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A THEORETICAL AND EMPIRICAL INVESTIGATION OF BANKS' RISK TAKING BEHAVIOR

By

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ABSTRACT

A THEORETICAL AND EMPIRICAL INVESTIGATION OF BANKS' RISK TAKING BEHAVIOR

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This dissertation provides a theoretical and empirical investigation of banks' risk-taking behavior. Chapter I examines the relationship between banks' capitalization and risk-taking behavior. Conventional wisdom believes that relatively well-capitalized banks are less inclined to increase asset risk, because the option value of deposit insurance decreases as the capital to asset ratio increases. There are, however, at least three shortcomings in the existing theories that cast doubt on the validity of conventional wisdom: (1) Existing studies have neglected agency problems arising from the separation of management and ownership. (2) Past studies did not consider risk-return profiles in which higher risk is associated with higher return. (3) Empirical studies on this issue provide only mixed evidence.

The aim of Chapter I is to shed new light on this issue by incorporating into a single model the three different incentives of three agents – the bank regulator, the shareholder, and the manager – regarding the risk determination by a bank, and by introducing four distinct assumptions on the characteristics of risk-return profiles. By combining these two factors, the theoretical model demonstrates that banks' risk can either decrease or increase with capitalization depending on the relative forces of the three agents in determining asset risk and on various parametric assumptions about risk-return profiles.

Chapter II provides an empirical study for the theoretical analysis in Chapter I. In the empirical study, the regression equation is modeled in such a way that the differing incentives of the three agents are allowed to interact with each other. The regression results show apparent differences in risk-capitalization relationships across high and low capital banks, which indicates the presence of regulator's incentives in determining risk for low-capital banks. For high-capital banks, it is shown that the positive relationship between risk and capitalization strengthens as the shareholders' incentives gain relative forces, and weakens as the entrenched managers' incentives gain relative forces.

Chapter III studies a manager's risk-taking behavior in the banking industry when the manager has career concerns in the labor market. It is well known that there exists an investment distortion away from the first best outcome when the manager has career concerns in the labor market. For example, a risk-averse manager will prefer the riskiest investment project available when the manager's choice of a risky project is observable by the labor market. This paper extends previous studies by allowing that the manager's choice of a risky project is not observable by the labor market. Using the second best reputational equilibrium, it is shown that a risk-neutral manager can choose the least risky asset available. Since a proxy variable for an unobservable manager's action is unable to be obtained, an empirical test on the relationship between asset risk and managerial career concerns is confined only to the case where the manager's action is observable. It is assumed that the portfolio measures of risk based on accounting data are readily observable, and these are used as a proxy for the manager's choice of risky assets. The regression results show no discernible relationship between career concerns and asset risk, implying that the manager is roughly risk-neutral.

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TABLE OF CONTENTS

CHAPTER II
AN EMPIRICAL TEST ON THE RELATIONSHIP BETWEEN BANKS' RISK, AND CAPITALIZATION

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

BANKS' RISK, MORAL HAZARD AND CAPITALIZATION

A Survey and Unified Approach to Modeling Bank's Risk–Taking Behavior

1 Introduction

The finance literature established two important results about the agency problem of the shareholder vis–vis the debtholder, also known as 'asset substitution moral hazard.' First, the shareholder has an incentive to increase the risk of investment assets at the expense of the debtholder's interest once debt has been issued (Jensen and Meckling, 1976). And second, the shareholder increases monotonically the investment risk as the leverage ratio increases (Green and Talmor, 1986).

The same analyses are also done in the banking literature, where the debtholder is replaced by the deposit insurer. First, when deposit insurance is underpriced, there exists an insurance subsidy from the deposit insurance to the bank, called the option value of deposit insurance. Since the option value increases with asset risk (Merton, 1977), an equity value maximizing bank shareholder has an incentive to take excessive risks to exploit this option value (Dothan and Williams, 1980; Kareken and Wallace, 1978; Sharpe, 1978). Second, since the option value increases with the leverage ratio — i.e., decreases as the capital to asset ratio increases — relatively well-capitalized banks will be less inclined to increase asset risk (Keeley and Furlong, 1990; Furlong and Keeley, 1989).

This paper aims at reconsidering the above well–established results for the banking industry. The motivation for this paper is three–fold. First, even though the theoretical prediction is clear, empirical evidence on this issue is mixed in both the finance and banking literatures. In the finance literature, some authors (e.g., Baskin, 1989; Castanias, 1983) find a positive relationship between a firms' debt level and the riskiness of cash flows, while other authors (e.g., Bradley, Jarrell and Kim, 1984; Titman and Wessels, 1988) find an insignificant or a negative relationship. In the banking literature, while Keeley (1990) finds evidence in favor of the theory, other authors (Santomero and Vinso, 1977; Peek and Rosengren, 1997) find little connection between capitalization and the incidence of bank failure. Furthermore, Sheldon (1995, 1996B) finds that the capital ratio and the probability of failure are positively correlated, implying that more highly capitalized banks are more likely to fail. The mixed evidence suggests either there are methodological problems in the existing empirical studies or the theoretical prediction is incorrect.

Secondly, contrary to the theoretical predictions by Furlong and Keeley (1989, 1990), it is often suggested by academics, practicing bankers, and regulators that banks — especially those banks that had to raise capital to meet higher capital standards — shift their portfolio structure from low–risk assets toward higher–risk, higher–return assets in order to compensate for additional costs imposed by the more stringent capital standards.[1] It seems that bankers and regulators are not totally convinced by the theoretical propositions regarding the relationship between asset risk and leverage. One problem of the earlier theoretical studies is that asset risks are characterized by a mean preserving spread or second order stochastic dominance. In these risk characteristics, riskier assets,

[1]This view on the effect of capital regulation is widely held by regulators and the public press and is also often found in academic studies. The introduction of risk–based capital regulation in 1980s was largely motivated by this view. (For the discussion of this issue, see Reinicke, 1995, pp. 134-181.)

in general, have higher variance and smaller mean return, which means that they do not represent higher–risk higher–return assets. Therefore, the findings of these theoretical studies, in fact, cannot be used as the grounds for the argument against the belief of bankers and regulators.

Thirdly, most theoretical studies consider a bank that is run by an owner–manager. This approach, however, may be flawed because in reality the shareholder of a bank delegates the running of the bank to the manager. Thus, this approach neglects the agency problem arising from the separation of management from ownership. If the manager privately chooses his actions and these are not directly observable by the shareholder, a moral hazard problem arises: the manager will choose his actions with a bias towards his private benefit rather than to maximize the shareholder's interest. This results in a double moral hazard problem: the shareholder's moral hazard due to underpriced deposit insurance, and the manager's moral hazard due to unobservable actions. Most of the existing literature deals with the first kind of moral hazard but does not consider the second kind of moral hazard. Since the incentives toward risk–taking could be considerably different between the shareholder and the manager, neglecting managerial incentives may cause an incorrect prediction about banks' risk taking behavior.

Based on these observations, this paper investigates the relationship between the bank's capitalization and risk taking behavior. A novel feature of the paper is that it identifies and incorporates into a single model the three different incentives of three agents regarding the risk determination of a bank. The three agents are the bank regulator (specifically deposit insurer), the shareholder, and the manger. The other novel feature is that it introduces four distinct assumptions on the characteristics of risk–return profiles. It not only considers the traditional risk ordering concepts such as mean preserving spread or second order stochastic dominance, but also considers a risk–return profile where high risk is associated with high return. By combining these two factors, the theoretical model demonstrates that the bank's risk can either decrease or increase with capitalization depending on the relative forces of the three agents in determining asset risk and on the various parametric assumptions. Specifically, it addresses whether more capitalized banks have an incentive to invest in higher–risk higher–return assets. This finding is interesting because it does not rely on risk averse agents (as in Kim and Santomero, 1988; or Koehn and Santomero, 1980), or complicated loan cost functions (as in Gennote and Pyle, 1990), nor regulatory constraints (as in Park, 1997).

This paper relates to three areas in the literature. It relates to the literature on the effect of a capital adequacy requirement on banks' asset risk. Existing studies on this issue do not reach a consensus. Kahane(1977), Koehn and Santomero (1980), and Kim and Santomero (1988) argue that uniform capital regulation can increase rather than decrease banks' risk–taking incentives, while Furlong and Keeley (1989, 1990) argue the opposite. Subsequent studies such as Gennote and Pyle (1990), and Besanko and Kanatas (1996) also have contradicting arguments. I intend to shed new light on this issue by constructing a complete model of risk determination that incorporates the differing incentives of three agents.

The second area is studies on the asset substitution effect in firms. The effect of leverage on asset risk has been conjectured by Jensen and Meckling (1976), was discussed by Gavish and Kalay (1983), and is established by Green and Talmor (1986). Using a surprisingly simple but generalized version of Gavish and Kalay's model, Green and Talmor demonstrate that the shareholder increases investment risk monotonically as the leverage ratio increases. The shareholder's objective in this paper is a direct application of their model applied to banking, but it is different from their study in that it incorporates the case of higher–risk higher–return investment assets.

The third stream of the literature is about managerial private benefits. Managerial private benefits commonly identified in the literature include shirking, managerial career concerns, stealing, and perquisites. Following Dewatripont and Tirole (1994a, b), I assume that managerial private benefits can either increase or decrease with asset risk. This simple assumption enables to demonstrate that the manager may have an incentive to increase the investment risk as capitalization increases.

The composition of the paper is as follows. Section 2 contains an extensive literature review. The basic set–up is constructed and the main assumptions are introduced in Section 3. The theoretical analysis is conducted in Section 4. Section 5 contains the summary and conclusion to the paper. An empirical test for the theories of this paper is provided in Chapter II of this thesis, "An Empirical Test on the Relation between Banks' Risk and Capitalization."

2 Discussion of the Literature

2.1 The Agency Problem of the Shareholder

In the world of perfect capital markets of Modigliani and Miller (1958, 1961), the market value of the firm is independent of its financing decisions; any increase or decrease in a firm's value caused by a change in investment policy accrues to the firm's shareholders. A policy which maximizes firm value also maximizes the wealth of the shareholders. Therefore, if capital markets are perfect, shareholders have an incentive to choose the investment policy which maximizes the market value of the firm (Fama, 1978).

The above scenario, however, ignores potential conflicts of interests between shareholders and debtholders. The agency problems arising from these conflicts are known as 'limited liability effect of debt financing' in the finance literature. One of the problems is that shareholders, who want to maximize the equity value rather than the total (equity + debt) value of the firm, have a tendency to shift investment projects into riskier ones.[2] This agency problem caused by the shareholder is known as 'asset substitution effect'. (See Gavish and Kalay, 1983; Green, 1983;, Green and Talmor, 1985; Jensen and Meckling, 1976, e.g.)

Jensen and Meckling (1976) consider two risky investment opportunities with equal market value (V) and different variance ($\sigma_1^2 < \sigma_2^2$). It is assumed that the shareholder is risk–neutral and wants to choose the project with the higher equity value. If the shareholder has the right to first decide which investment project to take, and then the opportunity to issue debt (denoted by B), he will be indifferent between the two alternatives. If, however, the order is reversed, then the shareholder will prefer the one with the larger variance, i.e., the riskier project. The reasoning is as follows: as Black and Scholes (1973) suggest, shareholders of a levered firm can be viewed as holders of a European call option whose exercise price equals the face value of the debt. Moreover, Merton (1973, 1974) shows that as the variance of the outcome distribution rises, the value of the call option (i.e., the equity) rises. This implies that the equity value (denoted by S) is higher with the riskier investment project ($S_1 < S_2$), where the risk is measured by the variance of its future outcome. This also implies that the value of

[2]There are other examples of conflicts of interest between shareholders and debtholders discussed in the literature. For example, Meyers (1977) considers the case that the shareholder rejects positive net present value projects (underinvestment). Bulow and Shoven (1978) deal with the conflicts of interest concerning the bankruptcy decision of a firm.

debt is smaller with the riskier investment project ($B_1 > B_2$), since $B_1 = V - S_1$ and $B_2 = V - S_2$. Therefore the equity value maximizing shareholder has an incentive to increase investment risk at the expense of the debtholder's interests.

Jensen and Meckling (1976) conjecture that the shareholder's incentive to increase the firm's risk is a monotonically increasing function of leverage ratio. Gavish and Kalay (1983) claim to be the first study to formally examine the effects of the leverage ratio on the shareholders' incentive to increase firm risk. Using an attractively simple model, they argue, contrary to the Jensen and Meckling's conjecture, that the shareholder's incentives to increase the investment risk (measured by the variance of its future outcome) is not an increasing function of the leverage ratio. Instead, it reaches a maximum where the face value of the bond equals the expected value of the firm. They conclude, thus, that shareholders who control firms with a high leverage ratio are less likely to choose high risk projects with negative net present value.

Jensen and Meckling's conjecture and Gavish and Kalay's counter–claim are reexamined by Green and Talmor (1986). Using a similar with but more generalized version of Gavish and Kalay's model, they argue that Gavish and Kalay's findings, in fact, cannot be interpreted as supporting their own argument. They show that as the promised debt payment increases, shareholders increase monotonically the risk of the firm,[3] which confirms the conjecture of Jensen and Meckling.

The discussion of the asset substitution effect in the context of banking goes back to Merton (1977). He has shown that demand–deposit guarantees are analogous to put options and can be valued using standard option pricing formulas. Consider a bank with a total asset portfolio of A dollars and demand deposits of D dollars. If the demand de-

[3]The main argument of their analysis is given in Proposition 1 of their paper.

posits are guaranteed by deposit insurance, then the value to the bank of the guarantee, $G(T)$, when the length of time until the maturity date of the deposits is T, is

$$G(0) = \max\{0, D - A\},$$

which is identical to that of a put option, where D corresponds to the exercise price and the value of the asset, A, corresponds to the common stock's price. Essentially, by guaranteeing the demand deposits, the deposit insurer has issued a put option on the assets of the bank which gives the bank the right to sell those assets for D dollars on the maturity date of the deposits.[4] Merton (1977) shows that the option value of deposit insurance, $G(0)$, increases as the leverage or asset risk increases.

In a similar context, but using state preference models, several authors (for instance, Dothan and Williams, 1980; Kareken and Wallace, 1978; Sharpe, 1978) have computed the net present value of the subsidy (option value) implicitly provided by the deposit insurance system to banks. They have shown that when deposit insurance is underpriced, equity–value maximizing bank shareholders will attempt to hold the riskiest portfolio they are allowed to hold.

It can be shown that under the underpriced deposit insurance, the value of bank equity can be decomposed into two parts:

$$E(V) = E(A) + E(I), \tag{1}$$

where V is the value of the bank equity, A is the net present value of bank asset, I is the value of deposit insurance subsidy and E is the expectation operator. If we

[4]One problem of the above analysis is that most demand type bank deposits do not have a maturity date, and thus the model assumption of a term–deposit is not strictly applicable. However, if we interpret the maturity date as the renewal date of the deposit insurance guarantee (i.e., the next bank examination date by regulatory agencies), then the model's structure is reasonable even for demand deposits. (See Merton, 1977, pp. 8–9.)

let $A = 0$, then the equity–value maximizing problem is identical to maximizing the insurance subsidy. Since the insurance subsidy is an increasing function of asset risk and leverage, equity–value maximizing banks will attempt to maximize the value of the insurance subsidy by increasing the asset risk and leverage.

The implication is that a more highly capitalized bank will be less inclined to increase asset risk, which is a similar argument as in the discussion for the asset substitution effect in the firm. While it seems that the discussion on the asset substitution effect in the firm has been virtually completed by the study of Green and Talmor (1986), it has a different perspective in banking. Since the banking industry is highly regulated, the leverage that a bank can take is strictly regulated by authorities in the form of capital adequacy regulation. The question regarding the effect of leverage on asset risk asked in the context of banking was whether more stringent capital adequacy requirements are effective in reducing the bank's incentive to take excessive risk.

2.2 Discussion on the Effectiveness of Capital Regulation

It appears that the literatures on the effects of capital regulation on banks' risk taking can be categorized into three groups. First, the literature that uses a mean–variance portfolio selection approach. There it is argued that uniform capital regulation can increase rather than decrease a banks' risk–taking incentives. Second, the literature using an equity–value maximization approach. This shows that more stringent capital regulation does not raise the bank's incentive to increase asset risk. Third, the literature that considers the effect of capital regulation in an imperfect information environment, where there exists managerial moral hazard.

2.2.1 Mean–Variance Portfolio Selection Approach

Studies using the mean–variance approach are Kahane (1977), Koehn and Santomero (1980), and Kim and Santomero (1988). Kahane is considered to be the first important work to cast doubt on the effectiveness of capital regulation. Using a mean–variance framework, where the intermediary wants to choose the composition of portfolios that minimize the standard deviation of return given the mean value of return, he finds that a minimum capital requirement increases the intermediary's probability of ruin. This finding is contrary to the conventional wisdom up till then, instigating further research on this issue.

Koehn and Santomero (1980) and related work by Kim and Santomero (1988) have been regarded as the main works using the mean–variance model. The main idea is developed in Koehn and Santomero; Kim and Santomero is an extension to the previous one. Their analyses are more advanced than Kahane (1977) in the sense that they evaluate the effect of capital regulation not only on the probability of failure but also on the portfolio risk. This is made possible by modelling banks as portfolio managers. That is, banks are assumed to be risk averse and choose a portfolio composition to maximize expected utility from uncertain profits. Regulators want to reduce the riskiness of the bank portfolio so as to reduce the probability of failure.

In Koehn and Santomero, the effect of uniform capital regulation depends on the bank's risk preference, specifically, the coefficient of relative risk aversion. If the regulator increases the capital to asset ratio (K/A), the bank's leveraging ability decreases. Then, relatively less risk averse banks — any bank with a relative risk aversion coefficient smaller than the critical value — would reshuffle assets toward riskier ones to offset the impact of the forced lower leverage. This leads to the key point of their argument: Higher capital standards can lead to more asset risk because banks that are required to increase capital will shift to higher yielding, riskier assets to increase the rate–of–return on equity. They conclude that capital regulation is an inadequate tool to control the riskiness of banks and the probability of failure. Consequently, they suggest that regulation should be imposed on both asset composition and capital.

Criticism of the mean–variance model comes from Keeley and Furlong (1990). They focus on Kahane (1977) and Koehn and Santomero (1980) (referred to as KKS). They point out that KKS uses one basic assumption that is inconsistent with the major result of the models. KKS assume that banks can borrow unlimitedly at a constant rate, which is possible only when the probability of failure is zero. This contradicts the result of the models that increases in asset risk caused by more stringent capital regulation would increase the probability of bank failure. If the probability of failure is zero from the beginning, how can the asset risk affect the probability of failure?

If deposit insurance is introduced in KKS, which is the case in Kim and Santomero (1988), then the inconsistency can be resolved. If models of KKS can be interpreted as assuming a fixed rate deposit insurance premium implicitly, however, another problem arises. Once a fixed rate premium is assumed, banks try to gain from the deposit insurance subsidy — called the option value of deposit insurance. Keeley and Furlong (1990) argue that mean–variance models ignore this point, and thus result in inappropriate predictions on the effect of capital regulation on banks risk taking.

2.2.2 Value Maximizing Approach

The value maximizing approach is different from the mean–variance model in that it assumes a risk neutral equity–value maximizing bank instead of a risk averse utility maximizing one. Since the work by Furlong and Keeley (1989), it has become standard in modeling the effectiveness of capital regulation. The early works of this approach are Furlong and Keeley (1989 and 1990).[5] These works are related to works that study the asset substitution effect in banking, such as Merton (1977), Sharpe (1978), Kareken and Wallace (1978), and Dothan and Williams (1980).

Based on theses previous analyses, Furlong and Keeley (1989) show that a reduction in leverage caused by stringent capital regulation reduces the marginal gain from increasing asset risk. Mathematically, this can be expressed as:

$$\frac{\partial I}{\partial \sigma \partial K}|_{\Delta D=0} < 0 \tag{2}$$

where σ is a measure of asset risk. Thus, assuming the stringency of asset regulation is not changed, more stringent capital regulation unambiguously reduces the incentive to increase asset risk and the risk exposure of the deposit insurance system.

Subsequent studies using the value maximizing framework show that Furlong and Keeley's model can be extended to allow for a negative effect of capital regulation on bank asset risk. Here we examine two of them, Gennote and Pyle (1990), which incorporates a loan cost function and Park (1997), which incorporates regulatory constraints.

Gennote and Pyle is a notable work that extends the option pricing model but yields a different conclusion on the effectiveness of the capital regulation. They argue that setting the net present value of bank assets to zero ($A = 0$) in the above papers is a

[5]The main idea of the model is developed in Furlong and Keeley (1989). Keeley and Furlong (1990) is devoted to addressing KKS.

critical assumption. They depart significantly from previous research by incorporating a loan cost function — capturing loan evaluation and monitoring costs, which make bank loans intrinsically different from zero net present value investments. They assume the cost function is increasing and convex in the level of investment and asset risk.

For formal analysis, they let $J(\nu, \sigma)$ denote the present value of the bank asset net of evaluation and monitoring costs, where ν represents the present value of cash flows and σ is a risk index. As before, the value of bank equity can be expressed as the sum of the deposit insurance subsidy and net present value of asset. For simplicity, let's eliminate the expectation operator in equation (1) and rewrite as follows:

$$V(\nu, \sigma) = J(\nu, \sigma) + I(\nu, \sigma) \tag{3}$$

Equation (3) shows symbolically that the bank's optimal asset portfolio is determined by the tradeoff between portfolio net present value and subsidy value. The first order conditions for an interior maximum are:

$$V_\nu = J_\nu(\nu, \sigma) + I_\nu(\nu, \sigma), \tag{4}$$

$$V_\sigma = J_\sigma(\nu, \sigma) + I_\sigma(\nu, \sigma). \tag{5}$$

The bank invests until the subsidy on the marginal dollar ($I_\sigma > 0$) offsets the (negative) present value of the marginal investment ($J_\sigma < 0$), where $I_\sigma > 0$ because the insurance subsidy is an increasing function of risk and $J_\sigma < 0$ because the loan cost function is convex in risk. The latter shows that insurance subsidies result in inefficient risk taking.

Based on this set-up, they investigate the necessary and sufficient conditions in which a tightening in the capital requirement results in an increase in asset risk and the probability of failure, where the necessary condition is that marginal costs increase with risk ($J_{\sigma v} < 0$) and the sufficient condition crucially depends on the properties of return distributions and the loan cost function. This conclusion supports the earlier conclusion that uniform capital regulation may be ineffective, and may even promote greater bank risk–taking. Even though their finding is interesting, it depends to a large extent on the specific functional forms assumed in the paper, and this restricts the predictive power of the model.

Park (1997) explicitly introduces regulatory constraints such that a bank cannot expect a positive insurance subsidy if it is classified as risky by regulators, where the probability of being classified as risky is a continuous function of capital ratios and the portfolio share of risky assets. As in Furlong and Keeley (1989), he assumes zero net present value investments, which implies that the bank managers seek to maximize the value of the deposit insurance subsidy. He predicts that a positive relationship between the capital ratio and the riskiness of the asset portfolio is possible in a bank with a high–variance investment opportunity, which is contrary to the result of Furlong and Keeley (1989, 1990).

2.2.3 Managerial Moral Hazard Approach

In the previous two approaches, it is assumed that banks are owned and managed by the same agent (the banker). The moral hazard problem in banks' risk taking behavior arises only from the incentives of banks' shareholders. In reality, however, the majority of large banks are owned by a large number of small investors. Bank managers own (at most) a small fraction of their bank's equity. Therefore it may be more appropriate to concentrate on the incentives faced by these managers rather than on those of the shareholders. Not much work has been done in this area, however, partly because it is more difficult to understand how the bank's solvency and the performance of managers are related. Here we examine Besanko and Kanatas (1996).

Besanko and Kanatas apply a value–maximizing model in an imperfect information environment and show that capital regulation can be counter–productive. The main feature of their study is that more stringent capital standards invoke two types of moral hazard problems: asset–substitution and effort–aversion moral hazards.

Asset–substitution moral hazard arises because bank owners want to benefit from the underpriced deposit insurance. As in Furlong and Keeley (1989, 1990), they show that capital regulations limit the bank's incentive to increase risky assets. Therefore, if asset–substitution moral hazard were the only consideration, an increase in the capital standard would unambiguously improve bank safety.

The second type of moral hazard, effort aversion moral hazard, is an application to banking of Jensen and Meckling's (1976) agency problem that involves a firm's insiders and its outside investors. In the model, bank insiders own a fraction of the bank's equity. They make a loan portfolio decision and an effort decision. The model is constructed such that an increase in bank capital has two effects on the managerial effort level. On the one hand, it induces more effort because substituting equity for deposits increases the banks' market value of equity, although it does reduce any deposit insurance subsidy. On the other hand, it dilutes the bank insiders' (managers') ownership share,[6] which reduces their marginal benefit of effort. In their model, the dilution effect is so strong that it dominates the beneficial effect that the capital standard has on effort. Therefore the equilibrium effort actually decreases as the capital standard is raised.

[6] It is assumed here that the bank issues stock to satisfy the capital standard, and the insiders are excluded from obtaining the new stock.

Between the asset substitution and effort aversion effects, it is uncertain which of the two dominates. It depends on the level of capital and the bank's particular circumstances. Under certain conditions, increasing capital standards may increase asset risk and reduce bank safety.

3 The Model

3.1 The Financial Structure of a Bank

I consider a two–date model. At $t = 0$, a bank is endowed with an amount, K, of capital and issues a fixed amount, D, of deposits. By assuming K and D are given exogenously to the bank, I deliberately abstract from the leverage decision (D/K) of the bank. If leverage is allowed to vary endogenously in the model, the choice of risky assets can also affect the leverage decision. The interaction between the two is an interesting issue, but I do not discuss this issue because I am primarily interested in the effect of bank capitalization on the bank's choice of risky assets. Accordingly, I treat the leverage ratio as determined *ex ante*. However, I assume the endowment of capital, K, varies cross–sectionally across banks. Each bank is endowed with a different amount of capital but issues the same amount of deposits. Consequently each bank has a distinct level of capitalization, which may allow banks to have different preferences over risky assets.

The bank invests capital and deposits in risky assets of which the return is a random variable. The returns on risky investments are realized at date $t = 1$. At $t = 1$, the bank pays back a fixed amount of $D_1 > D$ to depositors. I assume all the bank deposits are fully insured by the government with a fixed rate insurance premium. For simplicity, the insurance premium is normalized to be zero. Thus, $\frac{D_1}{D}$ defines the risk-free interest factor (1 plus the interest rate) on deposits. It should be noted that if the bank is not insured, then D_1 will be different depending on the leverage level and riskiness of bank assets, because depositors will require a risk premium.

Before I proceed further, some justifications for the assumption of full coverage and a fixed rate insurance premium will be useful. Under the current deposit insurance plan, various types of deposits normally are covered up to $100,000 for each single account holder. However, the Federal Deposit Insurance Corporation (FDIC) can provide virtually 100% insurance coverage for nearly all depositors, whenever possible, by avoiding closing a bank.[7]

The assumption of a fixed rate insurance premium may not be relevant under the current deposit insurance system because U.S. banks are subject to risk-based premiums after 1993 as mandated by the FDIC Improvement Act of 1991. More risky banks must pay higher insurance premiums. The FDIC assesses the degree of risk exposure of an individual bank based on (1) the adequacy of capital and (2) the risk class judged by examination results.[8] However, the current insurance plan is not completely risk sensitive and fairly priced. As long as there exists an insurance subsidy through deposit insurance to the bank, the assumption of a fixed rate insurance premium will be relevant in studying banks' risk–taking behavior under deposit insurance.

The literature to date does not document much empirical evidence on the deposit

[7]The FDIC is authorized to provide direct assistance to troubled banks, it can provide the assistance required to get a closed bank reopened, and most importantly it can assist bank mergers between a failing bank and a sound bank by engaging in 'purchase and assumption transactions.' (The FDIC can pay the sound bank to acquire the assets and assume the liabilities of a failing bank.)

[8]There are three classes of capitalization — well capitalized, adequately capitalized, and undercapitalized — and three supervisory risk categories — A, B and C. The well–capitalized, A–rated depositories pay the lowest deposit insurance fees per each $100 of deposit they hold, while the undercapitalized, C–rated institutions pay the greatest insurance fees. (See Rose, 1999, p. 418.

insurance pricing for the current deposit insurance system. Empirical studies for the period prior to the reform of 1991 provide mixed evidence on deposit insurance pricing (Marcus and Shaked, 1984; Pennacchi, 1987; Ronn and Verma, 1986). However, some authors discuss the infeasibility or the undesirability of fairly priced deposit insurance. For example, Chan, Greenbaum and Thakor (1992) show that fairly priced deposit insurance may not be feasible in the presence of private information (the possibility that the bank will misrepresent its asset risk in order to obtain more favorable insurance pricing) and moral hazard (the possibility that the bank will skew its asset choice in favor of more risk). Frexias and Rochet (1998) show that, in a more general case, fairly priced deposit insurance may actually be viable under asymmetric information, but that it will never be completely desirable from a general welfare viewpoint.

3.2 Properties of Return Distributions

Let r denote the interest factor on the banks' investment asset.[9] Conditional on a risk parameter, α, the cumulative distribution function (*c.d.f.*) of asset return is denoted by $F(r|\alpha)$ and its associated probability density function (*p.d.f.*) by $f(r|\alpha)$. I assume the conditional distributions satisfy the location and scale parameter (LS) condition defined by William Feller (1971, pg. 137):

Definition 1 *Two distributions $F(r|\alpha_1)$ and $F(r|\alpha_2)$ are said to be of the same type if $F(r|\alpha_1) = F(\gamma + \delta \times r \mid \alpha_2)$ with $\delta > 0$. I refer to δ as scale factor, and γ as centering (or location) constant.*

[9] In other words, it is the return per dollar on the investment asset

The LS condition says that changes in distributions from $F(r|\alpha_1)$ to $F(r|\alpha_2)$ amount only to a change in the centering of the distribution and a uniform shrinking or stretching of the distribution. This means that if the support of the distribution is bounded, it changes with α.[10] I assume the supports of the distributions are contained in the interval $[0, \bar{r}]$, for all values of α. In other words, the value that r can take is bounded below by zero and above by $\bar{r}$. The LS condition specifies how the random variables must be related to one another, but places no restriction on the functional form of the *c.d.f.* describing any particular random variable (Meyer, 1987).[11]

Assume a choice set in which all random variables conditional on risk parameter, $r \mid \alpha$, differ from one another by location and scale parameters. Let X be the random variable obtained from one of the $r \mid \alpha$ using the normalization transformation $X = \frac{r|\alpha - \mu(\alpha)}{\sigma(\alpha)}$, where $\mu(\alpha)$ and $\sigma(\alpha)$ are the mean and standard deviation of $r \mid \alpha$. Note that the normalized random variable has a mean of zero and a standard deviation of one. Now all $r \mid \alpha$ can be expressed as:

$$r \mid \alpha = \mu(\alpha) + \sigma(\alpha)X \qquad (6)$$

In other words, all $r \mid \alpha$ are equal in distribution to $\mu(\alpha) + \sigma(\alpha)X$. I assume the risk parameter α lies in the set $[0, 1]$ and this set completely characterizes the investment opportunity set of a bank. I will occasionally refer to the standard deviation of the asset return, $\sigma(\alpha)$, as the asset risk.

I make distinct assumptions on how changes in risk parameter α affect the mean

[10] If the support of $F(r|\alpha_1)$ is $[g, h]$, then the support of $F(r|\alpha_2)$ is $[\gamma + \delta g, \gamma + \delta h]$.

[11] Examples of distributions which are closed under the LS condition are the normal and uniform families. The lognormal family is not closed under this condition, even though it belongs to the two–parameter families. It should be noted that the LS condition is different from the concept of a two parameter family of distribution functions. The LS condition is a well–defined special case of the ill–defined two–parameter family condition. (For further discussion of this issue, see Rothschild and Stiglitz, 1970 and Meyer, 1987.)

and standard deviation of asset return. As one will see later, different assumptions have different implications on the bank's probability of failure and asset risk choice.

3.2.1 Constant-Variance FSD($\mu'(\alpha) < 0$ and $\sigma'(\alpha) = 0$)

This assumption corresponds to the case where increasing α makes the investment asset riskier in the sense of first order stochastic dominance sense[12] (hereafter FSD). The assumption of FSD has been widely used in principal–agent models, where it is assumed that the agent's hidden action shifts the distribution of the uncertain outcome in sense of FSD.[13] This assumption is necessary, for the principal would like to see the agent increase his effort.[14] This assumption has not been used in the banking literature, however, because this is too strong an assumption for studying the dynamics of bank shareholder's risk-taking behavior in conjunction with capitalization. This case is represented by a vertical line in (σ, μ) space.

3.2.2 MPS($\mu'(\alpha) = 0$ and $\sigma'(\alpha) > 0$)

This is the case of mean preserving spread (MPS).[15] The concept of MPS (i.e., equal mean and different variance) has been popularly used in ordering risky assets in the banking and finance literature, because the variance of the asset provides a simple measure for ordering riskiness among risky assets. For example, Furlong and Keeley (1989,

[12] A distribution $F(r)$ is said to stochastically dominate the distribution $G(r)$ in the first order if and only if $G(r) - F(r) \geq 0, \forall r \in [0, \bar{r}]$.

[13] See, for instance, Holmstrom (1979), Harris and Raviv(1979), Holmstrom and Milgrom(1987), Zwiebel(1995), or Jeitschko and Mirman (2002) among others.

