place as well as the investment schedule i faced by the bank. Since $\sigma_i(F) - \sigma^*$ is decreasing in the fraction of equity capital in place, it provides some motivation for linking the level of bank capitalization to FDIC risk-based deposit insurance premia. Nevertheless, since $\sigma_i(F) - \sigma_i^*$ is also a function of the overall riskiness of the bank's investment opportunity set (the set of activities undertaken by the bank), it is clear that insurance premia should be based on measures of risk, other than bank capital adequacy.

The value-maximizing level of risk σ_1^* in the portfolio of activities 1 is different from σ_2^*, the value-maximizing level in the portfolio of activities 2. This suggests that the regulatory corrective actions should not be designed to move all banks to some low common level of risk. These measures may push a bank with activity set 2 go below its optimal level of risk. On the other hand, since the risk shifting incentive is larger with greater leverage (lower capital ratios), regulatory measures designed to move a bank which is critically undercapitalized to a higher level of capitalization will reduce the investment distortion. Accordingly, the deposit insurance premium will be set corresponding to a level of risk, which is a function of the degree of capitalization, F, and measures of the risk class of activities or assets held by the bank, i. The current FDICIA provisions (mandatory and discretionary) and premium zones seem to reflect such a logic. Finally, to dramatize this point, that capital ratios alone are insufficient measures of bank risk, we show an investment technology for which capital regulation will be ineffective. Consider the asset activity set 3, graphed in Figure 1, where σ_3^* is not unique. In fact, all levels of $\sigma_3 \varepsilon [\sigma_3^*, \bar{\sigma}]$ yield value $V_3(\sigma_3^*)$. Here for any level of deposit financing, bank insiders would shift asset risk all the way to $\bar{\sigma}$. Since $\sigma_3(F) = \bar{\sigma}_3$ for any level of debt (F), capital requirements are ineffective in holding a bank's risk choice close to σ_3^*. In this case, FDIC insurance premiums should be based on asset risk level $\bar{\sigma}_3$, irrespective of the degree of bank capital. In a market with a large supply of risky (near) zero-net-present-value investments (such as those in the capital markets or wholesale loan markets), the investment schedule discussed above may not be unusual. The current, post FDICIA, risk-based FDIC deposit insurance premium schedule does not seem to reflect the possibility of such an investment opportunity set. Even for a high degree of capitalization, large premiums may be required for some banks (e.g., wholesale money center banks) to take into account risk-shifting to very high levels $\bar{\sigma}$ under such investment opportunity sets.[5]

[5] This is assuming that such investment opportunity sets are not reflected in CAMEL and thus is supervisory evaluations which are currently the second dimension (other than capital) to the FDIC's risk-based deposit insurance premium schedule.

2.2 *A Detailed Model*

A detailed model of the asset risk choices made by a bank under moral hazard and incomplete contracting is developed here.[6] The model is designed to capture the key regulatory issues in a simple framework. Consider a representative depository institution (bank) and a representative risky asset (loan) opportunity set. The risky choices made by the bank (as embodied in the loans extended) are modeled as "private actions". That is, there is less-than-perfect external monitoring of the risk choices by outsiders (depositors and regulators), and consequently there is "incomplete contracting" *vis a vis* those choices. Imperfect observability of private actions and incomplete contracting are at the heart of the agency tradition, and are crucial for our analysis. Here, we continue to assume no agency conflict between the bank's stockholders (owners) and its managers.

Ours is a three date two-period model. At t=0, the bank collects deposits and engages in residual financing through equity subject to existing regulatory constraints. Deposits are insured by a government agency (the FDIC) and the bank pays the relevant insurance premium π. All associated contracts are written and "priced" at t=0, given the information available at t=0 and admissible contracting opportunities.[7] The prices of the bank's financial claims (interest rates on deposits and the price of equity) are determined in a rational-expectations manner.

At t=1, asset investment opportunities appear. This represents the possible loans (asset choices) that the bank can make. For simplicity we assume that these investment opportunities

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[6]In the structure of its basic set-up the model is similar to that in section 2 of John, John and Senbet (1991). The reader may refer to that paper for additional details.

[7]The financing claims are restricted to debt and equity. The optimal management compensation contract is endogenously derived in section 3.

are of two types: (1) safe investments which are loan opportunities (to which the bank has monopoly access) with zero risk and non-negative net present value (NPV), and (2) a choice from a menu of possible risky investments (loans) which are indexed by a parameter q. The projects underlying these loans require an investment N to be made at t=1 (for simplicity we assume a zero risk-free rate of interest). The returns from the risky loan-backed projects are high or low (H dollars or L dollars, respectively), with H>I>L>0, where q is the probability of the high outcome H, and (1 - q) the probability of the low outcome, L. The bank's insiders observe the parameter q at t=1 before they choose between the riskless loan and risky loans. The value of the parameter q is not observed by outsiders -- that is, by either depositors or regulators (government). This precludes any contracting contingent on the value of the parameter (q). However, all the relevant parties know that q is distributed uniformly over the interval [0,1]. This modeling device captures the intuition that, given the level of monitoring undertaken by regulators and outside investors, the managers/owners of the bank have additional (inside) information about the prospects of the loan (captured in q). Therefore, bank insiders have discretion in their choice of investment risk.

