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Risk Taking, Guarantees, Securitization and the Option to Change Strategy: The Economics of Pulling a Fast One

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Abstract
of

Risk Taking, Guarantees, Securitization and the Option to Change Strategy: The Economics of Pulling a Fast One

This paper analyzes the risk-taking behavior of financial intuitions that have guarantees (e.g., banks with deposit insurance or Government Sponsored Enterprises with implicit guarantees) and/or institutions that find it beneficial to develop a reputation for not taking risk. For instance, banks putting together asset-backed securities have a choice of delivering the riskiest loans they can get away with or putting safe loans into deals because developing a reputation for selling good securities will get them larger fees later. The paper focuses on the following questions: Is it rational for financial institutions to take on less risk than they can get away with, and if it is rational, under what conditions will they shift strategies and increase their risk after having established a reputation for low risk? To answer the question we allow for future benefits from survival in the form of "franchise value," which comes from a good reputation and/or from continuing to receive a guarantee, and which they might lose if they increase risk. With franchise value they might take less risk than they are allowed; however, if they experience large enough negative shocks, they can reach a tipping point where they will change their strategy discontinuously, and "gamble for resurrection."

I. Introduction

This paper analyzes the risk-taking behavior of financial intuitions that have guarantees (e.g., banks with deposit insurance or Government Sponsored Enterprises with implicit guarantees or any of the financial institutions (FIs) around the world that are "Too Big To Fail") or institutions that find it beneficial to develop a reputation for not taking risk. For instance, banks putting together asset-backed securities (ABS) have a choice of delivering the riskiest loans they can get away with or putting safe loans into deals because developing a reputation for selling good securities will get them larger fees later. The bailouts of different institutions like Bear Stearns, Fannie Mae, Freddie Mac, and the American International Group (AIG) by the US government, and the apparent *de facto* coverage of European bank depositors suggest that most important financial intuitions have some sort of financial guarantee along with options to use the guarantees strategically. Changes in underwriting standards associated with securitizing subprime loans and the recent unraveling of that market suggest that strategic behavior of FIs putting together ABS deals are subject to possibly large changes in strategic decisions about risk-taking.

The paper focuses on two questions: Is it rational for FIs to take on less risk than they can get away with; and if it is rational, under what conditions will they shift strategies and increase their risk after having established a reputation for low risk? To answer the first question we allow for future benefits from survival in the form of franchise value, which comes from a good reputation or from continuing to receive a guarantee, and which they might lose if they increase risk. With franchise value they might take less risk than they are allowed. However, if they experience large enough negative shocks, they can reach a tipping point where they will change their strategy discontinuously, and "gamble for resurrection." Our contribution is to bring future considerations into strategic behavior.

We focus first on the case of a bank with a guarantee; we return to the (isomorphic) securitization application later on. We model the guarantee as having two parts: a current guarantee, which is a put option that guarantees debt until the next "audit," and a franchise value, which is the right to future benefits of the bank's charter, including access to future guarantees, if the institution passes the audit. That there is a cost to defaulting in the form of losing a valuable asset, the franchise, can limit the institution's risk-taking even though it could get away with a large amount of risk-taking after its audit. However, bad luck during a particular period can increase risk-taking, and perhaps in a very abrupt way. Hence, an important part of the value of a guarantee is in the option to change strategy between audits, or the option to "Gamble for Resurrection."

Our point of departure is a well known model of deposit insurance by Merton (1977), which uses the Black-Scholes option pricing model to price deposit insurance and other guarantees. It does this by modeling the guarantee as a put option which would be exercised at the end of an audit if the bank has negative net worth. The model has been used in empirical work, for example, Marcus and Shaked (1984), Ronn and Verma (1986). These papers found that deposit insurance was apparently overpriced, given estimated parameters of the option model. However, the widespread losses caused by failures in the Savings and Loan Industry in the 1980s suggest that overcharging for insurance was not a problem.

We find that FIs have incentives to take on a low level of risk for sufficiently high franchise value and/or asset value. They will adjust their strategy if there are changes in asset value, with small adjustments for small shocks. However, there are also threshold values of franchise and asset value that will trigger discontinuous changes (gambling for resurrection) in risk-taking. Something quite analogous happens with banks that put together structured securitization deals. Developing a good reputation by selling low risk securities is a sort of franchise, but strategy can change abruptly, for instance as competition and the range of risk possibilities increase.

II. Background

Debt has been widely studied using option pricing models. Earlier studies are Merton (1974), Geske (1977), Galai and Masulis (1976), and Galai (1988). All these studies price the value of firms' debts as put options. Debt insurance, or more specifically deposit insurance, has also had a comprehensive literature. The first to model deposit insurance as a put option is Merton (1977).

Merton (1978), Marcus and Shaked (1984), Ronn and Verma (1986) and others have developed option-based models of deposit insurance. For example, Ronn and Verma (1986) argue that while banks tend to take more risk given the existence of deposit insurance, risk-adjusted deposit insurance can provide incentives to the banks to limit risk-taking. They provide estimation on the level of risk and the value of a risk-adjusted deposit insurance premium. Furlong and Keeley (1989), using the state-preference model, find that high bank capital ratio requirements reduce the incentive for increasing asset risk and that value-maximizing banks will increase their capital rather than reduce debt in order to meet the more stringent requirements.

Ritchken *et. al.* (1993) model the shareholders' equity of a bank as a combination of its charter value, which allows its continuous operation, and the value of the deposit insurance, both of which are contingent claims. Park (1997) extends the study to solve for the optimal capital ratio and the proportion of the bank's assets invested in the risky project. Episcopos (2004) develops an option model that is used to find the optimal fund reserves for the Bank Insurance Fund (BIF), and it illustrates the results using a sample of 40 US chartered bank holding companies in the top 50 rankings. Jeitchko and Jeung (2005) provide a theoretical framework that shows that the choice of high-risk investment is a consequence of meeting stringent capital standards. They further investigate the incentives for risk-taking from the viewpoints of the deposit insurer, the shareholder, and the bank manager.