[14] In other words, it is a necessary condition for the multiplier of agent's incentive compatibility constraint to be positive (Holmstrom 1979, Proposition 1).

[15] A distribution $G(r)$ is said to be a mean preserving spread of the distribution $F(r)$ if the *p.d.f.* $g(r)$ is obtained from the *p.d.f.* $f(r)$ by taking some of the probability weight from the center of $f(r)$ and adding it to each tail of $f(r)$ in such a way to leave the mean unchanged (Rothschild and Stiglitz, 1970).

1990) adopt this concept when they investigate bank's risk taking behavior using Black and Sholes option pricing formula. In their formula, the value of bank equity does not depend on mean return of bank asset, $\mu(\alpha)$, which implies that the effect of the risk parameter on the mean return is equal to zero ($\mu'(\alpha) = 0$).[16] However, as one will see, the concept of MPS is also not an appropriate criterion in examining the asset substitution moral hazard in banks as long as the bank shareholder's objective is concerned. This case is represented by a horizontal line in (σ, μ) space.

3.2.3 Strict Mean-Variance Ordering($\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$)

This is the case considered in Green and Talmor (1986). It is assumed that by increasing α the bank decreases the mean ($\mu'(\alpha) < 0$) and scales up the asset risk ($\sigma'(\alpha) > 0$). Note that this case reduces to the traditional mean–variance ordering[17] if the assumption is replaced by $\mu'(\alpha) \leq 0$ and $\sigma'(\alpha) \geq 0$. It is known that if $F(r \mid \alpha)$ satisfies the LS condition, and the scale parameter is a monotone increasing function of variance alone, then the mean–variance ordering is equivalent to the concept of second order stochastic dominance.[18] (See Fishburn and Vickson, 1978 for a discussion of this issue.) So this assumption is a special case of second order stochastic dominance (SSD). If we consider any two risky alternatives, then the assumption implies the single crossing of

[16]In the Black-Scholes formula, the mean return of the asset(μ) only indirectly impacts the value of equity through its impact on the current asset value. If the effect of risk parameter on mean return were not equal to zero ($\mu'(\alpha) \neq 0$), then a change in asset risk(σ) accompanies a change in mean return, which impacts asset value and thus equity value. This indirect impact is not captured in Furlong and Keely's analysis.

[17]A distribution $F(r)$ is said to dominate the distribution $G(r)$ in the sense of mean–variance ordering if and only if $\mu_F \geq \mu_G$ and $\sigma_F \leq \sigma_G$. This concept should not be confused with the mean–variance approach to evaluate the expected utility, where the expected utility is assumed to be a function of mean and variance of random variables. While this latter issue is very important for risk–averse agents, it is irrelevant in this study, because I am assuming universal risk neutrality. (For the discussion of the latter issue, see Bigelow, 1993; Meyer, 1987; Sinn, 1989.)

[18]A distribution $F(r)$ is said to stochastically dominate the distribution $G(r)$ in the second order if and only if $\int_0^y [G(r) - F(r)]dr \geq 0, \forall y \in [0, \bar{r}]$.

the two distributions. One may note that the single crossing of *c.d.f.*s implies SSD and excludes FSD. One will see that this case is a more appropriate concept for risk ordering in studying bank shareholder's asset substitution moral hazard in conjunction with capitalization. Some authors such as Bhattacharya, Boot and Thakor (1998) and Besanko and Kantas (1996) use the concept of SSD in explaining the asset substitution moral hazard under deposit insurance. However they do not explicitly recognize the possibility that the concept of SSD can allow FSD and therefore asset substitution moral hazard may not occur in a set of *c.d.f.*s that can be ordered by SSD. This case is represented by a negatively sloped convex function[19] in (σ, μ) space.

3.2.4 Higher-Risk Higher-Return($\mu'(\alpha) > 0,\ \sigma'(\alpha) > 0,\ \frac{d}{d\alpha}(\frac{\mu(\alpha)}{\sigma(\alpha)}) = \frac{\mu'\sigma - \sigma'\mu}{\sigma^2} < 0$)

I extend Green and Talmor (1986) by assuming that an increase in α increases both the mean ($\mu'(\alpha) > 0$) and the asset risk ($\sigma'(\alpha) > 0$), but increases the former less than the latter, i.e, $\frac{d}{d\alpha}(\frac{\mu(\alpha)}{\sigma(\alpha)}) = \frac{\mu'\sigma - \sigma'\mu}{\sigma^2} < 0$. The ratio, $\frac{\mu}{\sigma}$, is the inverse of the coefficient of variation, which is commonly used as a measure of the dispersion of the distribution of a positive random variable in statistics theory. Thus the assumption implies that the dispersion of the return distribution increases with α. This case is represented by a concave function in (σ, μ) space.[20]

The assumption itself does not provide a measure of risk ordering between alternative

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[19]The function is convex because $\frac{d}{d\alpha}(\frac{\mu(\alpha)}{\sigma(\alpha)}) = \frac{\mu'\sigma - \sigma'\mu}{\sigma^2} < 0$, where the inequality holds because I am assuming $\mu' < 0$ and $\sigma' > 0$. It is easy to verify that $\mu'\sigma - \sigma'\mu = \sigma \times \mu \times \alpha \times (\frac{\mu'\alpha}{\mu} - \frac{\sigma'\alpha}{\sigma}) = \sigma \times \mu \times \alpha \times (\epsilon_\mu - \epsilon_\sigma)$, where ϵ_μ is the elasticity of mean return with respect to α and ϵ_σ is the elasticity of standard deviation with respect to α. So the condition, $\mu' < 0$ and $\sigma' > 0$, implies $\epsilon_\mu < \epsilon_\sigma$, which in turn implies that for a unit change in α the change in standard deviation is larger than the change in mean return. When the function is negatively sloped, this is equivalent to saying that the function is convex.

[20]Again, the concavity results from the condition $\epsilon_\mu < \epsilon_\sigma$. When the function is positively sloped, this condition is equivalent to saying that the function is concave.

risky assets. However, as one will see, this assumption has an implication on the probability of failure. If one measures the riskiness of an asset by the probability of failure that the asset carries, then this assumption can be used as a measure for ordering risk. It is important to note that it may be this assumption that represents more appropriately the risky asset alternatives of a bank, as is well described by the phrase, "higher–risk higher–return assets." This last case is included to examine the argument that more capitalized banks invest in "higher–risk higher–return assets" and thereby have higher probability of failure.

It may be noted that the condition $\frac{d}{d\alpha}(\frac{\mu(\alpha)}{\sigma(\alpha)}) = \frac{\mu'\sigma-\sigma'\mu}{\sigma^2} < 0$ trivially holds in the first three cases. Under this condition, the support of the new distribution is bounded below by $a \equiv -\frac{\mu(\alpha=1)}{\sigma(\alpha=1)}$ and above by $b \equiv \frac{\bar{r}-\mu(\alpha=0)}{\sigma(\alpha=0)}$ (see Figure 2).

Finally, I assume that the expected return of the risky asset is no less than the risk free interest factor ($\mu(\alpha) \geq \frac{D_1}{D}$). A bank will be willing to invest in a negative net present value project if the option value of deposit insurance is large enough. However, I exclude negative net present value projects from analysis. The following summarizes assumptions on the properties of return distributions.

Assumption 1 *The various conditional return distributions satisfy the following properties:*

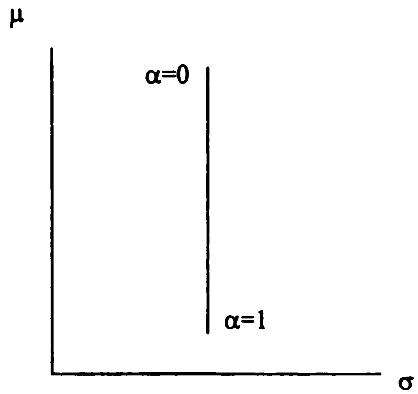
(a) The scale and location parameter condition.

(b) The mean and variance of the asset return satisfy either

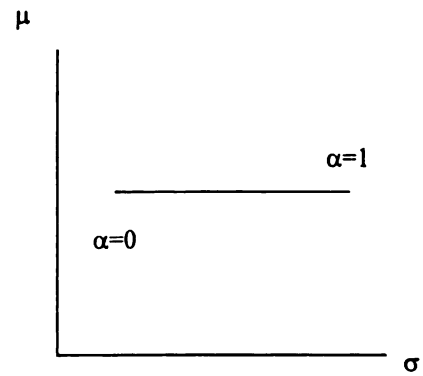
(i) $\mu'(\alpha) \leq 0$ *and* $\sigma'(\alpha) \geq 0$*; or*

(ii) $\mu'(\alpha) > 0$, $\sigma'(\alpha) > 0$, *together with* $\frac{d}{d\alpha}(\frac{\mu(\alpha)}{\sigma(\alpha)}) = \frac{\mu'\sigma-\sigma'\mu}{\sigma^2} < 0$

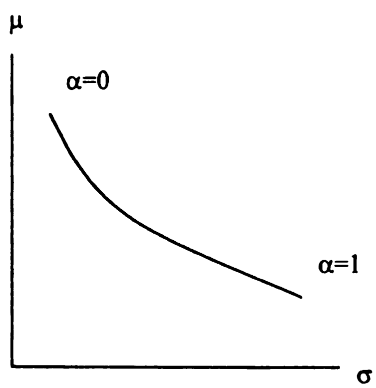
(c) It is assumed that $\mu(\alpha) \geq \frac{D_1}{D}, \forall\alpha \in [0,1]$.



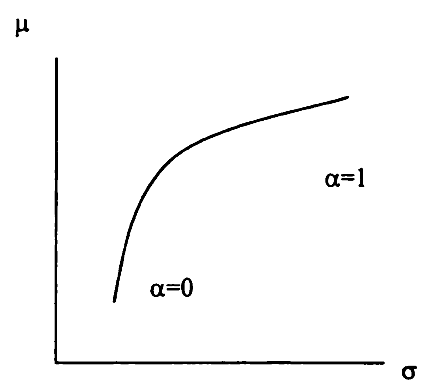
(1) $\mu'(\alpha) < 0$ and $\sigma'(\alpha) = 0$



(2) $\mu'(\alpha) = 0$ and $\sigma'(\alpha) > 0$



(3) $\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$



(4) $\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$

Figure 1: Illustrations of Investment Opportunity Sets

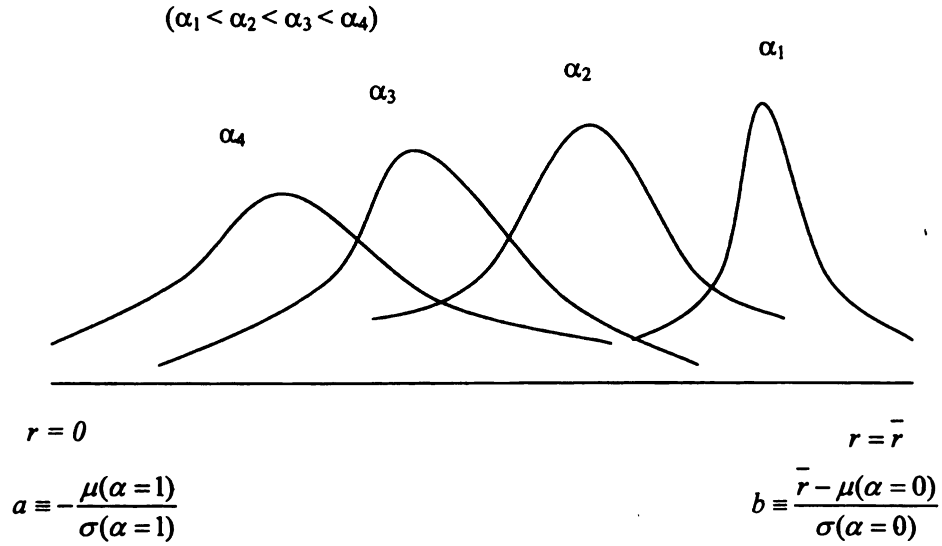


Figure 2: Illustration of Conditional Probability Density Functions

Before beginning the theoretical analysis, it is worth discussing two issues regarding the model. First, one may note that the first three risk ordering concepts will be inappropriate if there were no deposit insurance subsidy. A rational investor will never choose a dominated risky asset in the sense of the first three cases unless there is a subsidy for choosing a dominated asset.

The other important issue in choosing a risky asset is diversification. Suppose a bank has a well–diversified portfolio, and it wants to take an additional risky asset among a set of risky alternatives. In this case, it is the marginal or incremental risk — i.e., the change in portfolio risk in response to the addition of the asset — rather than the stand–alone risk of the individual asset that the bank considers as a selection criterion. Even if a risky alternative asset is dominated by the other alternative, it still can be chosen if the correlation of the asset with the existing portfolio is significantly low and thus the marginal risk of the asset is smaller compared to the other assets. In this two period model of asset choice, stand–alone and marginal risks are assumed to be identical, and I abstract away from the issue of diversification in the analysis.

3.3 Probability of Failure

A bank fails if the value of its liabilities exceeds the value of its assets at date 1. A bank fails at date 1 if:

$$D_1 > (D+K)r, \text{ or } r < \tfrac{D_1}{D+K} \equiv r^f.$$

Since the endowment of capital, K, is nonnegative, r^f is bounded by zero and $\frac{D_1}{D}$, i.e., $r^f \in (0, \frac{D_1}{D})$.

The probability of bank failure is defined as:

$$P(K,\alpha) = \int_0^{r^f} f(r \mid \alpha)dr = \int_a^c f(x)dx = F(C) \tag{7}$$

where $a = -\frac{\mu(\alpha)}{\sigma(\alpha)}$ and $c = \frac{r^f - \mu(\alpha)}{\sigma(\alpha)}$.

The effect of a capital increase on the probability of failure can be decomposed into two parts:

$$\frac{\partial P(K,\alpha)}{\partial K} = \frac{dP}{dK} + \frac{\partial P}{\partial \alpha}\frac{\partial \alpha}{\partial K} \tag{8}$$

The first part ($\frac{dP}{dK}$) is the buffer effect of capital on the probability of failure. The second part is a combination of the asset choice effect on the probability of failure ($\frac{\partial P}{\partial \alpha}$) and the asset substitution effect of capital ($\frac{\partial \alpha}{\partial K}$), i.e, the effect of a capital increase on asset choice. The following propositions formally state these effects.

Proposition 1 *Given the value of the risk parameter α, the probability of failure is a decreasing function of capital, K.*

proof. $\frac{\partial P(K,\alpha)}{\partial K} = f(c)\frac{1}{\sigma}\frac{\partial r^f}{\partial K} = -\frac{f(c)}{\sigma}\frac{D_1}{(D+K)^2} < 0$. ∎

This intuitively shows the buffer effect of capital, i.e. larger capital absorbs more risk. The buffer effect implies that bank safety increases with capital. Since I am assuming deposits (D) and promised repayments to depositors (D_1) are fixed, more capital increases the probability of bank solvency.

Proposition 2 *The probability of failure is a non–decreasing function of risk parameter α under the following conditions:*

(i) $\mu'(\alpha) \leq 0$ and $\sigma'(\alpha) \geq 0$; or

(ii) $\mu'(\alpha) > 0$, $\sigma'(\alpha) > 0$, $\frac{d}{d\alpha}(\frac{\mu(\alpha)}{\sigma(\alpha)}) = \frac{\mu'\sigma - \sigma'\mu}{\sigma^2} < 0$ and $r^f < \mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$.

proof. $\frac{\partial P(K,\alpha)}{\partial \alpha} = f(c)\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2}$.

Since $\mu(\alpha) \geq \frac{D_1}{D} > r^f \equiv \frac{D_1}{D+K}$, it is easy to verify that the sign of the above expression is non–negative if $\mu'(\alpha) \leq 0$ and $\sigma'(\alpha) \geq 0$. For the second case, since I am assuming $\mu'\sigma - \sigma'\mu < 0$, it is positive if and only if $r^f < \frac{\sigma'\mu - \mu'\sigma}{\sigma'} = \mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$. ∎

The implication of Proposition 2 is that the probability of failure increases with asset risk for all possible values of capital in the first case. For the second case, however, it can increase or decrease with asset risk depending on bank capitalization. If the bank is well–capitalized in the sense that r^f is smaller than $\mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$ for arbitrary $\alpha \in [0, 1]$, then it increases with asset risk. If the bank is poorly–capitalized in the sense that $r^f > \mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$, then it can actually decrease with asset risk. It shows that when the second case represents appropriately the characteristics of asset return, the riskiness of an asset is not an inherent property of the asset: It can be defined only in conjunction with bank's capitalization.

For the remaining analysis of the paper, I assume that the condition, $r^f < \mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$, always holds. This assumption practically implies that one of the two following conditions holds. (1) The bank has large enough capital so that $r^f < \mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$ holds for any possible values of α, ϵ_μ, and ϵ_σ. (2) ϵ_σ is much greater than ϵ_μ so that $r^f < \mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$ holds for any possible values of α and K. If the ratio $\frac{\epsilon_\mu}{\epsilon_\sigma}$ is close to zero, then the condition $r^f < \mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$ will always hold, because r^f is bounded above by $\frac{D_1}{D}$, which is no greater than $\mu(\alpha)$. Formally I assume the following.

Assumption 2 *The critical interest factor, r^f is less than $\mu(\alpha)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$ for all α.*

3.4 Equity Value and Option Value of Deposit Insurance

At date $t = 0$, the bank invests capital, K, and deposits, D, in risky assets. The expected value of bank equity at $t = 1$ is:

$$
\begin{aligned}
V(\alpha) &= \int_0^{r^f} 0 f(r \mid \alpha) dr + \int_{r^f}^{\bar{r}} [(D+K)r - D_1] f(r \mid \alpha) dr \\
&= \int_c^b [(D+K)(\mu(\alpha) + \sigma(\alpha)x) - D_1] f(x) dx \\
&= \int_a^b [(D+K)(\mu(\alpha) + \sigma(\alpha)x) - D_1] f(x) dx - \int_a^c [(D+K)(\mu(\alpha) + \sigma(\alpha)x) - D_1] f(x) dx \\
&= [(D+K)\mu(\alpha) - D_1] + [D_1 F(c) - (D+K) \int_a^c [\mu(\alpha) + \sigma(\alpha)x] f(x) dx] \qquad (9)
\end{aligned}
$$

where $a \equiv -\frac{\mu(\alpha=1)}{\sigma(\alpha=1)}$, $b \equiv \frac{\bar{r} - \mu(\alpha=0)}{\sigma(\alpha=0)}$ and $c = \frac{r^f - \mu(\alpha)}{\sigma(\alpha)}$.

The first bracket in the last line of equation (9) is the expected return on the investment net of payments to depositors (NER) and the second bracket corresponds to the option value(OV) of deposit insurance as described by Merton (1977). This term is positive by definition because it represents a bankruptcy state where $D_1 > (D+K)[\mu(\alpha) + \sigma(\alpha)x]$. By guaranteeing the promised payment of D_1, the deposit insurance system has issued a put option on the assets of the bank that gives the bank the right to sell those assets for D_1 dollars at date 1. If OV is the value to the bank of the deposit insurance at date 1, then

$$OV = \max[0, (D+K)[\mu(\alpha) + \sigma(\alpha)x] - D_1] \tag{10}$$

If $D_1 > (D+K)[\mu(\alpha)+\sigma(\alpha)x]$, the deposit insurance system should pay the difference $D_1 - (D+K)[\mu(\alpha) + \sigma(\alpha)x]$. This is the cost of the deposit insurance system when the bank fails. The expected value of this cost is exactly the second bracket of equation (9).

Regarding the option value, two important observations should be noted. First, because of the option value of deposit insurance, the shareholder is willing to invest even in a project that has negative expected net present value (NPV). If a bank is allowed to exploit the option value without any regulatory restraints, then the equilibrium in a perfect capital market requires that the bank shareholder earns only the risk-free rate of return. In other words, equilibrium requires that:

$$\begin{aligned} V(\alpha) - K\frac{D_1}{D} &= (D+K)\mu(\alpha) - D_1 - \int_a^c [(D+K)(\mu(\alpha)+\sigma(\alpha)x) - D_1]f(x)dx - K\frac{D_1}{D} \\ &= (D+K)[\mu(\alpha) - \frac{D_1}{D}] + \int_a^c [D_1 - (D+K)(\mu(\alpha)+\sigma(\alpha)x)]f(x)dx = 0 \end{aligned} \tag{11}$$

The first term is the excess expected return of the asset over the risk free interest factor and the second term is the option value. As one has seen, the second term is positive by definition. Therefore the first term must be negative for the equation to hold. Under the deposit insurance subsidy and without any regulatory constraints, bank shareholders want to see the bank assets invested even in negative NPV projects.[21] In

[21] This point has been noted elsewhere. For example, Gavish and Kalay (1983), in discussing the asset substitution effect in the firm, note that the firm is more likely to accept projects with negative net present value, the higher the leverage ratio is. Barnea, Haugen and Senbet (1985) also note that, under certain conditions, risk shifts benefit managers and stockholders against debt holders even when a negative net present value project is adopted.

reality, however, the tendency to invest in negative NPV projects is limited by the fact that the FDIC imposes various regulatory constraints (on– and off–site examinations, capital regulation, etc.) on banks' risk–taking behavior.[22] For analytical purposes, it is assumed in this paper that the bank can invest only in nonnegative NPV projects.

Second, the option value is a decreasing function of capital. To see this, differentiate the option value with respect to capital:

$$\begin{aligned}\frac{\partial OV(K)}{\partial K} =& D_1 f(c)\frac{-D_1}{\sigma(D+K)^2} - \int_a^c (\mu + \sigma x)f(x)dx \\ & - (D+K)(\mu + \sigma\frac{r^f - \mu}{\sigma})f(c)\frac{-D_1}{\sigma(D+K)^2} \\ =& -\int_a^c (\mu + \sigma x)f(x)dx < 0 \end{aligned} \tag{12}$$

Note that the first and third terms cancel out since $r^f = \frac{D_1}{D+K}$. The last inequality follows from the fact that X is bounded below by $a \equiv -\frac{\mu}{\sigma}$.

Thus, a bank endowed with a larger capital stock will be less inclined to exploit the option value of deposit insurance. In fact, the expected cost of the deposit insurance system (OV) decreases as the capital stock increases: A bank with more capital is less likely to fail, and if it fails, it imposes smaller losses on the deposit insurance system. If we further assume that the bank is allowed to choose its capital level, then the option value maximizing bank will have an infinite level of leverage, or a zero capital to asset ratio. (See Furlong and Keeley, 1989; Keeley and Furlong, 1990 for this argument.) This gives one rationale for the capital adequacy requirements: By requiring a bank to keep a minimum capital ratio, the regulator can limit the expected cost of the deposit insurance system.

[22]The coexistence of underpriced deposit insurance and regulatory constraints are explained by Buser, Chen and Kane (1981). They argue that the FDIC intentionally sets the premium (explicit premium) below the fair value to induce banks to purchase insurance, and charges regulatory restrictions as an additional implicit premium to reduce moral hazard problem.

4 Theoretical Analysis

This section investigates the effect of capitalization on bank's optimal asset risk by three different economic agents: deposit insurer, shareholder and manager. These are the agents who are actually involved in determining asset risk of a bank. The shareholder participates by monitoring (Shleifer and Vishny, 1986) or control challenge (Fluck, 1999), the manager operates the bank, and the deposit insurer imposes regulatory restraints. The objective of each economic agent is stated, optimal risk corresponding this objective is drawn, and the effect of capitalization on optimal risk is analyzed. Finally, a complete model of risk determination is examined and comparative static analyses are provided. It is demonstrated that the different incentives for these agents cause a different effect of capitalization on bank's risk.

4.1 Optimal Asset Risk of the Deposit Insurer

The deposit insurer is most interested in protecting the deposit insurance fund, which can be achieved by minimizing the option value of deposit insurance. The deposit insurer's problem is given by:

$$\begin{aligned}\min_{\alpha} OV(\alpha) &= -\int_{a}^{c} [(D+K)(\mu(\alpha)+\sigma(\alpha)x) - D_1]f(x)dx \\ &= D_1 F(c) - (D+K)\int_{a}^{c} [\mu(\alpha)+\sigma(\alpha)x]f(x)dx \qquad (13)\end{aligned}$$

The expression shows that option value is a function of the probability of failure ($F(c)$) and the expectation in state of bankruptcy, $\int_a^c [\mu(\alpha)+\sigma(\alpha)x]f(x)dx$.

The first order condition can be obtained by applying Leibnitz's rule;

$$OV_\alpha = \frac{\partial OV(\alpha)}{\partial \alpha} = -(D+K)\int_a^c [\mu'(\alpha) + \sigma'(\alpha)x]f(x)dx$$

$$= -(D+K)[\mu'(\alpha)F(c) + \sigma'(\alpha)\int_a^c xf(x)dx] \tag{14}$$

Note that the effect of α on $c = \frac{r^f - \mu(\alpha)}{\sigma(\alpha)}$ cancels out because

$$D_1 f(c)\frac{\partial c}{\partial \alpha} - [(D+K)[\mu(\alpha) + \sigma(\alpha)\frac{r^f - \mu(\alpha)}{\sigma(\alpha)}]]f(c)\frac{\partial c}{\partial \alpha}$$

$$= [D_1 - (D+K)\frac{D_1}{D+K}]f(c)\frac{\partial c}{\partial \alpha} = 0.$$

4.1.1 Traditional Mean-Variance Ordering($\mu'(\alpha) \leq 0$ and $\sigma'(\alpha) \geq 0$)

Since the mean value of the random variable X is zero and $c = \frac{r^f - \mu(\alpha)}{\sigma(\alpha)} < 0$, the sign of the expectation, $\int_a^c xf(x)dx$, is negative. Thus the sign of equation (14) is nonnegative for all values of capital, K. Therefore the option value minimizing deposit insurer prefers the least risky asset possible when properties of asset returns are characterized by FSD, MSD or SSD. Intuitively, since the probability of failure increases and mean return decreases with risk parameter in all these cases, the deposit insurer has no incentive to prefer positive level of optimal risk, α^d, where superscript d indicates the optimal risk of deposit insurer.

4.1.2 Higher-Risk Higher-Return($\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$)

Assuming the second order condition for an interior solution is satisfied (see Appendix 1), α^d can be obtained by setting OV_α equal to be zero, which is implicitly given by:

$$\mu'(\alpha^d)F(c) + \sigma'(\alpha^d)\int_a^c xf(x)dx = \mu'(\alpha^d) + \sigma'(\alpha^d)\frac{\int_a^c xf(x)dx}{F(c)}$$

$$= \mu'(\alpha^d) + \sigma'(\alpha^d)E(x \mid x < c) = 0 \tag{15}$$

This shows the trade-off that the deposit insurer considers in determining the optimal level of α. The deposit insurer will choose α^d such that the marginal increase in mean return be equalized with the marginal increase in asset risk weighted by the conditional expectation in state of bankruptcy[23]. (Note that the conditional expectation has a negative sign.) Therefore there exists an optimal level of α which minimize the option value of deposit insurance.

4.1.3 Comparative Static Analysis: The Effect of Capital on α^d

The following proposition characterizes the changes in the deposit insurer's risk tolerances in response to the change in capital level.

Proposition 3 *Suppose return properties are characterized in such a way that a higher risk is associated with a higher mean return(* $\mu'(\alpha) > 0$, $\sigma'(\alpha) > 0$, *and* $\frac{d}{d\alpha}(\frac{\mu(\alpha)}{\sigma(\alpha)}) = \frac{\mu'\sigma - \sigma'\mu}{\sigma^2} < 0$*). Also assume that Assumption 2(* $r^f < \mu(\alpha^d)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$*) holds. Then the optimal asset risk of deposit insurer,* α^d*, increases with capital.*

proof. Totally differentiating the first order condition (FOC) gives,

$$\frac{d\alpha^d(K)}{dK} = -\frac{\frac{\partial^2 OV}{\partial\alpha\partial K}}{\frac{\partial^2 OV}{\partial\alpha^2}} \tag{16}$$

Assuming that the second order condition (SOC) for an interior optimum is satisfied (see Appendix 1), the denominator on the right-hand side of (16) is positive. Thus the

[23] In other words, it is the average size of the realized value of random variable X when the bank goes to bankruptcy. This quantity is also called expected shortfall, or tail conditional expectation. (See Jorion, 2001, p. 97.)

sign of (16) is determined by the sign of the nominator.

$$\begin{aligned}\frac{\partial^2 OV(\alpha^d)}{\partial\alpha\partial K} &= -\int_a^c [\mu'(\alpha^d) + \sigma'(\alpha^d)x]f(x)dx \\ &\quad - (D+K)(\mu'(\alpha^d) + \sigma'(\alpha^d)\frac{r^f - \mu(\alpha^d)}{\sigma(\alpha^d)})f(c)\frac{1}{c}(\frac{-D_1}{(D+K)^2}) \\ &= (\frac{\mu'(\alpha^d)\sigma(\alpha^d) + \sigma'(\alpha^d)(r^f - \mu(\alpha^d)}{\sigma(\alpha^d)})\frac{r^f f(c)}{\sigma} \end{aligned} \tag{17}$$

Note that $-\int_a^c[\mu'(\alpha^d) + \sigma'(\alpha^d)x]f(x)dx = 0$ from the first order condition. The sign of the above expression is negative if $r^f < \mu(\alpha^d)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$. Therefore $\frac{d\alpha^d(K)}{dK} > 0$. ■

For an intuitive interpretation of Proposition 3, we need to go back to the deposit insurer's minimization problem. To minimize the option value, the deposit insurer wants to minimize the probability of failure, $D_1F(c)$, and to maximize the partial expectation, $(D+K)\int_a^c[\mu(\alpha) + \sigma(\alpha)x]f(x)dx$. At α^d, the deposit insurer achieves the minimum by balancing the trade-off between the two. An increase in capital, however, makes the existing α^d sub-optimal by decreasing the probability of failure (buffer effect of capital) and changing the partial expectation. Therefore there arises a need to readjust the risk parameter to a new optimal level.

When $r^f < \mu(\alpha^d)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$, an increase in α increases both the probability of failure (Proposition 2) and the partial expectation.[24] If there were no change in capital, an increase in $\alpha > \alpha^d$ would make the deposit insurer worse off by raising the probability of failure more than the partial expectation. When there is an increase in capital, however, the buffer effect of capital (partly) offsets the effect of an increase in α on the

[24]Differentiating the partial expectation with respect to a gives;

$$(D+K)[\mu'(\alpha)F(c)+\sigma'(\alpha)\int_a^c xf(x)dx]+[(D+K)(\mu(\alpha)+\sigma(\alpha)\frac{r^f-\mu(\alpha)}{\sigma(\alpha)})f(c)\frac{\partial c}{\partial\alpha}] = 0+D_1f(c)\frac{\partial c}{\partial\alpha} > 0.$$

The "zero" is from the FOC and the inequality follows from the results in the proof of the Proposition 3.

probability of failure. Therefore, it is better off for the deposit insurer to increase the partial expectation by moving to $\alpha^{d(NEW)} > \alpha^{d(OLD)}$.

4.2 Optimal Asset Risk of the Shareholder

I assume a risk neutral bank shareholder (the owner-manager) who wants to maximize the market value of bank equity. The use of value maximization as the decision-maker's objective ignores the potential conflicts of interests between the shareholder and the manager, and thereby abstracts from the issues of the managerial moral hazard and risk sharing which are the key issues of the traditional principal-agent theories. It does allow us, however, to focus on the asset substitution moral hazard under deposit insurance. Since the endowment of capital, K, and deposit level, D, are assumed to be fixed, the objective of the shareholder is to choose a risky asset to maximize the equity value. I am interested in how the shareholder's preferred risky asset changes as the level of endowment, K, changes.

The shareholder's problem is to choose the optimal level of risk parameter, α^s, to maximize the expected value of bank equity:

$$\max_{\alpha} V(\alpha) = \int_c^b [(D + K)(\mu(\alpha) + \sigma(\alpha)x) - D_1]f(x)dx \tag{18}$$

The first order condition of the above problem with respect to α is:

$$V_\alpha = \frac{\partial V(\alpha)}{\partial \alpha} = (D + K) \int_c^b [\mu'(\alpha) + \sigma'(\alpha)x]f(x)dx \tag{19}$$

Note that the effect of α on $c = \frac{r^f - \mu(\alpha)}{\sigma(\alpha)}$ cancels out as before.

4.2.1 Constant Variance FSD($\mu'(\alpha) < 0$ and $\sigma'(\alpha) = 0$)

In this case the sign of equation (19) is negative, and the objective function $V(\alpha)$ achieves its global maximum at $\alpha = 0$. If risky alternatives can be ordered in the sense of first order stochastic dominance, then the risk-neutral equity-value maximizing bank shareholder will always choose the least risky asset ($\alpha^s = 0$) regardless of bank capitalization. Therefore, there does not exist incongruity in preference over risky asset choice between the deposit insurer and the bank shareholder. In this case, no regulation is needed to induce the bank to choose less risky asset, because the bank itself is inclined to choose it.

4.2.2 MPS($\mu'(\alpha) = 0$ and $\sigma'(\alpha) > 0$)

Since the objective function $V(\alpha)$ is maximized at $\alpha^s = 1$, the risk-neutral equity-value maximizing bank shareholder always prefers the riskiest asset regardless of bank capitalization. If the bank's opportunity set includes risky assets that have the same expected returns, the choice of risky asset completely depends on the option value of the deposit insurance. One may know from equation (14) that option value increases monotonically with α if $\mu'(\alpha) \leq 0$ and $\sigma'(\alpha) \geq 0$.