The amount N + π has to be raised by the bank at t=0. At this time bank owners contribute capital of amount Q, which is the fair price for the cash flow they expect to receive at t=2, and issue debt claims with promised payments F to depositors. These depositors contribute an amount B at t=0, where B represents the rational expectations price of the promised payment F at t=2. In our framework, π can also be determined in a rational expectations manner as the actuarially fair value of the deposit insurance premium for the bank. However, the regulator may choose to charge an insurance premium that is less than actuarially fair (e.g., fixed) as a means of inducing a bank to expand its deposit base. This may serve the regulator's social objectives better (e.g., achieve a greater supply of liquidity to the economy).

At t=2, loans mature and proceeds are collected. Let T denote this terminal cashflow which is equal to I if the riskless investment was chosen at t=1, or equal to H or L depending on the outcome from the risky investment if that choice was made at t=1. The deposit insurance agency (FDIC) honors its guarantee by paying the depositors max(0,F-T). Depositors are thus paid off fully if their deposits are fully insured. We assume that all deposits are insured.

As noted above, in this section, we assume that management's compensation in place completely aligns their incentives with those of the shareholders. In section 3, we will consider manager-stockholder conflicts, their effect on risk choices and risk-shifting incentives, and how managerial compensation structures should affect FDIC insurance premiums and regulatory actions.

We abstract from discounting in all time periods by assuming that the riskless rate of interest is zero. In our frictionless capital market with no transactions costs, the firm's securities (deposits, equity and deposit insurance) can be valued using a risk-neutral valuation approach by taking the relevant conditional expectation of cashflows (e.g., with respect to the equivalent martingale measure).

For a given cut-off value of q^c, $0 \leq q^c \leq 1$, an investment policy of investing in the risky asset (loan) for $q \geq q^c$ and in the riskless asset (loan) for $q < q^c$ will be denoted as an investment policy $[q^c]$. Given that q is uniformly distributed over [0,1], an investment policy $[\tilde{q}]$ produces the distribution of terminal cashflows as follows: H with a probability $\frac{1}{2}[1 - \tilde{q}^2]$, I with a probability $\tilde{q}$ and L with a probability $\frac{1}{2}[1 - \tilde{q}]^2$. The value of the terminal cashflows resulting from an investment policy [q̃] denoted $V(\tilde{q})$, can easily be specified:

$$V(\tilde{q}) = \tilde{q}I + \frac{L}{2}[1-\tilde{q}]^2 + \frac{H}{2}[1-\tilde{q}^2] \tag{1}$$

The variance of the terminal cashflows, $\sigma(\tilde{q})$ can also be specified in the obvious manner. It is easily seen that as $(\tilde{q})$ varies from 1 to 0, $\sigma(\tilde{q})$ varies from 0 to $(\frac{H-L}{2})^2$. This relationship between $\tilde{q}$ and $\sigma(\tilde{q})$ is strictly monotonic (decreasing), and hence one-to-one. $V(\tilde{q})$ also varies with $\tilde{q}\varepsilon[0,1]$. The Pareto-optimal investment policy [q̂] which maximizes $V(\tilde{q})$ is given by:

$$\hat{q} = \frac{I-L}{H-L}. \tag{2}$$

and the resulting value $V(\hat{q})$ can be specified at follows:

$$V(\hat{q}) = \hat{q}I + \frac{L}{2}[1-\hat{q}]^2 + \frac{H}{2}[1-\hat{q}^2] \tag{3}$$

When $\tilde{q}$ is varied from 1 to 0, the value of terminal cashflows increases from I to $V(\hat{q})$ and then decreases to (H+L)/2. We can now combine the behavior of the variance $\sigma(\tilde{q})$ and mean $V(\tilde{q})$ achievable under different investment policies [q̃] to obtain the following pattern: as $\tilde{q}$ varies from 1 to 0, the investment policy becomes increasingly riskier (i.e., variance increases monotonically) but the mean value first increases (from I to $V(\hat{q})$) attains a maximum at $\hat{q}$ and then decreases to (H+L)/2. If the mean values $V(\tilde{q})$ are plotted against the corresponding variance attained $\sigma(\tilde{q})$, we obtain the investment schedules of the type 1 and 2, displayed in

Figure 1. As risk $\sigma(\bar{q})$ increases from 0 to $\sigma(\hat{q})$ the mean increases first (from I to $V(\hat{q})$), and then for further increases in risk (from $\sigma(\hat{q})$ to $\left(\frac{H-L}{2}\right)^2$), the value declines from $V(\hat{q})$ to $\frac{(H+L)}{2}$.

Equation (3) characterizes $V(\hat{q})$, the value which could have been achieved if q were perfectly observed by all parties (including investors and regulators) and if a complete set of enforceable contracts specifying the bank's investment policy could have been written. In other words, $V(\hat{q})$ is the highest value achievable in a full-information scenario with complete contracting. Thus, the investment policy $[\hat{q}]$ and the resulting value, $V(\hat{q})$, form useful benchmarks to measure the distortions caused by risk-shifting incentives due to financing with deposits (debt).

2.3 *An Analysis of Capital Regulation*

Under complete contracting the bank's management will contractually undertake to implement the investment policy $[\hat{q}]$, or equivalently go to the point $\{\sigma(\hat{q}), V(\hat{q})\}$ on the investment opportunity frontier. We can next consider the incentive effects of a bank's typical financial structure -- whereby it issues a substantial proportion of deposit claims to finance assets. Let us examine the effects on investment incentives from financing with deposit claims of promised payment F. It will be convenient to parametrize the level of equity capital maintained by the bank in terms of F, where F and (equity) capital are inversely related.

When the level of depository financing is high enough, such that the bank's cashflows from investment are insufficient to repay the depositors in some state of the world (i.e., $L < F$), then bank management will implement an investment policy riskier than $[\hat{q}]$. These risk-shifting incentives, induced by outstanding debt, are well-known. We will characterize these incentives explicitly in Proposition 1 as a basis for capital regulation.