On the question of revising strategy, Foster *et al* (1994) use a VAR model to capture both credit risk and interest rate risk for a representative bank with deposit insurance and use the model to show that the ability to switch strategy in mid year (between audits) from just credit risk to both credit and interest rate risk in the event of a negative shock during the period greatly increases the value of the bank's deposit insurance. However, they do not explain why the bank does not take on both risks right from the beginning. Schwartz and Van Order (1988) develop an option-based model of the behavior of Fannie Mae in the early 1980s when it had negative net worth. They find that the implied volatility of Fannie Mae's assets did indeed go up, but not by very much, suggesting that value of Fannie Mae's charter, its implied guarantee and favorable position in the mortgage market, provided franchise value that limited its risk-taking even when it was in trouble. But that paper also did not develop a model of why they changed strategy.

III. Modeling Debt Guarantees: The Put Option Model

We model a guarantee that begins with a Merton-like model of deposit insurance.

Regulators have information about capital and have capital regulations, but are only imperfectly able to control risk-taking. In particular, we assume that they are unable to control risk-taking between audits. To simplify the problem setting, we assume that the debt is completely insured, and the insurance is not priced. We can interpret the length of time until the maturity of the insurance as the amount of time until the next audit by the guarantor of the debt with the total amount of debt throughout the period assumed constant. Then the guarantee is defined by an audit period and a rule for closure if the audit is failed. This is a convenient, if simple, metaphor for actual closure rules and capital requirements.

We assume that interest rates are constant, which is a simplification that leaves out an important part of risk. In terms of option valuation with stochastic interest rates, Rabinovitch (1989) has provided a closed form solution for call options with stochastic risk-free rates (see also Vasicek (1977) for more details). Adding a stochastic rate adds complications to the modeling and analyzing processes. For instance, when pricing bank loans subject to default risk, Grenadier and Hall (1996) also consider a stochastic interest rate in the valuation of defaultable loans. They suggest that closed-form solutions are possible for certain stochastic process specifications. However, their proposal that numerically solving the governing equation by finite-difference methods is preferable highlights the complications of analytical solutions, if they exist.

Ronn and Verma (1986) show that if interest rates are described by a lognormal diffusion process, the value of equity as a call option can still be used to obtain the value of the firm and its corresponding variance by incorporating the variance of the interest rate and the covariance between the value of the firm and the interest rate. In other words, the existence of stochasticity in interest rate need not seriously complicate the valuation of deposit insurance. They also claim that estimates of deposit insurance premium will not be seriously affected by breaking the assumption of constant interest rate. We do not introduce stochastic interest rates, but rather stay within the Black-Scholes framework with fixed interest rates because it is easier to manipulate. However, it is probably the case that a major source of quick changes in risk comes from changes in interest rate risk.

The Model

Consider a Financial Institution, which we call a *bank*, with a liability structure that consists of equity, E, and insured debt (including interest), D. If the bank's asset value, V, falls short of D (that is, it cannot repay the debt when they mature at time T), then the insurer will pay the debt holders the shortfall. Then the value of the insurance to the bank at time T is

$$P_T = Max\left[De^{r(T-t)} - V_T, 0\right] \tag{1}$$

where r is the risk-free rate, and t is the time the insurance is valued.

The value of the bank's assets at any time t is V, which is a random variable following a geometric Brownian motion, that is,

$$dV = \mu_v V\, dt + \sigma_v V dz \tag{2}$$

where μ_v and σ_v are, respectively, the instantaneous mean and volatility of dV, and dz is the Wiener process. It is obvious from (1) that the value of the insurance at any time t is a European put option with D as the exercise price. The premium of such a single-period put, representing the full deposit insurance under risk neutral pricing is given by

$$P_t = DN(-d_2) - VN(-d_1) \tag{3}$$

where $d_1 = \dfrac{\ln v + r(T-t) + \frac{1}{2}{\sigma_V}^2 T(T-t)}{\sigma_V \sqrt{T-t}}$,

$$d_2 = \frac{\ln v + r(T-t) - \frac{1}{2}{\sigma_V}^2 (T-t)}{\sigma_V \sqrt{T-t}}$$

and $v = \dfrac{V}{D}$.

The value of the bank is the value of a call on the assets at the end of the period, which is equivalent to the put in equation (3) plus the initial equity put up by the bank, $V - D$. Once initial equity is set, maximizing wealth implies choosing the optimal value of P_t, which is equivalent to maximizing volatility (because P_t is increasing in σ_v).

We extend this model to a two-period case by considering what happens at the end of the period and its link to the period after. We assume that if the bank survives, it continues to get insurance under the same conditions as in the first period. Hence, there is a benefit in the form of access to future benefits.

IV. Choosing the Level of Risk

We assume that the bank is alive for one or two periods. Its portfolio is a combination of two assets, a risky one and a safer one with asset volatilities given by σ_v^h and σ_v^l, respectively. It is possible that $\sigma_v^l = 0$. By choosing its portfolio it also chooses its risk level, σ_v, which we take to be the choice variable; σ_v must be between σ_v^h and σ_v^l. If it survives the first period, it reconstitutes itself with free insurance during the second period. During the terminal period it will take as much risk as possible because there is no cost to risk-taking. Hence, the value of the guarantee (the put option) on bank's assets in the second period is fixed at P^*, which is given by valuing the guarantee with risk level σ^h. We investigate the extent to which access to the second period guarantee and other benefits limit risk taking in the first period.