In general, a risk neutral agent is indifferent between risky assets if the expected returns are the same. However, under the deposit insurance system, the risk neutral shareholder strictly prefers the riskier asset, because the riskier asset gives the higher option value. This is the moral hazard problem inherent in the deposit insurance system. Since there exists incongruity in preference over risky asset choice between the deposit insurer and the bank shareholder, some kind of regulation is needed to remedy this moral hazard problem. However, it cannot be any type of capital regulation, because the bank's asset choice is not affected by its capital level. The capital adequacy regulation would not succeed in reducing the incentives for the bank to take excessive risks.

4.2.3 Strict Mean-Variance Ordering($\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$)

An interior solution exists in this case, assuming the second order condition is satisfied (see Appendix 2). From equation (19), the optimal level of α is implicitly given by:

$$\mu'(\alpha^s)[1 - F(c)] + \sigma'(\alpha^s) \int_c^b xf(x)dx = \mu'(\alpha^s) + \sigma'(\alpha^s) \frac{\int_c^b xf(x)dx}{[1 - F(c)]}$$

$$= \mu'(\alpha^s) + \sigma'(\alpha^s) E(x \mid x > c) = 0 \qquad (20)$$

The shareholder will choose α^s such that the marginal increase in mean return be equalized with the marginal increase in asset risk weighted by the conditional expectation in state of solvency.

We have seen that bank equity value can be decomposed into two parts: expected return from the investment project net of payment to depositors (NER) and option value of deposit insurance (OV). When choosing risky assets, the shareholder considers both parts and chooses the asset that maximizes the sum of these two parts. In other words, the shareholder faces a trade-off in determining the optimal level of α. By increasing α, the shareholder can increase the insurance subsidy, but at the same time he decreases the mean return from the investment. Therefore there exists an optimal level of α which maximizes the equity value of the bank. The existence of an interior α^s highlights the moral hazard problem under deposit insurance. It shows that even the second order stochastically dominated asset can be pursued by bank shareholder. Without the deposit insurance subsidy, the second order stochastically dominated asset will never be chosen by risk neutral agents.

4.2.4 Higher-Risk Higher-Return($\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$)

In this case, Equation (19) is positive for all values of capital. This means that the risk-neutral equity-value maximizing bank shareholder will choose the maximum possible value of risk parameter ($\alpha^s = 1$) regardless of bank capitalization. One cannot demonstrate a relationship between bank's capitalization and its risk-taking behavior toward higher-risk higher-return investment alternative. The bank prefers a higher-risk higher-return asset in all events as far as the shareholder's objective is concerned.

4.2.5 Comparative Static Analysis: The Effect of Capital on α^s

The following proposition states how the shareholder changes α^s in response to the change in capital level. It is a direct application of Green and Talmor (1986)'s Proposition 1 into our model.

Proposition 4 *Suppose return properties are characterized by strict mean-variance ordering ($\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$). Then the shareholder monotonically decrease the risk of the bank ($\frac{d\alpha^s(K)}{dK} < 0$), as bank capitalization increases.*

proof. Totally differentiating the FOC gives,

$$\frac{d\alpha^s(K)}{dK} = -\frac{\frac{\partial^2 V}{\partial\alpha\partial K}}{\frac{\partial^2 V}{\partial\alpha^2}}.$$

Assuming that the SOC for an interior optimum is satisfied, the denominator on the right-hand side of (20) is negative. And the sign of the nominator is negative,

$$\frac{\partial^2 V(\alpha^s)}{\partial\alpha\partial K} = \int_c^b [\mu'(\alpha^s) + \sigma'(\alpha^s)x]f(x)dx$$
$$- (D+K)(\mu'(\alpha^s) + \sigma'(\alpha^s)\frac{r^f - \mu(\alpha^s)}{\sigma(\alpha^s)})f(c)\frac{1}{c}(\frac{-D_1}{(D+K)^2})$$
$$= \sigma'(\alpha^s)(\frac{\mu'(\alpha^s)}{\sigma'(\alpha^s)} + \frac{(r^f - \mu(\alpha^s)}{\sigma(\alpha^s)})\frac{r^f f(c)}{\sigma} < 0, \quad (21)$$

because I am assuming $\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$ and $r^f - \mu(\alpha) < 0$. Note that $\int_c^b [\mu'(\alpha^s) + \sigma'(\alpha^s)x]f(x)dx = 0$ from the first order condition. Combining these two factors gives a negative sign for Equation (20). ■

The result of the Proposition 4 has been well observed by several authors.[25] In a banking context, Furlong and Keeley (1989) and Keeley and Furlong (1990) argue that "a more stringent capital regulation does not increase the incentives for insured banks to increase asset risk." However, Proposition 4 must be interpreted with caution. It holds only under two conditions. First, that the shareholder's objective is concerned in determining optimal risk of the bank; and second that the risk-return profiles are characterized by strict mean-variance ordering($\mu' < 0$ and $\sigma' > 0$).

An intuition of Proposition 4 is that the shareholder of a poorly capitalized bank will prefer a riskier investment project than the shareholder of a well-capitalized bank.[26] Intuitively, poorly capitalized banks have little to lose by bankruptcy, so they want to maximize the option value of deposit insurance by gambling in riskier assets. On the other hand, the shareholder of a well-capitalized bank will prefer a less risky investment project, because he has more to lose in case of bankruptcy than the poorly capitalized

[25] See Furlong and Keeley (1989), Keeley and Furlong (1990), Gavish and Kalay (1983), and Green and Talmor (1986).

[26] This is consistent with Dewatripont and Tirole(1994 b)'s finding that very poorly capitalized banks gamble in risky investments: "Shareholders favor risk,..., their bias toward risk is stronger, the lower the bank's solvency" (pp. 145-147).

bank. The analysis suggests that capital regulation can serve as a major instrument to align the risk preference of the bank with that of the deposit insurer. By enforcing higher capital adequacy regulation, the deposit insurer can induce the bank to choose safer assets that carry a smaller probability of failure.

Even though the theoretical prediction of Proposition 4 is well established, there are two points that cast doubt on the validity of it. First, the banking literature provides only mixed evidence on the relationship between bank capitalization and asset risk. Most studies using market measure of risk (Demsetz and Strahan, 1997; Hannan and Hanweck, 1988; Keeley, 1990, among others) or using portfolio measure of risk (Berger, 1995, McManus and Rosen, 1991, among others) find a negative relationship between the two. The negative relationship in these studies is so prevalent that some authors call it an empirical regularity.

However, other empirical studies find little connection between capitalization and the incidence of bank failure. For example, Santomero and Vinso (1977) find that increased capital does not materially lower a bank's failure risk. Peek and Rosengren (1997) find that four-fifths of banks failing in New England during the 1980s and early 1990s were classified by examiners as "well capitalized" before they failed. Sheldon (1995, 1996B), based on the studies on banks in Switzerland and international banks, find that the level of the capital ratio and the probability of failure are positively correlated, implying that more highly capitalized banks are more likely to fail.

The second point that is contrary to the theoretical predictions of Proposition 4 is that it has been often believed by academics as well as practical bankers[27] that banks –

[27]For academic literature see Kahane (1977), Koehn and Santomero (1980), Kim and Santomero (1988). For opinions of bankers, for example, William McDonough, vice chairman of First National Bank of Chicago, concerning a Federal Reserve proposal to require banks to hold capital in connecting with interest rate and contracts, is quoted as saying that '...the proposal could lead banks to take

especially those banks that had to raise capital to meet higher capital standards – had shifted their portfolio structure from low-risk assets toward high-risk, high-return assets in order to compensate additional costs imposed by the more stringent capital standards. Regulatory authorities were also worried about this possibility. The introduction of a risk-related capital requirement – which was debated during 1980s and finally adopted in Basle Capital Accord in 1988 – was a regulatory reaction to cope with the possible adversary incentive problems caused by more stringent capital regulation. If the views of the bankers and regulators cannot be considered as totally flawed, then one need another theory regarding the relationship between asset risk and capitalization.

One of the reasons for the existing studies to fail to address the above two points is that they have focused only on the case of the mean preserving spread (case 2) or of the second order stochastic dominance (case 3). They do not consider the case where higher risk is associated with higher return (case 4). The other reason is that they do not consider the fact that the bank is operated by a manager who may have different interests than the shareholder. In other words, the existing studies have dealt with the conflicts between shareholder and debtholder (deposit insurer), but not the conflicts between shareholder and manager. The manager's objective model is introduced to show that a bank with larger capital may pursue higher-risk, higher-return assets, and thereby partially or even fully offset the strengthened buffer effect of capital.

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on riskier business to compensate for the lower returns they would almost assuredly get by having to maintain more capital.' (New York Times article on March 5 1987). (Recited from Furlong and Keeley, 1989, p. 883.) The studies by Furlong and Keeley (1989) and Keeley and Furlong (1990) were intended to argue against both these academics and bankers. Reinicke (1995, pp. 134-181) also discusses this issue.

4.3 Optimal Risk of the Manager

4.3.1 A Discussion on Managerial Incentives

After the seminal work by Jensen and Meckling (1976), the contractual view of the firm[28] has been established as a major theory of the firm, where the firm is treated as a nexus for a set of contracting relationships among individuals rather than as a personalized entity maximizing profits. The key feature of the new theory is that it incorporates the agency problem as an essential element. This raises the possibility that the manager's preferences over risky assets may be different from those of the shareholder.

The agency problem of the manager arises because the manager's objective is to maximize his private benefit rather than to take fiduciary duty for the shareholder or to respect the debtholder's (deposit insurer in this model) interests. As is indicated by Dewatripont and Tirole (1994 b), the manager's preferences toward risk can be complicated. The manager may be averse to risk in some circumstances and be risk seeking other times.[29]

In literature, the manager has been considered to be more risk-averse than the shareholder (for example, Amihud and Lev, 1981; Fama, 1980). The human capital of the manager translates primarily into the wage compensation, bonuses, stock options and perquisites which come from the employment with the firm. The risk associated with these benefits is not only closely related to the firm's risk but also firm specific and undiversifiable. Hence the manager behaves in a much more risk averse fashion to protect his human capital than the shareholder in choosing risky projects.

[28] The contractual view of the firm traces back to Coase (1937), was established by Jensen and Meckling (1976) and was further developed by Fama and Jensen (1983a,b)

[29] Gorton and Rosen (1995) also differentiate two types of managers: good and bad managers. While good managers choose safe loans and behave too conservatively, bad managers take excessively risky loans.

However, as Dewatripont and Tirole (1994 b) indicate, the manager may have several reasons to favor increasing asset risk. The manager who values a low-pressure job of selecting loans will devote less efforts to credit analysis and thereby increase the likelihood of selecting bad loans. Or, it is possible that the manager's human capital grows faster when there are more complex assets involved. Obviously, riskier assets in general require a better quality of management. The management of commercial loans or financial derivatives demands more attention than the purchase of Treasury bonds. Another source of risk-seeking is the manager's inclination toward growth (Jensen, 1986). Since wage compensation, promotion and perquisites are related to growth of the firm, a manager would like to invest in a very risky project which has negative net present value rather than leave it uninvested.

Let $B = B(\alpha)$ denote managerial private interests and assume it is a function of the risk parameter. Considering the above discussion, it is difficult to define a priori the specific functional form of $B(\alpha)$. It can be a monotonic decreasing function of $\alpha (B'(\alpha) < 0)$ if the manager is averse to risk, it can be a monotonic increasing function of $\alpha (B'(\alpha) > 0)$ if he is risk seeking. Alternatively it can also be a non-monotonic function of α, for example, showing risk-seeking for low or moderate level of α and risk-averse for high level of α.

4.3.2 A Model of Managerial Objective

To focus on the effect of capitalization on asset risk under the presence of managerial incentives to pursue private benefits, I abstract the normative theory of optimal contracts between the shareholder and the manager, and of the optimal regulatory constraints imposed by the regulatory authorities (including deposit insurer). Specifically, I assume that the monetary equivalent of the managerial private benefit is so small compared to the amount of the investment asset ($K + D$) that the distribution of final outcomes between economic agents does not matter. Moreover, the manager's choice of risk parameter (α) is private information to the manager and managerial consumption of this private benefit is observed also only by the manager. Otherwise other economic agents can deduct the value of the choice of α from the observed value of private benefit, $B(\alpha)$. The final outcomes from the investment assets are observable to all parties but assumed to be nonverifiable.[30] Therefore both the manager's action (choice of α) and the outcomes from the action are not contractible. The only way that the shareholder or regulators discipline the manager is to fire the manager when the outcomes are unsatisfactory. For simplicity, I assume that they can fire the manager only if the bank bankrupts.

Following Jensen and Meckling (1976) and Williams (1987), I assume that the manager consumes all the private benefits after observing the outcome from the current investments. This specification differs from the usual principal-agent models, in which agents act privately for personal gain before observing their firm's final outcomes. In this setting, the manager considers a trade-off in choosing the optimal asset risk between the increase in private benefits and the probability of loosing them due to bankruptcy.

One problem in applying the basic model developed in Section 3 is that the support of the distribution for the LS family changes with α. This is a crucial problem when agency problem is introduced. If the supports of the two distributions are different, then

[30] There are two different definitions on the nonverifiability of cash flows in literature. The first one, costly state verification (Glae and Hellwig, 1982; Townsend, 1979 and others), assumes that profits are completely unobservable unless a verification cost is paid. The other stream, represented by such authors as Hart and Moore (1989, 1994, 1995), Bolton and Scharfstein (1990), and Fluck (1998), assumes that profits are observable but not verifiable to outsiders and courts. The resulting optimal contracts are very similar for the two approaches.

the agency problem can be solved costlessly through forcing contracts. However, under the assumption that the outcomes from the investment are nonverifiable, the changing support is not a problem. An alternative way to avoid this problem is to assume a return distribution that has full support regardless of α. For example, the normal distribution has support from $-\infty$ to $+\infty$, and thus is not suffered from the problem of changing support. By one way or another, I assume that the changing support is not a problem in the analysis. Thus I continue to use the same notations for the analysis of managerial incentives in determining optimal risk.

4.3.3 Manager's Choice of Asset Risk

The manager's maximization problem is to choose the optimal risk, α^m, to maximize the expected value of the private benefit of control;

$$\max_{\alpha} E(B) = \int_{c}^{b} B(\alpha) f(x) dx = B(\alpha)[1 - F(c)] \tag{22}$$

where $c = \frac{r^f - \mu(\alpha)}{\sigma(\alpha)}$. The expected value of the private benefit is the amount of the private benefit multiplied by the probability of solvency. Applying Leibnitz's rule yields the first order condition (FOC);

$$\begin{aligned} E(B)_{\alpha} = \frac{\partial E(B)}{\partial \alpha} &= \int_{c}^{b} B'(\alpha) f(x) dx - B(\alpha) f(c) [\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2}] \\ &= B'(\alpha)[1 - F(c)] - B(\alpha) f(c) [\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2}]. \end{aligned} \tag{23}$$

Consider the following two specifications for managerial private benefits:

(1) Private benefit is a non-increasing function of risk($B'(\alpha) \leq 0$)

If the private benefit is a non-increasing function of α ($B'(\alpha) \leq 0$), the sign of the

FOC will be negative in general. When the return distribution is characterized by the first three cases ($\mu'(\alpha) \leq 0$ and $\sigma'(\alpha) \geq 0$), it is immediately obvious that the sign of the FOC is negative. For the last case ($\mu'(\alpha) > 0$, $\sigma'(\alpha) > 0$, $\mu'\sigma - \sigma'\mu < 0$), it is negative if $r^f < \mu(\alpha^m)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma}), \forall \alpha^m \in [0, 1]$. In other words, a manager who does not benefit from an increase in risk is generally expected to choose the lowest level of risk ($\alpha^m = 0$).

(2) Private benefit is an increasing function of risk($B'(\alpha) > 0$)

Assuming the second order condition (see Appendix 3) is satisfied, an interior solution ($\alpha^m \in (0, 1)$) will exist if the second term of the right hand side of the equation (23) is positive. One may note that the sign of the second term is positive in the usual cases: (i) $\mu'(\alpha) \leq 0$ and $\sigma'(\alpha) \geq 0$, or (ii) $\mu'(\alpha) > 0$, $\sigma'(\alpha) > 0$, $\mu'\sigma - \sigma'\mu < 0$ and $r^f < \mu(\alpha^m)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$.

The optimal level of asset risk is determined by $E(B)_\alpha = 0$. The FOC shows the trade-off that the manager considers in choosing the asset risk. The manager can increase his private benefit by choosing a higher value of α. But it comes at a cost. By increasing asset risk, the manager also increases the probability of failure, which lowers the expected value of the private benefit.

(3) Comparative Static Analysis: The Effect of Capital on α^m.

The following proposition states how the manager's optimal risk (α^m) changes in response to a change in capital level.

Proposition 5 *Suppose the following assumptions hold.*

(a) The managerial private benefit increases with $\alpha(B'(\alpha) > 0)$;

(b) the mean and variance of the return satisfy either

(i) $\mu'(\alpha) \leq 0$ *and* $\sigma'(\alpha) \geq 0$, *or*

(ii) $\mu'(\alpha) > 0$, $\sigma'(\alpha) > 0$, $\mu'\sigma - \sigma'\mu < 0$, *and* $r^f < \mu(\alpha^m)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$;

(c) $f'(c) < 0$; *and*

(d) $\epsilon_B > \epsilon_\sigma$, *where* $\epsilon_B = \frac{B'(\alpha)\alpha}{B(\alpha)}$ *and* $\epsilon_\sigma = \frac{\sigma'(\alpha)\alpha}{\sigma(\alpha)}$.

Then the manager increases the optimal asset risk in response to the marginal increase of bank capital ($\frac{d\alpha^m(K)}{dK} > 0$*).*

proof. Totally differentiating the FOC gives,

$$\frac{d\alpha^m(K)}{dK} = -\frac{\frac{\partial^2 E(B)}{\partial\alpha\partial K}}{\frac{\partial^2 E(B)}{\partial\alpha^2}} \tag{24}$$

Assuming that the SOC for an interior optimum is satisfied, the denominator on RHS of (24) is negative. Thus the sign of (24) is determined by the sign of the nominator.

$$\begin{aligned}\frac{\partial^2 E(B)}{\partial\alpha\partial K} &= -B'(\alpha^m)f(c)\frac{1}{\sigma}(\frac{-D_1}{(D+K)^2}) \\ &- B(\alpha^m)f'(c)[\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2}]\frac{1}{\sigma}(\frac{-D_1}{(D+K)^2}) - B(\alpha^m)f(c)[\frac{-\sigma'}{\sigma^2}][\frac{-D_1}{(D+K)^2}] \\ &= \frac{1}{\sigma}(\frac{D_1}{(D+K)^2})[B'(\alpha^m)f(c) + B(\alpha^m)f'(c)[\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2}] - \frac{\sigma'}{\sigma}B(\alpha^m)f(c)] \\ &= \frac{1}{\sigma}(\frac{D_1}{(D+K)^2})[B(\alpha^m)f'(c)[\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2}] + B'(\alpha^m)f(c)(1 - \frac{\epsilon_\sigma}{\epsilon_B})]\end{aligned} \tag{25}$$

Since I am assuming $f'(c) > 0, -\mu'\sigma - \sigma'(r^f - \mu) > 0, B'(\alpha)$, and $\epsilon_B > \epsilon_\sigma$, the sign of the expression is positive. Therefore, the sign of equation (24) is positive. ■

It may be difficult to directly relate the result of the Proposition 5 into real world predictions, because it crucially depends on several strong assumptions. The sign of $f'(c)$ depends on the shape of the PDF of the random variable X. The sign is more likely to be positive if the PDF is bell shaped, unimodal, not extremely negatively skewed (skewed to the left). It has been widely accepted in modern portfolio theory that even if individual asset returns are not exactly normal, the distribution of returns of a large portfolio will resemble a normal distribution quite closely.[31] Therefore, if the set of alternative risky assets the manager considers is composed of diversified portfolios rather than individual investment project, then it is very likely that the sign of $f'(c)$ is positive. For a normal distribution, it always holds that $f'(c) > 0$, because $c = \frac{r^f - \mu(\alpha)}{\sigma(\alpha)}$.

Note also that assumption $\epsilon_B > \epsilon_\sigma$ is a sufficient condition for the result $\frac{d\alpha^*(K)}{dK} > 0$ to hold. Therefore the result may still hold even if the assumption $\epsilon_B > \epsilon_\sigma$ does not hold. Nonetheless it seems reasonable to assume $\epsilon_B > \epsilon_\sigma$ for Proposition 5. It requires that the elasticity of the private benefit with respect to α is greater than the elasticity of asset risk with respect to α. Intuitively, if the increase in asset risk caused by a marginal increase in α, ϵ_σ, is very large, then the resulting increase in the probability of failure will also be large (Recall that $\frac{\partial P(K,\alpha)}{\partial \alpha} = f(c)[\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2}] \gg 0$ if $\sigma' \gg 0$). Therefore the manager who has a trade-off between increasing his private benefit and the probability of failure would find it not optimal for him to increase the risk parameter α in response to an increase in bank capital.

Proposition 5 provides the grounds for the argument that more capitalized bank in fact may engage in higher-risk higher-return investment projects and thus have higher probability of failure. This finding was obtained by combining the managerial incentive to pursue private benefits and the risk characteristics representing higher-risk higher-return assets. However, since the maintenance of Proposition 5 depends on several parametric assumptions, the validity of it remains to be tested in an empirical study.

[31]The normality assumption is a little strong assumption for bank asset portfolio, where the asset portfolio is in large part composed of loans. Bank loan returns are not normally distributed due to the upper limit on loan prices that occurs when interest rates are zero. It is known that bank loan returns are negatively skewed.

4.4 A Complete Model of Risk Determination

I have discussed three differing incentives of three agents regarding the risk determination of a bank. Since all three agents are involved in affecting the choice of asset risk, it is necessary to develop a complete model of risk determination that encompass the differing incentives of the three agents. The specific process of risk determination of each bank will be different depending on the corporate governance mechanism which coordinate the differing incentives.

In this paper, it is assumed that the three differing incentives are captured by a single objective function ($U(\alpha)$) of a bank that is given by as a weighted average of the value of bank equity $V(\alpha)$, managerial private benefit $E(B(\alpha))$, and regulatory restraints $OV(\alpha)$. Specifically, suppose that the choice of α can be considered as the solution to the following maximization problem;

$$\max_{\alpha} U(\alpha) = \omega V(\alpha) + \beta E(B(\alpha)) - \rho OV(\alpha) \tag{26}$$

where ω is the relative weight placed on the value of bank equity, β is the relative weight placed on managerial private benefit, and ρ is the relative weight placed on regulatory restraints. The regulatory restraints are captured here by the option value of deposit insurance. Since the option value is the expected loss of deposit insurance fund in case of bankruptcy, it seems reasonable to assume that the regulator imposes regulatory restraints according to the option value. The regulatory restraints are not enjoyed by the bank, and thus expressed as a negative value. For the following analysis, the parameters ω, β, ρ are all assumed to be strictly positive.

The parameters ω, β, ρ are assumed to be functions of various corporate governance mechanisms such as managerial ownership share (Morck, Shleifer and Vishny, 1988), monitoring by board of directors (Adams, 2001; Adams and Mehran, 2002), monitoring by large shareholders (Shleifer and Vishny, 1986), control challenge by dispersed shareholders (Fluck, 1999), the managerial labor market (Fama, 1980), the threat of a takeover (Jensen and Ruback, 1983; Scharfstein, 1988), and general regulatory policies (Park, 1997). For example, ω is an increasing function of managerial ownership share, and β is a decreasing function of monitoring and takeover threat. The parameter ρ may differ depending on bank capitalization. Banks with low capital are likely to be subject to close supervisory surveillance from the bank regulator, because low capital may indicate poor performance or higher default risk.

The parameters ω and ρ capture the agency problem of the shareholder associated with deposit insurance subsidy, and the parameter β captures the agency problem of the manager. These agency problems will disappear when the value of weights are given by $\omega = \rho$ and $\beta = 0$. This is the case when the deposit insurance is fairly priced and the manages' incentives are perfectly aligned with those of the shareholders'. I consider the optimal risk that will be achieved in this case as the socially optimal risk. Formally I define as follows.

Definition 2 *The socially optimal level of risk is defined as the one that will be obtained when there do not exist agency problems. Specifically, it is the risk level that maximizes the expected value of the bank asset, which is* $(D+K)\mu(\alpha)$.

According to the definition, the socially optimal asset risk is simply the one that gives the highest level of mean return. For example, it is zero if $\mu'(\alpha) < 0$ and one if $\mu'(\alpha) > 0$. It will be any $\alpha \in [0,1]$ if $\mu'(\alpha) = 0$. (See Table 1.)

Assuming that the SOC for an interior optimum is satisfied, the optimal asset risk of the bank (α^*) is implicitly given by the FOC;

$$U_\alpha = \omega V_\alpha + \beta E(B)_\alpha - \rho O V_\alpha = 0 \tag{27}$$

where subscript α denotes the first derivative of the objective function with respect to α. All the functions are evaluated at the optimal level of risk, α^*. For notational simplicity, the asterisk $*$ is omitted in the subscript α. The SOC is given by

$$U_{\alpha\alpha} = \omega V_{\alpha\alpha} + \beta E(B)_{\alpha\alpha} - \rho O V_{\alpha\alpha} < 0. \tag{28}$$

The SOC is a complicated function of various parameters, and is not easy to verify. For further analysis, I simply assume that the SOC is satisfied. One may note that the SOC is automatically satisfied if all the SOCs for the individual agent's maximization problem are satisfied. I denote α^* as the optimal risk of the bank, α^d as the optimal risk of the deposit insurer, α^s as optimal risk of the shareholder, and α^m as the optimal risk of the manager.

4.4.1 Comparison of Optimal Asset Risk

Table 1 provides the summary of optimal asset risks of individual economic agents as well as the joint outcome. Several points are immediately obvious from the table. First, since the objective function of the bank is a linear combination of the objective functions of individual agents, the optimal risk of the bank (α^*) must also be a linear combination of the optimal risks of individual agents (α^d, α^s and α^m). The table shows that, except for the case of FSD, the optimal risk of the bank is smaller than the optimal risk of the shareholder (α^s). In fact, in most cases, it is the shareholder who wants the highest level of risk among the three agents. The shareholder who benefits from the risk shifting associated with the deposit insurance subsidy has an incentive to increase the risk level above the level that is optimal from the standpoint of the bank.

Second, the manager is generally more conservative in determining asset risk than the shareholder. This is the case even when the manager's private benefit is assumed to increase with asset risk, as is shown in the table, cases 2 and 4. This finding is quite consistent with the findings of other studies such as Hirshleifer and Thakor (1992),[32] Holstrom and Ricart I Costa (1986)[33] and Gorton and Rosen (1995)[34] who find excessive managerial conservatism in different contexts. The reason of the managerial conservatism in our model is that the manager stands to lose his private benefit of control in case of bankruptcy.

Third, it is shown in Table 1 that the deposit insurer prefers the least risky asset among economic agents. In fact, in case 4, the optimal risk for the deposit insurer is lower than the socially optimal risk (i.e. the risk level that will be obtained when there do not exist agency problems). This suggests that there may exist potential conflicts among regulatory agencies.[35] As is shown in case 2 and 4, while the deposit insurer (FDIC) maintains the most conservative asset risk policy, other bank regulators who stand from the viewpoint of social planner are less conservative in evaluating optimal risk. The reason of this is that while the FDIC is primarily interested in minimizing the

[32]They show that in an unlevered firm, ceteris paribus, managerial reputation building can cause excessive conservatism in investment policy relative to the shareholders' optimum despite universal risk neutrality and costless bankruptcy.

[33]They show that in the absence of an explicit contract, a risk-averse manager may not undertake any investments because the returns from reputation with investment is a mean preserving spread of the returns from reputation with no investment. The manager will be reluctant to take actions which are informative about his ability and thereby expose him to risk.

[34]In their model, the risk averse manager shows excessively safe behavior, who stands to lose invested wealth, firm-specific human capital, and the benefits associated with control in the event of bankruptcy.

[35]In U.S., there are three federal regulatory agencies together with state regulators. The three federal agencies are Federal Reserve Bank (FRB), Office of the Comptroller of the Currency (OCC), and the Federal Deposit Insurance Corporation (FDIC). Although the underlying philosophy of the three bank regulatory agencies toward bank regulation is fundamentally the same, there have been differences in actual policies and practices. These differences are largely attributable to variations in the main functions of the agencies.

	Case 1: $\mu' < 0, \sigma' = 0$ (FSD)	Case 2: $\mu' = 0, \sigma' > 0$ (MPS)	Case 3: $\mu' < 0, \sigma' > 0$ (SSD)	Case 4: $\mu' > 0, \sigma' > 0$ $\mu'\sigma - \sigma'\mu < 0$
Deposit Insurer	$\alpha^d = 0$	$\alpha^d = 0$	$\alpha^d = 0$	$\alpha^d \in [0, 1]$
Shareholder	$\alpha^s = 0$	$\alpha^s = 1$	$\alpha^s \in [0, 1]$	$\alpha^s = 1$
Manager ($B'(\alpha) \leq 0$)	$\alpha^m = 0$	$\alpha^m = 0$	$\alpha^m = 0$	$\alpha^m = 0$
Manager ($B'(\alpha) > 0$)	$\alpha^m \in [0, 1]$	$\alpha^m \in [0, 1]$	$\alpha^m \in [0, 1]$	$\alpha^m \in [0, 1]$
The bank ($B'(\alpha) \leq 0$)	$\alpha^* = 0$	$0 \leq \alpha^* \leq 1$	$0 \leq \alpha^* \leq \alpha^s$	$0 \leq \alpha^* \leq 1$
The bank ($B'(\alpha) > 0$)	$0 \leq \alpha^* \leq \alpha^m$	$0 \leq \alpha^* \leq 1$	$0 \leq \alpha^* \leq$ $max[\alpha^s, \alpha^m]$	$min[\alpha^d, \alpha^m]$ $\leq \alpha^* \leq 1$
Socially optimal risk	0	Any $\alpha \in [0, 1]$	0	1

Table 1: Comparison of Optimal Asset Risk

risk of loss to the deposit insurance fund, the other federal agency, for example the OCC, is inclined to place emphasis on individual banks when setting regulatory constraints, with an eye toward maintaining competitive, viable banking institutions.[36]

4.4.2 Comparative Static Analysis: The Effect of ω on α^*

Using the FOC and SOC, the following propositions provide general comparative static statements concerning the optimal asset risk.

[36]Orgler and Wolkowits(1976) give a discussion on regulatory focuses and jurisdiction of three federal agencies (pp. 65-66).

Proposition 6 *(1) The optimal asset risk of the bank (α^*) increases with the weight placed on the value of bank equity ($d\alpha^*/d\omega > 0$) if one of the following conditions holds;*

(a) $\mu' = 0, \sigma' > 0$ *(MPS);*

(b) $\mu' > 0, \sigma' > 0$ *and* $\mu'\sigma - \sigma'\mu < 0$*;*

(c) $\mu' < 0, \sigma' > 0$ *(SSD) and* $B'(\alpha) \leq 0$*;*

(d) $\mu' < 0, \sigma' > 0$ *(SSD),* $B'(\alpha) > 0$ *and* $\alpha^* < \alpha^s$*;*

(2) The optimal asset risk of the bank (α^*) decreases with the weight placed on the value of bank equity($d\alpha^*/d\omega < 0$) if one of the following conditions holds;

(e) $\mu' < 0, \sigma' = 0$ *(FSD) and* $B'(\alpha) > 0$

(f) $\mu' < 0, \sigma' > 0$ *(SSD),* $B'(\alpha) > 0$ *and* $\alpha^* > \alpha^s$*;*

proof. Totally differentiating the FOC gives;

$$V_\alpha d\omega + \omega V_{\alpha\alpha} d\alpha + E(B)_\alpha d\beta + \beta E(B)_{\alpha\alpha} d\alpha - OV_\alpha d\rho - \rho OV_{\alpha\alpha} d\alpha = 0$$

Rearranging and setting $d\beta = d\rho = 0$ gives,

$$\frac{d\alpha^*}{d\omega} = -\frac{V_\alpha}{\omega V_{\alpha\alpha} + \beta E(B)_{\alpha\alpha} - \rho OV_{\alpha\alpha}}$$

where V_α is given by

$$V_\alpha = (D + K) \int_c^b [\mu'(\alpha) + \sigma'(\alpha)x] f(x) dx$$

Assuming the SOC is satisfied, the sign of $d\alpha^*/d\omega$ depends on the sign of V_α.

i) Condition (a) or (b): It is obvious that $V_\alpha > 0$ under these two conditions.

ii) Condition (c) or (d): Assume $V_{\alpha\alpha} < 0$ (SOC for the maximization problem of the shareholder), then $V(\alpha)$ achieves its maximum at $V_\alpha(\alpha^s) = 0$. Under one of these two conditions, it holds that $\alpha^* < \alpha^s$. It follows that $V_\alpha > 0$.

iii) Condition (e): The sign of V_α is negative under FSD.

iv) Condition (f): $V(\alpha)$ achieves its maximum at $V_\alpha(\alpha^s) = 0$. Under this condition, it holds that $\alpha^* > \alpha^s$. It follows that $V_\alpha < 0$. ■

Proposition 6 specifies the conditions for the asset risk to increase or decrease with the relative weight placed on the value of bank equity. As discussed in sub-section 3.2, Condition (e) is an improper risk-ordering concept for bank's risk-taking behavior. Therefore, unless Condition (f) characterizes the process of risk determination of a bank, the optimal risk of the bank is generally expected to increase with the weight placed on the value of bank equity. Under Conditions (a) to (d), the optimal risk of the bank (α^*) is smaller than the optimal risk of the shareholder (α^s). Therefore, under these conditions, α^* is expected to increase toward α^s as more weight is placed on the shareholder's interests in constructing the objective function of the bank.