Proposition 1: (Capital Regulation):

(a) For a level of deposits of promised payment $F \geq 0$, the bank manager will implement an investment policy $[q(F)]$ where $q(F)$ is given in equation (4):

$$
\begin{aligned}
q(F) &= \hat{q} \text{ when } F \leq L \\
&= \frac{(I - F)}{(H - F)} \text{ when } L < F < I \\
&= 0 \text{ when } F \geq I
\end{aligned}
\tag{4}
$$

(b) For any value of deposits such that $F > L$ (i.e., in some states the bank cannot honor the promise to depositors from the cashflows of its investments), the bank manager implements an investment policy $[q(F)]$ which is suboptimal (i.e., $V(q(F)) < V(\hat{q})$) and riskier than the Pareto optimal one, $[\hat{q}]$, i.e., $\sigma(q(F)) > \sigma(\hat{q})$.

(c) In the range of F, $L < F < I$, the terminal cashflow distribution resulting from the investment policy $[q(F)]$, implemented by the manager is strictly increasing in risk for increasing F, i.e., $\frac{\partial \sigma(q(F))}{\partial F} > 0$, and decreasing in value for increasing F,

i.e., $\frac{\partial V(q(F))}{\partial F} < 0$.

Proof: Follows from John, John and Senbet (1991). ∎

Proposition 1, parts (b) and (c), provide the motivation for capital-based regulation. As shown in part (c), the extent of risk undertaken beyond the optimal level, $\Delta\sigma(F) \equiv \sigma(q(F)) - \sigma(\hat{q})$, as well as the value lost due to risk-shifting, $\Delta V(F) \equiv V(\hat{q}) - V(q(F))$, are both functions of the bank's equity capital. With a higher capital ratio, i.e., lower F, $\Delta\sigma$ is lower and ΔV is higher. Regulating the bank's incentives, via capital requirements, leaves the bank enough freedom to pursue activities which are unique to its investment opportunity set with attendant risk $\sigma(\hat{q})$. Importantly, regulation mandating the risk levels of bank activities (loans extended) may push it to levels below $\sigma(\hat{q})$. That is, while capital regulation does allow the bank to go to a risk level of $\sigma(\hat{q})$ or beyond, the bank's own incentives would limit the risk-shifting to a total risk of $\sigma(\hat{q}) + \Delta\sigma(F)$. From a regulatory perspective, since banks have different investment opportunities with different maximal $\sigma(\hat{q})$, direct intervention by regulators to push *all banks to some common* (low) level of risk will not be optimal.

Since $\Delta\sigma(F)$ is increasing in F, it is clear that the total risk taken by the bank $\sigma(\hat{q}) + \Delta\sigma(F)$ is increasing in its leverage ratio or decreasing in its capital adequacy ratio. This implies that with lower and lower levels of capitalization, bank asset risk-shifting will be more and more severe. As the bank's degree of capitalization falls from well capitalized to critically undercapitalized, the degree of bank risk-shifting $\Delta\sigma(F)$ may increase dramatically. In the case of PCA zones 3 to 5, when the bank is undercapitalized (or worse, significantly or critically undercapitalized), $\Delta\sigma(F)$ could be at unacceptable levels. Here regulators may require insiders to recapitalize the bank so as to move it to a higher capital zone. Moreover, as implied by Proposition 2 below, the regulator may have incentives to restrict asset choice -- especially for poorly capitalized banks. That is, the regulator may directly restrict the asset activities of the bank such that for, any given level of F, its risk-shifting incentives are low.

Proposition 2: (Asset Regulation):

For any given level of F, $L \leq F < I$, the risk-shifting incentives are increasing in $(H - I)$. As the successful returns from the risky loan (project) get closer and closer to that from the riskless loan (project), i.e., $(H - I)$ gets smaller, the risk-shifting incentives get smaller and $\Delta\sigma(F)$ gets smaller.

Proof:

Recall that with a deposit level of F, $L \leq F < I$ the manager implements the investment policy [q(F)] instead of the Pareto optimal one [$\hat{q}$]. The risk-shifting incentives can be characterized by:

$$\hat{q} - q(F) = \frac{(I - L)}{(H - L)} - \frac{(I - F)}{(H - F)}$$
$$= \frac{(H - I)(F - L)}{(H - F)(H - L)}$$

which is decreasing in $(H - I)$ for a given $F > L$. When $F = L$, and there are no risk-shifting incentives (and therefore deposits are riskless). For a given level of deposits, $F>L$, $\hat{q} - q(F)$ and therefore $\Delta\sigma(F)$, is decreasing in $(H - I)$. ∎

The intuition of Proposition 2 is straightforward: if the return from the successful outcomes of risky investments are not much higher than that of the riskless investment, the risk-shifting incentives are minimized, even for high levels of deposits (low levels of capitalization). Proposition 2 suggests that if a bank persists to be at low levels of capitalization, such that its $\Delta\sigma(F)$ for its existing investment (asset) menu is very high, the regulator does have the option of restricting the investment menu of the bank. Here the strategy will be to restrict certain high risk (high return with low probability) activities that a well capitalized bank may be permitted to undertake. Under the PCA procedures of the FDICIA, for undercapitalized banks (i.e., those in capital zones 3,4, and 5) there are mandatory and discretionary restrictions on asset growth as well as required approvals for acquisitions and branching.

