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Subordinated Debt and the Quality of Market Discipline in Banking

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Abstract: Subordinated debt is compared to common equity as a source of market discipline in banking. The debt issued by a bank is modeled as a contingent claim on the bank's assets. The model highlights the effects of moral hazard and market discipline, and shows how market pricing of subordinated-debt transforms the risk-taking incentives facing bank shareholders. The effects on both the deposit guaranty liability and the probability of bank failure are examined. The conclusions from the model are that subordinated debt has few advantages over equity, either as a form of bank capital or as a source of market discipline; indeed, in some important regards it is distinctly inferior. With regard to the potential information content of subordinated-debt prices, the model illustrates that the same information is available from stock prices, although subordinated-debt market data could be complementary.

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Subordinated Debt and the Quality of Market Discipline in Banking

> [The Federal Reserve] will be focusing increased research effort on topics related to market discipline in general and subordinated debt in particular. (Meyer, 1999)

1. Introduction

Regulators have long recognized that imperfect pricing of the safety net creates moral hazard at banks, and have implemented policies to address both the incentives and the effects. Recently, banking policy makers have been considering the use of subordinated debt as a tool to this end. Subordinated debt would be expected to impose a degree of market discipline on banks and encourage behavior consistent with regulatory objectives, mitigating the recognized moral hazard:

> It may be possible to increase market discipline by requiring large, internationally active banks to issue a minimum amount of certain types of subordinated debt to the public. [Subordinated debt holders] face only downside risk, and thus their risk preferences are very close to those of the [deposit insurer]. Subordinated debt holders would therefore be expected to impose market discipline on the bank that is quite consistent with what bank supervisors are trying to do…and such debt would provide an extra cushion of protection for taxpayers. (Meyer, 1998)

Some of the extant empirical evidence shows that subordinated debt prices and yields respond in some degree to changes in risk at issuing banks. The report by the Federal Reserve Study Group on Subordinated Notes and Debentures (1999) summarizes that evidence.

Recent subordinated debt proposals include those by Calomiris (1999) and the U.S. Shadow Financial Regulatory Committee (2000), but earlier variations have been put forward by Benston et. al (1986), Wall (1989), Evanoff (1993) and others. Most of the proposals were summarized and compared in the report issued jointly by the Federal Reserve Board and the U.S. Treasury (2000), which considered the feasibility and desirability of mandatory subordinated debt issuance. These proposals are based on the proposition that subordinated debt is a unique, and in some sense better, source of market discipline than other potential sources. Specifically, whereas equity claims are known to introduce a degree of moral hazard to bank asset decisions, subordinated debt is seen as less prone to creating such incentive problems, and as even serving to reduce the moral hazard. The recent proposal by the Shadow Financial Regulatory Committee (SFRC) is fairly representative. After noting that current bank capital adequacy standards assign an inferior role to subordinated debt (by relegating it to a second tier of capital), the SFRC asserts that:

> The suspicions about subordinated debt are ill-founded. If anything, from the perspective of both banks and regulators, subordinated debt does at least as good a job as equity of protecting depositors and the deposit insurance fund, as well as of providing incentives for banks to avoid taking excessive risks. In fact, subordinated debt offers advantages to regulators that are superior to common equity, in three principal respects. (SFRC 2000, page 16)

The three advantages cited in the SFRC document are alignment of incentives between subordinated debt holders and the deposit insurer, visible market signals provided by subordinated-debt prices or yields, and incentives created for bankers to disclose risks to the market.

As the quote above suggests, the various subordinated debt proposals tend to rely on features that might be described as the “quality” of the market discipline provided by subordinated debt. Other instruments might also provide market discipline, but subordinated debt is seen as having distinct advantages, having to do with the mitigation of risk-taking incentives as well as the potential value of the consequent market signals if the debt is publicly traded.

In this paper, I develop a simple theoretical framework within which the effects of subordinated debt can be evaluated, taking into account moral hazard and market discipline. I focus particularly on the relative merits of subordinated debt as compared to common equity capital. The results are derived within a fairly standard contingent-claim model. To give subordinated debt the benefit of the doubt, the type of debt contract considered in the model is unrealistically severe, in the sense that the market discipline it provides is perfect: it is both instantaneous and complete.

The results contradict the fundamental assumptions of most of the policy proposals: equity and subordinated debt have exactly the same impact on banks' risk-taking incentives. That is, the "quality" of the market discipline is identical, even taking into account the moral hazard effects that arise with equity. Beyond the impact on incentives, a dollar of subordinated debt capital and a dollar of equity capital have identical marginal effects on the deposit guarantor. Moreover, if bank failure (where failure is defined as occurring when a bank's equity capital is exhausted and the bank's assets handed over to its creditors) is also an important policy concern – that is, if failures carry costs in addition to their impact on the deposit guarantor – then equity really is *superior* to subordinated debt. These findings may explain the standard intuition of international banking and financial regulators that subordinated debt is inferior to equity as a form of prudential capital.

I also consider subordinated debt as a source of information about the condition of banks, since this is cited as one of its advantages. Within the context of the theoretical model, subordinated-debt prices contain no information about the condition of issuers beyond what can be derived from their equity prices. In addition, and more importantly, the model illustrates that a simple focus on subordinated-debt credit spreads may be very misleading. Numerical results illustrate that banks with narrower debt spreads might actually present greater risks; correctly interpreting the spreads requires fairly sophisticated adjustments for differences in the structure of banks' capital and funding. Subordinated debt still may have some value as a source of information for indirect discipline, although the most promising aspects of that information have not been prominent in the policy dialogue to date.

The next section of this paper describes the basic structure of the model used to evaluate the role of subordinated debt; subordinated debt is modeled as a contingent claim, largely following the approach of Black and Cox (1976). In the third section, the impact of market discipline imposed by subordinated debt on banks' risk-taking incentives is examined within the context of the model. The fourth section uses the market-discipline results to look at the net impact of subordinated debt on the safety-net liability and the probability of bank failure. A fifth section discusses considerations related to the use of subordinated-debt prices or yields as a source of information about the condition of banks, and a final section concludes with a brief summary and some observations on the policy implications.