One possible interpretation of ω is managerial ownership share. According to the convergence-of-interest hypothesis, the managers' incentives will be the more likely to be aligned to those of the shareholders as their ownership stake increases (Morck, Shleifer and Vishny, 1988). A testing implication that follows is that the bank's asset risk increases with the managerial ownership share ($V_\alpha > 0$), if one of the Conditions (a) to (d) in Proposition 6 appropriately characterizes the risk-return profiles of a bank. I expect these conditions generally hold for most of the banks.

4.4.3 Comparative Statistic Analysis: The Effect of Capital on α^*

Proposition 7 *(1) Suppose the effect of the weight placed on the value of bank equity is dominant and the effects of the weights placed on the managerial private benefit and the* *option value are very small in the bank's objective function. The optimal asset risk of the bank (α^*) increases with capital if $V_{\alpha K} > 0$, and decreases with capital if $V_{\alpha K} < 0$. The sign of $V_{\alpha K}$ is indeterminate under Conditions (a) to (e) of Proposition 6, and negative under Condition (f).*

(2) Suppose the effect of β is dominant and the effects of ω and ρ are very small in the bank's objective function. The optimal asset risk of the bank (α^*) increases with K if $E(B)_{\alpha K} > 0$, and decreases with K if $E(B)_{\alpha K} < 0$. The sign of $E(B)_{\alpha K}$ is positive under the conditions listed in Proposition 5, and indeterminate if $B'(\alpha) < 0$.

(3) Suppose the effect of ρ is dominant and the effects of ω and β are very small in the bank's objective function. The optimal asset risk of the bank (α^*) increases with K if $OV_{\alpha K} < 0$, and decreases with K if $OV_{\alpha K} > 0$. The sign of $OV_{\alpha K}$ is indeterminate under Assumptions 1 and 2.

proof. Totally differentiating the FOC with respect to α and K gives;

$$\omega V_{\alpha K} dK + \omega V_{\alpha\alpha} d\alpha + \beta E(B)_{\alpha K} dK + \beta E(B)_{\alpha\alpha} d\alpha - \rho OV_{\alpha K} dK - \rho OV_{\alpha\alpha} d\alpha = 0$$

Rearranging gives,

$$\frac{d\alpha^*}{dK} = -\frac{\omega V_{\alpha K} + \beta E(B)_{\alpha K} - \rho OV_{\alpha K}}{\omega V_{\alpha\alpha} + \beta E(B)_{\alpha\alpha} - \rho OV_{\alpha\alpha}}$$

(1) The SOC implies that the sign of the denominator is negative. Thus, if β and ρ are assumed to be very small, the sign of $\frac{d\alpha^*}{dK}$ depends on the sign of $V_{\alpha K}$. From the proof of Proposition 4, it is shown that

$$V_{\alpha K} = \int_c^b [\mu'(\alpha) + \sigma'(\alpha)x] f(x) dx + (\mu'(\alpha) + \sigma'(\alpha)\frac{r^f - \mu(\alpha)}{\sigma(\alpha)})\frac{r^f f(c)}{\sigma}.$$

The sign of the second term of the right hand side (RHS) is negative in all cases. The sign of the first term of RHS is positive under Conditions (a) to (e), and negative under

Condition (f). Therefore the sign of $V_{\alpha K}$ is indeterminate under Conditions (a) to (e), and negative under Condition (f).

(2) If ω and β are assumed to be very small, the sign of $\frac{d\alpha^*}{dK}$ depends on the sign of $E(B)_{\alpha K}$. From the proof of Proposition 5, it is shown that

$$E(B)_{\alpha K} = \frac{1}{\sigma}(\frac{D_1}{(D+K)^2})[B(\alpha)f'(c)[\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2}] + B'(\alpha)f(c)(1 - \frac{\epsilon_\sigma}{\epsilon_B})].$$

The sign of $E(B)_{\alpha K}$ is positive if $f'(c) > 0, , -\mu'\sigma - \sigma'(r^f - \mu) > 0, B'(\alpha) > 0$ and $\epsilon_\sigma > \epsilon_B$. It is indeterminate if $B'(\alpha) < 0$.

(3) If ω and ρ are assumed to be very small, the sign of $\frac{d\alpha^*}{dK}$ depends on the sign of $OV_{\alpha K}$. In the proof of Proposition 3, it is shown that

$$OV_{\alpha K} = -\int_a^c [\mu'(\alpha) + \sigma'(\alpha)x]f(x)dx - (\mu'(\alpha) + \sigma'(\alpha)\frac{r^f - \mu(\alpha)}{\sigma(\alpha)})\frac{r^f f(c)}{\sigma}$$

The sign of the second term of the right hand side (RHS) is negative in all cases. The sign of the first term of the RHS is positive if $\mu'(\alpha) \leq 0$ and $\sigma'(\alpha) \geq 0$. It is indeterminate if $\mu'(\alpha) > 0, \sigma'(\alpha) > 0$ and $r^f < \mu(\alpha^m)(1 - \frac{\epsilon_\mu}{\epsilon_\sigma})$. Thus the sign of $OV_{\alpha K}$ is indeterminate under Assumptions 1 and 2. ■

The terms V_α and $E(B)_\alpha$ can be interpreted as marginal gains to the agents from an increase in α. Proposition 7-1 and 7-2 say that when the marginal gains increase with capital ($V_{\alpha K} > 0, E(B)_{\alpha K} > 0$), the bank is likely to increase optimal risk in response to an increase in capital. This argument is quite interesting because it is contrary to the prediction made by Proposition 4 which maintains that more capital does not induce the bank to choose riskier assets as far as the shareholder's incentives are concerned. In fact, the prediction of Proposition 4 can be applied only under certain conditions - $\mu' < 0, \sigma' > 0$ (SSD), $B'(\alpha) > 0$ and $\alpha^* > \alpha^s$- and cannot be generalized to other cases.

The term OV_α can be interpreted as the marginal increment in regulatory restraints from an increase in α. Proposition 7-3 implies that the bank is likely to increase (decrease) optimal risk in response to an increase in capital if the marginal increment in regulatory constraints decreases (increases) with capital. The sign of $OV_{\alpha K}$ cannot be determined in our model. The most likely scenario, however, is that $OV_{\alpha K}$ takes a negative sign. Recognizing more capital increases bank safety, the bank regulator will be willing to take more forbearing regulatory policies toward risk for banks with more capital than for banks with less capital.

Proposition 7 is neither exhaustive nor conclusive in specifying the conditions that are necessary to determine the sign of the effect of capital on bank's optimal risk. It only states that the effect of capital on bank's risk can be either negative or positive depending on the relative forces of various factors. However, it is enough to shed a new light in solving two puzzles regarding the relationship between bank's risk taking behavior and capitalization.

First, the theory provides a model of bank's risk determination which is consistent with the mixed evidence documented in banking literature regarding the relationship between capitalization and asset risk. The mixed evidence suggests that the predictions of the existing theoretical works are incomplete. The mixed evidence, however, is consistent with the model. Since the relative forces of various factors can be different from bank to bank, it seems reasonable to expect mixed evidence depending on the sample adopted in the empirical study.

Second, Proposition 7 provides the grounds for the argument that a more capitalized bank in fact may engage in higher-risk higher-return investment project, and thus have higher probability of failure. This finding was obtained by constructing a complete model of risk determination where not only the shareholder's moral hazard but also the manager's moral hazard problem are introduced. This situation could happen when higher-risk higher-return ($\mu' > 0, \sigma' > 0$) characteristics are combined with $V_{\alpha K} > 0$ or $E(B)_{\alpha K} > 0$. This finding is interesting because it does not rely on risk averse agents (Kim and Santomero, 1988; Koehn and Santomero, 1980), or complicated loan cost functions (Gennote and Pyle, 1990), nor regulatory constraints per se (Park, 1997).

A testable implication of Proposition 7-1 and 7-2 is that the relation between asset risk and capitalization will be different depending on the managerial ownership share (ω). If managerial ownership share is small, then managerial incentives will dominate in the process of risk determination. If, on the other hand, managerial ownership share is very large, then the shareholder's incentives dominate in the process of risk determination. I also expect that the marginal gains are affected differently by the increase of capital. Both $V_{\alpha K}$ and $E(B)_{\alpha K}$ can take either negative or positive sign. For example, suppose $V_{\alpha K} > 0$ and $E(B)_{\alpha K} < 0$. In this case, I expect a negative relationship between capitalization and risk when managerial ownership share is small, and a positive relationship when managerial ownership share is large.

Proposition 7-3 also provides a testable implication. I expect the relative weight placed on regulatory restraints, ρ, be larger for banks with low capital than those with high capital. The regulatory authorities will impose stricter regulatory constraints for banks with capitalization below the regulatory minimums. This suggests a possible difference in risk-capitalization relationship between high- and low- capital banks. For banks with low capital, I generally expect that bank risk decreases as capital decreases.

5 Conclusion

This paper provides a theoretical framework to investigate the relationship between banks' capitalization and risk–taking behavior. The conventional wisdom is that relatively well–capitalized banks are less inclined to increase asset risk, because the option value of deposit insurance decreases as the capital to asset ratio increases. There are, however, at least three shortcomings in the existing theories that cast doubt on the validity of the conventional wisdom: (1) Existing studies have neglected the agency problem arising from the separation of management and ownership. (2) Past studies do not consider risk–return profiles in which higher risk is associated with higher return. (3) Empirical studies on this issue provide only mixed evidence.

The aim of this paper is to shed new light on this issue by incorporating into a single model the three different incentives of three agents — the bank regulator, the shareholder, and the manager — regarding the risk level of a bank. Moreover, four distinct assumptions on the characteristics of risk–return profiles are considered. By combining these two factors, the model demonstrates that banks' risk can either decrease or increase with capitalization depending on the relative forces of the three agents in determining asset risk and on various parametric assumptions about risk–return profiles.

Specifically, the major findings of the paper can be summarized as follows. First, it is shown that the differing incentives of three agents result in differing optimal risk by each agent. The deposit insurer who is interested in protecting the deposit insurance fund has the most conservative policy toward risk–taking. The shareholder who benefits from the risk shifting associated with the deposit insurance subsidy has an incentive to increase the risk level beyond the level which is optimal from the standpoint of bank.

The manager who stands to lose his private benefit of control in case of bankruptcy is generally more conservative in determining asset risk than the shareholder. This finding is quite consistent with the findings of other studies that find excessive managerial conservatism in different contexts.

Second, it is shown that a bank's risk can be either negatively or positively related to capitalization depending on the relative forces of the three agents in determining asset risk. The two variables considered in this paper to identify the relative forces of the three agents are the capital–to–asset ratio and managerial ownership. It is presumed that regulatory concerns are dominant factors in determining asset risk for banks with low capital, because these banks are likely to be subject to close supervisory surveillance from the bank regulator. Assuming that bank regulators will impose stricter regulatory policies concerning risk for banks with less capital ($OV_{\alpha K} < 0$), it is predicted that bank risk is positively related with capitalization for banks with low levels of capital.

Based on the convergence–of–interests hypothesis, managerial ownership is used as the variable to differentiate the managerial incentives from the shareholder's incentives. Accordingly, it is presumed that managerial incentives will dominate in the process of risk determination for banks with low managerial ownership, and that shareholder's incentives will dominate for banks with high managerial ownership. However, the theoretical model does not provide a deterministic prediction whether the risk is positively or negatively related with capitalization, because the marginal gains to the agents from an increase in α can either increase or decrease with capital depending on various parametric assumptions.

APPENDIX

1 The Second Order Condition (SOC) for the Deposit Insurer's Problem

$$\begin{aligned}
\frac{\partial^2 OV(\alpha^d)}{\partial \alpha^2} &= -\int_a^c [D+K][\mu''(\alpha^d) + \sigma''(\alpha^d)x]f(x)dx \\
&- (D+K)(\mu'(\alpha^d) + \sigma'(\alpha^d)\frac{r^f - \mu}{\sigma})f(c)\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2} \\
&= -(D+K)[\mu''(\alpha^d)F(c) + \sigma''(\alpha^d)\int_a^c xf(x)dx] \\
&+ (D+K)f(c)\frac{((\mu'(\alpha^d)\sigma(\alpha^d) + \sigma'(\alpha^d)(r^f - \mu(\alpha^d)))^2}{\sigma^3(\alpha^d)} \qquad \text{(A.1)}
\end{aligned}$$

The signs of $\mu''(\alpha^d)$ and of $\sigma''(\alpha^d)$ can be either negative or positive, as they depend on the specific trade-off between μ and σ exhibited by the bank's investment opportunity set (Green and Talmor, 1986). Note that the second order condition is trivially satisfied if $\mu''(\alpha^d) < 0$ and $\sigma''(\alpha^d) > 0$. The last conditions imply that the mean return increases at a decreasing rate and the standard deviation increases at an increasing rate with α.

2 The Second Order Condition (SOC) for the Shareholder's Problem

$$\begin{aligned}
\frac{\partial^2 V(\alpha^s)}{\partial \alpha^2} &= \int_c^b [D+K][\mu''(\alpha^s) + \sigma''(\alpha^s)x]f(x)dx \\
&- (D+K)(\mu'(\alpha^s) + \sigma'(\alpha^s)\frac{r^f - \mu}{\sigma})f(c)\frac{-\mu'\sigma - \sigma'(r^f - \mu)}{\sigma^2} \\
&= (D+K)[\mu''(\alpha^s)[1 - F(c)] + \sigma''(\alpha^s)\int_c^b xf(x)dx] \\
&+ (D+K)f(c)\frac{((\mu'(\alpha^s)\sigma(\alpha^s) + \sigma'(\alpha^s)(r^f - \mu(\alpha^s)))^2}{\sigma^3(\alpha^s)} \qquad \text{(A.2)}
\end{aligned}$$

The condition imposes a restriction that at least one of the signs of $\mu''(\alpha^s)$and $\sigma''(\alpha^s)$ must be negative.

3 The Second Order Condition (SOC) for the Manager's Maximization Problem

$$\begin{aligned}\frac{\partial^2 E(B)}{\partial\alpha^2} =& B''(\alpha)[1-F(c)] - B(\alpha)f(c)[\frac{-\mu'\sigma - \sigma'(r^f-\mu)}{\sigma^2}] \\ &- B'(\alpha)f(c)[\frac{-\mu'\sigma - \sigma'(r^f-\mu)}{\sigma^2}] \\ &- B(\alpha)f'(c)[\frac{-\mu'\sigma - \sigma'(r^f-\mu)}{\sigma^2}]^2 \\ &- B(\alpha)f(c)[\frac{-\sigma(\mu''\sigma + \sigma''(r^f-\mu)) + 2\sigma'(\mu'\sigma + \sigma'(r^f-\mu))}{\sigma^3}]\end{aligned} \tag{A.3}$$

The SOC, $\frac{\partial^2 E(B)}{\partial\alpha^2} \leq 0$, depends on many factors and it is not easy to verify the satisfaction of it. However, the condition trivially holds under the assumptions (i) $\mu'(\alpha) \leq 0,\ \sigma'(\alpha) \geq 0$(Case 1-3), (ii) $\mu'(\alpha) > 0,\ \sigma'(\alpha) > 0,\ \frac{\partial}{\partial\alpha}(\frac{\mu(\alpha)}{\sigma(\alpha)}) < 0$, and $r^f < \mu(\alpha^m)(1-\frac{\epsilon_\mu}{\epsilon_\sigma})$(Case 4), (iii) $B'(\alpha) > 0$, and additional assumptions (iv) $B''(\alpha) < 0$, that is, private benefit increases at a decreasing rate with α, (v) $f'(c) > 0$, the slope of PDF is positive at $c = \frac{r^f-\mu(\alpha)}{\sigma(\alpha)}$, and lastly (vi) $-\sigma(\mu''\sigma + \sigma''(r^f-\mu)) + 2\sigma'(\mu'\sigma + \sigma'(r^f-\mu)) > 0$, a condition which is hard to interpret.

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CHAPTER II

AN EMPIRICAL TEST ON THE RELATIONSHIP BETWEEN BANKS' RISK AND CAPITALIZATION

1. Introduction

The aim of this chapter is to provide an empirical investigation on the relationship between banks' capitalization and risk-taking behavior. Specifically, it provides an empirical test for the theoretical analysis implemented in Chapter I. The theoretical model has demonstrated that a bank's risk can either decrease or increase with capitalization depending on the relative forces of incentives of the three agents and on various parametric assumptions about risk-return profiles.

The relationship between banks' capitalization and risk-taking behavior has been one of the important issues in banking literature because of its implications on regulatory policies. Even though theoretical studies in favor of minimum capital regulation have argued that relatively well-capitalized banks are less inclined to increase asset risk, existing empirical studies on this issue have found only mixed evidence. While some authors (Boyd & Graham, 1996; Frulong, 1988; Keeley, 1990; McManus & Rosen, 1991) find a negative relationship between asset risk and capitalization, other authors (Peek & Rosengren, 1997; Santomero & Vinso 1977; Sheldon, 1995, 1996B) find little connection or a positive relationship between the two. The mixed evidence in existing studies is a part of the motivation for the empirical study of this paper.

The empirical methodology adopted in this study is mostly distinguished from those in other studies in that it allows for the interaction of the differing incentives of three agents involved in risk determination. Specifically, it introduces a piecewise linear specification with respect to capital-to-asset ratio to differentiate the regulator's incentives from those of the other two agents: shareholder and the manager. It also introduces interaction terms between capital ratio variables and managerial ownership variables to capture the differing incentives of the shareholder and the manager.

The regression results provide evidence that is generally consistent with the hypotheses posited in this study. For example, the apparent difference in the risk-capitalization relationships across high and low capital banks strongly indicates the presence of regulators' incentives in determining asset risk for low-capital banks. Moreover, the dynamics of the incentives of the shareholder and the manager is shown to exist for high-capital banks. It is shown that the positive relationship between portfolio risk and capitalization strengthens as the shareholder's incentives gain more relative forces, and weakens as the entrenched manager's incentives gain more relative forces. However, I failed to identify any negative relationship between portfolio risk and capitalization, which other studies have found as an empirical regularity (for example McManus & Rosen, 1991). This may be due to the characteristics of the sample banks employed in this study. A further investigation on this issue with a larger sample is warranted.

The composition of this paper is as follows. In Section 2 a discussion of the literature regarding various measures of risk and their relation to capitalization is presented. Testing hypotheses, variable description, and summary statistics are provided in Sections 3, 4 and 5 respectively. Sections 6, 7, and 8 detail regression results. Section 9 contains the summary and conclusion to the paper.

2. Various Measures of Bank Risk and Their Relation to Capitalization: A Discussion of the Literature

In this section various measures of bank risk that widely appear in banking literature are discussed. Since each measure of bank risk has its own characteristics and limitations, no single measure provides a perfect measure of bank risk. Empirical studies provide only mixed evidence on the relationship between capitalization and bank risk. It will be made clear that the mixed evidence is not only due to differences in sample data or sample periods for which the analysis is implemented, but also due to differences in the risk measures adopted.

2.1 Market Measure of Equity Risk

The most popularly used measure of bank risk in empirical studies is the market measure of equity risk, defined as the volatility of a bank's stock return over a given period[1]. Under the assumption of efficient markets, this would give a good measure of bank risk, because all the relevant information about profitability and risk will be reflected in the stock price.

One problem of equity risk is that it not only reflects the business risk of real assets held by the bank but also reflects the financial risk associated with financial leverage (inverse of capital-to-asset ratio). As the bank increases financial leverage, it also increases the risk of its common stocks (Galai & Masulis, 1976; Hamada, 1972; Lev,

[1] Three different measures of equity risk are used in empirical studies. Total risk is the standard deviation of the bank's daily (weekly, monthly) returns. Systematic risk is the component of risk that is attributable to market wide risk sources. Firm specific risk is the risk that is unique to an individual bank.

1974; Mandelker & Rhee, 1984). Intuitively, the higher the financial leverage, the larger the volatility of the earnings residual accruing to shareholders, and hence, the higher the financial risk of the common stock[2]. However the financial leverage does not affect the risk of a bank's asset. Therefore using equity risk as the dependant variable would give a misleading estimate of the effect of capitalization on asset risk.

Due to this problem, no empirical studies have seriously attempted to investigate the relationship between capitalization and bank risk as measured by equity risk. Some authors, however, have used the capital-to-asset ratio as a control variable in regression with equity risk as the dependent variable. For example, Demsetz and Strahan (1997) find a strong negative relationship between capital-to-asset ratio and market measure of equity risk. However, Saunders, Strock, and Travols (1990) find that capital-to-asset ratio is generally insignificantly related to equity risk.

2.2 Standard Deviation of Asset Returns

To abstract from the financial risk, some authors have used the standard deviation of return on assets (ROA) as a measure of bank risk. The standard deviation of ROA can be calculated either from market or accounting data. One problem with using market data is that the standard deviation of ROA is not directly observable. However, it can be estimated using the Black-Scholes option pricing formula, which provides a theoretical

[2] For instance, "the systematic risk of equity (β_S) is greater than or equal to the systematic risk of the firm (β_V) for $\beta_V > 0$", Galai & Masulis, 1976, p. 59.

link between the observable equity return volatility and the unobservable asset return volatility[3].

Furlong (1988) and Sheldon (1996 a) estimate the standard deviation of ROA using market data, and investigate the effect of the implementation of the more stringent capital regulations[4] on bank risk as measured by the standard deviation of ROA. They find little evidence that the implementation of the more stringent capital regulations (and the resulting increases in capital-to-asset ratios) did increase the standard deviation of ROA. This result is used as evidence for the argument that more capital does not increase bank risk.

Boyd and Graham (1986) use book values to calculate the standard deviation of ROA. It can be easily shown that the book value measure of standard deviation can be, theoretically, either positively or negatively related to capitalization[5]. In an empirical test, they find that the capital-to-asset ratio is negatively related to the standard deviation of ROA, which is consistent with the results of Furlong (1988) and Sheldon (1996 a).

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[3] Specifically, a market measure of the standard deviation of ROA can be estimated by solving the following two simultaneous equations:

$$E = AN(x) - DN(x - \sigma_A\sqrt{T}) \text{ and } \sigma_E = N(x)\frac{A}{E}\sigma_A,$$

where $x = \frac{\ln(A/D) + \sigma_A^2 T/2}{\sigma_A\sqrt{T}}$, E = market value of bank equity, A = market value of bank asset, D = current book value of bank debt (i.e., the face value of debt at maturity discounted by the risk-free rate of interest = Xe^{-rT}), N(x) = the standard normal cumulative density function evaluated at x, ln = natural logarithm function, σ_A = the instantaneous standard deviation of the return on asset, σ_E = the instantaneous standard deviation of the return on equity, and T = time until the next audit of the bank's assets, which is set to $T = 1$. Ronn and Verma (1973) give a detailed discussion of this issue.

[4] They are the introduction of uniform capital standards during the first half of 1980s in the United States and the implementation of the Basle Capital Accord of 1988.

[5] Let's denote r = rate of return on assets, r_a = rate of return on assets before interest expense, l = rate of return on debt. Then it holds that $r = r_a - l \times (D/A)$, where A = asset and D = debt. It follows that $\sigma^2_r = \sigma^2_{ra} + \sigma^2_l \times (D/A)^2 - 2 \times (D/A) \times \text{cov}(r_a, l)$. It is obvious that σ^2_r is a convex function of leverage ratio (D/A) so that the observed relationship between the two variables could theoretically be positive or negative or both, depending on the range of the data over which one tests (Boyd & Graham, 1986).

Even though the standard deviation of ROA is the most popular measure of risk, it is not free of shortcomings. For example, return on asset A has a smaller standard deviation than that of asset B, but asset A can still be riskier than asset B in the sense of first order or second order stochastic dominance[6]. Due to this shortcoming, empirical studies have developed other measures of bank risk such as default risk and portfolio risk.

2.3 Measures of Default Risk: Probability of Failure

Default occurs when a party under a contract fails to perform its financial obligations. Considering the importance of default risk (or credit risk)[7], it is not surprising that academics as well as industry have developed diverse measures of default risk[8]. In banking literature, several authors (Boyd & Graham, 1986; Santomero & Vinso, 1977; Sheldon, 1996a, 1996b) have used the risk of ruin model to evaluate the default risk of a banking institution and examine the relationship between bank risk and capitalization.

There are several variants of the risk of ruin model[9]. At its most simple level, it is considered that a bank failure has occurred when the (market) value of its assets (A) falls

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[6] Suppose that return on asset A is narrowly dispersed on the support [0, 10], and return on asset B is widely dispersed on the support [10, 100]. Obviously, asset B has greater standard deviation, but asset A is riskier (in the sense of the first order stochastic dominance). (See Chaper I Section 3 for the discussion of risk ordering concepts.)

[7] Default risk and credit risk are used interchangeably in the market. However, "while default risk could refer to any failure to perform under the contract, credit risk is more specific, referring to a financial inability to pay" (Smithson, 1998, p. 403). Default "should not be interpreted as bankruptcy, because creditors often forgive small shortfalls rather than bear larger bankruptcy costs or transfers to other creditors" (Scott, 1981, p. 342).

[8] Altman and Saunders (1998) provide a nice summary on the evolution of the literature on the default (credit) risk measures. They identify various kinds of default risk measures such as (1) expert systems and subjective analysis (2) accounting based credit-scoring models, (3) risk of ruin models, (4) term structure derivation of probability of default, (5) capital market based mortality rate models, and (6) neural network analysis.

[9] Scott (1981), and Santomero and Vinso (1977) discuss variants of risk of ruin models.

below its debt obligations to outside creditors. In other words, a bank fails when losses exceed capital (K). Then the probability of failure is calculated as;

Probability of failure = Probability (profits $< -$ K).

Dividing both terms of the inequality in the parentheses by asset (A), the probability of failure can be expressed as:

Probability of failure = Probability (ROA $< -$ K/A),

where ROA denotes the rate of return on assets. Assuming the distribution of ROA satisfies the location and scale parameter condition (see Definition 1 in Chapter I), the probability of failure equals:

$$\text{Probability of failure} = \text{Probability}\left((ROA - \mu_{ROA}) / \sigma_{ROA} < Z\right) \leq 1 / 2Z^2$$

$$Z = (- K/A - \mu_{ROA}) / \sigma_{ROA}$$ [10],

where μ_{ROA} is the expected value of ROA and σ_{ROA} is the standard deviation of ROA. The last inequality follows from Chebyshev's inequality[11]. It says that a bank fails if the standardized ROA falls below Z. Note that lower Z-values indicate a lower probability of failure. The absolute value of Z is an estimate of the number of standard deviation below the mean that profits have to fall to make capital negative. In this sense, it is an indicator of the probability of failure. Even though Z provides a simple measure of probability of failure, it comes at the cost of predicting only an upper limit to the true probability of failure.

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[10] The variable Z should not be confused with Altman, Haldeman, and Narayanan (1977)'s Zeta score, which is also a probability of default measure and is obtained by combining and weighing key accounting variables. Altman et al.'s Zeta model, accounting based credit-scoring model, is the best known and most commonly used.

[11] The Chebychev inequality is a theorem of probability theory that places an upper limit on the probability that an arbitrary random variable will diverge from its mean by a given number of standard deviations. The "1/2" in the expression reflects the fact that insolvency occurs only in one tail of the distribution.

The variable Z, however, is an inappropriate risk measure to use in the investigation of the relationship between bank risk and capitalization, because it directly depends on the capitalization variable (K/A). Since Z is expressed as a monotone decreasing function of capital-to-asset ratio (K/A), one can expect a negative correlation between the two variables in empirical study. In fact, Boyd and Graham (1986), using accounting data, find a strong negative relation between default risk measure (Z) and capitalization, indicating that well capitalized banks have a smaller probability of failure than undercapitalized banks.

On the other hand, other studies using different versions of Z find opposite results. Sheldon (1995, 1996b) includes the overhead ratio in calculating Z[12], and finds, using accounting data, that the level of capital-to-asset ratio and the probability of bank default are positively correlated, implying that more highly capitalized banks are more likely to fail. He interprets this result as indicating that a simple leverage ratio is a poor guide for assessing the soundness of a bank. Santomero and Vinso (1977) extend the simple risk of ruin model into a multi-period model where changes in capital (profit) follow a Poisson process. They calculate the Z-value at the time the risk exposure obtains its maximum. Using accounting data, they find that the impact of additional capital on Z is negligible, implying that the increased capital does not materially lower a bank's failure risk.

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[12] Z is defined as $(\alpha - K/A - \mu_{ROA}) / \sigma_{ROA}$, where α is the ratio of overhead (taxes plus expenses on personnel, materials and office space) to total assets.

2.4 Measure of Default Risk: Implicit Default Risk Implied by CD Rates

Another way of calculating default risk is to impute implied probabilities of default from the term structure of yield spreads between risk-free and risky corporate securities. Hannan and Hanweck (1988) and Keeley (1990) have assumed that large (over $100,000) certificates of deposits (CD), which are uninsured by deposit insurance, contain a risk premium related to the bank's default risk[13].

If the above prediction is correct, then banks with more capital to asset ratio should have lower default probabilities and thus should have lower CD rates. In empirical tests, both of the two studies find a strong negative relationship between CD rates and capital-to-asset ratio. For example, Keeley finds that a one percentage point increase in a bank's capital-to-asset ratio would lower its CD rate by 14 basis points.

Even though the method and results of these studies are quite interesting, they suffer from the same problem as the risk of ruin models. Since the negative relationship between CD rates and capital-to-asset ratio is predominated by the buffer effect of capital (i.e., more capital absorbs more risk: see Proposition 1 in Chapter I), it is difficult to get an implication for the asset substitution effect of capital, i.e., the effect of capital increases on asset choice. To investigate the asset substitution effect of capital, it is necessary to develop a risk measure that is not directly affected by the capital-to-asset ratio. Accounting based portfolio risk, which is a popularly used risk measure in banking literature, serves this purpose.

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[13] Theoretically, "the relationship between CD rates and the likelihood of insolvency can be expressed as

$$(1+r)^{-t} = (1-p)^{t}(1+r_f)^{-t} + [1-(1-p)^{t}](1-l)(1+r_f)^{-t},$$

where r is the one-period CD yield, p is the conditional one-period probability of default (assumed to be constant over time), r_f represents the risk-free rate, l is the expected loss per dollar of deposits in the event of default, and t is the number of periods until maturity" (Hannan & Hanweck, 1988, p. 204).

2.5 Portfolio Risk

Portfolio risk is defined as the proportion of risky assets in the banks' portfolio. Even though the proportion of certain risky assets in a bank's portfolio may not exactly reflect the overall asset risk of a bank, it may reflect project choice by bank managers and thus in some degree the overall asset risk. For this reason, several authors (Berger, 1995; Gorton & Rosen, 1995; McManus & Rosen, 1991) have used the composition of a bank's portfolio as a measure of asset risk. Popularly used portfolio risk measures include the ratio of commercial and industrial (C&I) loans to total assets (C&I/TA), the ratio of risk-weighted assets to total assets based on the Basle Accord risk-based capital guidelines (RWA/TA), and the ratio of nonperforming assets to total assets (NPRF/TA).

It is known that C&I loans are riskier than the other categories of loans[14]. Empirical studies (Gorton & Rosen, 1995; Samolyk, 1994) find evidence that banks with a higher proportion of C&I loans to assets have higher levels of nonperforming assets[15]. RWA/TA is considered to be a better *ex-ante* indicator of overall risk than C&I/TA. While C&I/TA focuses on a specific portfolio item, Basle Accord guidelines group all assets into different portfolio categories and assign different risk weights according to the perceived riskiness of the portfolio categories. Unlike the other two variables – C&I/TA and RWA/TA – NPRF/TA is an ex post measure of risk. The ex post measure depends on luck and other factors as well as on *ex ante* risk. NPRF/TA may contain information

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[14] The major loans made by U.S. commercial bank lending activities can be segregated into four broad categories. They are real estate, C&I, individual, and others. C&I loans includes credit to construct business plants and equipment, loans for business operating expenses, and loans for other business uses. It is the second largest loan category in dollar volume among the loan portfolio of U.S. commercial banks.

[15] Nonperforming loans are those that are 90 days or more past due or not accruing interest.

on risk differences between banks not caught by RWA/TA, and thus is used as a complementary risk measure of RWA/TA.

Most empirical studies using portfolio risk find evidence that portfolio risk is negatively related to capital-to-asset ratios. Berger (1995) finds that the capital-to-asset ratio is negatively related to RWA/TA and NPRF/TA. Avery and Berger (1991) also find some evidence that supports the conclusion that more capitalized banks tend to have lower portfolio risks. McManus and Rosen (1991) also find similar results, but they find that the negative relation between capital-to-asset ratio and portfolio risks is weaker for banks with low capital – i.e., banks with capital-to-asset ratio below 7 percent – than for banks with high capital. They suggest this may be due to the effects of regulatory supervision.

The risk measure RWA/TA, however, is not free of flaws. The relative risk weights assigned to calculate risk weighted assets considers only credit risk. They do not take into account the other pillar of bank risk, i.e., market risk. On this score, the variable RWA/TA provides only a partial measure of asset risk. Moreover, the relative weights assigned to each portfolio category may not correspond with the actual risk involved. Lastly, since there are only 4 kinds of relative weights (0, 20, 50 and 100 per cent), each category of portfolio may consist of assets with varying levels of risk. For instance, all commercial loans have the same weight (100 percent) regardless of the creditworthiness of the borrower – whether a company with a credit rating of AAA or CCC. Therefore, it is possible that two banks with the same value of RWA/TA will in fact have different risk levels.