We further assume that beyond the access to future guarantees, the bank also enjoys franchise value, which may come from tax breaks, monopoly power, regulatory privileges and/or management perks. We model franchise value as coming from two sorts of benefits: those that are fixed, $F(T-t)$, such as management perks, that are independent of asset choice as long as the firm is alive, and are proportional to the length of the period between audits, and those that depend on the assets the firms hold, such as excess return on the risky asset (but not the safe one). This benefit is assumed to depend on the risk, σ_v, that the bank chooses to take on and is given by $f(\sigma_v)(T-t)$; i.e., it too is proportional to the length of the period.

Then the bank has an implicit asset, which is the sum of the benefits of future guarantees and franchise value. These are given by:

$$P_t + F(T\text{-}t) + f(\sigma_v(T-t)) \equiv B_t \tag{4}$$

$F(T-t)$ in the first period is given and is not subject to optimization, but the probability of staying alive to get it next period is. In the final period B_t is equal to B^*, the level of B_t where $\sigma_v = \sigma_h$. It is predetermined, because in the last period the bank always chooses the maximum risk. The bank's total assets are

$$A_t = V_t + B_t \tag{5}$$

We begin by assuming that the bank sets a risk level at the beginning of the period to maximize the present value of wealth including the value of the implicit assets, and then sticks with that level during the period. We then extend the model to the introduction of an option to change that policy midway through the period, for instance, because asset values have fallen and shareholders equity has been eroded.

At the beginning of each period, the bank starts with a predetermined level of *D* and *V*, with *V* set by regulators once *D* is chosen and a corresponding capital ratio, *V/D,* set by the regulators. Let $v = V/D$ and $v = v_0 > 1$ be what is required at the beginning of each period. We assume that σ_v is the only instrument that the bank can choose to maximize wealth.

The position of the bank at the beginning of the period is both a call on its assets, or equivalently an equity position with a put, and current excess income from the franchise. Again, the fixed value in the current period is unaffected by the optimization, but the other income, $f(\sigma_v)(T-t)$, is not. The call has the advantage that if exercised the banks gets a free put and the franchise value next period. Then the call at the end of the first period looks like:

$$C^*_{t_1}\left(V_{t_1}, t_1\right) = \begin{cases} B^* + V_{t_1} - D & if \quad D \le V_{t_1} \\ \\ 0 & if \quad V_{t_1} \le D \end{cases} \tag{6}$$

That is, we can model this as equivalent to a call option on *V* with exercise price *D,* but which also pays off an amount *B** (the put and the franchise value for the second period) if the option is exercised. The bank is defined by its level of debt, which we take as fixed. Then letting r = 0, $\rho = \ln v$, and $\sigma = \sigma_v \sqrt{T-t}$, $b = B^*/D$, $\sigma_v^h \sqrt{T} - t = \sigma^h$, $\sigma_v^l \sqrt{T} - t = \sigma^l$ and D = 1, we have

$$d_1 = \frac{\rho + \frac{1}{2}\sigma^2}{\sigma},$$

$$d_2 \equiv = \frac{\rho - \frac{1}{2}\sigma^2}{\sigma},$$

The value of the firm, W, is given by

$$W = c(v,\sigma) + F + f(\sigma)(T-t) + bN(d_2(v,\sigma)) \tag{7}$$

where $c(v,\sigma)$ is the value of a Black-Scholes call option on the debts divided by D. Its value is given by $\frac{P_t}{D} + v - 1$. The last term is the franchise benefit available only if the call is exercised, times the risk-neutral probability of exercising the call, all divided by D. The bank chooses σ to maximize W.

First we turn to the first order conditions. Differentiating equation (7) with respect to σ gives

$$\frac{\partial W}{\partial \sigma} = vN'(d_1)\left(\frac{-d_2}{\sigma}\right) - (1-b)N'(d_2)\left(-\frac{d_1}{\sigma}\right) + f'(\sigma)(T-t) = 0 \tag{8}$$

This shows that there can be a tradeoff: the first and last terms are positive, depicting the effect of increasing risk on the current positive guarantee for sufficiently high level of risk, while the second is the effect of increased risk on the value of the next period, which can be (but is not necessarily) negative..

Then noting that

$$N'(d_1)/N'(d_2) = e^{-\frac{1}{2}\left(d_1^2 - d_2^2\right)} = e^{-\ln v} = v^{-1}$$

we have

$$\frac{\partial W}{\partial \sigma} = f'(\sigma)(T-t) + vN'(d_1)\left(1 - b\frac{d_1}{\sigma}\right) = 0 \tag{9}$$

We begin with the simple case where franchise value is fixed, so that $f'(\sigma) = 0$. In that case the first order condition is

$$vN'(d_1)\left(1 - b\frac{d_1}{\sigma}\right) = vN'(d_1)\left(\left(1 - \frac{b}{2}\right)\sigma^2 - b\rho\right)\frac{1}{\sigma^2} = 0 \tag{10}$$

This has two solutions. One is $N'(d_1) = 0$, which is approached as σ approaches 0 and which is also a corner solution. The other is when the second term in parenthesis is zero, or

$$\sigma^2 = \frac{b\rho}{(1 - b/2)} \tag{11}$$

Because the required level of v, v_0, is greater than one $\rho > 0$. Then the right hand side of (11) is negative; and there is no solution if $b > 2$.[1] In that case franchise value is so large that wealth is always decreasing in risk and the bank always chooses the least

[1] Note that this implies that the franchise value is twice the level of deposits. While this may seem like large, in the case where a manager weighs his perks high relative to shareholder value, *b* can be quite high.

risk. If that is not the case (or, $b < 2$), then there is a unique solution for a positive level of risk.