2. Structure of the Model

Consider a hypothetical bank with assets worth A in market value. The value of the assets is random, and evolves over time as a martingale. The bank operates for T periods, then liquidates without cost. To finance the assets, the bank issues three types of claims: senior debt (or deposits) with promised payment D_T, junior (or subordinate) debt with promised payment B_T, and a residual equity claim receiving A_T-D_T-B_T if the bank is solvent at the end of the period. For simplicity, the debt claims are assumed to be single-payment instruments earning continuously compounded rates of return.

The promised payments on the claims may not actually be received; both equity and debt are risky, since they must be paid out of assets and asset value is random. Payoffs are shown in Table 1 for various possible terminal asset values. Limited liability is assumed for the residual claimant in all cases.

Table 1: Payoffs to Claimants at Termination (t=T) for Various Values of Assets

	$D_T + B_T < A_T$	$D_T < A_T < D_T + B_T$	$A_T < D_T$
Senior debt (deposits)	D_T	D_T	A_T
Junior (subordinated) debt	B_T	A_T - D_T	0
Equity	$A_T – D_T – B_T$	0	0

If the bank is solvent (the first column in Table 1), both tranches of debt are paid in full, and equity keeps the residual. If assets are not sufficient to pay all debt claims (the second column), shareholders default, and the junior debt absorbs the first loss and thereby becomes the residual claim. However, if the asset value is low enough (insufficient to pay off the depositors in full, as in the last column), then subordinated debtholders receive nothing, and depositors (or any guarantor) receive the remaining asset value.

Figure 1 shows the payoff structure of the subordinated debt as a function of assets. Figure 2 illustrates that the junior debt contract can be viewed as a composite of two elemental financial instruments: a written (or sold) call option with exercise price D_T+B_T, and a purchased call option with exercise price D_T. This equivalence between subordinated debt and a pair of options was pointed out by Black and Cox (1976).

Under standard assumptions for risk-neutral contingent-claim valuation, the market value of the equity at $t=0$ is:

$$E = AN(x) - (B + D)N(x - s) \tag{1}$$

where variables without subscripts are present values[1], s is the T-period volatility of the

[1] I have chosen to keep the notation as simple as possible to focus on the key issues. Thus, interest rates have been rolled into the quantity variables. If the deposits are riskless and earn the riskfree rate r, then D is simply the current value of deposits, D_0. If the continuously compounded return on the subordinated debt is at a rate y that differs from the riskfree rate, then B in this notation is actually $B_0 e^{(y-r)}$, that is it incorporates any spread. This comes into play in the discussion of market discipline in the next section, where the impact of market discipline in the debt market shows up as changes in the level of B.

return on assets[2], *N( )* is the cumulative normal density (reflecting the common modeling assumption that unexpected changes in the value of assets are determined by a Wiener process that introduces normally distributed noise), and *x* is defined as:

$$x \equiv \frac{s}{2} + \frac{\ln(A/(B+D))}{s} \qquad (2)$$

Similarly, the value of the junior debt can be written as:

$$S = AN(z) - DN(z-s) - AN(x) + (B+D)N(x-s) \qquad (3)$$

where *z* is defined as:

$$z \equiv \frac{s}{2} + \frac{\ln(A/D)}{s} \qquad (4)$$

Evaluating the relative merits of equity and subordinated debt requires a sense of the public policy objectives that underlie bank regulation. One likely objective is limiting the liability associated with the safety net. In the model here, the safety net is assumed to absorb all risk for the senior debt and none for the junior debt; that is, deposits are fully insured or guaranteed and subordinated debt is not.[3] In that case, the liability to the provider of the safety net (the guarantor's liability) can be expressed as:

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[2] Definition of s as the *T*-period volatility again simplifies notation, eliminating the usual option-pricing terms involving the square root of *T*.

[3] The assumption about deposit coverage obviously is crucial, and all of the policy proposals reflect this in one way or another; it is universally acknowledged that subordinated debt has little or no policy value if market participants believe it is covered by the safety net.

$$L = DN(s - z) - AN(-z) \quad (5)$$

For a bank of given size, this liability is affected by two factors: the degree of deposit leverage[4] at the bank, reflected in the relationship between *A* and *D*, and the riskiness of the bank's assets, reflected in the bank's choice of asset volatility s. For the guarantor, the impact of subordinated debt depends on how it affects these two factors, leverage and asset risk.

However, regulatory concerns likely extend beyond the impact on the deposit guaranty liability, particularly if the event of bank failure is costly. In that case, regulators may also focus on the probability of bank failure[5], which is the probability that bank assets will fall short of total debt claims at the horizon *T*. The risk-neutral probability of bank failure is given by:

$$P = N(s - x) \quad (6)$$

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[4] "Leverage" in this sense refers only to the gearing between deposits and assets, not to total debt including the subordinate piece. The deposit leverage is the relevant factor for the safety-net liability.

[5] See for example the discussion of maximum insolvency probability as a sound practice for evaluations of capital adequacy in the proposed revision of risk-based capital standards (Bank for International Settlements (1999), Annex 3 paragraph 8).

Note that while this is the probability of failure under the risk-neutrality assumption used in the model, it is not the true probability of failure, as it does not include a rate of return on assets. The impact of this simplification will be discussed below where relevant.

3. Impact of Debt Market Discipline on Risk-Taking Incentives

To examine the effects of market discipline, consider first a benchmark case in which there is none. Equity holders make the relevant decisions about the composition and management of the assets, and therefore are able to affect the level of asset volatility s. If the terms of the debt are assumed to be fixed for the life of the contract, so that outstanding debt does not exert market discipline on shareholders, the marginal value to equity of an increase in asset risk[6] is given by:

$$\frac{dE}{ds} = (B + D) N'(x - s) \tag{7}$$

As is well recognized, the positive sign of this expression is the essence of the moral hazard problem in leveraged firms like banks.[7]

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[6] That is, a mean-preserving spread in the distribution of the bank's instantaneous rate of asset returns.