3. Testing Hypotheses

The conventional hypothesis says that bank capitalization is negatively related to asset risk. Since the deposit insurance subsidy – the option value of deposit insurance – decreases with the capital to asset ratio, relatively well-capitalized banks will be less inclined to increase asset risk (Keeley & Furlong, 1989, 1990). This hypothesis would be a correct description of the state of art if the shareholder's objective dominates in the determination of a bank's optimal risk. The hypothesis is flawed, however, because two other agents – the bank regulator and the manager – are involved in determining asset risk. They are likely to have different preferences over risky asset choice than the shareholder. The theoretical analysis of Chapter I (Proposition 7) has shown that the risk-capitalization relationship is dependent on the relative forces of the differing incentives of the three agents. Therefore a more appropriate hypothesis would be one that incorporates the differing incentives of three agents – the bank regulator, the shareholder, and the manager – regarding the risk determination of a bank.

It is likely that bank regulator's incentives dominate in the process of risk determination for those banks with low capital – i.e., banks with capital-to-asset ratio below some critical level. One may recall from the analysis in Chapter I that the bank regulator (or the deposit insurer) is primarily interested in protecting the deposit insurance fund, and prefers the least risky assets among the three agents. Recognizing low capital implies higher default risk, the bank regulator will impose stricter regulatory constraints for low capital banks.

A closer supervisory surveillance by the bank regulator for low capital banks may prevent bank managers from seeking risk, because they are aware of the potential bad influence on his reputation and future career when the bank is classified as a risky bank by regulators[16]. To avoid the stricter regulatory constraints and the resulting increased regulatory costs[17] which would be imposed when the capital-to-asset ratio falls below the regulatory minimum (e.g., 5.0 percent), the shareholder of a low capital bank would not like to increase asset risk to take advantage of the deposit insurance subsidy.

The implication is that bank risk is positively related to capitalization for banks with low capital. The bank regulator will be willing to take more forbearing regulatory policies toward banks' risk-taking as the capital-to-asset ratio increases, because they recognize that more capital reduces default risk. As the regulatory constraints become loosened, the bank manager (shareholder) would like to increase the risk of the bank to the level where the marginal benefit and cost of the increase in risk are equalized. In the context of the theoretical model in Chapter I, this hypothesis is equivalent to assuming that $OV_{\alpha K}$ takes a negative sign. The negative sign implies that the bank is likely to increase optimal risk in response to an increase in capital if the marginal increment in regulatory constraints (OV_{α}) decreases with capital (Proposition 7-3). The following hypothesis is to test Proposition 7-3 in Chapter I.

Hypothesis 1: For banks with low capital, bank risk and capitalization are positively related.

It is assumed that, for banks with high capital, the regulator's incentives have minimal impact in the determination of bank risk compared to those of the shareholder

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[16] Among the five dimensions of CAMEL ratings by regulatory authorities is included the quality of management.

[17] For example, "banks whose overall CAMELS rating is toward the low, riskier end of the numerical scale – an overall rating of 4 or 5 – are examined more frequently than the highest-rated banks, those with ratings of 1, 2, or 3" (Rose, 1999, p. 524).

and the manager. Recognizing that regulatory constraints are not binding, the shareholder and the manager will have discretion to choose risky assets according to their preferences. It is very important in this paper to further distinguish the incentives of the manager from those of the shareholder to implement an empirical test on the relationship between capitalization and bank risk. This paper attempts to do this by allowing an interaction term between capital-to-asset ratio and managerial ownership[18]. This paper claims to be the first study to incorporate the managerial ownership to capture the relationship between bank risk and capitalization.

Empirical studies widely report nonlinear association between managerial ownership and shareholder's incentives. Morck, Shleifer and Vishny (1988) maintain the coexistence of two conflicting effects with respect to managerial ownership. The first one is the alignment effect, according to which the manager's incentives will be more likely to be aligned to those of the shareholder as managerial ownership stake increases. The second one is the entrenchment effect, which refers to the fact that managers tend to pursue private benefits as managerial ownership becomes substantial. According to Morck et al. and others, the entrenchment effect dominates the alignment effect when the managerial ownership belongs to intermediate level (e.g. 5 to 25 percent). On the other hand, the alignment effect is believed to dominate the entrenchment effect when the managerial ownership is either below a certain level (e.g. 5 percent) or above a certain level (e.g. 25 percent).

[18] As discussed in Section 4.4 of Chapter I, there are other variables that can be used to distinguish the differing incentives of the manager and the shareholder. These variables include monitoring by board of directors, monitoring by large shareholders, control challenge by dispersed shareholders, the managerial labor market, or the threat of takeover. The managerial ownership is used in this study, simply because it is the easiest variable to obtain.

The coexistence of the two conflicting effects suggests the following two hypotheses regarding the relationship between capitalization and bank risk. If managerial ownership belongs to the range where the entrenchment effect dominates the alignment effect, the managerial incentives will dominate the shareholder's incentives in the process of risk determination. In this case, the relationship between capitalization and risk will be determined mainly by the sign of $E(B)_{\alpha K}$, which is interpreted as the effect of capital on the marginal gain to the manager ($E(B)_{\alpha}$) from an increase in bank risk. Unfortunately, the theoretical analysis of Chapter I (Proposition 7-2) does not provide a deterministic prediction on the sign of $E(B)_{\alpha K}$. The sign of $E(B)_{\alpha K}$ can be either positive or negative depending on various parametric assumptions.

Hypothesis 2: For banks with high capital and intermediate level of managerial ownership, capitalization and asset risk are negatively related if the marginal gain to the manager from an increase in risk decreases with capital ($E(B)_{\alpha K} < 0$). They are positively related if $E(B)_{\alpha K} > 0$.

If, on the other hand, managerial ownership belongs to the range where the alignment effect dominates the entrenchment effect, the shareholder's incentives will dominate the managerial incentives in the process of risk determination. In this case, the relationship between capitalization and risk will be determined mainly by the sign of $V_{\alpha K}$, which is interpreted as the effect of capital on the marginal gain to the shareholder (V_{α}) from an increase in bank risk. The sign of $V_{\alpha K}$ is also indeterminate in the theoretical analysis of Chapter I (Proposition 7-1). Therefore the testing hypothesis is posited as follows.

Hypothesis 3: For banks with high capital and high (or low) managerial ownership, capitalization and asset risk are negatively related if the marginal gain to the shareholder from an increase in risk decreases with capital ($V_{\alpha K} < 0$). They are positively related if $V_{\alpha K} > 0$.

4. Description of the Variables

4.1 Dependent Variable: Asset Risk

The measures of risk used in this study are two kinds of portfolio risk, which are the ratio of risk weighted assets to total assets (RWA/TA) and the ratio of nonperforming assets to total assets (NPRF/TA). As discussed in Section 2, while the *ex ante* measure of risk – RWA/TA – is believed to be a better measure of risk, the *ex post* measure of risk – NPRF/TA – may also contain information on risk differences between banks not caught by RWA/TA. The other popular measure of portfolio risk – the ratio of the commercial and industrial loans to total assets (C&I/TA) – is not considered in this study, because C&I loans is already reflected in risk weighted assets (C&I loans have 100 percent risk weights) and thus is a part of RWA/TA. These portfolio risk measures are calculated using accounting data as of the end of year 1999.

Some justifications for using portfolio risk are in order. First, studies using portfolio risk report prevailing evidence that it is negatively related to capital-to-asset ratios. Thus any new finding contrary to this empirical regularity could be interpreted as evidence supporting the hypotheses posited in this study. Second, it is discussed in

Section 2 that one shortcoming of return volatility (standard deviation) as a measure of risk is that a larger return volatility does not necessarily imply a greater asset risk. The portfolio risk, however, does not suffer from this problem. A larger portfolio risk can unambiguously be interpreted as implying larger bank risk. Third, unlike the measures of default risk (Z-values), portfolio risk is not, at least theoretically, directly related to capitalization. Thus portfolio risk is a more appropriate measure of risk than default risk to investigate the effect of capital on asset risk. Finally, portfolio risk which is calculated based on accounting data allows a broader sample than the other risk measures which are based on market data. Market-based data is available only for a small subset of banks, generally the larger ones.

Factor analysis[19] has been used to construct an index (denoted as *FACTOR*) that combines the two measures of portfolio risks. I could have included other measures of risk such as standard deviation of ROA or probability of failure (Z) in constructing FACTOR. The accounting data used in this study allow for calculations of these two measures of risk. (See Section 5 for the description of the data used in this study). However, I chose not to use these two variables for the following two reasons. First, the calculation of these two variables requires more than one year (probably more than 5 years) to get reliable estimates of accounting data, whereas data for other variables used in this study are obtained only from one accounting year. One important premise of this study is that there exists a relationship between a bank's risk and managerial ownership. Since the managerial ownership varies from year to year as bank's operating managers change every year, it seems to be inappropriate to link the current level of managerial ownership to the risk measures that are obtained from the distant past. Secondly, the

[19] For introductory explanations about factor analysis, see Kim and Mueller (1978a and 1978b).

regression with FACTOR constructed including these two measures of risk did not give interesting results. This is not a surprise, considering the first reason discussed above. It would be an interesting study to include in constructing FACTOR other market measures of risk such as market measure of equity risk, market measure of asset return volatility, and market measure of default risk. Apparently neglecting these market measures is one of the limitations of this study, and a more extended research with these market measures remains as a task to be implemented in the future.

The new variable, *FACTOR*, created by the factor analysis is the risk measure used in the regression analysis. The factor analysis is implemented using a computer package (Stata). The analysis reveals that each portfolio risk measure has the same loading on the common factor. In other words, the correlations between the underlying common factor and each of the portfolio risks have the same magnitude. Table 2.1 reports correlation coefficients between portfolio risk measures and the newly created variable, *FACTOR*.

Table 2.1 Correlation Coefficients between Risk Measures

	RWTA/TA	NPRF/TA	FACTOR
RWTA/TA	1.0	.075	.733
NPRF/TA		1.0	.733

4.2 Capital-to-Asset Ratio (CAR)

Capital-to-asset ratio (CAR) is our measure of bank capitalization. Capital is defined as the total shareholder's equity reported on the balance sheet at year end. I believe this ratio is a superior measure for bank capitalization relative to the other measures such as primary capital[20] divided by total assets. It is the shareholder's equity that can be used as a buffer against general potential losses. It is with this ratio, CAR, that the FDIC assesses the degree of capitalization of a bank[21]. In these senses, the variable, CAR, represents the true capitalization of a bank.

CAR is measured using accounting data as of the end of year 1999. One problem with using a contemporaneous value of CAR as an explanatory variable is the possibility of an endogeneity problem. An endogeneity problem arises, when one or more of the explanatory variables are jointly determined with the dependent variable. In this case, a precise *ceteris paribus* interpretation between dependent and explanatory variables cannot be drawn. Since both the variables of asset risk and CAR are determined by the same agent – i.e., bank manager – it is most likely that the two variables are endogenously determined. For example, a manager who chooses a high level of asset risk may also be inclined to choose a high level of capital-to-asset ratio[22] in order to increase the ability of capital to absorb potential loss associated with higher risk. Moreover, there is a good reason to suspect that there may be feedback from asset risk to CAR. If a high risk asset is associated with high earnings on average, and bank managers tend to retain some of the earnings in the bank rather than distribute them to shareholders, then a bank with high risk asset will have a high level of CAR on average. On the other hand, if high

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[20] Primary capital differs from equity capital mostly in that it includes loan loss reserves as capital while equity capital does not. Since the loan loss reserve is reserved for potential losses associated with specific portfolio items, it cannot be considered as a part of true capital which can be used as a buffer against general unspecified potential losses.

[21] "According to the FDIC Improvement Act of 1991, a bank possessing a CAR ratio greater than 5 percent would be considered well capitalized. A CAR ratio of 4 percent or more would be considered adequate capitalization. A bank would be labeled undercapitalized if the ratio falls below 4 percent" (Rose, 1999, p. 484).

[22] Managers can control capital-to-asset ratio several ways, for example, changing divided policy, issuing new stock, selling off assets (i.e., securitization).

risk asset is associated with low earnings on average, then a bank with high risk asset will have a low level of CAR on average.

It is tempting to use lagged CAR as an explanatory variable to circumvent the endogeneity problems. However, since CAR is significantly serially correlated (the correlation coefficient between CAR and one year lagged CAR is 0.92), the endogeneity problem is unlikely to be resolved when lagged CAR is used. Thus, I prefer to use contemporaneous CAR rather than lagged CAR as the explanatory variable. Due to the endogeneity problem, the estimated relationship between asset risk and CAR cannot have a "causality" interpretation. It shows, however, the tradeoff between asset risk and CAR controlling other variables fixed.

4.3 Managerial Ownership Share (MOS)

Managerial ownership is measured as the aggregate percentage shares held by all officers and directors of the bank as reported in the bank's proxy statement filed with the Securities and Exchange Committee (SEC) for the year 1999. The proxy statement reports common stocks beneficially owned by all officers and directors, where the term "beneficial ownership" is defined by SEC regulations to include common stocks owned directly and indirectly (through spouse, minor children and relatives), and options exercisable within 60 days of the record date.

4.4 Asset Returns

In the theoretical model developed in Chapter I, return on assets is one of the key variables that affect the value of bank equity. Accordingly, the decision of asset risk will be influenced by the return on assets. It should be noted, however, that the cross-sectional test on the relationship between return and risk is not a test on the risk-return profiles of an individual bank. Since the investment opportunity set of a bank is not observable, it is impossible to test the risk-return profiles. Moreover, the measures of risk – portfolio risk – used in the empirical study do not exactly match the measure of risk used in theoretical studies, which is the standard deviation of asset returns. Asset returns are measured by the ratio of net income to total assets (ROA) using data as of the end of year 1999.

4.4 Bank Size

Bank size is one of the key factors shaping the bank's portfolio composition and determining its asset risk. On the one hand, large banks tend to have more diversified portfolios, and thus tend to have lower level of risk than small banks. On the other hand, however, large banks are more likely to engage in risky activities, by making more commercial and industrial (C&I) loans[23], by holding assets in trading accounts, and by participating in derivatives markets. Considering these two conflicting forces together, the effect of size on risk cannot be hypothesized *ex-ante*.

[23] "Larger banks typically are wholesale lenders, concentrating on large-denomination loans to corporations and other business firms (C&I loans). Smaller banks, on the other hand, tend to emphasize retail credits, in the form of small denomination consumer loans, home mortgage loans, real estate and agriculture loans. It is known that C&I loans are riskier than the other category of loans" (Rose, 1999, pp. 519-522).

Bank size is also related to the other variables controlled in this study. Several authors (Berger, Ofek & Yermack, 1997; Demsetz, Saidenberg & Strahan, 1997; Demsetz & Strahan 1995, 1997) find positive relationship between firm size and leverage. Larger banks tend to have lower capital-to-asset ratios because of their diversification advantage. I conjecture that bank size negatively affects managerial ownership share as size typically reduces ownership concentration. Following the general convention, bank size is measured by the natural log of the total book value assets, which is measured by the units of 1000 dollars using data as of the end of year 1999.

5. The Data and Summary Statistics

Data are collected from two sources. Accounting data are obtained from the consolidated financial statements for bank holding companies (BHCs) filed with the Federal Reserve System (FRS) on the form FR Y-9C[24]. Data for managerial ownership share are collected from a bank's proxy statement[25] which is filed with the Securities Exchange Commission (SEC) on the form DEF 14A[26]. Because proxy statements are required to be filed with the SEC only for publicly traded BHCs, data for managerial ownership share is available only for publicly traded BHCs, while the accounting data

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[24] This report is required by law: Section 5(c) of the Bank Holding Company Act (12 U.S.C. 1844) and Section 225.5(b) of Regulation Y [12 CFR 225.5(b)]. Beginning in 1986, all top-tier BHCs with at least $150 million of total consolidated assets and all BHCs with more than one subsidiary are required to file this form. This form is posted on Federal Reserve Bank of Chicago website: www.chicagofed.org/economicresearchanddata/data/bhcdatabase.

[25] When a shareholder vote is required – the circumstances under which shareholders are entitled to vote is governed by state law – and any person solicits proxies with respect to securities registered under Section 12 of the 1934 Act, that any person generally is required to furnish a proxy statement containing the information specified by Schedule 14A. The proxy statement is intended to provide security holders with the information necessary to enable them to vote in an informed manner.

[26] This form is posted on the SEC website: www.sec.gov/info/edgar.

includes both the private held and publicly traded BHCs[27]. Since this study requires managerial ownership, the sample includes only publicly traded BHCs.

The sample data used in this study are collected from the year of 1999. There is no good reason to select this year as the sample period. Due to the high costs consumed collecting data from proxy statements, I only include one year of data.

Unfortunately, the two databases do not contain a common bank identifier. Each bank in the two databases had to be matched manually using company name and business addresses. There were 1,695 BHCs in the FRS data set for 1999. Among these banks, only 516 BHCs exactly matched their names and business addresses with those in proxy statements filed with SEC. Therefore I consider the 516 BHCs as publicly traded BHCs and the remaining 1,179 BHCs as privately held BHCs. Even though I tried to be complete in matching the two databases, it is still possible that the group of privately held BHCs may in fact include some publicly-traded BHCs, because the identification process was implemented manually.

Table 2.2 compares summary statistics of each variable between publicly traded and privately held BHCs. The mean difference reported in the last column shows that two explanatory variables –ROA and total assets – and the risk measure NRPF/TA do not have significant differences in mean. It shows, however, that the publicly traded BHCs on average have smaller CAR and larger risk as measured by RWA/TA (and thus the FACTOR) than the privately held BHCs.

Table 2.3 provides Spearman' rank correlation coefficients and p-values between each of the three risk measures and each independent variable. A careful inspection reveals

[27] "Public firms are those whose stock or debt is traded on any regional or national exchange, or which could be traded. Private firms are not publicly traded, and no ready market for their shares exists. For the most part, the only potential purchases are other, existing, shareholders" (Beaty & Harris, 1998, p. 302).

that it is RWA/TA rather than NPRF/TA that characterizes the correlation between FACTOR and independent variables. The coefficients between NPRF/TA and independent variables are hardly significant in most cases, indicating that NPRF/TA is a poorer measure of risk than RWA/TA. However, the coefficient between NPRF/TA and managerial ownership is larger in magnitude and more significant than that between RWA/TA and managerial ownership. In this sense, NPRF/TA contains some information on bank risk that is not captured by RWA/TA.

It is shown that variables CAR and ROA are correlated with risk measures in a different fashion in the two data sets. The variable CAR is positively correlated with risk measures in the publicly traded BHCs but negatively correlated in the privately held BHCs. The variable ROA is positively correlated with RWA/TA (and FACTOR) in the publicly traded BHCs but negatively correlated in the privately held BHCs. Note also that the managerial ownership is negatively correlated with risk measures even though the coefficients are practically very small and insignificant except for the case of NPRF/TA. This implies that managerial ownership is either independent of or related non-linearly to portfolio risk measures.

These observations suggest the possibility that the behavior of publicly traded BHCs may be different from that of privately traded BHCs. A further discussion on this issue will be given in a later part of the paper.

Table 2.2 Summary Statistics

	Publicly Traded BHCs				Privately Held BHCs				Mean differ.
	Mean	Min	Max	Obs	Mean	Min	Max	Obs	
RWA/TA(%)	70.1	11.9	156.1	515	66.2	0	114.4	1,116	3.9 (6.2)
NPRF/TA	.46	0	4.6	516	.51	0	15.8	1,173	.05 (1.7)
Factor × 100	3.2	-67.9	182.3	515	-1.5	-109.7	415.0	1,110	4.7 (3.5)
CAR(%)	8.7	3.5	23.4	516	9.0	1.1	63.0	1,179	.3 (2.1)
ROA(%)	1.05	-3.5	3.3	516	1.1	-3.2	15.9	1,179	-.05 (-1.5)
Total Assets (million)	6,419	104	406,105	516	4,205	38	716,937	1,179	2,214 (1.3)
Managerial Ownership(%)	18.6	.3	90	516	-	-	-	-	-

1. RWA/TA, NPRF/TA, CAR, ROA are calculated using book value numbers at year end of 1999.
2. Data for Ownership are obtained from bank proxy statements filed with SEC by the date of March or April 1999.
3. Mean difference is the difference in means of two data sets; one of publicly traded BHCs and the other of privately held BHCs. t-values are reported in ( ).

Table 2.3 Spearman's Rank Correlation Coefficients

		CAR	*ROA*	*log(asset)*	*Managerial Ownership*
RWA/TA	Publicly Traded BHCs	.07 <.09>	.18 <.0>	.16 <.0>	-.05 <.24>
	Privately Held BHCs	-.21 <.0>	-.03 <.32>	.12 <.0>	-
NPRF/TA	Publicly Traded BHCs	.04 <.42>	-.06 <.14>	.06 <.20>	-.08 <.06>
	Privately Held BHCs	-.03 <.34>	-.07 <.01>	.005 <.90>	-
FACTOR	Publicly Traded BHCs	.08 <.08>	.09 <.03>	.11 <.01>	-.07 <.11>
	Privately Held BHCs	-.18 <.0>	-.07 <.02>	.06 <.04>	-

- p-values for the tests that risk measures are independent of explanatory variables are reported in < >.

6. A Test on the Relationship between Bank Risk and Managerial Ownership

6.1 A Discussion on Two Conflicting Hypotheses on Managerial Ownership

Morck et al. (1988) identify two conflicting hypotheses regarding the relationship between managers' ownership and their incentives. The first one is the convergence-of-interest hypothesis, according to which the managers' incentives will more likely be aligned with those of the shareholders as their ownership stake increases. In a contractual view of the firm in the sense of Jesen and Meckling (1976), the divergence of interests between the managers and the shareholder causes agency costs represented by a reduction in the wealth of the shareholders.[28] Therefore, managers with larger ownership share will be interested in reducing the agency costs by aligning their incentives to those of the shareholders.

The other hypothesis is the entrenchment hypothesis, which predicts that the tendency of the managers to pursue private benefits will occur only when the managerial ownership share is substantial. Managerial entrenchment is defined as the extent to which managers fail to experience discipline from external and internal corporate governance mechanisms (Berger et al., 1997). Managerial ownership is considered to be a major variable associated with managerial entrenchment. A manager who owns a small stake may be subject to many pressures to act in the interest of shareholders. In contrast, a manager who controls a substantial fraction of the firm's equity may be able to indulge in

[28] This is called residual loss in Jensen and Meckling (1976). Other agency costs they identify include the monitoring expenditures by the principal and the bonding expenditures by the agent.

behaviors which maximize his private benefits because he may have enough voting power or influence to guarantee his employment with the firm. However as the managerial ownership increases further, the managers will align their interests with the shareholders', because it is the managers themselves who stand to pay a larger share of the agency costs. Therefore the entrenchment hypothesis predicts a non-monotonic relationship between the managers' ownership and their incentives.

Studies using linear specification find only mixed evidence on the relationship between bank risk and managerial ownership. For example, while Saunders et al. (1990) find a positive relationship, Chen, Steiner, and Whyte (1998) report a negative relationship between the two. On the other hand, a majority of literature reports the fitness of a non-linear specification regarding managerial ownership structure. Several studies of non-financial firms (McConnell & Servaes, 1990; Morck et al., 1988; Stulz, 1988) find a nonlinear relationship between insider ownership and firm value. In the banking literature, several authors (Anderson & Fraser, 2000; Demsetz et al., 1997; Gorton & Rosen, 1995) find a nonlinear relationship between managerial ownership and bank risk. However the specific form of non-linearity differs depending on risk measures, sample period in the analysis, and approaches analyzing the relationship.

6.2 Testing Equation

To test the relationship between bank risk and managerial ownership, I use a piecewise linear specification as is used by Morck et al. (1988):

$$Risk = \beta_0 + \beta_1\,(MOS\ 0to5) + \beta_2\,(MOS\ 5to25) + \beta_3\,(MOS\ over\ 25)$$

$$+ \beta_4\,(CAR) + \beta_5\,(Asset\ return) + \beta_6\,(Bank\ size) \qquad (2.1)$$

where *MOS 0to5* = managerial ownership if managerial ownership < 5 percent

= 5 percent if managerial ownership ≥ 5 percent

MOS 5to25 = 0 if managerial ownership < 5 percent

= managerial ownership minus 5

if 5 ≤ managerial ownership < 25 percent

= 20 percent if managerial ownership ≥ 25 percent

MOS over25 = 0 if managerial ownership < 25 percent

= managerial ownership minus 25

if managerial ownership ≥ 25 percent

For example, when managerial ownership is equal to 27 percent, one would have *MOS 0to5* = 5, *MOS 5to25* = 20, *MOS over27* = 2. The piecewise linear regression allows the slope of MOS to change at 5 and 25 percent. The theoretical justification for the particular numbers (5 and 25) is not very strong[29]. The piecewise linear specification is not the only specification used to test the non-linearity of the relationship between managerial ownership and bank risk. The piecewise linear specification and the numbers (5 and 25) are used in this study, because they are popularly used in empirical studies.

[29] Morck et al. discuss some justifications for using these particular numbers. "The 5 percent ownership level is used, for example, by Herman (1981) as a focal stake beyond which ownership is no longer negligible and by the SEC as a point of mandatory public disclosure of ownership. The breakpoint at 25 percent is in part motivated by Weston (1979) who suggests 20-30 percent as the ownership range beyond which a hostile bid for the firm cannot succeed" (pp. 298-299). Demsetz et al. (1997) and Anderson and Fraser (2000) also have used piecewise linear specification and the breakpoints of 5 and 25.

Following the entrenchment hypothesis, and the conventional hypothesis that the shareholders have incentives to increase asset risk to exploit deposit insurance subsidy, I expect that the signs of *MOS 0to5* and *MOS over27* are positive, and the sign of *MOS5to25* is negative.

6.3 Regression Results

The regression results are reported in Table 2.4. The first regression (1) is the simple linear specification. It shows that the coefficient of MOS is insignificant both statistically and practically. The second regression (2) is the piecewise linear specification with breakpoints of 5 and 25. It shows a strong evidence that the managerial ownership is non-linearly related to bank risk. The portfolio risk falls as managerial ownership increases over the range of zero to 5 percent; it increases with managerial ownership from 5 to 25 percent; and then it decreases again as managerial ownership increases, but the last decline is insignificant. The result is very consistent with the finding of Gorton and Rosen, who use a semi-parametric approach and find a similar pattern regarding the relationship between portfolio risk and managerial ownership.

Morck et al. (1988) argues that the entrenchment effect dominates the alignment effect over the range in which managerial ownership is 5 to 25 percent. Gordon and Rosen (1995) also take this view when they argue that the managerial entrenchment occurs at intermediate levels of managerial stock holdings. If this argument is correct, then the regression results of the piecewise linear specifications imply that the shareholder's incentive is negatively related to bank risk. This finding is quite interesting, because it is contrary to the conventional hypothesis that the shareholder has an incentive to increase asset risk to exploit the option value of deposit insurance.

Interpreting the regression results in the context of the entrenchment hypothesis, however, should be done with caution. The coefficient of *MOS over25* is practically very small in magnitude. It is statistically insignificant as well. Other authors (Anderson et al., 2000; Demsetz et al., 1997) using market measure of equity risk find that the coefficient of *MOS over25* is occasionally positive. This conflicting evidence requires one to take caution in interpreting the regression results of Table 2.4 in the context of the entrenchment or alignment effect hypothesis. This issue will be discussed again in Section 8. At this point, it is sufficient to note that bank risk is nonlinearly associated with managerial ownership with breakpoints at 5 and 25 percent.

Interestingly, two explanatory variables used as controls, *CAR* and *ROA*, do not have predicted signs. As will be discussed in next section, the positive sign of *CAR* suggests that the risk-taking behavior of publicly traded BHCs may be different from the one of privately held BHCs. The negative sign of *ROA* shows that after controlling other variables, it is in fact negatively correlated with FACTOR for publicly traded BHCs, even though the Spearman's rank correlation coefficient test result in Table 2.3 shows that it is positively correlated with FACTOR for these BHCs. Similarly, the result of regression (5) reported in Table 2.5 shows that after controlling other variables *ROA* is positively correlated with FACTOR for privately held BHCs, even though Spearman's test shows otherwise. The coefficient of *log(asset)* is positive and significant both statistically and practically. It shows that larger banks engage in riskier business than smaller banks.

Table 2.4: Ordinary Least Squares Regression Results for a Test on the Relationship between Portfolio Risk and Managerial Ownership

	Predicted Sign	Dependent Variable: FACTOR × 100 (1)	(2)
MOS	+	.07 [.9]	
MOS 0to5	+		-3.71*** (-2.4)
MOS 5to25	–		.44** (2.4)
MOS over25	+		-.12 [-1.0]
CAR	–	1.89**** [2.9]	1.92*** [3.0]
ROA	+	-8.32* [-1.8]	-8.0* [-1.7]
Log(asset)	+	4.31*** (5.6)	3.75*** [4.5]
R-Squared		.07	.09
# Observations		515	515

1. Heteroscedasticity robust t-statistics are given in parentheses.
2. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.
3. p-values for the F-test are 0.0 in both the regressions.
4. The predicted sign of *MOS* is positive according to the conventional hypothesis that the shareholders have incentives to increase asset risk to exploit option value. According to the entrenchment hypothesis, the predicted sign of MOS 0to5 and MOS over25 are positive and that of MOS 5to25 is negative. The predicted sign of *CAR* is negative according to empirical regularity. The predicted sign of *ROA* is positive for publicly-traded BHCs according to Spearman's correlation coefficient test reported in Table 2.3. The predicted sign of *log(asset)* is positive according to Spearman's correlation coefficient test reported in Table 2.3.

7. Tests on the Relationship between Bank Risk and Capitalization for Low Capital Banks

7.1 Testing Equation

To test the relationship between bank risk and capitalization for low capital banks (Hypothesis 1), a piecewise linear specification with respect to capital-to-asset ratio (*CAR*) is employed. The piecewise linear specification allows for slope change at *CAR* = 7 percent.

$$Risk = \beta_0 + \beta_1 (CAR\ 0to7) + \beta_2 (CAR\ over7) + \beta_3 (MOS) + \beta_4 (Asset\ return) + \beta_5 (Bank\ size) \qquad (2.2)$$

where $CAR\ 0to5 = CAR$ if CAR $<$ 5 percent
= 5 percent if CAR $\geq$ 5 percent

$CAR\ overQ = 0$ if CAR $\leq$ 5 percent
= CAR minus 5 if CAR > 5 percent

A discussion for choosing the breakpoint that divides high and low capital banks would be needed. A possible criterion would be 5 percent which is the threshold for a bank to be classified as a well capitalized bank by regulators.[30] However, academics have argued that the capital ratio threshold associated with the current definition of a well-capitalized bank may be set too low for determining the health of the bank.[31]

[30] "The FDIC Improvement Act (FDICIA) of 1991 requires that bank regulators assign every bank to one of five regulatory categories based on leverage ratio: well-capitalized banks for leverage ratio of 5 percent or higher, adequately capitalized banks for 4 percent or higher, undercapitalized banks for below 4 percent, significantly undercapitalized banks for below three percent, critically undercapitalized banks for below 2 percent. Once a bank becomes undercapitalized, federal regulators take early intervention in order to force its ownership and management to strengthen its capital position" (Rose, 1999, p. 484).

[31] Peek and Rosengren (1997) discuss this issue. Benston and Kaufman (1994, 1994b) also discuss for earlier criticism of the way FDICIA was implemented.

Based on their study on the New England banking crisis, Peek and Rosengren (1997) conclude that troubled banks experienced rapid, large declines in capital-to-asset ratios. For instance, they find that one-third of the failed banks experienced a decline in their capital ratio in excess of 5 percentage points in a single quarter, which is enough to wipe out the entire capital of any bank that nearly satisfies the 5 percent threshold. They also find that regulators issue formal actions for a large number of well-capitalized banks, which indicates that regulators themselves consider the 5 percent capital cushion to be insufficient in protecting the deposit insurance fund from bank failures.

McManus and Rosen (1991) suggest that the critical capital ratio for dividing high- and low-capital banks be 7 percent, which is well above the regulatory minimum.[32] Using a parametric regression method, they find that bank portfolio risk is negatively related to capital ratio for banks with capital ratio above 7 percent (high-capital banks). They find, however, that the negative relationship is significantly weaker for banks with capital ratio below 7 percent (low-capital banks).[33] They ascribe this result to the regulation and regulatory supervision. Due to stricter regulatory supervision, low capital banks would not be inclined to increase their asset risk to take advantage of the deposit insurance subsidy. Following McManus and Rosen, CAR = 7 percent is used in this paper as the criterion. According to the criterion, approximately 24.5 percent (416) of the all BHCs (1,695) that exist in the year of 1999 are classified as low-capital banks.

[32] The ratio of primary capital to total assets must be at least 5.5 percent. (For the discussion of primary capital, see Section 4.2.)

[33] As will be made clear shortly, this study is different from theirs in two aspects. Firstly, it divides the banks into publicly traded and privately held banks. Secondly, it allows interaction between capitalization variables and managerial ownership variables.

7.2 Regression Results

Regression (3) in Table 2.5 shows the relationships between capitalization and portfolio risk for the all BHCs when CAR = 7.0 percent is used as a criterion dividing high- and low-capital banks. It is shown that no relationship exists between the two variables for low-capital banks, while an apparent negative relationship for high capital banks exists. This evidence indicates that there exists a difference in the relationship between capitalization and portfolio risk across high- and low-capital banks.