It should be noted that even though we have assumed moral hazard (and incomplete contracting *vis a vis* risk choices), an appropriate FDIC insurance premium can still be specified. This premium can be tied to the capital ratio maintained by the bank as well as observable parameters of its investment opportunity set. In our framework the FDIC premium could be tied to F (the capital ratio) and {I, H, L}, the parameters of a bank's investment technology. Even though the details of the bank's risk choice (the realized level of q) are not observed by the regulator and are not contractible, the investment policy which will be implemented is [q(F)], as specified in Proposition 1. Hence the appropriate fair, revenue neutral, FDIC premium π is given by Proposition 3.

<u>Proposition 3:</u> (Pricing of FDIC Premium Under Capital Regulation):

Given a level of capitalization corresponding to F, F < H, a fairly priced, revenue neutral, FDIC premium is specified as follows:

$$\pi(F) = q(F)(F - I)^{+} + (\tfrac{1}{2})(1 - q(F))^{2}(F - L)^{+} \tag{5}$$

where q(F) is specified in (4) of Proposition 1 and a quantity y^{+} denotes max {0,y}.

Note that π(F) is completely specified in terms of the bank's capitalization level and the observable parameters {I,H,L} of its investment opportunity set. In spite of moral hazard, the level of bank capitalization fixes the investment policy [q(F)] that a bank's management will pursue in their own best interests (in this case -- also the best interests of the stockholders). If the regulator further restricts the bank's activities directly, so as to alter the bank's investment parameters {I,H,L}, this will also be reflected in the premium $\pi(F)$ specified in (5). The implementation of the 1993 FDIC premium based on capital zone rating and supervisory ratings (e.g., CAMEL or Capital, Asset quality, Management Quality, Earnings and Liquidity) does have its parallels to our specification where the premium depends on capital and observable asset or investment technology parameters. However, the following limitations of capital regulation are immediate:

(1) For any level of risky debt, i.e., $F > L$, Proposition 1 tells us that $q(F) < \hat{q}$ and there is risk-shifting (i.e., $\Delta\sigma(F) > 0$) even if the FDIC premium is priced fairly (as given in (5)). This is because risk-shifting incentives remain. Since banks typically have high leverage levels, even in the high capitalization zones of the FDICIA's PCA provisions, as a result there will still be some amount of risk-shifting.

(2) Given that the FDIC premium is priced as in equation (5), and all other claims are fairly priced, the stockholders of the bank still suffer the costs of risk-shifting given by $\Delta V(F) \equiv V(\hat{q}) - V(q(F))$. Since this value loss is minimized at $F = L$, stockholders would want to limit depository financing. However, low levels of debt in the bank's capital structure may be inconsistent with the regulators social objective regarding bank's provision of liquidity services to the economy. At high levels of leverage, the bank's risk-shifting problems get aggravated. In this context, it would be useful to have a solution to the risk-shifting problem which can be implemented at any level of leverage and which would also be acceptable to a social planner (regulator). It can be seen that the mechanisms of bank regulation that we propose in section 3

can be implemented at *any level* of deposits (debt) for the banking sector.

(3) According to the provisions of the FDICIA, for poorly capitalized banks, certain mandatory restrictions may be imposed on the bank's asset choice, as indicated in Proposition 2. While the logic of asset regulation in modifying the bank's investment technology is clear, it can potentially lead to investment inefficiencies, since the restrictions imposed by the regulator may remove positive net present value projects from the bank's menu of investment opportunities.

3. Bank Management Compensation

In this section we will explore the role of management compensation contracts in bank regulation. This is done by realistically allowing for different incentives among bank managers and bank owners, *i.e.*, explicitly recognizing agency conflicts between bank owners and managers as well as between bank insiders and outsiders. A general way of looking at bank regulation and the fair pricing of FDIC insurance premia is as follows: given the lack of contracting opportunities on specific risk choices to be made by the bank manager, the ability to precommit to specific risk choices is lost -- giving way to risk-shifting incentives and the possibility of mispriced FDIC insurance. The level of bank capitalization can provide some indirect precommitment. The level of capitalization is generally observable and it can be used to precommit to an investment policy, [q(F)] in (4), which in turn can be used to arrive at the FDIC premium $\pi(F)$ in (5). However, as Proposition 1 shows, some risk-shifting incentives will still remain.

In many ways, the incentives of a bank manager, are most directly influenced through his or her compensation structure. In other words, stockholders can precommit to specific investment choices by revealing to regulators (outsiders) the observable details of the compensation mechanism they use to influence the incentives of the decision-maker, i.e., the manager. By revealing the parameters of top-management's compensation structure, shareholders can precommit to an investment policy, which will be freely chosen by the manager given the compensation structure (and associated incentives) put in place by stockholders. Bank regulation and the pricing of FDIC insurance should take into account the parameters of top-managements compensation. If regulators price FDIC insurance correctly (incorporating parameters of the bank's compensation structure), but otherwise leave the choice of the compensation structure itself entirely to the bank's shareholders, it can be shown that bank shareholders will choose, *on their own*, the compensation structure which will induce a Pareto optimal investment policy, [$\hat{q}$]. Moreover, to the extent that this can be accomplished, for any level of capitalization or deposits F, we obtain an additional degree of freedom such that the social planner can optimally choose bank leverage F^*.