The second order condition is

$$\frac{\partial^2 W}{\partial \sigma^2} = vN'(d_1)\left(\frac{d_2 d_1}{\sigma}\right)\left(1 - b\frac{d_1}{\sigma}\right) + vN'(d_1)b\left(\frac{d_2 + d_1}{\sigma^2}\right)$$

$$= vN'(d_1)\left[\left(\frac{d_2 d_1}{\sigma}\right)\left(1 - b\frac{d_1}{\sigma}\right) + b\left(\frac{d_2 + d_1}{\sigma^2}\right)\right] < 0. \qquad (12)$$

In the neighborhood of first order condition the first term is zero, and the second term is

$$\frac{d_2 + d_1}{\sigma^2} = \frac{2\rho}{\sigma^2} > 0\,.$$

Hence for positive equity, this gives the solution to solving the problem of *minimizing* the bank's wealth given that it is going to have maximum risk is the second period. Figure 1 shows the wealth of the bank with fixed franchise value as a function of risk. Figure 2 depicts the slope the line in Figure 1 as a function of risk.

Figure 1 Wealth as a Function of Risk: Special Case with Fixed Franchise Value

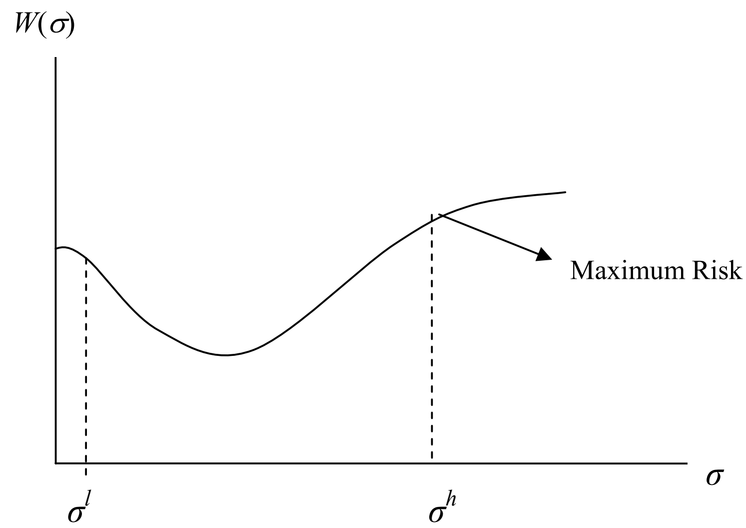
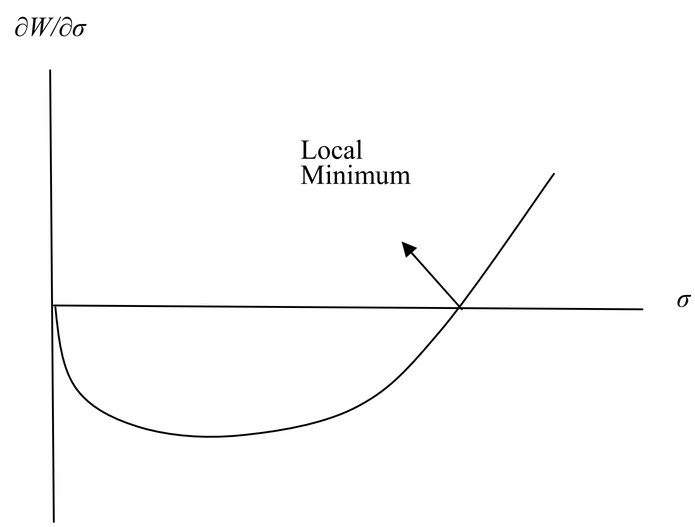


Figure 2 Slope of Wealth Function as a Function of Risk



Maximizing wealth leads to a corner solution. To see which corner is the solution, we examine the extreme cases, where risk is either σ^l or σ^h. The levels of wealth associated with these two risk levels are

$$W(\sigma^l) = c(\sigma^l) + bN(d_2(\sigma^l))$$

and

$$W(\sigma^h) = c(\sigma^h) + bN(d_2(\sigma^h)) \tag{13}$$

We are interested in conditions where the bank chooses not to take the maximum risk; that is when $W(\sigma^h) < W(\sigma^l) < 0$. Taking the difference between the two, we have

$$\Delta = W(\sigma^h) - W(\sigma^l) = c(\sigma^h) - c(\sigma^l) + bN(d_2(\sigma^h)) - bN(d_2(\sigma^l)) \tag{14}$$

The net of the first two terms is positive because the value of a call is always increasing in risk. The net of the last two terms can be positive or negative. Normally we expect the low risk strategy to have a higher probability of survival. This will occur if $\rho \geq -1/2(\sigma^l \sigma^h) \equiv \rho^* \equiv \ln(v^*)$ (obtained by solving $N(d_2(\sigma^h)) = N(d_2(\sigma^l))$). If, however, $\rho < \rho^*$, increasing risk increases both the value of the first period call option and the probability of survival. That requires negative equity. If equity is positive, there is always a value of *b* that makes Δ negative. This establishes that there are situations where the bank will take less than the maximum amount of risk allowed.

We can characterize these situations by setting expression (14) equal to zero and solving for *b* as a function of *v*, which will give the locus of points for which the bank is indifferent between the high risk and low risk strategies. Points above that locus (high values of *b* given *v*) will be points where it is optimal to take the lowest possible risk during the first period.