The results of regression (3), however, do not provide evidence in favor of Hypothesis 1 that predicts a positive relationship for low-capital banks. The coefficient of *CAR 0to7* is zero both practically and statistically. The results suggest that the relative force of regulators' incentives may not be strong enough to guarantee a positive relationship for low capital banks. The regression results, however, strongly suggest that the regulator's incentive is an important factor in determining risk of a low-capital bank.

The summary statistics of Table 2.2 and correlation coefficients of Table 2.3 have indicated that the risk-taking behavior of the publicly-traded BHCs is different from that of the privately-held BHCs. To examine this issue, equation 2.2 is separately estimated for the publicly-traded and privately-held BHCs respectively. As is shown in Table 2.5, the risk-capitalization relationship is substantially different between the two groups of BHCs. There could be a negative relationship between capitalization and portfolio risk for the privately-held BHCs and a positive relationship between the two for the publicly-traded BHCs. It may also be noted that the coefficients of ROA have different signs between the two groups of BHCs. The coefficients of log(asset) are statistically and practically significant only for the publicly-traded BHCs.

Some explanations for the observed difference in risk-taking behavior across these two groups of BHCs would be needed. Some authors (Beatty & Harris, 1998; Ke, Petroni & Saffieddine, 1999) argue that agency cost or information asymmetry between owner and manager is smaller for privately-held BHCs. The reasoning for this argument is that (1) privately-held companies tend to have more concentrated ownership structure, (2) they are directed, managed and operated by the majority shareholders, (3) and shareholders of these companies exercise closer or more direct monitoring over management than those of publicly-traded companies. If this argument is correct, then it would be the shareholders' incentives that are dominating factors in determining asset risk for the privately-held BHCs.

It has been discussed in Proposition 4 of Chapter I as well as in previous studies in banking and finance (for example, Furlong & keeley, 1989; Gavish & Kalay, 1983; Green & Talmor, 1986; Keeley & Furlong, 1990) that shareholders would like to monotonically decrease the risk of the bank as capitalization increases if the risk-return profiles are characterized by strict mean-variance ordering. The negative relationship between capitalization and risk found here for the privately-held BHCs confirms that this well established theoretical prediction is in fact correct. One may note that the negative relationship between the two implies that that the marginal gain to the shareholder from an increase in risk decreases with capital ($V_{\alpha K} < 0$).

On the other hand, the positive relationship found here for publicly-traded BHCs and the discussions in Section 8.2.3 indicates that the marginal gain to the shareholder increases with capital ($V_{\alpha K} > 0$) for publicly-traded BHCs. One possible explanation for this conflicting evidence is the presence of agency costs for the publicly-traded BHCs. As

soon as the managers' incentives begin to play a substantial role in determining asset risk of a bank, the optimal risk of the bank (α^*) will be different from that of the shareholder (α^s). In other words, while the optimal risk of the bank is expected to be the same as the optimal risk of the shareholder for privately held BHCs, they are expected to be different for publicly traded BHCs. Therefore, it is possible that the sign of the effect of an increase in capital on the shareholders' marginal gain ($V_{\alpha K}$) might be different between these two groups of BHCs.

The other possible explanation for the conflicting evidence is that the characteristics of risk-return profiles may be generally different across these two groups of BHCs. Since the privately held banks are unable to access external equity financing, they may have a very conservative investment policy toward a risky project which may have high return but low probability of success. When the bank's equity capital is substantially wiped out due to the poor performance of the risky project, the business of the privately held BHCs can be substantially threatened, because raising additional capital is very difficult to them. On the hand, the public banks, which have more access to equity markets, would be willing to be involved in a very risky project in an attempt to earn high return. Even though the risky project turns out to be a failure, they may still go to the equity market for additional funds, and have another chance for profitable investment. As discussed in Proposition 7 of Chapter I, this difference in risk-return profiles can result in different signs of $V_{\alpha K}$.

The two explanations above are neither satisfactory nor complete. They are given here because they are consistent with the underlying assumptions of theoretical analysis in Chapter I. Other explanations for the difference in risk-taking behavior between public and private banks should be further developed. A more detailed discussion of this issue is beyond the scope of this study and remains for future research.

Table 2.5: Ordinary Least Squares Regression Results for Tests on the Relationship between Portfolio Risk and Capitalization (A)

		Dependent Variable: FACTOR × 100		
	Predicted Sign	(3) All BHCs	(4) Privately-Held BHCs	(5) Publicly-Traded BHCs
CAR 0to7	+	.0 [.0]	-1.71 [-1.5]	6.77*** [3.3]
CAR over7	–	-.94*** [-3.1]	-1.53*** [-4.6]	1.23 [1.6]
ROA	..	2.96 [1.0]	5.56* [1.8]	-10.20** [-2.2]
Log(asset)	+	2.0*** [3.4]	.87 [.9]	4.05*** [5.3]
R-Squared		.02	.03	.08
# Obs.		1,625	1,110	515

1. Heteroscedasticity robust t-statistics are given in parentheses.
2. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.
3. p-values for the F-test are 0.0 in all of the regressions.
4. The predicted sign of *CAR 0to7* is positive according to Hypothesis 1. The predicted sign of *CAR over7* is negative according to empirical regularity. The sign of *ROA* cannot be predicted ex ante because the Spearman's correlation coefficient test (Table 2.3) and the previous regression results (Table 2.4) report different signs. The predicted sign of *log(asset)* is positive according to Spearman's correlation coefficient test (Table 2.3) and previous regressions.

8. Tests on the Relationship between Bank Risk and Capitalization for High Capital Banks

8.1 Testing Equation

A piecewise linear specification that allows for the interaction among variables is introduced to test Hypotheses 2 and 3. To capture the non-linearity associated with managerial ownership and capitalization, a piecewise linear specification with respect to both managerial ownership and capital ratios is introduced. Interaction terms between capital-to-asset ratio and managerial ownership are introduced to capture the relative forces of the incentives of the shareholder and the manager in characterizing the dynamic relationship between capitalization and asset risk.

$$
\begin{aligned}
Risk = {} & \beta_0 + \beta_1\,(CAR\ 0to7) + \beta_2(CAR\ 0to7 * MOS\ 0to5) \\
& + \beta_3\,(CAR\ 0to7 * MOS\ 5to25) + \beta_4\,(CAR\ 0to7 * MOS\ over25) \\
& + \beta_5\,(CAR\ over7) + \beta_6\,(CAR\ over7 * MOS\ 0to5) \\
& + \beta_7\,(CAR\ over7 * MOS\ 5to25) + \beta_8\,(CAR\ over7 * MOS\ over25) \\
& + \beta_9\,(MOS\ 0to5) + \beta_{10}\,(MOS\ 5to25) + \beta_{11}\,(MOS\ over25) \\
& + \beta_{12}(Asset\ return) + \beta_{13}\,(Bank\ size) \qquad (2.3)
\end{aligned}
$$

8.2 Regression Results

8.2.1 Test Results for the Relationship between Risk and Managerial Ownership Revisited

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The interaction terms and three variables of managerial ownership are relevant to test the relationship between bank risk and managerial ownership. The regression results reported in Table 2.6 show that the three managerial ownership variables are not very significant. Two (*MOS 5to25, MOS over25*) of the three MOS variables are not only statistically but also practically insignificant. The p-value of the F-tests for the three variables also shows that the three variables are jointly insignificant. The insignificancy of the MOS variables may reflect the fact that the MOS variables *per se* do not have any explanatory power after controlling the six interaction terms. It is also due to the severe multicolinearity between MOS variables and interactions terms[34]. The insignificance of the three MOS variables, however, should not be interpreted as implying that managerial ownership does not affect the portfolio risk. One may note that the effect of the managerial ownership on portfolio risk is quite substantial when the interaction terms together with the three MOS variables are considered.

Figures 2.1 to 2.3 illustrate the effect of managerial ownership on portfolio risk as measured by FACTOR corresponding to three different groups of capital-to-asset ratios. Each of the three capital ratio groups corresponds to low-capital (CAR below 5), intermediately-capitalized (CAR between 7 to 9), and highly-capitalized (CAR above 13). Interestingly, the three curves do not have consistent patterns. One may note that the curves with intermediately capitalized BHCs are the most consistent with the regression

[34] Generally, "multicollinearity is said to exist when there is 'substantial' correlation among two or more independent variable in the sample. When there exists multicollinearity, it is known that the individual t-statistics are insignificant" (Wooldridge, 2000, pp. 94-97). For instance, the coefficient of determination (R^2) obtained from regressing *MOS 0to5* on two interaction terms (*CAR 0to7* × *MOS 0to5 and CAR over7* × *MOS 0to5*) is 0.799.

results (Table 2.4) of simple piecewise linear specification with respect to managerial ownership.

According to the entrenchment hypothesis, one would expect the same sign for the slope between two ranges: MOS below 5 percent and MOS above 25 percent. These are the ranges where the alignment effect dominates the entrenchment effect. Unfortunately, the evidence is not very supportive of this argument. The argument is consistent only with the curve corresponding to highly-capitalized BHCs (CAR above 13). The other two groups of curves do not exhibit consistent patterns regarding dynamics of differing incentives of the shareholder and the manager.

An underlying assumption for the three hypotheses posited in this study is that the incentives of the shareholder and the manager are not important factors in determining asset risk of a low-capital bank. Consistent with this assumption, the slope of the curve for low-capital banks (CAR below 5) is close to zero over the range MOS above 5 percent. A similar pattern of the curves with CAR= 7 to 9 over the same range suggests that a similar argument may also apply to intermediately-capitalized banks. For those banks with a capital-to-asset ratio near the regulatory minimum (5 percent), the shareholder's incentives to increase risk are curbed by the potential of regulatory pressure. Recognizing the possibility of a rapid decline of the capital-to-asset ratio below the regulatory minimum in case of poor investment performance, shareholders of these banks might not be inclined to increase asset risk to exploit the option value of deposit insurance. In fact, except for the divergence at a very low level of MOS, the two groups of curves stay at a very narrow range of FACTOR from –20 to +5.4. In other words, except for some outliers, BHCs with a capital-to-asset ratio below some intermediate level tend to keep portfolio risk at a level that is considered to be reasonable by the regulator.

Based on the argument made above, I take the curves of highly-capitalized BHCs (CAR above 13) as the one that represents the dynamics of incentives of the shareholder and the manager. Following Morck et al. (1988) and others, I take the ranges of MOS below 5 and above 25 as the ones where the alignment effect dominates the entrenchment effect. The positive slopes of the curves over this range imply that the marginal gain to the shareholder from an increase in risk is positive ($V_\alpha > 0$). As is discussed in the Proposition 6 of Chapter I, this would be the case if the optimal risk of the shareholder (α^s) is greater than that of the bank (α^*). In this situation, α^* is expected to grow toward α^s as more weight is placed on the shareholder's incentives in determining bank risk.

Similarly the range of MOS between 5 to 25 can be considered as the one where the entrenchment effect dominates the alignment effect. Because the optimal risk of the bank is a weighted average of the optimal risk of agents, the optimal risk of the manager (α^m) must be smaller than the optimal risk of the bank. Therefore α^* is expected to decrease toward α^m as more weight is placed on the incentives of the entrenched manager. This implies a negative marginal gain to the entrenched manager ($E(B)_\alpha < 0$) and a negative slope of the curve over the range of MOS between 5 to 25 percent. The conflicting two forces of alignment and entrenchment effects are in balance over this range, and thus the slope of the curve is close to zero.

The evidence and reasoning discussed above cast doubt on the validity of the existing empirical studies that find a simple negative relationship between bank risk and managerial ownership. For example, several authors such as Chen et al. (1998) and

Anderson and Fraser (2000) find a negative relationship between the two using the sample period of the 1990s. They ascribe the negative relationship to the fact that the increased regulatory efforts after late 1980s to control banks' risk-taking[35] have substantially reduced the option value of deposit insurance. Consequently, according to their argument, the shareholder would not like to take excessive risk in an attempt to explore the option value. The regression results provided in this study, however, suggest that the shareholder's incentive to increase asset risk do still exist, but only for the highly well-capitalized banks.

The evidence also casts doubt on the validity of the study of Gorton and Rosen (1995) that discusses the managerial entrenchment without considering bank capitalization. Using a semi-parametric approach, they find a similar pattern on the relationship between portfolio risk and capitalization as the curves of intermediately-capitalized BHCs. To remain consistent with the usual entrenchment argument, they are forced to describe the entrenched (bad) manager as the one who makes a riskier loan than the one that is optimal from the standpoint of the bank shareholder. The evidence found in this study, however, suggests that their interpretation of managerial entrenchment toward risk may not be correct. The manager is, in fact, more conservative in the choice of asset risk than the shareholder, which is usually the case in the other studies (such as Hirshleifer & Thakor, 1992; Holstrom & Ricart I Costa, 1986) that find excessive managerial conservatism in different contexts. (See Section 4.4.1 of Chapter I, for the discussion of this issue.)

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[35] The most prominent examples are the introduction of risk-based capital standard by Basle Capital Accord (1988) and of risk-based deposit insurance premia under the FDCIA (1993).

8.2.2 Test Results for the Hypotheses 1 Revisited

The regression results in Table 2.6 and graphical illustrations provided in Figure 2.4 show the presence of the difference in the risk-capitalization relationship between high- and low-capital BHCs even after allowing interactions with managerial ownership variables. Figure 2.4 shows that the curves representing the risk-capitalization relationship are kinked at *CAR* = 7 with a stronger positive relationship for low-capital BHCs. It is shown in the curve with MOS = 3 that the relationship is in fact negative for BHCs with high-capital and low managerial ownership. The difference in risk-capitalization relationship between high- and low-capital BHCs, however, is much weaker for BHCs with high managerial ownership (MOS = 40).

8.2.3 Test Results for the Hypotheses 2 and 3

The variables relevant to test Hypotheses 2 and 3 are *CAR over7* and the three interaction terms with managerial ownership (*CAR over7* × *MOS 0to5, CAR over7* × *MOS 5to25,* and *CAR over7* × *MOS over25*). These variables capture the dynamic relationship between portfolio risk and capitalization associated with managerial ownership. The partial effect of capitalization on portfolio risk ($\frac{\Delta FACTOR}{\Delta CAR}$) for low-capital BHCs is estimated as:

$$\frac{\Delta FACTOR^{LOW}}{\Delta CAR} = 35.39 - 6.39 * MOS0to5 + .095 * MOS5to25 + .001 * MOSover25. \quad (2.4)$$

Similarly the partial effect for high-capital BHCs is estimated as:

$$\frac{\Delta FACTOR^{High}}{\Delta CAR} = -5.01 + 1.31*MOS0to5 - .05*MOS5to25 + .15*MOSover25. \quad (2.5)$$

From these expressions, it is clear that the partial effect of capitalization on portfolio risk depends on the level of managerial ownership. For example, if managerial ownership is 30 percent, then the values of MOS variables are given by:

$MOS0to5 = 5$, $MOS5to25 = 20$, and $MOSover25 = 5$.

Plugging these numbers into equation (2.5) gives the following partial effect:

$$\frac{\Delta FACTOR^{High}}{\Delta CAR} = -5.01 + 1.31*5 - .05*20 + .15*5 = 1.29.$$

Figure 2.5 demonstrates the partial effect of capitalization on portfolio risk corresponding to various values of managerial ownership. In other words, it shows the relationship between $\frac{\Delta FACTOR}{\Delta CAR}$ and MOS. One may note that the curve with CAR < 7 represents the partial effect for low-capital BHCs ($\frac{\Delta FACTOR^{LOW}}{\Delta CAR}$) and the curve with CAR > 7 represents the partial effect for high-capital BHCs ($\frac{\Delta FACTOR^{High}}{\Delta CAR}$).

Again, I believe that the curve with CAR < 7 does not appropriately represent the dynamics of the incentives of shareholders and managers. Accordingly, it is the curve with CAR > 7 that is relevant to test Hypotheses 2 and 3. In the curve with CAR > 7, it is shown that the effect of capitalization first increases with managerial ownership to the point where MOS = 5 percent, and slightly declines to the point where MOS = 25 percent, and finally strongly increases with managerial ownership. This pattern is somewhat consistent with that of the curves of highly-capitalized BHCs in Figure 2.3.

Therefore, the curve with CAR > 7 in Figure 2.5 can be interpreted in a similar fashion as the ones in Figure 2.3.

The upward sloping portions of the curve with CAR > 7 in the Figure 2.5 indicate the strengthening of the shareholder's incentives in determining asset risk of a bank. The upward sloping portions imply not only that capitalization and portfolio risk are positively related but also that the positive relationship is strengthening as the shareholder's incentives gain more relative forces. In the context of Hypothesis 3, I take this evidence as indicating that the marginal gain to the shareholder from an increase in risk increases with capital ($V_{\alpha K} > 0$).

Over the range where the managerial ownership is 5 to 25 percent, the effect of capitalization on risk is slightly decreasing. This evidence strongly suggests the coexistence of the entrenchment and the alignment effect over this range. Since the alignment effect implies $V_{\alpha K} > 0$, the entrenchment effect should imply $E(B)_{\alpha K} < 0$. In other words, it implies that the marginal gain to the manager from an increase in risk decreases with capital. These two conflicting effects are in balance over this range so that the slope of the curve is close to zero.

It should be noted, however, that the effect of capitalization on portfolio risk is positive except for very low values of managerial ownership. This evidence seems to be inconsistent with Hypothesis 2, which predicts a negative relationship between capitalization and risk when the sign of $E(B)_{\alpha K}$ is negative and the managerial incentives dominate the shareholder's incentives in determining asset risk. It seems to me that the managerial incentives are not strong enough to surpass the shareholders' incentives even over the range where the managerial entrenchment effect is dominant.

Table 2.6: Ordinary Least Squares Regression Results for a Test on the Relationship between Portfolio Risk and Capitalization (B)

		Dependent Variable: FACTOR × 100		
	Predicted Sign	Coefficients	Robust t-statistics	p-value for F-test
CAR 0to7	+	35.39***	2.92	0.0
CAR 0to7 × MOS 0to5		-6.34**	-2.1	
CAR 0to7 × MOS 5to25		.095	.2	
CAR 0to7 × MOS over25		.001	.01	
CAR over7	+	-5.01**	-2.2	0.03
CAR over7 × MOS 0to5		1.31**	2.2	
CAR over7 × MOS 5to25		-.05	-.4	
CAR over7 × MOS over25		.15*	1.9	
MOS 0to5	+	36.8*	1.8	.17
MOS 5to25	–	-.19	-.1	
MOS over25	+	-.3	-.3	
ROA	–	-9.9**	-2.2	
Log(asset)	+	3.39***	4.0	
Number of observations		515		

1. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.
2. The sum of the four *CAR* variables for low-capital BHCs is expected to be positive according to Hypothesis 1. The sum of the four *CAR* variables for high-capital BHCs is also expected to be positive according to the result of previous regression (5). According to the entrenchment hypothesis, the predicted sign of *MOS 0to5* and *MOS over25* are positive and that of *MOS 5to25* is negative. The predicted sign of *ROA* is positive according to the result of previous regression (5). The predicted sign of *log(asset)* is positive according to Spearman's correlation coefficient test (Table 2.3) and previous regressions.

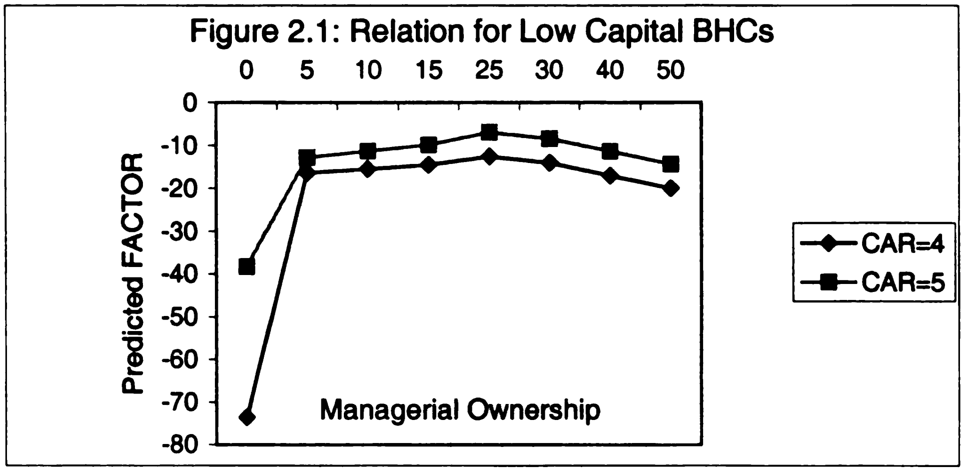
Figure 2.1: Relation for Low Capital BHCs
0 5 10 15 25 30 40 50
0
-10
-20
-30
-40
-50
-60
-70
-80
Predicted FACTOR
Managerial Ownership
CAR=4
CAR=5

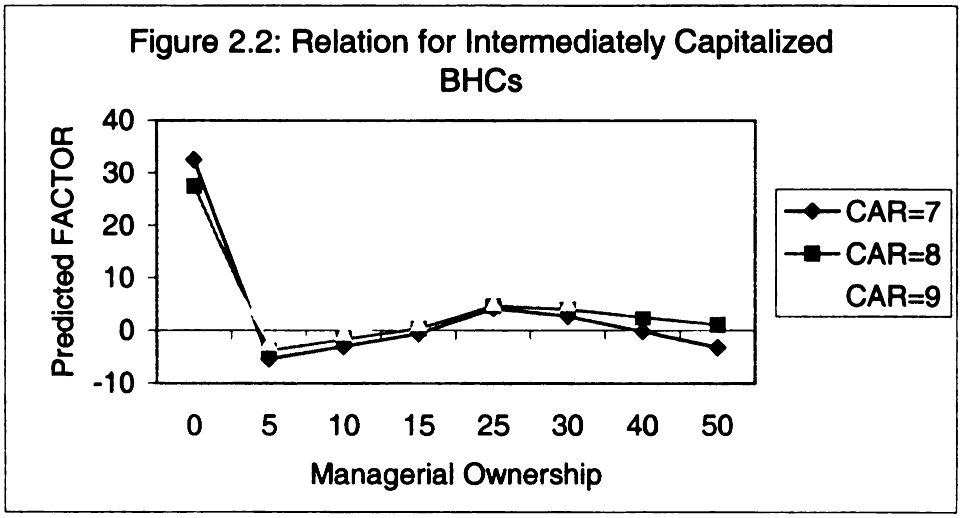
Figure 2.2: Relation for Intermediately Capitalized BHCs
40
30
20
10
0
-10
Predicted FACTOR
0 5 10 15 25 30 40 50
Managerial Ownership
CAR=7
CAR=8
CAR=9

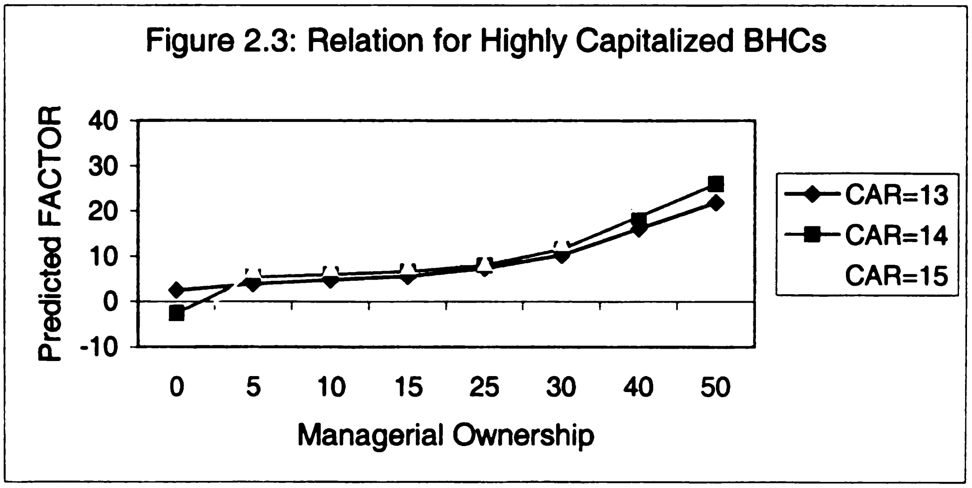
Figure 2.3: Relation for Highly Capitalized BHCs
40
30
20
10
0
-10
Predicted FACTOR
0 5 10 15 25 30 40 50
Managerial Ownership
CAR=13
CAR=14
CAR=15

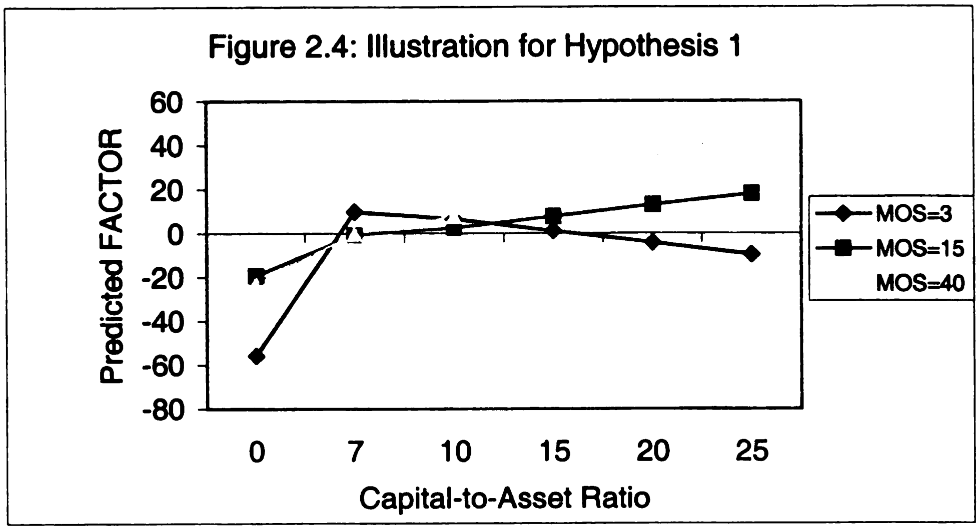
Figure 2.4: Illustration for Hypothesis 1
Predicted FACTOR
60
40
20
0
-20
-40
-60
-80
0
7
10
15
20
25
Capital-to-Asset Ratio
MOS=3
MOS=15
MOS=40

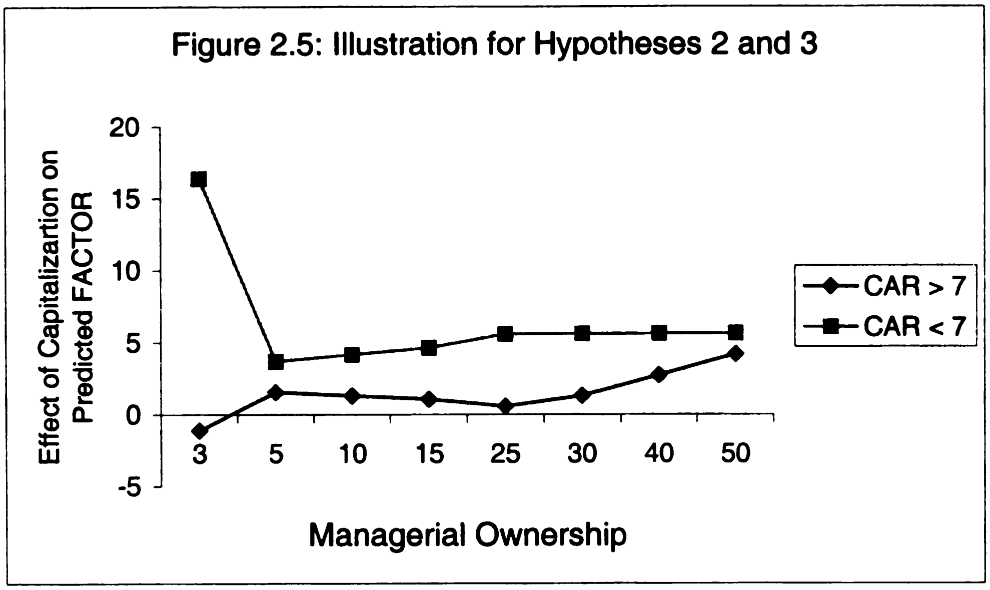
Figure 2.5: Illustration for Hypotheses 2 and 3
Effect of Capitalizartion on Predicted FACTOR
20
15
10
5
0
-5
3
5
10
15
25
30
40
50
Managerial Ownership
CAR > 7
CAR < 7

9. Conclusion

This chapter provides an empirical test of the relationship between bank capitalization and portfolio risk. The underlying hypothesis is that the relationship will be different depending on the relative forces of the incentives of the three agents involved in determining asset risk of a bank. It is hypothesized that the regulator's incentives dominate in the process of risk determination for low-capital banks. For high-capital banks, the other two agents – shareholder and manager – are assumed to have discretion to choose risky assets according to their preferences. However, the relative forces of the incentives of the two agents are assumed to be different depending on managerial ownership. It is hypothesized that managers' incentives dominate in the process of risk determination for intermediate level of managerial ownership, and that the shareholder's incentives dominate either for high-, or low-levels of managerial ownership. A piecewise linear specification together with interaction terms between capital ratio variables and managerial ownership variables are introduced to test these hypotheses.

The major findings of the empirical tests can be summarized as follows. First, unlike the existing studies that have found a negative relationship between portfolio risk and capitalization, I find a positive relationship between the two for the publicly-traded BHCs used in this study. However, it is shown that there still exists a difference in the relationship between capitalization and portfolio risk across high- and low-capital banks, which indicates the presence of regulators' incentives in determining asset risk for low-capital banks.

Second, the dynamics of the incentives of the shareholder and the manager are shown to exist only for the highly capitalized banks. For these banks, it is shown that the entrenchment effect dominates over the range of managerial ownership between 5 to 25 percent and that the alignment effect dominates over the range of managerial ownership below 5 or above 25 percent. This dynamic does not exist for banks with a capital ratio below the intermediate level. This evidence casts doubt on the validity of the earlier studies (Anderson & Fraser, 2000; Chen et al., 1998) that find a simple negative relationship between bank risk and managerial ownership or an earlier study (Gorton & Rosen, 1995) that discusses managerial entrenchment without considering bank capitalization.

Third, over the range where the alignment effect dominates the entrenchment effect, the positive relationship between capitalization and portfolio risk strengthens as the shareholder's incentives gain more relative force. This evidence indicates that the marginal gain to the shareholder from an increase in risk increases with capital. Fourth, over the range where the entrenchment effect dominates the alignment effect, the positive relationship between capitalization and portfolio risk weakens as the entrenched manager's incentives gain more relative force. This evidence implies that the marginal gain to the manager from an increase in risk decreases with capital. The last two arguments show the dynamics of the incentives of the shareholder and the manager regarding the risk determination of a bank.

Like most of the other empirical studies, this study is not free from its own weaknesses and limitations. Some of them are worthy of being mentioned. First, the sample data used in this study may not be large enough to give reliable estimation results.

The sample is collected only for the year 1999 and consists of only 515 publicly-traded BHCs. Second, the regression results have shown that the risk-capitalization relationship for the publicly-traded BHCs is substantially different from the one for privately-held BHCs, which suggests that the risk-taking behavior of the publicly-traded BHCs is substantially different from the one of privately-held BHCs. This study could provide only suggestive explanations for the difference in risk-taking behavior between these two groups of BHCs. Third, this study has used only managerial ownership as a variable to distinguish the differing incentives of the manager and the shareholder. There are other variables that can be used for the same purpose, including such variables as monitoring by board of directors, the threat of takeover, etc. Fourth, the measure of bank risk used in this study is confined to portfolio risk based on accounting data. As discussed in Section 2, there are diverse measures of bank risk that may give different estimation results than those found in this study. Considering these limitations, it is important to check the robustness of the results obtained in this study by enlarging the data set, by using different variables to differentiate the incentives of the agents, and by using different measures of bank risk.

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CHAPTER III

A RELATION BETWEEN BANK'S RISK AND MANAGERIAL CAREER CONCERNS

1. Introduction

When a manager's ability is unknown, the labor market forms beliefs on managerial ability. The labor market has prior beliefs about managerial ability and updates its beliefs on the basis of performance. Future wages are based on these updated beliefs. In these circumstances, career concerns naturally occur: The manager has an incentive to take actions in an attempt to influence the market's beliefs on his ability.

This paper studies managers' risk-taking behavior in the banking industry when the manager has career concerns in the labor market. The possibility that managerial career concerns can create a divergence in preferences regarding project choice between a manager and a firm has been widely recognized in the literature. The prevailing finding is that there exists an investment distortion away from the first best outcome when the manager has career concerns in the labor market. For example, Hermalin (1993) finds that a risk-averse manager will prefer the riskiest investment project available when the manager's choice of a risky project is observable by the labor market. The reason for this is that manager's reputational risk decreases with project risk when his actions are observable. However Hermalin describes only in passing the manager's (project) risk-taking behavior when the manager's actions are unobservable.

The first objective of this paper is to examine the manager's risk-taking behavior when his actions are not observable by the labor market. Using the equilibrium concept of perfect Bayesian equilibrium, this paper shows that a risk-neutral (or not very risk-averse) manager's preference over risky project choice depends on the underlying assumption on the properties of the investment opportunity set. If the opportunity set is characterized in such a way that a higher risk is associated with a lower mean return, only the least risky asset can be sustained as the second best reputational equilibrium. If, on the other hand, a higher risk is associated with a higher mean return, only the riskiest asset will be sustained as the second best reputational equilibrium.