The analysis in section 2 dealt with the risk-shifting incentives of managers who fully act on behalf of the best interests of equity-holders. In other words, compensation structure in place was assumed to align perfectly managements interests with those of equityholders. In this section, management compensation is endogenous and *may or may not* align management interests with those of shareholders. The structure of management compensation in place most directly affects the riskiness of the investment policy implemented by management when moral hazard and incomplete contracting provide some degree of managerial discretion over investment policy. We examine below, how the incentive features of management compensation structures, chosen by the bank, together with a bank's capital ratio, determine its overall investment policy and risk. In particular, the rationale for linking features of management compensation, along with the level of capital maintained, to regulatory design and FDIC insurance pricing will be explored. This is particularly important in the light of the fact that capital requirements and asset restrictions have been the primary basis for U.S. bank regulation thus far, including post-FDICIA, while, managerial compensation has, at best, played a subsidiary role in regulatory design.

3.1 A Simple Contract with Incentive Features

Although a large variety of structures can be considered as candidates for bank management compensation contracts, we will consider a simple family of contracts with some important incentive features. This family is closely related to the structures observed in practice and includes among its members an optimal contract. In this sense, we believe that a restriction of the compensation structure to this piecewise linear family is without to much loss of generality.

The compensation structure is characterized as follows:

The manager gets a fixed cash salary, $S \geq 0$, and a fraction α of the equity of the bank. In addition to the salary he (or she) gets a bonus which is increasing in the degree of capitalization of the bank (or equivalently in the terminal cash flows realized).[8] If the bank is insolvent, or severely undercapitalized, the bonus is zero. When the terminal cash flow T is such that $T - F > 0$, the first λ dollars of $T - F$ is paid to the manager as a bonus. The total payout to equityholders is $\max \{0, T - F - \lambda\}$, and the manager gets a fraction, α of the pay-off to

[8]See, Houston and James (1993) for a discussion of the greater relative empirical importance of cash compensation - salary plus bonus -- in banks relative to non-bank firms.

equityholders. Such a compensation contract will be called the contract {S, λ, α}. For convenience, we will assume that the fixed salary component is paid out of the bank's operating cashflow such that the terminal cashflow T = {I, H, L} is residual to the fixed payments, S, to the manager (see Figure 2).

Insert Figure 2 Here

The manager will implement an investment policy, $[q^m]$, which is optimal for him given his compensation contract {S, λ, α}. It is clear that the investments undertaken (e.g., loans made) will depend on the parameters λ and α of the management compensation structure as well as the level of bank capitalization implied by F.[9]

For expositional convenience, in the next proposition, we assume that $I - F - \lambda \geq 0$. That is, equity has some payout even when the riskless asset is chosen. We will now characterize the investment policy $[q^m]$ and some of its properties.

Proposition 4: (Incentive Effects of Compensation Features):

Given the management contract {S, λ, α} and a capitalization level $F > L$,

(a) The investment policy $[q^m]$ implemented is given by equation (6).

[9] The relationship between investment policy and managerial compensation, given an existing capital structure, has been studied in John and John (1993). Also, Madan, Senbet, Soubra (1993) study the relationship between compensation structure and capital structure in the context of a three-party conflict between management, shareholders, and debtholders.

$$q^m = \frac{(1-\alpha)\,\lambda + \alpha\,(I-F)}{(1-\alpha)\,\lambda + \alpha\,(H-F)} \tag{6}$$

(b) For any $\lambda > 0$ and $\alpha < 1$, $q^m > q(F)$, i.e., the investment policy is less risky than when manager's interests are fully aligned with equity interests.

(c) $q^m(\lambda)$ is increasing in λ, i.e., the larger the bonus, the more conservative the investment policy.

(d) $q^m(\alpha)$ is decreasing in α, i.e., the larger the equity share of the manager, the riskier, the investment policy.

Proof:

(a) Given a management compensation schedule $\{S, \lambda, \alpha\}$ and $I - F - \lambda \geq 0$, the manager undertakes the risky project only when q is such that:

$$q[\lambda + \alpha\,(H - F - \lambda)] \geq [\lambda + \alpha\,(I - F - \lambda)]$$

Equivalently, when $q \geq q^m$, where q^m is given by equation (6), the investment policy implemented is $[q^m]$.

(b) Since $(H - F) > (I - F) \geq \lambda$, we have from (6), $q^m > q(F) = \frac{\alpha\,(I-F)}{\alpha\,(H-F)}$, from (4).

(c) Given H > I, and $0 < \alpha < I$, we have $\frac{\partial q^m}{\partial \lambda} > 0$.

(d) For $\lambda > 0$, $\alpha > 0$ and H > I, we have $\frac{\partial q^m}{\partial \alpha} < 0$. ▮

The intuition of Proposition 4 is straightforward. For $\lambda > 0$, and $\alpha = 0$, the manager implements the very conservative investment policy [1], of investing in the riskless project for all values of q. He is only worried about protecting his bonus λ and implements an investment policy which turns out to be in the interest of depositors. Of course, such an investment policy is suboptimal from an efficiency point of view and results in loss of bank value $V(\hat{q}) - I$. As managerial equity share α is increased from 0, the manager acts more and more like an equityholder, implementing riskier and riskier investment policies. However, for any $\alpha < 1$, protecting the bonus makes him act in a more conservative fashion than the q(F), of Proposition 1, where his interests were fully aligned with those of equityholders. As λ gets larger, the bonus is more important and he becomes more conservative, i.e., q^m is larger. Thus, in general, α and λ have offsetting effects on managerial risk-taking incentives.

Two insights follow from the above discussion for FDIC regulation. First, it is clear that the structure of management compensation, e.g., size of bonus (λ) relative to managerial equity share (α), may affect the riskiness of the bank's asset portfolio in a manner analogous to the level of capital (leverage) maintained. Hence, regulatory policy, and FDIC premiums, should potentially take into account the incentive features of management compensation. Second, since managerial bonus and the equity fractions have offsetting effects on a manager's risk-shifting incentives, a bank may be able to fine-tune these two incentive features so as to precommit to implementing a Pareto-optimal investment policy. We will discuss these two insights further below.