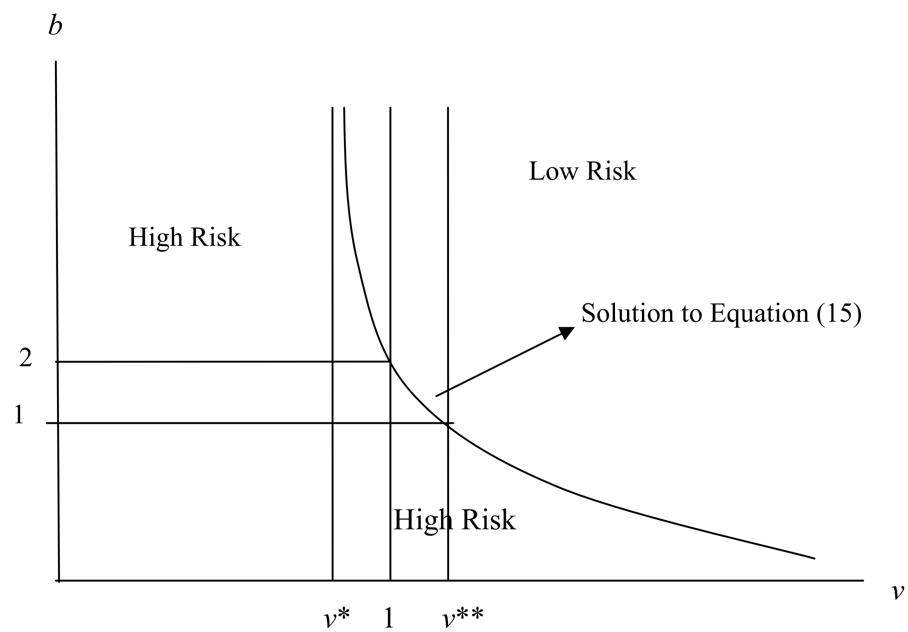
From (14), the critical value for the bank is given by

$$v\left[N\left(d_1^h\right) - N\left(d_1^l\right)\right] + (1-b)\left[N\left(d_2^l\right) - N\left(d_2^h\right)\right] = 0 \qquad (15)$$

or

$$b = -\frac{vN\left(d_1^h\right) - vN\left(d_1^l\right) + N(d_2^l) - N(d_2^h)}{N\left(d_2^h\right) - N\left(d_2^l\right)} \equiv b(v).$$

The relationship between b and v looks as is depicted in Figure 3. Combinations above the curve imply the low risk strategy. There is a unique interval of b that cuts off high risk and low risk strategy given $v > 1$. Note that b approaches infinity as the denominator approaches zero, which happens as v approaches v^* (where $v^* = e^{-\frac{1}{2}\sigma^l\sigma^h}$). It can also be shown (see Appendix) that b approaches zero as v approaches infinity, and $b = 1$ when $v = v^{**}$ (where $v^{**} = e^{\frac{1}{2}\sigma^l\sigma^h}$) and $b = 2$ when $\rho = 0$ (or, $v = 1$). Combinations to the left of v^* always involve the high risk strategy.



Equilibrium

We can define an equilibrium as one in which the required level of v at the beginning of each period, v^0, is the same every period. This is the case where the regulator enforces the same capital rule every period. Let $p^*(v^0)$ be the value of the guarantee (put) associated with v^0**,** and $b(v^0)$ be the associated terminal franchise value from equation (15). Then it can be shown that

$$b(v^0) > p^*(v^0). \tag{16}$$

That is, the "breakeven" franchise value is greater than the put value. This implies that for the bank to take less than maximum risk, the franchise value must be greater than just access to the next period's guarantee (otherwise it is better to take maximum risk now rather than waiting). There must be something extra, such as monopoly power or management perks.

The high risk strategy is more likely to be chosen as the franchise value falls. In particular, because the low risk strategy is only chosen if the bank (or its management via perks) has some monopoly power, competition promotes risk taking. The choice also depends on the risk range; increasing the level of the highest risk increases the probability of taking high risk, and lowering the value of the low risk decreases it.

Endogenous σ^l

The assumption of a minimum risk level is awkward because banks always have access to Treasury bonds or other risk-free securities, in which case the minimum risk level is zero.[2] However, we also want to use the model to analyze how firms revise their risk when they have a negative shock to asset value. This cannot be done with

[2] It could be that the risk free strategy has negative value because of taxes and/or transaction costs. In that case the minimum risk would be the minimum associated with breaking even.

zero risk.[3] Thus, returning to the full model in equation (8), we allow for the availability of risk free asset. To simplify, we let *f(σ)(T-t) = f*(T-t)σ ≡ fσ*. Including *f(σ)* leads to a straightforward result: Because the slope of $W(\sigma)$ when f is zero, is zero when $\sigma = 0$, adding f makes the slope of $W(\sigma)$ positive at zero risk. This opens up the possibility that there will be an optimal interior solution for a low risk level, although it does not affect Figure 3 much.

The first order condition is now

$$f + vN'(d_1)\left(1 - b\frac{d_1}{\sigma}\right) = 0 . \tag{17}$$

A necessary condition for this to hold is

$$\left(1 - b\frac{d_1}{\sigma}\right) < 0 \tag{18}$$

The second order condition is

$$\frac{\partial^2 W}{\partial \sigma^2} = vN'(d_1)\left(\frac{d_2 d_1}{\sigma}\right)\left(1 - b\frac{d_1}{\sigma}\right) + vN'(d_1)b\left(\frac{d_2 + d_1}{\sigma^2}\right) < 0. \tag{19}$$

Now it can be negative. In particular it can be seen that (19) is negative at $\sigma = 0$. Note that a necessary condition for an interior maximum is that the first part of (19) must be negative, which requires that $d_2 d_1 > 0$. This implies $\rho > \frac{\sigma^2}{2}$ or $d_1 > \sigma$.

Figure 4 below depicts the slope of the $W(\sigma)$ curve, as in Figure 2. The horizontal line

[3] There could be some level of operations risk that keeps risk positive even if the assets are risk free.

is *-f*, representing the slope of $f(\sigma)(T\text{-}t)$. The intersection determines the optimal level of σ^l. Unless f is so large that it is entirely below the curve, there is an interior solution. Then there are two possible interior solutions; the smaller is a local maximum and the larger is a local minimum. Hence, we have a more complicated, but similar, model where the bank optimizes, choosing σ^l and then comparing wealth levels for σ^l and σ^h.