[7] As is also well recognized, a weakness of this type of model is that there is no interior optimum σ. The model can be modified to create the possibility of interior solutions, but such modifications are complex, and more importantly are unlikely to be relevant to the issues explored in this paper. As Bliss (2000) points out, more complex option structures or alternative distributional assumptions also affect the specific results.

Changes in asset volatility also affect the value of the subordinated-debt claim, through their impact on the probability of default losses. If contract terms are fixed for the life of the debt, then the change in the debt value from a change in s is:

$$\frac{dS}{ds} = DN'(z-s) - (B+D)N'(x-s) \tag{8}$$

This can be shown to be negative – debtholders lose if asset risk rises, all else equal – provided the bank is solvent. (See Black and Cox (1976) for a discussion of how the sign depends on the value of assets relative to liabilities for subordinated debt in general, or Gorton and Santomero (1990) for the same point in a more specific banking context.)

The expression for dS/ds in (8) shows that subordinated debt, as a junior claim, is affected in two opposite ways by an increase in asset risk. One is obvious, the impact on the probability that the bank's assets will be insufficient to pay claims in full, thereby imposing credit losses on the subordinated debt; that is essentially the second term above. The other effect, reflected in the positive first term in (8), may be less obvious: all else equal, an increase in asset volatility also makes it more likely that the subordinated debt will be paid in full, while a portion of the downside risk is absorbed by the senior debt. Limited liability creates an option that confers benefits on the junior debt from the increase in volatility, at the expense of the senior debt.

Turning now to the case in which subordinated debt *does* provide market discipline, in the context of this model the discipline operates through renegotiation of the terms of the subordinated-debt contract if shareholders change asset volatility. I assume that the debt contract has been structured to allow debtholders to exercise market discipline by changing the payment due on the debt. Since this is the key difference between the model presented here and most other contingent-claim models of banks in the literature, it is important to be clear about the exact assumptions regarding the nature of the debt.

From above, the debt is modeled as a non-interest-bearing instrument, with a single payoff at maturity. The debt maturity date coincides with the maturity date of the bank's assets (as well as the termination date of the bank). Thus, because the debt is outstanding for the entire life of the bank, it satisfies one of the commonly imposed requirements for regulatory capital, that the debt be long-term and not subject to early payment at the option of the holder.

The promised payment is B_T. The market value of the bond at time t is S, which is equal to $B_T e^{-y(T-t)}$ where y is the continuously compounded debt yield. The aim of the debtholders is to keep S constant, and the subordinated debt contract specifies that they do so by changing B_T, since there is no explicit coupon interest rate to adjust. That is, under this debt contract, debtholders observe the level of risk imposed upon them, and then require adjustment of the only term that can be adjusted, the terminal payoff, to keep the value of the debt constant. In terms of the quoted yield, an increase in B_T would be reflected in a corresponding increase in y.

The date at which adjustment occurs also can be viewed as a mandatory reissuance date. In essence, all of the outstanding subordinated debt is refunded through a new issue with a new terminal payment that forces shareholders to compensate debtholders for the risks they bear, generating "direct" market discipline. Obviously, subordinated debt is not structured this way in practice.[8] But this characterization captures all of the relevant features for present purposes, and has the added advantage of keeping the model relatively simple. Note that the "quality" of the market discipline provided by a hypothetical debt contract of this type surpasses that of any existing real-world debt, since debtholders observe the level of asset risk σ without error and are able to fully adjust.

As a result of the assumptions about the subordinated debt, the present value of the terminal payment on the debt becomes dependent on the riskiness of the bank's assets. To acknowledge the dependence of B on σ, the model is rewritten with $B(s)$ replacing B. With that change to the model, the total effect on S of a change in s becomes:

$$\frac{dS}{ds} = DN'(z-s) - \big(B(s)+D\big)N'(x-s) + B'(s)N(x-s) \qquad (9)$$

Similarly, with B dependent on s, the marginal value of risk-taking for equity becomes:

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[8] The nearest analog to this type of contract in real-world capital markets might be auction-rate securities, where terms of the instrument are periodically reset to maintain par value.

$$\frac{dE}{ds} = \left(B(s) + D\right)N'(x - s) - B'(s)N(x - s) \qquad (10)$$

Comparing this to the expression for the no-discipline case in (7), the main difference is the inclusion of the term involving $B'(s)$, which represents the primary restraint on risk-taking from the subordinated debt market.

Assuming that adjustment of the debt terms is perfect – in the sense of being both continuous and complete – gives additional insight into the quality of market discipline the debt provides. To envision such a contract, imagine debtholders (or perhaps their agent) standing at the shoulder of bank management, and announcing the appropriate change in debt terms as each opportunity to modify the bank's assets arises: "If you make *that* loan, the new required payment on the debt will be…" In that way, the bank is disciplined to factor the full effects of any potential change of risk into its decision calculus. In effect, the debt has a very strong, continuously monitored covenant in place that ensures that any change in asset risk, as reflected in s, is counteracted by adjustments in the terms of the debt. This assumption is very favorable to a subordinated-debt policy. Less frequent adjustment – or its analog, mandatory periodic issuance – tends to weaken the force of market discipline. If the subordinated debt cannot be shown to provide significant benefits in this case, it will not do so under weaker assumptions.