For any level of debt F, Proposition 4 implies that investment policy [q^m] is safer than [q(F)]. How much more conservative [q^m] is in relation to [q(F)] is determined by the management's compensation structure; specifically, by the relative importance of λ and α. Larger α's bring q^m closer to q(F) and larger λ's take it closer to 1. By implication, regulatory actions in each of PCA's five zones of capitalization should take into account the incentive features of the management compensation schedule used by the bank. For example, a bonus which is lower for inadequate levels of bank earnings and by implication inadequate levels of capitalization, will induce *less* risk-shifting incentives by management.

Discretionary restrictions on the salary of officers (top-management) in significantly and critically undercapitalized banks -- included in the prompt corrective action (PCA) provisions of FDICIA -- seem to be somewhat similar in spirit to the results we have derived here -- although our results suggest that such restrictions should be *bank specific in nature*. We can also argue that the incentive features of the compensation structure in place should be considered more directly in setting appropriate FDIC insurance premia.

Specifically, parallel to Proposition 3, we can derive the appropriate FDIC premium, π^m, where the incentive effects of management compensation on asset risk choice are considered. Hence, the following proposition is immediate:

<u>Proposition</u> <u>5</u>: (Pricing FDIC Premia by Incorporating Managerial Compensation Features):

Given a level of capitalization corresponding to F, F < H, and a management compensation contract {S, λ, α} in place, a fairly priced, revenue-neutral, FDIC premium is specified as follows:

$$\pi^m = q^m(F - I)^+ + \tfrac{1}{2}(1 - q^m)^2 (F - L)^+ \qquad (7)$$

where q^m is specified in (6) of Proposition 4 and a quantity y^+ denotes max {0, y}.

Note that π^m is specified in terms of the capitalization level F, the observable parameters of the management compensation structure λ and α and, as before, those of the bank's investment opportunity set {I, H, L}. In spite of moral hazard and incomplete contracting, we know that $[q^m]$ in (6) is the investment policy that bank managers will pursue in their own best interests given the bank's capitalization and management compensation structure in place. Linking FDIC premia and/or PCA intervention policy to the capitalization and compensation parameters enables the regulator to get at the correct risk choices that would be implemented by investment policy $[q^m]$.

3.2 An Optimal Management Compensation Structure

For any given level of F, and management compensation $\{S, \lambda, \alpha\}$ in place, the investment policy implemented will be $[q^m]$, where q^m is specified in (6). If the insurance premium π^m is correctly priced as in (7) (and correspondingly, depositors' claims are correctly priced) anticipating rationally the investment policy $[q^m]$, then the bank's equityholders suffer the loss in value, $V(\hat{q}) - V(q^m)$, due to the distorted investment policy $[q^m]$. This makes it in the best interests of the equityholders to choose, at t=0, capital and compensation structures which will induce managers to pick, (at t=1) an investment policy $[q^m]$, where $q^m = \hat{q}$, the Pareto-optimal investment policy.

The level of capitalization F and the management compensation parameters λ and α can be chosen by the equityholders to induce the investment policy $(\hat{q})$. In fact, for any level of F, an optimal compensation structure can be chosen by owners such that the Pareto optimal investment policy is implemented.

Proposition 6: (Optimal Compensation Features):

For any level of capitalization (and the associated promised payment F), the optimal management compensation structure parameters $\hat{\lambda}$ and $\hat{\alpha}$ satisfy the relation

$$\hat{\lambda} = \frac{\hat{\alpha}}{(1-\hat{\alpha})}(F-L)\,. \qquad (8)$$

Proof:

Substitute (8) in the expression for q^m in (6) and simplify to obtain $q^m = \hat{q}$. This implies that a management compensation structure $\{S, \hat{\lambda}, \hat{\alpha}\}$ satisfying (8) is an optimal one. ∎

The intuition behind the optimal compensation structure is straightforward. For a large value of the bonus λ and a small value of equity ownership α, the manager will invest too conservatively, i.e., $q^m > \hat{q}$. On the other hand, if λ is small and α is large, then the manager engages in risk-shifting, i.e., $q^m < \hat{q}$. The trade-off between λ and α produces the "middle-ground" optimal values given by (8).

Another interesting observation worth emphasizing is that in a regime where FDIC premiums are fairly priced, by linking premiums to both capitalization (i.e., F) and management compensation parameters (i.e., λ and α), equityholders are induced to pick the optimal compensation structure $\{S, \hat{\lambda}, \hat{\alpha}\}$ at t=0 as a means of precommitting to the depositors and regulators that the optimal investment policy [$\hat{q}$] will be implemented. Consequently, banks need only be charged the insurance premium $\pi^m(\hat{q})$ specified in (7). That is, the regulator does not have to mandate the exact details of the bank's managerial compensation as was initially implied under the FDICIA for poorly capitalized banks. Instead, the equityholders, will in their own self-interest, put in place an optimal compensation structure at t=0. Since the effectiveness of the precommitment depends on the observability of the parameters of the compensation scheme, such as λ and α, the appropriate audit and regulatory processes must play a role in facilitating the precommitment aspect of the compensation structure. The recent SEC regulation, which requires mandatory disclosure of the details of management compensation structures, will be helpful in achieving the degree of transparency required. Finally, the disclosure costs for banks should also be quite small. That is, requiring (and monitoring) disclosure of bank compensation schemes should be a relatively low cost form of regulation, especially compared to seeking to monitor and control the asset/investment technologies of banks, as in current practice.