Figure 4: Interior solution for low risk level

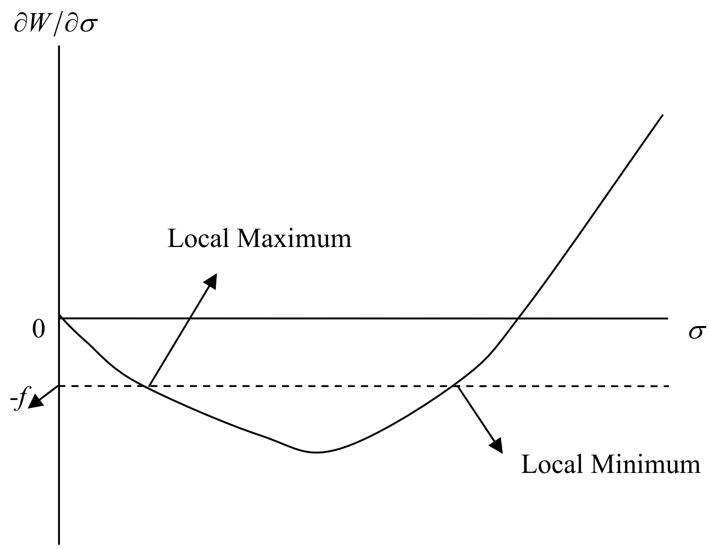
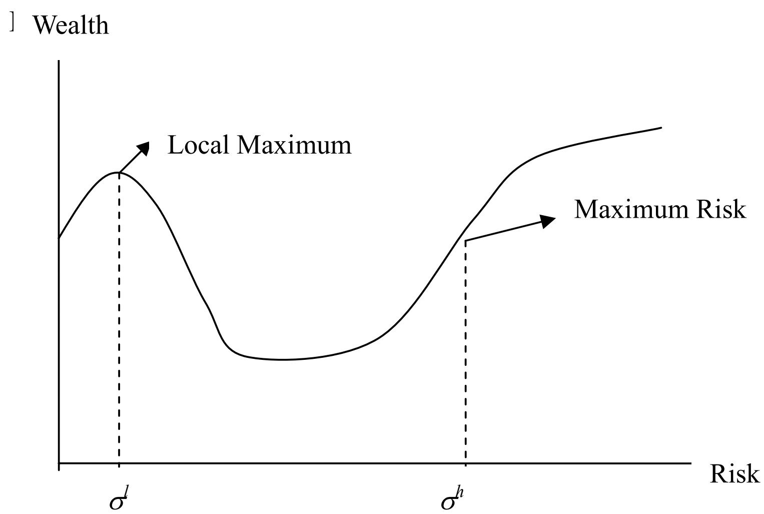


Figure 5 shows wealth as a function of risk, as was depicted in Figure 1, in the case where f is not too large.

Figure 5 Wealth as a Function of Risk: The General Case



There are still two possibilities; the difference now is that the minimum risk is endogenous and will respond to changes in data, like *v* or *b*. In the neighbourhood of an interior solution, differentiating (17) with respect to *v* and applying (19) we have:

$$\frac{\partial \sigma}{\partial v} = -\frac{\partial^2 W}{\partial \sigma \partial v}\left(\frac{\partial^2 W}{\partial \sigma^2}\right)^{-1}$$

which has the same sign as $\frac{\partial^2 W}{\partial \sigma \partial v}$. Then

$$\begin{aligned}\frac{\partial^2 W}{\partial \sigma \partial v} &= N'(d_1)\left(1 - b\frac{d_1}{\sigma}\right) + vN''(d_1)\frac{\partial d_1}{\partial v}\left(1 - b\frac{d_1}{\sigma}\right) + vN'(d_1)\left(-\frac{b}{\sigma}\frac{\partial d_1}{\partial v}\right) \\ &= N'(d_1)\left(\left(1 - b\frac{d_1}{\sigma}\right)\left(1 - \frac{d_1}{\sigma}\right) - \frac{b}{\sigma^2}\right) \qquad (20)\end{aligned}$$

Although the sign of this appears to be ambiguous, the level is finite. The response to an increase in F is given by

$$\frac{\partial \sigma}{\partial F} = vN'(d_1)\left(\frac{d_1}{\sigma}\right) \Big/ \frac{\partial^2 w}{\partial \sigma^2} < 0. \tag{21}$$

That is, an increase in franchise value that comes from the fixed part of it (e.g., management perks) will decrease risk taking.

The actual strategy will either be σ^l as a function of v and b as determined above, or σ^h. The determination will be given by expression (15) except that σ^l is now a function of v. In this case we have to take account of the fact that σ^l is chosen optimally, so that $\partial W/\partial v$ is replaced by dW/dv, with the latter including the effect of v on σ^l. However, because σ^l is chosen so as to maximize $W(\sigma)$ the envelope theorem implies that the conditions are still the same (i.e., $dW/dv = \partial W/\partial v$ because $\partial W/\partial\sigma^l=0$). Hence, the trade off is still given by a curve like that in Figure 3**.**

If the bank is at an interior low risk solution, then a small decrease in asset value will cause it to take a small adjustment to risk. However, decreased asset value means a lower level of W^l. As v falls toward 1, W^l will approach W^h. When they become equal, there will be a discrete change in strategy and a discrete increase in risk-taking.

V. Changing Strategies

Next we assume that the strategy of the (high or low) level of risk has been chosen at the beginning of the period, and with which the bank has the option to change half way through the period. Because σ includes both the volatility of the asset, V, and the square root of time until the audit, the choice of σ at any time is essentially the same as at the beginning of the period. Figure 3 still applies.