With this strong form of debt-market discipline, any change in s brings an immediate change in $B(s)$ that leaves S unchanged; that is, $B'(s)$ must be such that the total derivative dS/ds is zero, to keep the subordinated debtholders whole in expectation.[9] From the expression for dS/ds in (9) above, $B'(s)$ must be such that:

$$\left(B(s) + D\right)N'(x - s) - B'(s)N(x - s) = DN'(z - s) \tag{11}$$

Substituting this into the expression for dE/ds, perfect adjustment for risk implies that:

$$\frac{dE}{ds} = DN'(z - s) \tag{12}$$

This expression is exactly the effect of s on a call option on assets with exercise price D. As with any option, this derivative is positive, so equityholders still benefit from increases in asset risk. The net impact of perfect market discipline by subordinated debt is to make the risk-taking incentives of equity holders depend on an implicit call option with exercise price of D, instead of equity's initial implicit call with a strike of $D+B$.

For intuition on this central result, recall that subordinated debt is effectively the combination of a written call option at $D+B$ and a purchased call at D. The call option with the higher strike reflects risk transfer between subordinated debt and equity; its

[9] This assumes the firm is sufficiently solvent that it is possible to compensate the debtholders for risk. If the value of assets is very low, it may be impossible to set a debt payoff (or promised yield) that would make the debtholders whole in expectation. The analysis in this paper thus applies primarily to banks that are solvent.

impact on risk-taking is eliminated by the continuous adjustment of the terms of the debt contract. However, the positive impact of changes in s on the other option essentially are passed through to equity by the subordinated debtholders, in the sense that the debtholders reduce the compensation required from shareholders by the amount of the gain in value they receive at the expense of the deposit guarantor. This is similar in spirit to the observation by Furlong and Keeley (1987) that "equityholders can compensate the uninsured debtholders for risk in the form of higher promised interest rates [or in the current model, a higher yield corresponding to a higher promised terminal payment] and still benefit from fixed-rate deposit insurance…". Taking into account the compensating payment, the marginal value of risk-taking to equity holders facing continuous and perfect market discipline from subordinated debt is exactly equal to the impact on one of the two component options, the one that reflects the margin between the senior (deposit) debt claim and all junior claims (subordinated debt plus equity).

The subordinated debt market does "punish" shareholders for shifting risk to debtholders, which is the essence of market discipline. But because subordinated debt is just that – subordinate, and therefore junior to deposits – the subordinated debtholders in effect "give credit" to shareholders for the portion of risk shifted past them to the senior claimant (or any deposit guarantor). Thus, it is only partially correct to state that the incentives of subordinated debtholders are aligned with regulators' preferences.[10] In fact, in one sense they are exactly opposed, since the deposit guarantor has in effect written a put option to the subordinated debtholders. The other implicit option contract, between

[10] Dewatripont and Tirole (1993) also note the incentive conflict that arises from the junior standing of subordinated debt.

subordinated debt and equity, creates incentives in the desired direction, but the net effect is lessened by the existence of the put option associated with the guaranty.

4. Impact of Subordinated Debt on Key Regulatory Concerns

Regulatory policies may aim at limiting the safety-net liability *L*, limiting the probability of failure *P*, or (most likely) some combination of the two. They may do this through restrictions on asset risk (s) or on the structure of claims (in the model, the leverage relationship between *A* and *D*). I assume that the structure of claims is set by capital standards, which may include a role for subordinated debt, while asset risk is set by equity holders under the influence of any market discipline provided by debt.[11]

I consider three policy options:

- *Case I: Capital Substitute.* Subordinated debt is required in some amount (as a fraction of assets) as a replacement for equity capital.
- *Case II: Capital Supplement.* Subordinated debt is required as in Case I, but as an addition to existing capital rather than as a replacement.
- *Case III: Equity Capital Increase.* Instead of subordinated debt, the bank is required to hold additional equity capital in the amount that would have been subordinated debt under Case II.

[11] In addition to regulatory capital standards, the structure of claims may be influenced by market forces, and by aspects of the legal environment such as tax laws and bankruptcy codes.

The last of these three is not really a subordinated-debt policy, but is a useful comparison. In all cases I take the level of assets as fixed, so that the policy options amount to decisions about how the total market value of claims (which is identical to the total market value of assets A) is distributed among the three types of instruments (senior debt, junior debt, and equity). Since regulatory capital standards generally address book values, the focus on market values in this paper is a simplification, to abstract from measurement issues that arise due to the use of historical-cost accounting conventions.

The relative merits of policy alternatives can be evaluated by their effects on L and P. Two types of effects can be distinguished: leverage-related effects, due to the changes in the various types of debt at a given level of asset risk, and moral-hazard related effects due to changes in the value equity holders receive from a unit change in asset volatility all else (such as the bank's debt structure) equal.

The leverage-related effects can be derived from the equations for L and P in (5) and (6) respectively, through the partial derivative with respect to debt. With A and s fixed, L depends only on the level of deposits D, and P depends only on total debt $D+B$. Differentiating gives:

$$\frac{\partial L}{\partial D} = N(x) > 0 \qquad (13)$$

and

$$\frac{\partial P}{\partial (D+B)} \quad = \quad \frac{N'(s - z)}{(D+B)s} \quad > \quad 0 \qquad (14)$$

The first expression shows that more deposit funding raises the deposit guaranty liability, while the second shows that more total debt raise the probability of failure, all else equal. Both results are intuitive.

The moral-hazard effects cannot be fully assessed without a more complete model of regulatory preferences, which is beyond the scope of this paper. However, the impact of policy alternatives can be partially assessed through their impact on the marginal value of risk, which is captured by the sensitivity of equity to a mean-preserving spread in the asset return distribution (an increase in s). From the expression for dE/ds in (12), the marginal value of asset risk changes only if deposits change relative to assets; the effect is given by:

$$\frac{d}{dD}\left(\frac{dE}{ds}\right) \quad = \quad \frac{zN'(z-s)}{s} \qquad (15)$$

This is positive for all solvent banks, and even for marginally insolvent banks (those with assets slightly less than total debt). Equity gains value from an increase in asset risk, and the marginal effect is positively related to leverage. This is a well-known result; see for example Furlong and Keeley (1989). Policies that reduce dE/ds are more likely to lead shareholders to choose lower levels of asset risk by reducing the marginal payoff to risk-seeking, which is likely to reduce both L and P in turn.