4. Conclusions

We have examined the incentive structure of the post-FDICIA regulation of U.S. banks, particularly, the efficacy of bank capital requirements and restrictions on asset risk choice, in controlling risk-shifting incentives. While demonstrating the limitations of capital and asset regulation, we argue for a more prominent role for management compensation structures in bank regulation. We show that the effectiveness of capital regulation hinges on the characteristics of the underlying asset investment opportunities schedule facing a depository institution. In the limit, for certain investment opportunity sets characterized by competitive asset/loan markets, capital regulation is ineffective, since a depository institution has an incentive to shift to the highest feasible risk level -- irrespective of the capital requirement imposed on it.

We show that an actuarially fair deposit insurance premium can be structured as a function of a bank's capitalization and the "observable" parameters of the investment schedule facing the depository institution. The pricing of deposit insurance is possible even in the presence of the moral hazard problems arising from imperfect observability (by outsiders) of the private investment incentives of bank insiders. This is because the regulator can calculate the incentive-based risk choices induced by the level of capitalization employed by the institution and the parameters of the bank's asset investment schedule. On a qualitative level, this may parallel the procedure for the 1993 implementation of FDIC risk-based deposit insurance premiums which classify institutions on the basis of capitalization and supervisory ratings (i.e., on regulators' subjective rankings such as CAMEL). Thus, the FDICIA reforms can be viewed as moving bank regulation toward a recognition of linkages between risk-incentives, capital regulation, and bank investment opportunity sets.

However, our analysis argues that mandatory restrictions on asset choice may lead to socially counterproductive outcomes. This is particularly the case when the goal of mandatory restrictions is to push banks into a common pool of asset risk choice (or, more generally, to minimize risk). In our framework, institutions are characterized by different investment opportunity sets, with differing risk choices that are optimal from the standpoint of overall value maximization or investment efficiency. Consequently, pushing institutions to a common pool of (low) risk investments will lead to an inefficient allocation of resources in the economy.

A principal aspect of our analysis was to consider, not only conflicts between the regulator and a bank, but also between the management and the owners of a bank. -- see Section 3. This is particularly important, because investment risk choices are generally controlled by management whose risk-taking behavior depends on the structure of the compensation schedule specified by stockholders. We show how managerial compensation serves as a direct regulatory mechanism that induces optimal risk choice from the standpoint of the regulator (and society at large).

Importantly, we show that Pareto-optimal investment risk choices by banks can be achieved without direct regulation of managerial compensation and/or equity capitalization. We show that, when a fairly priced insurance premium reflects the structure of managerial compensation, along with the level of bank capitalization, it pays bank equity-holders to pick optimal managerial compensation contracts that ensure first-best investment risk choices. That is, there is no need to regulate the details of managerial compensation, so long as they are observable, since picking an optimal compensation scheme precommits equityholders to value-maximizing investments choice. The role of bank auditing and required disclosure can also be thought of as facilitating precommitment of the bank's compensation structure. The regulatory role of bank management compensation is particularly significant, given the limitations of capital and asset regulation that we have pointed out earlier.

Analogous to our results on capital regulation, there is a practical regulatory parallel regarding the role of bank management compensation. In particular, it is clear that regulatory action in the five zones of PCA capitalization should actively take account of the incentive effects of managerial compensation on banks risk-taking. While discretionary bank-specific restrictions on pay of officers of critically undercapitalized banks, as suggested in the PCA provisions of FDICIA, seem desirable in the context of our analysis, our results suggest that *no direct regulation* of management compensation is required as long as the insurance premium incorporates parameters of the compensation structure in place, as well as level of bank capitalization.