Assume that franchise value is high enough to induce the bank initially to choose the low risk strategy. From expression (15) above we see that the cut off for switching from a low risk to high risk strategy depends on the equity ratio, v. It must have begun greater than one by regulation, but it could have then fallen to a level below the cut-off level given by Figure 3. Hence, the "probability" of switching to a high risk strategy increases if the asset value declines for a given level of b. Furthermore, if v falls below v^*, there will be a switch to maximum risk regardless of the franchise value. At this point high risk increases both the current call value and the probability of surviving.

This is "gambling for resurrection". Note that institutions with high franchise value may continue to pursue the low risk strategy even if they have negative equity, a possible explanation for the finding in Schwartz and Van Order (1988) that Fannie Mae did not take a large increase in risk despite negative equity in the early 1980s, in contrast to the more competitive Savings and Loan industry, which had little franchise value. The full model with f positive is consistent with high franchise institutions adjusting their risk a little, but not gambling for resurrection as v falls. The process of switching strategies applies in reverse. A bank that begins with a risky strategy and gets lucky (increase in v) might switch to the low risk strategy for the remainder of the period.

The model suggests complications in pricing. The value of insurance is the value of the put for the first half of the period plus the expected value of the put in the second half of the period. Letting v^c be the switch point from the safe to risky strategy and

$p(v,\sigma)$ be the value of the put, the value of insurance, G, for an institution that starts out taking low risk is given by:

$$G(v^0,b)=\frac{1}{2}p\left(\sigma^l\left(v^0\right),v^0\right)+\frac{1}{2}\left[\int_{v^c}^{\infty}N'\left(\frac{-\ln v+\frac{1}{2}\left(\sigma^l(v)\right)^2}{\sigma^l(v)}\right)p\left(\sigma^l(v),v\right)dv+\int_{-\infty}^{v^c}N'\left(\frac{-\ln v+\frac{1}{2}\left(\sigma^h\right)^2}{\sigma^h}\right)p\left(\sigma^h,v\right)dv\right]$$

Note that the value of σ^h does not depend on v.

Adding and subtracting $\left[\int_{0}^{v^c}N'\left(\frac{-\ln v+\frac{1}{2}\left(\sigma^l(v)\right)^2}{\sigma^l(v)}\right)p\left(\sigma^l(v),v\right)dv\right]$, we depict the guarantee in terms of the basic put for the low risk strategy plus the expected difference in put value over the second half of the period as

$$G(v^0,b)=p\left(\sigma^l\left(v^0\right),v^0\right)+\frac{1}{2}\left[\int_{-\infty}^{v^c}N'\left(\frac{-\ln v+\frac{1}{2}\left(\sigma^h\right)^2}{\sigma^h}\right)p\left(\sigma^h,v\right)dv-\int_{0}^{v^c}N'\left(\frac{-\ln v+\frac{1}{2}\left(\sigma^l(v)\right)^2}{\sigma^l(v)}\right)p\left(\sigma^l(v),v\right)dv\right]$$

(22)

The key difference from the Merton model is the last term, which is the expected value from switching. It explains why results of earlier models, such as Ronn and Verma (1986) might have suggested that deposit insurance was overpriced, because their model did not consider the option to change strategy.[4]

Securitization

A structured securitization (ABS) is quite similar to the corporate (limited liability)

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[4] Note that for an institution that starts out taking the high risk strategy there is a corresponding formula, which is less than the value corresponding to the first term of (22) because the bank might, if it gets lucky, switch to the low risk strategy.

structure of the bank described above. The simplest version is a senior/subordinated structure, where the senior part is like the bank debt above and the subordinated part like the equity. Assume that the subordinated part is kept by the bank and the senior part is sold to investors who know the initial value of the securities in the pool and the range of possible risk, but not the level of risk. They do not know even *ex post* the quality of the loans, whether they were high risk or low risk, but they do know if the bank's last deal paid off. If it did then the bank receives a premium, *b*, for its next deal. Hence, the bank guarantee model can be used to analyze a simple securitization structure. For simplicity, we assume that the value of *b* is independent of the asset mix, so we do not analyze an endogenous low risk level. Note, as above, that b has to be greater than the terminal value of the put for the low risk level to be chosen. That is, the bank needs some sort of extra income (or management perks or fees) for the low risk strategy to work. We assume that investors know the asset value at the time the pool is formed and the asset to debt ratio is what is needed for the senior tranche to get an AAA rating assuming that the low risk strategy is followed. Hence, we can reuse Figure 3.

If the deal allows active management of the pool after it is formed, then the analysis of changing strategy between audits goes through as above. The bank will tend to substitute risky assets for safer assets in a discontinuous way if asset values fall below the critical value. If active management is not allowed, then the changes in strategy take place at the beginning of the period as the bank decides on whether or not to trade currently profitable risk-taking with future reputation. A bank that suddenly loses franchise value (*e.g.,* the monopoly power was temporary and competition lowers *b*) has an incentive to move to the risky strategy. Similarly, an increase the risk of the riskiest asset (and an increase in the risk of the safest asset) will tend to increase the level of risk, as will awareness by the bank (but not inventors) that the underlying securities are overvalued.

I. Conclusions

This paper explains the importance of franchise value to the risk-taking strategies of financial institutions that have debt guarantees or the option of trading less risk now for high fees later in putting together structured asset-backed securities. It develops a model of the option to change strategy. Institutions with high franchise values tend to adopt low risk strategies that will allow them to pass audits and capital requirements.

Institutions such as the Savings and Loans in the 1980s with weak franchise value are more likely to take on risk, and institutions with strong franchises may be able to grow out of problems without increasing risk even if their "market" value is negative. However, financial institutions also have incentives to make abrupt changes in strategies if asset values decline (gambling for resurrection). The cost of financial guarantees may come more from the option to take high risk in the future than from the risk embedded in the bank's current portfolio.