Each of the three cases can be described in terms of changes in the elements of the bank's capital structure E, D, and B (or $D+B$, since assets and therefore total claims are fixed by assumption). The desirability of each alternative can then be evaluated by examining the leverage-related effects on L and P along with the moral-hazard related effects on the marginal value of risk. Leverage-related increases in L or P, or increases in $dE/d\sigma$, are likely to be viewed unfavorably by policy makers; reductions in any of these would likely be viewed as good. (Again, without more structure on regulatory preferences, the net desirability of a policy with mixed effects would be unclear. However, this issue does not arise in any of the cases considered.)

Table 2 provides a summary of the key elements of the analysis for the remainder of this section. Each row represents one of the cases. The first four columns characterize each policy alternative's balance sheet effects, while the last three columns measure the impact on variables of interest to policy makers. The three cases are discussed in order.

Table 2: Impact of Policy Alternatives

Balance Sheet Description of Each Case					Leverage-Related Effects		Effect on Marginal Value of Asset Risk
Case	**Deposits**	**Sub Debt**	**Total Debt**	**Equity**	ΔL	ΔP	$\Delta dE/d\sigma$
I	0	$\Delta B > 0$	$\Delta(D+B) = \Delta B > 0$	$\Delta E = -\Delta(D+B) < 0$	0	$\frac{\partial P}{\partial(B+D)}\Delta B > 0$	0
II	$\Delta D = -\Delta B < 0$	$\Delta B > 0$	0	0	$\frac{\partial L}{\partial D}\Delta D < 0$	0	$zN'(z-\sigma)\Delta D/\sigma < 0$
III	$\Delta D < 0$	0	$\Delta(D+B) = \Delta D < 0$	$\Delta E = -\Delta(D+B) > 0$	$\frac{\partial L}{\partial D}\Delta D < 0$	$\frac{\partial P}{\partial(B+D)}\Delta D < 0$	$zN'(z-\sigma)\Delta D/\sigma < 0$

Description of Cases

- *Case I: Capital Substitute.* Subordinated debt replaces part of equity capital.
- *Case II: Capital Supplement.* Subordinated debt adds to existing capital rather replacing equity.
- *Case III: Equity Capital Increase.* The bank holds additional equity capital in the amount that would have been subordinated debt under Case II.

Case I: Capital Substitute

Case I is covered in the first row of Table 2. Increases in *B* are matched dollar-for-dollar by reductions in equity, leaving *D* unchanged; total debt *D+B* increases by the amount of the change in subordinated debt. Since deposits are unchanged, there are no leverage-related effects on *L*. The safety net is covering the same deposits, financing the same assets; the size of the capital "cushion" has not changed, only its composition. However, the probability that the bank will fail goes up, since total debt increases and equity declines; thus the negative sign in the ΔP column for Case I.

Equity's rewards from risk-taking are unchanged by this policy alternative. In the contingent-claim framework, recall that perfect risk-adjustment in the terms of the subordinated debt causes $dE/d\sigma$ to reflect only the impact of the portions of risk shifted to the deposit guarantor. The impact of this risk-shifting is captured in the call option on assets with strike price of *D* (the lower of the two call options that in effect comprise the subordinated debt). The payoff structure of this option is unchanged by the subordinated debt policy in Case I, so the relevant derivative also is unchanged.

More intuitively, shareholders' interests direct them toward activities that increase the value of shares, and away from actions that reduce value. At best, the "discipline" provided by market-priced subordinated debt takes the form of adjusting the required payments so that the value of the debt does not change as asset risk changes. That is, the subordinated debtholders ensure that bank shareholders are unable to extract positive net present value from them.[12] Since the debt then becomes a zero-net-present-value proposition for the shareholders, it becomes irrelevant to their value-maximizing decision making. Shareholders focus instead on actions that extract value from the other potential source, the imperfectly priced deposits. As a result, any policy that leaves deposits unchanged relative to assets – as is true in Case I, since only the composition of the non-deposit claims changes – has no effect on equityholders' decisions about asset risk, because it does not change the marginal value of that risk.

With the unfavorable leverage effect on the probability of failure, and no potentially offsetting benefits for L or the marginal value of asset risk, this variant of a subordinated-debt policy almost certainly is undesirable.

Case II: Capital Supplement

In this second case, increases in B are matched dollar-for-dollar by reductions in D, as subordinated debt is substituted for deposits; this is captured in the first two cells of the second line in Table 2. Total debt (and therefore equity) is unchanged. The reduction in deposits works to reduce the deposit guaranty liability (the ΔL column), while the

[12] One reviewer suggested that holders of subordinated debt might be punitive, making an increase in asset risk a *negative* net present value proposition for the bank. This seems implausible if capital markets are competitive. Absent some sort of monopsonistic behavior by debt purchasers, there should always be investors willing to purchase the bank's debt at a price (or rate) that fairly compensates for the risks borne. The bank would always choose to place the debt with those investors, rather than any group that was trying to require punitive, above-market terms.

partial effect on the probability of failure (the ΔP column) is nil since the default point – total debt – is unaffected.

The asset-risk, or volatility, effect also is favorable. Since for given asset size the marginal value of risk depends positively on deposits, and deposits are lower, equity holders would perceive less benefit from a mean-preserving spread in asset returns, and would be less likely to bear the regulatory or other costs of attempting to increase s at the expense of the deposit guarantor. Thus, with the leverage effect reducing the exposure of the deposit guarantor, a neutral impact on failure probabilities, and the reduced value of marginal changes in asset volatility, a subordinated-debt requirement of this type would have desirable effects.

In Case II, the size of the subordinated-debt tranche matters for two reasons. Deposits receive more protection against loss due to the addition of a larger subordinated-debt tranche. In addition, the subordinated-debt piece substitutes an instrument from which equity cannot extract value for a portion of the mispriced deposit funding, reducing the moral-hazard related incentives facing equity.