The second objective of the paper is to consider the possibility of bankruptcy in our analysis. Most previous studies in this area consider the project choice problems of unleveraged firms. In a levelaged firm with risky debt, however, bankruptcy is inevitable when investment returns are very low. Assuming that large enough bankruptcy penalties are imposed on the manager, it is shown that a risk-neutral manager prefers less riskier assets. This result does not depend on the observability of the manager's actions, or the characteristics of risk-return profiles.

The third objective of the paper is to provide an empirical test for the theoretical model developed in this paper. In the regression with a measure of portfolio risk, which is presumed to be readily observable by outsiders, it is found that there is a positive but not significant relationship between managerial career concerns and asset risk. This evidence is consistent with the assumptions that (1) bankruptcy penalties are negligible, and (2) the manager behaves approximately in a risk-neutral fashion (or a small degree of risk-aversion).

There are many other studies that have examined investment distortions arising from managerial career concerns. In Holmstrom and Ricart I Costa (1986), the manager displays under- or over-investment depending on whether or not explicit contracting is introduced. Hirshleifer and Thakor (1992) show that managerial reputation building can cause excessive conservatism toward safe projects relative to the shareholders' optimum. Hermalin (1993) examines the effect of career concerns on the manager's risky project choice when the manager's actions are observable. Milbourn, Shockley and Thakor (2001) show that career concerns cause the manager to make overinvestment in the production of information precision. This paper distinguishes itself from other studies in that it examines the relationship between the manager's risk-taking behaviors and career concerns under different assumptions and provides an empirical test on the relationship between career concerns and asset risk in the banking industry.

The rest of the paper is organized as follows. Section 2 introduces the basic set-up and main assumptions used in the model. Section 3 develops the equilibrium analysis. Section 4 provides an empirical test for the theory developed in Section 3. Section 5 summarizes and concludes the paper.

2. Basic Set-Up

There is a bank manager and a labor market. The labor market may be either internal or external. For the internal labor market within the bank, the employer – the bank shareholder in this case – is the principal who evaluates managerial ability. In the following analysis, I do not differentiate between the internal and external labor markets. I work on a simple two-date model, i.e., $t = 0$ and $t = 1$. The basic set-up of this paper is developed in what follows[1].

2.1 Financial Structure of a Bank

At $t = 0$, a bank is endowed with an amount, K, of capital and issues a fixed amount, D, of deposits. The bank invests capital and deposits in risky assets of which the return is a random variable. The returns on risky investments are realized at date 1. At $t = 1$, the bank pays back a fixed amount of $D_1 > D$ to depositors. I assume all the bank deposits are fully insured by the government with a fixed rate insurance premium. For simplicity, the insurance premium is normalized to be zero. Thus $\frac{D_1}{D}$ defines the risk-free interest factor (1 plus interest rate) on deposits.

A bank fails if the value of its liabilities exceeds the value of its assets at date 1. A bank fails at date 1 if:

$$D_1 > (D+K)r, \quad \text{or} \quad r < \frac{D_1}{D+K} \equiv r^f,$$

[1] The assumptions about the financial structure of a bank and properties of return distributions are similar to the those developed in Chapter I.

where r denotes the interest factor on the banks' total investment. Since the endowment of capital, K, is nonnegative, r^f is bounded by zero and $\frac{D_1}{D}$, i.e., $r^f \in \left(0, \frac{D_1}{D}\right)$.

2.2 Properties of Return Distributions

At date zero ($t = 0$), the manager chooses the riskiness of the investment asset which is captured by the risk parameter $\alpha \in [0,1]$. The set [0, 1] completely characterizes the investment opportunity set, where $\alpha = 0$ implies the least risky investment alternative and $\alpha = 1$ implies the riskiest one.

When the manager chooses the risk parameter α, the returns from the investment conditional on α are characterized as follows:

$$r|\alpha = a + \mu(\alpha) + \sigma(\alpha) \times z,$$

where a is a random variable representing the manager's ability, $\mu(\alpha)$ is the intrinsic mean return (i.e., the mean return if the manager had zero ability), $\sigma(\alpha)$ is the intrinsic standard deviation (i.e., the standard deviation of the return if the manager's ability is known with certainty), and z is a random variable representing error term.

The random variables – manager's ability (a), error term (z) – are known to be jointly independent and normally distributed according to

$$a \sim N(a_0, \sigma_a^2), \quad z \sim N(0,1).$$

Therefore, I am assuming that the investment returns are normally distributed with mean $a_0 + \mu(\alpha)$ and variance $\sigma_a^2 + \sigma^2(\alpha)$ when the manager chooses α.

One problem of the normality assumption is that the stochastic return has support from $-\infty$ to $+\infty$, which is unreasonable given that the returns from investment cannot take on negative values. For the following reasons, however, I prefer to work with the normal distribution. First, the basic intuition will be the same if I do the analysis with other distributions which have positive support such as gamma distributions with support [0, ∞), or beta distribution with support [0,1]. One advantage of the normal distribution compared to other distributions is that it is much easier to do an analysis with normal distributions. Second, it has been widely accepted in modern portfolio theory that even if individual asset returns are not exactly normal, the distribution of returns of a large portfolio will resemble a normal distribution quite closely. Therefore, if the set of alternative risky assets the manager considers is composed of diversified portfolios rather than an individual investment project, than normality is a good approximation of the true return distribution. Lastly, for all practical purposes, I can choose the means $(a_o, \mu(\alpha))$ to be sufficiently large and/or the variances $(\sigma_a^2, \sigma^2(\alpha))$ to be sufficiently small so that the probability that returns take on a negative value is very small and thus can be ignored.

I consider the following two cases on the characteristics of the risk-return profiles, that is, how does a change in risk parameter (α) affect the mean and standard deviation of return distributions. A more detailed discussion on this issue is presented in Chapter I.

(1) $\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$

It is assumed that by increasing α the manager decreases the mean ($\mu' < 0$) and scales up the asset risk ($\sigma' > 0$). This means that an investment asset with higher α is dominated by the one with lower α in the sense of second order stochastic dominance.

(2) $\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$

An increase in α increases both the mean ($\mu'(\alpha) > 0$) and the asset risk ($\sigma'(\alpha) > 0$). This assumption does not provide a measure of risk ordering between alternative risky assets. However with one more condition introduced later in Section 3.2, it can be shown that alternative risky assets can be ranked from the standpoint of a safety-first-rule (Roy, 1952). That is, the probability of failure increases with α (see Chapter I Section 3).

Each of the above two cases is a rough description of the properties of the bank's investment opportunity set. The first case is popularly used in theoretical work on a bank's risk-taking behavior. It implies a negatively sloped convex function in the $\mu - \sigma$ space. The second case is one of the underlying assumptions in mean-variance portfolio selection theory. It presumes a concave function in the $\mu - \sigma$ space with positive slope. It is impossible to know *a priori* which case properly describes the properties of a specific bank's investment opportunity set. I will frequently refer to μ as mean return and σ as risk of the investment asset. Graphical illustrations for these two cases are given in Figure 1 of Chapter I.

2.3 Information Structure

There are three variables on which I need to make informational assumptions in the model. They are the outcome of the investment (realized return), the manager's action (choice of risky asset), and the manager's ability. I assume that the final outcomes from the investment are observable to all parties but assumed to be noncontractible. The assumption of non-contractibility practically eliminates the possibility of contract design based on realized return by the principal. The purpose of this paper is to investigate the effect of managerial career concerns on risky asset choice rather than to develop a normative theory of optimal contract design under the presence of managerial career concerns.

Second, I assume that the manager's ability is unknown to the labor market. The distribution of managerial ability is assumed to be a common knowledge to all agents in the economy. It is irrelevant in the model, however, whether the manager knows his ability or not. The reason for this is that, as will be discussed in Section 3, the expected payoff to the manager is not a function of managerial ability. Only the mean and variance of managerial ability are components of the expected payoff. Therefore the manager's risk-taking behavior is not affected by the fact that the manager knows his ability. If the payoff to the manager were a function of managerial ability, then the asymmetric information about the manager's ability would result in adverse selection[2], where managers with differing ability would exhibit differing risk-taking behavior. By construction, the effect of adverse selection on risky asset choice is not an issue in this model[3].

[2] A discussion on the agency relationship when adverse selection (i.e. agent has private information his type) and moral hazard (i.e. agent's actions are unobservable to the principal) are simultaneously present is provided by Jeitschko and Mirman (2002). Their study is different from this study in that they are primarily interested in (short-term) optimal contract design under the presence of both of these aspects together with the elements of noisy observations and on-going interactions between parties.

[3] Zwiebel (1995) studies investment distortion in a setting with managerial concern for reputation and asymmetric information on ability. In his model, the manager's payoff is constructed to be a function of managerial ability. Consequently, managers with differing abilities have differing investment behavior.

Lastly, regarding the informational assumption on the manager's choice of risky asset, I will consider two cases[4]: the case that it is observable and the other case that it is not observable. Each of these two cases has its own real world grounds to which it is applicable. The manager's choice of risky project is observable in the cases where it is evaluated by stock analysts, publicly announced by public press, monitored by large creditors and shareholders, and examined by bank regulators. Some risky measures, such as portfolio measure of risk, are directly observable by simply looking at the financial statements of the bank.

However, there are other cases where the manager's choice of risky project is not observable. For example, a manager may choose to make loans to a nearly bankrupt firm that is run by his relatives instead of to a high quality blue chip company. Since both of the loans belong to the same risk-weight categories under Basle Accord risk-based capital guidelines, this action (choice of loans between two firms) is not revealed in the portfolio measure of risk (RWA/TA). The observability of this kind of manager's action will be different depending on how much the bank is covered by analysts, and/or is monitored by other stakeholders. Analysts will not be interested in firms which are not publicly traded in exchange; public press often discriminates against small firms as far as the extent of news coverage is concerned[5]; while large shareholders may participate in active monitoring, dispersed stakeholders may not engage in active monitoring due to a free rider problem; and finally regulators pay less attention to those banks that satisfy

[4] Even though the informational assumption on mangers' ability is quite common in career concerns literature, there are two streams of literature on the informational assumption on the managers' action. One stream is to assume unobservable actions of managers. Gibbons and Murphy (1992) and Meyer and Vickers(1997) belong to this kind of stream. The other stream, which includes such authors as Holmstrom and Ricart I Costa (1986), Hermalin (1993) and Milbourn et al (2001), assumes that managers' actions are observable.

[5] It is generally considered that information asymmetry is larger in small firms than in large firms. (For example, see Vermaelen (1981) for the discussion of this issue.)

regulatory guidelines. Therefore it seems reasonable to assume that the informational asymmetry regarding the manager's choice of asset risk differs from bank to bank depending on the various factors considered above.

When the manager's actions are not observable, he has an incentive to take actions (i.e., choice of asset risk), in an attempt to influence the market's beliefs on the managerial ability. However, the manager cannot influence the equilibrium beliefs on his ability, because in equilibrium the market will anticipate these actions and draw correct inferences about ability from the observed outcome. The manager also knows that he cannot deceive the labor market in a systematic way and thus cannot influence the equilibrium beliefs. However the manager still has to take actions only to acquire equilibrium beliefs on his ability.

2.4 Wage Contract

At t = 1, the manager must be paid the market value of his perceived ability. This condition must hold not only for the external labor market but also for the internal labor market. If the manager is not paid according to the market value of his perceived ability by the bank (the internal labor market), he will quit the bank and find another job which will compensate him according to his perceived ability[6]. Therefore the wage corresponding to his perceived ability (hereafter, implicit wage) is the reservation wage for the manager. Since this is one period model and $t = 1$ is the last date of the world, the quitting constraint cannot force the bank to pay the manager the implicit wage. However,

[6] Following Harris and Holmstrom (1982) and Holmstrom and Ricart I Costa (1986), I am essentially assuming that involuntary servitude is prohibited.

I assume the bank makes a precommitted wage contract with the manager at $t = 0$ that it will pay him the implicit wage at $t = 1$.

Some authors have argued that implicit incentive from career concerns is not enough in disciplining managerial moral hazards. It is argued that implicit incentives from career concerns are not a perfect substitute for explicit incentives from compensation contracts. For example, Holmstrom (1999) shows that in the absence of explicit contracts, managers work too hard in early years (while the market is still assessing their abilities) and not hard enough in later years (while the market has learned their abilities). Gibbons and Murphy (1992) also argue that explicit contracts are still necessary even in the presence of career concerns. They show that an optimal compensation contract optimizes total incentives – the combination of explicit incentives from compensation contract and implicit incentives form career concerns.

Even though the importance of explicit incentives is recognized, this paper still concentrates on the implicit incentives from career concerns. To highlight the effect of career concerns on managerial investment behavior, explicit incentives are not considered in this model. I assume that the manager is guided primarily by his career concerns in the labor market in choosing risky asset.

2.5 Preferences

I assume all agents in the economy are risk-neutral. While the bank's shareholder seeks to maximize the expected value of bank equity, the manager cares about the labor market's $t = 1$ perception of his ability (a_1). Specifically, the manager's objective is to choose the optimal level of α to maximize his expected utility:

$$\underset{\alpha}{Max}\, U(\alpha) = E_0[a_1(\alpha)]\,.$$

The manager's expected utility (U) is simply the expected value of his perceived ability at t = 1. The expectation operator, E_0, represents the manager's lottery over $t = 1$ outcomes as of date $t = 0$. The information set on which the labor market's $t = 1$ perception of managerial ability is based includes the prior distribution of managerial ability, the observed outcome of the investment, the manager's choice of asset quality (if it is observable), and the bank's solvency state. It is assumed that the manager has no effort related disutility. This assumption eliminates usual moral hazard problems resulting from the agent's effort choice.

2.6 Sequence of the Events

The sequence of the events is stated as follows. The following four events occur at $t = 0$. (1) The bank is endowed with capital K and receives deposits D. (2) The manager and the labor market form prior beliefs on managerial ability. (3) The manager makes the investment on the risky asset. (4) The manager's action is observed by the labor market if it is observable.

The following four events occur at $t = 1$. (5) Outcomes of the investment are realized. (6) The labor market updates its beliefs on the managerial ability. (7) The manager is rewarded by his reputation. (8) The bank pays back deposits D_1 to depositors.

3. Equilibrium Analysis

3.1 Equilibrium Analysis without Considering Bankruptcy State

I first do the equilibrium analysis without considering the possibility of bankruptcy. This would be the case if the bank is 100 percent equity financed, or if the liabilities of the bank are composed of only riskless debts[7]. This assumption is unrealistic, but it will provide us simple intuitive equilibrium dynamics driven by managerial career concerns. The first best outcome, which will be obtained when the manager does not have his career concerns in the labor market, is trivial. Under the assumption of universal risk neutrality and no bankruptcy, the first best choice of risky asset would be the one that maximizes the expected return of the investment. I consider investment distortion caused by the managerial career concerns in both the cases where the manager's actions are observable and not observable.

3.1.1 Case 1: Manager's Actions Are Observable[8]

When a random variable follows a normal distribution, it is well-known from DeGroot (1970) that the posterior distribution of the random variable is also normal, where the mean of the posterior distribution is a weighted average of prior mean and observation. I denote $a_1(\alpha)$ as the mean perceived ability of the manager at $t = 1$ (i.e.,

[7] When banks are insured by the deposit insurance system, debts issued by banks are partly riskless. It is the deposit insurance system who has the right to make bankruptcy decision and stands to lose when the value of bank assets falls below the value of bank liabilities.
[8] The model developed and the results obtained in this section are similar to those of Hermalin (1993).

the posterior mean ability), when the risk parameter chosen by the manager is α. If the realized investment return at $t = 1$ is r_1 (subscript indicates $t = 1$), then the observation on the managerial ability is $r_1 - \mu(\alpha)$. Note that the error term is zero on average and has no implication on the observation of managerial ability.

Thus, suppose the returns from the investment conditional on α are characterized as follows:

$$r|\alpha = a + \mu(\alpha) + \sigma(\alpha) \times z,$$

where the manager's ability (a) and error term (z) are known to be jointly independent and normally distributed according to

$$a \sim N(a_0, \sigma_a^2), \quad z \sim N(0,1).$$

Then the posterior mean ability, denoted as $a_1(\alpha)$, is calculated as;

$$a_1(\alpha) = a_0 \left[\frac{\frac{1}{\sigma_a^2}}{\frac{1}{\sigma_a^2} + \frac{1}{\sigma^2(\alpha)}} \right] + [r_1 - \mu(\alpha)] \times \left[\frac{\frac{1}{\sigma^2(\alpha)}}{\frac{1}{\sigma_a^2} + \frac{1}{\sigma^2(\alpha)}} \right]$$

$$= \frac{\sigma^2(\alpha)}{\sigma_a^2 + \sigma^2(\alpha)} a_0 + \frac{\sigma_a^2}{\sigma_a^2 + \sigma^2(\alpha)} \times [r_1 - \mu(\alpha)] \qquad (3.1)$$

In words, the posterior mean ability is a weighted average of (i) the prior mean ability (a_0), which is deterministic and (ii) the observation on ability ($r_1 - \mu(\alpha)$) inferred by the realized value of returns, which is stochastic. The weights are relative precisions (inverse of variance) of ability and the error term to the total precision of return. It may be noted that more weight is placed on the observation on ability as the uncertainty about ability (σ_a^2) increases. Therefore, the larger the uncertainty is about his ability, the manager has the more incentives to take actions to influence the labor market's belief.

Lemma 1: Using $r_1 = a + \mu(\alpha) + \sigma(\alpha) z_1$, the mean and variance of the posterior mean ability are obtained by;

$$E_0(a_1) = \frac{\sigma^2(\alpha) \times a_0 + \sigma_a^2 \times E_0(r_1 - \mu(\alpha))}{\sigma_a^2 + \sigma^2(\alpha)}$$

$$= \frac{\sigma^2(\alpha) \times a_0 + \sigma_a^2 \times (a_0 + \mu(\alpha) - \mu(\alpha))}{\sigma_a^2 + \sigma^2(\alpha)} = a_0 \quad (3.2)$$

$$Var_0(a_1) = \left[\frac{\sigma_a^2}{\sigma_a^2 + \sigma^2(\alpha)}\right]^2 Var_0(r_1 - \mu(\alpha))$$

$$= \left[\frac{\sigma_a^2}{\sigma_a^2 + \sigma^2(\alpha)}\right]^2 (\sigma_a^2 + \sigma^2(\alpha)) = \frac{\sigma_a^4}{\sigma_a^2 + \sigma^2(\alpha)} \quad (3.3)$$

where the subscripts in E_0 and Var_0 indicate that expectations are calculated at $t = 0$. ♦

Two important observations follow from the above results. First, the expected value of posterior mean ability does not depend upon the manager's choice of risk parameter α. This confirms the well-known result that beliefs form a martingale. Since managerial ability is independent of the error term, the posterior mean ability will not be affected by the manager's action if it is observable by the labor market. In other words, a manager's action is reputationally irrelevant when it is observable.

The above observation implies that there will be an under-investment when the risk averse manager is given the option to invest or not (Holmstrom & Ricart I Costa, 1986). Before taking actions, the manager's perceived ability on average is a_0, which is a certainty. After taking actions, the mean perceived ability becomes an uncertainty of which the expected value is the same as the certainty a_0. Therefore the manager perceives the posterior mean ability as a mean preserving spread to the prior mean ability. Allowing the market to update about his ability exposes the manager to reputational risk. Consequently, if a risk averse manager is given an option not to take actions, then no investment will be undertaken at date zero. The risk averse manager will wish to avoid actions that are informative about his abilities. I exclude this case by assuming that no investment is not an option to the manager at date zero.

Second, the variance of the posterior mean ability decreases as the manager increases the riskiness of the investment asset. That is, it is a decreasing function of the risk parameter α. This can be easily verified;

$$\frac{\partial Var_0(a_1)}{\partial \alpha} = -\frac{\sigma_a^4 \times 2\sigma(\alpha) \times \sigma'(\alpha)}{\left[\sigma_a^2 + \sigma^2(\alpha)\right]^2} < 0 .$$

The inequality holds because $\sigma'(\alpha) > 0$. Together with the fact that the expected value of posterior mean ability is the same for all the values of risk parameter, α, the second observation implies that the expected payoff to the manager from reputation (perceived mean ability in the labor market at t = 1) for different α can be ordered in the sense of mean preserving spread (MPS). As the manager decreases the riskiness of the investment asset, he increases the riskiness of his payoff from reputation. Consequently, if the market can observe the manager's choice of asset risk, the manager minimizes his reputational risk by undertaking the most risky investment alternatives possible (Hermalin, 1993).

One interesting case is one in which the intrinsic variance goes to infinity ($\sigma^2(\alpha) \to \infty$) as the risk parameter approaches one ($\alpha \to 1$). In this case the variance of the posterior mean ability goes to zero. In others words, the mean perceived ability becomes a certainty in the limit as the manager chooses the riskiest asset available. From equation (3.1), one may note that the relative weight placed on the observation of ability (r_1 - $\mu(\alpha)$) becomes zero and the relative weight placed on the prior mean ability (a_0) becomes one. Since the observation of the ability adds no information in updating the managerial ability, the posterior mean ability must be equal to the prior mean ability. Therefore the payoff to the manager from choosing the riskiest asset available is equivalent to the one from no investment. I have eliminated this case by assuming that the investment returns are normally distributed, and thus that the second moment of the return distributions is finite.

The above observations imply that the effect of managerial career concerns on the manager's investment behavior crucially depends on the assumption whether the manager is risk-averse or risk-neutral. It is apparent that a risk-averse manager will choose the riskiest possible investment asset. On the other hand, a risk-neutral manager will be indifferent among investment alternatives. The following proposition is the restatement of the results found by Hermalin (1993).

Proposition 1: Assume that the manager's choice of risky asset is observable by the labor market. Then a risk-neutral manager who maximizes the expected value of posterior mean ability is indifferent among investment alternatives. On the other hand, a risk-averse manager will choose the riskiest asset available. ♦

3.1.2 Case 2: Manager's Actions Are Unobservable

When the manager's actions are unobservable, the labor market must make a conjecture about the action taken by the manager. This provides an incentive for the manager to take actions in an attempt to influence the market's ex post beliefs on his ability. In equilibrium, however, the market will make a correct conjecture about the manager's action and thus will not be systematically deceived about the expected ability of the manager. I restrict the analysis to a pure-strategy equilibrium and assume that the manager does not randomize asset choice.

A dynamic game with incomplete information requires the equilibrium concept of perfect Bayesian equilibrium. A perfect Bayesian equilibrium consists of strategies and beliefs satisfying the following two requirements: (1) the players' strategies must be sequentially rational (utility maximizing) and (2) the players' beliefs are determined by Bayes' rule and the players' equilibrium strategies. The perfect Bayesian equilibrium in this model – named as 'the second-best reputational equilibrium' following Milbourn et al (2001) – is defined as a manager's strategy and the market's beliefs about risky asset choice such that:

- The manager's equilibrium choice of asset risk is utility-maximizing given the beliefs of the market;
- The market updates beliefs according to Bayes rule, and the market's beliefs coincide with the manager's choice of asset risk.

Let's denote by $\alpha^* \in [0,1]$ and a_1^* the equilibrium risk parameter and the equilibrium payoff to the manager respectively. Also denote $\alpha^d \in [0,1]$ and a_1^d as a risk parameter and payoffs to the manager in deviation. To check whether the potential equilibrium can be sustained as a stable equilibrium, one needs to find whether the manager has an incentive to deviate given the beliefs of the market. Note that one only need to compare the means and variances of the posterior mean ability in equilibrium and in deviation. The mean and variance if the equilibrium posterior mean ability are given in Lemma 1.

Lemma 2: Using $r_1 = a + \mu(\alpha^d) + \sigma(\alpha^d)z_1$, the mean and variance of posterior mean ability from deviation are calculated by;

$$E_0(a_1^d) = \frac{\sigma^2(\alpha^*)a_0 + \sigma_a^2 E_0(r_1 - \mu(\alpha^*))}{\sigma_a^2 + \sigma^2(\alpha^*)}$$

$$= a_0 + \frac{\sigma_a^2}{\sigma_a^2 + \sigma^2(\alpha^*)} \times \left[\mu(\alpha^d) - \mu(\alpha^*)\right] \qquad (3.4)$$

$$Var_0(a_1^d) = \left[\frac{\sigma_a^2}{\sigma_a^2 + \sigma^2(\alpha^*)}\right]^2 Var_0(r_1)$$

$$= \left[\frac{\sigma_a^2}{\sigma_a^2 + \sigma^2(\alpha^*)}\right]^2 \times \left[\sigma_a^2 + \sigma^2(\alpha^d)\right] \qquad (3.5) \ ♦$$

Lemma 3: Using the results of Lemma 1 and Lemma 2, the gains in reputation and the difference in variance that the manager obtains by deviation are calculated as;

$$E_0(a_1^d) - E_0(a_1^*) = \frac{\sigma_a^2}{\sigma_a^2 + \sigma^2(\alpha^*)} \times \left[\mu(\alpha^d) - \mu(\alpha^*)\right],$$

$$Var_0(a_1^d) - Var_0(a_1^*) = \left[\frac{\sigma_a^2}{\sigma_a^2 + \sigma^2(\alpha^*)}\right]^2 \times \left[\sigma^2(\alpha^d) - \sigma^2(\alpha^*)\right]. \qquad ♦$$

Proposition 2: Assume that the manager's choice of risky asset is unobservable by the labor market and that risk-return profiles are characterized by $\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$. Then the only equilibrium that can be sustained as the second-best reputational equilibrium is $\alpha^* = 0$ for both of the risk-neutral and risk-averse managers.

Proof: Suppose the labor market believes that there is some $\alpha^* > 0$. Then the manager may deviate the equilibrium by choosing either $\alpha^d > \alpha^*$ or $\alpha^d < \alpha^*$. If the manager deviates the equilibrium by increasing the risk parameter ($\alpha^d > \alpha^*$), the reputational gain is negative, $E_0(a_1^d) - E_0(a_1^*) < 0$, and the variance is greater, $Var_0(a_1^d) - Var_0(a_1^*) > 0$. Thus both the risk-neutral and risk-averse manager would not deviate the equilibrium by choosing $\alpha^d > \alpha^*$.

On the other hand, if the manager deviates the equilibrium by choosing $\alpha^d < \alpha^*$, the reputational gain is positive, $E_0(a_1^d) - E_0(a_1^*) > 0$, and the variance is smaller, $Var_0(a_1^d) - Var_0(a_1^*) < 0$. Thus both the risk-neutral and risk-averse manager would deviate the equilibrium by choosing $\alpha^d < \alpha^*$. However, the market anticipates in advance that any belief $\alpha^* > 0$ will be deviated by the manager. Therefore the only equilibrium that can be sustained as the second-best reputational equilibrium is $\alpha^* = 0$. That is, the market believes and the manager actually chooses the least risky asset in the set of risky alternative assets. QED.

Proposition 3: Assume that the manager's choice of risky asset is unobservable by the labor market and that risk-return profiles are characterized by $\mu'(\alpha) > 0$ and

$\sigma'(\alpha) > 0$. Then the only equilibrium that can be sustained as the second-best reputational equilibrium is $\alpha^* = 1$ for the risk-neutral manager.

Proof: In this case, a manager can make the reputational gain positive, $E_0(a_1^d) - E_0(a_1^*) > 0$, by deviating to $\alpha^d > \alpha^*$. Thus a risk-neutral manager will always deviate the equilibrium by increasing the riskiness of the asset. Thus only the riskiest asset ($\alpha^* = 1$) is sustainable as an equilibrium with a risk-neutral manager. QED.

For a risk-averse manager, however, it is difficult to predict the sustainable equilibrium, because a positive reputational gain is associated with a greater variance. The existence and the particular value of a sustainable equilibrium α^* will depend on the specific functional form of the manager's utility function.

3.2 Equilibrium Analysis with Bankruptcy Penalties

If the bank goes to bankruptcy, it is inevitable for the manager to bear some costs associated with bankruptcy. If the labor markets have perfect knowledge about the properties of asset returns, perceived managerial ability will only depend on the realized value of asset returns and will not be affected by the event that the bank goes to bankruptcy. However, it is possible that a labor market outside the banking sector cannot observe the manager's outcome that is necessary to evaluate the manager's ability. In this case, bankruptcy may convey information to the non-banking sector about the manager's ability and may therefore lower outside opportunities for the manager. That is, bankruptcy may lead to reputational loss for the manager. I assume that the manager's perceived ability is zero in case of bankruptcy. This is tantamount to assuming that the manager is not able to redeem the precommitted wage from the bank in case of bankruptcy. It is a general consensus in literature that the firm-specific human capital is lost if the firm goes bankrupt.

In addition to the reputational loss, I assume that bankruptcy penalties[9] are imposed on the manager if the bank goes bankrupt. Following Diamond 1984 and Zwiebel 1995, I consider non-pecuniary bankruptcy penalties, where the manager's loss is not enjoyed by the other agents in the economy. They may include a manager's time spent in bankruptcy proceedings, costly explaining of poor results, search costs of the fired manager, and the manager's loss of reputation due to bankruptcy.

To do the analysis, I need some additional assumptions and notational changes. They are summarized as below.

(A1) $-F$ denotes bankruptcy penalties.

(A2) The prior mean ability is assumed to be zero ($a_0 = 0$).

(A3) Denote $\Sigma^2(\alpha) = \sigma_a^2 + \sigma^2(\alpha)$, or $\Sigma(\alpha) = \sqrt{\sigma_a^2 + \sigma^2(\alpha)}$.

(A4) It is assumed that $\frac{d}{d\alpha}\left[\frac{\mu(\alpha)}{\Sigma(\alpha)}\right] = \frac{\mu' \times \Sigma^2 - \mu \times \sigma \times \sigma'}{\Sigma^3} < 0$, and

$$r^f < \mu(\alpha)\left[1 - \frac{\varepsilon_\mu}{\varepsilon_\sigma} - \frac{\varepsilon_\mu}{\varepsilon_\sigma} \times \frac{\sigma_a^2}{\sigma^2(\alpha)}\right], \text{ where } \varepsilon_\mu = \frac{\mu'(\alpha)\alpha}{\mu(\alpha)} \text{ and } \varepsilon_\sigma = \frac{\sigma'(\alpha)\alpha}{\sigma(\alpha)}.$$

(A5) It is assumed that $\mu(\alpha) \geq \frac{D_1}{D}$, $\forall \alpha \in [0,1]$.

[9]) Bankruptcy penalty was introduced by Diamond (1984) and Gale and Hellwig (1985) as an incentive scheme in financial contract to induce borrower to truthfully reveal cash flows from investment. Diamond considered a non-pecuniary penalty function, whereas Gale and Hellwig (1985) considered a pecuniary penalty.

(A1) introduces bankruptcy penalties. (A2) is used as a normalization. It is introduced to make the calculation easier. (A3) is for notational simplicity. Under (A2) and (A3), asset return is normally distributed with mean $\mu(\alpha)$ and variance $\Sigma^2(\alpha)$: $r \sim N(\mu(\alpha), \Sigma^2(\alpha))$. Assumption (A4) implies that the dispersion of the return distribution increases with α. Assumption (A5) implies that the manager invests in positive net present value project.

Lemma 4: Under Assumption (A4), the probability of failure increases with α.

Proof: See Appendix 1.

Lemma 4 is similar to Proposition 2 of Chapter I. This lemma provides a measure of risk ordering for the case where higher risk is associated with higher return ($\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$). A detailed discussion of this issue is referred to in Section 3 of Chapter I.

Under the assumptions, when the realized investment return is r_1, the manager's payoff (utility) is given as:

$$U(\alpha) = E_0\left[\frac{\sigma_a^2}{\Sigma^2(\alpha)}(r_1 - \mu(\alpha))\right], \qquad \text{if } r_1 \geq r^f$$

$$U(\alpha) = -F \qquad \text{if } r_1 < r^f. \tag{3.6}$$

3.2.1 Case 1: Manager's Actions Are Observable

The manager's choice of asset risk depends on the expected utility, which in turn depends on expected reputation and expected bankruptcy penalties. The manager's maximization problem is given by:

$$\underset{\alpha}{Max}\,U(\alpha) = \int_{-\infty}^{r^f} 0 \times \left\{ \frac{1}{\sqrt{2\pi}\,\Sigma} e^{-\frac{1}{2}\left[\frac{y-\mu}{\Sigma}\right]^2} \right\} dy + \int_{r^f}^{\infty} \frac{\sigma_a^2}{\Sigma^2}(y-\mu) \left\{ \frac{1}{\sqrt{2\pi}\,\Sigma} e^{-\frac{1}{2}\left[\frac{y-\mu}{\Sigma}\right]^2} \right\} dy$$

$$- F \times \int_{-\infty}^{r^f} \left\{ \frac{1}{\sqrt{2\pi}\,\Sigma} e^{-\frac{1}{2}\left[\frac{y-\mu}{\Sigma}\right]^2} \right\} dy. \tag{3.7}$$

The first term of the right hand side (RHS) shows that the manager loses all of his reputation and cannot indemnify his wage from the bank in case of bankruptcy. The second term of RHS is the expected value of posterior mean ability in case of solvency. The third term is the expected bankruptcy penalties. For notational simplicity, $\mu(\alpha)$ and $\sigma(\alpha)$ are abbreviated as μ and σ .

Lemma 5: The manager's expected utility can be expressed as;

$$U(\alpha) = \frac{\sigma_a^2}{\Sigma} \times \phi(\frac{r^f - \mu}{\Sigma}) - F \times \Phi\left(\frac{r^f - \mu}{\Sigma}\right) \tag{3.8}$$

where ϕ and Φ are PDF and CDF of standard normal distribution respectively[10].