Similarly, the model suggests reasons for sharp changes in the risk of structured ABS deals, as was the case recently with subprime mortgages. The incentive to deliver relatively safe loans in exchange for a reputation diminishes as competition increases, the risk range increases (e.g., the discovery that market will tolerate or not know about diminished underwriting quality), and the underlying assets become underpriced relative to what the market thinks.

References

Clauretie, Terrence M. and Mel Jameson (1990). Interest Rates and the Foreclosure Process: An Agency Problem in FHA Mortgage Insurance, *Journal of Risk and Insurance*, 57, 701-711.

Edelstein, Robert H. (1974). The Value of Information and the Optimal Governmental Guarantee on its Agencies' Issues, *Journal of Finance*, 29(2), 471-484.

Episcopos, Athanasios (2004). The Implied Reserves of the Bank Insurance Fund, *Journal of Banking and Finance* 28, 1617-1635.

Fischer, Stanley (1978). Call Option Pricing When the Exercise Price is Uncertain, and the Valuation of Index Bonds, *Journal of Finance*, 33, 169-176.

Foster, Chester, Edward Golding and Robert Van Order (1992)

Galai, Dan and Ronald W. Masulis (1976). The Option Pricing Model and the Risk Factor of Stock, *Journal of Financial Economics*, 3, 53-81.

Galai, Dan (1988). Corporate Income Taxes and the Valuation of the Claims on the Corporation, *Research in Finance*, 7, 75-90.

Geske, Robert (1977). The Valuation of Corporate Liabilities as Compound Options, *Journal of Financial and Quantitative Analysis*, 12, 541-552.

Geske, Robert (1979). The Valuation of Compound Options, *Journal of Financial Economics*, 7, 63-81.

Geske, Robert and H.E. Johnson (1984). The American Put Option Valued Analytically, *Journal of Finance*, 39, 1511-1524.

Grenadier, Steven R. and Brian J. Hall (1996). Risk-based Capital Standards and the Riskiness of Bank Portfolios: Credit and Factor Risks, *Regional Science and Urban Economics*, 26, 433-464.

Jackson, Jerry R. and David L. Kaserman (1980). Default Risk on Home Mortgage Loans: A Test of Competing Hypotheses, *Journal of Risk and Insurance*, 47, 678-690.

Jeitschko, Thomas D. and Shin Dong Jeung (2005). Incentives for Risk-taking in Banking — a Unified Approach, *Journal of Banking and Finance*, 29, 759-777.

Kau, James B., Donald C. Keenan, and Walter J. Muller, III (1993). An Option-Based Pricing Model of Private Mortgage Insurance, *Journal of Risk and Insurance*, 60, 288-299.

Merton, Robert (1974). On the Pricing of Corporate Debt: The Risk Structure of Interest Rates, *Journal of Finance*, 29, 449-470.

Merton, Robert (1977). An Analytic Derivation of the Cost of Deposit Insurance and

Loan Guarantees, *Journal of Banking and Finance*, 1, 3-11.

Park, Sangkyun (1997). Risk-taking Behavior of Banks under Regulation, *Journal of Banking and Finance*, 21, 491-507.

Rabinovitch, Ramon (1989). Pricing Stock and Bond Options When the Default Free Rate is Stochastic, *Journal of Financial and Quantitative Analysis*, 24, 447-57.

Ritchken, Peter, James B. Thomson, Ramon P. DeGennaro, and Anlong Li (1993). On Flexibility, Capital Structure and Investment Decisions for the Insured Bank, *Journal of Banking and Finance*, 17, 1133-1146.

Ronn, Ehud and Avinash K. Verma (1986). Pricing Risk-Adjusted Deposit Insurance: An Option-Based Model, *Journal of Finance*, 41, 871-895.

Schwartz, Eduardo and Robert Van Order, (1988) "Valuing the Implicit Guarantee of the Federal National Mortgage Association," *Journal of Real Estate Finance and Economics*, 1, 23-34.

Swan, Craig (1982). Pricing Private Mortgage Insurance, *Journal of the American Real Estate and Urban Economics Association*, 10, 276-296.

Vasicek, Oldrich (1977). An Equilibrium Characterization of the Term Structure, *Journal of Financial Economics*, 5, 177-88.

Appendix

Why *b* approaches zero as *v* approaches infinity

Manipulating (15) it can be seen that

$$b = -v\frac{N\left(d_1^h\right) - N\left(d_1^l\right)}{N\left(d_2^h\right) - N\left(d_2^l\right)} + 1 .$$

We are interested in knowing what *b* approaches when *v* goes to infinity. Since all the cumulative normal distributions in the fraction approach 1 as v approaches infinity, we have the indeterminate form of 0/0. Therefore, applying l'Hôpital's rule,

$$\begin{aligned}\lim_{v\to\infty}\frac{N\left(d_1^h\right) - N\left(d_1^l\right)}{N\left(d_2^h\right) - N\left(d_2^l\right)} &= \lim_{v\to\infty}\frac{N'\left(d_1^h\right) - N'\left(d_1^l\right)}{N'\left(d_2^h\right) - N'\left(d_2^l\right)} \\ &= \lim_{v\to\infty}\left(\frac{1}{v}\frac{N'\left(d_1^h\right) - N'\left(d_1^l\right)}{N'\left(d_1^h\right) - N'\left(d_1^l\right)}\right) \\ &= \lim_{v\to\infty}\frac{1}{v}\end{aligned}$$

Therefore,

$$\begin{aligned}\lim_{v\to\infty} b &= \lim_{v\to\infty}\left((-v)\frac{1}{v} + 1\right) \\ &= 0\end{aligned}$$