Case III: Equity Capital Increase

This case considers the impact of increasing equity rather than subordinated debt. The policy-related benefits of the preceding case, Case II, arose because the increase in subordinated debt reduced the strike price of the option the guarantor has implicitly written. Moving the strike of that option reduced deposit exposure, and at the same time reduced the marginal gain to shareholders from increasing asset risk.

However, the strike price of the deposit guaranty option can be shifted by exactly the same amount if additional equity is issued instead of subordinated debt; the key aspect of either policy is that deposits contribute a smaller share of funding for the bank's assets, with junior instruments providing the rest. In the last row of Table 2, the reduction in deposits is the same as in Case II, but the offsetting funds come from equity rather than subordinated debt. Reducing deposits using equity has exactly the same leverage-related impact on L (the ΔL column) as the reduction in Case II. Moreover, the moral-hazard related effects, as reflected in the decline in the marginal value of asset risk, also are exactly the same. These points have been made in the past by Furlong and Keeley, who note that "a bank would not be expected to react differently regarding its asset risk when forced to raise debt capital compared to equity, everything else equal…[R]equiring a bank to increase its regulatory capital by issuing more debt would reduce the exposure of the deposit insurance system… However raising equity capital has the same effect" (Furlong and Keeley, 1987)).

But if bank failures are costly, the results are even stronger. Because of the reduction in total debt, an increase in equity capital lowers the probability of bank failure (the ΔP column), yielding additional policy benefits. As a result, equity capital provides more "bang for the buck"; if a dollar of non-deposit funding is to be added, the benefits of equity capital likely outweigh those of subordinated debt, even taking into account the moral hazard associated with equity and the market discipline provided by the debt.

An additional implication is that regulators may be able to achieve a given net policy benefit with a somewhat smaller mandated issuance of equity than subordinated debt. Because of the favorable impact of an equity increase on the probability of bank failure, regulators might be able to accept somewhat smaller leverage-related reductions in the deposit guaranty liability and the marginal value of asset risk and still achieve the same net benefit.[13] Of course, this result is speculative in the absence of fully specified regulatory preferences.

Subordinated Debt and Regulatory Forbearance

The discussion of the three cases above takes as axiomatic that a higher probability of bank failure – defined as a state in which bank assets are insufficient to pay all debt claims – is undesirable. However, in some proposals for regulatory use of subordinated debt, this effect is actually viewed favorably. In this strand of thought, regulatory forbearance of problem institutions is a significant issue.[14]

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[13] Some subordinated debt proposals point out that interest payments on subordinated debt are likely to generate tax benefits that are not available from equity. Such tax benefits would tend to reduce the cost of subordinated debt as capital, all else equal. Leaving aside the questionable social welfare effects of this reduction in taxes, it is unlikely that there would be a *net* benefit to the bank from the tax shield, since a value-maximizing bank would have taken taxes into account (along with regulatory requirements and other financial distress-related costs) in designing its capital structure in the first place.

[14] Regulatory forbearance arises if regulators have incentives that make them reluctant to close institutions that should be closed.

With a tranche of subordinated debt inserted between deposits and equity capital, subordinated debtholders take action to force resolution in states of the world where assets are insufficient to pay all claims but are still in excess of deposits.[15] These are cases in which subordinated debt becomes the residual claimant, corresponding to $D_T<A_T$£B_T+D_T in the notation used above. Resolution without losses to depositors or their guarantor would be assured in these cases, which might be desirable if regulators are prone to forbear. The introduction of subordinated debtholders places a constraint on the actions of regulators; in effect, it is market discipline *on regulators* that is the key contribution of subordinated debt in this view.[16]

However, these cases in which bank failure is forced by subordinated debtholders would be avoided entirely if equity capital were used instead of subordinated debt in the same amount. For a simple example, suppose assets of 100 are financed by 92 of deposits, 4 subordinated debt, and 4 equity. If assets fall to 95 (or anywhere between 92 and 96), the subordinated debtholders declare equityholders in default and seize the bank. But if instead the assets had been financed with 8 equity and *no* subordinated debt (and 92 deposits), the bank would still be solvent in the same state of the world, and no closure would occur.

Whether this removal of regulatory discretion is desirable from a public policy perspective depends on how significant a problem one believes forbearance to be,

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[15] These actions might be direct through the courts or indirect through pressure exerted on regulators, depending on details of the legal regime surrounding bankruptcy of banks.
[16] The joint Fed-Treasury (2000) study explicitly identifies this as one of five potential benefits of mandatory subordinated debt issuance by banks.

whether one believes supervisory discretion has benefits of its own, and how large the costs of bank closure are. There is some direct empirical evidence on failure-related costs, but assessment of the other two factors – the value of discretion versus the cost of forbearance – is largely a matter of belief and anecdote. If it is valuable to tie the hands of regulators dealing with problem institutions, then policies that encourage subordinated-debt capital may indeed be beneficial.

5. Information Content of Subordinated Debt

One of the potential benefits of any marketable instrument issued by a bank is that its price conveys something about the condition of the issuer, possibly revealing new information. If subordinated debt reveals new information about banks that is either unavailable or available only at higher cost from other sources, then prices (or yields) of subordinated debt may be useful to bank supervisors:

> An additional benefit of having subordinated debt traded on the open market is that price movements would provide a clear signal of the market's evaluation of the bank's financial condition that, even if it were not used to help price deposit insurance, could serve as an early warning aid to supervisors. (Meyer, 1998)

Alternatively, subordinated-debt prices may serve as a signal to other at-risk bank claimants, providing “indirect” market discipline:

> “Indirect” market discipline is exerted through risk-sensitive debt and equity instruments when private parties … monitor secondary market prices… then take a variety of actions that increase bank operating costs. … The anticipation of these actions, which are essentially various types of penalties, provides banking organizations with incentives to refrain from excessive risk-taking. (Meyer, 1999)

These “indirect” effects could complement any direct market discipline.