Proof: See Appendix 2.

The expected reputation consists of two parts: $\frac{\sigma_a^2}{\Sigma}$, a part proportional to the relative weight placed on the observation of ability, and $\phi(\cdot)$, the expected value of the

[10] Observe that if we plug in $-\infty$ instead of r^f, then $\phi\left(\frac{-\infty - \mu_i}{\Sigma_i}\right) \to 0$, and $\Phi\left(\frac{-\infty - \mu_i}{\Sigma_i}\right) \to 0$. Thus the posterior mean perceived ability becomes zero, which is the same as prior mean perceived ability ($a_0 = 0$).

observation on ability. The expected bankruptcy penalties are the bankruptcy penalties multiplied by the probability of failure.

Proposition 4: Assume that substantial bankruptcy penalties are imposed on the manager if the bank goes bankrupt. Assume also that the manager's choice of risky asset is observable. Then a risk-neutral manager who maximizes the expected value of posterior mean ability chooses the least risky asset available.

Proof: (i) $\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$ (Appendix 3)

While the effect of a marginal increase of α on expected reputation is ambiguous, the probability of failure unambiguously increases with α. Thus if the bankruptcy penalties are large enough, the expected utility decreases with α. That is, $\frac{dU(\alpha)}{d\alpha} < 0$, if F is large enough such that:

$$F > \frac{\sigma_a^2 \times \sigma \times \sigma' \times \Sigma^2 - \sigma_a^2 (r^f - \mu)\left(\mu' + (r^f - \mu) \times \sigma \times \sigma'\right)}{\Sigma^2 \times \left(\mu' \times \Sigma^2 + (r^f - \mu) \times \sigma \times \sigma'\right)} \quad \text{for all } \alpha \in [0.1].$$

(ii) $\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$ (Appendix 4)

Under the condition that $r^f < \mu(\alpha^*)\left[1 - \frac{\varepsilon_\mu}{\varepsilon_\sigma} - \frac{\varepsilon_\mu}{\varepsilon_\sigma} \times \frac{\sigma_a^2}{\sigma^2(\alpha^*)}\right]$, for $\forall \alpha^* \in [0,1]$, one has the same result as in the above case. That is, it holds that $\frac{dU(\alpha)}{d\alpha} < 0$ for large enough bankruptcy penalties, F. QED.

For a risk-averse manager it is difficult to predict the optimal risk of the manager, because a decrease in risk brings a trade-off between the decrease in the probability of failure and an increase in the variance of the posterior mean ability. The specific level of risk will depend on the functional form of the manager's utility function.

3.2.2 Case 2: Manager's Actions Are Unobservable

The equilibrium payoff to the manager is given in equation (3.8), which is reintroduced as:

$$U(\alpha^*) = \frac{\sigma_a^2}{\Sigma(*)} \times \phi\left(\frac{r^f - \mu(*)}{\Sigma(*)}\right) - F \times \Phi\left(\frac{r^f - \mu(*)}{\Sigma(*)}\right) \qquad (3.8)$$

where $\Sigma(*) = \Sigma(\alpha^*)$ and $\mu(*) = \mu(\alpha^*)$ denote the equilibrium parameter values in abbreviation forms.

Let $U(\alpha^d)$ denote the utility, and $\Sigma(d) = \Sigma(\alpha^d)$, $\mu(d) = \mu(\alpha^d)$ the parameter values the manager obtains by deviating from the equilibrium.

Lemma 6: The manager's expected utility when he deviates the equilibrium can be expressed as:

$$U(\alpha^d) = \frac{\sigma_a^2 \Sigma(d)}{\Sigma^2(*)} \phi\left(\frac{r^f - \mu(d)}{\Sigma(d)}\right) + \frac{\sigma_a^2(\mu(d) - (\mu(*))}{\Sigma^2(*)}\left[1 - \Phi\left(\frac{r^f - \mu(d)}{\Sigma(d)}\right)\right]$$

$$- F \times \Phi\left(\frac{r^f - \mu(d)}{\Sigma(d)}\right) \qquad (3.9)$$

Proof: See Appendix 5. QED.

***Lemma** 7*: Using the results of Lemma 5 and Lemma 6, the gains in expected utility the manager obtains by deviation are calculated as:

$$U(\alpha^d) - U(\alpha^*) = \frac{\sigma_a^2}{\Sigma^2(*)}\left[\Sigma(d)\phi(d) - \Sigma(*)\phi(*) + (\mu(d) - (\mu(*))(1 - \Phi(d))\right]$$

$$- F \times (\Phi(d) - \Phi(*)). \qquad (3.10) \blacklozenge$$

The first term of RHS represents the expected reputational gain, and the second terms represents the difference in the expected bankruptcy penalties that the manager obtains by deviating the equilibrium.

Proposition 5: Assume that substantial bankruptcy penalties are imposed on the manager if the bank goes bankrupt. Assume also that the manager's choice of risky asset is unobservable by the labor market.

(1) If risk-return profiles are characterized by $\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$, then the only equilibrium that can be sustained as the second-best reputational equilibrium is $\alpha^* = 0$ for both of the risk-neutral and risk-averse managers.

(2) If risk-return profiles are characterized by $\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$. Then the only equilibrium that can be sustained as the second-best reputational equilibrium is $\alpha^* = 0$ for the risk-neutral manager.

Proof: (1) As before, the manager will never deviate by choosing $\alpha^d > \alpha^*$. This is because, in this case, the expected bankruptcy penalties are larger $(\Phi(d) > \Phi(*))$ and the expected reputational gain is negative[11]. On the other hand, it always pays for the manager to deviate by choosing $\alpha^d < \alpha^*$. In this case, the expected bankruptcy penalties are smaller $(\Phi(d) < \Phi(*))$ and the expected reputational gain is positive. Thus the manager will deviate any equilibrium with $\alpha^* > 0$ by choosing $\alpha^d < \alpha^*$. Therefore the only sustainable equilibrium is $\alpha^* = 0$.

(2) If the manager deviates the equilibrium by choosing $\alpha^d > \alpha^*$, the expected reputational gain is positive. However, the expected bankruptcy penalties becomes larger under the condition $r^f < \mu(\alpha^*)\left[1 - \frac{\varepsilon_\mu}{\varepsilon_\sigma} - \frac{\varepsilon_\mu}{\varepsilon_\sigma} \times \frac{\sigma_a^2}{\sigma^2(\alpha^*)}\right]$ for all $\alpha^* \in [0,1]$. Thus there is a trade-off between the expected reputational gain and the increase in the expected bankruptcy penalties. If the increase in expected bankruptcy penalties dominates the expected reputational gain for all $\alpha \in [0,1]$, it does not pay for the manager to deviate the equilibrium by choosing $\alpha^d > \alpha^*$. For similar reasoning, it pays for the manager to deviate the equilibrium by choosing $\alpha^d < \alpha^*$. Therefore, the only sustainable equilibrium in this case will be $\alpha^* = 0$. QED.

Note that the second part of Proposition 5 is only for risk-neutral manager. For a risk-averse manager, additional information on the degree of risk aversion or the specific functional form is needed to make a prediction on the optimal risk of the manager.

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[11]) This is obvious. We know from the equation (3.4) that the expected reputational gain is negative when the expectation is taken for the entire support [-∞, +∞]. (It was $\frac{\sigma_a^2(\mu(d) - \mu(*))}{\Sigma^2(*)} < 0$). The expectation for the case under consideration is taken for the range $[\frac{r^f - \mu}{\Sigma}, +\infty]$. The difference in the two partial expectations must be proportional to and have the same sign as the difference in the expectation taken for the entire support.

3.3 Summary of the Section

Table 3.1 summarizes that the relation between risk and managerial career concerns can be either positive or negative depending on underlying assumptions about various factors such as manager's risk tolerance, the characteristics of risk-return profiles, the severity of bankruptcy penalties to the manager, and most of all, whether the manager's actions are observable or not.

When bankruptcy penalties are absent (or negligible), predictions on the relation between risk and career concerns are quite diverse. When the manager's actions are observable, it is generally expected that there is a non-negative relation between the two. When the manager's actions are unobservable, the effect of managerial career concerns on the manager's investment behavior is different depending on the underlying characteristics of risk-return profile. The two are predicted to be negatively related if the risk-return profile is characterized by $\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$, and positively related if the risk-return profile is characterized by $\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$.

When bankruptcy penalties are substantial, it is generally expected that a negative relation between the two occurs unless the manger is very risk-averse. In the analysis, it is assumed that the manager behaves approximately in a risk neutral fashion. A risk neutral manager will be concerned with only the reputational gain (i.e., the expected value of mean posterior ability), but not the reputational risk (i.e., the variance of mean posterior ability). For a risk-averse manager who evaluates both the reputational gain and risk in choosing asset risk, it is hard to predict the relation between asset risk and managerial career concerns.

Table 3.1: Summary of the Relation between Risk and Career Concerns

<table>
<tr><th></th><th colspan="3">Assumptions</th><th>Relation between risk and career concerns</th><th>Case Number</th></tr>
<tr><td rowspan="5">Without F[1]</td><td rowspan="2">Actions observable</td><td colspan="2">Risk-averse manager</td><td>Positive relation</td><td>< 1 ></td></tr>
<tr><td colspan="2">Risk-neutral manager</td><td>No relation</td><td>< 2 ></td></tr>
<tr><td rowspan="3">Actions not observable</td><td>$\mu'(\alpha) < 0$[2]
$\sigma'(\alpha) > 0$</td><td>Risk-neutral or averse manager</td><td>Negative relation</td><td>< 3 ></td></tr>
<tr><td rowspan="2">$\mu'(\alpha) > 0$[3]
$\sigma'(\alpha) > 0$</td><td>Risk-neutral manager</td><td>Positive relation</td><td>< 4 ></td></tr>
<tr><td>Risk-averse manager</td><td>Indeterminate</td><td>< 5 ></td></tr>
<tr><td rowspan="5">With F</td><td rowspan="2">Actions observable</td><td colspan="2">Risk-averse manager
F large</td><td>Indeterminate</td><td>< 6 ></td></tr>
<tr><td colspan="2">Risk-neutral manager
F large</td><td>Negative relation</td><td>< 7 ></td></tr>
<tr><td rowspan="3">Actions not observable</td><td>$\mu'(\alpha) < 0$[2]
$\sigma'(\alpha) > 0$</td><td>Risk-neutral or risk- averse manager</td><td>Negative relation</td><td>< 8 ></td></tr>
<tr><td rowspan="2">$\mu'(\alpha) > 0$[3]
$\sigma'(\alpha) > 0$</td><td>Risk-neutral anager
F large</td><td>Negative relation</td><td>< 9 ></td></tr>
<tr><td>Risk-averse manager
F large</td><td>Indeterminate</td><td>< 10 ></td></tr>
</table>

1) F is bankruptcy penalties.
2) Increase in risk is associated with decrease in mean return.
3) Increase in risk is associated with increase in mean return.

4. Empirical Analysis

4.1 Testing Hypothesis

The manager's action (choice of risky asset) is proxied by a measure of portfolio risk based on accounting data. The portfolio risk is defined as the proportion of risky assets in a bank's portfolio such as the ratio of risk-weighted assets to total assets based on the Basle Accord risk-based capital guidelines (RWA/TA), and the ratio of nonperforming assets to total assets (NPRF/TA). These ratios are revealed to the general public through various kinds of financial statements such as annual report (10-K). The bank is also required to submit this information to bank regulators, for example, in its call reports. Therefore, it seems reasonable to assume that these ratios are readily observable by outsiders. However, a proxy variable for unobservable manager's action is unable to be obtained. Accordingly, an empirical test for the relationship between asset risk and managerial career concerns is confined only to the cases 1, 2, 5, and 6 in Table 3.1, where the manager's actions are observable.

The other factors that need to be controlled to implement the test are manager's risk tolerance, and the severity of bankruptcy penalties to the manager. Unfortunately, these two factors are unable to be controlled in an empirical analysis. A possible procedure for empirical tests is (1) to make reasonable assumptions on each of these two factors, (2) to establish testing hypotheses, and then (3) to find empirical evidence which may or may not support the hypotheses. One problem with this method is that it is difficult to make reasonable assumptions on each of these factors. Therefore I follow the procedure in the inverse order. That is, I (1) set up a testing equation, (2) find empirical evidence, and then (3) suggest implications on the underlying assumptions.

4.2 Variable Description

The portfolio risk considered in this chapter is the same as the one used in Chapter II, i.e., an index (denoted as *FACTOR*) that combines two measures of portfolio risk. A detailed description of the measures of portfolio risk and various control variables such as, *Capital-to-Asset Ratio (CAR), Managerial Ownership Share (MOS), Asset Return (ROA), Bank Size (log(Total Asset)),* are referred to in Section 4 of Chapter II.

4.2.1 Career Concerns Variables: *CEO age, Years on Board*

Even though it may be the case that all officers and directors as a group are involved in determining the bank's asset risk, I focus on the career concerns of the CEO. This is not only because it is very difficult to get reasonable data on career concerns of all officers and directors as a group, but also because the CEO plays the most important role in determining the risk policy of the bank.

I view the age of the CEO, denoted *CEO Age*, as the best available proxy for the CEO's stage in his career. I presume both internal and external career concerns will be greater for younger CEOs who have many years remaining in the active work force. A younger CEO is likely to serve the bank for a longer period by having more chances to get reappointed as CEO. A younger CEO will be more interested in post-retirement opportunities such as serving outside (both corporate and community) directorships, entering politics, acting as consultants, judgeships, and so on (Brickley, Coles and Linck, 1998). Therefore it is expected that a CEO would have less career concerns, as he gets older. I use the negative of *CEO age* to measure the career concerns of the CEO, so that a higher value of the variable indicates greater career concerns.

Studies on career concerns (for example Gibbons & Murphy, 1992; Brickley, et al., 1999) have used CEO tenure as a proxy for the CEO's career concerns. The basic intuition is that the uncertainty about the CEO's ability decreases the longer the CEO is with the firm. If there is less uncertainty about CEO ability, he will have less incentive to take actions to influence the labor market's belief on his ability (see Section 3 of this chapter). Moreover, the CEO's control benefits also decrease as the CEO tenure increases, because there are fewer periods remaining until retirement. Considering these two effects together, it is expected that the CEO has smaller career concerns as his tenure increases. CEO tenure, however, is not used in this study, because not all the proxy statements disclose the year the CEO joined the firm.

Empirical studies, for example Adams (2001), have used the number of years the CEO has been on the board (*Years on Board*) as a proxy for the CEO's tenure. I believe, however, *Years on Board* provides only limited and noisy information on a CEO's career history for the following reasons. First, some CEOs in the sample have been transferred from positions in other companies and started their careers in the banks as the banks' CEOs. The number of years that these CEOs have been on the board of the bank will be substantially shorter than those of the other CEOs who are in a similar stage in their career. Second, even though the longer *Years on Board* implies smaller internal career concerns within the bank (i.e. CEOs are closer to retirement), it does not necessarily mean smaller external career concerns that the CEOs can have after retirement. For these reasons, *Years on Board* is considered to be an inferior measure of career concerns to *CEO Age*. I use the variable *Years on Board* as a robustness check for the results obtained from the regression with *CEO Age*. Consistent with *CEO age*, I use the negative of *Years on Board* to measure the career concerns of CEO.

4.3 The Data and Summary Statistics

Data are collected from two sources. Data for variables regarding career concerns - *CEO age, Years on Board* - and managerial ownership share are collected from a bank's proxy statement which is filed with the Securities Exchange Committee (SEC) on the form DEF 14A. Accounting data are obtained from the consolidated financial statements for bank holding companies (BHCs) filed with the Federal Reserve System (FRS) on the form FR Y-9C. A detailed description for collecting data is referred to in Section 5 of Chapter II.

Table 4.1 reports information on two proxy variables for career concerns. CEOs in the sample are 55.3 years old on average, the youngest being 35 and the oldest being 80 years old. The years on board for the CEOs are 12.4 on average, ranging from 0 to 41. Table 4.2 reports Spearman's rank correlation coefficients and p-values between variables. The correlations between measures of portfolio risk and career concerns variables are very small in magnitude and statistically insignificant. This suggests that the managerial career concerns are not related in a significant way to the bank risk as measured by portfolio risk. It is shown that the two proxy variables for career concerns, *CEO Age* and *Years on Board*, are highly correlated each other with Spearman's rank correlation coefficient of 0.42 and p-value of 0.0.

Table 3.2 Summary Statistics

	Mean	Standard Deviation	Minimum	Maximum	Number of Obs.
CEO Age	55.4	7.6	35	80	509
Years on Board	12.4	8.1	0	41	503

Table 3.3 Spearman's Rank Correlation Coefficients

	RWTA/TA	NPRF/TA	FACTOR	Years on Board
CEO Age	-.011 <.80>	-.013 <.77>	-.027 <.54>	.419 <.0>
Years on Board	-.03 <.50>	-.019 <.67>	-.047 <.29>	

- p-values for the tests that two variables independent are reported in < >.

4.4 Regression Results

Table 3.4 reports regression results for the tests on the relationship between portfolio risk and managerial career concerns. The managerial career concerns is measured by negative *CEO age* in regression (1), and by negative *Years on Board* in regression (2). It is shown that the two regressions have similar results. All the explanatory variables including the career concerns variables have coefficients with similar magnitudes and similar significances. It may be noted that non-linear or dynamic relationships with respect to capital-to-asset ratio and managerial ownership are ignored, because they are not primary concerns in this study. Allowing changing slopes and interaction terms of these two variables as in Chapter II did not affect the estimates on the career concerns variables.

The career concerns variables have positive coefficients, but they are insignificant both practically and statistically. It is estimated in regression (1) that a CEO younger by 10 years increases portfolio risk as measured by FACTOR × 100 only by the magnitude of 2.2. This is very small amount considering that the standard deviation of the risk measure is 27.4. To check if the two measures of portfolio risk – RWA/TA and NPRF/TA – are related to career concerns variables in a different fashion, each of the two measures is regressed separately (Table 3.5). It is shown that RWA/TA has significant relationship with career concerns variables, while NPRF/TA has not.

Overall the regression results show at most marginal evidence that career concerns are positively related to portfolio risk. However the magnitudes of the coefficients are too small to believe that there is any identifiable relationship between career concerns and bank's risk. This evidence is generally consistent with the case < 2 >

in Table 3.1, where it is assumed that (1) bankruptcies penalties are negligible, (2) manager's actions are observable, and (3) the manager behaves approximately in a risk-neutral fashion (or a small degree of risk-aversion).

Table 3.4: Ordinary Least Squares Regression Results for Tests on the Relationship between Portfolio Risk and Managerial Career Concerns (A)

		Dependent Variable: FACTOR × 100	
	Predicted Sign	(1)	(2)
Career Concerns I[1]	..	.22 [1.5]	
Career Concerns II[2]	..		.19 [1.6]
Capital-to-Asset Ratio	+	2.03*** [2.9]	2.0*** [2.9]
Managerial Ownership	+	.1 [1.2]	.1 [1.2]
Return on Asset	–	-8.66* [-1.9]	-8.45* [-1.8]
Log(asset)	+	4.61*** [5.7]	4.51*** [5.6]
R-Squared		.08	.08
Number of Observations		507	499

1. Negative CEO Age
2. Negative Years on Board
3. Heteroscedasticity robust t-statistics are given in brackets.
4. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.
5. The theoretical model does not provide predicted signs for the career concerns variables. The signs of control variables are predicted according to the regression results in Chapter II.

Table 3.5: Ordinary Least Squares Regression Results for Tests on the Relationship between Portfolio Risk and Managerial Career Concerns (B)

	Dependent Variable			
	RWA/TA (3)	NPRF/TA (4)	RWA/TA (5)	NPRF/TA (6)
Career Concerns I[1]	.12* [1.8]	.001 [.5]		
Career Concerns II[2]			.12** [2.0]	.0002 [.1]
Capital-to-Asset Ratio	.75** [2.3]	.03** [2.6]	.74** [2.4]	.03** [2.6]
Managerial Ownership	.09** [2.1]	-.001 [-.9]	.08** [2.1]	-.001 [-.8]
Return on Asset	1.46 [1.1]	-.38*** [-2.9]	1.63 [1.4]	-.38*** [-2.8]
Log(asset)	2.31*** [5.7]	.04*** [2.6]	2.28*** [5.5]	.03** [2.5]
R-Squared	.10	.15	.10	.15
Number of Observations	507	508	499	500

1. Negative CEO Age
2. Negative Years on Board
3. Heteroscedasticity robust t-statistics are given in brackets.
4. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

5. Conclusion

This paper examined the effect of managerial career concerns on banks' risk-taking behavior. The major findings of the paper can be summarized as follows. First, the theoretical analysis has confirmed the finding of Hermalin(1993) that a risk-averse manager will prefer the riskiest investment project available when the manager's choice of risky project is observable by the labor market. It is shown that while the expected value of posterior mean ability is the same across various levels of investment risk, the variance of the posterior mean ability decreases with the riskiness of the invested asset. In this situation, a risk-averse manager whose expected payoff is simply the expected value of posterior mean ability would like to decrease the riskiness of his payoff from reputation by increasing the riskiness of the investment asset. The reasoning suggests that a risk-neutral manager, on the other hand, will be indifferent among risky investment alternatives. The empirical implication is a positive relation between asset risk and managerial career concerns for a risk-averse manager, and no significant relation between the two for a risk-neutral manager.

Second, it is shown that when the manager's actions are not observable by the labor market, his risk-taking behavior is different depending on the underlying assumptions regarding the properties of the investment opportunity set. For example, if the risk-return profiles are characterized in such a way that a higher risk is associated with a lower mean return, the reputational gain from deviation is positive when the manager deviates from the equilibrium by choosing a risk level that is smaller than the equilibrium level. Since the market, in equilibrium, will make a correct conjecture about the manager's action, the only equilibrium that can be sustained as the second-best reputational equilibrium is that the market believes and the manager actually chooses the least risky asset in the set of risky alternative assets. The prediction is a negative relation between asset risk and managerial career concerns.

Third, if substantial bankruptcy penalties to the manager are introduced in the analysis, a risk-neutral manager not only considers the expected reputational gain but also considers the expected bankruptcy penalties. When model assumptions are constructed in such a way that the probability of failure increases with asset risk, it pays for the manager to choose less risky assets among the set of investment alternatives. In this case the theoretical analysis concludes there should be a negative relation between asset risk and managerial career concerns.

Fourth, empirical tests on the predictions made by the theoretical analysis are provided. In the regression with a measure of portfolio risk as the dependent variable, I find a positive but insignificant coefficient on the career concerns variable as measured by negative *CEO Age*. This implies there is no discernible relationship between managerial career concerns and asset risk when the measure of risk is readily observable by outsiders. This evidence is also consistent with the assumptions that (1) bankruptcies penalties are negligible, and (2) the manager behaves approximately in a risk-neutral fashion (or a small degree of risk-aversion).

APPENDIX

1. Proof of Lemma 4

The probability of failure is;

$$P = \int_{-\infty}^{r^f} \left\{ \frac{1}{\sqrt{2\pi}\,\Sigma} e^{-\frac{1}{2}\left[\frac{y-\mu}{\Sigma}\right]^2} \right\} dy = \int_{-\infty}^{\frac{r^f-\mu}{\Sigma}} \left\{ \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}z^2} \right\} dy = \Phi\left(\frac{r^f - \mu}{\Sigma} \right).$$

Note that

$$\frac{\partial \frac{1}{\Sigma}}{\partial \alpha} = \frac{\partial \left[\sigma_a^2 + \sigma^2(\alpha)\right]^{-\frac{1}{2}}}{\partial \alpha} = -\frac{1}{2} \times \left[\sigma_a^2 + \sigma^2(\alpha)\right]^{-\frac{3}{2}} \times 2\sigma(\alpha) \times \sigma'(\alpha) = -\frac{\sigma(\alpha) \times \sigma'(\alpha)}{\Sigma^3}. \quad \text{(AP1)}$$

Using this result, it is shown that;

$$\frac{\partial P(K,\alpha)}{\partial \alpha} = f\left(\frac{r^f - \mu}{\Sigma}\right) \times H, \text{ where } H = \frac{-\mu'(\alpha)}{\Sigma} - \frac{(r^f - \mu) \times \sigma \times \sigma'}{\Sigma^3}.$$

The sign of H is positive if $\mu'(\alpha) < 0$ and $\sigma'(\alpha) > 0$ because we are assuming $r^f < \mu(\alpha)$. If risk-return profile is characterized by $\mu'(\alpha) > 0$ and $\sigma'(\alpha) > 0$, it is positive if $r^f < \frac{\mu \times \sigma \times \sigma' - \mu' \times \Sigma^2}{\sigma \times \sigma'}$, which can be expressed as;

$$r^f < \mu(\alpha)\left[1 - \frac{\mu'\alpha}{\mu} \times \frac{\sigma}{\sigma'\alpha} \times \frac{\Sigma^2}{\sigma^2}\right]$$

$$= \mu(\alpha)\left[1 - \frac{\varepsilon_\mu}{\varepsilon_\sigma} \times \frac{\sigma_a^2 + \sigma^2(\alpha)}{\sigma^2(\alpha)}\right] = \mu(\alpha)\left[1 - \frac{\varepsilon_\mu}{\varepsilon_\sigma} - \frac{\varepsilon_\mu}{\varepsilon_\sigma} \times \frac{\sigma_a^2}{\sigma^2(\alpha)}\right].$$

2. Proof of Lemma 5

The realized return, r_l, is normally distributed according to $N(\mu(\alpha), \Sigma^2(\alpha))$. Thus, using $r = \Sigma \times z + \mu$, the equation (3.7) can be rewritten as:

$$U(\alpha) = \frac{\sigma_a^2}{\Sigma^2} \times \int_{\frac{r^f - \mu}{\Sigma}}^{\infty} (\Sigma z) \left\{ \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2} z^2} \right\} dz \; - F \times \int_{-\infty}^{\frac{r^f - \mu}{\Sigma}} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2} z^2} dz$$

$$= \frac{\sigma_a^2}{\Sigma^2} \times \int_{\frac{r^f - \mu}{\Sigma}}^{\infty} (\Sigma z) \phi(z) dz - F \times \Phi\left(\frac{r^f - \mu}{\Sigma} \right),$$

where ϕ and Φ are PDF and CDF of standard normal distribution respectively. In a standard normal distribution, it can be shown that $z\phi(z) + \phi'(z) = 0$. Using this property, we finally get the following result.

$$U(\alpha) = \frac{\sigma_a^2 \Sigma}{\Sigma^2} \times \int_{\frac{r^f - \mu}{\Sigma}}^{\infty} -\phi'(z) dz - F \times \Phi\left(\frac{r^f - \mu}{\Sigma} \right)$$

$$= \frac{\sigma_a^2 \Sigma}{\Sigma^2} \times \left[0 - (-\phi(\frac{r^f - \mu}{\Sigma})) \right] - F \times \Phi\left(\frac{r^f - \mu}{\Sigma} \right)$$

$$= \frac{\sigma_a^2}{\Sigma} \times \phi(\frac{r^f - \mu}{\Sigma}) - F \times \Phi\left(\frac{r^f - \mu}{\Sigma} \right).$$

3. Proof of Proposition 4 Part (i) ($\mu'(\alpha)<0, \sigma'(\alpha)>0$)

Using (AP1), it is shown that;

$$\frac{\partial U(\alpha)}{\partial\alpha} = -\frac{\sigma_a^2 \times \sigma \times \sigma'}{\Sigma^3} \times \phi(\frac{r^f-\mu}{\Sigma}) + \frac{\sigma_a^2}{\Sigma} \times \phi'(\frac{r^f-\mu}{\Sigma}) \times H$$

$$-F \times \phi(\frac{r^f-\mu}{\Sigma}) \times H \qquad \text{(AP2)}$$

where $H = \frac{-\mu'(\alpha)}{\Sigma} - \frac{(r^f-\mu)\times\sigma\times\sigma'}{\Sigma^3} > 0$. It may be recalled that we are assuming (1) $\mu'(\alpha)<0$, $\sigma'(\alpha)>0$, and (2) $r^f < \mu(\alpha)$. The second assumption implies $\phi'(\bullet)>0$. Thus the first and third terms of RHS are negative and the second term is positive. This means that the effect of a marginal increase of α on expected reputation is ambiguous, and the probability of failure unambiguously increases with α.

Using $z\phi(z)+\phi'(z)=0$, the second term of the RHS can be substituted by the term $-\frac{\sigma_a^2}{\Sigma} \times \frac{r^f-\mu}{\Sigma} \times \phi(\frac{r^f-\mu}{\Sigma}) \times H$. Using this, the above equation can be rearranged as;

$$\frac{\partial U(\alpha)}{\partial\alpha} = -\phi(\frac{r^f-\mu}{\Sigma}) \times \left[HF + \frac{\sigma_a^2}{\Sigma} \times \frac{r^f-\mu}{\Sigma} H + \frac{\sigma_a^2 \times \sigma \times \sigma'}{\Sigma^3} \right] \qquad \text{(AP3)}$$

It is obvious that the expected utility function is a decreasing function of α if the bankruptcy penalties are sufficiently large. That is, $\frac{\partial U(\alpha)}{\partial\alpha} < 0$ if

$$F > -\frac{\sigma_a^2}{\Sigma} \times \frac{r^f-\mu}{\Sigma} - \frac{\sigma_a^2 \times \sigma \times \sigma'}{\Sigma^3 H}$$

$$= \frac{\sigma_a^2 \times \sigma \times \sigma' \times \Sigma^2 - \sigma_a^2 (r^f-\mu)\left(\mu' + (r^f-\mu)\times\sigma\times\sigma'\right)}{\Sigma^2 \times \left(\mu' \times \Sigma^2 + (r^f-\mu)\times\sigma\times\sigma'\right)} \text{ for all } \alpha \in [0.1]. \qquad \text{(AP4)}$$

4. Proof of Proposition 4 Part (ii) $(\mu'(\alpha) > 0, \sigma'(\alpha) > 0)$

From the equation (AP2), the sign of $H = \frac{-\mu'(\alpha)}{\Sigma} - \frac{(r^f - \mu) \times \sigma \times \sigma'}{\Sigma^3}$ is now indeterminate because we are now assuming $\mu'(\alpha) > 0$. Recall that we are assuming $\frac{d}{d\alpha}\left[\frac{\mu(\alpha)}{\Sigma(\alpha)}\right] = \frac{\mu' \times \Sigma^2 - \mu \times \sigma \times \sigma'}{\Sigma^3} < 0$. Thus the sign of H is positive if $r^f < \mu(\alpha^*)\left[1 - \frac{\varepsilon_\mu}{\varepsilon_\sigma} - \frac{\varepsilon_\mu}{\varepsilon_\sigma} \times \frac{\sigma_a^2}{\sigma^2(\alpha^*)}\right]$. In this case, the same result holds as in the case of $\mu'(\alpha) < 0, \sigma'(\alpha) > 0$. That is, the first and third terms of RHS in equation (AP2) are negative and the second term is positive. Therefore, $\frac{\partial U(\alpha)}{\partial \alpha} < 0$ for large F such as hat in the condition (AP4).

$$F > \frac{\sigma_a^2 \times \sigma \times \sigma' \times \Sigma^2 - \sigma_a^2 (r^f - \mu)\left(\mu' + (r^f - \mu) \times \sigma \times \sigma'\right)}{\Sigma^2 \times \left(\mu' \times \Sigma^2 + (r^f - \mu) \times \sigma \times \sigma'\right)}.$$

5. Proof of Lemma 6

From equation (3.4) and by the assumption $a_0 = 0$, it follows that $a_1(\alpha^d) = \frac{\sigma_a^2 (r_1 - \mu(\alpha^*))}{\Sigma^2(\alpha^*)}$. The realized return, r_1, is normally distributed according to $N(\mu(\alpha^d), \Sigma^2(\alpha^d))$. Thus, the expected utility in deviation is calculated as:

$$U(\alpha^d) = \int_{r^f}^{\infty} \frac{\sigma_a^2}{\Sigma^2(*)} (y - \mu(*)) \left\{ \frac{1}{\sqrt{2\pi}\,\Sigma(d)} e^{-\frac{1}{2}\left[\frac{y-\mu(d)}{\Sigma(d)}\right]^2} \right\} dy - F \times \int_{-\infty}^{r^f} \left\{ \frac{1}{\sqrt{2\pi}\,\Sigma(d)} e^{-\frac{1}{2}\left[\frac{y-\mu(d)}{\Sigma(d)}\right]^2} \right\} dy .$$

Using $r = \mu(d) + \Sigma(d) \times z$, the above equation can be rewritten as:

$$U(\alpha^d) = \frac{\sigma_a^2}{\Sigma^2(*)} \times \int_{\frac{r^f - \mu(d)}{\Sigma(d)}}^{\infty} (\Sigma(d) z + \mu(d) - \mu(*)) \left\{ \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2} z^2} \right\} dy - F \times \Phi\left(\frac{r^f - \mu(d)}{\Sigma(d)} \right)$$

$$= \frac{\sigma_a^2 \Sigma(d)}{\Sigma^2(*)} \phi\left(\frac{r^f - \mu(d)}{\Sigma(d)} \right) - \frac{\sigma_a^2 (\mu(*) - \mu(d))}{\Sigma^2(*)} \left[1 - \Phi\left(\frac{r^f - \mu(d)}{\Sigma(d)} \right) \right] - F \times \Phi\left(\frac{r^f - \mu(d)}{\Sigma(d)} \right),$$

which gives the equation (3.9).

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