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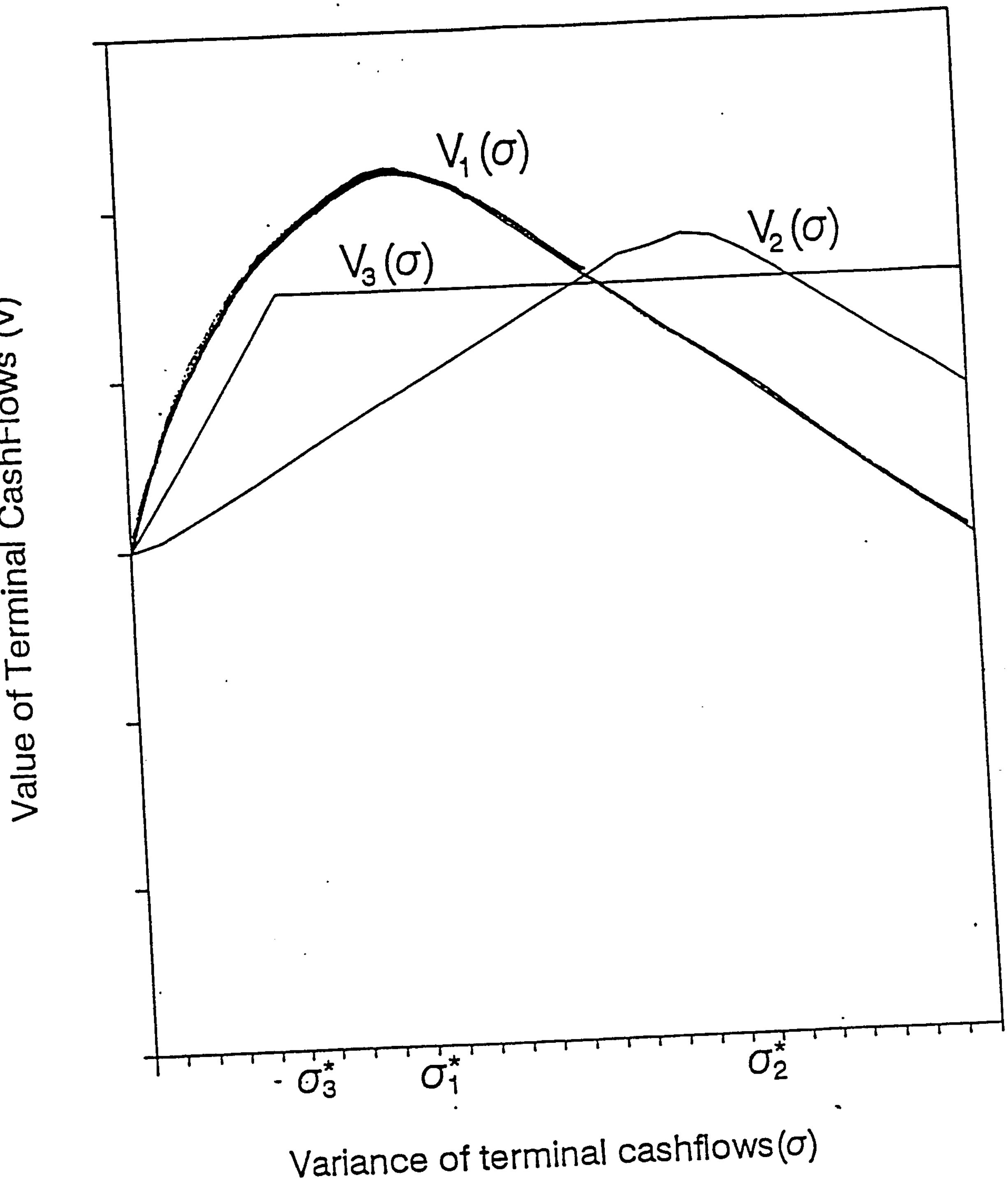

Figure 1: Capital Requirements and Bank's Investment Opportunity Set

(V,σ) - characterization of the investment opportunities of the bank

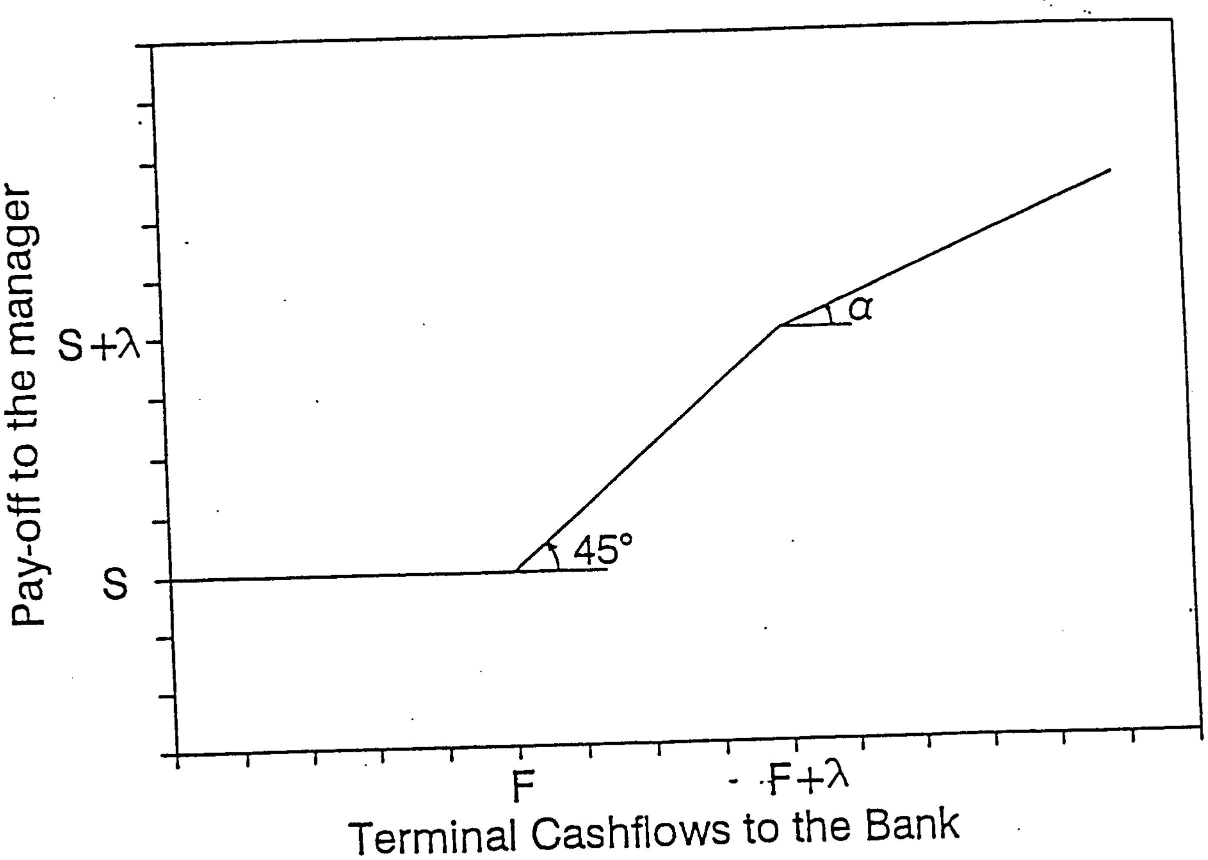

Figure 2: The generic form of the management compensation contract