In the context of the model in this paper, what information about the bank could subordinated debt reveal? The two variables that are difficult to observe directly but that are crucial to assessing either the condition of the bank or the size of the safety-net liability are the market value of assets A and the asset volatility s. These could be inferred by observing the price (or equivalently the yield) of the subordinated debt S in conjunction with its volatility. Fairly well developed tools in finance (see for example Merton (1977)) can be modified to take a contingent-claim model of subordinated debt as above, construct a second equation based on Ito’s Lemma, and then solve the non-linear equations simultaneously for the two variables of interest. Bank supervisors could use that information to assess the risk a bank poses to the safety net and to evaluate remedial actions.

However, exactly the same information can be obtained using the same techniques from any claim with a non-linear payoff. Assets are the source of risk in the model, and the cash flows on all non-linear claims are contingent on the value of the same assets with the same risk characteristics. Thus, in principle no additional information is available from subordinated debt that is not also available from, for example, equity prices. Since market prices for equity are available for a much larger number of banking organizations than are subordinated-debt prices, and since equity markets generally are much deeper, they would appear to be a preferable source of information for the kind of monitoring that underlies indirect market discipline, all else equal.

Interpreting Credit Spreads on Subordinated Debt

Part of the attraction of subordinated debt is that the credit spread (the difference between the debt yield and a comparable risk-free benchmark) is easily computable and appears to be directly relevant to evaluating the riskiness of the bank. However, the contingent-claim model of subordinated debt emphasizes that information from credit spreads on junior debt must be interpreted carefully. Market-determined spreads on subordinated debt should be expected to respond to changes in risk; however, subordinated debt is a composite of two options, one of which actually *gains* value if bank management increases asset risk. This is similar to the Gorton and Santomero (1990) conclusion about the relationship between subordinated debt spreads and volatility.

As a result, in comparing two banks, the bank with the larger credit spread between the risk-free rate and the yield on its subordinated debt might actually have a *lower* probability of failure, or impose a smaller deposit guaranty liability, than the bank with the smaller spread. This can easily occur if the capital structures of the two firms differ – even if both are well capitalized. To illustrate, Table 3 provides calculations from the contingent claim model for hypothetical banks with an array of capital structures and asset volatilities; each example assumes assets of 100. The credit spread on subordinated debt is computed as $\ln(B_T/S)$, with S evaluated using the contingent-claim framework above and T=1 assumed for scaling. The probability of failure and the deposit guaranty liability are computed using the equations for L and P developed above.[17]

Comparing Bank A to Bank C, or Bank B to Bank D, it is evident that two banks with the same spreads can have probabilities of failure and deposit guaranty values that differ by multiples. Another interesting comparison is Bank A versus Bank E: despite E's substantially narrower credit spread (and lower asset volatility), the probability of default is more than double that of Bank A. Similarly, although Bank D has a much narrower credit spread on subordinated debt than Bank C, it imposes a much greater liability on the deposit guarantor.[18]

Table 3: Relationship between Credit Spreads and Policy Variables
(assuming assets A=100)

Bank	Deposits (D)	Sub Debt (B)	Asset Volatility (σ)	**Credit Spread on Sub Debt**	**Default Probability (P)**	**Guaranty Liability (L)***
A	90	1	.044	**1.25%**	**1.7%**	**0.1142**
B	90	3	.030	**0.25%**	**0.8%**	**0.0017**
C	90	5	.031	**1.25%**	**5.1%**	**0.0026**
D	60	1	.174	**0.25%**	**0.3%**	**0.0624**
E	90	5	.029	**0.85%**	**3.9%**	**0.0009**

* Multiplied by 1000

[17] One caveat to the results in Table 3 is that, as noted earlier, P is the risk-neutral, rather than the true, probability of failure. In these examples, if one assumes a positive relationship between risk and return in asset markets, banks with higher σ would also have higher expected asset returns, which would tend to reduce the true default probability relative to the values calculated here. To fully develop this nuance would require a model of asset pricing; that would affect the specific numbers and lead to more qualifications of the central results, but the intuition would remain the same.

[18] These results also hold if the impact is evaluated in terms of the liability per dollar of deposits, L/D.

It seems to be taken for granted that regulators should prefer banks with narrower debt spreads. But the intuition that debt spreads and any relevant measure of risk (such as P or L) are always positively related is accurate only for senior debt, or for a particular subordinate issue provided the issuer is sufficiently solvent. It is *not* correct for junior debt if the composition of funding – the relative sizes of the various classes of debt – is not held constant.[19]

Note that all of the banks in these examples are solvent, and indeed are fairly well capitalized; none is in the convex region of the payoff function that creates the features noted by Gorton and Santomero.[20] Simply observing that banks in practice do not operate in that region is not sufficient to void either the Gorton-Santomero results or the current results. It is not necessary for banks to actually be *in* that region to make interpreting spreads difficult; the existence of that portion of the payoff function, and the positive probability of reaching it in some states of the world, is sufficient to complicate the use of observed credit spreads.[21]

As the examples in Table 3 illustrate, yields or spreads on subordinated debt can only be interpreted within a framework that accounts for the contingent aspects of the contract. A straight comparison of credit spreads can be misleading absent appropriate adjustments for the structure of claims on bank assets. To make those adjustments, an

[19] Bliss (2000) makes similar points, within a somewhat different theoretical framework.
[20] Thus, none of these cases illustrate the possibility that the credit spread might also be inversely related to asset volatility σ, which is the Gorton-Santomero result.
[21] The complex relationship between spreads and bank condition may be part of the explanation for the consistent empirical findings of at best weak relationships between debt spreads and other measures of risk; for a recent example, see Evanoff and Wall (2001).

option-type model can be used. Since the requisite models are fundamentally the same as those that are applied to equity prices to extract information about bank risk, the apparent simplicity of using debt spreads to monitor banking risk is deceptive.

The examples also suggest a special case in which differences in credit spreads *are* related to differences in bank risk: if the structure of claims is identical. This is unlikely to be true in cross-sectional comparisons between multiple banks, but may be nearly true in time-series comparisons for a single bank, since capital structure tends to change slowly. However, even this fact may be of limited value for bank supervision. A change in the credit spread for a single bank, with capital structure held roughly constant, indicates the direction of change in risk. But the challenge bank supervisors generally face is that they must allocate scarce supervisory resources across banks. Changes in credit spreads for individual banks reveal the *direction* of changes in risk, but the *size* of the changes cannot be compared meaningfully across banks to identify the firms in greatest need of supervisory attention. Using subordinated debt spreads, supervisors could identify all banks for which risk increased during a period[22], but would be unable to draw further distinctions within that large group except between banks with identically structured claims.

[22] A group that would be expected to include half of the banks on average.

Other Possible Uses of Subordinated Debt as a Source of Information

If subordinated debt prices depend on the same underlying factors as other claims and therefore contain the same implicit information, is subordinated debt without information value? Market prices of subordinated debt might supply valuable information for other, more subtle reasons. First, the asset values and asset volatilities that can be computed from either equity or debt are likely to be subject to error, due to noise in observed prices in each market. If the noise in subordinated-debt pricing is not perfectly correlated with the noise in equity pricing, the use of the two together should lead to better estimates.

Second, solving for unobservable quantities in the two-equation contingent-claim approach described above typically involves making ad hoc assumptions about some of the other parameters (such as default point, franchise value if any, and the nature of the asset return distribution). Additional contingent claims on the same underlying assets – which subordinated debt in effect is – possibly could be used to specify additional equations to solve for one or more other unobservable parameters, eliminating some of the reliance on ad hoc assumptions.[23] Both of these avenues should be explored further.

[23] Schellhorn and Spellman (1991) make a similar suggestion in a similar context.

6. Summary and Policy Implications

Subordinated debt issued by a bank should be viewed as a contingent claim, with payoff dependent on the value of the bank's assets at the future payment date. Modeling it as such highlights the effects of moral hazard and the mitigating role of market discipline. It also permits investigation of the impact of subordinated debt market pricing and associated market discipline on likely regulatory concerns such as the deposit guaranty liability and the probability of bank failure.

The model in this paper shows how an extreme version of subordinated debt (structured to provide continuous, perfect market discipline) transforms the risk-taking incentives facing bank shareholders. With this foundation, the impact of subordinated debt on the safety-net liability and on failure probabilities is examined. Subordinated debt produces policy benefits if the debt is issued as an *addition* to existing equity capital; however, new equity in the same amount is better. Subordinated debt that *replaces* part of equity in the bank's capital structure almost certainly is harmful, increasing the probability of bank failure. However, this higher probability of failure may alternatively be viewed as the imposition of a market-enforced "early closure" threshold; if regulatory forbearance is viewed as a significant problem, then subordinated debt as bank capital could be a desirable policy. With regard to indirect market discipline, subordinated-debt prices or yields should contain useful information, although the model implies that the same basic information is available from stock prices.

For policy makers, this paper makes two main points. First, the belief that subordinated debt is preferable to equity as a type of bank capital because it is has limited upside potential is wrong. Dollar for dollar, equity and junior debt have the same "cushioning" effect against losses, and (more remarkably) the same effect on the bank's incentives to take risk. However, equity helps reduce the probability of bank failure, while debt does not. If it is desirable for banks to reduce their leverage to protect the deposit guarantor or to reduce the incidence of costly failures, then equity capital is better than debt – including subordinated debt – even taking into account the moral hazard associated with equity and the effects of debt-market discipline.

Second, the belief that yield spreads on subordinated debt can be used as a simple tool to monitor changes in bank condition is wrong. The theoretical relationship between subordinated debt spreads and the variables of likely interest to bank regulators is complex; higher spreads may be associated with either higher or lower default probabilities and safety-net liabilities, and comparisons of spreads (or changes in spreads) across firms cannot be used to evaluate differences in condition. If appropriate tools are not applied to interpret the subordinated-debt prices – for example, if credit spreads or changes in spreads are simply tracked or compared – the results can give misleading signals about banks. As a source of meaningful information about bank risk, equity is probably preferable; in theory, stock prices and subordinated debt prices (or yields) are virtually identical in their potential information content and in the complexity of the tools required to extract that information, but in practice equity markets are much more liquid than debt markets for most banking firms.

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Figure 1

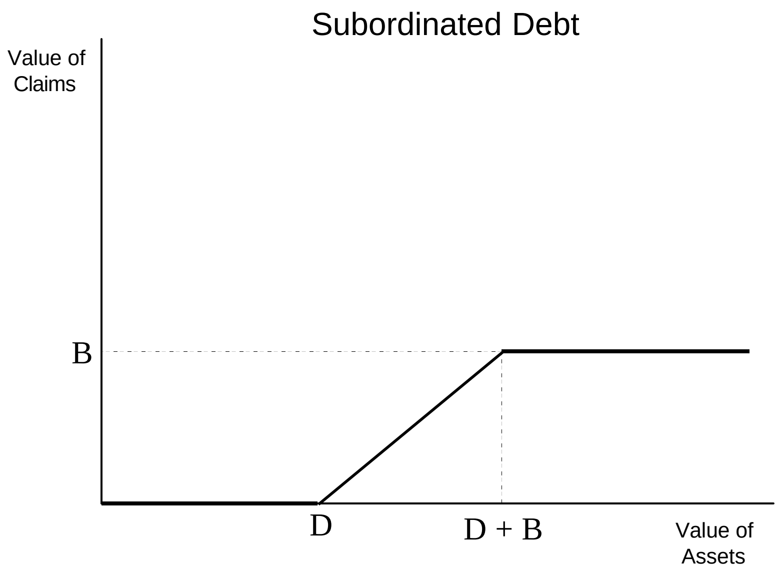

Figure 2